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ABSTRACT

Across cities, estimates of local land rents and firm productivity are inferable from wage and housing-cost data using knowledge of the housing cost function. Differences in amenity values are capitalized into the sum of local land values and federal-tax payments. A calibrated model is used to predict how amenities are capitalized into land rents, wages, and housing costs, and with U.S. data, to estimate land-rent, firm-productivity, and total amenity-value differences of cities. Private land values vary mainly from consumption amenities, while social land values, from productive ones. The most productive and valuable cities are coastal, sunny, mild, educated, and large.

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1 Introduction

Standard economic theory predicts that the value of land will completely reflect differences in the economic value of local amenities – such as clean air or public infrastructure – when all other factors of production are fully mobile (see, e.g., Ricardo 1817, George 1879, Tiebout 1956, Arnott and Stiglitz 1979). This kind of equilibrium environment forms the basis of hedonic methods used to value individual amenities (see, e.g., Oates 1969). Furthermore, across cities with distinct labor markets, local wage levels indicate the degree to which amenities directly benefit firms, by raising their productivity, or directly benefit households, by improving their quality of life (Rosen 1979, Roback 1982). In this type of long-run environment, this paper examines how different amenities, particularly those for firms, are reflected in local prices, especially for land. It also estimates differences in the total value, or "worth," of amenities across U.S. cities, and investigates how these differences may be influenced by certain observable amenity measures.

Unfortunately, comparable data on land values are exceedingly rare, which makes determining amenity values much more complicated.[1] Without land values, researchers have typically turned to readily available data on local housing values, often assuming that a percentage difference in housing values, say of 10 percent, reflects a similar percentage difference in land values (Beeson and Eberts 1989, Rauch 1993, Dekle and Eaton 1999, Haughwout 2002, Gabriel and Rosenthal 2004, Glaeser and Saiz 2004, Shapiro 2006, Chen and Rosenthal 2008). This assumption may lead to underestimated land-value differences, since land accounts for only a fraction of housing costs, and other costs due to capital and labor differ far less across cities. Furthermore, cost differences arising from local wage levels are observable and can be accounted for to isolate costs due to land. Other housing-cost determinants may be unobservable, most importantly productivity differences in the local housing sector, possibly from geography or regulations. These make it more difficult to infer land and amenity values.[2]

[1]This paper does not address temporal issues that would make land rents deviate from land values by more than an interest rate, and so the terms "rents" and "values" are used interchangeably. As land is combined here in a model with labor and housing services, it is more appropriate to think of the prices here as referring to flow values rather than asset values.

[2]Davis and Polumbo (2007) infer the costs of land rents across metropolitan areas by subtracting construction

The difficulties associated with missing land-value data are concentrated in determining the value of amenities for firms, which the same literature (i.e., the list in the preceding paragraph) attempts to do. As shown below, amenities that raise the productivity of firms producing tradable goods (across cities) raise wages and housing values together, while amenities that raise the productivity of firms that produce local goods (not tradable across cities) instead, lower wages and housing values in the same proportion. Without data on land values, which reflect both types of amenities positively, we may confuse low productivity in local goods for high productivity in tradable goods. Even if amenities for non-tradable production are absent, estimates of productivity in tradables will be biased, under-weighing housing-cost differences and over-weighing wage differences, if they do not incorporate the cost structure of housing.

Furthermore, only by accounting for the cost-structure of housing and other non-tradables can we realistically calibrate this kind of model to the national economy and use it to predict how amenities to households and firms affect the local prices of land, labor, and housing. As demonstrated in Albouy (2009), a realistic calibration takes into account federal taxes, which distort the relationship between the values of amenities and the value of land. In short, by indirectly taxing amenities that raise wages, and subsidizing those that lower them, taxes cause amenities for tradable production to be under-capitalized in land values, while causing amenities for households or non-tradable production to be over-capitalized. Numerically, these effects are quantitatively important, especially for productive amenities in tradables, which have 37 percent of their value appropriated by federal and state governments, rather than local land. It also appears that quality-of-life amenities have their value reflected much more in higher local prices than in lower wages. Local wage levels do reflect over 100 percent of the value of trade-productive amenities. Productive amenities in non-tradables raise land values by more than their value, but only weakly lower local prices and wages.

costs, obtained from R.S. Means, from observed housing data. While insightful, this methodology implicitly assumes that the suburban sample of houses is representative, that housing productivity does not vary across metropolitan areas, and that there are no other costs, such as expenditures to overcome regulatory burdens, to producing housing other than construction and land costs. As mentioned below, Rappaport (2008a, 2008b), uses a model similar to the one here, but for different applications.

Using readily available data on wages and housing costs from the 2000 U.S. Census, I provide new estimates of inter-metropolitan differences in local-firm productivity, land values, and total amenity values, combining them with quality-of-life and federal-tax differential estimates from Albouy (2008, 2009). These are based on the assumption, implicit in the previous literature, that cities do not vary in the productivity of their housing and local-goods sectors. This leaves out their influence on local land values, but has little impact on estimates of productivity in tradables. According to these data, the three most productive metropolitan areas are San Francisco, New York, and Los Angeles. The least productive cities are generally small and isolated.

San Francisco also claims prize being the most valuable city in the United States, as it has the most valuable combination of amenities in consumption and production. The remaining top 15 includes a number of large, productive, cities – Honolulu, San Diego, Los Angeles, New York, Seattle, Boston, Denver, and Chicago – as well as small, pleasant ones – Santa Barbara, Monterey, San Luis Obispo, Cape Cod, Santa Fe, and Naples. Across cities, production amenities account for a larger proportion of value differences than quality-of-life amenities. Yet, because federal taxes tax the former and subsidize the latter, consumption amenities have a greater impact on the value of land. Nevertheless, production amenities appear to account for the lion share of wage and housing-cost differences across the United States, contrary to claims made by Roback (1982).[3]

Lastly, I examine the value of individual amenities using hedonic methods based on cross-sectional correlations. This resembles analyses seen in the previous literature for quality-of-life amenities, but goes further by including productive amenities. Interestingly, tradable productivity is associated with larger city sizes and higher education levels, in line with estimates in the literature that use a simpler measure of productivity. Sunniness, coastal proximity, and mild seasons appear to be amenities for both firms and households, while hilly terrain is a disamenity for firms. Accounting for fiscal externalities from taxation, the most valuable cities in the United States may be summed up as being typically large, mild, sunny, coastal, and well-educated.

[3] Roback (1982) states that ”the combined evidence seems persuasive that the regional differences in earnings can be largely accounted for by regional differences in local amenities,” where by ”local amenities,” she appears to be referring to quality-of-life amenities only.

2 Prices and Amenities in Equilibrium

2.1 Model Set-up and Basic Notation

To explain how prices vary with amenity levels across cities, I use the general equilibrium model of Albouy (2009), which adds federal taxes to the Rosen (1979) and Roback (1980, 1982) model. The national economy contains many cities, each small relative to the national economy, and indexed by j. These cities trade with each other and share a homogenous population of mobile households. Households consume a numeraire traded good, x, and a non-traded "home" good, y, with local price, p^j. In application, the price of home goods is measured by the flow cost of housing services, although theoretically they should also proxy for cost-differences in all locally-provided goods.[4]

Firms produce traded and home goods out of land, capital, and labor. Within a city, factors receive the same payment in either sector. Land, L, within each city is homogenous and immobile, and is paid a city-specific price r^j; each city's land supply, $L^j(r)$, may depend positively on r^j, with a finite elasticity $\varepsilon^j_{L,r} \in [0.\infty)$. Capital, K, is fully mobile across cities and is paid the price $\bar{\imath}$ everywhere. The supply of capital in each city, K^j, is perfectly elastic at this price, while the national level of capital may be fixed or depend on $\bar{\imath}$. Households, N, are fully mobile, have identical tastes and endowments, and each supplies a single unit of labor. Because households care about local prices and quality of life, wages, w^j, may vary across cities. Nationally, the total number of worker-households is fixed at $N^{TOT} = \sum_j N^j$.

Households own identical diversified portfolios of land and capital, and payments to these factors are rebated lump sum, with payments $R = \frac{1}{N_{TOT}} \sum_j r^j L^j$ from land and $I = \frac{1}{N_{TOT}} \sum_j \bar{\imath} K^j$ from capital. Total income, $m^j \equiv R + I + w^j$, varies across cities only as wages vary. Out of this income, households pay a federal income tax of $\tau(m)$, which the federal government redistributes back in uniform lump-sum payments. Deductions and state taxes have only a minor impact on the estimates, and so I discuss them in Appendix B.[5]

[4]Non-housing goods, such as haircuts and restaurant meals, are considered to be a composite commodity of traded goods and non-housing home goods. I discuss multiple types of home goods in Appendix D.4, which shows that if housing is more land-intensive than non-housing home goods, then housing will more strongly reflect amenity values.

[5]Results are robust to elastic labor and land supply, so long as the new units supplied are equivalent to existing

Cities differ in three general attributes: (i) quality of life, Q^j, which raises household utility; (ii) the level of productivity in the traded-good sector, A_X^j, or "trade-productivity;" and (iii) the level of productivity in the home-good sector, A_Y^j, or "home-productivity." These attributes depend on a vector of city amenities, $\mathbf{Z}^j = (Z_1^j, ..., Z_K^j)$, through functions $Q^j = \widetilde{Q}(\mathbf{Z}^j)$, $A_X^j = \widetilde{A_X}(\mathbf{Z}^j)$, and $A_Y^j = \widetilde{A_Y}(\mathbf{Z}^j)$. For a consumption amenity, e.g., safety or clement weather, $\partial\widetilde{Q}/\partial Z_k > 0$; for a trade-production amenity, e.g., navigable water or agglomeration economies, $\partial\widetilde{A_X}/\partial Z_k > 0$; for a home-production amenity, e.g., flat geography or the absence of land-use restrictions, $\partial\widetilde{A_Y}/\partial Z_k > 0$. An amenity may affect more than one attribute, or affect an attribute negatively. To simplify, each city attribute is normalized to have an average value of one over cities.

2.2 Equilibrium Conditions

The utility function $U(x, y; Q^j)$ represents household preferences, and is quasi-concave over x and y, and increasing in quality of life, Q^j. The dual expenditure function for a household, $e(p^j, u; Q^j)$ measures the cost of consumption needed to attain utility u, and is increasing in p^j, and decreasing in Q^j. Since households are fully mobile, no city can offer a higher level of utility than another, and so all inhabited cities must offer the same utility, $\bar{u}$.[6] This means that firms in cities with higher prices or lower quality of life, compensate their workers with a greater after-tax income:

$$e(p^j, \bar{u}; Q^j) = m^j - \tau(m^j). \tag{1}$$

Operating under perfect competition, firms produce traded and home goods according to the functions $X = A_X^j F_X(L_X, N_X, K_X)$ and $Y = A_Y^j F_Y(L_Y, N_Y, K_Y)$, where F_X and F_Y are concave and exhibit constant returns to scale. All factors are fully employed and have the

units (Roback 1980) Also, results do not change if the government uses tax revenues to purchase tradable goods.

[6]Formally, $e(p^j, u; Q^j) \equiv \min_{x,y}\{x + p^j y : U(x, y; Q^j) \geq u\}$. The use of a single index Q^j assumes that amenities are weakly separable from consumption. The model generalizes to one with heterogenous workers that supply different fixed amounts of labor if these workers are perfect substitutes in production, have identical homothetic preferences, and earn equal shares of income from labor. Additonally, the mobility condition need not apply to all households, but only a sufficiently large subset of mobile marginal households (Gyourko and Tracy 1989). Appendix D.3 discusses the case with multiple household types that vary in preferences and skills.

same price in each sector The unit cost of producing a tradable good is $c_X(r^j, w^j, \bar{\imath}; A_X^j) = c_X(r^j, w^j, \bar{\imath})/A_X^j$ where $c(r, w, i) \equiv c(r, w, i; 1)$.[7] A symmetric definition holds for the unit cost of a home good, c_Y. As markets are competitive, firms make zero profits in equilibrium. Therefore, for given output prices, more productive cities must pay higher rents and wages to achieve zero profits. In equilibrium, the following zero-profit conditions hold in all producing cities

$$c_X(r^j, w^j, \bar{\imath})/A_X^j = 1 \tag{2}$$

$$c_Y(r^j, w^j, \bar{\imath})/A_Y^j = p^j. \tag{3}$$

Roback (1982) presents a similar three-equation model of this form, but never applies it. Instead she uses data on land values in a simplified two-equation model, which reduces the last equation to $r^j = p^j$. Such a model ignores the fact that the price of many local goods also depends on the price of local labor, as explained by Tolley (1974). Subsequent analyses have relied on this two-equation model using housing values instead of land values: this practice is better for modeling households, but worse for modeling firms.[8]

This model of spatial equilibrium expressed in equations (1), (2), and (3) provides a one-to-one mapping between the three prices (r^j, w^j, p^j) and the three attributes (Q^j, A_X^j, A_Y^j), meaning the latter are are exactly identified when all three prices are observed. These conditions hold even when the attributes are endogenous, and thus are well-suited for the purpose of measurement. They are less well-suited for comparative statics, as they do not capture potential feedback mechanisms, such as a dependence of A_X^j on population size, N^j, through agglomeration economies. [9]

[7] $c_X(r^j, w^j, \bar{\imath}; A_X^j) \equiv \min_{L,N,K}\{r^j L + w^j N + \bar{\imath} K : A_X^j F(L, N, K) = 1\}$.Appendix D.3 demonstrates that productivity differences that are not Hicks-neutral have similar impacts on relative prices across cities, but not on quantities.

[8] While Roback (1982) applies her two-equation model with actual land values, she also expresses strong doubts about the quality of her land value data and their ability to capture the value of productive amenities. Subsequent authors, including Blomquist et al. (1988), Beeson and Eberts (1989), and Gyourko and Tracy (1989, 1991) equate land with housing, which is not a problem when only the value of quality-of-life amenities is considered. An authoritative review of the amenity literature in Gyourko et al. (1999), uses the Rosen-Roback model extensively, but makes no mention of this third equation.

[9] To appreciate the potential complexity of comparative statics, say that a city's population, N^j, pollutes it, lowering Q^j. If a city receives a theme-park, improving Q^j, this will attract migrants, raising N^j and indirectly lowering Q^j through pollution, confounding the effect. Yet, it may be possible to measure the value of the theme-park if pollution

2.3 Expenditure and Cost-share Parameters

For households, denote the share of gross expenditures spent on traded goods and home goods as $s_x^j \equiv x^j/m^j$ and $s_y^j \equiv p^j y^j/m^j$; denote the shares of income received from land, labor, and capital income as $s_R^j \equiv R/m^j$, $s_w^j \equiv w^j/m^j$, and $s_I^j \equiv I/m^j$. For firms, denote the cost-shares of land, labor, and capital in the traded-good sector as $\theta_L^j \equiv r^j L_X^j/X^j$, $\theta_N^j \equiv w^j N_X^j/X^j$ and $\theta_K^j \equiv \bar{\imath} K_X^j/X^j$; denote equivalent cost-shares in the home-good sector as ϕ_L^j, ϕ_N^j, and ϕ_K^j. Finally, denote the shares of land, labor and, capital used to produce traded goods as $\lambda_L^j \equiv L_X^j/L^j$, $\lambda_N^j \equiv N_X^j/N^j$, and $\lambda_K^j \equiv K_X^j/K^j$. Assume home goods are more cost-intensive in land relative to labor than traded goods, both absolutely, $\phi_L^j \geq \theta_L^j$, and relatively, $\phi_L^j/\phi_N^j \geq \theta_L^j/\theta_N^j$, implying $\lambda_L^j \leq \lambda_N^j$. To help keep track of this notation, table 1 summarizes the main parameters, which without superscripts, refer to national averages. and shows their values calibrated in Section 3.1.[10]

TABLE 1: MODEL PARAMETERS

Parameter	Notation	Calibrated Value
Home-goods share	s_y	0.36
Income share to land	s_R	0.10
Income share to labor	s_w	0.75
Traded-good cost-share of land	θ_L	0.025
Traded-good cost-share of labor	θ_N	0.825
Home-good cost-share of land	ϕ_L	0.233
Home-good cost-share of labor	ϕ_N	0.617
Share of land used in traded good	λ_L	0.17
Share of labor used in traded good	λ_N	0.70
Average marginal tax rate	τ'	0.361
Average deduction level (see Appendix)	δ	0.291

or population levels are controlled for.

[10]These shares obey the identities $\lambda_L = s_x\theta_L/s_R$, $\lambda_N = s_x\theta_N/s_w$, and $\lambda_K = s_x\theta_K/s_I$.

2.4 Log-Linearization of the Equilibrium Conditions

To make them empirically transparent and allow for calibration, I log-linearize conditions (1), (2), and (3) to express each city $j's$ price differentials in terms of its attribute differentials, relative to the national average. These differentials are for logarithms so that, for any variable, z, $\hat{z}^j = d\ln z^j = dz^j/\bar{z} \cong (z^j - \bar{z})/\bar{z}$, approximates the percent difference in city j of z, relative to the geometric average $\bar{z}$, with $E[\hat{z}^j] = 0$. The one exception to this notation is $\hat{Q}^j \equiv -(\partial e/\partial Q)(1/\bar{m})dQ^j$, which represents the fraction of gross income a household is willing to pay to live in city j to enjoy its quality of life, relative to an average city.[11]

Log-linearized versions of (1), (2), and (3) describe how prices co-vary with city attributes.[12]

$$-s_w(1-\tau')\hat{w}^j + s_y\hat{p}^j = \hat{Q}^j \tag{4a}$$

$$\theta_L\hat{r}^j + \theta_N\hat{w}^j = \hat{A}_X^j \tag{4b}$$

$$\phi_L\hat{r}^j + \phi_N\hat{w}^j - \hat{p}^j = \hat{A}_Y^j \tag{4c}$$

These equations are first-order approximations of the equilibrium conditions around a nationally-representative city. These first-order expressions are useful analytically, and appear to be fairly accurate for the range of data considered in the United States. As discussed in Appendix A, second-order approximations of the equilibrium conditions, which account for endogenous shifts of the share values, do not produce appreciably different inferences under plausible parametrizations except at the very extremes of the data.

Equation (4a) measures local quality of life from how high the cost-of-living, $s_y\hat{p}^j$, is relative to

[11]This analysis does not take into account changes in the willingness-to-pay for amenities, and does not assign any particular unit to Q^j, so that $-(\partial e/\partial Q)\,dQ^j$, the monetarized willingness-to-pay to live in city j, cannot be meaningfully decomposed. Therefore, $\hat{Q}^j$ is better interpreted as a compensating differential, rather than a compensating variation – see Rappaport (2008b) for how these may differ.

[12]When simply linearized with Shephard's Lemma, the system of equations produces

$$\begin{aligned} -(\partial e/\partial Q)dQ^j &= \bar{y}\cdot dp^j - (1-\tau')\cdot dw^j \\ dA_X^j &= \overline{(L_X/X)}\cdot dr^j + \overline{(N_X/X)}\cdot dw^j \\ \bar{p}\cdot dA_Y^j &= \overline{(L_Y/Y)}\cdot dr^j + \overline{(N_Y/Y)}\cdot dw^j - dp^j \end{aligned}$$

The first equation is log-linearized by dividing through by $\bar{m}$, and the third, by dividing by $\bar{p}$.

after-tax nominal income, $s_w(1-\tau')\hat{w}^j$. Equation (4b) measures local trade-productivity, $\hat{A}_X^j$, from how high the labor costs, $\theta_N\hat{w}^j$, and land costs, $\theta_L\hat{r}^j$, are in traded-good production. Equation (4c), measures local home-productivity, $\hat{A}_Y^j$, from how high the labor costs, $\phi_N\hat{w}^j$, and land costs, $\phi_L\hat{r}^j$, are in home-good production relative to the home-good price, $\hat{p}^j$. Stated in reverse, cities are inferred to have low home-productivity if the price of home goods is high relative to the local input costs. Each equilibrium condition states that the relative value of a city's amenities to households or firms is measured implicitly by how much they will pay for them.

With data on wage, housing-cost, and land-rent differences across all cities, as well as knowledge of the average parameter values, equations (4a) to (4c) produce estimates of the attribute differentials $\hat{Q}^j$, $\hat{A}_X^j$, and $\hat{A}_Y^j$. Without data on land rents, $\hat{r}^j$, quality of life, $\hat{Q}^j$, is still identified; but trade-productivity, $\hat{A}_X^j$, and home-productivity, $\hat{A}_Y^j$, are under-identified without an additional restriction.

2.5 Inferring Land Rents and Productivity from Housing Costs and Wages

Land-rent differences may be inferred from wage and housing-cost differences by rearranging (4c):

$$\hat{r}^j = \frac{1}{\phi_L}\left(\hat{p}^j - \phi_N\hat{w}^j + \hat{A}_Y^j\right) \tag{5}$$

Thus, land-rent differentials differ from housing-cost differentials through three effects. First, *the land-share effect*, which implies the land-rent differential is $1/\phi_L > 1$ multiplied by the home-good price differential attributable to land. Second, *the labor-cost effect*, as the labor-cost component of the home-good price, $\phi_N\hat{w}^j$, is a confounding element: researchers must subtract this to isolate housing-value differences due to land costs. Third, *the home-productivity effect*, as a city with high home-productivity, has home-good prices that are low relative to the value of land, since it produces so efficiently. Holding wages and home-good prices constant, cities with greater home-productivity have higher land values.

With land-rent data, trade-productivity differences are measurable directly from (4b); without them, they are inferable from wage and home-good prices by substituting (5) into (4b):

$$\hat{A}_X^j = \frac{\theta_L}{\phi_L}\hat{p}^j + \left(\theta_N - \phi_N \frac{\theta_L}{\phi_L}\right)\hat{w}^j + \frac{\theta_L}{\phi_L}\hat{A}_Y^j. \tag{6}$$

This differs from the formula in previous studies, $\hat{A}_X^j = \theta_L \hat{p}^j + \theta_N \hat{w}^j$, through the same effects mentioned above. The land-share effect requires that home-good price differentials are weighted by $\theta_L/\phi_L > \theta_L$, as housing-cost differentials typically understate land-rent differentials. The labor-cost effect implies that wage differentials should be weighted by $\theta_N - \phi_N \theta_L/\phi_L < \theta_N$, as higher wages lead to higher housing costs: failing to make this adjustment double-counts the labor-costs included in $\hat{p}^j$. The home productivity effect implies that cities with high home-productivity have land values understated by home-good prices, meaning that trade-productivity estimates are also understated. The last effect implies that, when only wages and home-good prices are observed, low home-productivity may be mistaken for high trade-productivity, as both are positively associated with high wages and home-good prices. The magnitude of this mistake depends on the ratio θ_L/ϕ_L.[13]

2.6 The Capitalization of Amenity Values and their Total Value

Inverting the system of equations (4a) to (4c) reveals how quality of life, trade-productivity, and home-productivity determine local land rents, wages and home-good prices. To make it easier to compare equations, I multiply each differential by its share of income, so that each equation expresses the change in land, labor, and home-good values relative to average total local income. Thus, a one-percent increase in $s_R \hat{r}^j$ represents an increase in land values equal to one percent of

[13] To aid intuition, consider two extreme cases. In the first case, traded goods are made without land, i.e. $\theta_L = 0$, and so trade-productivity is given by the wage level alone, $\hat{A}_X^j = \theta_N \hat{w}^j$. This case, commonly assumed, appears to be reasonable as θ_L in modern production is small. But the variation in $\hat{p}^j$, and more fundamentally $\hat{r}^j$, may be large relative to the variation in $\hat{w}^j$, so that it provies substantial additional information about $\hat{A}_X^j$. Furthermore, with housing costs in equation (6), it is the ratio θ_L/ϕ_L that matters, and this ratio may be much larger than θ_L if ϕ_L is small. In the second case, the cost shares in both sectors are the same, i.e. $\theta_L = \phi_L$, and $\theta_N = \phi_N$, in which case trade-productivity is given by $\hat{A}_X^j = \hat{p}^j + \hat{A}_Y^j$. Holding home-productivity constant, trade-productivity is given by home-good prices since they reflect the input costs of traded-good firms exactly. But then, trade-productivity differences are perfectly confounded by home-productivity, which lowers home-good prices in the same proportion that trade-productivity raises them.

income. Each attribute is also multiplied by its weight in determining household welfare. Accordingly, a one percent increase in $s_x \hat{A}_x^j$ has a value equal to a one-percent increase in consumption.

With these normalizations, I express the inverted system below using only the fractions of land and labor in traded-good λ_L and λ_N, and the tax rate τ'.

$$s_w \hat{w}^j = \frac{w}{m} dw^j = \frac{1}{1 - \frac{\lambda_L}{\lambda_N}\tau'} \left(-\frac{\lambda_L}{\lambda_N}\hat{Q}^j + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X^j - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y^j \right) = \frac{1}{1 - \frac{\lambda_L}{\lambda_N}\tau'} s_w \hat{w}_0^j, \tag{7a}$$

$$s_R \hat{r}^j = \frac{l}{m} dr^j = \frac{1}{1 - \frac{\lambda_L}{\lambda_N}\tau'} \left[\hat{Q}^j + \left(1 - \frac{1}{\lambda_N}\tau'\right) s_x \hat{A}_X^j + s_y \hat{A}_Y^j \right] = s_R \hat{r}_0^j - \tau' s_w \hat{w}^j, \tag{7b}$$

$$s_y \hat{p}^j = \frac{y}{m} dp^j = \frac{1}{1 - \frac{\lambda_L}{\lambda_N}\tau'} \left[\frac{\lambda_N - \lambda_L}{\lambda_N}\hat{Q}^j + (1-\tau') \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X^j - (1-\tau') \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y^j \right], \tag{7c}$$

where the subscript "0" denotes price differentials without taxes, and $l^j = L^j/N^j$ is the land-to-labor ratio. Recall these expressions are log-linearizations around the national average.

The first expression (7a) demonstrates how wage levels increase with trade-productive amenities, but fall with quality-of-life and home-productive amenities. Taxes augment the capitalization of all amenity values by the factor $1/\left(1 - \tau'\lambda_L/\lambda_N\right) > 1$, as higher tax payments are compensated with higher wages, causing positive feedback effects.

When $\tau' = 0$, the second equation, (7b), expresses the canonical result that land values capture the total value of amenity differences, denoted

$$\hat{\Omega}^j \equiv \hat{Q}^j + s_x \hat{A}_X^j + s_y \hat{A}_Y^j = s_R \hat{r}_0^j. \tag{8}$$

Local land values will also capitalize the value of the local federal differential, given by

$$d\tau^j/m \equiv \tau' s_w \hat{w}^j, \tag{9}$$

which is normalized to express how much, more or less, households in a particular city pay in federal income taxes relative to their total income. Consequently, land values capitalize quality-of-life and home-production amenities by more than their value, as they lower wages and with them, federal taxes. Land values capitalize trade-production amenities by more than their value as they as they raise wages and tax burdens.[14] Ultimately, the full value of an amenity is reflected by its impact on federal tax revenues as well as land values, and researchers must account for both to determine their full value. When land-value data are missing, researchers may measure the total value of amenities using

$$\hat{\Omega}^j = s_R \hat{r}^j + \tau' s_w \hat{w}^j = \frac{1}{1-\lambda_L} \left\{ s_y(\hat{p}^j + \hat{A}_Y^j) + \left[\tau' \left(1-\lambda_L\right) - \left(1-\lambda_N\right) \right] s_w \hat{w}^j \right\}, \tag{10}$$

which comes from substituting (5) into (8). Here, it is unclear whether higher wage levels signal greater city value, as the positive federal-tax effect, $\tau' \left(1-\lambda_L\right)$, runs counter to the negative labor-cost effect, $-\left(1-\lambda_N\right)$, from using housing rather than land-value data.

Equation (7c) expresses how amenities are capitalized into local home-good values. Overall, home-good prices capitalize amenities very differently than land values, especially for home-production amenities, which lower home-good values and raise land values.[15] Federal taxes increase how much home goods capitalize quality-of-life amenities and decrease how much they capitalize production amenities of either kind.

While it is already evident from equation (6) that trade- and home-productivity are not separately identifiable from wage and housing-cost data, equations (7a) and (7c) make this intuition clearer. Trade-productive amenities for firms raise the wages of local workers, increasing the demand for local goods, raising their price so that their value rises in proportion to the after-tax wage bill. On the other hand, home-productive amenities lower the price of home goods through

[14] Wihout taxes, the linearized version of (7b) is $\overline{(L/N)}dr^j = -(\partial e/\partial Q)dQ^j + \overline{(X/N)}dA_X^j + \overline{(pY/N)}dA_Y^j = d\Omega^j$. Per capita, $\overline{(L/N)}dr^j$ is the change in land value, $-(\partial e/\partial Q)dQ^j$ is the improvement in quality-of-life across the resident population, $\overline{(X/N)}dA_X^j$ is the decrease in costs in local production of tradables, and $\overline{(pY/N)}dA_Y^j$ is the decrease in costs of the local production of non-tradables. These expressions differ from those in Albouy (2009) because the are expressed in terms of the differential value relative to all income, and use factor fractions, λ, rather than cost-shares.

[15] Roback (1982, p. 1265) reports a linear analogue to equation (7c) without taxes in her equation 9, expressed in derivatives of cost and indirect utility functions. Roback states that the effect of improvements in quality-of-life on non-traded prices is ambiguous, although this is not true if non-traded goods are relatively land intensive, an assumption which could be used to support Roback's assumption that the determinant in equation 9 (Δ^*) is greater than zero.

greater supply. These lower prices attract workers and allow firms to pay them less, so that the after-tax wage bill is lowered by the same amount.[16] Both types of amenities affect wages and housing-cost in the same proportion, albeit in different directions. Thus, it may be impossible to distinguish a city where both types of productivity are high, say Atlanta, from a city where both types of productivity are low, say Richmond. If we can observe land values, it is possible to distinguish them as land values should be higher in Atlanta than in Richmond, controlling for quality of life. As I show below, home-productivity is much harder to identify than trade-productivity, which can be estimated fairly accurately from (6) assuming $A_Y^j = 0$. This assumption poses more of a problem for estimating land values from (5) since these are heavily influenced by differences in home-productivity.

Lastly, as I explain in Appendix B, tax benefits for home-good consumption, such as mortgage-interest deductions for housing, increase the local value of amenities that lead to higher home-good costs, i.e., those that raise quality of life or trade-productivity or lower home-productivity.

2.7 Simple Hedonic Regressions using Amenity Measures

Using linear regression methods, it is standard practice to use the model above to determine the value of individual amenity measures $(Z_1^j, ...Z_K^j)$. The literature has focused on the value of amenities for households, rather than for firms, never treating the two together in a unified way, as I do here. This involves running seven, mutually-consistent regressions, assumed to be linear for simplicity, of the form

$$v^j = \sum_k Z_k^j \pi_{kv} + \varepsilon_v^j, \tag{11}$$

where $v \in \{\hat{w}, \hat{p}, \hat{Q}, \hat{A}_X, \hat{r}, d\tau/m, \hat{\Omega}\}$. As the system is linear, the amenity coefficients, π_k, express the effect of a one-unit increase in an amenity to the regressor. The amenity coefficients, π_{kv},

[16] This discussion igmores the important feedback effect of higher land rents on wages through the local labor market, similar to that described by Tolley (1974). The term $1/\lambda_N = 1/[1-(1-\lambda_N)] = \sum_k^\infty (1-\lambda_N)^k$, in (7) accounts for this multiplier effect: a rise in land-values by $\hat{r}^j$, directly raises home-good prices by $\phi_L \hat{r}^j$, raising overall cost-of-living by $s_y \phi_L \hat{r}^j$. To compensate households, firms raise wages by $1/s_w$ times this amount, $(s_y/s_w)\,\phi_L \hat{r}^j$, raising home-good prices indirectly by $\phi_N\,(s_y/s_w)\,\phi_L \hat{r}^j = (1-\lambda_N)\,\phi_L \hat{r}^j$, and leading to further feedback effects.

share the same interrelationships as their corresponding regressors, v, do, as expressed in (4), (9), (7), and (10). Together, these regressions estimate the full social value of each amenity through $\hat{\Omega}$, splitting it into values received by households and firms through $\hat{Q}$ and $\hat{A}_X$. The regressions also decompose the value of an amenity retained locally in land values through $\hat{r}$, and the value appropriated federally in tax revenues through $d\tau/m$.

Because home-productivity is unobserved, the estimates of r, A_X, and Ω are flawed, and therefore it is helpful to to control for observable factors which might influence home-productivity. In addition, these cross-sectional regressions have many well-known empirical caveats – including omitted variable bias, simultaneity, multi-collinearity, and small sample problems – and so we should not expect them to produce conclusive results. Nevertheless, the exercise in Section 4.5, below, is suggestive and illustrates how the estimates are interrelated, providing guidance and understanding for future research.

3 Calibration and Capitalization Predictions

3.1 Parameter Choices

As the log-linearized model is an approximation around the national average, I can calibrate it using national statistics. Because of accounting identities, only six parameters are free, but choosing these requires reconciling slightly conflicting sources.

Starting with income shares, Krueger (1999) makes the case that s_w is close to 75 percent. Poterba (1998) estimates that the share of income from corporate capital is 12 percent, and thus s_I should be higher, and is taken as 15 percent. This leaves 10 percent for s_R, which is roughly consistent with estimates in Keiper et al. (1961) and Case (2007).[17]

Turning to expenditure shares, Albouy (2008), Moretti (2008), and Shapiro (2006) find that housing costs can also be used to approximate non-housing cost differences across cities. The

[17] The values Keiper et al. (1961) reports were at a historical low: that total land value was found to be about 1.1 times GDP. A rate of return of 9 percent would justify using $s_R = 0.10$. Case (2007), ignoring agriculture, estimates the value of land to be \$5.6 trillion in 2000 when personal income was \$8.35 trillion, implying a smaller share.

cost-of-living differential is $s_y \hat{p}^j$, where $\hat{p}^j$ is equal to the housing-cost differential and s_y is the expenditure share on housing plus an additional term to capture how a one-percent increase in housing costs predicts a $b = 0.26$-percent increase in non-housing costs. In the Consumer Expenditure Survey (CEX), the share of income spent on shelter and utilities, s_{hous}, is 0.22, although the share of income spent on other goods, s_{oth}, is 0.56, with the remaining 0.22 spent on taxes or saved (Bureau of Labor Statistics 2002). Thus, the coefficient on housing costs is equal to $s_y = s_{hous} + s_{oth} b = 0.22 + 0.56 \times 0.26 = 36$ percent. This leaves s_x at 64 percent.[18]

I choose the cost-shares to be consistent with the expenditure and income shares above. θ_L appears small: Beeson and Eberts (1989) use a value of 0.027, while Rappaport (2008a, 2008b) uses a value of 0.016. Valentinyi and Herrendorff (2008) estimate the land share of tradables at 4 percent, but because their definition of tradables makes this an upper bound, I use a value of 2.5 percent for θ_L here.

Following Carliner (2003) and Case (2007), I use a cost-share of land in home-goods, taken as housing, ϕ_L, at 23.3 percent: this is slightly above values reported in McDonald (1981), Roback (1982), and Thorsnes (1997), in order to take into account for secular increase in land cost-shares over time, seen in Davis and Palumbo (2007). Together the cost and expenditure shares imply that s_R is 10 percent, consistent with other income shares, and that λ_L is 17 percent. This seems reasonable as the remaining 83 percent of land for home goods includes all residential land and considerable commercial land.[19]

The one remaining choice determines the cost-shares of labor and capital in both production sectors. As separate information on ϕ_K and θ_K is unavailable, I set both cost-shares of capital to

[18] Utility costs account for one fifth of s_{hous}, which means that without them this parameter would be roughly 0.18. As shown below, taking out utility costs would be largely offset by larger differentials in housing costs, $\hat{p}^j$.

[19] These proportions are roughly consistent with other studies. In the base calibration of the model, 51 percent of land is devoted to actual housing, 32 percent is for non-housing home goods, and 17 percent is for traded goods, including those purchased by the federal government. Keiper et al. (1961) find that about 52.5 of land value is in residential uses, a 22.9 percent in industry, 20.9 percent in agriculture. Case (2007), ignoring agriculture, finds that in 2000 residential real estate accounted for 76.6 percent of land value, while commercial real estate accounted for the remaining 23.4 percent. Appendix D.4, there may be advantages to modeling housing and non-housing home goods, separately, but there is little additional information on non-housing goods to calibrate this model better. My suspicion is that non-housing home goods are less land-intensive and more labor-intensive than housing goods. Accounting for this would likely lower the implied share of total income going to land.

be equal at 15 percent to be consistent with s_I. Accounting identities then determine that θ_N is 82.5 percent, ϕ_N is 62 percent, and λ_N is 70.4 percent.

The federal tax rate includes taxes on income and payroll, as well as relevant state taxes due to variation in wages within states. While the effective tax rate varies a little, it may be approximated with a marginal tax rate, τ', of 36.1 percent. Appendix B.3 contains details on these taxes, as well as tax benefits for housing.

3.2 Predicted Capitalization Effects

With the calibrated parameter values, the capitalization formulas in (7) predict exactly how amenity values are capitalized into local prices. Table 2 reports how a one-dollar increase in the local value of quality of life, trade-productivity, or home-productivity affects the value of local land rents, wages, housing costs, federal taxes or total amenities. The coefficients in panel A ignore federal taxes, providing a simpler counterfactual starting point to understand the capitalization process. The effects of federal taxes are shown in panel B, with minor adjustments for state taxes and the deductibility of housing expenditures. Panel C provides direct elasticities, which remove the income normalizations introduced in Section 2.6; it should be recalled that all of these results are only exact around the national average, and are only approximations elsewhere..

The first row of panel A demonstrates how in the absence in taxes, land values capitalize the value of local amenities one-for-one, regardless of their origin. A quality-of-life improvement worth one dollar is offset for households by a 77 cent increase in the cost of local goods and a 23 cent reduction in nominal income, so that real income falls by exactly one dollar. A dollar value of trade-productive amenities is reflected by a \$1.19 increase in wages, which are fully offset by higher local costs, as households are indifferent to this improvement. The coefficient is larger than one because

In panel B, we see that land rents capitalize only 63 percent of the value of trade-productive amenities, meaning 37 percent of their value is appropriated by federal taxes. Meanwhile, consumption amenities are effectively subsidized at a rate of 19 percent, and home-production amenities at a rate of 8 percent, boosting land values out of proportion with their true values.

Home-good prices capitalize 92 percent of the value of consumption amenities, which are only weakly reflected in lower local wages. This raises serious concerns for studies (e.g. Moore 1998) that measure the value of household amenities using only nominal wages. Home-good values capitalize 90 percent of the value of trade-productive amenities, while wages reflect 128 percent of their value. This means that wage-only measures of productivity, often seen in the agglomeration literature, may be overstated. Finally, home-productive amenities have a small negative effect on wages, and an even smaller effect on home-good prices. From panel B, we see that taxes have a fairly minor effect on how wages reflect amenities, and slightly larger effects on how home-good prices capitalize values, increasing the effect of household amenities and decreasing the effect of production amenities.[20] Overall, it appears that home-good prices are almost as good as land values in reflecting the value of quality-of-life and trade-productivity differences across cities, but fail in reflecting home-productivity differences.

4 Prices and the Value of Amenities across U.S. Cities

This application estimates wage and housing-cost differences across metropolitan areas, and uses them to measure the overall value of differences in amenities, separated into consumption and production. Hedonic regressions demonstrate that much of this variation may statistically explained by specific amenities.

4.1 Data and Wage and Housing-Cost Differentials

I estimate wage and housing-cost differentials with the 5-percent sample of Census data from the 2000 Integrated Public Use Microdata Series (IPUMS). I define cities at the Metropolitan Statistical Area (MSA) level using 1999 OMB definitions, and treated Consolidated MSAs as a single city

[20]Rappaport's (2008b) finds a capitalization effect of quality of life on wages similar to the one here without taxes, as his calibration implies similar values of λ_L and λ_N. Unlike the model here, his also directly accounts for non-linearities using constant-elasticity-of-substitution (CES) utility and production functions.

(e.g. San Francisco includes Oakland and San Jose), as well as all non-metropolitan areas within each state. This classification produces a total of 325 areas of which 276 are actual metropolitan areas and 49 are non-metropolitan areas. Appendix C provides more details. The large sample guarantees that the estimated differentials are precise.

To estimate inter-urban wage differentials, $\hat{w}^j$, I use the logarithm of hourly wages from full-time workers, ages 25 to 55. These differentials should control for skill differences across workers to provide an analogue to the representative worker in the model and isolate the effect of a city on a worker's wage. Thus, I regress log wages on city-indicators (μ_w^j) and on extensive controls (X_{wi}^j) — each fully interacted with gender — for education, experience, race, occupation, industry, and veteran, marital, and immigrant status, in the equation $\ln w_i^j = X_{wi}^j \beta_w + \mu_w^j + \varepsilon_{wi}^j$, and use the estimates of μ_w^j for the wage differentials. Identifying these differentials requires that workers do not sort across cities according to their unobserved skills. [21] An overstated wage differential for a city biases trade-productivity upwards and quality of life downwards.

To estimate housing-cost, $\hat{p}^j$, I use both housing values and gross rents, with utilities, to calculate a flow cost. Following previous studies, I calculate comparable imputed rents for owned units by multiplying reported housing values by a rate of 7.85 percent (Peiser and Smith 1985) and adding this to utility costs.[22] To avoid measurement error from imperfect recall or rent control, the sample includes only units that were acquired in the last ten years. I then regress housing costs on flexible controls (X_{pi}^j) – interacted with renter-status – for size, rooms, acreage, commercial use, kitchen and plumbing facilities, type and age of building, and the number of residents per room in the equation $\ln p_i^j = X_{pi}^j \beta_p + \mu_p^j + \varepsilon_{pi}^j$, and use the estimates of μ_p^j for the housing-cost differentials. Proper identification of housing-cost differences requires that average unobserved housing

[21] This assumption may not hold completely, but as argued in Albouy (2008), sorting may be less of an issue than commonly presumed for three major reasons. First, the variance in wages across metros in observable skills is relatively small. Second, different types of labor, according to education, are paid remarkably similar premia across cities. Third, dropping individuals that currently reside in a metropolitan area away from their state of birth changes the wage differentials by very little.

[22] Based on an analysis of owner-occupied units, it appears that housing-cost differentials would be, on average, 20 percent larger if utility costs are excluded. In the mobility condition, this would be largely offset by using a value of s_y to exclude utilities that would be 20 percent smaller. In the housing-cost equation, it would suggest that including utilities should require using a smaller value of ϕ_L since utilities are likely to be less land-intensive than housing. However, the value of ϕ_L already appears to be somewhat low relative to recent studies.

quality does not vary systematically across cities. An overstated housing-cost differential biases both trade-productivity and quality of life upwards.[23]

I divide amenities into two categories and collect their data from various sources. The first category involves natural site-specific characteristics such as climate and geography, which are not determined by a city's inhabitants. These include inches of precipitation, heating-degree days and cooling-degree days per year (*City and County Databook 2000*), sunshine out of the fraction possible (National Oceanic and Atmospheric Association 2008), and whether a metropolitan area is adjacent to a major coast (Atlantic, Pacific, Gulf or Great Lake). The second category involves amenities that depend on a city's inhabitants. I only include three types of artificial "amenities" here. The first two are metropolitan population and the share of the adult population with college degrees: these are not standard amenities, *per se*, but are likely determinants of amenities. The third, is the Wharton Residential Land-Use Regulatory Index, or WRLURI, provided by Gyourko et al. (2008), which is used to control for housing-productivity differences.

4.2 Land-Value, Trade-Productivity, and Total-Value Measures

Using the wage and housing-cost differentials from above, I infer land-rent, trade-productivity, and quality of life with equations (4a), (5), (6), (10), calibrated with the parameters from Section 3.1, and also adjusted for housing deductions and average state taxes. Because land-values are not separately observed, I must impose a restriction to identify productivity differences. Thus, I assume there are no home-productivity differences across cities, i.e., $\hat{A}_Y^j = 0$, for all j. This assumption is implicitly made by the previous literature which equates that housing is land, which also assumes $\phi_L = 1$ and $\phi_N = \phi_K = 0$.[24]

[23]This issue may not be grave as Malpezzi et al. (1998) determine that housing-cost indices derived from the Census in this way perform as well or better than most other indices.

[24]The actual formulas are more complex and differ slightly by state. The simplified formulas presented are close approximations based on regression estimates.

The calibrated equations yield the following relationships, which I call the "adjusted" model:

$$\hat{r}^j = 4.29\hat{p}^j - 2.75\hat{w}^j \ (+4.29\hat{A}_Y^j) \tag{5*}$$

$$\hat{Q}^j = 0.32\hat{p}^j - 0.49\hat{w}^j \tag{4a*}$$

$$\hat{A}_X^j = 0.11\hat{p}^j + 0.79\hat{w}^j \ (+0.11\hat{A}_Y^j) \tag{6*}$$

$$\hat{\Omega}^j = 0.39\hat{p}^j + 0.01\hat{w}^j \ (+0.39\hat{A}^j). \tag{8*}$$

The terms in parentheses give the bias that results from unobserved home-productivity differences: this appears to be large for land rents, minor for trade-productivity, and moderate for total value. Otherwise, the total value is surprisingly well approximated by housing costs, weighted by slightly more than the home-good expenditure share. This is by coincidence, as the labor-cost and federal-tax effects through wages in (10) are of opposite and almost equal size.

These relationships are modeled rather differently in the previous literature, which not only equates land and housing, but ignores federal taxes and, as discussed in Albouy (2008), typically ignores non-labor income sources and non-housing local costs, setting $s_w = 1$ and $s_y = 0.25$, leading to the formulae:

$$\hat{r}^j = \hat{p}^j \tag{5**}$$

$$\hat{Q}^j = 0.25\hat{p}^j - \hat{w}^j \tag{4a**}$$

$$\hat{A}_X^j = 0.025\hat{p}^j + 0.825\hat{w}^j \tag{6**}$$

This "unadjusted" model does not obey the standard income identities, as it assumes that land and capital income are paid to absentee owners. Thus, there is no clear analogue to $\hat{\Omega}^j$, although the value of amenities as a fraction of resident income is $0.27\hat{p}^j$.

Figures 1A and 1B illustrate the adjusted and unadjusted models in a coordinate system with wages and housing costs. Each figure draws an iso-rent curve for cities with average rent, i.e. $(\hat{w}^j, \hat{p}^j)$ points with $\hat{r}^j = 0$ in (5); a mobility condition for cities with average quality of life, with

$\hat{Q}^j = 0$ in (4a); and a zero-profit condition for cities with average productivity, with $\hat{A}_X^j = 0$ in (6). All of these curves intersect at zero, since cities with average wages and housing-costs are inferred to have average rents, quality of life, and productivity. In the adjusted model, the positive slope of the iso-rent curve illustrates the labor-cost effect, as higher wage levels increase the cost of housing at a rate ϕ_N. The second, thinner, iso-rent curve, corresponding to a rent-differential of 0.25, illustrates the land-share effect: the adjusted curve intercepts the housing-cost axis at 0.06 $\simeq$ 0.25/ϕ_L. The mobility condition slopes positively at the rate $(1 - \tau')s_w/s_y$, so that housing costs increase with wage levels to keep real consumption levels from rising. The flatter adjusted slope accounts for federal taxes, non-housing costs, and non-labor income. The slope of the zero-profit condition, $\phi_N - \phi_L\theta_N/\theta_L$, is determined by the rate at which housing costs, proxying for land costs, fall with local wage levels in order for firms to break even. The flatter adjusted slope accounts for the greater weight the land-share and labor-cost effects put on housing costs relative to labor costs. Iso-value curves, tracing out the points where cities have the same total amenity value, with $\hat{\Omega}^j = 0$ in (10), are not drawn: in both models the curves are very flat.

With the adjusted curves, figure 2 plots the estimated wage and housing cost differences across U.S. metropolitan areas. The vertical distance between a city's marker and the average iso-rent curves, measures the inferred land-rent differential. Figure 3 plots these differentials against housing costs, and draws a line for how inferred land rents depend on housing costs if wages are held constant at the national average. The vertical distance between a city's marker and this line measures the labor-cost effect, while the distance from the line to zero measures the land-share effect. The latter tends to be larger, and is negatively correlated with the labor-cost effect since wages and housing costs are positively correlated.

Figure 4 graphs the quality-of-life and trade-productivity estimates. A change in coordinate systems from figure 2 to figure 4 illustrates visually how these values are inferred. The average mobility condition in figure 2 provides the axis for trade-productivity in figure 4, while the average zero-profit condition does the same for quality of life. In both figures, cities with markers above the average mobility condition have greater quality of life, while those with markers to the right of the average zero-profit condition have greater trade-productivity. The average iso-rent and iso-value curves also pass through the coordinate change, with their downward slope illustrating how rents and values increase with both quality of life and trade-productivity. The iso-wage curve in figure 4 illustrates how wages capitalize productivity much more than quality of life, while the iso-housing-cost curve illustrates how housing capitalizes both almost equally.

4.3 The Most Productive and Valuable Cities

Table 3 lists the estimated wage, housing-cost, land-rent, quality-of-life, trade-productivity, federal-tax, and total-amenity-value differentials for a selected list of the largest and most valuable cities. The table also lists values by Census division, and metro areas classified according to population. Appendix table A1 presents a complete list of metro areas and non-metro areas by state; Appendix table A2 lists values by state. These number speak for themselves, but deserve some comment.

The most productive metro area is San Francisco, which includes the area near San Jose known as Silicon Valley. This is a little surprising, since productive agglomeration economies are thought to increase with population, and San Francisco is only the fifth largest metro area in the United States. Yet, the exceptional degree of knowledge spillovers and innovation in the area is well documented (Saxenian 1994, Florida 2008). The top ten most productive cities contains six other large metros – New York, Los Angeles, Chicago, Boston, Washington, and Detroit – but also three small metros – Monterrey (Salinas), Santa Barbara, and Hartford. The most plausible explanation for these small metros is that they are close to much larger, highly-productive metros. The relationship between population levels and productivity, seen in figure 5, is strongly evident, but contains many deviations worth investigating. The least productive metro area, Great Falls, MT, is quite remote, as are the two least productive states, South and North Dakota.

Figure 6 illustrates the impact of the model refinements on the trade-productivity estimates for a limited range of the data. The methodological refinement of putting more weight on housing costs is not enormous, but nonetheless changes the relative rankings of many cities, putting Los Angeles in front of Chicago, Boston in front of Detroit, Denver in front of Las Vegas, and Portland in front of Cincinnati.

Overall, the most valuable metropolis in the United States is also San Francisco: it not only has the highest productivity, but also the fourth highest quality of life. This is followed by six other Pacific cities – Santa Barbara, Honolulu, Monterrey, San Diego, Los Angeles, and San Luis Obispo – that offer both high quality of life and fairly high productivity. Next are a number of highly productive and somewhat amenable large metros – New York, Seattle, Boston, Denver, Portland, and Washington – as well as resort-like, yet economically vibrant, metros like Cape Cod, Santa Fe, Naples, Reno, and Fort Collins.

Further down the list are smaller cities in less crowded areas such as in Arkansas, Oklahoma, West Virginia, Mississippi, and the Dakotas. As seen in figure 7, the relationship between total value and city size is fairly strong, given the strong relationship between size and productivity, seen above, and the weak relationship between size and quality of life (Albouy 2008). The estimates suggest that an acre of land in San Francisco is about 100 times more valuable than an acre in McAllen, TX, which has the lowest land value, and that an urban acre in the most valuable state, Hawaii, is worth almost 50 times an urban acre in the least valuable state, North Dakota.[25]

4.4 Explaining the Variation of Prices across Cities

Ultimately, it is variation in underlying amenities that determine the variation in housing costs, wages, and land rents across cities. Using (8), a decomposition of the variance of total amenity value yields

$$var(\hat{\Omega}^j) = var(\hat{Q}^j) + s_x^2 var(\hat{A}_X^j) + 2s_x cov(\hat{Q}^j, \hat{A}_X^j). \tag{14}$$

One way to assess whether the variance in total amenity values is due primarily to quality-of-life or productivity differences, is to comparing the two variance terms, since if the variance of

[25]The results change only slightly if housing-cost measures based only on rental units are used. These measures better reflect the situation in central cities, where 45% of households are renters, rather than in suburbs, where only 27% are renters. Rent-only measures tend to be somewhat lower in places with lot of renters, like California, and in cities like Detroit, where the central city and the suburbs offer very different amenities. For the most part, using rents only will tend to lower quality-of-life, and to a lesser extent, trade-productivity estimates in cities where rents are comparably low.

either attribute is set to zero, the covariance term collapses to zero. Similar decompositions apply to wage, housing-cost, and land-value differences. As discussed in Section 2.2, since the model treats the attributes as fixed, this variance accounting is better for measuring proximate sources of price variation rather than determining their fundamental sources, which ideally would net out endogenous effects due to agglomeration and other processes.[26]

Results of the decomposition in table 4, Panel A, which accounts for federal taxes, reflect the situation in 2000. They reveal that quality of life accounts for a greater fraction of the variation in land values than does trade-productivity. On the other hand, trade-productivity variation is much more important in determining overall values. Figure 4 illustrates this, as its axes are scaled so that attribute differences of equal value are of equal distance: population-weighted, the spread of cities along the horizontal axis, measuring trade-productivity, is greater than along the vertical axis, measuring quality of life. The same is true of housing-cost differences, as they strongly reflect the attribute differences we can measure. Wage variation – and with it, variation in federal tax burdens – is driven almost entirely by trade-productivity.

Panel B presents a counter-factual distribution of rents, wages, and housing-costs with federal taxes removed, but with amenities distributed in the same manner. In this case, productivity differences would become even more important in determining land rents and housing costs.[27]

4.5 The Productive and Total Value of Individual Amenities

Based on the discussion in Section 2.7, table 5 displays the results of the seven regression equations of the form (11), which relate the measures presented above with the observable amenity measures described at the end of Section 4.1.

[26]This decomposition is different than the one in Beeson and Eberts (1989) and Deitz and Abel (2008), who decompose each differential into its productivity and quality-of-life component. Such a decomposition is hard to interpret since each component may have a different sign. For instance, San Francisco's wage differential of 0.26 is 119 percent "explained" by its higher productivity (which, alone, would make it 0.31) and -19 percent "explained" by its higher quality of life (which, alone, would make it -0.05).

[27]It is not clear from the analysis which type of amenity is more important in affecting household location choices. If quality of life is predominant, then typically "jobs follow people," while if productivity is predominant, then "people follow jobs." Analysis from Appendix D.2 suggests that household locations are most similar to land values, and thus, quality of life is predominant in the presence of federal taxes.

Controlling for other amenities, the elasticity of wages with respect to population is about 4 percent, consistent with estimates surveyed in Rosenthal and Strange (2004) and Melo et al. (2009). Because the elasticity of housing-cost is also large, at 6 percent, the trade-productivity elasticity is roughly 4 percent, allaying fears that wages may over-state the productivity effects of agglomeration across cities. As greater population size is not associated with lower quality of life, larger cities have greater total value in lieu of their higher productivity. In a similar vein, a ten-percent increase in the share of adults who finished four or more years of college (1.3 standard deviations), is associated with a 7-percent increase in wages and productivity, similar to the findings in Moretti (2004) based on more rigorous methods. The corresponding number for quality of life is 1.8 percent, meaning human-capital contributes to quality of life as well as local productivity, reinforcing findings in Shapiro (2006), based on instrumental-variable estimates, in a panel of cities.

The positive and significant coefficients on the regulatory land-use index (WRLURI) in the equations for trade-productivity, land rents, and total value are consistent with the predictions that regulations lower unmeasured home-productivity, driving up housing costs, and with them inferred land rents and trade-productivity. This variable is not significant in the quality-of-life equation, although regulations might be thought to improve the well-being of households.

The relationships between the natural amenities and productivity, never before estimated, reveal interesting patterns. Sunshine, coastal proximity, low levels of cold and low levels of heat appear to be amenities to firms as well as households. While the coefficient for coastal proximity may measure savings in transportation costs, the results for climate are more surprising, although they could have a psychological basis. For instance, Montesquieu (1748) hypothesized long ago that extreme temperatures inhibit the ability of humans to work. This is reinforced in engineering studies that both indoor and outdoor workers are less productive in warm temperatures (Engineering News Record, 2008). Although the estimates are robust to the latitude control, their magnitudes in the presence of modern indoor climate control raise questions about their validity. The regressions also suggest that hilly terrain, measured through average slope, is an amenity for households but a disamenity for firms, results that seem intuitive.

As seen through the R-squareds, the parsimonious set of amenities does a remarkably good job of explaining the observed variation, including 85 percent of trade-productivity, and 90 percent of land rents and total amenity value. It appears that population, education, sunshine, coastal proximity, average slope and mild temperatures all have strong associations with high economic values. Yet, the results also imply that the federal government effectively taxes households for living in areas that are large, flat, cool, and highly-educated.

5 Conclusion

This paper establishes that researchers are able to infer levels of local productivity in tradeables from wage and housing-cost data rather accurately if they take into account the cost structure of housing. Without better data, differences in productivity in non-tradeables are largely impossible to estimate, and these differences may be important when inferring land rents and the total value of amenities. The need to investigate home-productivity differences in further research is reinforced by the significance of land-use regulations in the hedonic regressions above.

The model outlined above, is also realistic enough to be sensibly calibrated to describe capitalization effects into various factor prices, so that researchers may more accurately measure the value of amenities, including social investments. The calibration suggests that housing absorbs about 90 percent of the value of amenities for households and firms producing tradeables. Wages reflect only a small fraction of quality-of-life differences, but more than 100 percent of trade-productivity differences. Statistically, variation in both types of amenities are explained rather well by overall population, education, and a small number of natural amenities. While variations in overall value across metro areas appear to be influenced more by productivity, land values appear to be influenced more by quality of life because of federal taxes. These taxes cause the price of land to under-value amenities in trade-productivity and over-value amenities in quality of life and home-productivity. This raises concerns that local incentives may lead to under-investments in amenities that improve local productivity, including those that lead to higher population levels and agglomeration economies in production.

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Appendix - Not for Publication

A Quadratic Land-Rent Estimates

The inferred land rent from equation (5) comes from a first-order approximation around the national average. This poses a problem if the cost-shares of land or labor vary substantially across cities due to variations in factor prices. I address this by taking a second-order approximation of equation (3) around the national average, and rearranging it to solve for the inaccuracy of the first-order approximation:

$$\hat{p} - \phi_L \hat{r}^j - \phi_N \hat{w}^j + \hat{A}_Y^j = \frac{1}{2}\phi_N\phi_L\left(1-\sigma_Y^{NL}\right)\left(\hat{w}^j - \hat{r}^j\right)^2 + \frac{1}{2}\phi_K\left[\phi_N\left(1-\sigma_Y^{NK}\right)\left(\hat{w}^j\right)^2 + \phi_L\left(1-\sigma_Y^{LK}\right)\left(\hat{r}^j\right)^2\right]. \tag{A.1}$$

σ_Y^{NL} is the (Allen-Uzawa) partial elasticity of substitution between labor and land, with other partial elasticities similarly defined. The first term on the right-hand side captures the substitution between labor and land, and the second, between capital - which has a constant price - and the other two factors.

If $\hat{A}_Y^j = 0$, then (A.1) may provide quadratic estimates of land-rent differentials, $\hat{r}^j$, in terms of $\hat{p}^j$ and $\hat{w}^j$. If the elasticities of substitution are less than one, as is likely, then the cost-share of land increases with land rents. Since the land-share effect depends inversely on the cost-share of land, the quadratic approximation of $\hat{r}^j$ is concave in $\hat{p}^j$, as the land-share effect decreases with $\hat{r}^j$. At the central point where $\hat{p}^j = \hat{w}^j = 0$, the quadratic and linear approximations formulas are tangent, and thus the concave quadratic approximation lies below the linear approximation, with the difference increasing in the square of $\hat{p}^j$. Therefore, the linear estimates overstate land-rent differences for $\hat{p}^j > 0$, and understate differences for $\hat{p}^j < 0$. Additionally, the cost-share of labor increases with $\hat{w}^j$ and decreases with $\hat{r}^j$, causing the need for additional adjustments for the labor-cost effect.

Appendix figure A1 illustrates a number of iso-rent curves in both the linear case and the quadratic case, where $\sigma_Y^{NL} = \sigma_Y^{KL} = \sigma_Y^{NK} = 0.67$.[28] Figure A2 graphs the quadratic land-rent estimates (numerical values are given in Appendix table A1) using the formula in (A.1) against the linear land-rent estimates. The quadratic estimates differ most from the linear estimates where housing costs are furthest from zero. Yet, even at these extremes, they differ by less than 20 percent.[29]

[28] These substitution elasticities are based on estimates in McDonald (1981) and Thorsnes (1997).

[29] There are three partial (Allen-Uzawa) elasticities of substitution in production for each combination of two factors, where $\sigma_Y^{LN} \equiv \left(\partial^2 c_Y / \partial w \partial r\right) / \left(\partial c_Y/\partial w \cdot \partial c_Y / \partial r\right)$ is the partial elasticity of substitution between labor and land in the production of Y, etc. Approximation of the cost-share is

$$\phi_L^j = \bar{\phi}_L\left\{1 + \left[\bar{\phi}_N\left(1-\sigma_Y^{NL}\right) + \bar{\phi}_K\left(1-\sigma_Y^{LK}\right)\right]\hat{r}^j - \bar{\phi}_N\left(1-\sigma_Y^{NL}\right)\hat{w}^j\right\}$$

where the $\bar{\phi}$ terms are used to represent average cost shares in the economy. In the case where $\hat{w}^j = 0$ and $\sigma_Y^{LK} = \sigma_Y^{NL} = \sigma_Y$, then (A.1) can be arreanged to show $\hat{r}^j = \hat{p}^j/\bar{\phi}_L - \left(1-\bar{\phi}_L\right)\left(1-\sigma_Y\right)\left(\hat{r}^j\right)^2$. The second term describes how the quadratic approximation is below the linear approximation when $\hat{r}^j \neq 0$.

Quadratic quality-of-life estimates are discussed in the Appendix of Albouy (2008), and are found to differ little from the corresponding linear estimates.

B Additional Tax Issues

B.1 Deduction

Tax deductions are applied to the consumption of home goods at the rate $\delta \in [0,1]$, so that the tax payment is given by $\tau(m - \delta py)$. With the deduction, the mobility condition becomes

$$\begin{aligned}\hat{Q}^j &= (1-\delta\tau')s_y\hat{p}^j - (1-\tau')s_w\hat{w}^j \\ &= s_y\hat{p}^j - s_w\hat{w}^j + \frac{d\tau^j}{m},\end{aligned}$$

where the tax differential is given by $d\tau^j/m = \tau'(s_w\hat{w}^j - \delta s_y p^j)$. This differential can be solved by noting

$$\begin{aligned}s_w\hat{w}^j &= s_w\hat{w}_0^j + \frac{\lambda_L}{\lambda_N}\frac{d\tau^j}{m} \\ s_y\hat{p}^j &= s_y\hat{p}_0^j - \left(1 - \frac{\lambda_L}{\lambda_N}\right)\frac{d\tau^j}{m},\end{aligned}$$

and substituting them into the tax differential formula, and solving recursively,

$$\begin{aligned}\frac{d\tau^j}{m} &= \tau' s_w\hat{w}_0^j - \delta\tau' s_y\hat{p}_0^j + \tau'\left[\delta + (1-\delta)\frac{\lambda_L}{\lambda_N}\right] \\ &= \tau'\frac{s_w\hat{w}_0^j - \delta s_y\hat{p}_0^j}{1-\tau'\left[\delta + (1-\delta)\lambda_L/\lambda_N\right]}.\end{aligned}$$

Substituting in (7a) and (7c) in the case where $\tau' = 0$, gives the tax differential in terms of amenities:

$$\frac{d\tau^j}{m} = \tau'\frac{1}{1-\tau'\left[\delta + (1-\delta)\lambda_L/\lambda_N\right]}\left[(1-\delta)\left(\frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X^j - \frac{\lambda_L}{\lambda_N}s_y A_Y^j\right) - \frac{(1-\delta)\lambda_L + \delta\lambda_N}{\lambda_N}\hat{Q}^j\right].$$

This equation demonstrates that the deduction reduces the dependence of taxes on productivity and increases the implicit subsidy for quality-of-life.

B.2 State Taxes

The tax differential with state taxes is computed by including an additional component based on wages and prices relative to the state average, as if state tax revenues are redistributed lump-sum to households within the state. This produces the augmented formula

$$\frac{d\tau^j}{m} = \tau'\left(s_w\hat{w}^j - \delta\tau' s_y\hat{p}^j\right) + \tau_S'[s_w(\hat{w}^j - \hat{w}^S) - \delta_S s_y(\hat{p}^j - \hat{p}^S)], \tag{A.2}$$

where τ_S' and δ_S are are marginal tax and deduction rates at the state-level, net of federal deductions, and $\hat{w}^S$ and $\hat{p}^S$ are the differentials for state S as a whole relative to the entire country.

B.3 Calibration of Tax Parameters

The federal marginal tax rate on wage income is determined by adding together federal marginal income tax rate and the effective marginal payroll tax rate. TAXSIM gives an average marginal federal income tax rate of 25.1 percent in 2000. In 2000, Social Security (OASDI) and Medicare (HI) tax rates were 12.4 and 2.9 percent on employer and employee combined. Estimates from Boskin et al. (1987, table 4) show that the marginal benefit from future returns from OASDI taxes is fairly low, generally no more than 50 percent, although only 85 percent of wage earnings are subject to the OASDI cap. HI taxes emulate a pure tax (Congressional Budget Office 2005). These facts suggest adding 37.5 percent of the Social Security tax and all of the Medicare tax to the federal income tax rate, adding 8.2 percent. The employer-half of the payroll tax (4.1 percent) has to be added to observed wage levels to produce gross wage levels. Overall, this puts an overall federal tax rate, τ' , of 33.3-percent on gross wages, although only 29.2 percent on observed wages.

Determining the federal deduction level requires taking into account the fact that many households do not itemize deductions. According to the Statistics on Income, although only 33 percent of tax returns itemize, they account for 67 percent of reported Adjusted Gross Income (AGI). Since the income-weighted share is what matters, 67 percent is multiplied by the effective tax reduction given in TAXSIM, in 2000 of 21.6 percent. Thus, on average these deductions reduce the effective price of eligible goods by 14.5 percent. Since eligible goods only include housing, this deduction applies to only 59 percent of home goods. Multiplying 14.5 percent by 59 percent, gives an effective price reduction of 8.6 percent for home goods. Divided by a federal tax rate of 33.3 percent, this produces a federal deduction level of 25.7 percent.

State income tax rates from 2000 are taken from TAXSIM, which, per dollar, fall at an average marginal rate of 4.5 percent. State sales tax data in 2000 are taken from the Tax Policy Center, originally supplied by the Federation of Tax Administrators. The average state sales tax rate is 5.2 percent. Sales tax rates are reduced by 10 percent to accommodate untaxed goods and services other than food or housing (Feenberg et al. 1997), and by another 8 percent in states that exempt food. Overall state taxes raise the marginal tax rate on wage differences within-state by an average of 5.9 percentage points, from zero points in Alaska to 8.8 points in Minnesota.

State-level deductions for housing expenditures, explicit in income taxes, and implicit in sales taxes, should also be included. At the state level, deductions for income taxes are calculated in an equivalent way using TAXSIM data. Furthermore, all housing expenditures are deducted from the sales tax. Overall this produces an average effective deduction level of $\delta = 0.291$.

C Data and Estimation

Wage and housing-price data come from the United States Census data from the 2000 Integrated Public-Use Microdata Series (IPUMS), from Ruggles et al. (2004). The wage sample is for workers ages 25 to 55, who report working at least 30 hours a week, 26 weeks a year. Place of residence determines the the MSA assigned to a worker, rather than their place of work. Below is a list of the controls used in the wage equation:

- 12 indicators of educational attainment;
- a quartic in potential experience, and potential experience interacted with years of education;
- 9 indicators of industry at the one-digit level (1950 classification);
- 9 indicators of employment at the one-digit level (1950 classification);
- 4 indicators of marital status (married, divorced, widowed, separated);
- an indicator for veteran status, and veteran status interacted with age;
- 5 indicators of minority status (Black, Hispanic, Asian, Native American, and other);
- an indicator of immigrant status, years since immigration, and immigrant status interacted with black, Hispanic, Asian, and other; and
- 2 indicators for English proficiency (none or poor).

All covariates are interacted with gender.

I first run the regression using census-person weights. From the regressions, I calculate a predicted wage is using the individual characteristics, not the MSAs, to form a new weight equal to the predicted wage multiplied by the census-person weight. Economically, these income-adjusted weights are more relevant since workers' influence on prices is determined by their endowment and income share (see Section D.3 below). The new weights are then used in a second regression, which is used to calculate the city-wage differentials from the MSA indicator variables. In practice, this weighting procedure has only a small effect on the estimated wage differentials.

Below is a list of the controls used in the housing-cost regression:

- 9 indicators of building size;
- 9 indicators for the number of rooms, 5 indicators for the number of bedrooms, number of rooms interacted with number of bedrooms, and the number of household members per room;
- 2 indicators for lot size;
- 7 indicators for when the building was built;
- 2 indicators for complete plumbing and kitchen facilities;
- an indicator for commercial use; and
- an indicator for condominium status (owned units only).

I first run a regression of housing values on housing characteristics and MSA indicator variables using only owner-occupied units, weighting by census-housing weights. From this regression, I calculate a new value-adjusted weight by multiplying the census-housing weights by the predicted value from this first regression using housing characteristics alone. Economically, these weights reflect the number of efficiency units of housing that observation provides. I then run a second regression with these new weights for all units, rented and owner-occupied, on the housing characteristics fully interacted with tenure, along with the MSA indicators, which are not interacted. I take the house-price differentials from the MSA indicator variables in this second regression. As with the wage differentials, this adjusted weighting method has only a small impact on the measured price differentials.

D Additional Theoretical Details

D.1 System of Equations

The entire system consists of fourteen equations in fourteen unknowns, with three exogenous parameters: Q, A_X, and, A_Y, with superscripts j supressed. The first three equations (1), (2), and (3) determine the prices of land, labor, and the home good, r, w and p. With these prices given, the budget constraint and the consumption tangency condition determine the consumption quantities x and y,

$$x + py = w + R + I - \tau(w) \tag{A.3}$$

$$(\partial U/\partial y) / (\partial U/\partial x) = p \tag{A.4}$$

where$R$ and I are given. Changes in output (X, Y), employment (N_X, N_Y, N), capital (K_X, K_Y), and land use (L_X, L_Y) are determined by nine equations in the production sector: six statements of Shepard's Lemma

$$\partial c_X/\partial w = N_X/X,\ \partial c_X/\partial r = L_X/X,\ \partial c_X/\partial i = K_X/X \tag{A.5}$$

$$\partial N_Y/\partial w = N_Y/Y,\ \partial c_Y/\partial r = L_Y/Y,\ \partial c_Y/\partial i = K_Y/Y \tag{A.6}$$

and three equations for total population, the land constraint, and total home-good production per capita

$$N_X + N_Y = N \tag{A.7}$$

$$L_X + L_Y = L(r) \tag{A.8}$$

$$Y = yN \tag{A.9}$$

D.2 Quantity Changes

D.2.1 Consumption

The budget constraint (A.3) and tangency condition (A.4) can be log-linearized to yield

$$s_x\hat{x} + s_y\left(\hat{p} + \hat{y}\right) = s_w\hat{w} - \frac{d\tau}{m} \tag{A.10}$$

$$\hat{x} - \hat{y} = \sigma_D\hat{p} \tag{A.11}$$

Subtracting (4a) from (A.10), $s_x\hat{x} + s_y\hat{y} = -\hat{Q}$ and substituting in (A.11) yields

$$\hat{y} = -s_x\sigma_D\hat{p} - \hat{Q} \tag{A.12}$$

In the simple case without taxes $\hat{p}_y = \frac{1}{s_y}\left(\frac{\lambda_N-\lambda_L}{\lambda_N}\hat{Q}^j + \frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X^j\right)$ and so we can see that home-good consumption is decreasing in both productivity and quality of life.

$$\hat{y} = -\frac{s_x}{s_y}\frac{1-\lambda_L}{\lambda_N}\sigma_D s_x\hat{A}_X^j - \left(\frac{s_x}{s_y}\frac{\lambda_N-\lambda_L}{\lambda_N}\sigma_D + 1\right)\hat{Q}$$

D.2.2 Production

In the production sector, differentiating and log-linearizing the Shepard's Lemma conditions (A.5) and (A.6) gives six equations of the following form

$$\hat{N}_X = \hat{X} - \hat{A}_X + \theta_L\sigma_X^{LN}(\hat{r} - \hat{w}) + \theta_K\sigma_X^{NK}(\hat{\imath} - \hat{w}) \tag{A.13}$$

These expressions make use of partial (Allen-Uzawa) elasticities of substitution, of which each sector has three for each combination of two factors, where $\sigma_X^{LN} \equiv (\partial^2 c/\partial w\partial r)/(\partial c/\partial w \cdot \partial c/\partial r)$ is the partial elasticity of substitution between labor and land in the production of X, etc. Because productivity differences are Hicks-neutral, they do not influence these elasticities of substitution. Log-linearizing the constraints (A.7), (A.8), and (A.9)

$$\begin{aligned}\lambda_N\hat{N}_X + (1-\lambda_N)\hat{N}_Y &= \hat{N}\\ \lambda_L\hat{L}_X + (1-\lambda_L)\hat{L}_Y &= \varepsilon_{L,r}\\ \hat{N} + \hat{y} &= \hat{Y}\end{aligned}$$

Substituting in (4b), (4c), and (A.12), setting $\hat{A}_Y = 0$, and rearranging gives a system of nine equations in nine unknowns. If partial elasticities within sectors are equal, $\sigma_Y^{NL} = \sigma_Y^{LK} = \sigma_Y^{NK} = \sigma_Y$, as in CES production, then these equations take on the matrix form below:

$$\begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0\\ 0 & 1 & 0 & -1 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0\\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0\\ \lambda_N & 0 & 0 & 0 & 1-\lambda_N & 0 & 0 & 0 & -1\\ 0 & \lambda_L & 0 & 0 & 0 & 1-\lambda_L & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \end{bmatrix} \begin{bmatrix} \hat{N}_X\\ \hat{L}_X\\ \hat{K}_X\\ \hat{X}\\ \hat{N}_Y\\ \hat{L}_Y\\ \hat{K}_Y\\ \hat{Y}\\ \hat{N} \end{bmatrix} = \begin{bmatrix} (\sigma_X - 1)\hat{A}_X - \sigma_X\hat{w}\\ (\sigma_X - 1)\hat{A}_X - \sigma_X\hat{r}\\ (\sigma_X - 1)\hat{A}_X\\ (\sigma_Y - 1)\hat{A}_Y + \sigma_Y(\hat{p} - \hat{w})\\ (\sigma_Y - 1)\hat{A}_Y + \sigma_Y(\hat{p} - \hat{r})\\ (\sigma_Y - 1)\hat{A}_Y + \sigma_Y\hat{p}\\ 0\\ \varepsilon_{L,r}\\ -s_x\sigma_D\hat{p} - \hat{Q} \end{bmatrix}$$

The quantities on the right-hand side of the equation are already derived from the observed data. The solution for $\hat{N}$ is given by

$$\begin{aligned}\hat{N} &= \sigma_D s_x \left(1 - \frac{\lambda_L}{\lambda_N}\right) \hat{p} + (\lambda_N - \lambda_L)\,\hat{Q} + \lambda_L \sigma_X (\hat{r} - \hat{w}) \\ &+ \sigma_Y \left[(1 - \lambda_L)\,\hat{r} - \left(1 - \frac{\lambda_L}{\lambda_N}\right) \hat{p} - \left(\frac{1}{\lambda_N} - 1\right) \lambda_L \hat{w}\right] + (1 - \sigma_Y)(\lambda_N - \lambda_L)\,\hat{A}_Y\end{aligned}$$

Note that $\hat{p}, \hat{w}$, and $\hat{r}$, are determined by $\hat{Q}$, and $\hat{A}_X$ and $\hat{A}_Y$, according to the capitalization formulas in Section 2.6.

According to the calibrated model where $\sigma_D = \sigma_Y = \sigma_X = 0.667$, the numerical solution to this equation is simply.

$$\hat{N} = 8.06\hat{Q} + 2.08\hat{A}_X + \varepsilon_{L,r}\hat{r}$$

According to table 3, the standard deviations of $\hat{Q}$ and $\hat{A}_X$ are 0.051 and 0.155: multiplied by the respective coefficients in the equation produces 0.414 and 0.324. This suggests that both quality of life and productivity are important determinants of population location decisions, although quality-of-life may be slightly more important. This is remarkably similar to the results for land rents. If increases in land supply through $\varepsilon_{L,r}$ are proportional to increases in land rents, this would reinforce the conclusion that quality of life is slightly more important in accounting for location decisions.

D.3 Multiple Household Types

For simplicity, ignore federal taxes and assume there are two types of fully mobile households, referred to as "a" and "b." The most interesting case is when some members of each type live in every city. The mobility conditions for each type are

$$\begin{aligned} e_a(p, w_a, u; Q_a) &= 0 \\ e_b(p, w_b, u; Q_b) &= 0 \end{aligned}$$

I generalize the two zero-profit conditions with unit-cost functions that have factor-specific productivity components.

$$\begin{aligned} c_X(w_a/A_{Xa}, w_b/A_{Xb}, r/A_{XL}, \bar{\imath}/A_{XL}) &= 1 \\ c_Y(w_a/A_{Ya}, w_b/A_{Yb}, r/A_{YL}, \bar{\imath}/A_{YK}) &= p \end{aligned}$$

The terms A_{Xa} and A_{Xb} give the relative productivity of each worker type in the city. Log-linearizing these equations:

$$\begin{aligned} s_{ya}\hat{p} - s_{wa}\hat{w}_a &= \hat{Q}_a \\ s_{yb}\hat{p} - s_{wb}\hat{w}_b &= \hat{Q}_b \\ \theta_{Na}\hat{w}_a + \theta_{Nb}\hat{w}_b + \theta_L\hat{r} &= \hat{A}_X \\ \phi_{Na}\hat{w}_a + \phi_{Nb}\hat{w}_b + \phi_L\hat{r} &= \hat{A}_Y \end{aligned}$$

where θ denotes the cost-shares of each factor, and $\theta_a \hat{A}_{Xa} + \theta_b \hat{A}_{Xb} + \theta_L \hat{A}_{XL} + \theta_K \hat{A}_{XK} \equiv \hat{A}_X$ and $\phi_a \hat{A}_{Ya} + \phi_b \hat{A}_{Yb} + \phi_L \hat{A}_{YL} + \phi_K \hat{A}_{YK} \equiv \hat{A}_Y$. The additivity of these effects proves that differences in productivity have the same first-order effects on prices regardless of the factor they augment directly when weighted by the cost-share of that factor.[30]

Let the share of total income accruing to type a worker be $\mu_a = N_a m_a / (N_a m_a + N_b m_b)$, with the other share $\mu_b = 1 - \mu_a$, and define the following income-weighted averages

$$
\begin{aligned}
& s_y \equiv \mu_a s_{ya} + \mu_b s_{yb},\ s_x \equiv 1 - s_y,\ \varsigma_y \equiv \mu_a s_{ya}/s_y \\
& \hat{Q} \equiv \mu_a \hat{Q}_a + \mu_b \hat{Q}_b,\ s_w \equiv \mu_a s_{wa} + \mu_b s_{wb},\ \hat{w} \equiv \mu_a \frac{s_{wa}}{s_w} \hat{w}_a + \mu_b \frac{s_{wb}}{s_w} \hat{w}_b \\
& \lambda_a = \frac{s_x \theta_{Na}}{s_x \theta_{Na} + s_y \phi_{Na}},\ \lambda_b = \frac{s_x \theta_{Nb}}{s_x \theta_{Nb} + s_y \phi_{Nb}},\ \lambda_N \equiv \frac{1}{s_y} \left[s_{ya} \mu_a \lambda_a + s_{yb} \mu_b \lambda_b \right]
\end{aligned}
$$

Then it is possible to show that the following capitalization formulas hold.

$$
\begin{aligned}
s_R \hat{r} &= \hat{Q} + s_x \hat{A}_X + s_y \hat{A}_Y \\
s_w \hat{w} &= -\frac{\lambda_L}{\lambda_N} \hat{Q} + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y + \left[\left(\frac{\lambda_a}{\lambda_N} - 1 \right) \mu_a \hat{Q}_a + \left(\frac{\lambda_b}{\lambda_N} - 1 \right) \mu_b \hat{Q}_b \right] \\
s_y \hat{p} &= \frac{\lambda_N - \lambda_L}{\lambda_N} \hat{Q} + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y + \left[\left(\frac{\lambda_a}{\lambda_N} - 1 \right) \mu_a \hat{Q}_a + \left(\frac{\lambda_b}{\lambda_N} - 1 \right) \mu_b \hat{Q}_b \right]
\end{aligned}
$$

Except for the terms in square brackets, ”[]”, these terms are otherwise identical to equations (7) without taxes. The bracketed term explains that wage and housing-cost differences increase in the quality-of-life of the labor type that is relatively more represented in the traded-good sector, or decreasing in the quality-of-life of the labor type more represented in the home-good sector. The wage of a-types resembles the average wage except that it is lower in places a-types prefer relative to b-types.

$$
\left[\frac{s_y}{s_{ya}} \right] s_{wa} \hat{w}_a = -\frac{\lambda_L}{\lambda_N} \hat{Q} + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y + \left[\frac{\lambda_b}{\lambda_N} \left(\hat{Q} - \frac{s_y}{s_{ya}} \hat{Q}_a \right) \right]
$$

The model assumes that both types of households live in each city. This assumption is easier to maintain if the type of labor they supply are imperfect substitutes in production.

Factor-specific productivity differences do have first-order effects on quantities in the model. For example, in the case where partial elasticities of substitution across factors within sectors are equal, the relative employment of a-types relative to b-types is

$$
\hat{N}_a - \hat{N}_b = -\sigma_X (\hat{w}_a - \hat{w}_b) + (\sigma_X - 1) \left(\hat{A}_{Xa} - \hat{A}_{Xb} \right)
$$

[30] This is more general than the models seen in Roback (1988) and Beeson (1991), who assume $s_{wa} = s_{wb} = 1$ and $\phi_L = 1$.

D.4 Multiple Home Goods

Suppose now that there is one type of household but two types of goods, 1 and 2, such as residential housing and local services. The four equilibrium conditions, using obvious definitions, are written

$$\begin{aligned} e(p_1, p_2, u)/Q &= m \\ c_X(w, r, \bar{\imath})/A_X &= 1 \\ c_{Y1}(w, r, \bar{\imath})/A_{Y1} &= p_1 \\ c_{Y2}(w, r, \bar{\imath})/A_{Y2} &= p_2 \end{aligned}$$

Log-linearizing these equations produces

$$\begin{aligned} s_{y1}\hat{p}_1 + s_{y2}\hat{p}_2 - s_w\hat{w} &= \hat{Q} \\ \theta_N\hat{w} + \theta_L\hat{r} &= \hat{A}_X \\ \phi_{N1}\hat{w} + \phi_{L1}\hat{r} - \hat{p}_1 &= \hat{A}_{Y1} \\ \phi_{N2}\hat{w} + \phi_{L2}\hat{r} - \hat{p}_2 &= \hat{A}_{Y2} \end{aligned}$$

If we define an aggregate shares, prices, and home-productivity appropriately

$$\begin{aligned} s_y \equiv s_{y1} + s_{y2}.\ \phi_L &\equiv \frac{s_{y1}}{s_y}\phi_{L1} + \frac{s_{y2}}{s_y}\phi_{L2} \\ \hat{p} \equiv \frac{s_{y1}}{s_y}\hat{p}_1 + \frac{s_{y2}}{s_y}\hat{p}_2,\ \ \hat{A}_Y &\equiv \frac{s_{y1}}{s_y}\hat{A}_{Y1} + \frac{s_{y2}}{s_y}\hat{A}_{Y2}, \end{aligned}$$

then the main results generalize:

$$\begin{aligned} s_R\hat{r} &= \hat{Q} + s_x\hat{A}_X + s_y\hat{A}_Y \\ s_w\hat{w} &= -\frac{\lambda_L}{\lambda_N}\hat{Q} + \frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X - \frac{\lambda_L}{\lambda_N}s_y\hat{A}_Y \\ s_y\hat{p} &= \frac{\lambda_N - \lambda_L}{\lambda_N}\hat{Q} + \frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X - \frac{\lambda_L}{\lambda_N}s_y\hat{A}_Y \end{aligned}$$

Now a question is whether using a local price index based on only one home-good price, e.g. the one for residential housing, $\hat{p}_1$, may be biased relative to using a more balanced local price index,

$\hat{p}$.[31] Weighted by the relevant total expenditure share, the bias is given by

$$
\begin{aligned}
s_y(\hat{p}_1-\hat{p}) = & \frac{\lambda_N\left(1-\lambda_L\right)\left(\phi_{L1}/\phi_L-1\right)-\lambda_L\left(1-\lambda_N\right)\left(\phi_{N1}/\phi_N-1\right)}{\lambda_N}\left(\hat{Q}+s_{y2}\hat{A}_{Y2}\right) \\
& +\frac{1-\lambda_L}{\lambda_N}\left[\lambda_N\left(\phi_{L1}/\phi_L-1\right)+\left(1-\lambda_N\right)\left(\phi_{N1}/\phi_N-1\right)\right]s_x\hat{A}_X \\
& +\left\{\frac{\lambda_N\left(1-\lambda_L\right)\left(\phi_{L1}/\phi_L-1\right)-\lambda_L\left(1-\lambda_N\right)\left(\phi_{N1}/\phi_N-1\right)}{\lambda_N}-\left[\frac{s_y-s_{y1}}{s_{y1}}\right]\right\}s_{y1}\hat{A}_{Y1}
\end{aligned}
$$

If the cost structure of both home goods are the same, i.e., if $\phi_{L1}=\phi_L$ and $\phi_{N1}=\phi_N$, then this collapses to $-(s_y-s_{y1})\hat{A}_{Y1}$, i.e., the price index will be biased towards how productive the city is in producing the first home good. When the first home good is more land intensive and less labor intensive than the second, i.e. if $\phi_{L1}>\phi_L$ and $\phi_{N1}<\phi_{N2}$ then an index based on the first home good will more strongly capitalize differences in $\hat{A}_X$. In this case, the first good will also more strongly capitalize differences in $\hat{Q}$, $\hat{A}_{Y1}$, and $\hat{A}_{Y2}$ so long as $(1/\lambda_L-1)\left(\phi_{L1}/\phi_L-1\right)>(1/\lambda_N-1)\left(\phi_{N1}/\phi_N-1\right)$, which should generally be the case as λ_L is much smaller than λ_N. In the extreme case, where the second good has the same factor proportions as the tradable good, i.e., $\phi_{L2}=\theta_L$ and $\phi_{N2}=\theta_N$, its price only capitalizes differences in its own productivity as $\hat{p}_2=\hat{A}_{Y2}$, and the first good does all of the capitalization.

The distinction between home goods and tradable goods is somewhat artificial, as most goods are a mixture of both, with the key distinction being how land and labor-intensive the goods are. The broader the definition of home goods, the larger is the effective share s_y, but the closer the cost shares ϕ_L and ϕ_N are to θ_L and θ_N. The capitalization effects on land are unchanged so long as s_R remains the same. The capitalization of Q and A_Y will also be the same, so long as the ratio λ_L/λ_N remains constant. The only capitalization effect that changes substantially are those for A_X in wages and prices, as $(1-\lambda_L)/\lambda_N$ must get larger as the definition of home goods expands, increasing the capitalization effect of trade-productive amenities.

[31] The capitalization into a specific home-good is. $s_{y1}\hat{p}_1 = \left(\frac{\lambda_N-\lambda_L}{\lambda_N}-\left[\lambda_{L2}-\lambda_{N2}\frac{\lambda_L}{\lambda_N}\right]\right)\left(\hat{Q}+s_{y2}\hat{A}_{Y2}\right)+\left(\frac{1-\lambda_L}{\lambda_N}-\left[\lambda_{L2}+\lambda_{N2}\frac{1-\lambda_L}{\lambda_N}\right]\right)s_x\hat{A}_X+\left(-\frac{\lambda_L}{\lambda_N}-\left[\lambda_{L2}-\lambda_{N2}\frac{\lambda_L}{\lambda_N}\right]\right)s_{y1}\hat{A}_{Y1}$

TABLE 2: PREDICTED EFFECT OF AMENITIES ON THE VALUE OF LAND RENTS, WAGES, AND HOME-GOOD PRICES

Amenity Type	Increase in Value from a One-Dollar Increase in Amenity Value		
	Quality of Life	Trade Productivity	Home Productivity
	$\hat{Q}^j$	$s_x \hat{A}_X^j$	$s_y \hat{A}_Y^j$
	(1)	(2)	(3)
Panel A: Federal Taxes Geographically Neutral			
Land Rents $s_R \hat{r}^j$	1.00	1.00	1.00
Wages $s_w \hat{w}^j$	-0.23	1.19	-0.23
Home-Good Prices $s_y \hat{p}^j$	0.77	1.19	-0.23
Panel B: With Federal Income Taxes			
Land Rents: $s_R \hat{r}^j$	1.19	0.63	1.07
Wages $s_w \hat{w}^j$	-0.27	1.28	-0.24
Home-Good Prices $s_y \hat{p}^j$	0.92	0.90	-0.17
Federal Tax Payment $d\tau^j / \bar{m}$	-0.19	0.37	-0.07
Panel C: Elasticities of Prices to Attributes, under Federal Income Taxes			
	$\hat{Q}^j$	$\hat{A}_X^j$	$\hat{A}_Y^j$
Land Rents: $\hat{r}^j$	11.85	4.01	3.86
Wages $\hat{w}^j$	-0.36	1.09	-0.12
Home-Good Prices $\hat{p}^j$	2.54	1.61	-0.17
Federal Tax Payment $d\tau^j / \bar{m}$	-0.19	0.24	-0.03
Total Value $\hat{\Omega}^j$	1.00	0.64	-0.07

Panel A is based on formulas in (7) using s_R = 0.10, s_w = 0.75, s_x = 0.64, s_y = 0.36, λ_L = 0.17, λ_N =0.704, and but also accounts for average state taxes and deductions for housing.

TABLE 3: WAGE, HOUSING COST, LAND RENT, QUALITY-OF-LIFE, PRODUCTIVITY, FEDERAL TAX, AND TOTAL AMENITY VALUE DIFFERENTIALS, 2000

	Population Size	Adjusted Differentials: Wages	Adjusted Differentials: Housing Costs	Inferred Land Rent	Amenity Values: Quality of Life	Amenity Values: Trade-Productivity	Federal Tax Differential	Total Amenity Value
Main city in MSA/CMSA								
San Francisco CA	7,039,362	0.26	0.81	2.78	0.14	0.29	0.05	0.32
Santa Barbara CA	399,347	0.07	0.66	2.65	0.18	0.13	-0.01	0.26
Honolulu HI	876,156	-0.01	0.61	2.62	0.20	0.06	-0.02	0.24
Monterey CA	401,762	0.10	0.59	2.24	0.14	0.14	0.01	0.23
San Diego CA	2,813,833	0.06	0.48	1.89	0.12	0.10	0.00	0.19
Los Angeles CA	16,373,645	0.13	0.45	1.57	0.08	0.15	0.02	0.18
New York NY	21,199,865	0.21	0.41	1.18	0.03	0.21	0.04	0.16
Seattle WA	3,554,760	0.08	0.31	1.10	0.06	0.10	0.01	0.12
Boston MA	5,819,100	0.12	0.29	0.93	0.03	0.13	0.02	0.12
Denver CO	2,581,506	0.05	0.24	0.89	0.05	0.07	0.01	0.10
Chicago IL	9,157,540	0.14	0.22	0.59	0.01	0.13	0.03	0.09
Portland OR	2,265,223	0.02	0.17	0.68	0.05	0.04	0.00	0.07
Washington-Baltimore DC	7,608,070	0.13	0.15	0.31	-0.01	0.12	0.03	0.06
Miami FL	3,876,380	0.00	0.13	0.54	0.04	0.02	0.00	0.05
Phoenix AZ	3,251,876	0.03	0.08	0.24	0.01	0.03	0.01	0.03
Detroit MI	5,456,428	0.13	0.05	-0.13	-0.05	0.11	0.04	0.02
Philadelphia PA	6,188,463	0.11	0.05	-0.09	-0.04	0.10	0.03	0.02
Minneapolis MN	2,968,806	0.08	0.02	-0.14	-0.03	0.07	0.03	0.01
Atlanta GA	4,112,198	0.08	0.01	-0.15	-0.03	0.06	0.02	0.01
Cleveland OH	2,945,831	0.01	-0.03	-0.17	-0.02	0.01	0.01	-0.01
Dallas TX	5,221,801	0.06	-0.04	-0.34	-0.04	0.05	0.02	-0.01
Tampa FL	2,395,997	-0.06	-0.08	-0.20	0.00	-0.05	-0.01	-0.03
St. Louis MO	2,603,607	0.01	-0.10	-0.46	-0.03	-0.01	0.01	-0.04
Houston TX	4,669,571	0.07	-0.11	-0.68	-0.07	0.05	0.03	-0.04
Pittsburgh PA	2,358,695	-0.04	-0.21	-0.77	-0.05	-0.05	-0.01	-0.08
San Antonio TX	1,592,383	-0.09	-0.25	-0.85	-0.04	-0.10	-0.02	-0.10
Oklahoma City OK	1,083,346	-0.13	-0.28	-0.83	-0.02	-0.14	-0.02	-0.11
McAllen TX	569,463	-0.21	-0.57	-1.86	-0.08	-0.23	-0.04	-0.23
Census Division								
Pacific	45,025,637	0.10	0.39	1.42	0.08	0.12	0.01	0.16
New England	13,922,517	0.07	0.19	0.61	0.03	0.07	0.01	0.07
Middle Atlantic	39,671,861	0.09	0.13	0.28	-0.01	0.09	0.02	0.05
Mountain	18,172,295	-0.06	0.00	0.16	0.03	-0.04	-0.02	0.00
East North Central	45,155,037	0.02	-0.07	-0.33	-0.03	0.00	0.01	-0.03
South Atlantic	51,769,160	-0.04	-0.08	-0.25	-0.01	-0.04	-0.01	-0.03
West South Central	31,444,850	-0.08	-0.24	-0.83	-0.04	-0.09	-0.01	-0.10
West North Central	19,237,739	-0.11	-0.25	-0.80	-0.03	-0.11	-0.02	-0.10
East South Central	17,022,810	-0.12	-0.32	-1.02	-0.04	-0.13	-0.02	-0.12
MSA Population								
MSA, Pop > 5 Million	84,064,274	0.16	0.32	0.96	0.03	0.16	0.03	0.13
MSA, Pop 1.5-4.9 Million	57,157,386	0.03	0.04	0.08	0.00	0.02	0.01	0.02
MSA, Pop 0.5-1.4 Million	42,435,508	-0.03	-0.09	-0.29	-0.01	-0.04	-0.01	-0.04
MSA, Pop < 0.5 Million	42,324,511	-0.10	-0.19	-0.52	-0.01	-0.10	-0.02	-0.07
Non-MSA areas	55,440,227	-0.16	-0.32	-0.91	-0.02	-0.16	-0.04	-0.13
United States	281,421,906	0.13	0.30	1.00	0.05	0.13	0.03	0.12
	total				*standard deviations*			

Wage and housing price data are taken from the U.S. Census 2000 IPUMS. Wage differentials are based on the average logarithm of hourly wages for full-time workers ages 25 to 55. Housing price differentials based on the average logarithm of rents and housing prices for units moved in within the last 10 years. Adjusted differentials are city-fixed effects from individual level regressions on extended sets of worker and housing covariates. The inferred land-rent, quality-of-life, trade-productivity, and total-amenity variables are estimated from equations (11) in the text, with some additional adjustements for housing deductions and state taxes, described in Appendix B.

TABLE 4: VARIANCE DECOMPOSTION OF QUALITY-OF-LIFE AND PRODUCTIVITY EFFECTS ON PRICE DIFFERENTIALS ACROSS CITIES

		Variance Decomposition Fraction of variance explained by		
	Variance	Quality-of-Life	Productivity	Covariance
	(1)	(2)	(3)	(4)
Panel A: With Federal Taxes				
Land Rents	1.002	0.370	0.287	0.342
Wages	0.019	0.018	1.132	-0.150
Housing Costs	0.093	0.184	0.498	0.318
Tax Differential	0.001	0.113	1.276	-0.398
Total Value	0.015	0.181	0.503	0.317
Panel B: Federal Taxes Geographically Neutral				
Land Rents	1.459	0.181	0.503	0.317
Wages	0.017	0.015	1.120	-0.134
Housing Costs	0.126	0.097	0.642	0.262
Tax Differential	0.000	.	.	.
Total Value	0.015	0.181	0.503	0.317

The variance is calculated across 274 metro areas and 49 non-metro areas by state, weighted by population.

TABLE 5: THE RELATIONSHIP BETWEEN SPECIFIC AMENITIES AND HOUSING COSTS, WAGES, QUALITY OF LIFE, PRODUCTIVITY, LAND RENTS, FEDERAL TAXES, AND TOTAL AMENITY VALUES

			Observables		Amenity Type		Capitalization Into		Total
	Mean	Standard Deviation	Housing Cost	Wage	Quality of Life	Trade Productivity	Local Land Rents	Federal Tax Payment	Amenity Value
			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Logarithm of Population	14.63	1.32	0.059***	0.041***	-0.001	0.038***	0.014***	0.009***	0.024***
			(0.008)	(0.004)	(0.002)	(0.004)	(0.003)	(0.001)	(0.003)
Percent of Population College Graduates	0.26	0.07	1.562***	0.672***	0.184***	0.698***	0.485***	0.146***	0.631***
			(0.161)	(0.069)	(0.040)	(0.067)	(0.058)	(0.017)	(0.064)
Whartron Residential Land-Use Regulatory Index (WRLURI)	0.05	0.93	0.030**	0.015**	0.002	0.015**	0.009*	0.003	0.012**
			(0.013)	(0.007)	(0.004)	(0.006)	(0.005)	(0.002)	(0.005)
Minus Heating-Degree Days (1000s)	-4.38	2.15	0.062***	0.023***	0.009**	0.025***	0.020***	0.004***	0.025***
			(0.010)	(0.006)	(0.003)	(0.006)	(0.004)	(0.002)	(0.004)
Minus Cooling-Degree Days (1000s)	-1.28	0.89	0.123***	0.023*	0.027***	0.032***	0.046***	0.001	0.048***
			(0.019)	(0.012)	(0.006)	(0.011)	(0.007)	(0.003)	(0.007)
Sunshine (percent possible)	0.60	0.08	0.995***	0.188**	0.232***	0.255***	0.375***	0.021	0.395***
			(0.127)	(0.093)	(0.040)	(0.083)	(0.044)	(0.024)	(0.051)
Inverse Distance to Coast (Ocean or Great Lake)	0.04	0.04	1.883***	0.387***	0.409***	0.507***	0.701***	0.033	0.734***
			(0.236)	(0.132)	(0.056)	(0.124)	(0.080)	(0.032)	(0.094)
Average Slope of Land (percent)	1.68	1.59	0.016***	-0.009***	0.010***	-0.005*	0.009***	-0.003***	0.006***
			(0.005)	(0.003)	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)
Latitude (degrees)	37.76	4.86	0.014***	0.010**	0.000	0.009***	0.003**	0.002**	0.006***
			(0.004)	(0.004)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)
Constant			-1.543	-0.749	-0.132	-0.757	-0.455	-0.161	-0.616
			(0.163)	(0.101)	(0.045)	(0.092)	(0.057)	(0.025)	(0.064)
R-squared			0.91	0.82	0.77	0.85	0.90	0.76	0.91

282 observations with complete data. Robust standard errors shown in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Regressions weighted by the sum of individuals in a city, each according to their predicted income in an average city. Amenity variables are described in Section 4.1.

Figure 1A: Adjusted Model

(This Research)

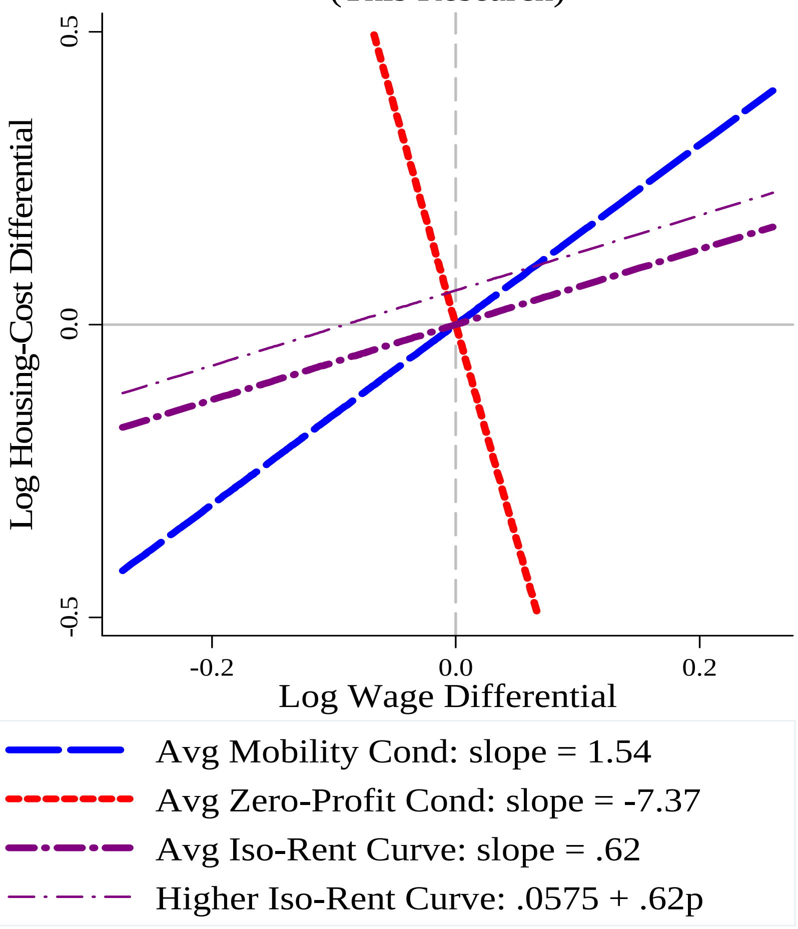


Figure 1B: Unadjusted Model

(Previous Literature)

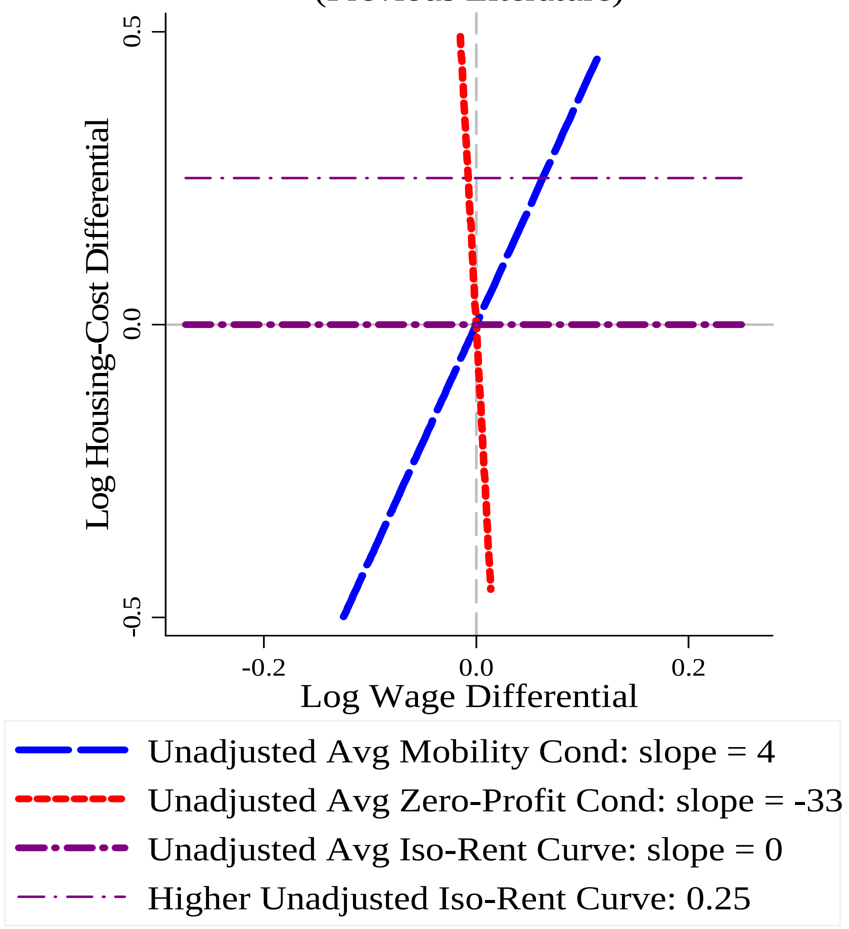


Figure 2: Housing Costs versus Wage Levels across Metro Areas, 2000

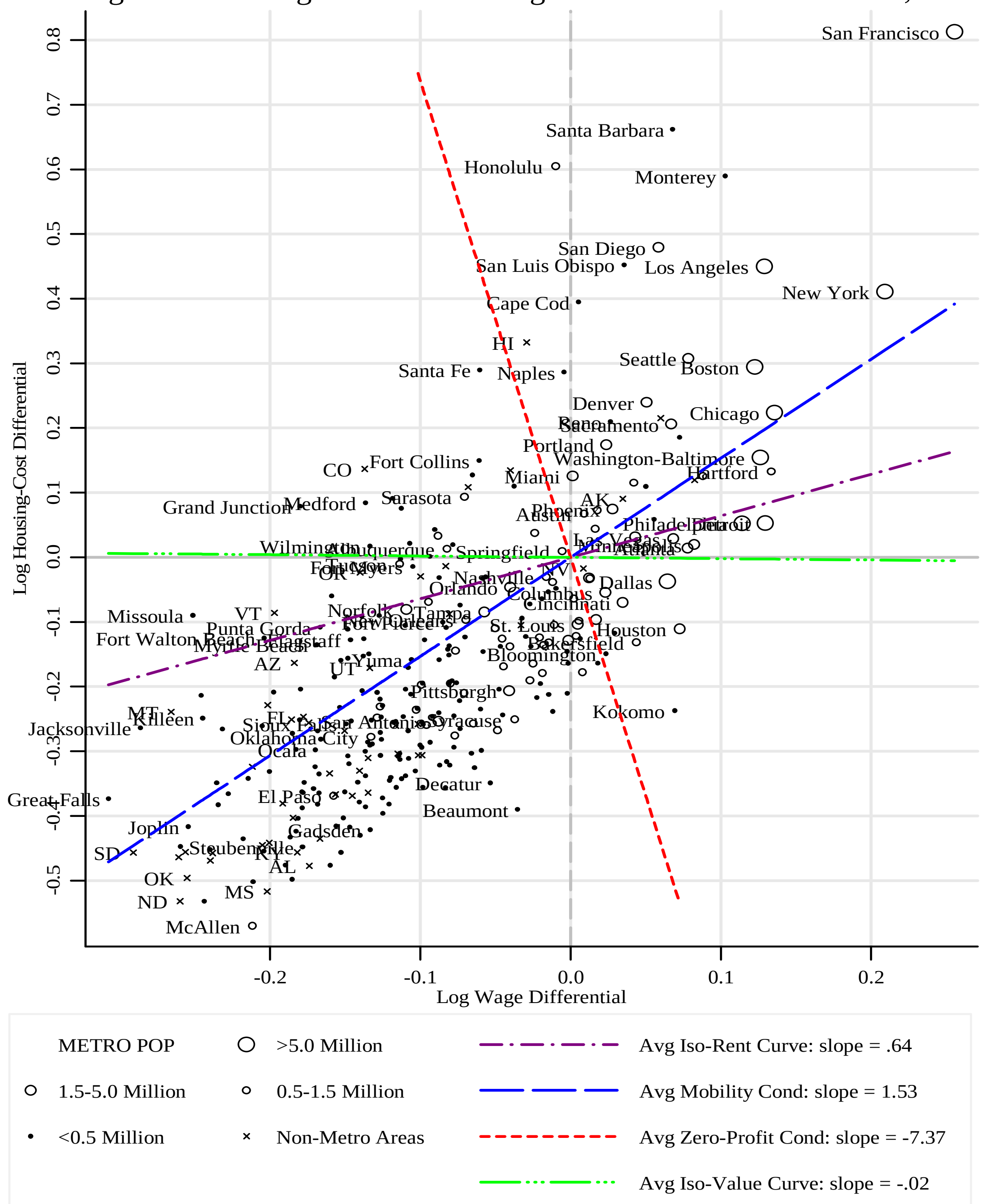
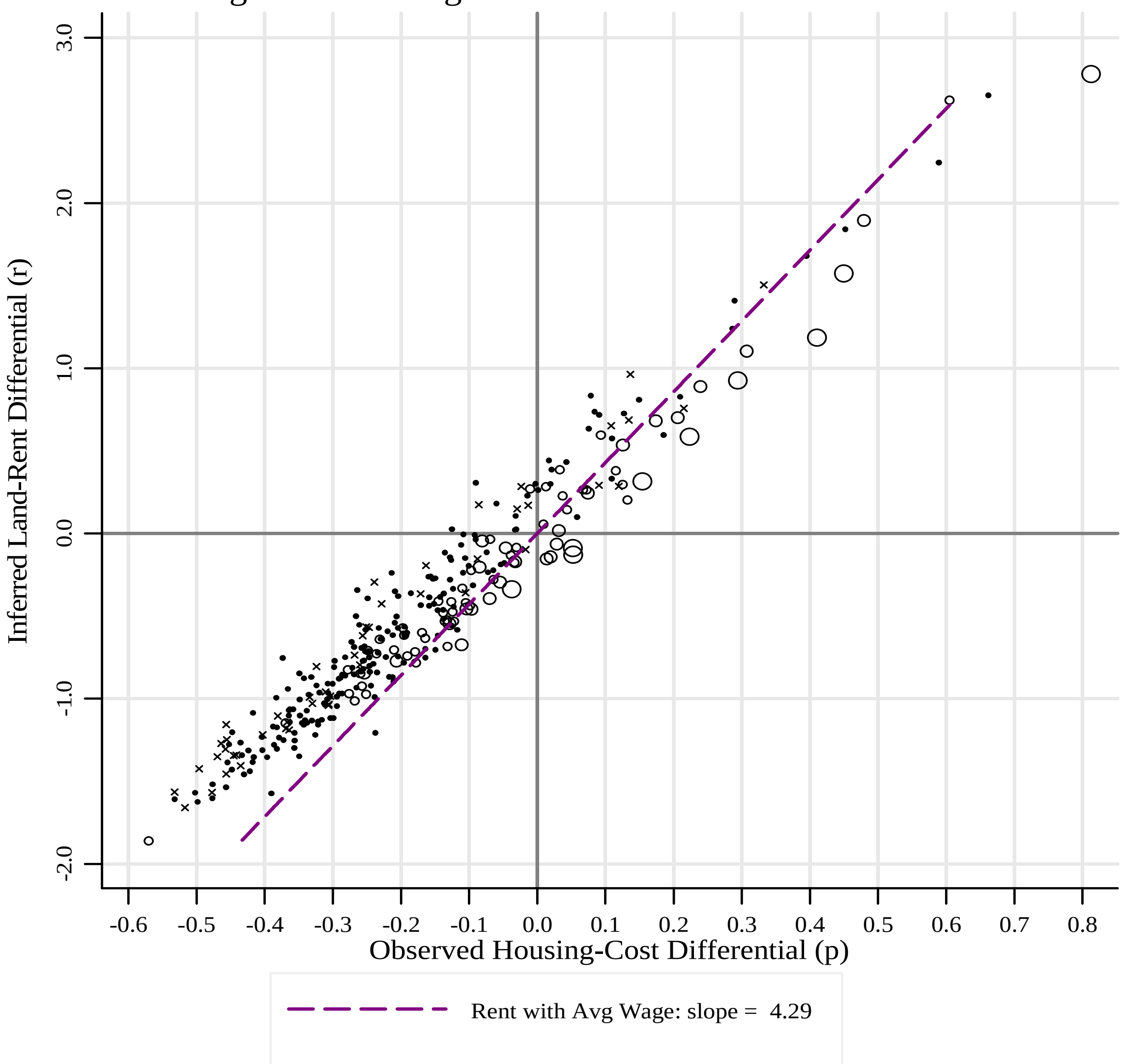


Figure 3: Housing Costs and Inferred Land Rents



Inferred land rents based on calibration: phiL =0.2333, phiN =0.6167, sigmaY = 1.0

Figure 4: Estimated Productivity and Quality of Life, 2000

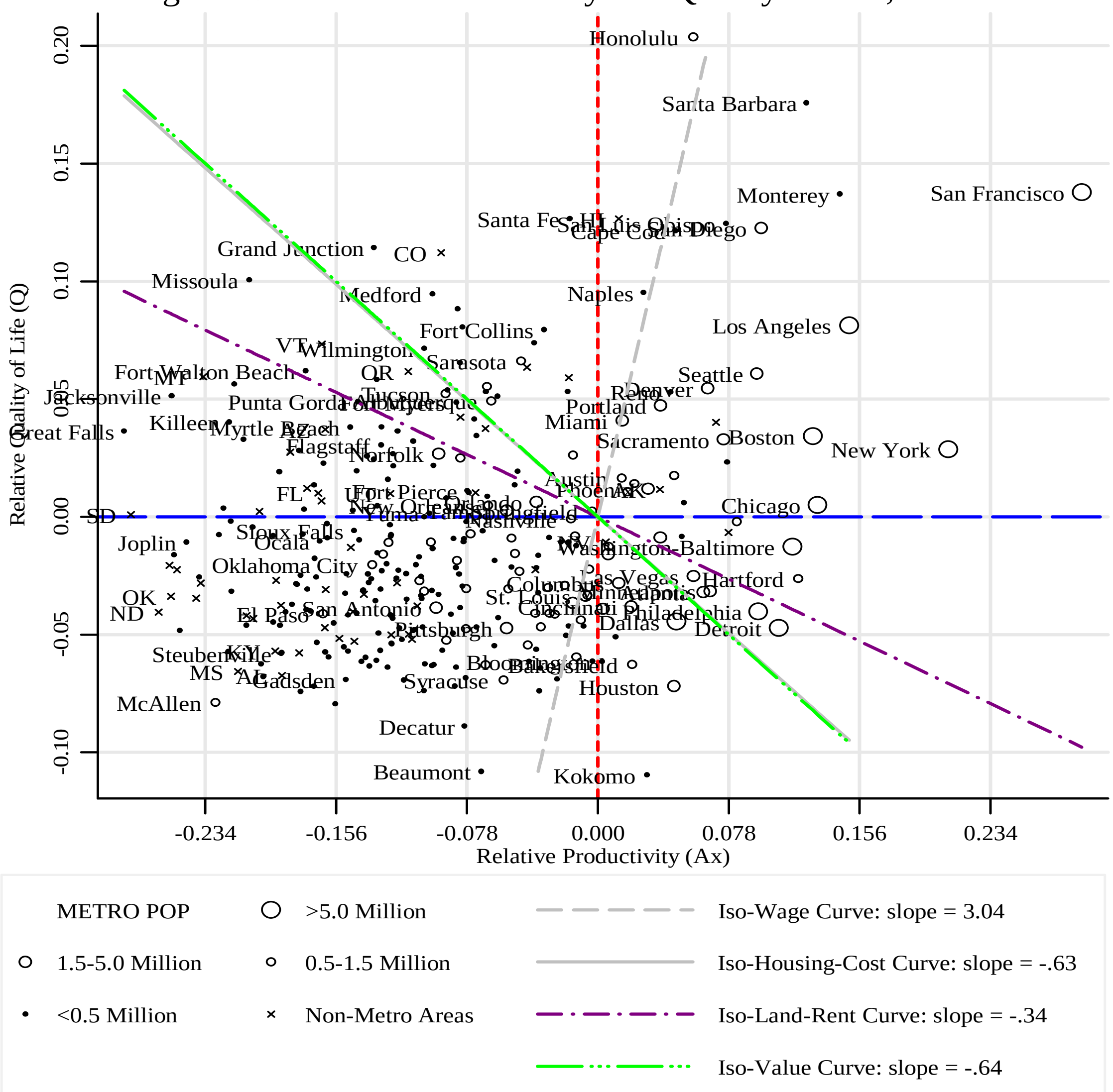


Figure 5: Productivity and Population Size

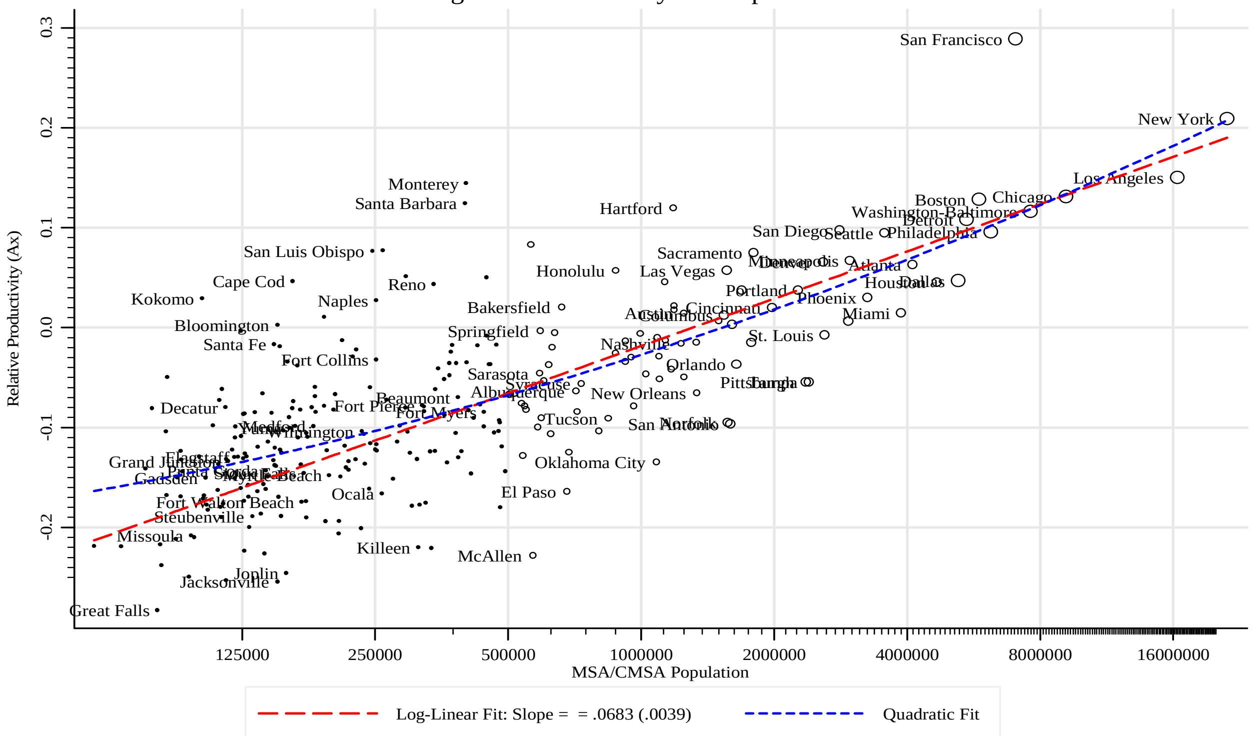


Figure 6: Trade-Productivity: Adjusted versus Unadjusted Estimates

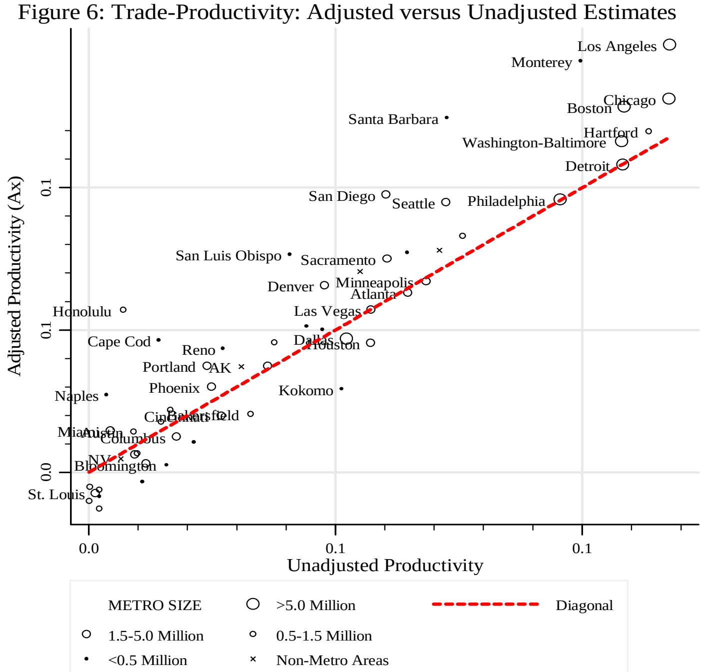
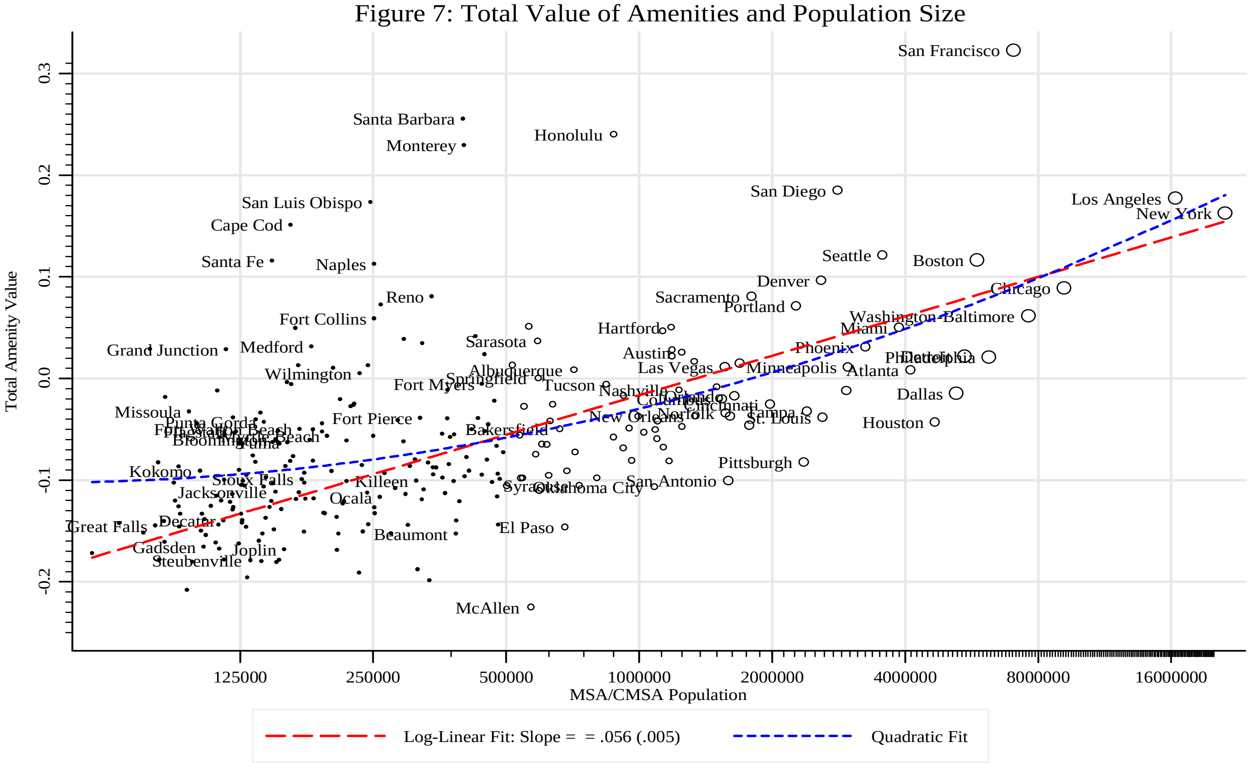


Figure 7: Total Value of Amenities and Population Size



APPENDIX TABLE A1: LIST OF METROPOLITAN AND NON-METROPOLITAN AREAS RANKED BY TOTAL AMENITY VALU

		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
San Francisco-Oakland-San Jose, CA	7,039,362	0.256	0.813	2.780	2.246	0.138	3	0.289	1	0.045	0.323	1
Santa Barbara-Santa Maria-Lompoc, CA	399,347	0.068	0.662	2.651	2.111	0.176	2	0.125	7	-0.010	0.255	2
Honolulu, HI	876,156	-0.010	0.605	2.620	2.069	0.204	1	0.057	22	-0.022	0.240	3
Salinas (Monterey-Carmel), CA	401,762	0.103	0.590	2.244	1.847	0.137	4	0.144	4	0.005	0.229	4
San Diego, CA	2,813,833	0.058	0.479	1.894	1.590	0.123	7	0.098	11	-0.004	0.185	5
Los Angeles-Riverside-Orange County, CA	16,373,645	0.129	0.450	1.573	1.369	0.081	14	0.150	3	0.020	0.177	6
San Luis Obispo-Atascadero-Paso Robles, CA	246,681	0.036	0.452	1.840	1.546	0.124	6	0.077	16	-0.011	0.173	7
New York, Northern New Jersey, Long Island, NY-NJ-CT-PA	21,199,864	0.209	0.411	1.184	1.077	0.029	51	0.209	2	0.044	0.163	8
Barnstable-Yarmouth (Cape Cod), MA	162,582	0.005	0.395	1.678	1.422	0.121	8	0.046	26	-0.017	0.151	9
Non-metro, HI	335,381	-0.029	0.332	1.504	1.285	0.126		0.013		-0.016	0.135	
Seattle-Tacoma-Bremerton, WA	3,554,760	0.078	0.308	1.103	0.992	0.061	22	0.095	13	0.011	0.121	10
Boston-Worcester-Lawrence, MA-NH-ME-CT	5,819,100	0.123	0.294	0.925	0.851	0.034	46	0.128	6	0.024	0.116	11
Santa Fe, NM	147,635	-0.060	0.290	1.408	1.206	0.127	5	-0.017	60	-0.025	0.116	12
Naples, FL	251,377	-0.004	0.286	1.239	1.087	0.095	11	0.027	34	-0.011	0.113	13
Denver-Boulder-Greeley, CO	2,581,506	0.051	0.240	0.888	0.812	0.054	26	0.066	19	0.008	0.097	14
Chicago-Gary-Kenosha, IL-IN-WI	9,157,540	0.136	0.224	0.585	0.558	0.005	80	0.131	5	0.030	0.089	15
Non-metro, RI	61,968	0.060	0.215	0.757	0.703	0.040		0.071		0.009	0.085	
Sacramento-Yolo, CA	1,796,857	0.067	0.206	0.699	0.653	0.033	48	0.075	17	0.011	0.081	16
Reno, NV	339,486	0.027	0.210	0.826	0.757	0.053	30	0.043	29	-0.002	0.081	17
Anchorage, AK	260,283	0.073	0.185	0.595	0.562	0.023	59	0.077	15	0.013	0.073	18
Portland-Salem, OR-WA	2,265,223	0.024	0.174	0.680	0.632	0.047	37	0.037	30	0.003	0.071	19
Washington-Baltimore, DC-MD-VA-WV	7,608,070	0.126	0.154	0.314	0.307	-0.013	122	0.116	9	0.030	0.062	20
Fort Collins-Loveland, CO	251,494	-0.061	0.150	0.808	0.730	0.079	16	-0.032	72	-0.022	0.059	21
Non-metro, CO	693,605	-0.137	0.137	0.962	0.843	0.112		-0.094		-0.044	0.052	
Stockton-Lodi, CA	563,598	0.088	0.126	0.296	0.289	-0.002	93	0.083	14	0.021	0.051	22
Hartford, CT	1,183,110	0.134	0.133	0.201	0.198	-0.026	155	0.120	8	0.030	0.050	23
Miami-Fort Lauderdale, FL	3,876,380	0.001	0.126	0.535	0.503	0.041	39	0.015	39	-0.003	0.050	24
Bellingham, WA	166,814	-0.065	0.127	0.726	0.660	0.074	17	-0.038	82	-0.023	0.050	25
Non-metro, CA	1,121,254	-0.040	0.134	0.686	0.630	0.059		-0.017		-0.021	0.048	
West Palm Beach-Boca Raton, FL	1,131,184	0.042	0.115	0.378	0.364	0.017	66	0.046	27	0.009	0.047	26
Non-metro, CT	148,665	0.083	0.119	0.285	0.279	-0.007		0.078		0.015	0.043	
Madison, WI	426,526	-0.038	0.110	0.574	0.533	0.053	28	-0.018	63	-0.016	0.042	27
New London-Norwich, CT-RI	293,566	0.050	0.110	0.332	0.321	0.006	79	0.051	23	0.006	0.039	28
Sarasota-Bradenton, FL	589,959	-0.071	0.094	0.595	0.548	0.066	19	-0.046	85	-0.023	0.037	29
Non-metro, MA	247,672	-0.068	0.108	0.652	0.597	0.063		-0.042		-0.029	0.036	
Non-metro, AK	366,649	0.035	0.090	0.292	0.283	0.012		0.037		0.006	0.035	
Eugene-Springfield, OR	322,959	-0.118	0.091	0.716	0.644	0.088	13	-0.084	127	-0.037	0.035	30
Medford-Ashland, OR	181,269	-0.136	0.084	0.736	0.658	0.095	12	-0.099	147	-0.042	0.031	31
Phoenix-Mesa, AZ	3,251,876	0.028	0.075	0.243	0.237	0.012	72	0.030	32	0.007	0.031	32
Corvalis, OR	78,153	-0.113	0.076	0.634	0.575	0.081	15	-0.081	122	-0.035	0.029	33
Grand Junction, CO	116,255	-0.180	0.079	0.833	0.731	0.114	9	-0.134	200	-0.055	0.029	34
Providence-Fall River-Warwick, RI-MA	1,188,613	0.018	0.073	0.262	0.255	0.014	69	0.022	35	0.002	0.028	35
Austin-San Marcos, TX	1,249,763	0.009	0.067	0.264	0.256	0.016	67	0.014	40	-0.001	0.026	36
Modesto, CA	446,997	0.056	0.059	0.098	0.098	-0.008	106	0.050	24	0.014	0.024	37
Detroit-Ann Arbor-Flint, MI	5,456,428	0.130	0.053	-0.130	-0.139	-0.047	215	0.108	10	0.035	0.022	38
Raleigh-Durham-Chapel Hill, NC	1,187,941	0.016	0.044	0.143	0.141	0.011	74	0.018	38	0.008	0.022	39
Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	6,188,463	0.114	0.052	-0.090	-0.096	-0.040	192	0.096	12	0.030	0.021	40

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		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
Salt Lake City-Ogden, UT	1,333,914	-0.024	0.038	0.226	0.219	0.026	55	-0.015	57	-0.006	0.017	41
Milwaukee-Racine, WI	1,689,572	0.043	0.032	0.018	0.017	-0.009	107	0.037	31	0.013	0.015	42
Colorado Springs, CO	516,929	-0.088	0.033	0.384	0.360	0.055	25	-0.066	103	-0.025	0.013	43
Portland, ME	243,537	-0.078	0.019	0.299	0.283	0.051	33	-0.060	97	-0.017	0.013	44
Burlington, VT	169,391	-0.107	0.021	0.386	0.359	0.065	20	-0.082	125	-0.026	0.013	45
Las Vegas, NV-AZ	1,563,282	0.068	0.029	-0.065	-0.067	-0.025	150	0.057	21	0.018	0.011	46
Minneapolis-St. Paul, MN-WI	2,968,806	0.082	0.020	-0.142	-0.149	-0.032	171	0.067	18	0.026	0.011	47
Chico-Paradise, CA	203,171	-0.090	0.043	0.432	0.402	0.053	29	-0.067	104	-0.033	0.010	48
Albuquerque, NM	712,738	-0.082	0.013	0.282	0.267	0.049	34	-0.064	100	-0.020	0.008	49
Atlanta, GA	4,112,198	0.078	0.014	-0.154	-0.161	-0.032	174	0.063	20	0.024	0.008	50
Wilmington, NC	233,450	-0.134	0.017	0.441	0.405	0.071	18	-0.104	155	-0.039	0.005	51
Springfield, MA	591,932	-0.006	0.009	0.055	0.055	0.002	87	-0.003	48	-0.005	0.000	52
Charlottesville, VA	159,576	-0.113	-0.003	0.300	0.281	0.054	27	-0.090	136	-0.034	-0.004	53
Fort Myers-Cape Coral, FL	440,888	-0.105	-0.014	0.228	0.215	0.049	36	-0.084	129	-0.028	-0.005	54
Non-metro, WA	994,967	-0.083	-0.014	0.170	0.162	0.037		-0.067		-0.022	-0.005	
Redding, CA	163,256	-0.094	0.001	0.263	0.248	0.041	38	-0.074	110	-0.032	-0.006	55
Tucson, AZ	843,746	-0.114	-0.010	0.268	0.252	0.052	31	-0.091	139	-0.033	-0.006	56
Non-metro, NV	250,521	0.008	-0.017	-0.097	-0.099	-0.011		0.005		0.002	-0.008	
Charlotte-Gastonia-Rock Hill, NC-SC	1,499,293	0.013	-0.033	-0.177	-0.182	-0.013	123	0.007	43	0.009	-0.008	57
Non-metro, NH	496,087	-0.100	-0.030	0.147	0.140	0.042		-0.082		-0.025	-0.010	
Non-metro, OR	919,033	-0.140	-0.024	0.284	0.264	0.062		-0.113		-0.039	-0.011	
Nashville, TN	1,231,311	-0.016	-0.030	-0.086	-0.086	-0.001	90	-0.016	59	-0.003	-0.011	58
Provo-Orem, UT	368,536	-0.056	-0.030	0.024	0.024	0.019	64	-0.048	87	-0.014	-0.011	59
Iowa City, IA	111,006	-0.087	-0.032	0.105	0.101	0.034	45	-0.072	109	-0.022	-0.012	60
Cleveland-Akron, OH	2,945,831	0.012	-0.032	-0.171	-0.176	-0.016	127	0.006	44	0.005	-0.012	61
Dallas-Fort Worth, TX	5,221,801	0.064	-0.037	-0.338	-0.360	-0.044	205	0.047	25	0.019	-0.014	62
Fresno, CA	922,516	-0.012	-0.039	-0.133	-0.135	-0.008	104	-0.014	56	-0.004	-0.017	63
Orlando, FL	1,644,561	-0.040	-0.046	-0.088	-0.088	0.006	78	-0.037	79	-0.008	-0.017	64
Pittsfield, MA	84,699	-0.058	-0.033	0.021	0.020	0.014	70	-0.050	89	-0.020	-0.018	65
Columbus, OH	1,540,157	0.023	-0.054	-0.296	-0.310	-0.028	159	0.013	41	0.009	-0.020	66
Merced, CA	210,554	-0.010	-0.048	-0.180	-0.184	-0.012	121	-0.013	55	-0.002	-0.020	67
Lancaster, PA	470,658	-0.015	-0.053	-0.188	-0.192	-0.011	117	-0.017	61	-0.003	-0.022	68
Green Bay, WI	226,778	-0.019	-0.064	-0.223	-0.229	-0.011	116	-0.022	66	-0.002	-0.025	69
Cincinnati-Hamilton, OH-KY-IN	1,979,202	0.035	-0.070	-0.394	-0.420	-0.038	186	0.020	37	0.014	-0.025	70
Allentown-Bethlehem-Easton, PA	637,958	0.002	-0.064	-0.280	-0.291	-0.022	141	-0.005	49	0.002	-0.026	71
Asheville, NC	225,965	-0.159	-0.060	0.181	0.167	0.058	23	-0.132	197	-0.044	-0.026	72
Yakima, WA	222,581	-0.027	-0.072	-0.236	-0.242	-0.009	108	-0.029	70	-0.004	-0.027	73
Charleston-North Charleston, SC	549,033	-0.095	-0.069	-0.036	-0.037	0.025	57	-0.082	123	-0.024	-0.028	74
Non-metro, VT	439,436	-0.197	-0.086	0.173	0.157	0.073		-0.165		-0.050	-0.032	
Tampa-St. Petersburg-Clearwater, FL	2,395,997	-0.057	-0.084	-0.204	-0.208	0.003	86	-0.054	94	-0.012	-0.032	75
Missoula, MT	95,802	-0.251	-0.090	0.306	0.271	0.101	10	-0.208	260	-0.063	-0.033	76
Yuba City, CA	139,149	-0.073	-0.074	-0.115	-0.116	0.009	76	-0.066	102	-0.022	-0.034	77
Norfolk-Virginia Beach-Newport News, VA-	1,569,541	-0.109	-0.081	-0.045	-0.047	0.027	53	-0.095	141	-0.029	-0.034	78
Non-metro, DE	156,638	-0.081	-0.088	-0.155	-0.157	0.010		-0.073		-0.021	-0.037	
New Orleans, LA	1,337,726	-0.070	-0.097	-0.224	-0.228	0.005	81	-0.065	101	-0.015	-0.037	79
Indianapolis, IN	1,607,486	0.017	-0.096	-0.459	-0.492	-0.039	189	0.003	45	0.009	-0.037	80
Richmond-Petersburg, VA	996,512	0.006	-0.098	-0.437	-0.466	-0.033	178	-0.006	50	0.006	-0.037	81

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		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
St. Louis, MO-IL	2,603,607	0.005	-0.104	-0.458	-0.489	-0.034	180	-0.007	51	0.008	-0.038	82
Bloomington, IN	120,563	-0.127	-0.090	-0.036	-0.038	0.032	49	-0.110	166	-0.035	-0.038	83
Fort Pierce-Port St. Lucie, FL	319,426	-0.085	-0.100	-0.197	-0.200	0.011	73	-0.078	113	-0.019	-0.039	84
Boise City, ID	432,345	-0.083	-0.109	-0.239	-0.243	0.010	75	-0.077	112	-0.015	-0.039	85
Visalia-Tulare-Porterville, CA	368,021	-0.032	-0.094	-0.315	-0.326	-0.016	130	-0.036	77	-0.008	-0.039	86
State College, PA	135,758	-0.139	-0.092	-0.010	-0.014	0.036	43	-0.120	173	-0.039	-0.040	87
Tallahassee, FL	284,539	-0.110	-0.106	-0.150	-0.152	0.022	61	-0.098	145	-0.026	-0.041	88
Harrisburg-Lebanon-Carlisle, PA	629,401	-0.011	-0.105	-0.420	-0.444	-0.029	162	-0.020	65	0.000	-0.042	89
Jacksonville, FL	1,100,491	-0.050	-0.110	-0.333	-0.345	-0.009	110	-0.051	90	-0.009	-0.042	90
Punta Gorda, FL	141,627	-0.167	-0.108	-0.006	-0.011	0.049	35	-0.143	212	-0.042	-0.043	91
Houston-Galveston-Brazoria, TX	4,669,571	0.073	-0.111	-0.675	-0.762	-0.072	267	0.045	28	0.025	-0.043	92
Richland-Kennewick-Pasco, WA	191,822	0.029	-0.117	-0.584	-0.640	-0.051	225	0.011	42	0.014	-0.044	93
Lawrence, KS	99,962	-0.148	-0.112	-0.070	-0.073	0.038	41	-0.129	190	-0.037	-0.045	94
Des Moines, IA	456,022	-0.030	-0.123	-0.444	-0.469	-0.022	140	-0.037	78	-0.001	-0.045	95
Kansas City, MO-KS	1,776,062	-0.001	-0.129	-0.547	-0.592	-0.037	184	-0.015	58	0.009	-0.046	96
Non-metro, MD	385,446	-0.033	-0.105	-0.360	-0.375	-0.022		-0.037		-0.010	-0.046	
Greensboro--Winston Salem--High Point, NC	1,251,509	-0.046	-0.126	-0.414	-0.435	-0.016	126	-0.049	88	-0.006	-0.047	97
Dayton-Springfield, OH	950,558	-0.021	-0.124	-0.475	-0.506	-0.030	164	-0.030	71	-0.002	-0.049	98
Bakersfield, CA	661,645	0.044	-0.132	-0.684	-0.767	-0.063	252	0.020	36	0.019	-0.050	99
Fort Walton Beach, FL	170,498	-0.204	-0.125	0.025	0.017	0.062	21	-0.174	241	-0.052	-0.050	100
Lafayette, IN	182,821	-0.070	-0.123	-0.336	-0.347	-0.006	98	-0.069	106	-0.016	-0.050	101
Spokane, WA	417,939	-0.097	-0.128	-0.281	-0.287	0.008	77	-0.090	138	-0.022	-0.050	102
Grand Rapids-Muskegon-Holland, MI	1,088,514	0.004	-0.122	-0.532	-0.575	-0.044	204	-0.010	53	0.003	-0.050	103
Bryan-College Station, TX	152,415	-0.138	-0.126	-0.162	-0.164	0.027	54	-0.122	176	-0.035	-0.051	104
Lansing-East Lansing, MI	447,728	0.006	-0.126	-0.557	-0.605	-0.046	211	-0.008	52	0.004	-0.052	105
Cedar Rapids, IA	191,701	-0.081	-0.137	-0.365	-0.378	-0.002	92	-0.078	115	-0.016	-0.052	106
Flagstaff, AZ-UT	122,366	-0.146	-0.128	-0.145	-0.147	0.030	50	-0.129	191	-0.038	-0.052	107
Louisville, KY-IN	1,025,598	-0.040	-0.138	-0.480	-0.510	-0.023	144	-0.047	86	-0.005	-0.053	108
Appleton-Oshkosh-Neenah, WI	358,365	-0.047	-0.138	-0.463	-0.489	-0.021	138	-0.052	91	-0.008	-0.054	109
York, PA	381,751	-0.026	-0.138	-0.518	-0.555	-0.032	175	-0.036	76	-0.003	-0.055	110
Columbia, SC	536,691	-0.076	-0.145	-0.410	-0.427	-0.007	99	-0.076	111	-0.015	-0.056	111
Lincoln, NE	250,291	-0.134	-0.150	-0.272	-0.277	0.022	62	-0.122	175	-0.029	-0.056	112
Myrtle Beach, SC	196,629	-0.169	-0.135	-0.116	-0.119	0.038	42	-0.148	217	-0.045	-0.057	113
Reading, PA	373,638	-0.002	-0.146	-0.618	-0.676	-0.046	210	-0.017	62	0.004	-0.057	114
Albany-Schenectady-Troy, NY	875,583	-0.014	-0.132	-0.526	-0.565	-0.041	198	-0.026	68	-0.005	-0.058	115
Sheboygan, WI	112,646	-0.058	-0.146	-0.465	-0.490	-0.019	133	-0.062	98	-0.011	-0.058	116
Rochester, NY	1,098,201	-0.018	-0.136	-0.532	-0.572	-0.041	195	-0.029	69	-0.006	-0.059	117
Bloomington-Normal, IL	150,433	0.024	-0.149	-0.705	-0.788	-0.061	248	0.003	46	0.011	-0.060	118
Champaign-Urbana, IL	179,669	-0.082	-0.142	-0.385	-0.400	-0.009	112	-0.080	119	-0.022	-0.060	119
Gainesville, FL	217,955	-0.148	-0.156	-0.262	-0.267	0.024	58	-0.134	201	-0.035	-0.061	120
Savannah, GA	293,000	-0.081	-0.151	-0.426	-0.445	-0.011	115	-0.080	120	-0.019	-0.062	121
Panama City, FL	148,217	-0.153	-0.159	-0.263	-0.267	0.026	56	-0.138	207	-0.036	-0.062	122
Janesville-Beloit, WI	152,307	-0.002	-0.164	-0.699	-0.775	-0.050	224	-0.019	64	0.007	-0.063	123
Yuma, AZ	160,026	-0.106	-0.158	-0.387	-0.401	0.002	88	-0.100	151	-0.024	-0.063	124
Rochester, MN	124,277	0.018	-0.164	-0.753	-0.848	-0.061	246	-0.003	47	0.012	-0.063	125
Athens, GA	153,444	-0.138	-0.153	-0.275	-0.281	0.016	68	-0.125	185	-0.037	-0.064	126
Dover, DE	126,697	-0.087	-0.158	-0.439	-0.458	-0.009	111	-0.086	133	-0.020	-0.064	127

APPENDIX TABLE A1: LIST OF METROPOLITAN AND NON-METROPOLITAN AREAS RANKED BY TOTAL AMENITY VALU

		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
Baton Rouge, LA	602,894	-0.045	-0.169	-0.601	-0.649	-0.031	166	-0.053	92	-0.005	-0.065	128
Toledo, OH	618,203	-0.025	-0.164	-0.636	-0.694	-0.041	196	-0.037	81	-0.001	-0.065	129
Melbourne-Titusville-Palm Bay, FL	476,230	-0.108	-0.171	-0.434	-0.452	0.000	89	-0.104	154	-0.023	-0.066	130
Non-metro, AZ	603,632	-0.184	-0.163	-0.194	-0.197	0.037		-0.163		-0.048	-0.067	
Memphis, TN-AR-MS	1,135,614	0.008	-0.178	-0.784	-0.886	-0.060	242	-0.013	54	0.011	-0.068	131
Birmingham, AL	921,106	-0.019	-0.179	-0.716	-0.794	-0.047	212	-0.034	73	0.003	-0.069	132
Non-metro, UT	524,673	-0.134	-0.171	-0.366	-0.376	0.010		-0.124		-0.033	-0.069	
Omaha, NE-IA	716,998	-0.080	-0.195	-0.617	-0.663	-0.019	134	-0.084	128	-0.011	-0.072	133
Daytona Beach, FL	493,175	-0.157	-0.185	-0.362	-0.372	0.019	63	-0.144	213	-0.036	-0.073	134
Little Rock-North Little Rock, AR	583,845	-0.099	-0.197	-0.572	-0.609	-0.011	119	-0.100	150	-0.017	-0.075	135
Greenville, NC	133,798	-0.081	-0.195	-0.613	-0.658	-0.022	139	-0.085	131	-0.014	-0.076	136
Tuscaloosa, AL	164,875	-0.098	-0.195	-0.564	-0.599	-0.013	124	-0.099	146	-0.020	-0.077	137
Canton-Massillon, OH	406,934	-0.079	-0.191	-0.602	-0.646	-0.024	148	-0.083	126	-0.017	-0.077	138
Fayetteville-Springdale-Rogers, AR	311,121	-0.139	-0.206	-0.503	-0.526	0.005	82	-0.132	195	-0.029	-0.080	139
Kalamazoo-Battle Creek, MI	452,851	-0.020	-0.196	-0.783	-0.878	-0.056	234	-0.037	80	-0.002	-0.080	140
Greenville-Spartanburg-Anderson, SC	962,441	-0.071	-0.210	-0.706	-0.771	-0.031	165	-0.078	114	-0.010	-0.081	141
Elkhart-Goshen, IN	182,791	-0.047	-0.204	-0.744	-0.822	-0.043	202	-0.059	96	-0.006	-0.081	142
Buffalo-Niagara Falls, NY	1,170,111	-0.027	-0.190	-0.742	-0.824	-0.054	231	-0.042	84	-0.007	-0.081	143
Benton Harbor, MI	162,453	-0.076	-0.194	-0.623	-0.671	-0.029	163	-0.081	121	-0.019	-0.081	144
Columbia, MO	135,454	-0.180	-0.204	-0.380	-0.390	0.023	60	-0.164	230	-0.044	-0.082	145
Pittsburgh, PA	2,358,695	-0.041	-0.207	-0.773	-0.860	-0.047	217	-0.054	93	-0.005	-0.082	146
Cheyenne, WY	81,607	-0.246	-0.214	-0.240	-0.245	0.056	24	-0.217	263	-0.059	-0.083	147
Montgomery, AL	333,055	-0.129	-0.209	-0.542	-0.570	-0.003	95	-0.124	183	-0.029	-0.083	148
Rockford, IL	371,236	-0.002	-0.211	-0.897	-1.033	-0.069	262	-0.024	67	0.005	-0.084	149
Roanoke, VA	235,932	-0.106	-0.212	-0.616	-0.658	-0.017	131	-0.107	162	-0.024	-0.085	150
Fayetteville, NC	302,963	-0.198	-0.209	-0.351	-0.359	0.028	52	-0.178	246	-0.051	-0.086	151
Jackson, MI	158,422	-0.014	-0.212	-0.870	-0.993	-0.064	259	-0.034	74	0.001	-0.086	152
Lewiston-Auburn, ME	90,830	-0.125	-0.229	-0.639	-0.683	-0.008	101	-0.123	180	-0.023	-0.087	153
Hickory-Morganton-Lenoir, NC	341,851	-0.127	-0.220	-0.592	-0.629	-0.008	105	-0.124	181	-0.028	-0.087	154
Peoria-Pekin, IL	347,387	-0.022	-0.217	-0.869	-0.989	-0.061	247	-0.041	83	-0.001	-0.088	155
Glens Falls, NY	124,345	-0.110	-0.204	-0.573	-0.608	-0.020	136	-0.109	163	-0.033	-0.090	156
Non-metro, ME	808,317	-0.201	-0.229	-0.426	-0.439	0.027		-0.184		-0.048	-0.090	
Pensacola, FL	412,153	-0.154	-0.232	-0.573	-0.604	0.003	85	-0.146	216	-0.034	-0.091	157
Kokomo, IN	101,541	0.069	-0.237	-1.208	-1.531	-0.110	276	0.029	33	0.030	-0.091	158
Knoxville, TN	687,249	-0.127	-0.231	-0.642	-0.686	-0.011	120	-0.125	184	-0.027	-0.091	159
Springfield, IL	201,437	-0.074	-0.222	-0.749	-0.823	-0.039	187	-0.082	124	-0.016	-0.091	160
Non-metro, MT	596,684	-0.266	-0.239	-0.294	-0.301	0.059		-0.236		-0.062	-0.091	
Tyler, TX	174,706	-0.102	-0.234	-0.722	-0.786	-0.025	151	-0.106	160	-0.021	-0.093	161
South Bend, IN	265,559	-0.060	-0.235	-0.842	-0.945	-0.047	214	-0.072	108	-0.009	-0.093	162
Lexington, KY	479,198	-0.088	-0.241	-0.790	-0.872	-0.033	177	-0.095	142	-0.015	-0.094	163
Huntsville, AL	342,376	-0.045	-0.244	-0.921	-1.053	-0.055	232	-0.062	99	-0.002	-0.094	164
Jackson, MS	440,801	-0.092	-0.246	-0.801	-0.886	-0.031	170	-0.099	149	-0.015	-0.095	165
Billings, MT	129,352	-0.180	-0.252	-0.582	-0.612	0.013	71	-0.169	236	-0.037	-0.095	166
Scranton--Wilkes-Barre--Hazleton, PA	624,776	-0.103	-0.236	-0.728	-0.793	-0.027	157	-0.106	161	-0.022	-0.095	167
Saginaw-Bay City-Midland, MI	403,070	-0.012	-0.239	-0.990	-1.158	-0.074	270	-0.035	75	0.003	-0.096	168
Non-metro, FL	1,144,881	-0.178	-0.247	-0.569	-0.597	0.010		-0.167		-0.040	-0.097	
Rocky Mount, NC	143,026	-0.111	-0.246	-0.750	-0.819	-0.024	145	-0.114	168	-0.022	-0.097	169

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		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
Davenport-Moline-Rock Island, IA-IL	359,062	-0.078	-0.245	-0.838	-0.936	-0.041	199	-0.088	135	-0.014	-0.098	170
Wichita, KS	545,220	-0.065	-0.257	-0.925	-1.052	-0.048	218	-0.079	116	-0.005	-0.098	171
Tulsa, OK	803,235	-0.096	-0.260	-0.849	-0.945	-0.032	172	-0.104	153	-0.013	-0.098	172
Mobile, AL	540,258	-0.129	-0.248	-0.709	-0.766	-0.016	128	-0.128	188	-0.027	-0.098	173
Non-metro, WY	345,642	-0.174	-0.256	-0.619	-0.655	0.007		-0.165		-0.037	-0.099	
Lakeland-Winter Haven, FL	483,924	-0.116	-0.254	-0.770	-0.842	-0.023	142	-0.119	172	-0.022	-0.099	174
Non-metro, ID	786,043	-0.186	-0.251	-0.565	-0.592	0.012		-0.174		-0.043	-0.099	
Sioux Falls, SD	172,412	-0.149	-0.258	-0.694	-0.745	-0.006	97	-0.146	215	-0.030	-0.099	175
Auburn-Opelika, AL	115,092	-0.132	-0.252	-0.716	-0.773	-0.015	125	-0.132	196	-0.028	-0.100	176
San Antonio, TX	1,592,383	-0.088	-0.254	-0.846	-0.943	-0.039	188	-0.097	143	-0.016	-0.100	177
Killeen-Temple, TX	312,952	-0.245	-0.249	-0.393	-0.404	0.040	40	-0.220	266	-0.061	-0.101	178
La Crosse, WI-MN	126,838	-0.126	-0.247	-0.713	-0.771	-0.020	135	-0.126	187	-0.029	-0.101	179
Amarillo, TX	217,858	-0.146	-0.253	-0.684	-0.734	-0.010	113	-0.142	211	-0.033	-0.101	180
Corpus Christi, TX	380,783	-0.099	-0.255	-0.820	-0.908	-0.034	179	-0.105	159	-0.019	-0.101	181
Chattanooga, TN-GA	465,161	-0.098	-0.258	-0.837	-0.930	-0.035	181	-0.105	158	-0.018	-0.102	182
Las Cruces, NM	174,682	-0.205	-0.261	-0.554	-0.579	0.019	65	-0.190	254	-0.047	-0.102	183
Rapid City, SD	88,565	-0.232	-0.266	-0.501	-0.520	0.033	47	-0.212	262	-0.052	-0.102	184
Eau Claire, WI	148,337	-0.118	-0.256	-0.772	-0.845	-0.026	154	-0.120	174	-0.026	-0.103	185
Wausau, WI	125,834	-0.074	-0.265	-0.934	-1.063	-0.049	222	-0.086	134	-0.011	-0.105	186
Non-metro, WI	1,723,367	-0.116	-0.260	-0.795	-0.873	-0.028		-0.120		-0.025	-0.105	
Syracuse, NY	732,117	-0.037	-0.251	-0.973	-1.127	-0.069	264	-0.056	95	-0.008	-0.105	187
Waterloo-Cedar Falls, IA	128,012	-0.127	-0.271	-0.813	-0.894	-0.023	143	-0.129	189	-0.024	-0.106	188
Fort Wayne, IN	502,141	-0.049	-0.268	-1.014	-1.180	-0.063	254	-0.067	105	-0.004	-0.106	189
Pueblo, CO	141,472	-0.168	-0.269	-0.689	-0.737	-0.003	94	-0.162	228	-0.038	-0.106	190
Oklahoma City, OK	1,083,346	-0.133	-0.278	-0.826	-0.909	-0.020	137	-0.135	202	-0.024	-0.107	191
Non-metro, MI	1,768,978	-0.102	-0.258	-0.826	-0.915	-0.038		-0.108		-0.024	-0.107	
Non-metro, NC	2,612,257	-0.150	-0.268	-0.736	-0.796	-0.013		-0.148		-0.034	-0.108	
Erie, PA	280,843	-0.108	-0.268	-0.854	-0.949	-0.035	182	-0.114	167	-0.023	-0.108	192
Springfield, MO	325,721	-0.185	-0.272	-0.658	-0.699	0.003	84	-0.175	242	-0.043	-0.109	193
Youngstown-Warren, OH	594,746	-0.077	-0.276	-0.970	-1.111	-0.052	227	-0.090	137	-0.013	-0.110	194
Jacksonville, NC	150,355	-0.286	-0.264	-0.344	-0.353	0.051	32	-0.254	275	-0.077	-0.111	195
Topeka, KS	169,871	-0.135	-0.286	-0.854	-0.944	-0.024	147	-0.137	206	-0.027	-0.112	196
Lubbock, TX	242,628	-0.166	-0.282	-0.750	-0.810	-0.009	109	-0.161	227	-0.037	-0.112	197
Biloxi-Gulfport-Pascagoula, MS	363,988	-0.132	-0.289	-0.875	-0.971	-0.026	156	-0.135	203	-0.025	-0.113	198
Evansville-Henderson, IN-KY	296,195	-0.093	-0.286	-0.970	-1.105	-0.047	213	-0.104	157	-0.017	-0.114	199
Williamsport, PA	120,044	-0.126	-0.282	-0.861	-0.955	-0.031	168	-0.130	192	-0.028	-0.114	200
Sherman-Denison, TX	110,595	-0.134	-0.291	-0.879	-0.976	-0.028	158	-0.137	205	-0.028	-0.115	201
Augusta-Aiken, GA-SC	477,441	-0.078	-0.294	-1.046	-1.216	-0.057	235	-0.093	140	-0.012	-0.116	202
Ocala, FL	258,916	-0.170	-0.298	-0.810	-0.883	-0.010	114	-0.166	232	-0.036	-0.117	203
Lake Charles, LA	183,577	-0.066	-0.303	-1.118	-1.324	-0.064	258	-0.085	130	-0.006	-0.118	204
Mansfield, OH	175,818	-0.099	-0.294	-0.988	-1.129	-0.048	219	-0.110	164	-0.019	-0.118	205
St. Cloud, MN	167,392	-0.100	-0.290	-0.969	-1.103	-0.048	220	-0.110	165	-0.022	-0.119	206
Macon, GA	322,549	-0.059	-0.299	-1.117	-1.326	-0.068	261	-0.079	117	-0.007	-0.119	207
Goldsboro, NC	113,329	-0.183	-0.297	-0.771	-0.833	-0.007	100	-0.176	243	-0.043	-0.120	208
Dubuque, IA	89,143	-0.148	-0.307	-0.909	-1.012	-0.024	146	-0.150	220	-0.029	-0.120	209
Monroe, LA	147,250	-0.126	-0.307	-0.966	-1.092	-0.036	183	-0.133	199	-0.024	-0.121	210
Lynchburg, VA	214,911	-0.137	-0.300	-0.911	-1.017	-0.031	169	-0.140	209	-0.030	-0.121	211

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		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity			Total Amenity Values	
Full Name of Metropolitan Area	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank	Federal Tax Differential	Value	Rank
Shreveport-Bossier City, LA	392,302	-0.115	-0.308	-1.004	-1.146	-0.042	201	-0.124	182	-0.021	-0.121	212
Muncie, IN	118,769	-0.114	-0.304	-0.989	-1.126	-0.043	203	-0.122	177	-0.023	-0.121	213
Non-metro, IN	1,690,582	-0.101	-0.306	-1.033	-1.190	-0.050		-0.113		-0.019	-0.122	
Non-metro, SC	1,205,050	-0.135	-0.311	-0.960	-1.082	-0.033		-0.140		-0.026	-0.122	
Non-metro, OH	2,139,364	-0.099	-0.306	-1.041	-1.202	-0.052		-0.111		-0.019	-0.123	
Waco, TX	213,517	-0.108	-0.311	-1.038	-1.195	-0.047	216	-0.118	171	-0.019	-0.123	214
Jackson, TN	107,377	-0.080	-0.322	-1.157	-1.377	-0.063	253	-0.098	144	-0.010	-0.125	215
Bangor, ME	90,864	-0.170	-0.324	-0.921	-1.023	-0.018	132	-0.169	235	-0.034	-0.126	216
Decatur, AL	145,867	-0.064	-0.326	-1.220	-1.480	-0.072	266	-0.085	132	-0.005	-0.126	217
Albany, GA	120,822	-0.082	-0.316	-1.129	-1.334	-0.063	255	-0.099	148	-0.014	-0.127	218
Charleston, WV	251,662	-0.103	-0.331	-1.133	-1.332	-0.052	226	-0.117	170	-0.014	-0.127	219
Non-metro, NM	783,991	-0.212	-0.324	-0.806	-0.872	0.002		-0.202		-0.046	-0.127	
Lima, OH	155,084	-0.087	-0.322	-1.139	-1.347	-0.062	251	-0.103	152	-0.015	-0.129	220
Sharon, PA	120,293	-0.147	-0.319	-0.963	-1.083	-0.033	176	-0.151	222	-0.033	-0.129	221
Non-metro, NY	1,503,399	-0.115	-0.304	-0.985	-1.121	-0.050		-0.123		-0.031	-0.129	
Laredo, TX	193,117	-0.200	-0.332	-0.870	-0.952	-0.008	103	-0.194	256	-0.045	-0.132	222
Binghamton, NY	252,320	-0.114	-0.313	-1.028	-1.179	-0.054	229	-0.123	179	-0.030	-0.133	223
Houma, LA	194,477	-0.110	-0.338	-1.146	-1.350	-0.054	230	-0.123	178	-0.018	-0.133	224
Owensboro, KY	91,545	-0.136	-0.338	-1.074	-1.236	-0.041	194	-0.144	214	-0.026	-0.133	225
St. Joseph, MO	102,490	-0.167	-0.335	-0.976	-1.096	-0.026	152	-0.168	234	-0.036	-0.133	226
Florence, SC	125,761	-0.120	-0.341	-1.131	-1.324	-0.049	223	-0.131	194	-0.020	-0.133	227
Non-metro, GA	2,519,789	-0.140	-0.330	-1.029	-1.173	-0.040		-0.146		-0.031	-0.134	
Non-metro, VA	1,550,447	-0.160	-0.334	-0.992	-1.118	-0.031		-0.162		-0.036	-0.135	
Clarksville-Hopkinsville, TN-KY	207,033	-0.214	-0.342	-0.877	-0.959	-0.004	96	-0.206	259	-0.049	-0.136	228
Florence, AL	142,950	-0.142	-0.348	-1.102	-1.275	-0.042	200	-0.149	218	-0.027	-0.137	229
San Angelo, TX	104,010	-0.177	-0.348	-1.006	-1.132	-0.025	149	-0.177	244	-0.038	-0.138	230
Abilene, TX	126,555	-0.235	-0.349	-0.848	-0.920	0.004	83	-0.223	268	-0.055	-0.139	231
Decatur, IL	114,706	-0.053	-0.349	-1.349	-1.699	-0.089	274	-0.080	118	-0.005	-0.140	232
Lafayette, LA	385,647	-0.116	-0.356	-1.207	-1.438	-0.057	236	-0.130	193	-0.019	-0.140	233
Victoria, TX	84,088	-0.083	-0.356	-1.299	-1.598	-0.074	269	-0.104	156	-0.010	-0.140	234
Alexandria, LA	126,337	-0.171	-0.358	-1.064	-1.213	-0.031	167	-0.173	239	-0.035	-0.142	235
Casper, WY	66,533	-0.228	-0.366	-0.941	-1.038	-0.002	91	-0.219	265	-0.048	-0.142	236
Duluth-Superior, MN-WI	243,815	-0.098	-0.356	-1.254	-1.519	-0.069	265	-0.116	169	-0.018	-0.143	237
Johnson City-Kingsport-Bristol, TN-VA	480,091	-0.179	-0.363	-1.064	-1.211	-0.028	160	-0.180	248	-0.037	-0.144	238
Hattiesburg, MS	111,674	-0.178	-0.364	-1.071	-1.221	-0.029	161	-0.180	247	-0.037	-0.144	239
Utica-Rome, NY	299,896	-0.112	-0.342	-1.159	-1.367	-0.064	257	-0.125	186	-0.028	-0.144	240
Great Falls, MT	80,357	-0.307	-0.373	-0.755	-0.801	0.036	44	-0.283	276	-0.069	-0.145	241
Elmira, NY	91,070	-0.120	-0.345	-1.148	-1.348	-0.061	245	-0.132	198	-0.031	-0.146	242
Altoona, PA	129,144	-0.150	-0.363	-1.142	-1.330	-0.045	207	-0.158	225	-0.032	-0.146	243
Non-metro, PA	1,889,525	-0.135	-0.364	-1.190	-1.405	-0.053		-0.145		-0.027	-0.146	
El Paso, TX	679,622	-0.158	-0.369	-1.148	-1.336	-0.041	197	-0.164	231	-0.031	-0.146	244
Terre Haute, IN	149,192	-0.125	-0.372	-1.251	-1.502	-0.060	244	-0.139	208	-0.023	-0.148	245
Cumberland, MD-WV	102,008	-0.167	-0.365	-1.102	-1.267	-0.040	191	-0.171	238	-0.039	-0.150	246
Non-metro, IA	1,600,191	-0.192	-0.381	-1.105	-1.264	-0.027		-0.192		-0.039	-0.150	
Non-metro, IL	1,877,585	-0.145	-0.369	-1.182	-1.389	-0.052		-0.154		-0.032	-0.150	
Odessa-Midland, TX	237,132	-0.121	-0.382	-1.304	-1.588	-0.063	256	-0.136	204	-0.020	-0.151	247
Fargo-Moorhead, ND-MN	174,367	-0.168	-0.382	-1.174	-1.370	-0.039	190	-0.174	240	-0.033	-0.151	248

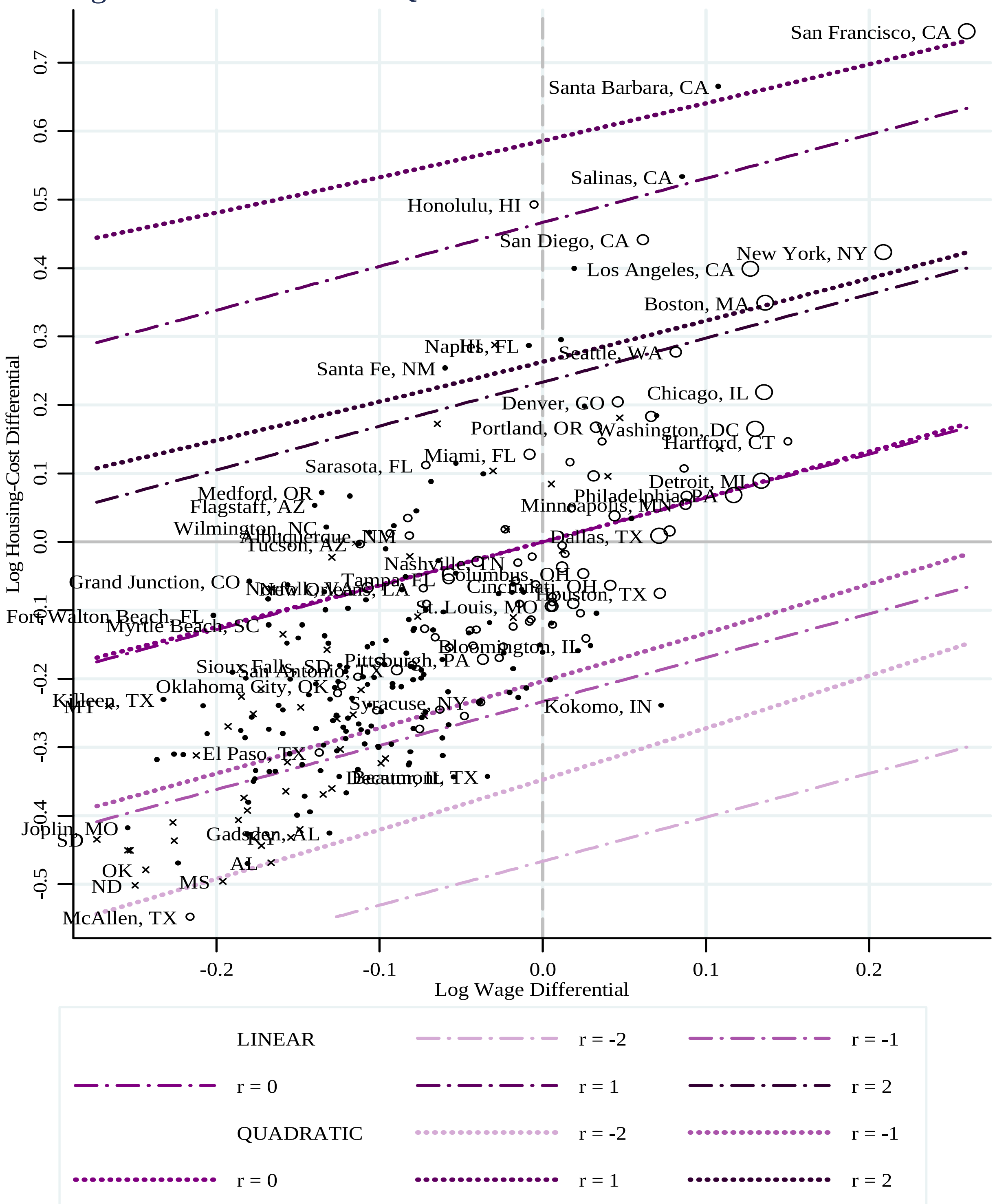
APPENDIX TABLE A1: LIST OF METROPOLITAN AND NON-METROPOLITAN AREAS RANKED BY TOTAL AMENITY VALUI

Full Name of Metropolitan Area	Population	Adjusted Differentials: Wages	Adjusted Differentials: Housing Costs	Land Rents: Linear	Land Rents: Quadratic	Quality of Life: Value	Quality of Life: Rank	Trade-Productivity: Value	Trade-Productivity: Rank	Federal Tax Differential	Total Amenity Values: Value	Total Amenity Values: Rank
Non-metro, MN	1,456,119	-0.157	-0.367	-1.142	-1.327	-0.047		-0.163		-0.037	-0.151	
Pocatello, ID	75,565	-0.125	-0.396	-1.355	-1.669	-0.061	249	-0.141	210	-0.016	-0.152	249
Columbus, GA-AL	274,624	-0.140	-0.379	-1.237	-1.473	-0.055	233	-0.152	223	-0.029	-0.152	250
Wichita Falls, TX	140,518	-0.234	-0.383	-0.995	-1.106	-0.008	102	-0.226	269	-0.053	-0.152	251
Longview-Marshall, TX	208,780	-0.136	-0.386	-1.280	-1.542	-0.057	237	-0.149	219	-0.025	-0.152	252
Beaumont-Port Arthur, TX	385,090	-0.035	-0.390	-1.574	-2.147	-0.108	275	-0.070	107	0.005	-0.153	253
Sumter, SC	104,646	-0.178	-0.388	-1.170	-1.361	-0.037	185	-0.182	249	-0.037	-0.154	254
Non-metro, TN	1,827,139	-0.185	-0.403	-1.219	-1.430	-0.038		-0.189		-0.037	-0.159	
Dothan, AL	137,916	-0.181	-0.404	-1.232	-1.450	-0.04	193	-0.186	250	-0.037	-0.160	255
Pine Bluff, AR	84,278	-0.156	-0.416	-1.353	-1.651	-0.053	228	-0.168	233	-0.025	-0.161	256
Danville, VA	110,156	-0.151	-0.403	-1.312	-1.586	-0.057	239	-0.163	229	-0.030	-0.162	257
Sioux City, IA-NE	124,130	-0.147	-0.417	-1.385	-1.708	-0.06	243	-0.161	226	-0.024	-0.162	258
Gadsden, AL	103,459	-0.133	-0.421	-1.440	-1.810	-0.069	263	-0.15	221	-0.021	-0.165	259
Anniston, AL	112,249	-0.183	-0.424	-1.314	-1.576	-0.046	209	-0.19	253	-0.036	-0.168	260
Joplin, MO	157,322	-0.254	-0.417	-1.086	-1.223	-0.011	118	-0.246	272	-0.059	-0.168	261
Fort Smith, AR-OK	207,290	-0.187	-0.433	-1.343	-1.620	-0.045	206	-0.194	255	-0.034	-0.169	262
Enid, OK	57,813	-0.218	-0.435	-1.267	-1.490	-0.032	173	-0.219	264	-0.045	-0.172	263
Non-metro, LA	1,098,766	-0.167	-0.435	-1.406	-1.733	-0.058		-0.178		-0.031	-0.172	
Non-metro, TX	3,159,940	-0.200	-0.442	-1.341	-1.611	-0.043		-0.206		-0.041	-0.175	
Non-metro, WV	1,042,776	-0.205	-0.445	-1.345	-1.614	-0.042		-0.21		-0.042	-0.176	
Non-metro, SD	493,867	-0.291	-0.457	-1.157	-1.310	0.001		-0.279		-0.062	-0.178	
Jonesboro, AR	82,148	-0.240	-0.452	-1.277	-1.498	-0.026	153	-0.238	271	-0.050	-0.178	264
Lawton, OK	114,996	-0.260	-0.448	-1.204	-1.384	-0.016	129	-0.253	274	-0.058	-0.178	265
Wheeling, WV-OH	153,172	-0.178	-0.448	-1.430	-1.767	-0.058	240	-0.189	251	-0.035	-0.178	266
Steubenville-Weirton, OH-WV	132,008	-0.178	-0.448	-1.429	-1.766	-0.058	241	-0.189	252	-0.036	-0.179	267
Jamestown, NY	139,750	-0.140	-0.430	-1.459	-1.840	-0.079	273	-0.157	224	-0.034	-0.180	268
Non-metro, AR	1,352,381	-0.238	-0.457	-1.306	-1.541	-0.028		-0.237		-0.049	-0.180	
Non-metro, KY	2,068,667	-0.182	-0.456	-1.456	-1.810	-0.057		-0.193		-0.035	-0.180	
Grand Forks, ND-MN	97,478	-0.204	-0.455	-1.387	-1.683	-0.046	208	-0.21	261	-0.042	-0.180	269
Parkersburg-Marietta, WV-OH	151,237	-0.153	-0.457	-1.537	-1.975	-0.072	268	-0.17	237	-0.027	-0.180	270
Non-metro, MO	1,800,410	-0.256	-0.456	-1.248	-1.449	-0.023		-0.251		-0.059	-0.183	
Non-metro, NE	811,425	-0.261	-0.464	-1.271	-1.481	-0.021		-0.256		-0.057	-0.184	
Huntington-Ashland, WV-KY-OH	315,538	-0.160	-0.477	-1.603	-2.098	-0.074	271	-0.177	245	-0.027	-0.188	271
Non-metro, KS	1,167,355	-0.240	-0.469	-1.351	-1.611	-0.035		-0.24		-0.053	-0.188	
Non-metro, AL	1,338,141	-0.174	-0.477	-1.568	-2.019	-0.067		-0.189		-0.031	-0.188	
Johnstown, PA	232,621	-0.190	-0.476	-1.519	-1.917	-0.062	250	-0.201	258	-0.039	-0.191	272
Texarkana, TX-Texarkana, AR	129,749	-0.185	-0.498	-1.625	-2.124	-0.068	260	-0.2	257	-0.033	-0.196	273
Non-metro, OK	1,352,292	-0.255	-0.496	-1.424	-1.720	-0.034		-0.255		-0.054	-0.197	
Brownsville-Harlingen-San Benito, TX	335,227	-0.211	-0.502	-1.570	-1.998	-0.057	238	-0.221	267	-0.041	-0.198	274
Non-metro, MS	1,820,996	-0.202	-0.517	-1.660	-2.180	-0.066		-0.215		-0.037	-0.203	
Bismarck, ND	94,719	-0.244	-0.532	-1.610	-2.052	-0.048	221	-0.25	273	-0.047	-0.208	275
Non-metro, ND	358,234	-0.260	-0.532	-1.565	-1.959	-0.041		-0.262		-0.052	-0.208	
McAllen-Edinburg-Mission, TX	569,463	-0.212	-0.570	-1.861	-2.641	-0.079	272	-0.228	270	-0.039	-0.225	276

APPENDIX TABLE A2: LIST OF STATES RANKED BY TOTAL AMENITY VALUE

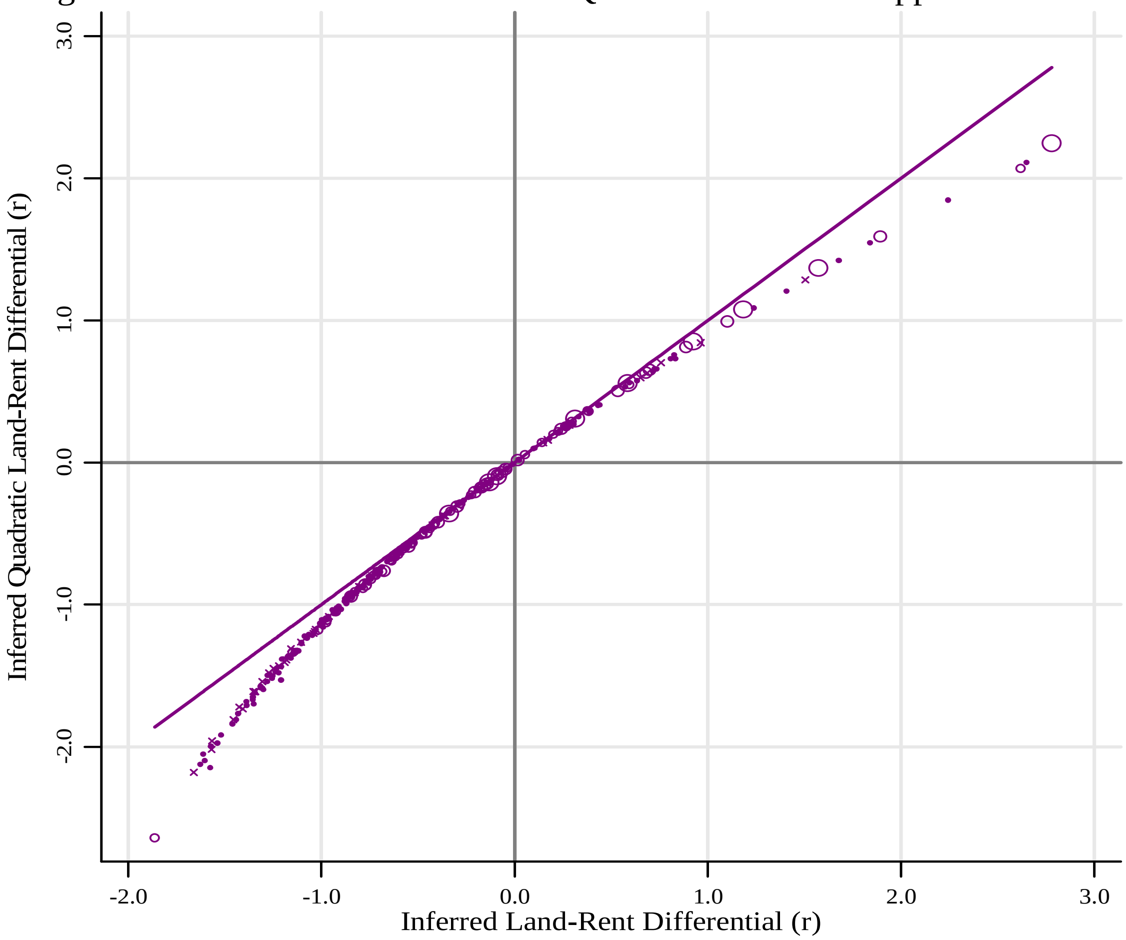
		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity		Federal Tax Differential	Total Amenity Values	
State Name	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank		Value	Rank
Hawaii	1,211,537	-0.015	0.530	2.311	1.852	0.182	1	0.045	10	-0.02	0.211	1
California	33,871,648	0.126	0.458	1.615	1.360	0.085	2	0.148	3	0.019	0.18	2
New Jersey	8,414,350	0.189	0.336	0.919	0.832	0.012	18	0.186	1	0.039	0.131	3
Connecticut	3,405,565	0.165	0.278	0.737	0.678	0.006	20	0.160	2	0.034	0.108	4
Massachusetts	6,349,097	0.094	0.251	0.816	0.749	0.034	9	0.101	5	0.017	0.098	5
New York	18,976,457	0.120	0.199	0.524	0.416	0.003	22	0.116	4	0.025	0.077	6
Washington	5,894,121	0.026	0.181	0.706	0.631	0.046	7	0.040	12	0.001	0.072	7
Colorado	4,301,261	-0.016	0.172	0.781	0.705	0.065	4	0.006	16	-0.01	0.069	8
New Hampshire	1,235,786	0.033	0.164	0.613	0.566	0.037	8	0.044	11	0.004	0.065	9
District of Columbia	572,059	0.126	0.154	0.314	0.307	-0.015	.	0.116	.	0.028	0.059	.
Alaska	626,932	0.050	0.130	0.418	0.399	0.016	15	0.054	8	0.009	0.051	10
Maryland	5,296,486	0.110	0.126	0.239	0.229	-0.016	29	0.101	6	0.025	0.049	11
Oregon	3,421,399	-0.045	0.106	0.579	0.534	0.058	5	-0.024	20	-0.015	0.043	12
Rhode Island	1,048,319	0.021	0.082	0.294	0.283	0.016	16	0.026	15	0.003	0.032	13
Illinois	12,419,293	0.065	0.063	0.091	0.025	-0.013	26	0.058	7	0.015	0.024	14
Nevada	1,998,257	0.054	0.054	0.082	0.069	-0.010	25	0.048	9	0.012	0.021	15
Arizona	5,130,632	-0.027	0.019	0.158	0.150	0.021	13	-0.019	17	-0.008	0.008	16
Delaware	783,600	0.043	-0.010	-0.159	-0.167	-0.025	33	0.033	14	0.011	-0.005	17
Utah	2,233,169	-0.055	-0.023	0.053	0.046	0.021	12	-0.046	26	-0.014	-0.008	18
Florida	15,982,378	-0.060	-0.036	0.013	-0.009	0.020	14	-0.051	27	-0.015	-0.013	19
Vermont	608,827	-0.172	-0.056	0.232	0.213	0.071	3	-0.142	39	-0.043	-0.02	20
Michigan	9,938,444	0.051	-0.061	-0.402	-0.444	-0.047	49	0.034	13	0.015	-0.025	21
Virginia	7,078,515	-0.035	-0.085	-0.268	-0.313	-0.010	24	-0.036	23	-0.006	-0.033	22
Wisconsin	5,363,675	-0.035	-0.099	-0.328	-0.371	-0.014	28	-0.038	24	-0.006	-0.039	23
New Mexico	1,819,046	-0.148	-0.136	-0.176	-0.229	0.032	10	-0.132	36	-0.034	-0.052	24
Minnesota	4,919,479	-0.009	-0.134	-0.548	-0.629	-0.039	43	-0.021	18	0.002	-0.053	25
Pennsylvania	12,281,054	-0.011	-0.135	-0.549	-0.623	-0.039	41	-0.023	19	0.001	-0.054	26
North Carolina	8,049,313	-0.084	-0.141	-0.373	-0.403	-0.003	23	-0.081	29	-0.017	-0.055	27
Ohio	11,353,140	-0.024	-0.143	-0.548	-0.614	-0.035	39	-0.034	22	-0.002	-0.057	28
Georgia	8,186,453	-0.021	-0.145	-0.562	-0.637	-0.037	40	-0.032	21	-0.001	-0.057	29
Maine	1,274,923	-0.160	-0.171	-0.294	-0.318	0.027	11	-0.145	41	-0.036	-0.066	30
Indiana	6,080,485	-0.031	-0.168	-0.633	-0.730	-0.039	42	-0.043	25	-0.003	-0.066	31
Texas	20,851,820	-0.041	-0.203	-0.754	-0.891	-0.045	46	-0.054	28	-0.005	-0.08	32
Idaho	1,293,953	-0.148	-0.212	-0.502	-0.538	0.007	19	-0.139	38	-0.032	-0.082	33
South Carolina	4,012,012	-0.100	-0.214	-0.640	-0.713	-0.018	30	-0.102	30	-0.019	-0.083	34
Montana	902,195	-0.256	-0.237	-0.313	-0.330	0.055	6	-0.227	48	-0.059	-0.09	35
Missouri	5,595,211	-0.106	-0.247	-0.766	-0.859	-0.026	34	-0.111	32	-0.02	-0.097	36
Tennessee	5,689,283	-0.101	-0.249	-0.787	-0.899	-0.029	36	-0.107	31	-0.019	-0.097	37
Wyoming	493,782	-0.193	-0.264	-0.599	-0.639	0.014	17	-0.181	46	-0.042	-0.102	38
Louisiana	4,468,976	-0.104	-0.264	-0.844	-0.990	-0.032	37	-0.111	33	-0.019	-0.103	39
Iowa	2,926,324	-0.140	-0.293	-0.870	-0.986	-0.024	32	-0.142	40	-0.027	-0.114	40
Kansas	2,688,418	-0.132	-0.312	-0.975	-1.131	-0.034	38	-0.137	37	-0.025	-0.122	41
Nebraska	1,711,263	-0.174	-0.319	-0.886	-1.007	-0.014	27	-0.172	43	-0.035	-0.124	42
Alabama	4,447,100	-0.114	-0.318	-1.051	-1.264	-0.046	48	-0.124	34	-0.02	-0.125	43
Kentucky	4,041,769	-0.121	-0.326	-1.066	-1.286	-0.045	45	-0.130	35	-0.021	-0.128	44
Arkansas	2,673,400	-0.185	-0.364	-1.050	-1.223	-0.023	31	-0.185	47	-0.037	-0.142	45
Oklahoma	3,450,654	-0.178	-0.369	-1.091	-1.269	-0.029	35	-0.181	45	-0.035	-0.144	46
South Dakota	754,844	-0.252	-0.389	-0.974	-1.088	0.003	21	-0.240	50	-0.053	-0.151	47
West Virginia	1,808,344	-0.161	-0.392	-1.239	-1.511	-0.045	47	-0.169	42	-0.03	-0.154	48
Mississippi	2,844,658	-0.167	-0.427	-1.370	-1.738	-0.054	50	-0.178	44	-0.03	-0.167	49
North Dakota	642,200	-0.234	-0.495	-1.478	-1.831	-0.041	44	-0.238	49	-0.046	-0.193	50

Figure A1: Linear versus Quadratic Inference of Land-Rent Differentials



Iso-rent curves based on calibration: phiL =.233333, phiN =.616667, sigmaY =.666667

Figure A2: Land Rents Inferred with Quadratic vs Linear Approximation



Quadratic inferred land rents based on calibration: phiL =0.2333, phiN =0.6167, sigmaY =0.6667