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What Are Cities Worth? Land Rents, Local Productivity, and the Capitalization of Amenity Values
David Albouy
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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

Economists from Ricardo (1817) to George (1879), Tiebout (1956), Oates (1969), Arnott and Stiglitz (1979) and others have explained how the economic value of local site characteristics, or "amenities," may be reflected in land rents. In principle, differences in the total value of local amenities across cities – or what cities are "worth" – may be estimated from land-rent differences, while the value of individual amenities may be inferred from land rents using hedonic techniques.[1] Amenities – which range from local taxes, public infrastructure, and pollution – are said to be for consumption when they raise the quality of life of households and for production when they lower the costs of firms, although some amenities do both.

Measuring the value of amenities across cities is made difficult by the fact that comparable data on land rents or values are exceedingly rare. However, amenities also affect more measurable prices, including the cost of housing, as housing services are produced from land as well as other inputs. Across local labor markets, amenity values are reflected in local wages, as firms may pay less in areas with consumption amenities and more in areas with production amenities, distinguishing the two amenity types. In a general-equilibrium model, Roback (1980, 1982) uses duality theory to demonstrate the dependence of wages, land rents, and housing costs on local amenity values with three equilibrium equations: the first, for households; the second, for producers of goods tradable across cities; and the third, for producers of non-tradables, including housing. This elegant model, presented in Sections 2.1 and 2.2 and log-linearized in Section 2.4, is popular as it requires data only on prices, not on quantities, to value amenities. However, the third equation, relating housing costs to local wages and land rents, has been ignored in empirical applications, which have relied on a less realistic two-equation model that equates housing with land.[2] This

[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. Since 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] Roback (1982) applies her two-equation model with actual land values, but 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 housinig, which is not a problem when only the consumption value of amenities is considered, although it is a problem with production amenities. An authoritative review of the amenity literature in Gyourko et al. (1999), makes extensive

may seem sensible given the available data, but as shown below, distinguishing land from housing is important when inferring the value of productive amenities, and how the value of amenities are capitalized into various prices [3]

Section **??** demonstrates that land rents may be inferred from housing costs when three of their features are taken into account. First, the cost-share of land in housing services is less than one, so that a 10-percent difference in local housing costs between two cities corresponds to more than a 10-percent difference in land rents. Second, differences in the cost of non-land inputs can influence housing costs. Third, production amenities in the housing sector may differ from those in the tradables sector, as some cities may have natural or regulatory environments that impede housing construction, raising the cost of housing relative to land.[4]

Because land is an input for firms, its price is needed to measure the value of productive amenities, both in the housing and tradable sector. In a competitive equilibrium with mobile firms, local productivity is measured by how high input prices are relative to output prices. As demonstrated in Section 2.6, estimates of productivity in tradables based on wage and housing-cost data – seen in Beeson and Eberts (1989), Rauch (1993), Dekle and Eaton (1999), Rudd (2000), Gabriel and Rosenthal (2004), Glaeser and Saiz (2004), Shapiro (2006), and Chen and Rosenthal (2008) – put too much weight on wages and too little on housing costs, as housing costs already count some wage costs and understate land-value differences. Furthermore, without land-rent data, productive amenities in the housing sector may be confused for production disamenities in the tradable sector, as the former lower the cost of housing relative to land.[5]

The derived demand for land through tradable and non-tradable production raises up the pri-

use of the Roback framework, but makes no mention of this third equation.

[3]Davis and Polumbo (2007) infer the costs of land rents across metropolitan areas by subtracting construction 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 similar three-equation model, but for different applications.

[4]Roback (1982) does note that "In general, the housing price gradient will not capture the full valuation of the amenities. An adjustment for the differences in wages must be included," (p.1266) but hte discussion ends there. To my knowledge, this adjustment has not been applied empirically. Rudd (2000) separates housing costs from land rents, but housing costs are divided into land, utilities, and structures.

[5]Tabuchi and Yoshida (2000) use actual data on land rents, although this is later conflated with housing services.

vate value of land to reflect the total value of all amenities across cities, when all other factors are perfectly mobile and distortions are absent.[6] In Section 3, the three-equation system is inverted to predict how land rents, wages, and housing costs are affected differently by amenities in consumption and in each type of production. These formulas rely on the cost structure in both types of production through the fractions of land and labor allocated in tradables relative to non-tradables. As demonstrated in Section **??**, these capitalization effects are complicated by federal income taxes, which as Albouy (2009) proves, cause amenities that raise wages to indirectly raise tax liabilities. The social value of land, as determined by its amenities, is understated by private land values in cities where wages are high, as the land has an external value that is federally appropriated. An amenity's full social value is determined by its effect on local land rents and federal tax revenues together, as seen in Section **??**. Because of how they influence wages, production amenities for traded goods are effectively taxed and their values are undercapitalized into local land rents, while consumption amenities and production amenities for non-traded goods are effectively subsidized and their values are overcapitalized.

Because of its realism, the model may be calibrated to the U.S. economy to estimate amenity values and predict capitalization effects — an exercise the two-equation model is not amenable to. The calibration, seen in Section **??**, is similar to those by Rappaport (2008a, 2008b), the only other work that applies the three-equation model, although he excludes taxes and uses numerical simulations to examine the interrelationships between urban variables and population density, rather than to use analytical and estimation methods to examine questions of amenity measurement and capitalization, as I do. Section **??** reveals that higher housing costs almost fully capitalize the value of amenities in consumption and the production of traded goods, but not non-traded ones. Lower wages only weakly capitalize consumption amenities, while higher wages more than fully capitalize amenities in tradable-good production. Amenities in non-tradable production have only a weak effect on prices other than land rents.

With 2000 U.S. Census data on wages and housing costs, I apply the calibrated model in

[6]Estimating the value of consumption amenities and overal quality of life is only alluded to tangentally here, as it is discussed thoroughly in Albouy (2008).

Section **??** to estimate inter-metropolitan differences in land rents, firm- productivity, and total amenity values, combining them with quality-of-life and federal-tax differences estimates from Albouy (2008, 2009). This estimation procedure and the implied capitalization effects are illustrated with novel graphs, which demonstrates their sensitivity to the calibration. The unavailability of land-rent data is dealt with by assuming that productivity in non-tradables is constant across cities. Among the caveats of this assumption is that it may fail to capture large variations in land rents, but it does not heavily bias measures of trade-productivity. The results demonstrate that cities with high housing costs are more productive than in previous estimates, and that overall, housing costs provide a good indicator of what cities are worth by an interesting coincidence. Across cities, the value of consumption amenities has a standard deviation of 5 percent of income, which is smaller than that of production amenities, at 9 percent, highlighting the importance of modeling amenities in production as well as consumption. Yet, because of federal taxes, consumption amenities have a greater influence on the distribution of land rents.

The exploratory Section 5.5 examines the cross-sectional relationship between individual amenities and the variables of the model. Tradable productivity is associated with city size and education levels, in line with estimates in the literature. Sunniness, coastal proximity, and mild seasons appear to be amenities to firms, as well as households, unlike hilly terrain, which is a disamenity to firms. The land-rent, productivity, and total value measures are also positively related to residential land-use restrictions, reflecting the bias of not having identified housing productivity. It appears that households are effectively taxed for living in cities that are large, educated, cool, and flat. Accounting for these fiscal externalities, it appears that the most valuable cities in the United States are large, mild, sunny, hilly, coastal, and well-educated.

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 three-equation general equilibrium model of Albouy (2009), which adds federal taxes to the three-equation Roback (1980, 1982) model. The national economy contains many cities, indexed by j, which trade with each other and share a homogenous population of mobile households. These 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 equated with the cost of housing services.[7]

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. The total number of worker-households is $N^{TOT} = \sum_j N^j$, which may be fixed or determined by international migration.

Households own identical diversified portfolios of land and capital, and payments to these factors are rebated lump sum, whereby $R = \frac{1}{N_{TOT}} \sum_j r^j L^j$ 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 is redistributed in uniform lump-sum payments. Deductions and state taxes are discussed in Appendix.B.[8]

[7]Non-housing goods are considered to be a composite commodity of traded goods and non-housing home goods. Multiple home-good types are considered in Appendix D.4.

[8]Results are robust to elastic labor and land supply, so long as the new units supplied are equivalent to existing units (Roback 1980). Furthermore, results do not change signicantly if tax revenues are used to purchase tradable goods.

Cities differ in three general attributes: quality of life, Q^j, which raises household utility; the level of productivity in the traded-good sector, A_X^j, or "trade-productivity," and 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 an average value of one, i.e. $E[Q^j] = E[A_X^j] = E[A_Y^j] = 1$, where E is an expectations operator over cities.

2.2 Equilibrium Conditions

Household preferences are modeled by a utility function $U(x, y; Q^j)$, that is quasi-concave over x and y, and increasing in quality of life, Q^j; the use of a single index Q^j assumes that amenities are weakly separable from consumption. The expenditure function for a worker in city j, $e(p^j, u; Q^j) \equiv \min_{x,y}\{x + p^j y : U(x, y; Q^j) \geq u\}$, gives 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, their utility must be the same across all inhabited cities, so that higher prices or lower quality-of-life must be compensated with greater after-tax income:

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

where $\bar{u}$ is the level of utility attained nationally by all households.[9]

Operating under perfect competition, firms produce traded and home goods according to the

[9]The model generalizes easily to a case 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 how the model's predictions are affected with multiple household types with different preferences and labor skills.

functions $X^j = A_X^j F_X^j(L_X^j, N_X^j, K_X^j)$ and $Y^j = A_Y^j F_Y(L_Y^j, N_Y^j, K_Y^j)$, where F_X and F_Y are concave and exhibit constant returns to scale. All factors are fully employed: $L_X^j + L_Y^j = L^j$, $N_X^j + N_Y^j = N^j$, and $K_X^j + K_Y^j = K^j$. Unit cost in the traded-good sector is $c_X(r^j, w^j, \bar{\imath}; A_X^j) \equiv \min_{L,N,K}\{r^j L + w^j N + \bar{\imath} K : A_X^j F(L, N, K) = 1\}$. For simplicity, let $c_X(r^j, w^j, \bar{\imath}; A_X^j) = c_X(r^j, w^j, \bar{\imath})/A_X^j$ where $c(r, w, i) \equiv c(r, w, i; 1)$.[10] A symmetric definition holds for the unit costs in the home-good sector, c_Y. As markets are competitive, firms make zero profits in equilibrium, so that for given output prices, more productive cities must pay higher rents and wages to achieve zero profits. Thus, in equilibrium, the following conditions hold in all cities:

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

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

In the simplified two-equation model, the last equation is reduced to $r^j = p^j$.

Amenities may be endogenous, but this poses fewer problems for measurement than for comparative statics. The prices (r^j, w^j, p^j) must satisfy conditions (1), (2), and (3) whether or not the attributes (Q^j, A_X^j, A_Y^j) are endogenous. 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 or population levels are controlled for.

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 $\theta_K^j \equiv$

[10]As shown in Appendix D.3 Non-Hicks-neutral productivity differences have similar impacts on relative prices across cities, but not on relative quantities.

$\bar{\imath} K_X^j / X^j$; 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 $\lambda_K^j \equiv K_X^j / K^j$.[11] 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 and shows their values calibrated in Section **??** according to averages in the United States economy.

TABLE 1: MODEL PARAMETERS

Economic Parameters	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
Tax Parameters		
Average marginal tax rate	τ'	0.361
Average deduction level (see appendix)	δ	0.291

2.4 Log-Linearization of the Equilibrium Conditions

To analyze the effect of city attributes on prices, assume that the three attributes, Q, A_X, and A_Y are continuous variables. The equilibrium conditions (1), (2), and (3) implicitly define the prices (w^j, r^j, p^j) as functions of $(Q^j, A_X^j,\ A_Y^j)$, and may be log-linearized to express city $j's$

[11] On average, the shares of land, labor, and capital are determined by the identities $\lambda_L = s_x \theta_L / s_R$, $\lambda_N = s_x \theta_N / s_w$, and $\lambda_K = s_x \theta_K / s_I$.

price differentials in terms of its attribute differentials relative to the national average. These differentials are expressed in 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 consumption amenities, relative to a city with an average quality of life.[12]

Log-linearized versions of (1), (2), and (3) describe how prices co-vary with city attributes.[13]

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

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

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

These equations are first-order approximations of the equilibrium conditions around a nationally-representative city and so the share values, now without superscripts, are national averages. These first-order expressions are useful for analytical purposes, 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 after-tax nominal income, $s_w(1-\tau')\hat{w}^j$. Equation (4b) measures local trade-productivity, $\hat{A}_X^j$, from

[12] 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.

[13] 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 $\bar{p}$.

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), the housing-cost equation, 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. Together, these equilibrium conditions state that the relative value of a city's amenities is measured by the implicit willingness-to-pay of households and firms for all of the city's amenities.

With accurate data on wage, housing-cost, and land-rent differences across cities, as well as knowledge of the economic parameters at the national level, the system of equations (4) can be solved for $\hat{Q}^j$, $\hat{A}_X^j$, 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, $\hat{A}_Y^j$, emphasized here are not identified separately without either a restriction on them, land rents, or a relationship between the three.

2.5 Inferring Land Rents 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:

Land-share effect: For given wages, the land-rent differential is $1/\phi_L$ times the home-good price differential, as land costs make up only a fraction, ϕ_L, of total home-good prices.

Labor-cost effect: In high-wage areas, the labor-cost component of the home-good price, $\phi_N \hat{w}^j$, needs to be subtracted, as it is not part of the land cost.

Home-productivity effect: Home-good prices in cities with high home-productivity understate the cost of local factors. Holding other prices constant, cities with greater home-productivity have higher rents.

Because home-productivity is not separately observed, land-rent differentials are estimated below by assuming that there are no home-productivity differences across cities, i.e. $\hat{A}_Y^j = 0$, for all j. This assumption causes land rents to be overestimated in cities with low home-productivity, but is still weaker than assuming that housing is land, so that $\phi_L = 1$, $\phi_N = 0$, and $\hat{A}_Y^j = 0$ for all j.

2.6 Inferring Local Trade-Productivity

With land-rent data, trade-productivity differences can be measured directly from (4b); without them, it may be inferred 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:

Land-share effect Home-good price differentials are weighted by θ_L/ϕ_L, which is greater than θ_L, as housing-cost differentials understate land-rent differentials, holding wages constant.

Labor-cost effect Wage differentials are weighted by $(\theta_N - \phi_N \theta_L/\phi_L)$, which is less than θ_N, to account for the fact that higher wages lead to higher housing costs. Failing to make this adjustment double-counts the labor-costs included in $\hat{p}^j$.

Home-productivity effect In cities with high home-productivity, home-good prices understate the cost of local land, so 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 confused for high trade-productivity, as both are positively associated with high wages and home-good prices. The magnitude of this confusion depends on the ratio θ_L/ϕ_L.[14]

[14]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

3 The Capitalization of Amenity Values and their Total Value

The effects of quality of life, trade-productivity, and home-productivity on local land rents, home-good prices, and wages are determined by inverting the system of equations (4). To make it easier to compare equations, each differential is multiplied by its share of income, so that the equations are expressed as the change in land, labor, and home-good values relative to total income. In addition, each attribute is multiplied by its weight in determining household welfare. With these normalizations, the inverted system may be expressed using only the parameters λ_L and λ_N.

3.1 Capitalization without Federal Income Taxes

To make the derivation tractable, begin by assuming there is no federal income tax, $\tau' = 0$, or, equivalently, that taxes are geographically neutral or lump sum. Then, the inversion yields

$$s_R \hat{r}_0^j = \frac{l^j dr^j}{m} = \hat{Q}^j + s_x \hat{A}_X^j + s_y \hat{A}_Y^j \equiv \hat{\Omega}^j \tag{7a}$$

$$s_w \hat{w}_0^j = \frac{dw^j}{m} = -\frac{\lambda_L}{\lambda_N}\hat{Q}^j + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X^j - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y^j \tag{7b}$$

$$s_y \hat{p}_0^j = \frac{y^j dp^j}{m} = \frac{\lambda_N - \lambda_L}{\lambda_N}\hat{Q}^j + \frac{1-\lambda_L}{\lambda_N} s_x \hat{A}_X^j - \frac{\lambda_L}{\lambda_N} s_y \hat{A}_Y^j \tag{7c}$$

where the subscript "0" denotes price differentials without taxes, and $l^j = L^j/N^j$ is the land-to-labor ratio. Equation (7a) is obtained by summing up (4a), s_x times (4b), and s_y times (4c), and expresses the canonical result that land values capture the total value of amenity differences, denoted $\hat{\Omega}^j$, equal to the properly weighted sum of attribute differences.[15]

By the zero-profit condition for traded-good firms, (4b), wage differences compensate firms for

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.

[15] The linearized version of (7a) 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 improvemnt 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.

rent and trade-productivity differences by $\hat{w}_0^j = -(\theta_L/\theta_N)\hat{r}_0^j + \hat{A}_X^j/\theta_N$, leading to (7b). Wages negatively capitalize the value of consumption and home-production amenities, but by less than 100 percent, as traded-goods are relatively labor-intensive, $\lambda_N > \lambda_L$. Wages positively capitalize the value of trade-production amenities, and by over 100 percent if the fraction of land in home goods, $1 - \lambda_L$, is greater than λ_N.[16]

By the mobility condition (4a), home-good price differences compensate for wage and quality-of-life differences according to $s_y \hat{p}_0 = s_w \hat{w}_0^j + \hat{Q}^j$, leading to (7c). Hence, consumption amenities are undercapitalized into local home-good values, while trade-production amenities may be over-capitalized. Home-good prices *negatively,* albeit partially, capitalize the value of home-production amenities.[17]

3.2 Capitalization with Federal Taxes

Federal taxes on labor income change the capitalization process so that land rents no longer fully reflect amenity values. Rewriting the mobility condition (4a) as $s_w \hat{w}^j - s_y \hat{p}^j = \tau' s_w \hat{w}^j - \hat{Q}^j$ states that differences in pre-tax real incomes compensate for higher federal taxes as the do for lower quality of life. The federal tax differentials, $d\tau^j/m = \tau' s_w \hat{w}^j$, are expressed as a fraction of total income, and are determined by local wages, which depend on amenities and also, endogenously on taxes. Nevertheless, they depend ultimately on tax-free wage level, $\hat{w}_0^j$, as seen by using the fact that higher tax burdens are like lower quality of life in equation (7b):

$$\frac{d\tau^j}{m} = \tau' s_w \hat{w}^j = \tau' \left(s_w \hat{w}_0^j + \frac{\lambda_L}{\lambda_N} \tau' s_w \hat{w}^j \right) = \frac{\tau'}{1 - \frac{\lambda_L}{\lambda_N}\tau'} s_w \hat{w}_0^j \tag{8}$$

[16]The term $1/\lambda_N = 1/[1 - (1 - \lambda_N)] = \sum_k^\infty (1 - \lambda_N)^k$, expresses a multiplier effect, accounting for the feedback effect of higher land rents on wages through the local labor market, similar to Tolley (1974). 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.

[17]Roback (1982, p. 1265) reports a linear analogue to equation (7c) 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.

Thus, as federal taxes are higher in cities with higher wages according to equation (7b), they are higher in cities with higher trade-productivity, lower quality-of-life, and lower home-productivity. Taking this into account, the capitalization formulas in the presence of taxes are

$$s_R\hat{r}^j = \frac{1}{1-\frac{\lambda_L}{\lambda_N}\tau'}\left[\hat{Q}^j + \left(1-\frac{1}{\lambda_N}\tau'\right)s_x\hat{A}_X^j + s_y\hat{A}_Y^j\right] = s_R\hat{r}_0^j - \frac{d\tau^j}{m} \tag{9a}$$

$$s_w\hat{w}^j = \frac{1}{1-\frac{\lambda_L}{\lambda_N}\tau'}\left(-\frac{\lambda_L}{\lambda_N}\hat{Q}^j + \frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X^j - \frac{\lambda_L}{\lambda_N}s_y\hat{A}_Y^j\right) \tag{9b}$$

$$s_y\hat{p}^j = \frac{1}{1-\frac{\lambda_L}{\lambda_N}\tau'}\left[\frac{\lambda_N-\lambda_L}{\lambda_N}\hat{Q}^j + (1-\tau')\frac{1-\lambda_L}{\lambda_N}s_x\hat{A}_X^j - (1-\tau')\frac{\lambda_L}{\lambda_N}s_y\hat{A}_Y^j\right] \tag{9c}$$

The first expression, (9a), demonstrates that the federal tax differential is fully capitalized into land values. Therefore, consumption and home-production amenities are capitalized by more than their value, as they lower federal taxes, while trade-production amenities are capitalized less, as they raise federal taxes. Equation (9b) is obtained by dividing (8) by τ' and substituting in (7b): with taxes, the capitalization of any amenity into wages is simply augmented by the factor $1/(1-\tau'\lambda_L/\lambda_N) > 1$. In (9c), federal taxes increase how much home goods capitalize consumption amenities and decrease how much they capitalize production amenities of either kind.[18]

3.3 The Total Value of Amenities

Rearranging the second equality of (9a), differences in the total value of amenities, $\hat{\Omega}^j$, equals the value captured by local land rents, $s_R\hat{r}^j$, plus the value captured by federal-tax payments, $d\tau^j/m$:

$$\hat{\Omega}^j = s_R\hat{r}_0^j = s_R\hat{r}^j + \frac{d\tau^j}{m} = s_R\hat{r}^j + \tau' s_w\hat{w}^j \tag{10}$$

Federal taxes introduce a wedge between the value of amenities capitalized into land rents, and the total economic value of those amenities. The effect of an amenity on federal tax revenues through wages must be added to its effect on land rents to obtain its full value.

[18] As shown in Appendix B, deductions in the tax system end up increasing the local value of amenities that lead to higher housing costs, i.e., those that raise quality-of-life or trade-productivity or lower home-productivity.

When land rents need to be inferred through wages and housing costs, the empirical counterpart of (10) can be obtained by substituting in (5) to obtain an expression for $\hat{\Omega}^j$:

$$\hat{\Omega}^j = \frac{s_R}{\phi_L}\hat{p}^j + \left(\tau' s_w - \frac{s_R \phi_N}{\phi_L}\right)\hat{w}^j + \frac{s_R}{\phi_L}\hat{A}_Y^j \quad (11a)$$

$$= \frac{1}{1-\lambda_L}\left\{s_y(\hat{p}^j + \hat{A}_Y^j) + \left[\tau'\left(1-\lambda_L\right) - \left(1-\lambda_N\right)\right] s_w \hat{w}^j\right\} \quad (11b)$$

It is theoretically ambiguous whether, conditional on housing costs, higher wage levels signal greater city value, as the negative labor-cost effect, $-\left(1-\lambda_N\right)$, in (11a) is countered by a positive federal-tax effect, $\tau'\left(1-\lambda_L\right)$.

3.4 Simple Hedonic Regressions using Amenity Measures

With data on individual amenity measures $(Z_1^j, ... Z_K^j)$, it is possible to estimate their effect on wages and housing costs. Regression coefficients may be used to determine their value in consumption or production, as well as their social and private values, with the latter subtracting off the effect of federal taxes. This involves running several, mutually-consistent regressions, which for simplicity, are assumed to be linear. This begins with regressions using housing costs and wage levels

$$\hat{p}^j = \sum_k Z_k^j \pi_{kp} + \varepsilon_p^j, \quad (12a)$$

$$\hat{w}^j = \sum_k Z_k^j \pi_{kw} + \varepsilon_w^j \quad (12b)$$

where we assume control for interregional variation in labor and housing quality. The effect of these amenities on quality-of-life and trade-productivity may be inferred using similar regressions

$$\hat{Q}^j = \sum_k Z_k^j \pi_{kQ} + \varepsilon_p^j, \quad (13a)$$

$$\hat{A}_X^j - \hat{A}_Y^j \frac{\theta_L}{\phi_L} = \sum_k Z_k^j \pi_{kA} + \varepsilon_A^j \quad (13b)$$

The second term on the right-hand side of the productivity equation $-\hat{A}^j_Y \theta_L/\phi_L$ accounts for the fact that positive trade-productivity estimates may contain negative home-productivity effects, which motivates using proxies to control for them. Similarly, local land values, federal revenues, total amenity values, reflecting the private, external, and social value of each amenity:

$$\hat{r}^j - \hat{A}^j_Y \frac{1}{\phi_L} = \sum_k Z^j_k \pi_{kR} + \varepsilon^j_R, \tag{14a}$$

$$\frac{d\tau^j}{m} = \sum_k Z^j_k \pi_{k\tau} + \varepsilon^j_\tau \tag{14b}$$

$$\hat{\Omega}^j - \hat{A}^j_Y \frac{s_R}{\phi_L} = \sum_k Z^j_k \pi_{\Omega R} + \varepsilon^j_\Omega \tag{14c}$$

The second term on the right-hand side of the land-rent equation $-\hat{A}^j_Y/\phi_L$, accounts for the potential bias in measured land rents due to home-productivity.[19]

As the system is linear, the amenity coefficients, π_k, express the effect of a one-unit increase in an amenity on the regressor, and share the same interrelationships as their regressors do, as expressed in (4), (8), (9), and (11a). There are many empirical caveats to running these types of regressions – including omitted variable bias, simultaneity, multi-collinearity, and small sample problems – and so one should not expect them to produce well-identified, conclusive results. Nevertheless, the exercise in Section 5.5, below, presents suggestive estimates, illustrates how they are interrelated, and guides further analysis.

4 Calibration and Prediction

4.1 Parameter Choices

The approximation formulas above should be calibrated using parameter values at the national level. Because of accounting identities, only six parameters are free, but choosing these requires

[19]Since all of these equations involve the same regressors, there are no efficiency gains to estimating them simultaneously through a system of seemingly unrelated regressions (SUR), and therefore they are simply estimated using ordinary least squares (OLS).

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).[20]

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 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).[21] Thus, the coefficient on 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.

The cost shares are chosen to be consistent with the expenditure and income shares above. θ_L appears small: Beeson and Eberts (1986) 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, although their definition of tradables differs from the one here. A value of 2.5 percent for θ_L is used here. Following Carliner (2003) and Case (2007), the cost-share of land in home-goods, taken as housing, ϕ_L, is taken at 23.3 percent: this is slightly above values reported in McDonald (1981), Roback (1982), and Thorsnes (1997) to take into account an increase in land-cost shares over time seen in Davis and Palumbo (2007). Together the cost and expenditure shares imply λ_L is 17 percent and s_R is 10 percent, consistently. This appears reasonable since the remaining 83 percent of land for home goods includes all residential land and much commercial land.[22] The one

[20].The values Keiper reports were at a historical low. Keiper et al. (1961) find 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.

[21]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, $\hat{p}^j$.

[22]These proportions are roughly consistent with other studies. In the base calibration of the model, 51 percent of

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, both cost-shares of capital are set equal to 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 when combined with relevant variation in wages with state tax rates, produces an approximate marginal tax rate, τ', of 36.1 percent. Details on this tax rate, as well as housing deductions, are discussed in Appendix B.3.

4.2 Predicted Capitalization Effects

With the calibrated parameter values, the capitalization formulas in section 3 predict exactly how amenity values are capitalized into local prices. Table 1 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 incorporate federal taxes, as in (9) with minor adjustments for state taxes and the deductibility of housing expenditures, while those in B ignore federal taxes, as in (7). The difference between Panels A and B highlights the effect of federal taxes.

In panel A, we see that because of federal taxes, land rents capitalize only 63 percent of the value of trade-productive amenities, meaning they are taxed at a rate of 37 percent, while consumption amenities are subsidized at a rate of 19 percent, and home-production amenities at a rate of 8 percent. Home-good prices capitalize 92 percent the value of consumption amenities, which are only weakly reflected in lower local wages. Trade-productive amenities are over-capitalized by 28 percent into higher wages, which means that wage-based measures of the effect of agglomeration in cities may overstate their productive value; home-good prices, on the other hand, understate them by 10 percent. Finally home-productive amenities only weak negative effect on wages, and

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.

an even weaker effect on home-good prices. Comparing these results with those in Panel B, we see that the largest effect of taxes is that increase the capitalization of consumption amenities and decrease that of trade-productive amenities into home-good prices.[23]

5 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 at the end, are used to explain this variation and try to value specific amenities.

5.1 Data and Wage and Housing-Cost Differentials

Wage and housing-cost differentials are estimated with the 5 percent sample of Census data from the 2000 Integrated Public Use Microdata Series (IPUMS). Cities are defined at the Metropolitan Statistical Area (MSA) level using 1999 OMB definitions. Consolidated MSAs are treated as a single city (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 of states. More details are provided in Appendix C. The entire 5 percent Census sample, guaranteeing that the wage and price differentials are precise.

Inter-urban wage differentials, w^j, are calculated from the logarithm of hourly wages for full-time workers, ages 25 to 55. These differentials control for skill differences across workers to provide an analogue to the representative worker in the model. Log wages are regressed 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

[23] 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.

equation $\ln w_i^j = X_{wi}^j \beta_w + \mu_w^j + \varepsilon_{wi}^j$. Estimates of μ_w^j are used as the wage differentials, and are interpreted as the causal effect of city characteristics on a worker's wage. Identifying these differentials requires that workers do not sort across cities according to their unobserved skills. [24] An overstated wage differential for a city will bias trade-productivity upward and quality of life downwards.

Both housing values and gross rents, including utility costs, are used to calculate a flow value of housing costs. Following previous studies, imputed rents are converted from housing values using a discount rate of 7.85 percent (Peiser and Smith 1985), with utility costs added, to make the imputed rents comparable to gross rents.[25] To avoid measurement error from imperfect recall or rent control, the sample includes only units that were acquired in the last ten years. Housing-cost differentials are calculated in a manner similar to wage differentials, using a regression of 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. This regression takes the form $\ln p_i^j = X_{pi}^j \beta_p + \mu_p^j + \varepsilon_{pi}^j$. Estimates of μ_p^j are used as housing-cost differentials. Proper identification of housing-cost differences requires that average unobserved housing quality does not vary systematically across cities. An overstated price differential will bias both trade-productivity and quality of life upwards.[26]

Amenity data are taken from various sources, and may be divided into two categories. The first involves natural site-specific characteristics such as climate and geography, which are considered to be exogenous to 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

[24] 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 current reside in a metropolitan area away from their state of birth does not change the estimates of the wage gaps hardly at all.

[25] 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.

[26] 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.

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. Only three types of artificial "amenities" are included here. The first two, population and the share of population with college degrees, are not standard amenities, per se, but are rather fundamental determinants of amenities. The third, is the Wharton Residential Land-Use Regulatory Index, or WRLURI, provided by Gyourko et al. (2007), which is used to control for housing-productivity differences.

5.2 Land-Rent, Productivity, and Total-Value Measures

Land-rent, trade-productivity, and quality-of-life differentials are inferred from observed wage and housing-cost differentials using equations (4a), (5), (6), (11a), with $\hat{A}_j = 0$ for all j, calibrated with the parameters from Section **??**, and adjusted for housing deductions and average state taxes.[27] This yields the following numerical relationships for what I call the "adjusted" model:

$$\hat{r}^j = 4.29\hat{p}^j - 2.75\hat{w}^j \ (+4.29\hat{A}_Y^j) \tag{15a}$$

$$\hat{Q}^j = 0.32\hat{p}^j - 0.49\hat{w}^j \tag{15b}$$

$$\hat{A}_X^j = 0.11\hat{p}^j + 0.79\hat{w}^j \ (+0.11\hat{A}_Y^j) \tag{15c}$$

$$\hat{\Omega}^j = 0.39\hat{p}^j + 0.01\hat{w}^j \ (+0.39\hat{A}^j) \tag{15d}$$

The terms in parentheses give the bias that results from not identifying home-productivity differences, which 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 (11a) are of opposite and almost equal size.

The relationships in (15) differ substantially from those typical of the previous literature (e.g.

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

Beeson and Eberts, 1989), based on the two-equation, or "unadjusted," model, which sets $\phi_L = 1$, $\phi_N = 0,$ and $\hat{A}_X^j = 0$, $\tau' = 0$, and typically $s_w = 1$ and $s_y = 0.25$, leading to the formulae:

$$\hat{r}^j = \hat{p}^j \tag{16a}$$

$$\hat{Q}^j = 0.25\hat{p}^j - \hat{w}^j \tag{16b}$$

$$\hat{A}_X^j = 0.025\hat{p}^j + 0.825\hat{w}^j \tag{16c}$$

This unadjusted 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 $0.27\hat{p}^j$.

The two numerical models are illustrated using graphs in Figures 1A and 1B, with wages and housing costs on the axes. Each draws an iso-rent curve across cities with average rent, a mobility condition across cities with average quality of life, and a zero-profit condition across cities with average productivity. In the adjusted model the slope of the iso-rent curve is positive, illustrating the labor-cost effect, as higher wage levels increase the cost of housing. The land-share effect is illustrated with the second, thinner, iso-rent curve, corresponding to a rent-differential of 0.25: in the unadjusted model, this curve intercepts the housing-cost axis at 0.25; in the adjusted model, it intercepts the axis at 0.0575.

The mobility condition slopes upward at the rate at which housing costs must increase as wage levels increase to keep households indifferent. As explained in Albouy (2008), the slope in the adjusted model is flatter to account for federal taxes, non-housing costs, and non-labor income. The slope of the zero-profit condition is downward sloping as it graphs the rate at which housing costs, proxying for land costs, must fall with local wage levels in order for firms to break even. The adjusted model has a flatter slope since the land-share and labor-cost effects make inferred land rents drop more rapidly than housing costs. Iso-value curves, tracing out the points where cities have the same total amenity value, can also be drawn, although in both models the curve is remarkably flat.[28]

A graph of wage and housing cost differences across U.S. metropolitan areas, with these adjusted curves, is presented in Figure 2. The land-rent differentials are inferred from the distance to the average iso-rent curve, and are graphed against housing costs in Figure 3, which draws a line for inferred land rents if wages are held constant at the national average. For a given city, the vertical distance between its marker and the line measures the labor–cost effect, while distance from the line to zero marker measures the land–share effect, which in practice, is much larger. Since wages and costs are positively related, the labor-cost effect slightly flattens the inferred land-rent gradient.

Quality-of-life and trade-productivity estimates are graphed in Figure 4. Their values can be understood graphically through a change in coordinate systems from Figure 2, where the average mobility condition and the average zero-profit condition in the in wage and housing-cost graph, give the axes to the new coordinate system in Figure 4 for productivity and quality-of-life. Since quality-of-life is constant across the average mobility condition, and trade-productivity increases with the distance rightward along this curve, it gives the horizontal axis for trade-productivity. Since trade-productivity is constant across the average zero-profit condition, and quality-of-life is increasing with the distance upwards along this curve, it gives the vertical axis for quality-of-life. 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 illustrates how wages capitalize productivity much more than quality of life, while the iso-housing-cost curves illustrates how costs capitalize both almost equally.

[28]If land rents are put on the vertical axis instead of housing costs, the labor-cost effect would disappear and the iso-value curve would unambiguously slope downward for $\tau' > 0$.

5.3 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 values are also reported by Census region and metropolitan population. A list of all cities and non-metro areas is in Appendix Table A1; state values are in Appendix Table A2. These number speak for themselves, but deserve some comment.

The most valuable metropolis in the United States is San Francisco, including the entire Bay Area. It combines the fourth highest quality-of-life with the very highest trade-productivity. This is followed by a number of smaller, resort-like, but economically vibrant cities, including Santa Barbara, Honolulu, and San Diego, and the large coastal powerhouses of New York, Los Angeles, Boston, Seattle, and Chicago (counting the Great Lakes as a coast). By putting significant weight on housing costs through the land-share effect, the trade-productivity estimate for Los Angeles is higher than that for Detroit, even though the latter has higher nominal wage levels.

Further down the list are smaller cities in less crowded areas such as West Virginia, Mississippi, and North and South Dakota. 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 of all cities, and that an urban acre in the most valuable state, Hawaii, is worth 45 times an urban acre in the least valuable state, North Dakota.

5.4 Explaining the Variation of Prices across Cities

Variation in housing costs, wages, and land rents across cities ultimately stem from variation in amenities. Using (7a), the variation in total amenity values can be decomposed as

$$var(\hat{\Omega}^j) = var(\hat{Q}^j) + s_x^2 var(\hat{A}_X^j) + 2s_x cov(\hat{Q}^j, \hat{A}_X^j) \quad (17)$$

One can assess whether the variance in total amenity values is due primarily to quality-of-life or productivity differences by comparing the two variance terms, since if the variance of either attribute is set to zero, the covariance term collapses to zero. This analysis takes the attributes as fixed, and is therefore better for accounting purposes than for determining how an exogenous change in the amenity distribution would affect rents. Such a change could be subject to feedback effects from population flows and the like, as discussed in Section 2.2.[29]

Results of the decomposition in Table 4, Panel A, which accounts for federal taxes, are meant to reflect the situation in 2000. It reveals that both quality of life and productivity strongly affect rents, but that the former is slightly more important. On the other hand, productivity variation is much more important in determining overall values. This is seen in Figure 4, which has its axes scaled so that attribute differences of equal distance have equal value: population-weighted, the spread of cities along the horizontal axis, measuring productivity, is greater than along the vertical axis, measuring quality of life. A similar decomposition reveals that wage variation – and with it, tax variation – is driven almost entirely by productivity.[30] Housing-cost differences are more heavily influenced by quality-of-life, but still much more by productivity.

Panel B presents a counter-factual distribution of rents, wages, and housing-costs if federal taxes were removed, but amenities across areas remained fixed. In this case, productivity differences would become even more important in the determination of land rents and housing costs.[31]

5.5 The Productive and Total Value of Individual Amenities

The positive relationships between trade-productivity and total-amenity value with population size are graphed in Figures 5 and 6. This is explored further in Table 5, which displays results of

[29]This decomposition is different than the one in Beeson and Eberts (1989) and Deitz and Abel (2008), who decompose each differentials 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, 119 percent of San Francisco's wage differential of 0.26 is explained by its higher productivity and -19 percent is explained by its higher quality of life.

[30]The finding that consumption amenities are mainly capitalized into higher prices rather than lower wages runs counter to the assertion in Roback (1982),"Thus, the combined evidence seems persuasive that the regional differences in earnings can be largely accounted for by regional differences in local amenities," where she appears to be referring to consumption amenities only.

[31]It is not clear from the analysis which type of amenity is more important in affecting household location choices. If consumption amenites are predominant, it can be said that in general "jobs follow people," while if production amenities are predominant, then "people follow jobs." Analysis from Appendix D.2 suggests that both amenity types are important, although it is difficult ascertain precisely given limitations of the model in dealing with quantities.

the seven regression equations in Section **??**, with the amenity variables described in Section **??**. Controlling for other amenities, the population elasticities of wages and trade-productivity are about 4 percent, consistent with estimates surveyed in Rosenthal and Strange (2004) and Melo et al. (2009). As demonstrated in Albouy (2008), greater population size is not associated with lower quality of life, meaning that larger cities have greater total value. A ten percent increase in the college share (1.3 standard deviations), leads to a 7-percent increase in 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 for trade-productivity, land rents, and total value are consistent with predictions from equations (13b), (14a), and (14c), when regulations are thought to lower unmeasured home-productivity, driving up housing costs. The relationships between the natural amenities and productivity, never before estimated, reveal some interesting patterns: sunshine and coastal proximity may increase trade-productivity, while extreme temperatures lower trade-productivity as well as quality of life. This raises interesting questions and lends weight to Montesquieu's (1752) theory that heat inhibits the ability of humans to work, which is reinforced in engineering studies that both indoor and outdoor workers are less productive in warm temperatures (Engineering News Record, 2008). Yet, the magnitude of this estimate in the presence of modern air-conditioning raises questions about its validity, although it is robust to the latitude control. The regressions also suggest that hilly terrain, measured through average slope is an amenity for households, but a disamenity for firms, a sensible result.

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.

6 Conclusion

This research establishes that differences in land rents, local productivity, and the total value of urban amenities may be inferred from local housing and labor costs if the cost structures in housing and tradables production is known, especially if variation in local-housing productivity is not a confounding factor. Inferred local land rents may be combined with federal tax revenue estimates to determine the full value of a city's amenities. This includes amenities to firms, which raise incomes, and amenities to households, which do not. The richer accounting provides a fuller and more accurate technique to value social investments, and measure the value of amenity differences across cities, of which a majority are accounted for by productivity differences. Observationally, these differences are well explained by population and education levels, as well as a number of natural amenities. However, the significance of land-use regulations in the regressions suggest that differences in unobserved home-productivity may be biasing the estimates, raising the need to estimate home-productivity using actual measures of land values or other means.

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Appendix - Not for Publication

A Quadratic Land-Rent Estimates

The inferred land rent from equation (5) is based on 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. This can be addressed by taking a second-order approximation of equation (3) around the national average, and rearranging to solve for the inaccuracy of the first-order approximation:

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

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 using (A.1) to solve for $\hat{r}^j$ in terms of $\hat{p}^j$ and $\hat{w}^j$ produces a quadratic estimate of land-rent differentials. 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 then 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, 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 $\sigma_Y^{NL} = \sigma_Y^{KL} = \sigma_Y^{NK} = 0.67$.[32] 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.[33]

[32] These substitution elasticities are based off of estimates in McDonald (1981) and Thorsnes (1997).

[33] 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 given by

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

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 rearreanged 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 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 (7b) and (7c) 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 tax rate on gross wages, although only a 29.2 percent rate 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 times 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

United States Census data from the 2000 Integrated Public-Use Microdata Series (IPUMS), from Ruggles et al. (2004), are used to calculate wage and housing price differentials. The wage differentials are calculated for workers ages 25 to 55, who report working at least 30 hours a week, 26 weeks a year. The MSA assigned to a worker is determined by their place of residence, rather than their place of work. The wage differential of an MSA is found by regressing log hourly wages on individual covariates and indicators for which MSA a worker lives in, using the coefficients on these MSA indicators. The covariates consist of

- 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;
- 2 indicators for English proficiency (none or poor).

All covariates are interacted with gender.

This regression is first run using census-person weights. From the regressions a predicted wage is calculated using individual characteristics alone, controlling for MSA, to form a new weight equal to the predicted wage times the census-person weight. These new income-adjusted weights are needed since workers need to be weighted by their income share. 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.

Housing price differentials are calculated using the logarithm reported gross rents and housing values. Only housing units moved into within the last 10 years are included in the sample to ensure that the price data are fairly accurate. The differential housing price of an MSA is calculated in a manner similar to wages, except using a regression of the actual or imputed rent on a set of covariates at the unit level. The covariates for the adjusted differential are

- 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;

- an indicator for condominium status (owned units only).

A regression of housing values on housing characteristics and MSA indicator variables is first run using only owner-occupied units, weighting by census-housing weights. A new value-adjusted weight is calculated by multiplying the census-housing weights by the predicted value from this first regression using housing characteristics alone, controlling for MSA. A second regression is run using 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. The house-price differentials are taken 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

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

These expressions make use of partial (Allen-Uzawa) elasticities of substitution. Each sector has three partial (Allen-Uzawa) elasticities of substitution in production for each combination of two factors, where $\sigma_X^{LN} \equiv \left(\partial^2 c/\partial w \partial r\right)/\left(\partial c/\partial w \cdot \partial c/\partial r\right)$ 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 affect these elasticities of substitution. Log-linearizing the constraints (A.7), (A.8), and (A.9)

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

where 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 taken 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 3.

According to the calibrated model where $\sigma_Y = \sigma_X = 0.667$, 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

Assume there are two types of fully mobile households, referred to as "a" and "b," and that some members of each type lives in every city. The mobility conditions for each type of household are

$$e_a(p, w_a, u; Q_a) = 0$$
$$e_b(p, w_b, u; Q_b) = 0$$

The two zero-profit conditions are generalized with unit-cost functions that have factor-specific productivity components.

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

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

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

where θ is used to denote 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.[34]

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

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

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

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

Except for the terms in square brackets, "[]", these terms are otherwise identical to equations (7a), (7b), (7c). 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.

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

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

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

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

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 one using only one home-good price, e.g. the one for residential housing, may be biased.[35] The bias is then given by

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

If $\phi_{L1} = \phi_L$ and $\phi_{N1} = \phi_N$, then this collapses to $-s_y\hat{A}_{Y!}$.

[35]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 1: PREDICTED EFFECT OF AMENITIES ON THE VALUE OF LAND RENTS, WAGES, AND HOME-GOOD PRICES, WITH AND WITHOUT FEDERAL

	Normalized Percent Increase in Value from a One-Percent Increase in Amenity Type		
Amenity Type	Quality of Life (1)	Trade Productivity (2)	Home Productivity (3)
Panel A: Federal Taxes Geographically Neutral			
Land Rents	1.00	1.00	1.00
Wages	-0.23	1.19	-0.23
Home-Good Prices	0.77	1.19	-0.23
Panel B: With Federal Income Taxes			
Land Rents	1.10	0.58	1.08
Wages	-0.25	1.29	-0.25
Home-Good Prices	0.85	0.87	-0.17
Federal Tax Payment	-0.10	0.42	-0.08

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: 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 B: 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 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 (9) 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 (15) in the text, with some additional adjustements for housing deductions and state taxes, described in Appendix B.

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

		Adjusted Differentials			Amenity Values			
Main city in MSA/CMSA	Population Size	Wages	Housing Costs	Inferred Land Rent	Quality of Life	Trade-Productivity	Federal Tax Differential	Total Amenity Value
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
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
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
Atlanta GA	4,112,198	0.08	0.01	-0.15	-0.03	0.06	0.02	0.01
Dallas TX	5,221,801	0.06	-0.04	-0.34	-0.04	0.05	0.02	-0.01
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
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.

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

		Adjusted Differentials			Amenity Values			
	Population Size	Wages	Housing Costs	Inferred Land Rent	Quality of Life	Trade-Productivity	Federal Tax Differential	Total Amenity Value
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.

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 (1)	Wage (2)	Quality of Life (3)	Trade Productivity (4)	Local Land Rents (5)	Federal Tax Payment (6)	Amenity Value (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 5.1.

Figure 1A: Adjusted Model
(This Research)

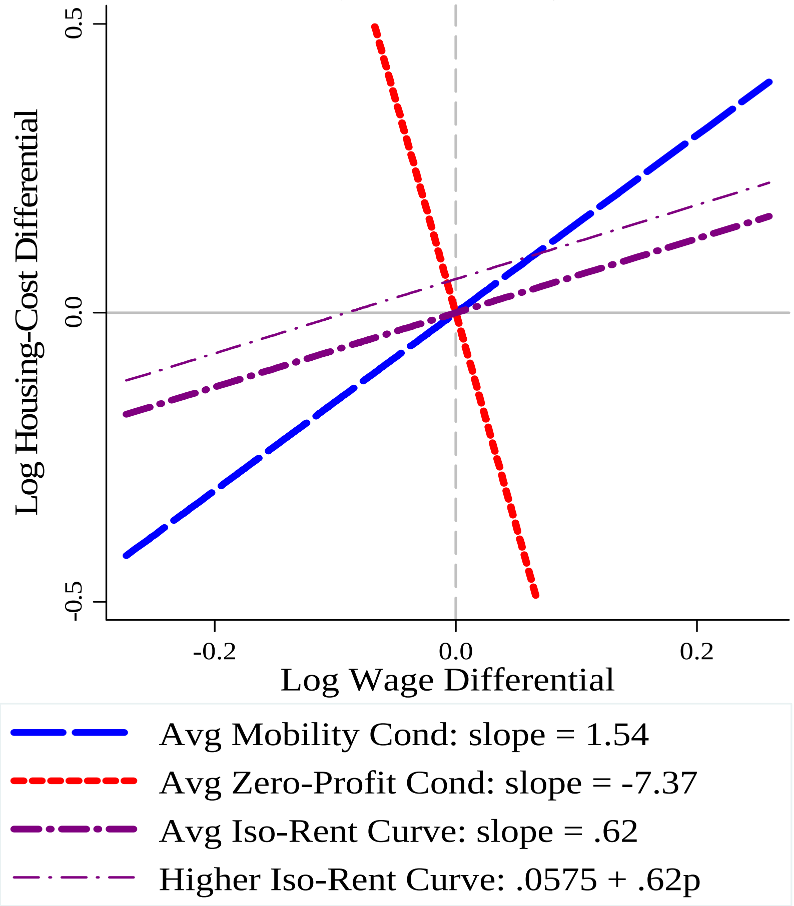


Figure 1B: Unadjusted Model
(Previous Literature)

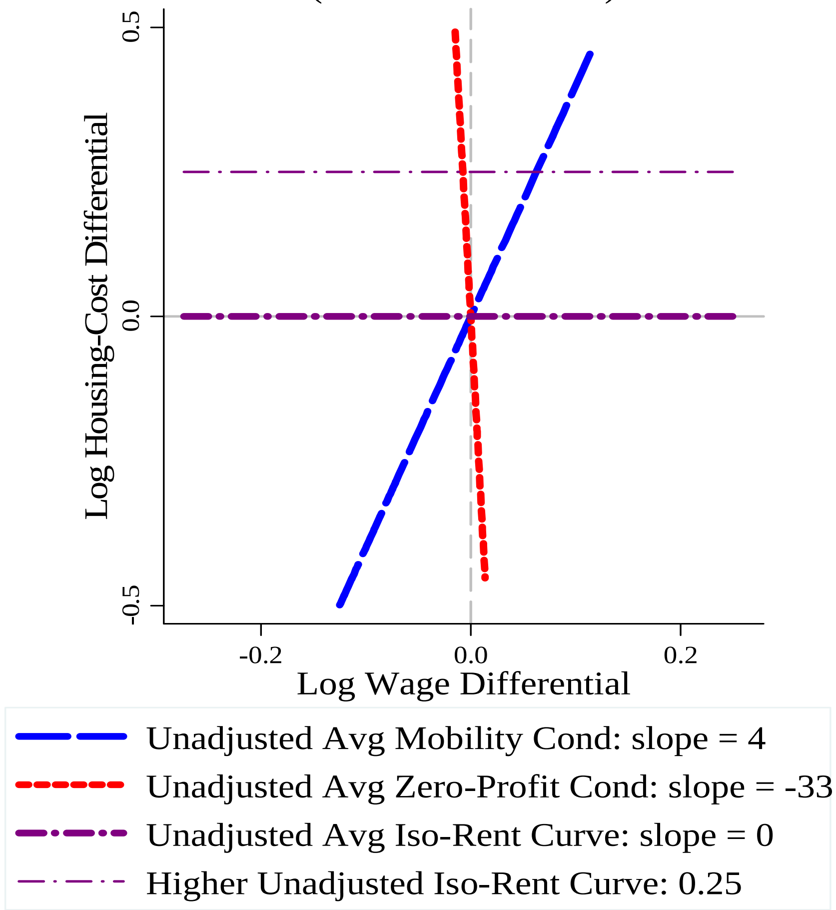


Figure 2: Housing Costs versus Wage Levels across Metro Areas, 2000

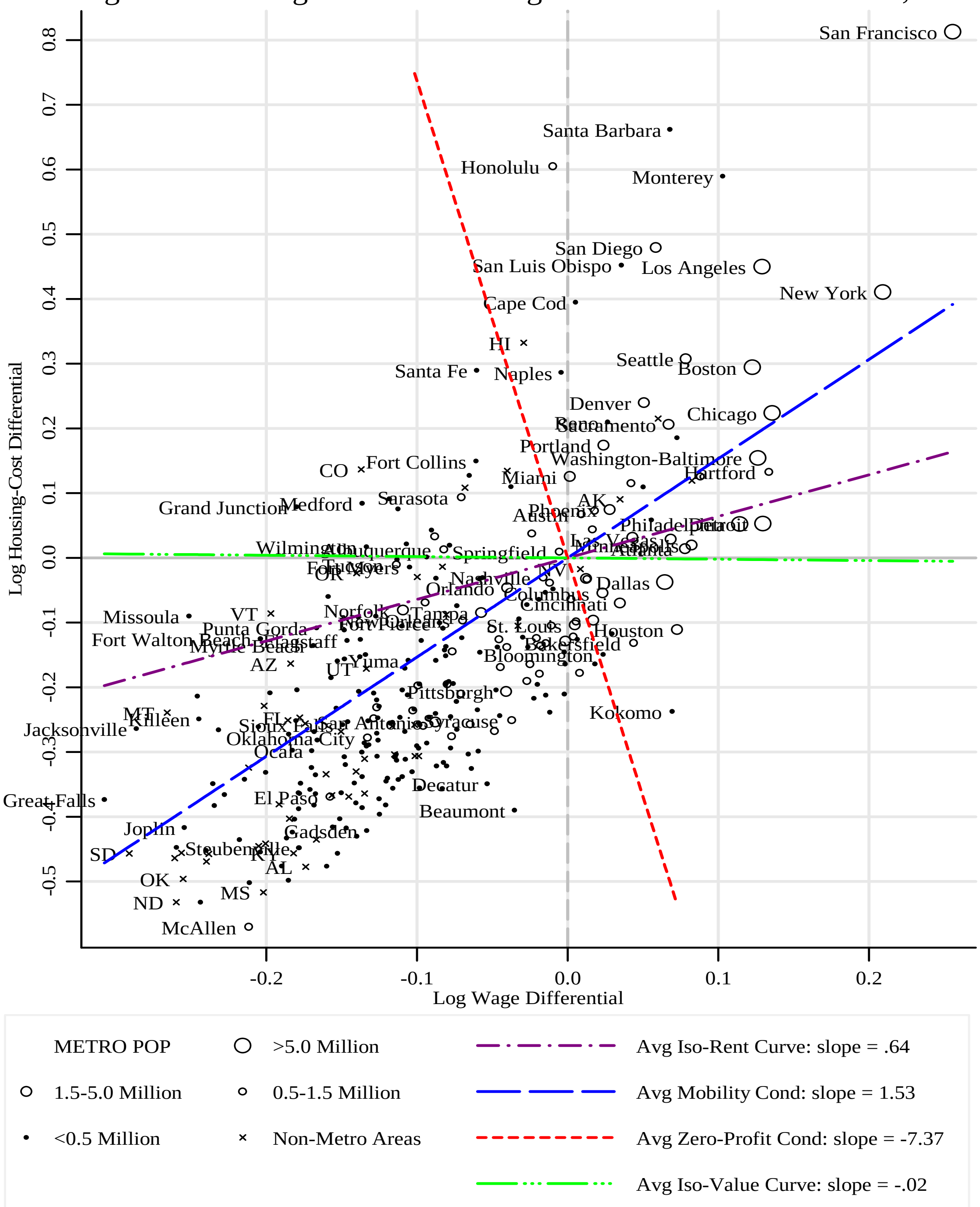
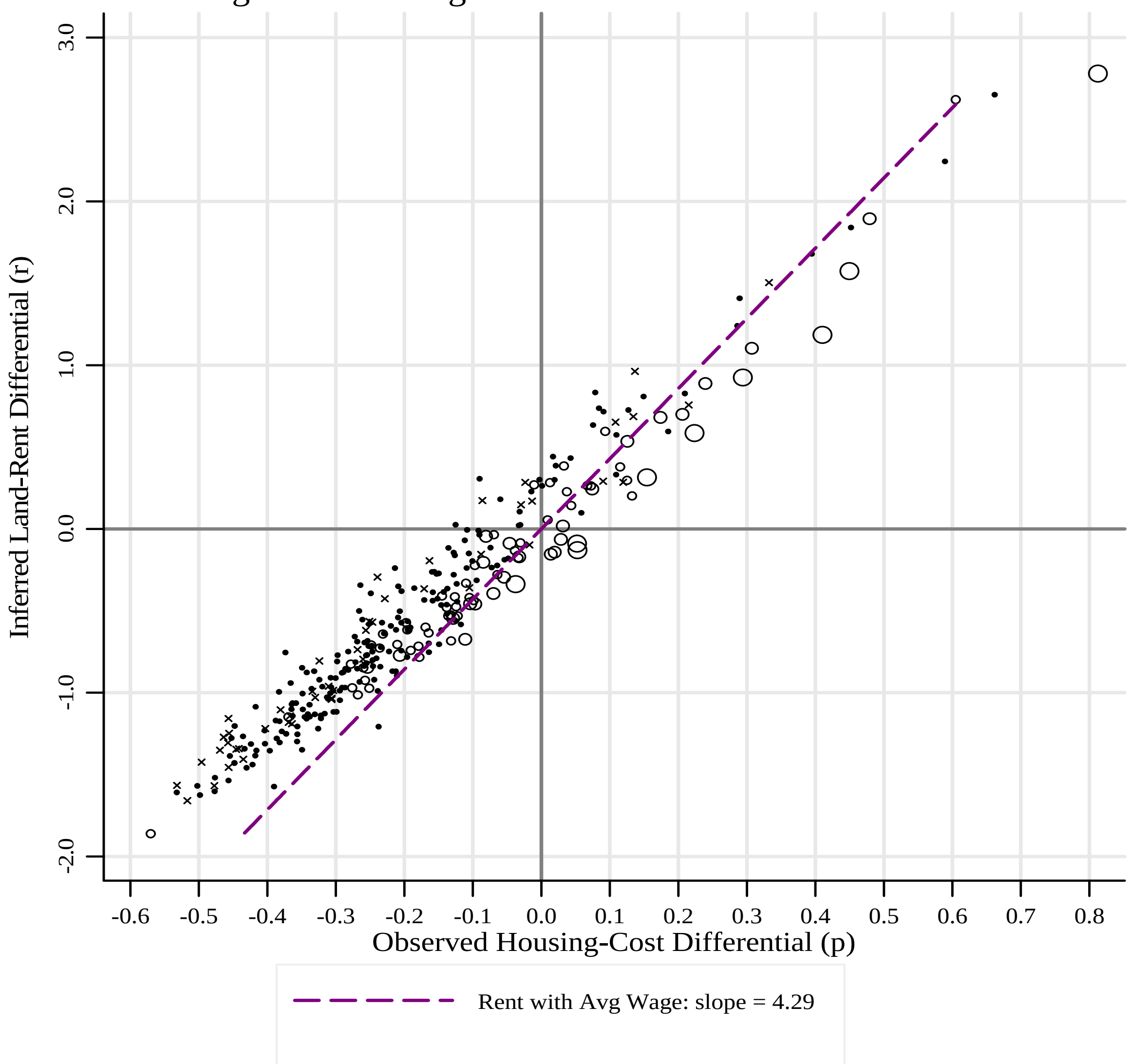


Figure 3: Housing Costs and Inferred Land Rents



Inferred land rents based on calibration: phiL =.233333, phiN =.616667, sigmaY = 1.0

Figure 4: Estimated Productivity and Quality of Life, 2000

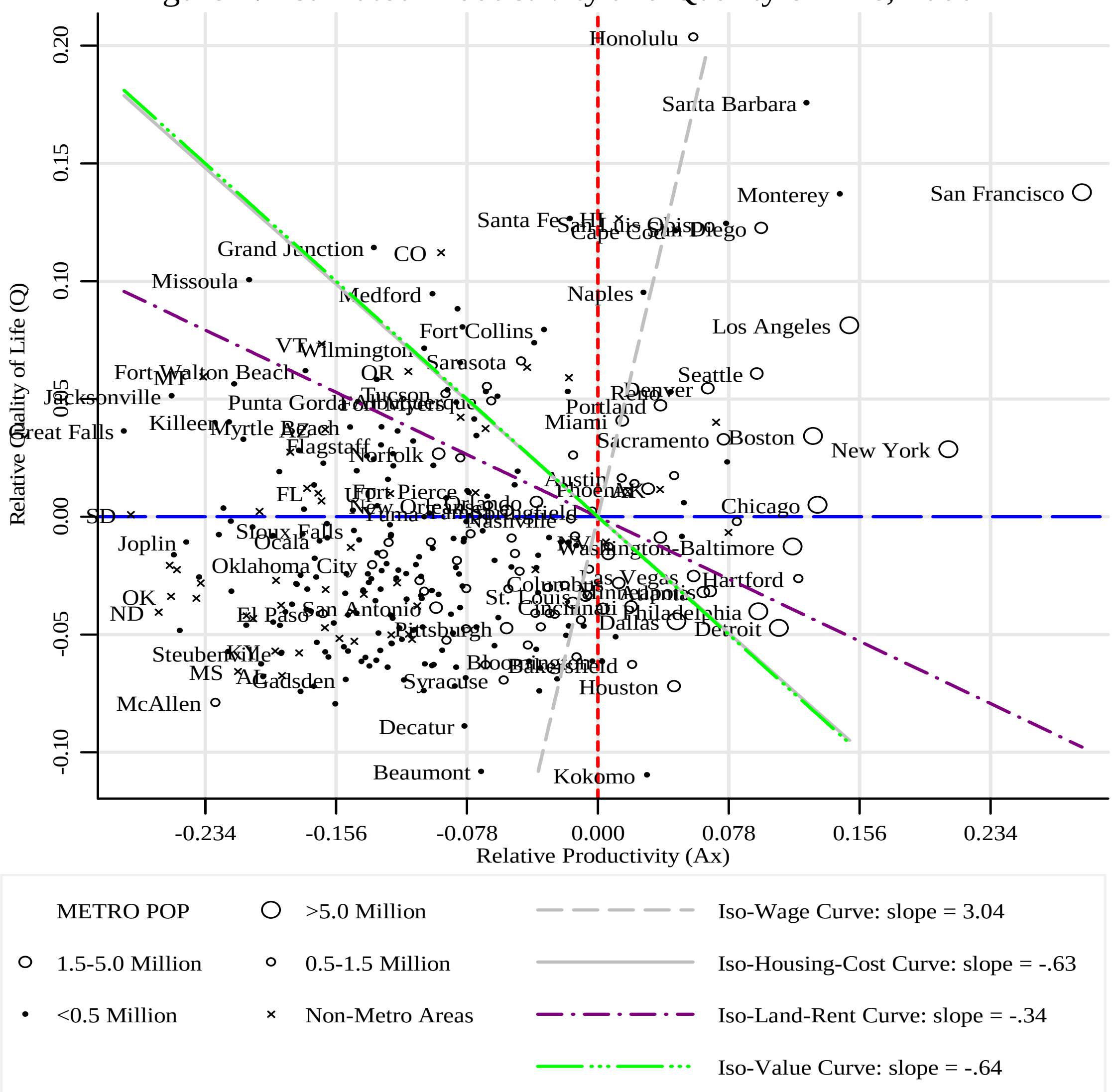


Figure 5: Productivity and Population Size

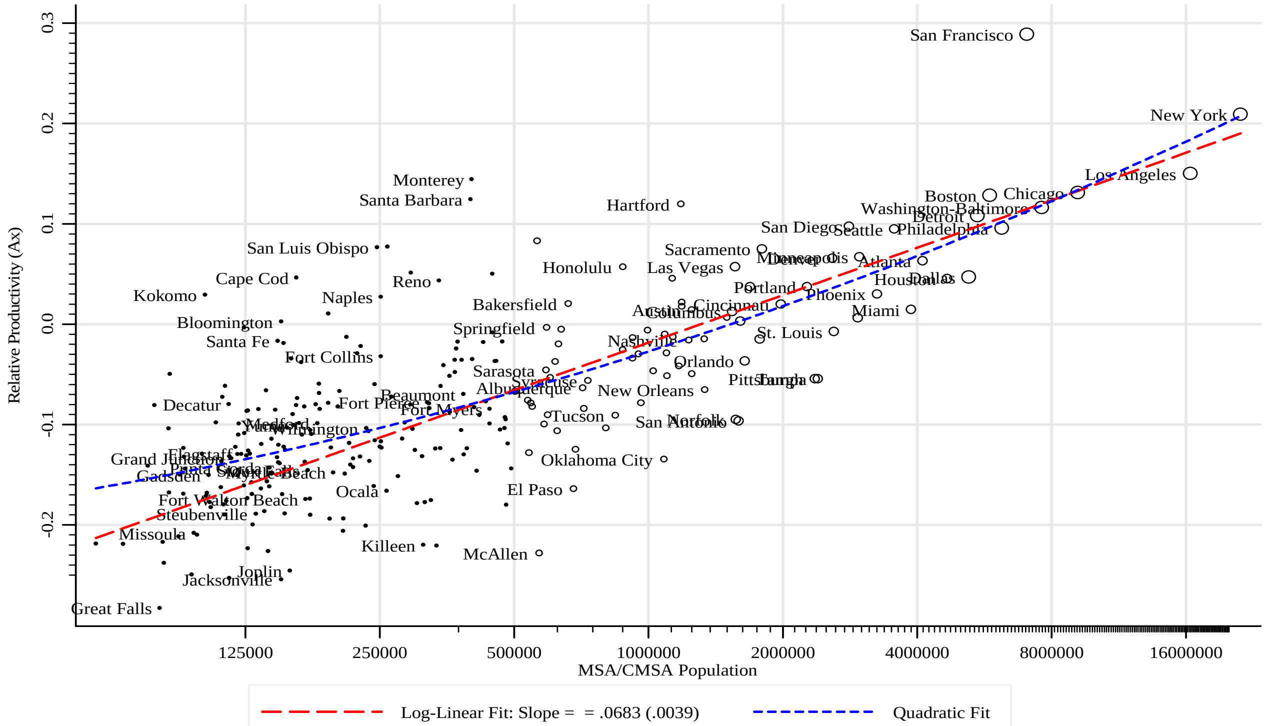
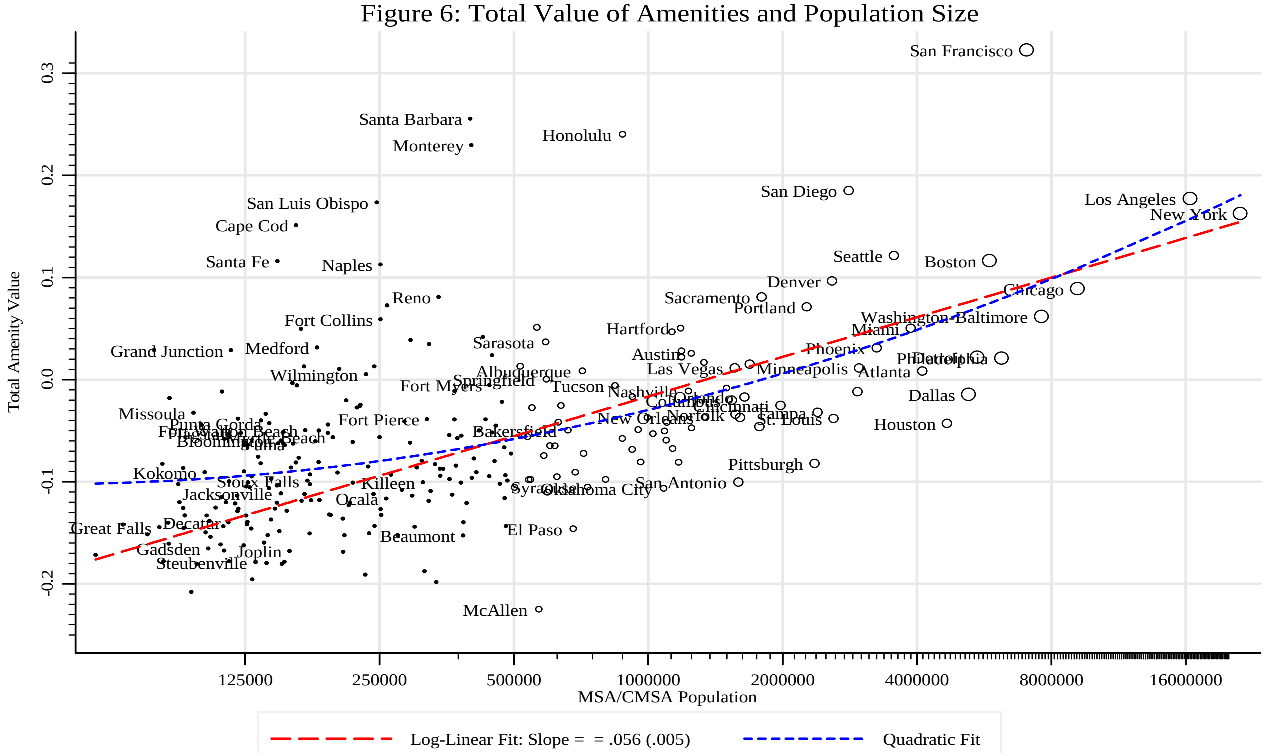


Figure 6: Total Value of Amenities and Population Size



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

		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

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

		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

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

		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 VALUE

		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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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
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

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

		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

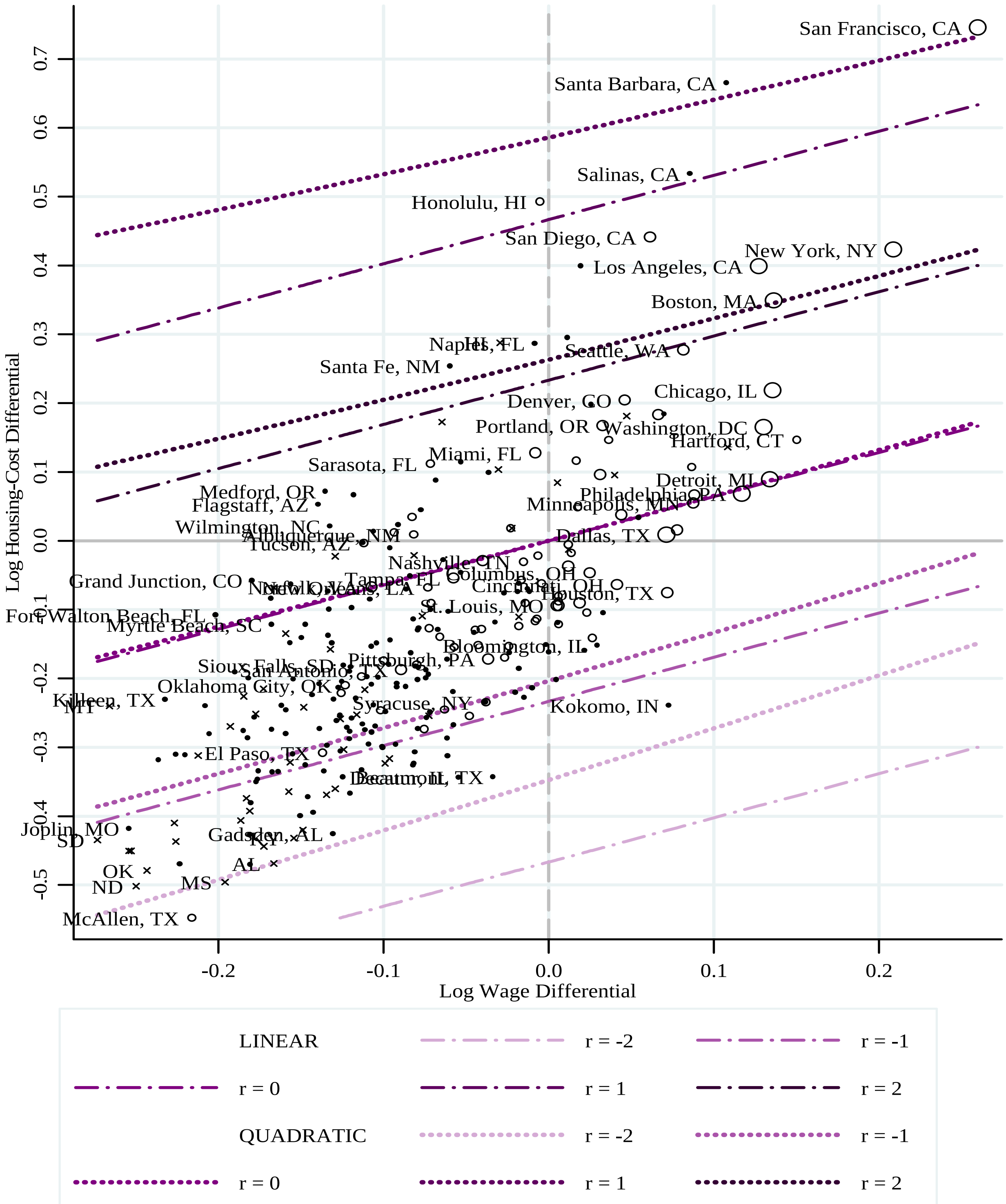
APPENDIX TABLE A1: LIST OF METROPOLITAN AND NON-METROPOLITAN AREAS RANKED BY TOTAL AMENITY VALUE

		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
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

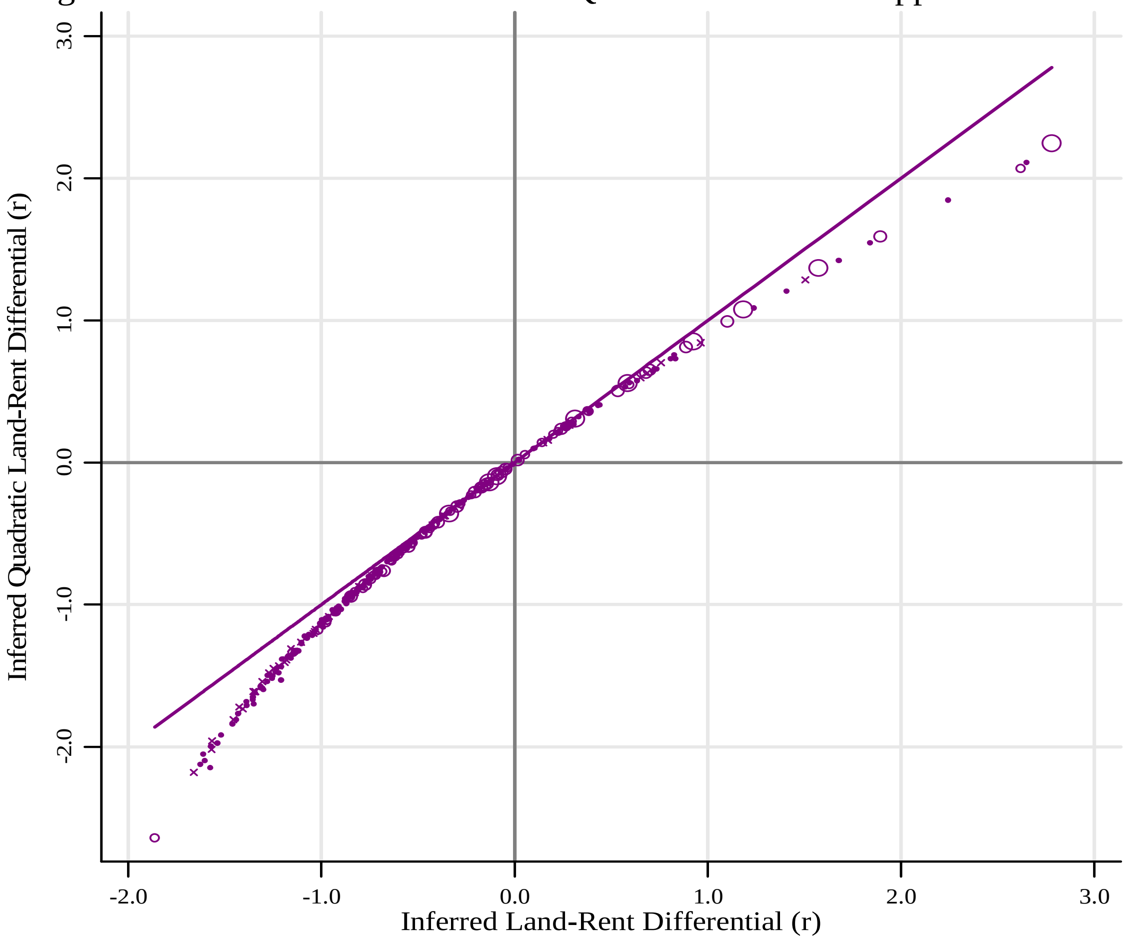
		Adjusted Differentials		Land Rents		Quality of Life		Trade-Productivity		Federal Tax Differential	Total Amenity Values	
State Name	Population	Wages	Housing Costs	Linear	Quadratic	Value	Rank	Value	Rank		Value	Rank
Hawaii	1,211,537	-0.015	0.530	2.311	1.852	0.182	1	0.045	10	-0.02	0.211	1
California	33,871,648	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