New Estimates of Quality of Life in Urban Areas

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Implicit markets capture compensation for intraurban and interregional differences in amenities and yield differences in housing prices and wages. These pecuniary differences become preference-based weights in a quality of life index. Hedonic equations are estimated using micro data from the 1980 Census and assembled county-based amenity data on climatic, environmental, and urban conditions. Ranking of 253 urban counties reveals substantial variation within and among urban areas.

Quality of life comparisons among areas attract the attention of residents, workers, business managers, and policymakers. Evidence of the influence of amenities, one dimension of quality, on housing, job, and migration decisions is found by Ronald Krumm (1980), Philip Graves (1983), and V. Kerry Smith (1983) among others. People are interested in comparing the bundle of amenities available at one location to bundles elsewhere.

The basic problem in constructing a quality of life index is developing a method for weighting the different amenities. Early work ranking cities by quality of life, for example, Ben-Cheih Liu (1976), produced overall quality of life indexes by weighting amenities in an atheoretic manner. Advances were made by Sherwin Rosen (1979), who suggests urban locations are best viewed as tied bundles of wages, rents, and amenities. Extending Rosen's work, Jennifer Roback (1982) constructed a model to show interregional amenity differences are bid into interregional differences in both wages and land rents. These differences yield implicit amenity prices which are appropriate weights for a quality of life index. The quality of life index we develop incorporates the wage and rent effects discussed by Rosen and Roback.

In contrast to previous research, our model allows for amenity variation both within and across urban areas. Agglomeration effects due to the productivity effects of city size provide a key linkage between firms of a given urban area. Our data extend the reach of empirical analysis; more cities are included, amenities are measured at the county level, housing rent data are for individual households rather than urban aggregates, and the data are more recent. Hedonic wage and rent equations are estimated using 1980 U.S. Bureau of the Census micro data matched with amenity data on climatic, environmental, and urban conditions. Implicit amenity prices are estimated from the hedonic results. These implicit prices are the amenity weightings in our quality of life index. The index is computed for 253 urban counties within 185 metropolitan areas of the United States.

I. Framework

A. *Households, Firms, and Urban Structure*

Central to our framework is the idea that different urban locations offer different sets

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of wages, rents, and amenities. Households attempt to maximize well-being and firms attempt to minimize costs by their location decisions. We assume a fixed number of urban areas in which individuals and firms may locate. Before location decisions are made, households and firms are freely mobile.[1] Each urban area is a collection of counties. For simplicity, we analyze the case of an arbitrary urban area composed of two counties. Each county is composed of a fixed amount of land and offers a different set of amenities that resident households and firms may enjoy. Counties in an urban area are linked together by agglomeration effects; the population of the entire urban area affects the production costs of firms, regardless of the county in which they are located.

Households gain utility through use of a composite commodity, local residential land, and local amenities. A household gains access to the amenities of the kth county through the purchase of residential land q_k, where $k \in \{1,2\}$. Both land and the consumption commodity are purchased out of labor earnings. Each household is endowed with one unit of labor. A household in county k sells its labor time to local firms and earns a wage w_k. Earnings comprise all of income and labor is homogeneous. Labor transportation costs within a given county are assumed to be negligible.[2]

The level of well-being attained by a household in county k is

$$(1) \qquad v^k = v^k(w_k, r_k; a_k),$$

where $v^k(\cdot)$ is the indirect utility function, r_k is the rental price of land in the kth urban area county, a_k is an index of local amenities, and the fixed, unit price of the composite commodity is suppressed. Utility in the kth county increases with an increase in wages in the kth county ($v^k_{w_k} > 0$) and decreases with an increase in the rental price of land within the county ($v^k_{r_k} < 0$). An increase in a county's amenities increases utility in that county if a_k is a consumption amenity ($v^k_{a_k} > 0$) and decreases utility if a_k is a disamenity in consumption ($v^k_{a_k} < 0$). A household residing in county k demands residential land $q_k = v^k_r / v^k_w$. Letting the amount of land within the kth county be fixed and equal to Q_k, the population of county k is $N^k = Q_k / q_k$. Given equation (1), this implies that a county's population is a function of its own wage, rent, and amenity levels.

Firms combine local labor and capital to produce the composite commodity. The prices of capital and the composite commodity are fixed by international markets. Prices and wages are normalized on the price of the composite good, and the price of the composite good is set to unity. Production technology is constant returns to scale in labor and capital. Local amenities enter production as shift parameters.

For a firm located in the kth county, unit production costs are

$$(2) \qquad c^k = c^k(w_k; a_k, N),$$

[1] The intraurban, interregional model is based on the assumption that the housing market is sufficiently national in scope that compensating differentials surface in the housing market as well as in the labor market. For evidence that is suggestive of the appropriateness of the national housing market assumption see Peter Linneman (1980).

[2] For simplification we assume there is no cross-county commuting, work hours are exogenous, and labor is homogeneous. Of course, commuting does exist, but most people do live and work in the same county. As calculated from the migration—place of work—travel time subsample of the 1980 Census A sample, among the people who live in one of the 340 urban counties identified, 81 percent live and work in the same county.

While labor supply is exogenous in our model, there may be some labor market response by households to amenity-level differences. We expect households who choose areas with low wages and high amenity levels to reduce their hours worked in response to the low relative price of leisure. This partial effect in the labor market magnifies the reduction in wages necessary to compensate for a difference in amenities. Even though we do not model labor supply or bring it directly into the estimation, we do illustrate how our quality of life measure varies with differences in hours worked by the household.

Another complication which has been considered in detail elsewhere is heterogenous labor. Roback (1988) shows that in an interregional context diversity of workers further dilutes the simple presumption of a negative relationship between amenities and wages and a positive relationship between amenities and rents.

where $c^k(\cdot)$ is a firm's unit cost function and the price of capital is left implicit. N is the population size of the entire urban area. N reflects agglomeration or congestion effects (George Tolley, 1974). As city size varies, unit costs of a firm may fall, remain constant, or increase ($c_N \lesseqgtr 0$). In terms of amenities, unit costs decrease with a change in a_k, if a_k is an amenity in production ($c^k_{a_k} < 0$), and increase with a change in a_k, if a_k is a production disamenity ($c^k_{a_k} > 0$). By Shephard's lemma a firm's demand for labor is $c^k_{w_k} > 0$.

As individuals and firms locate across different urban areas and counties, wages and rents adjust to clear their respective markets. A spatial equilibrium implies that households cannot improve utility and firms cannot reduce their costs by relocating. An intraurban equilibrium occurs when firms within an urban area produce at common production costs and all urban area households attain an equal level of utility. An interurban equilibrium implies that unit production costs are equal to the unit product price and households across all urban areas attain a common level of utility, u^0.

For an arbitrary urban area, the set of wages, land rents, and city size that sustains an intraurban and interurban equilibrium satisfies the system of equations

$$\text{(S1)} \qquad 1 = c^k(w_k; a_k, N)$$

$$u^0 = v^k(w_k, r_k; a_k)$$

$$N = \sum_{k=1}^{2} N^k,$$

where $k \in \{1,2\}$. The last equation links equilibrium wages and rents within an urban area through the effect of city size on firms' productivity. Using the set of wages and rents that satisfy (S1), one can solve for (a) the implicit price of the amenity a_k, and (b) the comparative static effects of a change in a_k on the equilibrium set of wages, land rents, and city size.

B. *Wages, Rents, and Implicit Amenity Prices*

Equilibrium wage and land rent differentials are used to compute the implicit prices of amenities. These implicit prices, f_k, are obtained by taking the total differential of the second equation in (S1) and rearranging to find $f_k = v^k_{a_k}/v^k_{w_k}$. Consequently, the implicit price of a_k is

$$\text{(3)} \qquad f_k = q_k(dr_k/da_k) - dw_k/da_k,$$

where dr_k/da_k is the equilibrium rent differential and dw_k/da_k is the equilibrium wage differential. We have Roback's (1982) result—that the implicit price is the sum of the land expenditure differential and the negative of the wage differential.

Comparative static analysis is used to solve for the anticipated sign of the equilibrium wage, rent, and city-size differentials, given specific assumptions regarding a_k. Unlike Roback we allow amenities to vary within an urban area; we permit $a_1 \neq a_2$ and $da_1 \neq da_2$. Comparative static results are obtained by taking the total differential of the system (S1) and then solving for the appropriate differentials. From the comparative static analysis, the wage and rent differentials are

$$\text{(4)} \qquad dw_k/da_k = \Big(-v^k_{a_k}c^k_N c^j_{w_j} v^j_{r_j} N^k_{r_k} - c^k_{a_k} v^k_{r_k} v^j_{r_j} \beta_j + N^k_{a_k} v^k_{r_k} v^j_{r_j} c^k_N c^j_{w_j}\Big)/D$$

$$\text{(5)} \qquad dr_k/da_k = \Big[-v^k_{a_k} v^j_{r_j}\big(c^k_{w_k}\beta_j - c^j_{w_j} c^k_N N^k_{w_k}\big) + c^k_{a_k} v^k_{w_k} v^k_{r_k} \beta_j - N^k_{a_k} v^k_{w_k} v^j_{r_j} c^k_N c^j_{w_j}\Big]/D,$$

where $k \neq j \in \{1,2\}$, $\beta_j = c^j_N[(v^j_{w_j}/v^j_{r_j})N^j_{r_j} - N^j_{w_j}] - c^j_{w_j}$, and D is the determinant of the differential system. $N^k_{r_k}$ is the partial effect of a change in rent in county k on population in county k. $N^k_{w_k}$, $N^j_{r_j}$, and $N^j_{w_j}$ are similarly defined for the wage effect and the effects in county j. $N^k_{a_k}$ is the partial effect of a change in amenities in county k on that county's population. Three more differentials exist and are shown in the Appendix. Two,

dw_k/da_j and dr_k/da_j, show the cross-county effects that occur between two counties within a given urban area. These arise due to agglomeration effects—a change in amenities in county j results in a change in city size that in turn affects the cost of firms within county k. The shift in the costs induces a change in wages and rents. Interestingly, the cross-county rent differential is proportional to the cross-county wage differential. The last differential, dN/da_k, indicates the effect of city size due to a change in the kth county's amenities.

The signs of the five wage, rent, and city-size differentials depend on alternative assumptions regarding: 1) the effect of amenities on households, 2) the impact of amenities on production costs, and 3) the effects of agglomeration. In general, it is not true that the wage differential is negative and the land rent differential is positive even if a_k is a consumption amenity. For instance, in the case in which the amenity increases household utility and reduces production costs, the own-county wage and rent differentials are both positive except where city-size effects increase firm costs. In the case in which city size increases firm costs and a_k is an amenity to households, but neutral with regard to unit costs, own-county rents and city size increase unambiguously with a_k. The sign of the agglomeration effect determines the sign of the wage differential. If firm costs fall as city size increases, the wage differential is positive. If size diseconomies prevail, the wage differential is negative. In the case in which a_k is an amenity to households and detrimental to firms, most of the comparative static effects are ambiguous. The comparative static results underscore the importance of accounting for both the wage and rent differentials in computing quality of life weights.[3]

Two problems arise in empirically implementing our model. First, the amenity price given in equation (3) is based in part upon residential land rents. However, residential land is typically bundled into a package of housing characteristics and land rents are difficult to observe. We can extend our model by introducing housing instead of land in the utility function and adding a production function for housing. As can be shown, the amenity price equation becomes

$$(6) \qquad f_k = h_k(dp_k/da_k) - dw_k/da_k,$$

where h_k is the quantity of housing purchased by a household in county k and p_k is the price of housing in county k.

Second, an estimate of equation (6) appears to require an unbiased estimate of own-county wage and housing-price differentials. In general, unbiased estimates of these wage and rent differentials would require controlling for the levels of amenities prevailing in all the other counties within a particular urban area. For several large urban areas in the United States this approach would require equations with an unwieldy number of independent variables. The omission of the cross-county amenities leads to biased own-county wage and rent differentials if amenities are correlated across counties in the same city. It can be shown, however, that in the amenity price equation (6), the terms causing the bias for each differential cancel.[4] The estimate of the full amenity

[3]In John Hoehn, Mark Berger, and Glenn Blomquist (1987) we show that in an interregional context with urban structure, full amenity values are a weighted average of compensation changes in housing and labor markets. In that paper, which focuses on differences between partial and full prices of amenities, monotonically increasing commuting costs are the sole source of variation in housing prices within each city. In our current model we impose less urban structure and allow for changes in a vector of amenities between counties. The result that full amenity values are a combination of compensatory changes in both markets also follows from our curent model. In the current model we are able to consider (noncommuting) variation in amenity changes within a city as well as across cities in order to facilitate comparisons of quality of life.

[4]A system of equations similar to (S1) except substituting housing for land, is used to derive the own-county wage and housing-price differentials and the cross-county wage and housing-price differentials. The derivations (similar to those in the Appendix) show that the cross-county wage and housing-price differentials are strictly proportional where the reciprocal of housing consumption is the factor of proportionality. If the wage and housing equations are estimated without

price is unbiased and useful as a weight in our quality of life index.

II. Data

The housing expenditure and wage equations used to measure amenity values are estimated with the 1 in 1000 A Public-Use Sample of the 1980 Census and other assembled data. The non-Census data are obtained from a variety of sources and merged to the Census data by county, Standard metropolitan Statistical Area (SMSA), or industry. Together, the Census data and the merged aggregate data consist of observations on 34,414 housing units and 46,004 individuals from 253 counties across the nation.[5]

The housing sample includes all housing units on 10 or fewer acres for which value of the unit or contract rent is reported. In the wage sample are all individuals aged 16 and over who reported their earnings, hours and weeks, had nonzero wage and salary earnings, and had positive total earnings. Monthly housing expenditures is the dependent variable in the housing equation. For renters, monthly housing expenditures is defined as gross rent including utilities. For owners, reported house value is converted to monthly imputed rent using a 7.85 percent discount rate obtained from a user cost study by Richard Peiser and Lawrence Smith (1985). Monthly expenditures for utilities are added to obtain gross imputed rent for owners. The dependent variable in the wage equation is average hourly earnings. The variable is obtained by dividing annual earnings by the product of weeks worked during the year and usual hours worked per week.

The housing-hedonic regression includes Census measures of structural characteristics and also central city status. The wage-hedonic regression has Census-based variable controlling for personal characteristics, occupational group, and central city status. Included in the wage equation is industry unionization from Edward Kokkelenberg and Donna Sockell (1985). The remaining variables common to both the housing- and wage-hedonic regressions come from data merged with the 1980 Census. These variables represent fifteen of the sixteen components of our quality of life index (QOLI). There are six variables measuring climatic conditions taken from *Comparative Climatic Data* prepared by the National Climatic Data Center (1983). A violent crime variable is included based on data reported in the *U.S. FBI Uniform Crime Reports for the United States* (1980). Coast is a variable that equals one if the county of residence touches an ocean or one of the Great Lakes. The teacher-pupil ratio is based on school district and county data on enrollment and salaries found in Volumes 3 and 4 of the 1982 *Census of Governments*. This school-input ratio is similar in construction to the ratio used by Steven Cobb (1984).

The estimated wage and housing-expenditure equations also include six environmental variables based on data from four differ-

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amenities from other counties, then the estimated own-effect differentials (γ_k^w and γ_k^p) each contain additional terms

$$\gamma_k^w = dw_k/da_k + \sum_{j \neq k} \delta_{kj}(dw_k/da_j),$$

$$\gamma_k^p = dp_k/da_k + \sum_{j \neq k} \delta_{kj}(dp_k/da_j),$$

where the a_j's are the levels of amenity a in other counties in the city and δ_{kj}'s are the coefficients obtained from a regression of a_k on the a_j's (J. Johnston, 1984, p. 260). However, use of γ_k^w and γ_k^p results in an estimate of f_k as

$$\begin{aligned} h^k\gamma_k^p - \gamma_k^w &= h^k\left[dp_k/da_k + \sum_{j \neq k} \delta_{kj}(dp_k/da_j)\right] - dw_k/da_k \\ &\quad - \sum_{j \neq k} \delta_{kj}(dw_k/da_j) \\ &= h^k(dp_k/da_k) - dw_k/da_k = f_k \end{aligned}$$

since from the Appendix $dp_k/da_j = (1/h_k)dw_k/da_j$. While the above refers to the case of a single amenity, the same result holds for multiple amenities where there is correlation across amenities. Thus, our empirical work provides unbiased estimates of the full amenity prices in addition to being conceptually superior to studies based on a single market.

[5]Although we have a national sample, we do not include all counties in the United States for two reasons. First, the Census A sample identifies only 340 counties, all of which have a population exceeding 100,000. Second, the number of counties is reduced further because we do not have a full set of amenity data for 87 of 340 urban counties.

ent sources. The ambient concentration of total suspended particulate (TSP) for each county is based on the U.S. Environmental Protection Agency (USEPA) SAROAD data. Visibility data are obtained from reports by John Trijonis and Dawn Shapland (1979) and daily weather observations are supplied by the National Climatic Center. The number of Superfund sites in the individual's county is based on information published in the Council on the Environmental Quality report, *Environmental Quality 1982*. The last three variables are measures of activity in the individual's county of residence based on the Resource Conservation and Recovery Act (RCRA) Application for Hazardous Waste Permit Tape obtained from the USEPA. The first two are counts of the number of treatment, storage, and disposal (TSD) facilities for hazardous wastes, and the number of National Pollution Discharge Elimination Systems (NPDES) water-pollution discharges in the county of residence. The last variable is the total licensed waste for landfills in the county.

During the course of the project we considered including other amenity measures in our overall bundle. Some of them, such as number of sports teams, were too highly correlated with an endogenous variable (city size) in our model. Others, such as overall tourism expenditures, had a price component as well as a quantity component, which made them unattractive. Finally, several measures could not be collected for a sufficient number of counties to estimate a national model which uses those measures.

III. Hedonic Regressions, Full Implicit Prices, and Amenity Components

Housing and wage hedonic equations are estimated for households and workers. A Box-Cox search was done over functional forms of

$$(7) \qquad \frac{Y^{\lambda}-1}{\lambda}=b_0+\sum_{i=1}^{n} b_i\frac{X_i^{\gamma}-1}{\gamma}+\varepsilon,$$

where Y is either rent or wage, the X_i are the independent variables, λ was varied from $+1.2$ to -0.4, and γ was either 1 (linear) or 0 (logarithm). The best functional form for the housing hedonic was $\lambda=0.2$ and $\gamma=1$, and the best form for the wage hedonic was $\lambda=0.1$ and $\gamma=1$. These functional forms yielded the highest values of the log-likelihood functions. The log-likelihood values for the best housing and wage equations are significantly different from the double-linear, double-log, and semilog forms at the .01 level.

Table 1 shows linearized (unboxed) coefficient estimates and standard errors for the sixteen amenities and disamenities included in the housing-expenditure and wage-hedonic regressions.[6] Amenities clearly affect housing expenditures and wages. All of the amenity parameter estimates shown in column 2 are at least two times larger than their standard errors in the housing-expenditure equation. Ten out of the sixteen wage equation estimates shown in column 3 exceed two times their standard error. Compared to regressions without amenities (not shown) the addition of the amenities results in an increase in R^2 from .587 to .662 (F value $=$ 480.0) in the housing expenditure equation and from .308 to .314 (F value $=$ 25.0) for the wage equation.

The amenity coefficients are adjusted to reflect mean annual household housing expenditures and labor earnings and then are combined using equation (6) to generate full implicit prices for the amenities. The fourth column of Table 1 gives the annual full implicit price and standard error for each amenity for the average household. A positive full implicit price indicates a marginal net amenity and a negative price indicates a marginal net disamenity. Only visibility has an unexpected sign, but its standard error is

[6] The full set of housing-expenditure and wage-hedonic regression results are available upon request. The regression coefficients are linearized in the following manner: $b_i' = b_i(\bar{y}^{-1-\lambda})$, where b_i' is the linearized coefficient, b_i is the estimated coefficient from the best functional form, $\bar{y}$ is the sample mean hourly earnings ($8.04) or monthly housing expenditures ($462.93), and λ is .2 in the housing equation and .1 in the wage equation. See Linneman (1980) for details on transforming Box-Cox coefficients.

TABLE 1—LINEARIZED PARAMETER ESTIMATES, FULL IMPLICIT PRICES, AND QUALITY OF LIFE INDEX COMPONENTS

Amenity Variable (Wage Sample Mean and Unit of Measurement)	Monthly Housing Expenditure Equation[a]	Hourly Wage Equation[b]	Full Implicit Price[c]	QOLI Component Mean	QOLI Component Minimum	QOLI Component Maximum
Precipitation	−1.047	−.0144	$23.50	$808	$88	$1574
(32.0 inches per year)	(.149)	(.004)	(9.71)	(291)		
Humidity	−2.127	.0065	−43.42	−2987	−3397	−1368
(68.3 percent)	(.251)	(.006)	(16.29)	(282)		
Heating Degree Days	−.0136	−.0001	−.08	−370	−780	−16
(4326 per year)	(.001)	(.00003)	(.06)	(167)		
Cooling Degree Days	−.0760	−.0002	−.36	−448	−1461	−20
(1162 per year)	(.002)	(.0001)	(.13)	(324)		
Wind Speed	11.88	.0961	−97.51	−881	−1209	−595
(8.89 miles per hour)	(.867)	(.022)	(55.54)	(139)		
Sunshine	2.135	−.0091	48.52	2929	2183	4172
(61.1 percent of possible)	(.235)	(.006)	(15.43)	(370)		
Coast	32.51	−.0310	467.72	105	0	468
(.330, =1 if county on coast)	(2.47)	(.063)	(161.09)	(196)		
Violent Crime	.0434	.0006	−1.03	−602	−2202	65
(647 per 100,000 population per year)	(.003)	(.0001)	(.19)	(326)		
Teacher-Pupil Ratio	635.3	−5.451	21,250.00	1774	742	4483
(.0799 teachers per pupil)	(71.6)	(1.85)	(4698.33)	(369)		
Visibility	−.8302	−.0026	−3.41	−62	−273	−27
(15.8 miles)	(.110)	(.003)	(7.03)	(55)		
Total Suspended Particulates	−.5344	−.0024	−.36	−25	−60	−13
(73.2 micrograms per cubic meter)	(.058)	(.001)	(3.77)	(7)		
NPDES Effluent Dischargers	−7.458	−.0051	−76.68	−74	−844	0
(1.51 county)	(.461)	(.012)	(30.56)	(136)		
Landfill Waste	.0095	.0001	−.11	−20	−1410	0
(477 hundred million metric tons per county)	(.001)	(.00002)	(.05)	(128)		
Superfund Sites	13.42	.1069	−106.07	−66	−955	0
(.883 per county)	(.693)	(.017)	(43.70)	(129)		
Treatment, Storage, and Disposal Sites	.2184	.0013	−.58	−9	−133	0
(46.4 per county)	(.024)	(.001)	(1.56)	(14)		
Central City	40.75	−.4537	645.02	113	0	645
(.290, =1 if residence in central city)	(2.54)	(.065)	(165.09)	(188)		
Quality of Life Index	–	–	–	186	−1857	3289
(1980 dollars per year)	–	–	–	(667)		
R^2	.6624	.3138				
n	34,414	46,004				
Log-Likelihood Value	−219,013	−124,403				

Note: Standard errors or standard deviations evaluated at the mean wage or rent and shown in parentheses.

[a]The dependent variable is actual or imputed monthly housing expenditures. Control variables which are included in the housing hedonic regression, but which are not reported include: units at address, age of structure, stories, rooms, bedrooms, bathrooms, condominium status, central air, sewer, lot size exceeds 1 acre, renter status, and renter interaction terms for each of these variables.

[b]The dependent variable is annual earnings divided by the product of annual weeks worked and usual hours per week. Control variables which are included in the wage-hedonic regression, but which are not reported include: experience, (age-schooling-6), experience squared, gender interaction with experience and experience squared, race, gender, gender interaction with race, marital status, gender interaction with marital status, gender interaction with children under 18, schooling, disabled, school enrollment status, dummies for 5 of 6 broad occupation groups and percent of industry covered by unions.

[c]As shown in equation (6) the full implicit price is the sum of the annual housing expenditure and wage differentials. To obtain an annual household full implicit price, the housing coefficients are multiplied by 12 (months per year) and the wage coefficients are multiplied by (1.54)(37.85)(42.79), the product of the sample means of workers per household, hours per week, and weeks per year.

more than twice as large as its full implicit price. Part of the difficulty is that visibility is highly correlated with humidity, total suspended particulates, and precipitation. The full implicit prices of heating degree days, total suspended particulates and treatment, storage and disposal sites are also small relative to their standard errors. The remaining twelve full implicit prices, however, are all twice as large as their standard errors.[7]

The full implicit prices in Table 1 are used to construct a quality of life index across urban counties in the following manner:

$$(8)\quad \mathrm{QOLI}_k = \sum_{i=1}^{16} f_i a_{ki} \qquad k = 1,\ldots,253,$$

where f_i is the full implicit price of amenity i, and a_{ki} is the quantity of amenity i observed in county k. The index is measured in dollars and is useful for making quality of life comparisons across areas. The difference in the value of the index between two counties gives the premium that the average household pays implicitly through the labor and housing markets to live in the more amenable county.[8]

Differences in the values of the QOLI are due to differences in the components, the $f_i a_{ki}$. To provide some idea of the magnitudes of these components and their variation across counties, the last three columns of Table 1 show the mean value of each amenity component across the counties in our sample, and also the standard deviation, minimum and maximum of the components. For example, individuals living in the county with the most crime are compensated $2267 implicitly in the labor and housing markets over those living in the county with the least crime, and $1600 over those in the county having the average rate of violent crime. For the entire bundle of amenities the difference in compensation between the most and least desirable county is $5146. The mean value of the QOLI is $186 while the standard deviation across counties is $667.

[7]Our intraurban, interregional amenity model does imply wages affect rents and rents affect wages. We estimate the wage and housing-price hedonics in reduced forms. Wages are not included in the housing-price hedonic so that dp_k/da_k implicitly reflects variation in w_k. Rents are not included in the wage hedonic so that dw_k/da_k implicitly reflects variation in p_k. These are appropriate specifications because according to our model the total, not partial, differentials belong in the amenity price, f_k, given by equation (6).

Of course, it is possible that the errors in the wage and housing-price hedonics are correlated due to unobservables which affect both wages and housing prices. We examine the extent of this correlation with a subsample of 21,379 householders, for whom we have a one-for-one correspondence between wages and housing prices. In this subsample, the correlation between the wage and housing-price residuals is .128, which is small but significant. However, seemingly unrelated regression estimates for the amenities differ inside the third decimal place from those obtained using ordinary least squares in only 3 of 32 cases. Further, the QOLI ranking obtained using the seemingly unrelated regression estimates is highly correlated with the one obtained using OLS estimates; the rank correlation is .997.

[8]The premium equals the value households place on differences in amenity bundles and is accurate for small variations in the typical bundle. Since the QOLI is based on marginal implicit prices, the estimated premia for large differences between amenity bundles are approximations. By comparing the bid function and hedonic function for a single amenity we can demonstrate that: 1) the value of the amenity is overstated for all amenity levels except the level chosen by the representative person; 2) QOLI is overestimated for high- and low-amenity counties; but 3) the county ranking by QOLI is unaffected. The ordering is not changed by overestimates for below and above average counties. For more than one amenity, the QOLI values for counties with a combination of extremely high and extremely low amenities are overestimated and these counties may be overranked.

We do find some evidence of overranking. For counties with either one amenity level more than two standard deviations below average and another amenity level more than two standard deviations above average or two amenity levels more than two standard deviations below average and two amenity levels more than two standard deviations above average, the average QOLI is $517. For counties with no amenity levels more than two standard deviations from the mean, the average QOLI is $129. Thus the counties with a combination of extremely high- and low-amenity endowments do have above average QOLI values and could be overranked. Fortunately, few counties have extreme combinations. Only 12 (5 percent) counties have a one-one extreme combination and only four (2 percent) counties have a two-two extreme combination of amenity levels. Of the 253 counties, 152 (60 percent) have no extreme values at all.

IV. Ranking Urban Areas by Quality of Life

Variation in amenity endowments across urban areas produces variation in the values of QOLI. Table 2 reports the complete ranking by quality of life for all counties for which we have complete data, 253 urban counties in 185 SMSA's. Given for each county are the rank, SMSA, and state in which the county is located and the QOLI premium. The top-ranked county is Pueblo, Colorado, with a $3,289 premium. The county with the (approximate) average QOLI is Woodbury in Sioux City, Iowa, with a $189 premium. The bottom-ranked county is St. Louis City in St. Louis, Missouri, with a $-1,857 premium.[9]

An advantage of this county-based analysis is that investigation of variation in quality of life within urban areas is possible. For the 253 counties in our sample we have observations from more than one county for 38 SMSA's. Table 3 shows the 10 SMSA's with the widest range of QOLI values. The difference in QOLI values between counties in the Milwaukee SMSA is $2,350. Milwaukee County has a QOLI of $558 which ranks 68th and Waukesha County has a QOLI of $-1,792 and is ranked 252nd. In the St. Louis SMSA, St. Louis City has a QOLI of $-1,857 which is the lowest of the 253 counties, and St. Clair, Illinois, has a QOLI of $-251 which is 195th. Other SMSA's which display intraurban differences of $900 or more are Denver-Boulder, Norfolk-Virginia Beach-Portsmouth, Minneapolis-St. Paul, Detroit, Richmond, Dayton, and Chicago. As Table 3 illustrates, substantial variation exists in quality of life within as well as across urban areas.

The QOLI values presented in Tables 2 and 3 are calculated using the characteristics of the average household and all 16 amenities included in the empirical analysis. For households having other than the mean characteristics, for example, working more or less hours, the standard QOLI may be inaccurate. Some households may value only a subset of the amenity bundle which means a more limited QOLI would be relevant for them. Also, the QOLI calculated in the paper is based on an equilibrium model, and to the extent disequilibrium influences are present a county's ranking may change. Table 4 addresses these issues by presenting alternative QOLI rankings for households with high and low hours worked and for subsets of amenities, along with giving some indication of how fast county population is growing. The alternative rankings and county population growth are shown for the top 15, middle 15, and bottom 15 counties as ranked by the standard QOLI.

The QOLI rankings for households with one-half and twice as many hours worked as the average show the sensitivity of the rankings to differences in exogenous household labor supply. Households with high and low numbers of hours worked will place different values on the amenities due to variation in the contribution of the hourly wage effect (dw/da) to the annual full implicity price. The rankings do change somewhat as hours of work change. But in general top counties stay near the top under different assumptions about hours worked and bottom counties stay near the bottom. Indeed, the rank correlation coefficients between the standard ranking and the low and high hours worked rankings are .63 and .83.

Also presented in Table 4 are rankings for three subsets of amenities: climate, environmental quality, and urban conditions. The urban conditions subset includes central city status, the violent crime rate, and teacher-pupil ratio. The rankings based on these subsets are related to the standard ranking in various degrees: the rank correlation between the climate subset and the standard

[9] Given our emphasis on intraurban variation in quality of life and our county-based data set, it is difficult to compare our results with SMSA rankings reported in previous studies. However, we can obtain an SMSA QOLI value by calculating population weighted average of QOLI values for counties within the SMSA. We have done this for the set of cities which are common to our study and those of Roback (1982) and Liu (1976) as reported by Roback (1982, p. 1275). The rank correlation for 19 common cities between our SMSA QOLI ranking and Roback's ranking is +0.40. The rank correlation for 18 common cities as reported by Roback between our SMSA QOLI ranking and Liu's ranking for environmental factors is +0.42. A comparison with the Rosen (1979) results is not made because he does not provide an overall ranking.

TABLE 2—QUALITY OF LIFE RANKING FOR 253 URBAN COUNTIES, 1980

Rank	County	Standard Metropolitan Statistical Area	State	QOLI (1980 dollars)
1	Pueblo	Pueblo	CO	$3288.72
2	Norfolk City	Norfolk-VA Beach-Portsmouth	VA	2105.77
3	Arapahoe	Denver-Boulder	CO	2097.07
4	Bibb	Macon	GA	1599.57
5	Washoe	Reno	NV	1575.37
		(Mean QOLI + 2 S.D. = $1520)		
6	Broome	Binghamton	NY	1485.63
7	Hampton City	Newport News-Hampton	VA	1444.63
8	Sarasota	Sarasota	FL	1430.84
9	Palm Beach	West Palm Beach-Boca Raton	FL	1422.54
10	Pima	Tucson	AZ	1341.86
11	Broward	Fort Lauderdale-Hollywood	FL	1326.91
12	Boulder	Denver-Boulder	CO	1319.47
13	Larimer	Fort Collins	CO	1297.84
14	Denver	Denver-Boulder	CO	1295.25
15	Charleston	Charleston-North Charleston	SC	1280.21
16	Monterey	Salinas-Seaside-Monterey	CA	1213.97
17	Roanoke City	Roanoke	VA	1129.65
18	Lackawanna	Northeast Pennsylvania	PA	1127.43
19	Leon	Tallahasee	FL	1066.51
20	Richmond City	Richmond	VA	1059.96
21	Fayette	Lexington-Fayette	KY	1055.50
22	Santa Barbara	Santa Barbara-Santa Maria-Lompoc	CA	1025.76
23	Ventura	Oxnard-Simi Valley-Ventura	CA	1022.83
24	Durham	Raleigh-Durham	NC	1014.01
25	New Hanover	Wilmington	NC	1000.92
26	Wake	Raleigh-Durham	NC	990.98
27	San Diego	San Diego	CA	980.93
28	VA. Beach City	Norfolk-VA Beach-Portsmouth	VA	967.70
29	Lancaster	Lancaster	PA	965.38
30	Manatee	Brandenton	FL	958.13
31	Weld	Greeley	CO	957.23
32	El Paso	El Paso	TX	923.02
33	Racine	Racine	WI	912.83
34	Guilford	Greensboro-Winston-Salem-High Pt.	NC	908.74
35	Lane	Eugene-Springfield	OR	884.00
36	Maricopa	Phoenix	AZ	870.69
		(Mean QOLI + 1 S.D. = $853)		
37	Lycoming	Williamsport	PA	844.97
38	Brevard	Melbourne-Titusville-Cocoa	FL	819.93
39	Fresno	Fresno	CA	808.87
40	Minnehaha	Sioux Falls	SD	803.73
41	Orange	Anaheim-Santa Ana-Garden Grove	CA	803.49
42	Lee	Fort Myers-Cape Coral	FL	803.36
43	Luzerne	Northeast Pennsylvania	PA	792.13
44	Berkshire	Pittsfield	MA	792.13
45	Forsyth	Greensboro-Winston Salem-High Pt.	NC	792.04
46	Dane	Madison	WI	791.58
47	Cumberland	Vineland-Millville-Bridgeton	NJ	787.31
48	Dauphin	Harrisburg	PA	763.67
49	Suffolk	Nassau-Suffolk	NY	757.40
50	Knox	Knoxville	TN	735.50
51	Washington	Fayetteville-Springdale	AR	733.41
52	San Joaquin	Stockton	CA	728.69
53	Adams	Denver-Boulder	CO	726.73
54	Blair	Altoona	PA	711.21
55	Hudson	Jersey City	NJ	709.16
56	Jackson	Pascagoula-Moss Point	MS	699.85
57	Spartanburg	Greenville-Spartanburg	SC	687.58

TABLE 2—CONTINUED

Rank	County	Standard Metropolitan Statistical Area	State	QOLI (1980 dollars)
58	Los Angeles	Los Angeles-Long Beach	CA	667.64
59	Greenville	Greenville-Spartanburg	SC	648.88
60	Nassau	Nassau-Suffolk	NY	620.16
61	Pinellas	Tampa-St. Petersburg	FL	610.17
62	Jefferson	Denver-Boulder	CO	608.77
63	Richmond	Augusta	GA	598.73
64	Richland	Columbia	SC	586.06
65	Aiken	Augusta	SC	585.33
66	Mobile	Mobile	AL	559.55
67	Stearns	St. Cloud	MN	558.70
68	Milwaukee	Milwaukee	WI	557.84
69	Clark	Las Vegas	NV	540.27
70	Passaic	Paterson-Clifton-Passaic	NJ	536.74
71	Montgomery	Philadelphia	PA	533.91
72	Ada	Boise City	ID	533.39
73	Vanderburge	Evansville	IN	530.66
74	Monroe	Rochester	NY	503.38
75	Chatham	Savannah	GA	498.30
76	Gaston	Charlotte-Gastonia	NC	474.70
77	Polk	Des Moines	IA	470.45
78	Albany	Albany-Schenectady-Troy	NY	454.78
79	Santa Cruz	Santa Cruz	CA	447.03
80	Sacramento	Sacramento	CA	427.14
81	Rensselaer	Albany-Schenectady-Troy	NY	424.19
82	Tuscalossa	Tuscalossa	AL	402.87
83	Kern	Bakersfield	CA	400.74
84	Orange	Orlando	FL	398.00
85	Weber	Salt Lake City-Ogden	UT	393.98
86	Mercer	Trenton	NJ	371.79
87	Sedgwick	Wichita	KS	365.52
88	Santa Clara	San Jose	CA	355.25
89	St. Louis	Duluth-Superior	MN	354.81
90	Allen	Fort Wayne	IN	348.79
91	Champaign	Champaign-Urbana-Rantoul	IL	340.84
92	Monmouth	Long Branch-Asbury Park	NJ	328.84
93	Stanislaus	Modesto	CA	313.42
94	Alameda	San Francisco-Oakland	CA	306.30
95	Cumberland	Fayetteville	NC	301.84
96	Yolo	Sacramento	CA	299.89
97	Bucks	Philadelphia	PA	298.85
98	Pierce	Tacoma	WA	298.78
99	Oneida	Utica-Rome	NY	286.39
100	Berks	Reading	PA	276.10
101	Linn	Cedar Rapids	IA	270.04
102	Volusia	Daytona Beach	FL	267.35
103	Spokane	Spokane	WA	265.20
104	Montgomery	Dayton	OH	263.88
105	San Francisco	San Francisco-Oakland	CA	260.40
106	Onondaga	Syracuse	NY	254.55
107	Lucas	Toledo	OH	250.74
108	Utah	Provo-Orem	UT	249.32
109	Ouachita	Monroe	LA	248.16
110	Lexington	Columbia	SC	246.48
111	Cambria	Johnstown	PA	243.41
112	San Mateo	San Francisco-Oakland	CA	238 14
113	Lancaster	Lincoln	NB	237.02
114	Johnson	Kansas City	KS	229.00
115	Davis	Salt Lake City-Ogden	UT	215.34
116	Schenectady	Albany-Schenectady-Troy	NY	199.24

TABLE 2—CONTINUED

Rank	County	Standard Metropolitan Statistical Area	State	QOLI (1980 dollars)
117	Rock	Janesville-Beloit	WI	196.04
118	Salt Lake	Salt Lake City-Ogden	UT	193.49
119	Woodbury	Sioux City	IA	189.48
		(Mean QOLI = $186)		
120	Davidson	Greensboro-Winston-Salem-High Pt.	NC	178.78
121	Butler	Hamilton-Middletown	OH	168.37
122	Montgomery	Washington	MD	166.10
123	Ingham	Lansing-East Lansing	MI	161.22
124	Ector	Odessa	TX	155.61
125	Sangamon	Springfield	IL	154.34
126	Taylor	Abilene	TX	152.52
127	Erie	Erie	PA	144.24
128	McLean	Bloomington-Normal	IL	140.27
129	Vigo	Terre Haute	IN	137.38
130	San Bernardino	Riverside-San Bernardino-Ontario	CA	135.46
131	Hamilton	Chattanooga	TN	131.69
132	Atlantic	Atlantic City	NJ	128.25
133	Winnebago	Rockford	IL	128.12
134	Benton	Richland-Kennewick-Pasco	WA	113.47
135	St. Joseph	South Bend	IN	108.11
136	Chesterfield	Richmond	VA	107.30
137	Shelby	Memphis	TN	105.46
138	Clackamas	Portland	OR	103.04
139	Lafayette	Lafayette	LA	100.40
140	Smith	Tyler	TX	97.32
141	Douglas	Omaha	NB	94.48
142	Marin	San Francisco-Oakland	CA	92.76
143	Comanche	Lawton	OK	84.37
144	Wyandotte	Kansas City	KS	80.93
145	Ramsey	Minneapolis-St. Paul	MN	79.31
146	Scott	Davenport-Rock Island-Moline	IA	65.83
147	Essex	Newark	NJ	64.67
148	Washington	Portland	OR	58.12
149	Lubbock	Lubbock	TX	57.58
150	Hamilton	Cincinnati	OH	51.79
151	Washtenaw	Ann Arbor	MI	43.74
152	Delaware	Philadelphia	PA	14.18
153	Cabell	Huntington-Ashland	WV	8.32
154	Trumbull	Youngstown-Warren	OH	5.20
155	Dist. of Col.	Washington	DC	3.35
156	Howard	Baltimore	MD	1.90
157	Etowah	Gadsden	AL	1.03
158	King	Seattle-Everett	WA	−7.54
159	Calhoun	Anniston	AL	−10.60
160	Elkhart	Elkhart	IN	−12.50
161	Bexar	San Antonio	TX	−22.07
162	Kenton	Cincinnati	KY	−24.39
163	Rock Island	Davenport-Rock Island-Moline	IL	−24.46
164	Clayton	Atlanta	GA	−25.74
165	Alachua	Gainesville	FL	−26.34
166	Philadelphia	Philadelphia	PA	−28.10
167	Black Hawk	Waterloo-Cedar Falls	IA	−29.70
168	E. Baton Rouge	Baton Rouge	LA	−39.09
169	Brown	Green Bay	WI	−43.73
170	Westchester	New York	NY	−72.12
171	Lake	Chicago	IL	−78.61
172	Kenosha	Kenosha	WI	−85.84
173	Lorain	Lorain-Elyria	OH	−86.76
174	Polk	Lakeland-Winter Haven	FL	−100.69

TABLE 2—CONTINUED

Rank	County	Standard Metropolitan Statistical Area	State	QOLI (1980 dollars)
175	Richland	Mansfield	OH	−104.10
176	Erie	Buffalo	NY	−104.22
177	Chester	Philadelphia	PA	−105.33
178	Outagamie	Appleton-Oshkosh	WI	−107.14
179	Orleans	New Orleans	LA	−118.47
180	Franklin	Columbus	OH	−120.61
181	Travis	Austin	TX	−129.26
182	Prince Geo.'s	Washington	MD	−133.44
183	Union	Newark	NJ	−140.05
184	Cuyahoga	Cleveland	OH	−142.85
185	Kankakee	Kankakee	IL	−143.84
186	DuPage	Chicago	IL	−158.03
187	Yellowstone	Billings	MT	−174.55
188	Mahoning	Youngstown-Warren	OH	−177.13
189	McLennan	Waco	TX	−186.91
190	Yakima	Yakima	WA	−188.39
191	Davidson	Nashville-Davidson	TN	−198.20
192	Duval	Jacksonville	FL	−238.25
193	Bay	Bay City	MI	−247.37
194	Stark	Canton	OH	−250.71
195	St. Clair	St. Louis	IL	−251 01
196	Jefferson	Beaumont-Port Arthur-Orange	TX	−260.20
197	Galveston	Galveston-Texas City	TX	−262.24
198	Hillsborough	Tampa-St. Petersburg	FL	−279.80
199	Marion	Indianapolis	IN	−284.10
200	Jefferson	Louisville	KY	−306.50
201	Macon	Decatur	IL	−308.75
202	Allegheny	Pittsburgh	PA	−308.92
203	Oakland	Detroit	MI	−314.44
204	Middlesex	New Brunswick-Perth Amboy	NJ	−318.20
205	Porter	Gary-Hammond-Each Chicago	IN	−320.47
206	Summit	Akron	OH	−329.96
207	Burlington	Philadelphia	NJ	−346.55
208	Monroe	Toledo	MI	−367.23
209	Dallas	Dallas-Ft. Worth	TX	−372.70
210	Wichita	Wichita Falls	TX	−381.59
211	Contra Costa	San Francisco-Oakland	CA	−386.62
212	Tarrant	Dallas-Ft. Worth	TX	−397.10
213	St. Clair	Detroit	MI	−406.06
214	Harford	Baltimore	MD	−410.29
215	Westmoreland	Pittsburgh	PA	−412.15
216	New York	New York	NY	−414.62
217	Anne Arundel	Baltimore	MD	−430.65
218	Nueces	Corpus Christi	TX	−436.06
219	Bergen	New York	NJ	−465.97
		(Mean QOLI − 1 S.D. = $ − 481)		
220	Baltimore City	Baltimore	MD	−485.32
221	St. Charles	St. Louis	MO	−486.10
222	Hennepin	Minneapolis-St. Paul	MN	−488.20
223	Camden	Philadelphia	NJ	−523.00
224	Saginaw	Saginaw	MI	−537.30
225	Clark	Portland	WA	−547.30
226	Dakota	Minneapolis-St. Paul	MN	−558.10
227	Snohomish	Seattle-Everett	WA	−562.70
228	Allen	Lima	OH	−585.10
229	Jackson	Jackson	MI	−635.30
230	Will	Chicago	IL	−676.10
231	Greene	Dayton	OH	−681.30
232	Niagara	Buffalo	NY	−682.70

TABLE 2—CONTINUED

Rank	County	Standard Metropolitan Statistical Area	State	QOLI (1980 dollars)
233	Calhoun	Battle Creek	MI	−701.10
234	Denton	Dallas-Ft. Worth	TX	−709.90
235	Peoria	Peoria	IL	−758.80
236	Rockland	New York	NY	−795.50
237	Cameron	Brownsville-Harlingen-San Benito	TX	−795.70
238	Medina	Cleveland	OH	−823.30
239	Hidalgo	McAllen-Pharr-Edinburg	TX	−823.80
240	St. Louis	St. Louis	MO	−875.30
241	Harris	Houston	TX	−916.30
242	Jefferson	St. Louis	MO	−918.30
243	Washington	Minneapolis-St. Paul	MN	−920.20
244	Kent	Grand Rapids	MI	−950.90
245	Kalamazoo	Kalamazoo-Portage	MI	−976.30
246	Cook	Chicago	IL	−979.10
247	Genesee	Flint	MI	−1018.50
248	Macomb	Detroit	MI	−1024.10
		(Mean QOLI − 2 S.D. = $ − 1148)		
249	Wayne	Detroit	MI	−1267.50
250	Brazoria	Houston	TX	−1403.50
251	Jefferson	Birmingham	AL	−1539.30
252	Waukesha	Milwaukee	WI	−1791.50
253	St. Louis City	St. Louis	MO	−1856.70

TABLE 3—INTRAURBAN VARIATION IN QUALITY OF LIFE

Standard Metropolitan Statistical Area	Counties	Range of QOLI (dollars)	Average QOLI[a] (dollars)	County QOLI (dollars)	County Rank[b]
Milwaukee, WI		$2350	$29		
	Milwaukee			$558	68
	Waukesha			−1792	252
St. Louis, MO-IL		1606	−990		
	St. Clair, IL			−251	195
	St. Charles, MO			−486	221
	St. Louis, MO			−875	240
	Jefferson, MO			−918	242
	St. Louis City, MO			−1857	253
Denver-Boulder, CO		1488	1198		
	Arapahoe			2097	3
	Boulder			1320	12
	Denver			1295	14
	Adams			727	53
	Jefferson			609	62
Norfolk-Virginia-Beach-Portsmouth, VA-NC		1138	1542		
	Norfolk City			2106	2
	Virginia Beach City			968	28
Philadelphia, PA-NJ		1057	9		
	Montgomery, PA			534	71
	Bucks, PA			299	97
	Delaware, PA			14	152
	Philadelphia, PA			−28	166
	Chester, PA			−105	177
	Camden, NJ			−523	223

TABLE 3—CONTINUED

Standard Metropolitan Statistical Area	Counties	Range of QOLI (dollars)	Average QOLI[a] (dollars)	County QOLI (dollars)	County Rank[b]
Minneapolis-St. Paul, MN		999	−372		
	Ramsey			79	145
	Hennepin			−488	222
	Dakota			−558	226
	Washington			−920	243
Detroit, MI		954	−968		
	Oakland			−314	203
	St. Clair			−406	213
	Macomb			−1024	248
	Wayne			−1268	249
Richmond, VA		953	686		
	Richmond City			1060	20
	Chesterfieid			107	136
Dayton, OH		945	89		
	Montgomery			264	104
	Greene			−681	231
Chicago, IL		900	−823		
	Lake			−79	171
	DuPage			−158	186
	Will			−676	230
	Cook			−979	246

[a] The average QOLI values are population-weighted averages of the county QOLI values.
[b] The county rank is taken from Table 2.

TABLE 4—DIFFERENCES IN MEASURED QUALITY OF LIFE BY AMENITY BUNDLE, HOURS WORKED AND POPULATION GROWTH

Rank	County	Standard Metropolitan Statistical Area	State	QOLI	QOLI Rank: Climate[a]	QOLI Rank: Environ. Quality[b]	QOLI Rank: Urban Condit.[c]	QOLI Rank: Low Hrs. Worked[d]	QOLI Rank: High Hrs. Worked[e]	Population Growth[f]
1	Pueblo	Pueblo	CO	$3289	9	221	1	1	1	0
2	Norfolk City	Norfolk-VA Beach-Portsmouth	VA	2106	35	13	5	17	2	−
3	Arapahoe	Denver-Boulder	CO	2097	29	168	3	2	9	+
4	Bibb	Macon	GA	1600	102	7	4	40	6	0
5	Washoe	Reno	NV	1575	3	171	130	6	26	+
6	Broome	Binghamton	NY	1486	239	138	2	10	27	−
7	Hampton City	Newport News-Hampton	VA	1445	35	3	48	31	12	0
8	Sarasota	Sarasota	FL	1431	47	2	26	128	3	+
9	Palm Beach	West Palm Beach-Boca Raton	FL	1423	10	40	102	69	5	+
10	Pima	Tucson	AZ	1342	4	191	151	58	10	+
11	Broward	Ft. Lauderdale-Hollywood	FL	1327	20	188	33	106	4	+
12	Boulder	Denver-Boulder	CO	1319	29	201	28	12	47	+
13	Larimer	Ft. Collins	CO	1298	29	170	50	20	32	+
14	Denver	Denver-Boulder	CO	1295	29	207	29	22	29	−
15	Charleston	Charleston-N. Charleston	SC	1280	14	38	110	41	19	0
*										
*										
*										
120	Davidson	Greensboro-Win. Sal.-High Pt.	NC	$179	83	21	198	174	90	0
121	Butler	Hamilton-Middletown	OH	168	127	195	92	188	82	0
122	Montgomery	Washington	MD	166	91	95	183	139	117	0
123	Ingham	Lansing-E. Lansing	MI	161	249	20	16	125	128	0

TABLE 4—CONTINUED

Rank	County	Standard Metropolitan Statistical Area	State	QOLI	QOLI Rank: Climate[a]	QOLI Rank: Environ. Quality[b]	QOLI Rank. Urban Condit.[c]	QOLI Rank: Low Hrs. Worked[d]	QOLI Rank: High Hrs Worked[e]	Population Growth[f]
124	Ector	Odessa	TX	156	85	133	173	119	130	0
125	Sangamon	Springfield	IL	154	199	25	76	99	146	0
126	Taylor	Abilene	TX	153	120	105	154	170	105	0
127	Erie	Erie	PA	144	174	216	35	67	169	0
128	McLean	Bloomington-Normal	IL	140	206	32	73	154	112	0
129	Vigo	Terre Haute	IN	137	189	24	86	180	98	–
130	San Bernardino	Riverside-San Bernardino-Ontario	CA	135	54	161	226	59	188	0
131	Hamilton	Chattanooga	TN	132	73	225	135	241	46	0
132	Atlantic	Atlantic City	NJ	128	65	197	182	29	209	0
133	Winnebago	Rockford	IL	128	201	136	61	135	132	0
134	Benton	Richland-Kennewick-Pasco	WA	113	147	140	125	142	133	+
*										
*										
*										
239	Hidalgo	McAllen-Pharr-Edinburg	TX	−824	253	83	75	252	155	+
240	St. Louis	St. Louis	MO	−875	195	193	227	226	230	0
241	Harris	Houston	TX	−916	181	250	100	245	218	+
242	Jefferson	St. Louis	MO	−918	195	164	237	235	226	+
243	Washington	Minneapolis-St. Paul	MN	−920	220	125	235	227	237	+
244	Kent	Grand Rapids	MI	−951	251	238	78	160	245	0
245	Kalamazoo	Kalamazoo-Portage	MI	−976	251	189	165	197	242	0
246	Cook	Chicago	IL	−979	135	251	168	150	248	–
247	Genesee	Flint	MI	−1018	238	200	212	201	243	0
248	Macomb	Detroit	MI	−1024	229	173	231	183	246	0
249	Wayne	Detroit	MI	−1268	124	247	242	243	241	–
250	Brazoria	Houston	TX	−1404	156	252	211	231	250	+
251	Jefferson	Birmingham	AL	−1539	241	248	188	253	238	0
252	Waukesha	Milwaukee	WI	−1792	244	253	113	177	253	0
253	St. Louis City	St. Louis	MO	−1857	195	184	253	251	252	–
Rank Correlation with QOLI (Table 2)			r	1.00	0.63	0.21	0.48	0.63	0.83	0.16

[a]The QOLI-climate ranking is based on QOLI values which are calculated using the full implicit prices shown in Table 1 and the subset of amenities which includes only: precipitation, humidity, heating degree days, cooling degree days, wind speed, sunshine, and coast.

[b]The QOLI-environmental quality ranking is based on the subset of amenities which includes only: visibility, total suspended particulates, NPDES effluent dischargers, landfill waste, superfund sites, and treatment, storage, and disposal sites.

[c]The QOLI-urban conditions ranking is based on the subset of amenities which includes only: central city, violent crime, and teacher-pupil ratio.

[d]The QOLI-low hours worked is based on QOLI values which are calculated as described in note c to Table 1 except the annual number of hours worked is halved.

[e]The QOLI-low hours worked is based on QOLI values which are calculated as described in note c to Table 1 except the annual number of hours worked is doubled.

[f]Growth is the percentage change in county population between 1970 and 1980. A plus is assigned to counties with growth greater than twice the average (> 33.4 percent) and a minus is assigned to counties with growth less than zero. A zero is assigned to counties with growth between zero and twice the average. The rank correlation reported is for QOLI and population growth.

ranking is .63, for environmental quality it is .21, and for urban conditions it is .48. Thus, the ranking for households who value only a subset of amenities can be quite different. These rankings for amenity subsets are also useful for illustrating which factors contribute to an individual county's high or low ranking. Pueblo, Colorado, the top-ranked county, has a high ranking for climate and a very low one for environmental quality. But it has the top ranking for urban conditions (in particular, the teacher-pupil ratio), which is an important contributor to its top overall ranking. Ingham (Lansing), Michigan, has very high rankings for environmental quality and urban conditions, but is almost on the bottom for climate, giving it a middle overall ranking. Thus, a household which did not consider climate as a component of quality of life would find Ingham County an attractive place to live. St. Louis City is at the bottom of the ranking. While its ranking is fairly low for all three subsets, its ranking for urban conditions is at the bottom. The high violent crime rate is an important contributor to the bottom ranking for urban conditions and to its overall ranking.

Finally, in order to address the possibility of disequilibrium influences, the last column of Table 4 shows the population growth the county experienced between 1970 and 1980. A plus sign indicates that the county grew by more than twice the average (> 33.4 percent), a minus sign is given to counties which experienced population loss between 1970 and 1980, while a zero indicates population growth between zero and 33.4 percent. There is a small but significant positive correlation (.16) between population change and the standard QOLI. Eight out of the 15 top counties are fast (+) growing, 13 out of 15 middle counties have had slow (0) growth, while among the bottom 15, there is a mix of fast and slow growth, and population losses. Overall, it does not appear that disequilibrium influences are overwhelming, and if anything, they reinforce the standard equilibrium-based QOLI.

V. Conclusions

This paper provides new quality of life rankings both across and within urban areas. The estimation is based on a national hedonic model which incorporates variation in both wages and housing expenditures. The wage and housing-expenditure equations are estimated using micro data from the 1980 Census and aggregate data on various amenities from other sources.

A quality of life index is constructed using preference-based weights, which are the amenity values derived from the hedonic estimation. The index is calculated for 253 counties, many of which are located in the same SMSA. The difference between the top- and bottom-ranked counties is estimated to be valued at \$5146 per household per year. The highest ranked counties tend to be connected with small- and medium-sized cities in the Sun Belt and Colorado. The bottom of the ranking is dominated by medium to large northern cities. Substantial intracity variation in measured quality of life is found. For example, \$1606 per household per year is the difference across counties in the St. Louis SMSA.

The results indicate that compensation for location-specific, nontraded amenities takes place in both the labor and housing market and that the amount is substantial. Quality of life is clearly one factor considered in location decisions along with other factors such as job availability. Indexes which include a set of factors different from ours may yield different rankings for different purposes. Nonetheless, our ranking is based on amenities which are an important component of economic well-being. The valuations of these nontraded amenities yield new quality of life comparisons across and within a wide variety of American urban areas.

Appendix

Comparative Static Results. Equilibrium wage, rent, and city-size differentials are solved for using the total differential of equation system (S1). This differential system is

$$\text{(A1)}\quad \begin{vmatrix} -v^1_{a_1} \\ -c^1_{a_1} \\ 0 \\ 0 \\ -N^1_{a_1} \end{vmatrix} = \begin{vmatrix} v^1_{w_1} & v^1_{r_1} & 0 & 0 & 0 \\ c^1_{w_1} & 0 & 0 & 0 & c^1_N \\ 0 & 0 & v^2_{w_2} & v^2_{r_2} & 0 \\ 0 & 0 & c^2_{w_2} & 0 & c^2_N \\ N^1_{w_1} & N^1_{r_1} & N^2_{w_2} & N^2_{r_2} & -1 \end{vmatrix} \begin{vmatrix} dw_1/da_1 \\ dr_1/da_1 \\ dw_2/da_1 \\ dr_2/da_1 \\ dN/da_1 \end{vmatrix} = A \begin{vmatrix} dw_1/da_1 \\ dr_1/da_1 \\ dw_2/da_1 \\ dr_2/da_1 \\ dN/da_1 \end{vmatrix}.$$

The determinate of A is

$$\text{(A2)}\quad D = -v_{r_1}^1 c_N^1 c_{w_2}^2 v_{r_2}^2 \left[N_{w_1}^1 - \left(v_{w_1}^1 / v_{r_1}^1\right) N_{r_1}^1\right] - v_{r_2}^2 c_N^2 v_{r_1}^1 c_{w_1}^1 \left[N_{w_2}^2 - \left(v_{w_2}^2 / v_{r_2}^2\right) N_{r_2}^2\right] - v_{r_1}^1 v_{r_2}^2 c_{w_2}^2 c_{w_1}^1.$$

D is negative if city size, N, is Walrasian stable with respect to a change in wages in county k, $k \in \{1,2\}$. The adjoint of A is

$$\text{(A3)}\quad C' = \begin{vmatrix} c_N^1 N_{r_1}^1 c_{w_2}^2 v_{r_2}^2 & v_{r_1}^1 v_{r_2}^2 \beta_2 & v_{r_1}^1 c_N^1 c_{w_2}^2 N_{r_2}^2 & v_{r_1}^1 v_{r_2}^2 c_N^1 \alpha_2 & -v_{r_1}^1 v_{r_2}^2 c_N^1 c_{w_2}^2 \\ v_{r_2}^2\left(c_{w_1}^1 \beta_2 - c_{w_2}^2 c_N^1 N_{w_1}^1\right) & -v_{r_1}^1 v_{w_1}^1 \beta_2 & -v_{w_1}^1 c_N^1 c_{w_2}^2 N_{r_2}^2 & -v_{w_1}^1 v_{r_2}^2 c_N^1 \alpha_2 & v_{w_1}^1 c_{w_2}^2 v_{r_2}^2 c_N^1 \\ c_{w_1}^1 N_{r_1}^1 c_N^2 v_{r_2}^2 & v_{r_1}^1 v_{r_2}^2 c_N^2 \alpha_1 & v_{r_1}^1 c_{w_1}^1 c_N^2 N_{r_2}^2 & v_{r_1}^1 v_{r_2}^2 \beta_1 & -v_{r_1}^1 c_{w_1}^1 v_{r_2}^2 c_N^2 \\ -c_{w_1}^1 N_{r_1}^1 c_N^2 v_{w_2}^2 & -v_{r_1}^1 v_{w_2}^2 c_N^2 \alpha_1 & -v_{r_1}^1\left(c_{w_2}^2 \beta_1 - c_{w_1}^1 c_N^2 N_{w_2}^2\right) & -v_{r_1}^1 v_{w_2}^2 \beta_1 & v_{r_1}^1 c_{w_1}^1 v_{w_2}^2 c_N^2 \\ -c_{w_1}^1 N_{r_1}^1 c_{w_2}^2 v_{r_2}^2 & -v_{r_1}^1 v_{r_2}^2 c_{w_2}^2 \alpha_1 & -v_{r_1}^1 c_{w_1}^1 c_{w_2}^2 N_{r_2}^2 & -v_{r_1}^1 v_{r_2}^2 c_{w_1}^1 \alpha_2 & v_{r_1}^1 c_{w_1}^1 v_{r_2}^2 c_{w_2}^2 \end{vmatrix}$$

where $\alpha_j = N_{w_j}^j - (v_{w_j}^j / v_{r_j}^j) N_{r_j}^j$ and $\beta_j = c_N^j [(v_{w_j}^j / v_{r_j}^j) N_{r_j}^j - N_{w_j}^j] - c_{w_j}^j$, $j \in \{1,2\}$. The term α_j is positive if the supply of labor to county j, $N_{w_j}^j$ is positively sloped with respect to change in the wage in county j. The term β_j is negative if the supply of labor to county j is Walrasian stable with respect to a change in wages in county j. $N_{w_j}^j$ is nonpositive if land is not an inferior good. $N_{r_j}^j$ is nonnegative if land is not a Giffen good.

The solution to the differential system is

$$\text{(A4)}\quad \begin{vmatrix} dw_1/da_1 \\ dr_1/da_1 \\ dw_2/da_1 \\ dr_2/da_1 \\ dN/da_1 \end{vmatrix} = (C'/D) \begin{vmatrix} -v_{a_1}^1 \\ -c_{a_1}^1 \\ 0 \\ 0 \\ -N_{a_1}^1 \end{vmatrix}$$

$$= \begin{vmatrix} -v_{a_1}^1 c_N^1 c_{w_2}^2 v_{r_2}^2 N_{r_1}^1 - c_{a_1}^1 v_{r_1}^1 v_{r_2}^2 \beta_2 + N_{a_1}^1 v_{r_1}^1 v_{r_2}^2 c_N^1 c_{w_2}^2 \\ -v_{a_1}^1 v_{r_2}^2\left(c_{w_1}^1 \beta_2 - c_{w_2}^2 c_N^1 N_{w_1}^1\right) + c_{a_1}^1 v_{w_1}^1 v_{r_1}^1 \beta_2 - N_{a_1}^1 v_{w_1}^1 v_{r_2}^2 c_N^1 c_{w_2}^2 \\ -v_{a_1}^1 c_N^2 c_{w_1}^1 v_{r_2}^2 N_{r_1}^1 - c_{a_1}^1 v_{r_1}^1 v_{r_2}^2 c_N^2 \alpha_1 + N_{a_1}^1 c_N^2 c_{w_1}^1 v_{r_1}^1 v_{r_2}^2 \\ v_{a_1}^1 c_N^2 c_{w_1}^1 v_{w_2}^2 N_{r_1}^1 + c_{a_1}^1 v_{r_1}^1 v_{w_2}^2 c_N^2 \alpha_1 - N_{a_1}^1 c_N^2 c_{w_1}^1 v_{w_2}^2 v_{r_1}^1 \\ v_{a_1}^1 c_{w_2}^2 v_{r_2}^2 c_{w_1}^1 N_{r_1}^1 + c_{a_1}^1 v_{r_1}^1 v_{r_2}^2 c_{w_2}^2 \alpha_1 - N_{a_1}^1 v_{r_2}^2 c_{w_2}^2 v_{r_1}^1 c_{w_1}^1 \end{vmatrix} / D.$$

Multiplying the cross-county rent differential, dr_2/da_1, by $v_{r_2}^2/v_{r_2}^2$ and factoring out the term $-v_{w_2}^2$ results in

$$\text{(A5)}\quad dr_2/da_1 = \left(-v_{w_2}^2/v_{r_2}^2\right)\left(-v_{a_1}^1 c_N^2 c_{w_1}^1 v_{r_2}^2 N_{r_1}^1 - c_{a_1}^1 v_{r_1}^1 v_{r_2}^2 c_N^2 \alpha_1 + N_{a_1}^1 c_N^2 c_{w_1}^1 v_{r_1}^1 v_{r_1}^2\right)/D = (1/q_2)(dw_2/da_1).$$

A result analogous to (A5) can be derived for dr_1/da_2.

For the case described in Section I, Part B, of the text, the signs of the differentials hold under the assumption that $N_{a_k}^k = 0$, $N_{w_k}^k \le 0$, and $N_{r_k}^k \ge 0$. An additively separable utility function is sufficient for N_{a_k} to equal zero. If land is not inferior and land is not a Giffen good, then $N_{w_k}^k \le 0$ and $N_{r_k}^k \ge 0$.

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