Amenity Valuation, Incomplete Compensation and Migration

David E. Clark
Associate Professor of Economics
Marquette University

November 9, 2004

Amenity Valuation, Incomplete Compensation and Migration

I. Introduction

Efficient policy decisions require comparisons of the costs of policy alternatives with their respective benefits. Although policy costs (at least the explicit costs) are often readily quantified, the same cannot be said on the benefit side. Economists have long known that market-clearing prices reflect the marginal willingness to pay for market goods. However, there are a wide range of nontraditional goods, ranging from environmental goods to local public goods and services that are not exchanged in traditional markets. This necessitates the use of techniques that can infer the marginal valuation of nonmarket goods.

Over the years, economists have employed a number of methods to assign monetary values to these nonmarket goods. Some of these methods rely on hypothetical market situations. For example, the Contingent Valuation Method (CVM) query's survey respondents about their willingness to pay (WTP) for hypothetical changes in environmental goods. Multiple regression analysis can then be used to disentangle the factors (both demographic and market) that determine WTP. Similarly, the conjoint approach values nonmarket goods by examining tradeoffs that respondents would be willing to make between various bundles of nonmarket goods. So long as a monetary value is one of the attributes of the bundles, then again, regression modeling can be used to infer implicit values for nonmarket goods from the survey responses. If carefully constructed, these survey approaches can provide important insights to policymakers as to how environmental goods are valued in a community. Nonetheless, there are potential caveats associated with reliance on stated preference approaches, resulting in part from the possibility that unobserved biases may exist in survey responses. Although careful survey design can mitigate some of these potential biases, this problem has led some economists to advocate methods that examine tradeoffs in actual markets in addition to hypothetical behavior in simulated market situations (Clark and Kahn, 1989).

The Intracity Hedonic Model

Since Tiebout (1956) first suggested that residents "vote with their feet" for the local fiscal bundle that best satisfies their preferences, economists and regional scientists have used that insight to implicitly value local site attributes. For example, Lancaster (1967) recognized that prices for heterogeneous goods depend on the characteristics of the good, and there were some early studies (e.g., Ridker and Henning, 1967; Wiend, 1973) that began to explore the relationship between transacted real-estate prices and locational attributes. However, it was Rosen (1974) who first developed a two-stage process, applied to housing markets to first derive implicit prices for housing attributes, and then to derive demand functions for those attributes. While other authors (Brown and Rosen, 1982; Epple, 1987; Bartik, 1987) suggested that the unique nature of the endogeneity of housing attributes made the identification problem more complex than Rosen first described, dozens of studies have been conducted since Rosen's seminal work. These studies have derived values for housing characteristics (Lichtenstein and Kern, 1987) as well as a plethora of neighborhood characteristics including crime (Thaler, 1978), air quality (Harrison and Rubinfeld, 1978), coastal amenities (Parsons and Wu, 1991; Palmquist, 1993), neighborhood historic preservation (Clark and Herrin, 1997, Coulson and Leichenko, 2004), environmental risks related to earthquakes and volcanoes (Bernknopf, Brookshire and Thayer, 1990), flooding, nuclear power (Nelson, 1981, Clark, Michelbrink, Allison and Metz, 1997), airport noise (Nelson, 1979), and hazardous waste (Kiel and McClain, 1995) to name just a few.

The Intercity Hedonic Model

Although some locational attributes vary within a city, others (e.g., climate) are relatively invariant within cities but vary substantially across cities, and an alternative hedonic framework has been developed to implicitly value those goods. The foundations of the interregional hedonic model can actually be traced back to Adam Smith (1776) who described in his *Wealth of Nations* a relationship between the "hardship" associated with a particular job and the resulting market wage (Smith, 1776, Chapter 4). While labor economists have long understood this underlying feature of job characteristics, regional economists began to more fully explore the relationship between local quality-of-life factors as they relate to interregional factor prices beginning in the later 1970's. Specifically, Rosen published a paper (Rosen, 1979) that derived implicit valuations of local quality-of-life factors using individual wage data. Roback (1981) more fully developed the interregional hedonic model by recognizing that there was endogeneity between wages and land prices, and as a result, locational attributes can be capitalized into both input prices. These insights were further refined by Blomquist, Berger and Hoehn (1988). In addition to deriving urban quality-of-life indices, the technique has been used to investigate the implicit valuation of noxious facilities (Clark and Nieves, 1992), and the value of professional sports teams (Carlino and Coulson, 2004).

A variant of the Roback model focuses solely on wage differentials. Henderson (1982) showed that full implicit prices can be derived from wage differentials alone as long as average land prices are controlled. This is equivalent to evaluating the individual household living at the urban edge, where land is valued by its agricultural productivity. This approach has been employed to value urban quality-of-life as it relates to city size (Clark, Kahn and Ofek, 1988; Herzog and Schlottmann, 1992), air quality (Cropper and Arriaga-Salinas), urban cultural amenities (Clark and Kahn, 1988) and other outdoor amenities (Clark and Kahn, 1989).

The Potential Consequences of Interregional Disequilibrium

There are three underlying assumptions that form the foundation for both the intra- and intercity hedonic models. The models assume that: (a) residents are knowledgeable about the level of site characteristics across locations; (b) there is a continuous offering of site characteristics such that utility maximizing sorting between locations is possible; and (c) residents are mobile between locations with zero transactions costs associated with relocations. While there are certainly obstacles to the satisfaction of each of these assumptions, the mobility requirement is of primary importance since it is the movement of labor on both the demand and supply sides of the labor market that ultimately drives wage and land price differentials. If residents respond quickly to changes in locational attributes, then labor and land markets would be expected to be in equilibrium both within regions (intraregional) and between regions (intraregional). Whereas intraregional equilibrium simply requires that the prices of labor and land within the region clear their respective local market, interregional equilibrium only exists when wages and land rent differentials across regions completely compensate for quality-of-life attributes. Thus, when an interregional equilibrium has been attained, individual utility levels are uniform across regions. It is the issue of interregional equilibrium that is investigated in this chapter, and to do so requires a more thorough investigation of the relationship between migration and amenities.

The role of amenities in the household migration decision was at the heart of a spirited debate during the late 1970's and 1980's. Some economists (Greenwood, 1985; Greenwood and Hunt, 1989) argued that differential returns to human capital were the primary factor motivating interregional migration, and that ongoing net migration flows resulted from persistent interregional disequilibria. Others (Graves, 1979; Graves and Linneman, 1979) countered that labor mobility would quickly eliminate disequilibria between regions. Thus, rather than emanating from an ongoing interregional disequilibrium, Graves and Linneman argued that migration resulted primarily from income growth and/or life-cycle changes in the population. These changes result in altered demand for goods and services, some of which (e.g., amenities, local public services, etc.) are location-specific. Thus, the only way to satisfy these altered demands for site-specific goods is to migrate to another location.

The outcome of this debate has important implications for amenity valuation using hedonic models. If mobility is not rapid enough to generate equilibrium in interregional factor prices, then amenity capitalization in factor prices will be incomplete, and implicit prices will not fully reflect the value (i.e., willingness to pay) placed on a particular attribute by the marginal resident or marginal worker. That is, wage and/or land rent differentials will either be inadequate, or perhaps more than necessary to compensate for the local amenity mix.

In this chapter, the issue of incomplete amenity capitalization is investigated. We explore the theoretical foundation for the Roback model and then discuss the evidence concerning whether the assumption of interregional equilibrium appears to be satisfied. We then turn to an investigation of the Henderson model that focuses on wage differentials. Again, we evaluate the theoretical foundations of the model, and then explore the empirical evidence on interregional equilibrium. We conclude with recommendations as to the application of both of these interregional models for amenity valuation.

II. Amenity Valuation in the Roback Framework

Roback (1982) begins with the assumption that households maximize utility subject to a budget constraint, choosing consumption levels of goods (x), land (d), and quality of life amenities (Q):

$$\text{Maximize } U=U(x,d;Q) \qquad (1a)$$

$$\text{Subject to: } w=x+r*d \qquad (1b)$$

Optimizing with respect to choice variables and substituting optimal x and d into equation (1a) gives the indirect utility function which expresses utility levels as a function of price of land (r), the price of x (considered a numeraire), income (w) and the exogenous amenity level (Q):

$$V=V(w,r;Q) \quad (1c)$$

Turning to the firm side of the market, if amenity levels are exogenous to the firm (e.g., climate), then the implicit value of the amenity is determined solely by households. Alternatively, some local amenities are endogenously determined by firm actions (e.g., air quality). In that case, an amenity improvement can only be achieved at a cost to firms. To show this, assume that firms spatially minimize the cost of production, C(x) determined by expenditure on labor, (L) and land (d), subject to a production constraint;

$$\text{Minimize } C(x)=w^*L + r^*D \quad (2a)$$
$$\text{s.t. } x=x(L,D;Q) \quad (2b)$$

Under conditions of constant returns to scale, firms equate unit production costs to the price of commodity x (assumed to be unitary) giving the equilibrium unit cost function:

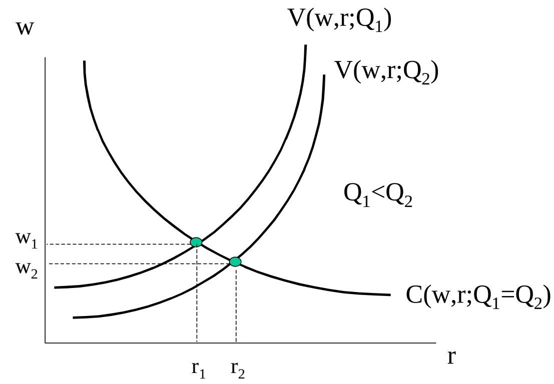
$$1=c(w,r;Q) \quad (2c)$$

Roback (1982) simultaneously solves equations (1c) and (2c) to identify a spatial equilibrium and an implicit amenity price. Spatial equilibrium implies that neither firms, nor households can make themselves better off by relocating. That is, firms cannot lower costs, and households cannot increase utility by moving to alternative locations. Thus, amenities are implicitly priced by the following equation:

$$\gamma = D^*\partial r/\partial Q - \partial w/\partial Q \ (3)$$

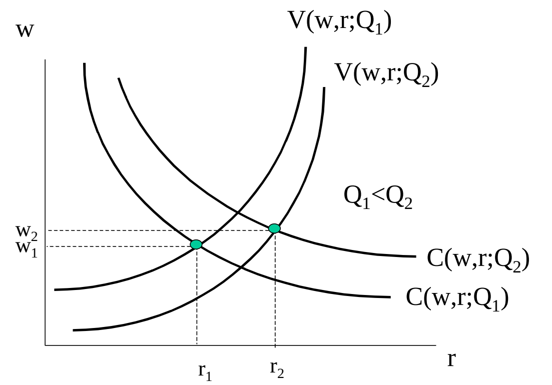
Graphically this is seen in Figure 1 where a nonproductive amenity (i.e. an amenity that does not influence the production function) improves from Q_1 to Q_2. Households accept lower wages (wages fall from w_1 to w_2) and are willing to pay higher rents (rents rise from r_1 to r_2). The implicit price is then simply the sum of the change in expenditure on land and the negative of the change in expenditure on labor.

Figure 1: Equilibrium Wage and Rent Differentials
(Amenity with No Productivity Effects)



Alternatively, when an amenity has productivity effects (e.g., assume that higher amenity levels increase firm productivity), then both the unit cost and the indirect utility functions shift, as seen in Figure 2. Specifically, the unit cost function shifts to the northeast since firms must now pay higher wages and/or rents to maintain unit costs when the firm is more productive at higher amenity levels. In this circumstance, the impact on rents is unambiguously positive, but the effect on the wage is uncertain.

Figure 2: Equilibrium Wage and Rent Differentials
(Amenity with Positive Productivity Effects)



In Figure 2, the shift in the unit cost function is stronger than the shift in the indirect utility function, leading to an increase in the wage. On the other hand, if an amenity was unproductive (i.e., it shifted the unit cost function to the southwest), the wage would be unambiguously reduced, but the effect on land prices would be uncertain.

Blomquist, Berger and Hoehn (1988) enhance the Roback model in several ways. First, their model permits city size to be endogenous. Second, they no longer assume that amenity levels remain uniform within a region. Rather, some amenities (e.g., air quality) may vary within and between regions. Finally, they introduce a production function for housing, and describe the implicit price in terms of housing (as opposed to land) expenditures and wage expenditures.

Finally, Mathur and Stein (1991) further expand on the interregional hedonic model by developing a general equilibrium model of wages and land rents that allows utility levels, certain amenity levels, and population to be endogenous between regions. Migration then becomes the equilibrating mechanism that eventually restores regional equilibrium. Significantly, they show that "in disequilibrium … there is a wedge between amenity differentials and the corresponding earnings and housing price differentials". The magnitude of any disequilibrium on implicit price calculations becomes an empirical issue.

Empirical Studies employing the Roback Approach

A number of empirical studies have utilized the methodology first outlined by Roback. As previously noted, Blomquist, Berger and Hoehn (1988) extended Roback's model theoretically, and empirically, they developed an urban quality of life index using the 1980 Public Use Microdata Sample (PUMS) from the U.S. Census of Population and Housing. They focused on 253 metropolitan counties and derived implicit prices for amenities related to climate, air quality, crime, educational quality, hazardous waste, and central city status. A quality of life index was computed as the sum of each amenity level times its implicit price. Clark and Nieves (1994) also applied the Roback model to 1980 PUMS data to generate implicit prices for various types of noxious activity. However, instead of focusing solely on metropolitan counties, they evaluated both urban and rural geographic areas (i.e., defined in the PUMS as Public Use Microdata Areas, or PUMA's). In addition to noxious facility densities[1] they also controlled for measures of climate, population density, crime, air quality and manufacturing employment, fiscal measures of taxation and spending, as well as a number of disequilibrium controls. More recently, Carlino and Coulson (2004) used the methodology to derive implicit prices for NFL Sports franchises. They used data from the Annual Housing Survey, and the Current Population Survey for various years and estimated a pooled cross-sectional/time-series model. In addition to the sports franchise measures, the models also control for numerous local amenity measures related to neighborhood quality, climate and local fiscal burden.

All of the aforementioned studies assume the existence of interregional equilibrium in the interregional hedonic model. However, several studies began to more fully evaluate the nature of disequilibrium and its impact on migration and on implicit prices. Berger and Blomquist (1992) use data from the 1980 PUMS to derive quality of life indices from both housing price and wage differentials. The hedonic housing price and wage functions both incorporate disequilibrium controls, permitting an estimate of the degree of disequilibrium in the implicit price. They then derived disequilibrium differences in wages and housing prices for various regions, as well as equilibrium differences in quality of life measures for those regions to

[1] These facilities included nuclear, gas, and coal-fired power plants, chemical weapons storage facilities, hazardous waste sites, refineries, radioactive contaminated sites, and liquefied natural gas storage facilities.

determine how equilibrium and disequilibrium factors influence the decision to move, and the destination of the mover. They find that the probability of moving (i.e., changing counties) increases with the potential disequilibrium gains in wages from moving, although disequilibrium housing price, and equilibrium quality of life factors were not found to matter in the decision to move. When examining the destination choice, both equilibrium quality of life, and disequilibrium wage and housing price differentials were all found to be significant determinants of the choice of destination. This study is both disconcerting and comforting. On the one hand, it suggests that there are regional disequilibria that influence wage and housing price differentials, implying that assumption of equilibrium that was made in earlier studies is not warranted. However, it also suggests that both equilibrium and disequilibrium differentials between regions serve as an important signal to migrants, and hence one would expect regional disequilibria to eventually dissipate.

A second study by Greenwood, Hunt, Rickman and Treyz, (1991) takes an alternative approach. They note that if an interregional equilibrium exists, then compensating differentials in wages and housing prices can be used to value amenity levels. That is, the implicit price derived from these differentials represents the marginal value (i.e., marginal willingness to pay) of the amenity. However, if the adjustment toward equilibrium is slow, then the implicit price calculations do not reflect true compensating differentials that equalize utility spatially. Rather, these differentials would be expected to either over- or under-compensate for the specific amenity mix. Greenwood et. al. show that the true compensating differential is that differential that would generate zero net in-migration to a region, other things equal. Thus, the authors use statewide data on income, housing prices, and migration over the period 1971-1988 to compute the equilibrium compensating differentials (i.e., the true marginal willingness to pay). These differentials are then compared with the implicit price derived from actual housing price and income differentials. They show that some states are classified as "amenity rich", meaning that the implicit price overstates the equilibrium compensating differential (i.e., over-compensation exists) whereas other states are amenity poor, or under-compensate for their amenity mix. This confirms the finding of Berger and Blomquist (1992) that at least some regions offer incomplete compensation, given their amenity bundle. However, they then compare the classification of amenity rich and amenity poor regions based on their estimates of the true equilibrium compensating differentials with the classification that would be derived from implicit price calculations of Blomquist, Berger and Hoehn (1988), that incorrectly assume regional equilibrium. They find that the differences in classifications are minor. This suggests that although the assumption of equilibrium across regions is not empirically borne out in the data, the bias to the implicit price that is introduced by the equilibrium assumption is likely to be minimal.

III. Theory of Interregional Amenity Wage Capitalization

Rosen published a paper in 1979 that derived an urban quality of life index from real urban wage differentials, and Henderson (1982) expanded upon that model by formally developing the conditions under which implicit prices reflect household willingness to pay. Like the Roback framework, the Henderson model derives implicit prices from the joint interaction of firms and workers in the labor market. While Henderson recognizes that cost of living differences are also important, it is shown that under certain circumstances, all of the amenity capitalization can be reflected in the compensating wage differential. The model is briefly described below.

Households are assumed to maximize utility subject to a budget constraint where households purchase housing (h) and other goods, x (priced as a numeraire). As was the case in the Roback model, the amenity or quality-of-life level (Q) is assumed to be exogenously determined. Thus, the model assumes that households:

$$\text{Maximize: } U(x,h;Q) \quad (4a)$$

$$\text{Subject to: } w=x + P_h{*}h \qquad (4b)$$

Again, by optimizing with respect to x and h, and substituting optimal values of these choice variables into the utility function, we derive the indirect utility function;

$$V=V(w,P_h;Q) \quad (5)$$

If an interregional equilibrium exists, utility is fixed at V^1, and thus the implicit function theorem can be used to derive a wage-acceptance function.

$$w_A = w_A(V^1,P_h;Q) \qquad (6)$$

The wage-acceptance function is shown in Figure 1, and can be used to describe the tradeoff between wages and amenities that maintains household indifference between two locations with different amenity mixes. Totally differentiating (6) with respect to Q, and assuming that $dV^1=0$ gives:

$$dw_A/dQ = \partial w_A/\partial P_h{}^{*}\partial P_h/\partial Q + \partial w_A/\partial Q \quad (7)$$

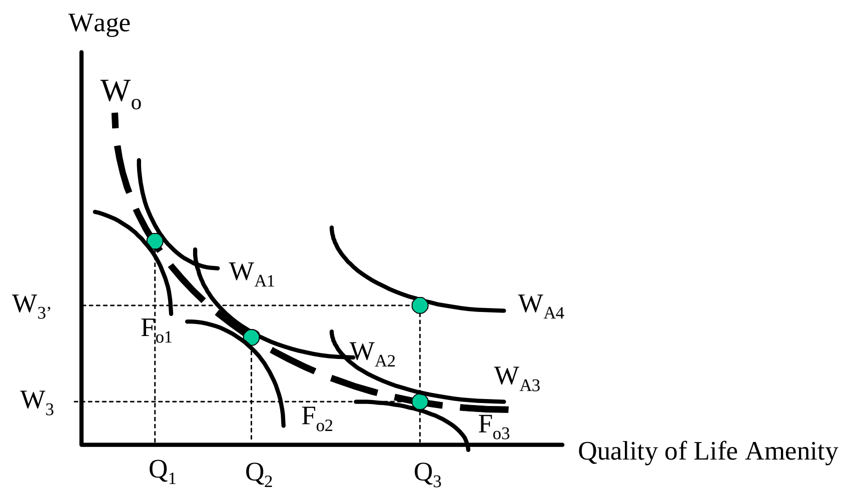
This indicates that wages differ spatially for one of two reasons: (a) housing prices vary (i.e., cost-of-living effects), or (b) locational amenities differ across space. Thus, the two terms on the right-hand side of equation (7) shows two effects. The first term has two components; ($\partial w_A/\partial P_h$) which is positive since higher cost-of-living from more expensive housing necessitates higher wages if the individual is to be indifferent between the two sites, and ($\partial P_h/\partial Q$) which is also positive since higher amenity levels drive up the average housing price in the community. Overall, the first term is expected to be positive. The second term ($\partial w_A/\partial Q$) is negative, reflecting the tradeoff between the amenity level and the wage. This term gives the marginal willingness to pay (i.e., equilibrium compensating differential) for small changes in the amenity, Q. Whereas dw_A/dQ is of an indeterminant sign, $\partial w_A/\partial Q$ is unambiguously negative. A key insight by Henderson (1982) is that if we control for the average housing price in the estimation of equation (6), we can isolate $\partial w_A/\partial Q$. That is, by controlling for the average amenity level, we are focusing on that individual who lives at the edge of the city. Since land prices at the city edge reflect agricultural productivity (assumed to be uniform), then any compensating differential for differential amenities must be reflected in wage differentials. If we allow for individual preferences to differ, then there will be a family of wage-acceptance functions that reflect those preference differences. This different taste groups are shown in Figure 3 as W_{A1},

W_{A2} and W_{A3}. In equilibrium, individuals will sort themselves such that the utility levels of their individual taste group are spatially invariant. Those with the strongest preferences for the amenity (e.g., taste group W_{A3}) will be willing to pay more for the amenity (i.e., accept more in wage reductions) than other taste groups.

On the firm side, there may be comparable wage-amenity tradeoffs that maintain constant costs to firms. If the amenity is endogenous to firms, improvements in the amenity can only be achieved at increased cost. Such would be the case for example with the air quality amenity. Thus, in equilibrium, firms would pay lower wages so as to offset the cost associated with the amenity improvement. This is wage-amenity relationship is shown in Figure 3 by firm-offer functions (F_{o1}, F_{o2}, F_{o3}), where the different curves represent firms with different production functions. Similar to the consumer side, those firms locating in the high amenity locations (e.g., firm production group F_{o3}) would be those firms with production technologies that permit them to produce the amenity (e.g., better air quality) at lowest cost.

In equilibrium, the wage-acceptance and firm offer functions interact to form an equilibrium reduced-form function known as the wage-opportunity locus (W_o in Figure 3) . Note that if the amenity is exogenous (e.g., climate), then the wage opportunity locus is simply the lower envelope of the various wage-acceptance functions. As long as there is a continuous offering of amenities and taste groups, the slope of the wage-acceptance function (which reflects the marginal willingness to pay for the amenity) is the same as the slope of the wage-opportunity locus (which reflects the implicit price).

Figure 3: Wage-Acceptance Function, Firm-Offer Function, and Wage Opportunity Locus



When an interregional equilibrium exists, the wage-amenity tradeoff is given by the wage-opportunity function. Suppose instead that there is overcompensation. That is, suppose that the wage at amenity level Q_3 is $W_{3'}$. In equilibrium, only W_3 is required to compensate for amenity level Q_3. This raises three issues. First, there is a motivation to move to the location with amenity level Q_3 since utility levels are higher at that location than other areas. Second, those wage differentials would be expected to be diminished as households and/or firms responded to the differential. Specifically, firms would be expected to exit, lowering demand for labor, and households would be expected to enter, raising the supply of labor, until the wage moves back to W_3. Finally, if the disequilibrium influence is not recognized, then the observed wage-opportunity locus would not equal W_o. Rather, if would expected to flatten, thereby distorting the estimate of the true willingness to pay.

Empirical Studies Employing the Intercity Hedonic Wage Approach

There have been a number of empirical studies that derive implicit values of local amenities and site characteristics by examining wage differentials. For example, Cropper and Arriaga-Salinas (1980) use an intercity hedonic wage model to derive estimates of marginal willingness to pay for air quality improvements; Clark, Kahn and Ofek (1988), derive an urbanization deflator of the U.S. GNP by examining the relationship between wages and urban city size; and Gyourko and Tracy (1991) derive implicit prices for urban fiscal goods and tax prices. Likewise, Clark and Kahn evaluated the marginal willingness to pay for outdoor recreational amenities (1989) as well as urban cultural amenities (1988). All of these studies assume the existence of an interregional equilibrium. However, Herzog and Schlottmann (1993) suggested that estimates of the marginal willingness to pay for urban amenities, specifically those related to city size, may be distorted by disequilibrium in urban labor markets. Using the 1980 Public Use Microdata Sample, they derive hedonic wage functions and then examine the implicit valuations implied by those estimates. They then estimate an individual out-migration function that is dependent upon the amenity levels, cost of living levels, and the “prospective wage”. The prospective wage is that wage that which is necessary to compensate for the local site characteristics, given individual human capital levels, and is derived from the hedonic wage function.

$$M=M(W_p,P_h(Q),P_x,Q) \qquad (8)$$

The variable M represents an individual migration dummy variable (1=outmigration, 0=otherwise), W_p is the prospective wage, P_h is the price of housing, and P_x is the price of other goods. By totally differentiating equation (8), and setting $dP_h=dP_x=dM=0$, and solving for MW_p/MQ, we derive the true equilibrium marginal willingness to pay. Comparing the marginal willingness to pay with the implicit value derived from the hedonic wage model, Herzog and Schlottmann show that implicit markets for amenities do not appear to be in equilibrium. Like the findings of Greenwood, Hunt, Rickman and Treyz (1991), these findings also cast doubt on the accuracy of estimates derived from models that simply assume equilibrium.

To assess whether the existence of regional disequilibria result in signals for migrants, a recent study by Clark, Herrin, Knapp and White (2003) employs a three-step procedure applied to data from the 1990 Public Use Microdata Sample of the U.S. Census of Population and Housing. In the first stage, Henderson’s wage opportunity locus is estimated. Specifically, the individual annual earnings are regressed on a vector of human capital characteristics for that individual (X_i), the median housing value in city j (MV_j) as required in the Henderson wage model, and city fixed effects, a_j.

$$\ln(\text{annual wage income}) = \exists X_i + \forall {*}MV_j + \ast a_j + e_{ij} \quad (9)$$

Note that equation (9) is estimated without an intercept term so that all citywide fixed effects can be estimated. The coefficient on the fixed effects reflect the capitalization of amenities, fiscal goods, as well as disequilibrium effects reflecting incomplete compensation for the amenity. To separate the equilibrium from the disequilibrium effects in the fixed effects, the second stage model regresses the parameter estimates of the fixed effects ($\ast_j$) on a vector of citywide amenities and fiscal characteristics (Q_j) as shown in equation (10).

$$\ast_j = (Q_j + u_j \quad (10)$$

By accounting for the contribution of the locational attributes (Q_j) (i.e., systematic equilibrium compensation due to quality of life factors), the residuals of the model should provide estimates of the degree of systematic undercompensation or overcompensation. That is, if the residual for any given city is positive, that implies that the locational attributes underestimated the true fixed effect, and hence workers in the city are overcompensated in the wage for the local amenity mix. The third stage model evaluates the influence of the degree of over-compensation and under-compensation on the likelihood of a move. The 1990 PUMS data identifies the metropolitan area of residence in 1985 and 1990. Clark, et. al. (2003) evaluate a sample of mobile householders (i.e., those household heads who have changed houses over the period). Some of these individuals moved within the city in which they resided and are classified as nonmigrants (Migr=0), whereas other changed cities and are hence defined as migrants (Migr=1). From this sample, the following binary logit model is estimated:

$$\text{Prob}(\text{Migr})_{i,o,d} = 0X_i + \vartheta Q_{o,d} + BOC_{o,d} + \Delta UC_{o,d} \quad (11)$$

From equation 11, the likelihood of migration of individual i, between some origin (o) and destination (d) is dependent on a vector of individual characteristics (X_i), a vector of locational attributes at the origin and destination ($Q_{o,d}$), and the degree of overcompensation ($OC_{o,d}$) and undercompensation ($UC_{o,d}$), again defined at the origin and the destination. If the decision to migrate is an efficient equilibrating mechanism, then overcompensation at the origin should decrease the likelihood of a move from a city, whereas overcompensation at the destination should increase the likelihood of migration. In contrast, undercompensation at the origin should increase the likelihood of out-migration, whereas undercompensation at the destination should decrease the likelihood of out-migration. The empirical findings bear out these predictions with all coefficients on the overcompensation and undercompensation variables found to be of the expected sign and highly significant. Migrants appear to be significantly repelled from their origin site by high levels of undercompensation at the origin and the opposite is true when the origin overcompensates for amenities. Likewise, high levels of overcompensation at the destination significantly increase the likelihood of an intermetropolitan migration, whereas high levels of undercompensation at the destination significantly decrease the likelihood of migration.

Testing Persistence in Regional Disequilibria

While the Clark, Herrin, Knapp and White (2003) findings suggest the existence of regional disequilibria in labor markets, they also suggest that migration behavior mitigates the disequilibrium problem. Thus, an important question is whether regional disequilibria appear to be persistent over time. To test this hypothesis, a net migration model of the following form was estimated for 603 metropolitan counties.[2]

$$NetMigRate_i = \forall + \exists Empl.Growth + \ast Q_i + (OC_i + 0UC_i$$

$NetMigRate_i$ represents the county net migration rate over the period 1995-2000; Empl.Growth is the growth in total employment over the period 1985-1995; Q_i is a vector of amenity, fiscal and racial/ethnic measures that existed in 1995; and OC_i and UC_i are the undercompensation and overcompensation measures that were derived by Clark et. al., (2003). Complete data descriptions and data sources are provided in Table 1. If labor markets adjust relatively quickly to regional disequilibria, then one would expect the coefficients (and 0 to be statistically insignificant.

[2] Some metropolitan counties were omitted due to incomplete data on explanatory variables.

Table 1- Variable Definitions and Data Sources[a]		
Variable Name	Description	Source
Net Migration rate	Difference between the total number of in and out-migrants to/from the county between 1995-2000 divided by 1995 population	U.S. Bureau of the Census – 2000 U.S. Census of Population and Housing
Metropolitan Employment Growth (1985-1995)	Growth in total employment in the metropolitan area between 1985 and 1995.	U.S. Bureau of Economic Analysis – Regional Economic Information System (REIS)
Heating Degree Days	Number of heating degree days - 65° average for the MSA – 30 year averages	NOAA – Comparative Climate Data
Cooling Degree Days	Number of cooling degree days - 65° average for the MSA– 30 year average [1329.303, 842.788]	NOAA – Comparative Climate Data
Temperature Difference	Average July – average January temperature – 30 year average for the MSA.	NOAA – Comparative Climate Data
Average Hours Sunshine	Average hours of sunshine per day – 30 year average for the MSA	NOAA – Comparative Climate Data
Average Humidity – July	Average relative humidity level in July – 30 year average for the MSA	NOAA – Comparative Climate Data
Average Inches of Snowfall	Average annual snowfall in inches – 30 year average for the MSA	NOAA – Comparative Climate Data
Average Inches of Precipitation	Average annual inches of precipitation – 30 year average for the MSA	NOAA – Comparative Climate Data
Ocean Coast Dummy	Dummy variable =1 if the county is on an ocean coast	U.S. Department of Agriculture – ERS database.
County Crime Index	Total crime rate for the county for 1995	FBI Uniform Crime Report
Central City Dummy	Dummy variable =1 if the county contains a central city for the metropolitan area.	U.S. Bureau of the Census definition
Population Density	County population in 1995 divided by county land area.	U.S. Bureau of the Census
Percent Black	Percent of county population that is black in 1992.	U.S. Bureau of the Census
Percent Hispanic	Percent of the county population that is Hispanic in 1992.	U.S. Bureau of the Census
Presence of Major League Sports Franchise	Dummy variable=1 if there is Major League Sports franchises in the metropolitan area.	ESPN.com
Ozone Nonattainment	Dummy variable =1 if MSA is in nonattainment of ozone standards; 0=otherwise.	U.S. Environmental Protection Agency
Sulfur Nonattainment	Dummy variable =1 if MSA is in nonattainment of sulfur standards; 0=otherwise.	U.S. Environmental Protection Agency
Pm10 Nonattainment	Dummy variable =1 if MSA is in nonattainment of 10 particulate matter standards; 0=otherwise.	U.S. Environmental Protection Agency

Table 1(continued) – Variable Definitions and Data Sources[a]		
Variable Name	Description	Source
Per Capita Other Local Tax Revenues	County per capita total municipal tax liability less the property tax in 1992	U.S. Bureau of the Census
Per Capita Property Tax Revenues	County per capita property tax revenues in 1992	U.S. Bureau of the Census
Per Capita Spending - Education	County per capita expenditures on local schools in 1992 (1982 dollars)	U.S. Bureau of the Census
Per Capita Spending - Highways	County per capita expenditures on municipal streets, sidewalks, bridges, etc. in 1992 (1982 dollars)	U.S. Bureau of the Census
Per Capita Spending – Police	County per capita expenditures on municipal police in 1992 (1982 dollars)	U.S. Bureau of the Census
Per Capita Spending – Fire	County per capita expenditures on firefighting in 1992 (1982 dollars)	U.S. Bureau of the Census
Per Capita Spending- Sewer/Sanitation	County per capita expenditures on sewerage and sanitation in 1992 (1982 dollars)	U.S. Bureau of the Census
Overcompensation	Degree of overcompensation in the metropolitan area in the county 1990	Derived from Clark, Herrin, Knapp and White, 2003.
Undercompensation	Degree of undercompensation in the metropolitan area in the county 1990	Derived from Clark, Herrin, Knapp and White, 2003.
[a]Thanks to John Carruthers for providing a database that assembled fiscal data, and census data at the county level over time.		

The regression findings are reported in Table 2. The model is found to have heteroskedasticity, and is corrected using White's consistent variance estimator. The model explains 48.1% of the variation in $NetMigRate_i$. Specifically, the *Metropolitan Employment Growth (1985-1995)* has a positive and significant coefficient as expected.[3] Among the climate measures, the *Average Hours of Sunshine* has a positive and significant impact on net migration, as does the *Average Inches of Precipitation* (at the 10% level of significance). The *Average July Humidity* level negatively affects the net migration rate, but only at the 10% level of significance in a one-tailed test.

Turning to other amenities and disamenities, the *Presence of a Major League Sports Team* has a positive and significant influence on net in-migration, and the *County Crime Index* has a negative and significant influence. Measures of air quality are statistically insignificant, as is a dummy variable for being located on an *Ocean Coast*. Two additional controls are added to capture unmeasured influences related to urban scale *(Population Density)* and *Central City* location. The *Population Density* variable is positive and just below significance at the 10% level in a two-tailed test. This suggests that density is on-net capturing net-amenities associated with more densely populated areas (e.g., better cultural amenities). On the other hand, net in-migration is detrimentally affected by a *Central City dummy* variable. This is likely reflecting the ongoing tendency for metropolitan areas to decentralize.

[3] The metropolitan, as opposed to the county-wide total employment growth rate is employed because workers in a particular county are assumed to compete for jobs throughout the metropolitan area.

Table 2: Net Migration Rate Regression – Metropolitan Counties				
Dependent Variable: *County Net Migration Rate*				
Variable	Coefficient	Std. Error	t-Statistic	Expected Sign
Intercept	-0.021329	0.037408	-0.570	
Employment Growth and Amenities/Disamenities				
Metropolitan Employment Growth	0.002080	0.000206	10.096	+
Heating Degree Days	4.25E-07	5.44E-06	0.078	-
Cooling Degree Days	7.33E-06	6.81E-06	1.076	-
Tempdiff (Avg. Jan – Avg. July)	-0.000728	0.000772	-0.943	-
Average Hours Sunshine	0.000435	9.62E-05	4.521	+
Average Humidity – July	-0.000339	0.000230	-1.473	-
Average Inches of Snowfall	-4.24E-05	0.000205	-0.207	-
Average Inches of Precipitation	0.000256	0.000137	1.863	?
Major League Sports Team	0.021193	0.005666	3.741	+
Particulate Matter – Nonattainment Area	0.013092	0.014293	0.916	-
Ozone – Nonattainment Area	0.004033	0.006625	0.609	-
Sulfur – Nonattainment Area	-0.017599	0.011475	-1.534	-
County Crime Index – 1995	-2.74E-07	1.07E-07	-2.559	-
Ocean Coastal Dummy Variable	0.000284	0.006266	0.045	+
Population Density	3.40E-06	2.08E-06	1.641	?
Central City Dummy Variable	-0.015342	0.004462	-3.438	?
Racial/Ethnic Characteristics				
Percent Black – 1992	-0.001071	0.000218	-4.912	?
Percent Hispanic – 1992	-0.001079	0.000297	-3.632	?
Fiscal Variables				
Per Capita Local Other Tax Revenue – 1992	-3.18E-05	1.88E-05	-1.688	-
Per Capita Local Property Tax Revenue – 1992	4.46E-05	1.42E-05	3.143	-
Per Capita Expenditure on Police – 1992	1.74E-05	9.58E-05	0.181	+
Per Capita Expenditure on Fire - 1992	-4.07E-05	1.87E-05	-2.173	+
Per Capita Expenditure on Education - 1992	-0.000705	0.000116	-6.097	+
Per Capita Local Expenditure on Highways - 1992	3.30E-05	6.36E-05	0.520	+
Per Capita Local Expenditure on Sewer and Sanitation – 1992	-0.000142	4.94E-05	-2.864	+
Undercompensation	0.001365	0.001378	0.990	+
Overcompensation	0.001841	0.001554	1.184	-
N=603 R^2 = 0.511 R^2_{adj}=0.488 AIC = -3.144 SC=-2.958 Log Likelihood: 1022.109, F=23.263				

Two measures of racial and ethnic concentration (i.e., *Percent Black*, *Percent Hispanic*) both have negative and significant impacts on the net migration rate.

An examination of the findings on fiscal measures generates some interesting results. The tax measures (*Per Capita Property Tax* and *Per Capita Other Tax*) have opposite impacts on net in-migration. *Per Capita Other Tax* has a negative and significant influence on net migration (5% significance level in a one-tailed test) as expected, whereas the *Per Capita Property Tax* measure has an unexpected positive impact, and its t-score is 3.1. While the specification controls for spending levels, this finding suggests that the property tax burden is likely capturing other unmeasured benefits from spending. On the spending side, none of the spending categories show positive and significant impacts on migration. Rather, *Per Capita Expenditure on Education*, *Fire Protection*, and *Sewer and Sanitation* all have negative and statistically significant (2-tailed test) impacts on the net migration rate. Clearly, there does not appear to be a positive relationship between spending levels and perceived quality of the public services.

Finally, the two measures of incomplete compensation, *(Undercompensation, Overcompensation)* are both positive, but statistically insignificant determinants of county-wide net in-migration rates. Thus, even though the assumption of regional equilibrium is not supported by several wage studies, (Henderson, 1982, Herzog and Schlottmann, 1993; Clark, Herrin, Knapp and White, 2003), these findings do suggest that labor markets eventually adjust. That is, the disequilibrium signals that existed in 1990 (Clark et. al., 2003) appear to have been sufficiently dissipated by interregional household mobility, and they do not appear to influence migration rates in the latter part of the 1990's.

IV. <u>Conclusions and Research Implications</u>

In this chapter, we explored interregional models of amenity valuation. These models, which have evolved since their inception in the late 1970's, provide important tools for policymakers who are trying to implicitly value nonmarket goods. Although the early studies that employed these techniques made the assumption that regional labor and land markets were in equilibrium, we now know that the equilibrium assumption is overly simplistic. Perhaps not surprisingly, regional factor markets do not instantaneously adjust to equilibrium after shocks. However, it is also clear that they do adjust, and the adjustment takes place relatively quickly. The empirical findings reported in this chapter suggest that the signals to migrate, which appeared to be relatively strong in 1990, no longer appear to influence the net migration rate just five years later.

I close with two points. First, although the assumption of equilibrium between regions is not supported empirically, this does not necessitate the abandonment of these techniques. Indeed, Greenwood, Hunt, Rickman and Treyz (1991) and Herzog and Schlottmann, (1993) have both suggested modifications to these approaches that more thoroughly model the feedback effects of migration on the estimation of implicit prices, and hence allow estimates of the marginal willingness to pay for local quality of life factors to be accurately derived. By making use of these modifications, true estimates of the utility preserving marginal willingness to pay can be derived. Second, while we recognize that the faulty assumption of interregional equilibrium has driven a wedge between the implicit price and the marginal willingness to pay estimates, the biases introduced appear to be mitigated by the self-correcting nature of regional factor markets.

Workers are not oblivious to interregional welfare differences, and firms do not ignore interregional cost differentials. Thus, although these markets may not be in equilibrium at any given point in time, it is likely that they continually adjust towards equilibrium, suggesting that even the early studies that assumed equilibrium may have generated reasonable estimates of marginal willingness to pay for local amenities.

References

Bartik, Timothy J. "The Estimation of Demand Parameters in Hedonic Price Models." *Journal of Political Economy,* Vol. 95(1), 1987, 81-88.

Blomquist, Glenn C., Mark C. Berger and John P. Hoehn. "New Estimates of Quality of Life in Urban Areas" *American Economic Review,* Vol. 78(1), 1988, 89-107.

Berger, Mark C. and Glenn Blomquist. "Mobility and Destination in Migration Decisions: The Roles of Earnings, Quality of Life and Housing Prices." *Journal of Housing Economics*, Vol. 2, 1992, 37-59.

Brown, James N. and Harvey S. Rosen. "On the Estimation of Structural Hedonic Price Models." *Econometrica*, Vol. 50, 1982, 765-768.

Carlino, Gerald and Edward N. Coulson. "Compensating Differentials and the Social Benefits of the NFL" *Journal of Urban Economics,* Vol. 56(1), 2004, 25-50.

Clark, David E., William E. Herrin, Thomas A. Knapp and Nancy E. White "Migration and Implicit Amenity Markets: Does Incomplete Compensation Matter?" *Journal of Economic Geography*, Vol. 3(3), 2003, 289-307.

Clark, David E. and James R. Kahn. "The Two-Stage Hedonic Wage Approach: A Methodology for the Valuation of Environmental Amenities." *Journal of Environmental Economics and Management*, Vol. 16, 1989, 106-120.

Clark, David E. and James R. Kahn. "The Social Benefits of Urban Cultural Amenities." *Journal of Regional Science*, Vol. 54, August 1988, pp. 363-377.

Clark, David E., James R. Kahn and Haim Ofek. "City Size, Quality of Life, and the Urbanization Deflator of the GNP: 1910-1984." *Southern Economic Journal*, Vol. 54, 1988, 701-714.

Clark, David E. and Leslie A. Nieves. "An Interregional Hedonic Analysis of Noxious Facility Impacts on Local Wages and Property Values." *Journal of Environmental Economics and Management*, Vol. 27, 1994, 235-253.

Clark, David E. and William E. Herrin. "The Impact of Public School Attributes on Home Sale Prices in California." *Growth and Change*, Vol. 31(3) 2000, 381-403.

Clark, David E. and William E. Herrin. "Historical Preservation Districts and Home Sale Prices: Evidence from the Sacramento Housing Market" *Review of Regional Studies*, 1997, Vol 27 (1), 29-48.

Clark, David E., Lisa Michelbrink, Tim Allison and William Metz. "Nuclear Power Plants and Residential Housing Prices: Evidence from Two California Plants." *Growth and Change,* Vol. 28(4), 1997, 496-519.

Coulson, Edward N., and Robin M. Leichenko. "Historic Preservation and Neighborhood Change", *Urban Studies,* Vol. 41(8), 2004, 1587-1600.

Cropper, M.L. and A.S. Arriaga-Salinas. "Inter-city Wage Differentials and the Value of Air Quality." *Journal of Urban Economics*, Vol. 8, 1980, 236-254.

Epple, Dennis. "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products." *Journal of Political Economy,* 95(1) 1987, 59-80.

Greenwood, Michael J., Gary L. Hunt, Dan S. Rickman and George I. Treyz. "Migration, Regional Equilibrium, and the Estimation of Compensating Differentials." *American Economic Review*, Vol. 81(5), Dec. 1991, 1382-1390.

Gyourko, Joseph and Joseph Tracy. "The Importance of Local Fiscal Conditions in Analyzing Local Labor Markets." *Journal of Political Economy*, Vol. 97(5), 1989, 1208-1231.

Harrison, David Jr. and Daniel L. Rubinfeld. "The Air Pollution and Property Value Debate: Some Empirical Evidence." *Review of Economics and Statistics,* Vol 6(4), 1978, 635-638.

Henderson, J. Vernon. "Evaluating Consumer Amenities and Interregional Welfare Differences." *Jounal of Urban Economics,* Vol. 11, 1982, 32-59.

Herzog, Henry W. and Alan M. Schlottmann. "Valuing Amenities and Disamenities of Urban Scale: Can Bigger be Better?" *Journal of Regional Science,* Vol. 33(2), 1993, 145-166.

Kiel, Katherine A. and Katherine T. McClain. "House Prices during Siting Decision Stages: The Case of an Incinerator From Rumor Through Operation." *Journal of Environmental Economics and Management,* Vol. 28, 1995, 241-255.

Lancaster, Kelvin J. "A New Approach to Consumer Theory." *Journal of Political Economy,* 74, 1966, 132-157.

Lichtenstein, Larry and Clifford R. Kern. "The Cost of Quality in Existing Housing: Estimates from Implicit Markets Model." *Journal of Urban Economics,* Vol. 22, 1987, 324-339.

Mathur, Vijay .K. and Sheldon Stein. "A Dynamic Interregional Theory of Migration and Population Growth", *Land Economics,* Vol. 67(3), August 1991, pp. 292-298.

Nelson, Jon P. "Airport Noise, Location Rent and the Market for Residential Amenities." *Journal of Environmental Economics and Management*, Vol. 6, 1979, 320-331.

Nelson, Jon P. "Three Mile Island and Residential Property Values: Empirical Analysis and Policy Implications" *Land Economics,* Vol. 57, 1981, 363-372.

Palmquist, Raymond B. "Valuing Localized Externalities." *Journal of Urban Economics,* Vol. 31(1), 1992, pp. 59-68.

Parsons, George and Yangru Wu. “The Opportunity Cost of Coastal Land Use Controls: An Empirical Analysis.” *Land Economics*, 67(3), 1991, 308-316.

Ridker, R. and J.A. Henning. “The Determinants of Residential Property Values with Special Reference to Air Pollution.” *Review of Economics and Statistics*, Vol. 49, 1967, 246-257.

Rosen, Sherwin. “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition.” *Journal of Political Economy*, Vol. 82, 1974, 35-55.

Rosen, Sherwin. “Wage-Based Indexes of Urban Quality of Life.” In P. Mieszkowski and M. Straszhaim, (eds.) *Current Issues in Urban Economics*, Baltimore: Johns Hopkins Press, 1979, 74-104.

Smith, Adam. *An Inquiry into the Nature and Causes of the Wealth of Nations*. 1776, Book 2, Chapter 4.

Smith, Bruce H. “The Effect of Ocean and Lake Coast Amenities on Cities.” *Journal of Urban Economics,* Vol. 33(1) 1993, 115-123.

Tiebout, Charles. “A Pure Theory of Local Expenditures.” *Journal of Political Economy*, Vol. 64(5), 1956, 416-424.

Thaler, Richard. “A Note on the Value of Crime Control: Evidence from the Property Market.” *Journal of Urban Economics*, Vol. 5, 1978, 137-145.

Roback, Jennifer. “Wages, Rents and the Quality of Life.” *Journal of Political Economy*, Vol. 90, 1982, 1257-1278.

Wieand, Kenneth F. “Air Pollution and Property Values: A Study of the St. Louis Area” *Journal of Regional Science*, 13, 1973, 91-95.