THE EFFECT OF WAGE AND RENT SHOCKS ON MIGRATION

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ABSTRACT

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In recent years considerable research has been devoted to the role of the location-specific amenities in the migration model under the assumption of interregional equilibrium. This research hypothesizes that migration takes place as a result of various kinds of shocks such as a technological shift and a change in the federal government expenditure.

The data which will be used in this migration model come from three sources. The main source is extracted from the Panel Study of Income Dynamics (PSID) which is annually released by Institute for Social Research in the University of Michigan. The PSID is panel-survey data composed of individual-level and family-level data. The data is operated by the Inter-University Consortium for Political and Social Research. The final aggregate data are composed of 2024 individuals residing in 123 counties.

The model sets up two kinds of hypotheses, one is based on the previous research and the other is based on the new hypothesized relationship in this work. The first hypothesis was that the existing amenity endowment is locally fixed so that quality of life differences are positively related to the actual in-migration. The second hypothesis was that regional shocks or exogenous changes in level of amenities are locally variable so

that wage and rent premiums are positively related to actual in-migration and are negatively related to future out-migration.

The empirical results support the importance of amenity difference as a pull factor for the actual move in migration behavior and the importance of wage and rent shocks as a pull factor for the actual and potential move. The results from the first hypothesis and the second hypothesis also show that both the systematic and unsystematic portions of amenity variations have an important role in explaining the migration behavior of households. This results also send us the implication of that environmental policies and others that protect and improve areas' amenities would induce the in-migration and thus regional development.

To my father UnPyo, my mother, Sukgue, and my wife Younhee,

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CHAPTER ONE: AN INTRODUCTION TO WAGE AND RENT SHOCKS

1. Introduction

A considerable body of work in regional science has been concerned with the determination of the value of amenity differences across areas. The beginning of this line of research has its root from the work of Rosen's (1979) survey of interregional wage differences, but other works have been done by Roback (1982, 1988), and most recently, Hoehn, Berger, and Blomquist (1987, 1988) and Knapp and Graves (1989). The assumption underlying these studies is that the interregional system is in equilibrium so that hedonic compensation for location-specific amenities will be captured both in the rent market and in the labor market.

In recent years considerable research has been devoted to the role of the location-specific amenities in the migration model under the assumption of interregional equilibrium. General equilibrium, where all workers are optimally located, is reached through inter-urban migration. Graves (1980) and Knapp and Graves (1989) hypothesized that migration takes place as a result of changes in demand for location-fixed amenities as a rise in income results in an increased demand for leisure activity on the part of an individual. However, the changes in demand for amenities do not necessary reflect utility differences that can be arbitraged through household migration.

Previous research did not consider location related shocks to be factors of migration. In this study, however, it is assumed that there are location-specific shocks at particular places in time. The location-specific shocks may come from a technological shift, economic shock, or a change in federal government's expenditures. It is assumed that an exogenous shock cannot be absorbed in the labor and rent market system for the some periods. The resulting divergence between the expected prices and the equilibrium prices in labor and rent markets will provide households with the incentive to move or stay.

For example, workers residing in areas with wage discount, wages persistently below those predicted by the hedonic wage regression, can increase their utility by moving to another location, since the wage (or rent) equation represents the average available wage/amenities opportunities. Workers residing in such areas will have a strong willingness to move. Similarly, areas with wage premium, wages persistently above those predicted by the hedonic wage regression can attract workers from another locations since they can maximize their utility by relocation. On the other hand, workers residing in areas with rent discount, rents persistently above those predicted by the rent regression, can increase their utility by moving to another location. Thus the rent and wage premiums or discounts would be push and pull factors in migration. They encourage workers to either move from or move into an area.

Any shock in an area will generates location-specific wage premium (or rent premium), a difference between the anticipated wage (or rent) and equilibrium wage (or rent). The existence of local wage or rent premiums makes it possible to reconcile continuing migration with the assumption of equilibrium. Each premium encourages adjustment toward equilibrium by inducing workers' relocation.

The wage and rent premiums are derived empirically from the error terms of hedonic wage and rent equations. The challenging part of this research is to distinguish the error that arises between firms and laborers from the error (rent or wage premium) that arises between areas. In a random effects model, individual constant terms of hedonic equations are randomly distributed across urban areas. This random distribution is appropriate since sampled urban counties were drawn from a large statistical population. In this research, since data structures are hierarchical in the sense that workers in each area are grouped into county units, each county consisting of a number of workers, a hierarchical linear model, or multilevel model, will be used in order to derive the rent and wage premiums.

2. PROBLEMS, HYPOTHESES & OBJECTIVES

2.1 Problems

In the analysis of migration, urban site attributes have been factors directly affecting the movement behavior of households. According to Evans (1990), if interregional differences are equalized when labor and rent markets adjust efficiently and instantaneously, there is no reason to include amenity variables in the migration models. And, of course, Blomquist, Berger, and Hoehn's (1988) free mobility assumption of households and firms in the interregional equilibrium does not exclude the possibility of migration. In fact, migration between areas takes the role of attaining equilibrium in the system. In this research we assume labor and rent markets are not instantaneously efficient by the existence of regional shock so that migration between areas is necessary for system to attain equilibrium. This assumption makes it possible to generate a new hypothesis that would allow migration to co-exist with interregional equilibrium.

A regional shock includes any shock coming from both nation-wide shocks and location-wide shocks. A nation-wide shock is defined as a shock having a national scale such as technological shift and a change in federal budget. An amenity is defined as a location-specific good. Unlike the general goods such as cloth and wheat, amenities are not transferable. They are fixed by location. An amenity shock is broadly defined as the unexpected change in the amount of location-specific goods resulting from various kinds of shocks.

Since nation-wide shocks indirectly affect the local markets, they change the amount of location-specific non-traded goods. In this sense, a nation-wide shock can be expressed as an amenity shock. On the other hand, location-wide shock is defined as a shock happening on a local base and is an amenity shock through direct path since the local government policies directly change the amount of the location-specific goods. Until now, previous works have not considered a regional shock as a factor to explain the migration. This study will investigate the importance of wage and rent shocks as determinant factors in migration.

2.2 Objectives & Hypotheses

The objective of this study is to test the empirical importance of wage and rent premiums in both actual in-migration and future out-migration. The first hypothesis would be that the existing amenity endowment is locally fixed so that the quality of life differences across areas are positively related to the actual in-migration and are negatively related to the future out-migration. The second hypothesis would be that the wage or rent premium differences across areas are positively related to the actual in-migration and are negatively related to the willingness to move.

The theoretical background for the first hypothesis comes from some past research (Graves, 1980; Graves, 1983; Graves and Waldman, 1991) arguing that with average incomes rising, one would expect net movement to locations offering a normal or superior bundles of amenities. In fact, migration is necessary any time the household has changed demands for location-fixed amenities.

While the first hypothesis considers the cause of migration as the change for the demand side of location-fixed amenity, the second hypothesis focuses on households' migration behavior due to wage and rent premiums which could be affected by the supply side of location-variable amenities as one of sources of regional shocks. The amenity shock, which is one of regional shocks, induces the differences between equilibrium prices and compensating prices in both labor market and rent market.

In the hedonic pricing framework which relates wages and rents to a set of local attributes, a worker chooses his or her residential location to maximize his utility. Inter-urban migration yields the equilibrium location pattern. In equilibrium, since a worker is assumed to maximize his utility, he does not have the incentive to move. In order for workers to remain in less desirable locations, positive compensation must be paid. Also in equilibrium, the level of the compensating wage should be equalized across areas. This means that firms must offer greater compensation to attract workers to areas with, for example, more crime, pollution, and other urban 'bads'. On the other hand, firms can attract workers with lower compensation to areas with, for example, higher quality schools, more parks, and other urban 'goods'.

If the wage(rent)/amenity opportunities were not fully realized in the markets by the unanticipated change in the level of the variable amenity endowment by the local government policies, there will be a wage premium in excess of the compensating wage which is based on the valuation of human capital and urban attributes, or a wage discount in lack of the compensating wage.

This dissertation applies the hedonic approach to calculate the wage (rent) premium or discount across areas which will exist in the temporary disequilibrium. General equilibrium, where all households are optimally located, is reached through inter-urban migration. When amenity shock happens in a location, rent premium and wage premium will be supposed to take an important factor in the migration decision. If households reside in areas with premiums below those predicted by the hedonic wage-rent regression, they will move to a more favorable area in order to maximize their utilities, since the hedonic wage-rent equation represents the average available wage-rent amenities' opportunities. Therefore, households' strong willingness to stay should be observed for areas with the positive premiums associated with location-variable characteristics. Similarly households' strong willingness to move should be observed for such areas with negative premiums, since their residents have the willingness to move due to unfavorable wage-rent amenity opportunities. On the other hand, if the premiums are observed with zero value in the specific location, there will be no incentive to move from that location.

CHAPTER TWO: LITERATURE REVIEW

1. INTRODUCTION

Economists, demographers, sociologists, and geographers have made numerous contributions to the migration literature since 1950. This review organizes migration literature into two broad categories: (1) studies dealing with gross migration and (2) studies explaining migration as an equilibrium vs. disequilibrium phenomena. This study will be presented as a new approach to understanding regional shocks as pull and push factors in migration.

2. MODELS OF GROSS MIGRATION

2.1 Gravity Models

A variety of analytical models have been applied to the analysis of place-to-place migration flows. These models have been macroscopic in structure, i.e., rather than dealing with individual migrants and their utility a

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calculus. They treated migration as a phenomenon with a certain statistical incidence in any population, given the characteristics of the population and of the amenity.

According to Lowry (1966), these models were based on three general principles:

1) Distance is a hindrance to migration.

2) The volume of out-migration from (in-migration to) a given place depends both the size of that place and on the aggregate size of all other accessible places.

3) Alternative destinations compete with each other for shares of the stream of out-migration from any given origin.

The practical interpretation of gravity model is that a distance is seen as a barrier and larger population as a magnet. More recently, the original mechanical view has been expanded to interpret distance and population as transportation costs and the economic influences of market size, respectively.

The substance of these principles finds its expression in the so-called "gravity model," various forms of which have been widely used in urban traffic studies, retail market analysis, studies of local residential patterns, and even interregional commodity flows and industrial location models.

Probably the best known of these migration models, and one of the first, is George K. Zipf's (1946) "Interaction Hypothesis" : Gross migration between two places varies positively with the product of their sizes, and negatively with the distance separating the places. The expanded gravity model of Lowry (1966) incorporated economic variables such as the regional unemployment rate and wage as well as "gravity" variables. The Lowry model has several dynamic implications as follows: people migrate in search of jobs from low-wage to high-wage areas, and from areas of surplus labor to those with labor shortages. Migrants, over time, will affect the labor market of the receiving area, and as its labor supply is augmented, its relative attractiveness is diminished, or vice versa. Areas with higher unemployment rates might be expected to experience both more out-migration and less in-migration.

2.2 Life-Cycle Approach

With the development of microdata sets such as the National Longitudinal Surveys and the University of Michigan's Income Dynamics Panel and the application of econometric techniques such as logit and probit regressions appropriate for their analysis, greater emphasis has been placed on various life-cycle and familial factors that influence the decision to migrate.

Following paragraph is extracted from W.A.V. Clark's analysis (1986, pp.41-42). A simple scale of age and possible moves can be used to show that for the first 15 to 18 years of an individual's life, he or she is probably a "tied" mover moving with the household in its relocation behaviors. Beyond that point, the individual begins a number of moves that are related initially to decisions to leave home and take a job or to attend college. During these first few years, several relocations are generated as individuals seek one or more compatible residences. This is followed by either marriage or some living arrangement that necessitates a move, possibly related to space, but certainly a move by one or more of the partners into a different unit. The addition of children may create additional moves, again largely related to a need for greater amounts of space at a point in the middle years between 25 and 45, and may be followed by a long period of relative stability (or instability created by divorce and death and resultant moves). The latter periods, after the ages of 50 or 60, with reductions in family size, create the pattern opposite to that we had during family expansion. The children leaving the nest generate a down-sizing of the space required, and so one or more moves are related to the need for less space. Finally, the deterioration of health may require some form of care and a move to a communal facility.

This explanation of the aging of the family and the associated compositional changes of the family structure over time is a useful device for understanding how many moves arise simply from the normal life-cycle transitions. The empirical results reported by Speare et al. (1975) indicate that demographic or life-cycle variables are the primary determinants of subjectively reported levels of dissatisfaction and are significantly correlated with observed mobility behavior even when controlling housing dissatisfaction.

Mincer (1978) introduced the concept of migration ties to provide a structure for the conflicts between spouses in making the migration decision. Migration occurs if the net family gain from moving is positive. Sandell and Koenig (1978) specifically tested the hypothesis that two-worker families will migrate less than those with only one worker. They also found that the employment of the wife and her job tenure have significant negative effects on family migration.

However, in the mid-1980s this standardized life-cycle view is somewhat less relevant. There is a greater instability in household structures (and, consequently, increased moves) both from divorces and from the recombination of stepchildren within households. According to Stapleton (1980), "the life cycle is an important generator of moves, and perhaps the critical element of understanding the mobility process, the life cycle alone is not a sufficient explanation of mobility decision making. It is true that housing needs are strongly conditioned by stages of the family life cycle, but we need to recognize that moves occur without changes in the family life cycle."

3. EQUILIBRIUM VS. DISEQUILIBRIUM

The literature relating the amenity to migration has gradually developed along two quite distinct lines, the disequilibrium approach and the equilibrium approach. Following Greenwood (1979), Greenwood and Hunt

(1989), Evans (1990), and Herzog, Jr. (1993), those who adopt the disequilibrium approach to migration modeling argue that urban "markets" for amenities (disamenities) are most likely not in a state of equilibrium, and that location-specific amenities do not have a direct effect on migration so that job growth seems high in high amenity areas. On the other hand, following Graves (1980), Graves (1983), Graves and Knapp (1985), Menke (1987), and Shield (1995), those who adopt the equilibrium approach to migration modeling suppose that migration will continue until the value of amenities is fully capitalized into rents and wages in all regions, and that population is attracted to high amenity areas, causing directly population growth which then results in job growth.

As Evans (1990, p. 518) noted, "we are left with the chicken and egg problem proposed by Muth (1971) - do people follow jobs or jobs follow people?" However, there is a common factor in approaches arguing that amenity supply is assumed to be fixed so that only changing demands for the location-specific amenities will result in changing optimal locations. My research suggests that amenity supply is variable and depends on the local government policies. The more important supply-induced cause of migration will be the unanticipated changes in supply of the location-specific amenities. For example, a past paper by Graves and Linneman (1979, p.395) suggests the importance of amenity shock in the intraurban movement of between blacks and whites. "Given the current state of racial prejudice, this would seem to explain the flight of white from deteriorating neighborhoods as blacks move into these areas. More specifically, if we treat interaction with blacks as a non-traded good, as blacks move into these neighborhoods sooner than the white residents expected, the supply and demand for this non-traded good are no longer equal. The equilibrium will be restored only after the out-migration of some whites from the neighborhood. Hence the greater are the unexpected changes in the supplies of the non-traded goods, the greater is the probability of migration." While Grave and Linneman's suggestion shows on the effect of exogenous change of non-traded goods on the intra-urban migration, this study extends it by considering the effect of exogenous change in amenity endowment on the inter-urban migration.

4. THE ROLE OF AMENITY IN THE MIGRATION MODEL

The role of location-specific amenities in models of migration will be explored in this section. The objective of this review section is to identify the differences of both the well-known amenity differences and the newly-made concept of amenity shock. Historically, conventional models assumed that amenity differences are revealed both in the rent market and in the labor market within the interregional equilibrium framework. On the other hand, amenity shock, which is meant by the unexpected change in the endowment of amenities, will not be revealed in both markets.

The choice of different amenities can be achieved only by relocation or migration. Graves and Linneman (1979) argue that in an equilibrium setting, rising per capita income levels lead to changing demands for amenities. These changing demands also lead to migration flows to better places with ambient amenities over time (Graves, 1983). According to such interregional equilibrium models, the complete capitalization of amenities will not provide people with the incentive to move because if a household's current state is judged to be satisfactory at the existing endowment of amenities, no action is taken. For example, a household would not always expect migration toward the higher wage areas since those locations have the higher wages because they are undesirable enough to receive the compensating wage.

Yet the empirical results still support that amenities appear to be strongly related to on-going migration. The inclusion of amenity variables in the migration models can be justified by the incomplete compensation of amenities. The partial compensation due to amenity shock will provide people with the incentive to move. Graves and Knapp (1988) developed a model which they applied to the mobility behavior of the elderly. Von Reichert and Rudzitis (1995) also developed a general model of destination choice using survey-based microdata of elderly migrants. When amenities are captured with a lower wage level and constant rent, the lower living cost at that location is likely to appeal to the retired elderly. Consequently, the retired elderly should prefer locations where amenity compensation is captured in wages rather than rents. Empirically they support that the nonlabor force, many of which are elderly and retired, have a stronger preference for low rent locations than the labor force. On the other hand, most of the labor force migrants were willing to accept cuts in household income when they chose to move to the high amenity counties (von Reichert and Rudzitis, 1992).

The role of amenity variables in the migration model has been important in various studies. Hass and Serow (1993) considered amenities as pull factors in the empirical study for the destination-selecting migrants whereas destination-specific migrants were likely to indicate ties to the area in the form of friends which can be expressed as location affinity. Leading push factors were bad climate and attributes of urbanization such as a high level of pollution and the most important pull factors were the environmental amenities of climate and scenic beauty.

This study sets up the first hypothesis about the importance of amenity differences in the migration decision, and then also sets up the second hypothesis such that amenity shock will provide people or households with the incentive to move. The amenity shock in the second hypothesis implies the unexpected change in location-variable amenities, such as environmental quality and education system.

5. LOCATION CHOICE IN EQUILIBRIUM MODELS

5.1 Background

There are several studies related to the effect of amenities on migration. Grave's results produce strong findings concerning the effect of amenity variables (Grave, 1979), whereas Greenwood and Hunt's results yield almost nothing in connection with a similar set of variables (Greenwood and Hunt, 1989). These two analyses explain the interactions among the supply of and demand for labor without considering explicitly consumer and producer amenities.

Several authors (Roback, 1982, 1988; Blomquist, Berger, and Hoehn, 1988) have addressed the possibilities of amenities being capitalized in both wages and rents such that both must be modeled together to correctly value amenities. In this sense, a question arises in light of the evaluation of locational amenities. To what extent are the levels of amenities captured in rents and to what extent are they captured in wages. Henderson (1982) derived a demarcation rule based on a distinction between variations in the level of amenities within a county, and variations in the level of amenities across counties.

Under plausible conditions the former are fully capitalized into rents, and the latter are fully capitalized into wages. However, since such a demarcation rule does not have a theoretical foundation, a more plausible question will be on the choice of equilibrium vs. disequilibrium of the model.

If the migration model assumes equilibrium, there is no way to include the amenity variables in the migration equation since amenity variation is already fully capitalized into both wage and rent. Hoch (1974), Roback (1982, 1988), Hoehn, Berger, and Blomquist (1987), and Schachter and Althaus (1989) support this kind of equilibrium approach so that interregional amenity differences are fully capitalized into both wages and rents in their models.

Another line of migration model, such as Arson and Schwartz (1973), Nelson and Wyzan (1989), and Fox, Herzog, Jr., and Scholttman (1989), argue that fiscal variables like tax and public expenditures affect human migration. As expected, their empirical results show that high state or local government taxes and the increase of income tax have the negative effect of in-migration. As also expected, good police and fire protection, as well as park, education, and recreation facilities have the positive effect of in-migration. In the present model, such fiscal variables are not included in the any equation in the model, but some of fiscal variables would be absorbed through the error terms which are the counterpart of amenity shock.

5.2 Interregional Wage-Rent Model

5.2.1 Workers

Roback assumes that a worker in terms of tastes and productivity, maximizes the following quasi-concave utility function:

$$U = U(x, l^c; s) \tag{1}$$

The variables included are defined as a composite commodity as the numeraire, x, the residential land consumed, l^c and a vector of amenities, s. The budget constraint is given as

$$w + I = x + r\, l^c, \tag{2}$$

where w and r represent wage and rental payments, respectively, and I represents the nonlabor income which is income from sources other than work (consisting of pension, interest, and dividends). For convenience, the nonlabor income, I, will be omitted until the empirical model uses it. The associated indirect utility function will be:

$$V(w, r; s) = \underset{x,\, l^c}{\mathrm{Max}} \{U(x, l^c; s) + [w - x - r\, l^c]\}$$

If we assume all workers are the same, the market equilibrium condition for workers is given by[1]

$$V(w\ , r;\, s) = k. \qquad (3)$$

Wages and rents must adjust to equalize utility in all occupied locations. Otherwise workers would have a willingness to move.

The indirect utility function, V, has the properties of increasing in wages, w, and decreasing in rents, r. In addition, $V_S \equiv \partial V/\partial s > 0$, indicating that s is an amenity. Roy's identity holds in the usual way for r, i.e. $V_r/V_w = - l^c$. The expression V_S/V_r is the marginal valuation of s in terms of money, or the implicit price of s. Hence, we define:

$p_S{}^* \equiv V_S/V_W = \partial x/\partial s + r\,\partial l^c/\partial s + U_S/U_X$.[2]

1

$$L = U(x, l^c; s) + \lambda\,(w - x - l^c r)$$
$$L_x = U_x - l = 0,\ L_{l^c} = U_{l^c} - lr = 0,\ \&\ L_\lambda = w - x - r = 0$$
$$\Rightarrow r = U_{l^c} / U_x$$
$$\Rightarrow\ x = x(w,r;s) \text{ and } l^c = l^c(w,r;s).$$
$$\Rightarrow V = V(w,r;s)$$

2 From

$$\begin{aligned}
V &= U\,[x(w,r;s),\, l^c(w,r;s);s] \\
V_S &= U_X\,\partial x/\partial s + U_l\,\partial l/\partial s + U_S \\
&= U_X\,\partial x/\partial s + rU_X\,\partial l^c/\partial s + U_S \ (\text{since } r = U_l/U_X) \\
V_W &= U_X\,\partial x/\partial w + U_l\,\partial l^c/\partial w \\
&= U_X\,\partial x/\partial w + rU_X\,\partial l^c/\partial w \\
&= U_X\,(\partial x/\partial w + r\,\partial l^c/\partial w) \\
&= U_X\ (\text{since } w = x + l^c r \text{ and } 1 = \partial x/\partial w + r\,\partial l^c/\partial w)
\end{aligned}$$

5.2.2. Firms

Assume that X is produced according to a constant returns to scale production function, $X = f(l^p, N; s)$ [3], where l^p is land used in production and N is the total number of workers in the county. It is assumed that there is only one firm in each county. The problem for the representative firm is to minimize costs subject to the production function.[4]

Since f is constant returns to scale, the unit cost function can be considered:

$$C(w, r; s) = \underset{N,\, l^p}{Min}\ \{w\ N/x + r\ l^p/X + [1 - f(N/X, l^p/X\,; s)]\}$$

The equilibrium condition for a representative firm is that unit cost must equal product price, assumed to be unity.

$$C(w, r: s) = 1. \tag{4}$$

Therefore, $p_s^* \equiv V_s/V_w = \partial x/\partial s + r\, \partial l/\partial s + U_s/U_x$. If changes in w and r are ignored, then the first two terms vanish and $V_s/V_w = U_s/U_x$. Thus, U_s/U_x captures the valuation of s at constant factor prices. The full valuation of s must take into account not only the constant price valuation but also the change in consumption bundle due to amenity induced price changes.

[3] Actually X is a function of capital as well as l^p and N. But since capital is perfectly mobile and is uninfluenced by amenities, its rate of return will be equal in all places. Hence, the capital input can be assumed to be optimized out of the problem.

[4] Since the focus is on the location difference, the assumption of a single firm in an area will be enough for the analysis. The representative firm possesses the whole land for production expressed as l^p in an area.

Otherwise, firms would have a willingness to move their capital to more profitable counties.

The unit cost function is increasing in both factor prices. If the amenity is productive, i.e., cost reducing input, then C_S is negative. Also, by Shephard's lemma, $C_w = N/X$ and $C_r = l^p/X$.

5.2.3 Equilibrium

Notice that equation (3) and (4) perfectly determine w and r as functions of s, given a level of k. The equilibrium levels of wages and rents can be solved from the equal utility and equal cost conditions. That is, w and r are determined by the interaction of the equilibrium conditions of the two sides of the market. The land market clearing conditions will be important later in determining the size of the population of a county. The effects of different quantities of s on wages and rents can be understood with the aid of figure 2.1.

The downward sloping lines are combinations of w and r which equalize unit costs at a given level of s. The assumption that s is productive means that at $s_2 > s_1$, factor prices must be higher to equalize costs in both counties. The upward sloping lines represent w-r combinations satisfying $V(w,r;\, s) = k$ at given levels of s. At high sunshine locations, people must pay higher rents at every wage to be indifferent between the two counties.

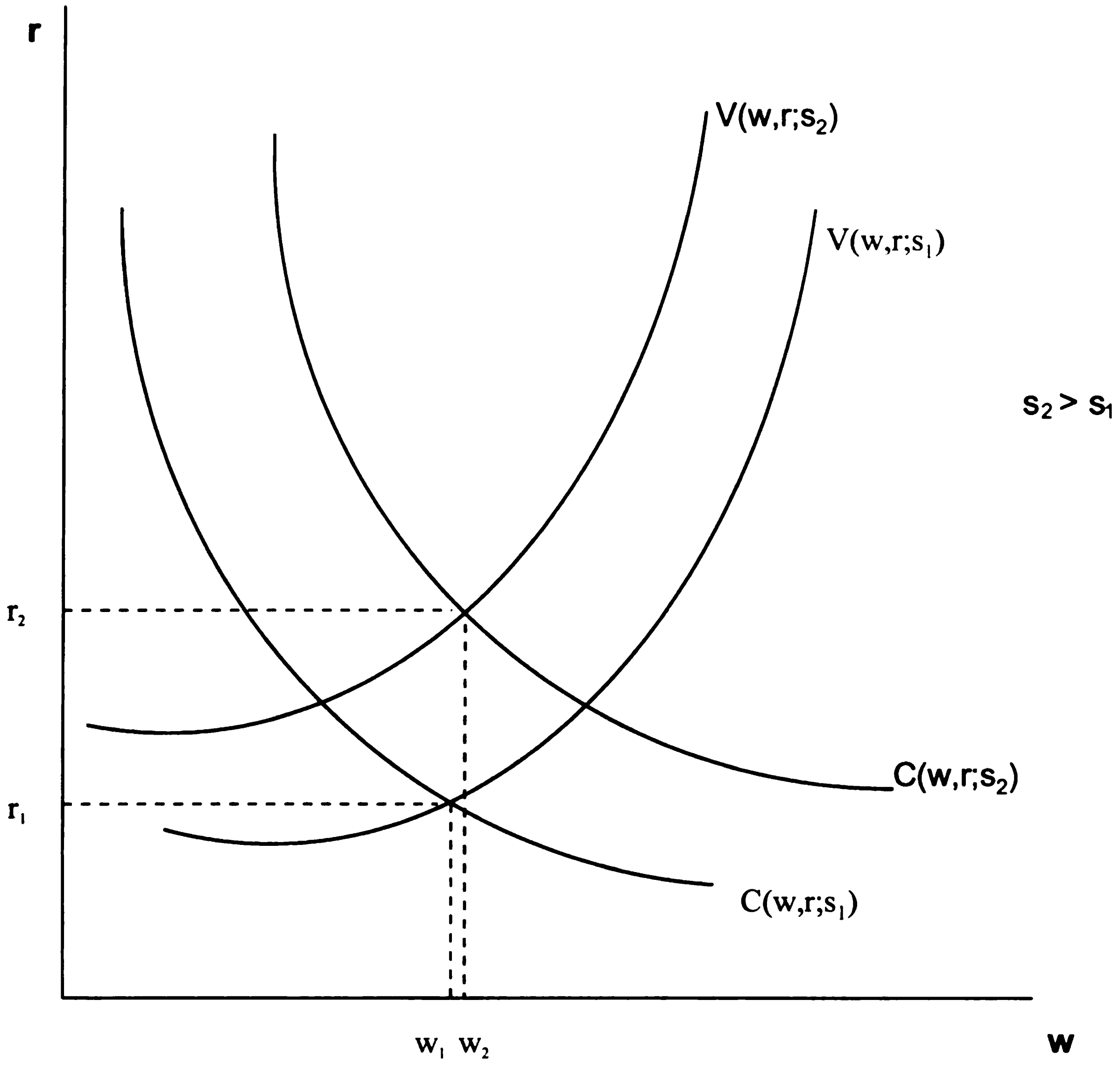

Figure 2.1- Equilibrium Wage and Rent in the Interregional Model

The figure clearly shows that in sunnier places, the rents should be higher while the change in wages is uncertain. The intuitive reason for this is that, with s productive, both firms and workers value the high s locations and hence are competing for the land and bidding up its price. A high wage, on the other hand, is a drawing card for workers but a disincentive for in-migration of firms.

These basic results can be obtained algebraically by differentiating equations (3) and (4) and solving for *dw/ds* and *dr/ds*. The result is equation (5):

$$
\begin{aligned}
\frac{dw}{ds} &= \frac{1}{\Delta}\{-V_s C_r + V_r C_s\} \gtrless 0 \\
\frac{dr}{ds} &= \frac{1}{\Delta}\{-V_w C_s + V_s C_w\} > 0 \\
\Delta &= V_w C_s - V_r C_w = \frac{L(s)V_w}{X} > 0
\end{aligned}
\tag{5}
$$

Using the properties of V and C, we can easily see that $dr/ds > 0$ while dw/ds depends on the relative strengths of the amenity and productivity effects. The amenity effect refers to the degree of a household's willingness to accept the lower wage in order to compensate for the relatively higher level of amenity. The productivity effect refers to the local productivity advantage to pay the relatively higher wage by the cost-reducing amenity input. Notice that dw/ds and dr/ds are, in principle, observable.

The two equations in (5) express dw/ds and dr/ds in terms of the amenity and productivity effects. Hence equations (5) provide a means of imputing V_S/V_W and C_S. Solving simultaneously and using Roy's identity:[5]

$$
\begin{aligned}
P_s^* &\equiv \frac{V_s}{V_w} = l^c\frac{dr}{ds} - \frac{dw}{ds} = -(\frac{dX}{ds} + \frac{dl^c}{ds}r) \\
C_s &= -(\frac{N}{X}\frac{dw}{ds} + \frac{l^p}{X}\frac{dr}{ds})
\end{aligned}
\qquad (6)
$$

These conditions have a straightforward interpretation. The value to consumers is measured by the sum of the numeraire good and the residential land they must forego. It is implied from equation (6) that a correct measure

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[5] $V(w, r;s) = k.$

Differentiating indirect utility function,

$V_W dw + V_r dr + V_S ds = 0.$

$dw + (V_r/V_W)dr + (V_S/V_W)ds = 0.$

$P_S^* \equiv V_S/V_W \quad = -(dw/ds + V_r/V_W\, dr/ds)$

$= -(dw/ds - l^c dr/ds)$ (since $l^c = -V_r/V_W$)

$= l^c dr/ds - dw/ds$

From budget constraint at equilibrium, $w(r,k,s) = X(w,r;s) + l^c(r,w;s)\, r(w,k;s).$

Differentiating with regard to s,

$dw/ds = dx/ds + r(dl^c/ds) + l^c(dr/ds).$

$P_S^* \equiv V_S/V_W \quad = l^c dr/ds - dw/ds$

$= l^c dr/ds - (dx/ds + r\, dl^c/ds + l^c dr/ds)$

$= -(dx/ds + r\, dl^c/ds)$ Q.E.D.

From equation (5),

$dr/ds = 1/\Delta\, \{-V_W C_S + V_S C_W\}$

$1/\Delta\, (Vw\, Cs) = -dr/ds + 1/\Delta\, (V_S C_W)$

$\Rightarrow \quad Cs \quad = -(dr/ds)(\Delta/V_W) + (V_S/V_W)\, C_W$

$= -dr/ds(1/V_W)\, \{V_W l^p/X - V_r N/X\} + (V_S/V_W)\, C_W$

(since $\Delta = V_W C_r - V_r C_W = V_W l^p/X - V_r N/X$)

$= -dr/ds\, l^p/X + dr/ds\, (V_r/V_W)\, N/X + V_S/V_W\, N/X$

$= -dr/ds\, l^p/X + N/X\, (dr/ds\, V_r/V_W + V_S/V_W)$

$= -dr/ds\, l^p/X + N/X(-dw/ds)$

$= -(N/X\, dw/ds + l^p/X\, dr/ds)$ Q.E.D.

of the price of urban attributes must include information from both the wage and the rent gradients.

The goal of this work is to find the effect of the unanticipated change of location-specific amenities, such as clean air and low crime rate, on the migration behavior of the households. The problem can be attacked by noting that urban amenities are consumed jointly with housing and employment. Therefore, both rent and wage may be key variables to valuation of the local characteristics.

It is assumed that in equilibrium, a consumer maximizes utility and a firm minimizes the cost so that neither has the willingness to move. Empirically, the quality of life index (QOLI), which measures location-specific amenity variation, will be calculated under the condition of the equilibrium.

CHAPTER THREE: THE CONCEPT OF AMENITY SHOCK

Until now, the previous works and their theoretical background have been reviewed. The changing demand and supply for amenities are two forces connecting the amenities to migration. The former force comes from the households' utilities and the latter forces come from the local government's policy change or environmental change such as natural disaster and pollution upheaval. This chapter will 1) review the new concept of a regional shock, 2) explore the role of regional shock in the migration model, and 3) finally derive the empirical hypotheses under both theoretical and empirical settings.

1. THE DEFINITION OF AMENITY AND AMENITY SHOCK

An amenity can usually be defined as a location-specific good. This simple definition captures all aspects of consumption or production decision that influence the location of the household or firm. Unlike the general goods such as steel, cloth, cotton, wheat, and etc., an amenity is dependent on location and there is no revealed market to sell and buy an amenity good. Some of the amenities such as parks and good weather are goods and others such as air pollution and cold weather are bads. The former goods can be defined as agreeable amenities which have desirable attributes and the latter be defined as adverse disamenities with undesirable attributes.

The amenity shocks are also regional shocks which include any shock coming from both nation-wide shocks and location-wide shocks. Nation-wide shock is defined as a shock having a national scale such as a technology shift and a change in the federal budget. An amenity shock can be defined as an unanticipated change in the amount of the location-specific goods in the specific location. Since nation-wide shock indirectly affects the local markets, it changes the amount of location-specific non-traded goods. In this sense, nation-wide shock can be an amenity shock through the indirect path. On the other hand, location-wide shock is defined as a shock happening on a local base and is an amenity shock through direct path since the local government policies directly change the amount of the location-specific goods.

The amenity or disamenity shock can take many different forms. An abnormal adverse weather condition such as a typhoon can reduce the living condition at a specific region and lead to a rise in out-migration with an increase in the level of disamenity. Alternatively, an increase in local government expenditures to make more parks can be interpreted as an amenity shock because people residing at a specific location will enjoy and appreciate the parks and will have the willingness to pay for them. Or take the case of the change of tastes for air pollution which induces a worker to find another location with a better condition of air pollution.

A different and somewhat more gruesome disamenity shock was the case of the big earthquake in San Francisco and Kyoto which killed so many citizens and deprived people of their living homes. The economic effects of these earthquakes can be roughly represented as a major disamenity shock affecting migration.

Empirically, regional shocks or amenity shocks will be measured as random shocks which are expressed as premiums and discounts in both labor and rent markets. In deriving the random shock, the following assumptions will be used ;

1) Wage and rent are the equilibrium prices in labor market and rent market in which the actual wage and rent are equal to the compensated wage and rent.

2) There are generally three kinds of error sources in estimation. They are omitted variables, measurement error, and fundamental randomness in human behavior. The random variables or stochastic error in both wage and rent regression equations represent omitted variables mixed with a purely random variation which excludes measurement error.

3) Wage and rent shocks absorb the perturbation coming from all kinds of error sources such as technology shifts, changes in federal budget, and economic shocks.

2. AMENITY SHOCK AND PREMIUMS

From the previous chapter two, we derived the interregional equilibrium conditions and provided the graphical explanation. The expected change in amenity level will be absorbed into the equilibrium wage and rent with compensation. The graphical explanation will be followed in figure 3.1. However, the unexpected change in amenity supply may not be absorbed into the equilibrium wage and rent.

When the amenity shock happens in an area, the new equilibrium level of wage and rent should be changed from (w_0, r_0) to (w_1, r_1) as in the figure 3.1. However, this exogenous shock is assumed for (w_0, r_0) to be stable for some periods without changing to new equilibrium, (w_1, r_1). In order to explain the wage and rent effects by amenity shock, both effects will be separately analyzed. Let's look at the rent effect first. The figure 3.2 shows us the rent premium with a positive amount when the wage remains constant. The rent premium gives the households better well-being since they don't need to pay the higher rent due to better amenity. The rent premium also provides firms the chance to increase the productivity with the combination of unpaid rent and better amenity. It is obvious that the rent premium is an amenity induced benefit for both households and firms residing in an area with amenity shock. The rent premium is the positive amount of rent veiled due to the amenity shock.

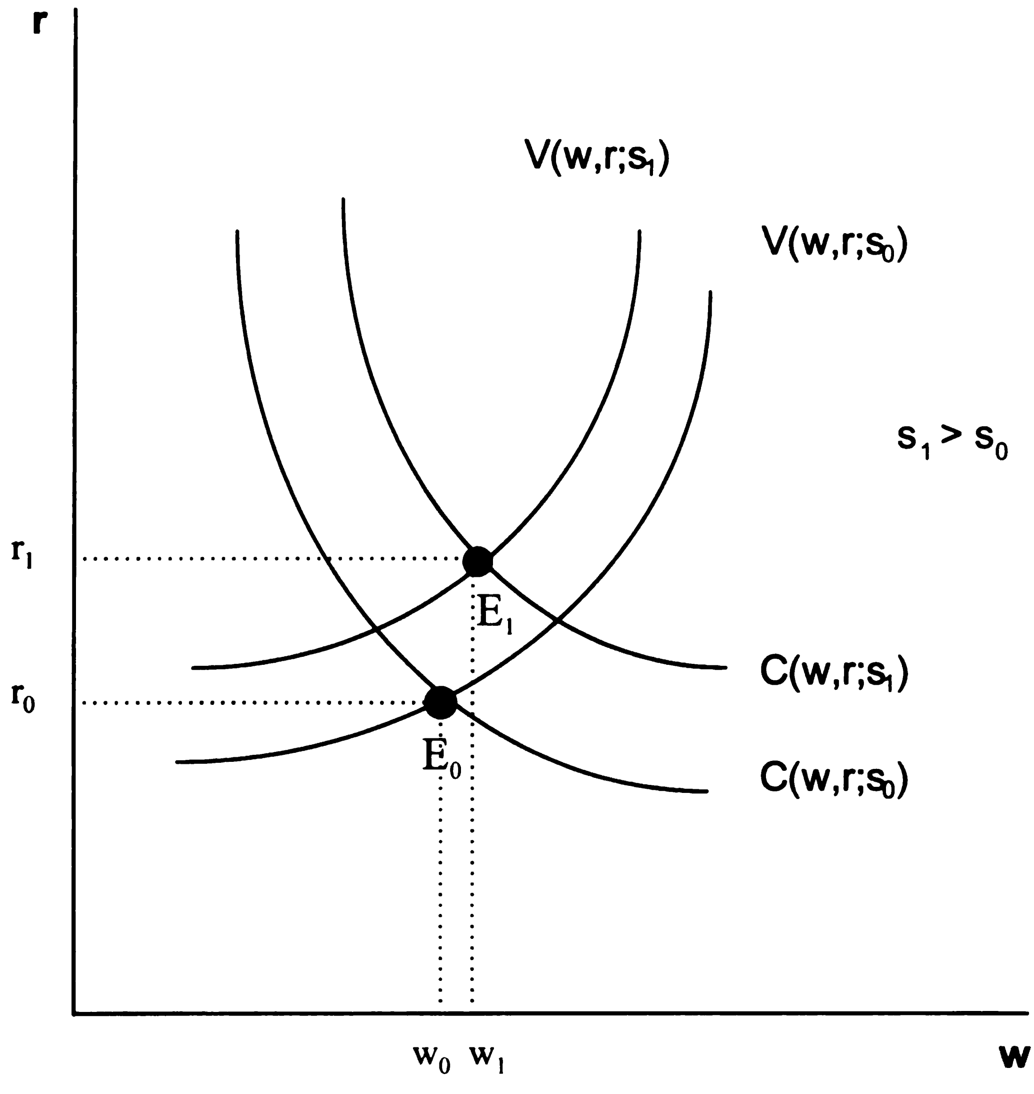

Figure 3.1- Equilibrium Wage and Rent

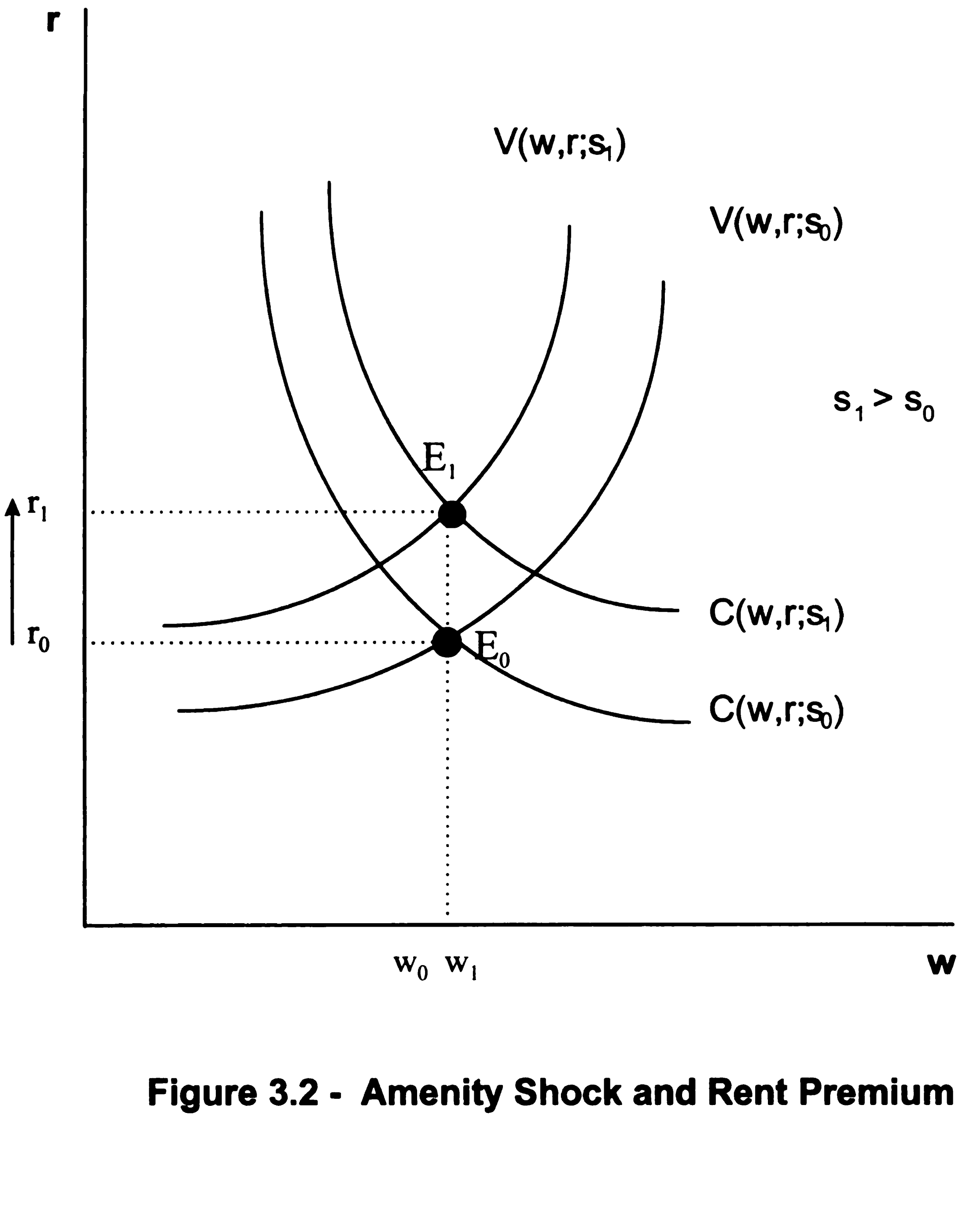

Figure 3.2 - Amenity Shock and Rent Premium

On the other hand, figure 3.3 shows that wage premium is revealed with the negative value due to the amenity shock when the rent remains constant. Workers should get the lower wage through the compensation process by the increased level of amenity. However, they don't need to get the discounted wage since the amenity shock will take time in adjusting the compensating wage. The wage premium with a negative value gives households a benefit, but it deprives firms of a chance to increase the productivity. However, the wage premium could be a pull factor of migration due to weak mobility of firms.

This section demonstrates the theoretical possibility of the existence of wage and rent premiums due to amenity shock. The above phenomena will be more specifically dealt with examples of labor and rental markets in the following section.

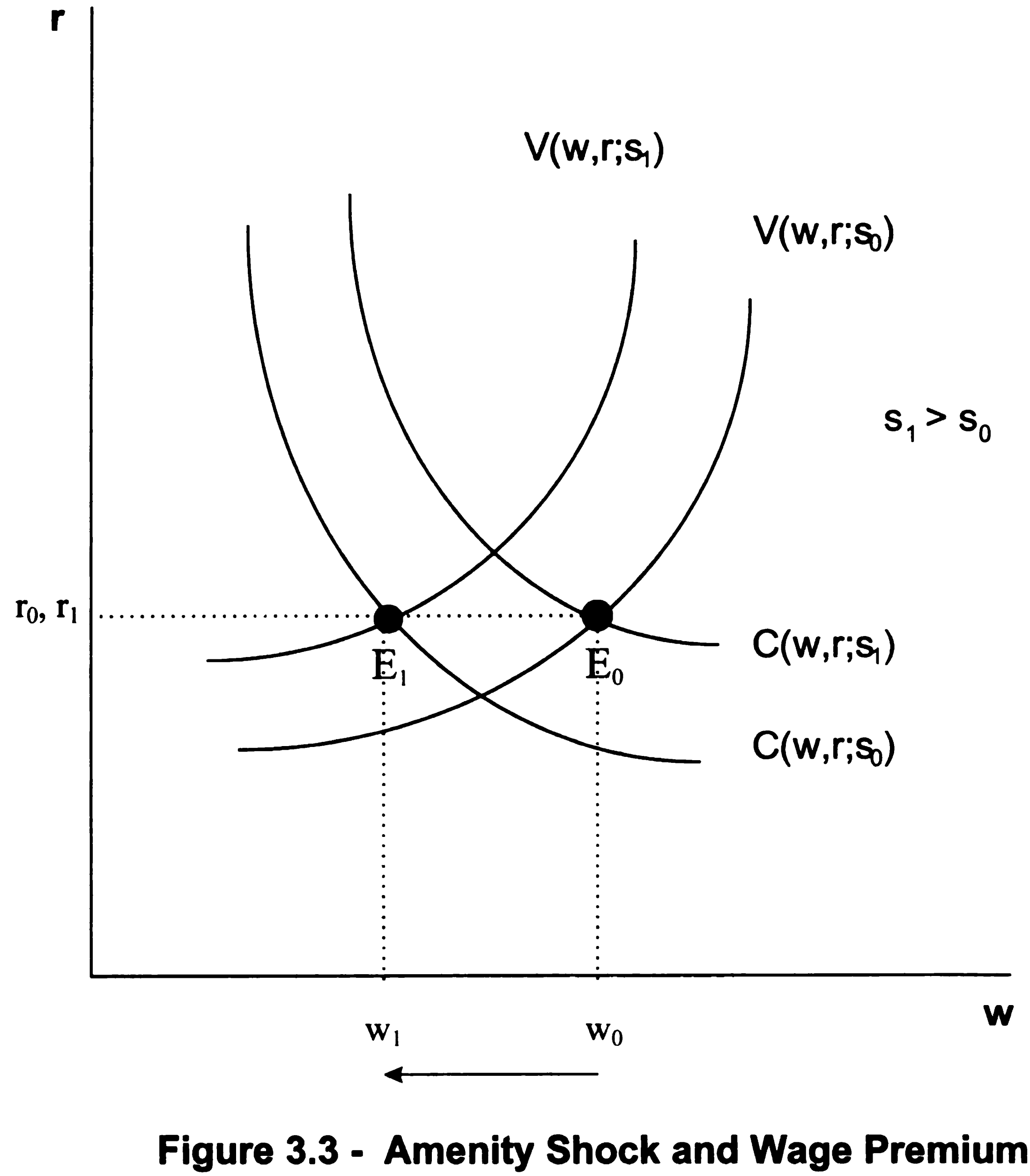

Figure 3.3 - Amenity Shock and Wage Premium

3. AMENITY SHOCK AND WILLINGNESS TO MOVE OR STAY

In this section, the amenity shock will be described within this migration model. The hypothetical setting in the labor and rental market is also exemplified in order to relate the amenity shock to the migration behavior. The amenity shock will be represented as the wage and rent premiums in the empirical setting. Finally, the two important empirical hypotheses will be derived in the following section 4..

3.1 Labor Market

There are two locations, region A and B with the same amount of amenity endowment. Let's suppose that a worker is living in region A and receives $500 per week. When he moves to region B, he is supposed to get the same wage in region B. Let's suppose that the local government in region A has planned and completed instantaneously a new park in order to improve the quality of life. The momentary construction of a new park in region A will bring out the unexpected change in the amount of amenity endowment. According to the wage compensation principle from the interregional equilibrium model, the wage should be discounted by the better condition in that location. The new equilibrium wage would be $470 by the wage discount, say, $30. However, due to unexpected change in the level of amenity endowment, the local labor market will not be adjusted to a new equilibrium condition for a span of adjusting time. The actual wage is above the expected or equilibrium wage. If a premium is defined as the amount at which something is valued above its normal or expected nominal value, the wage premium makes an existing wage be valued above the new equilibrium wage due to the regional shock. The extra wage premium(-\$30) is appended to the equilibrium wage in order to absorb the regional shock. In the wage estimation equation this phenomena will be expressed,

Actual wage(\$500) = Old Equilibrium wage(\$500) + η_w

η_w = wage shock = - \$30,

where the wage shock is expressed in the negative form since the amenity shock is negatively compensated to the wage. Under the instant equilibrium, all workers in the region A should be paid \$30 less than the normal wage, but in this disequilibrium, the wage will not be changed. Therefore, workers living in region A will enjoy relatively better affluence than workers living in region B.

The wage premium exists due to the amenity shock as the temporary disequilibrium wage and will be exhausted as the time goes by or as the firm realizes the wage advantage. The wage premium can also be expressed as the invisible extra bonus for workers living in a county with the amenity shock. The wage premium is the amount that workers are willing to pay for the amenity shock, but the firm temporarily cannot absorb the shock due to the late response or time lag due to incomplete flexibility of migration. In the complete equilibrium condition, workers have no incentive to move. However, in the temporary local disequilibrium condition, the existence of the amenity shock will provide workers with the incentive to move into the region with an amenity shock.

In the model, the value of amenity shock will represent the wage premium and will be revealed as a negative value. Since the disturbance term in the hedonic econometric wage equation represents the value of amenity shock, the error term of wage equation will have the negative relationship with in-migration and the positive relationship with out-migration.

3.2 Rent Market

Let's suppose that a worker pays rent of $500 per month. If amenity shock exists in region A, the amenity shock can be expressed as a money unit, say, $30. In the same way as in the labor market, actual rent should be equal to equilibrium rent. Therefore, there will be an extra rent premium($30) which is added to the equilibrium rent in order to absorb the regional shock. In the rent estimation equation this phenomena will be expressed, Actual rent(\$500) = Old Equilibrium rent(\$500) + η_r

η_r = rental amenity shock = \$30,

where rental amenity shock is expressed as the positive value since the amenity shock is positively compensated to the rent.

If we rewrite the wage amenity shock, η_w = wage amenity shock = -\$30. It is noteworthy when the amenity shock happens in a specific region, the value of the wage amenity shock will be revealed with the negative sign and the value of the rental amenity shock will be revealed with the positive sign.

The rent premium can be interpreted as the amount that the renter is willing to pay for the amenity shock, but he or she does not need to pay the well-being of the amenity due to a temporary lag of adjustment. All renters in the region A will enjoy the improved amenity quantity without paying more rent. This amenity shock will be expressed as the rent premium. Since the disturbance term in the hedonic econometric rent equation represents the value of amenity shock, the error term of the rent equation will have the positive relationship with the in-migration and the negative relationship with the out-migration.

4. REGIONAL SHOCK AND ADJUSTMENT THROUGH MIGRATION

In this section, the disequilibrium factors such as wage and rent premiums will be theoretically related to the workers' willingness to move by the workers' utility maximization. In order to do this work, the theoretical part of the interregional wage and rent equilibrium model will be reviewed.

From the worker's utility maximization condition, V(w, r ;s) = k, wage and rent must adjust to equalize utility in all occupied locations. Otherwise workers would have a willingness to move. Differentiating above the equilibrium equation with regard to w and r,

$$V_w dw + V_r dr = dk, \text{ where } V_w > 0 \text{ and } V_r < 0. \tag{1}$$

If we rewrite this equation in order to look at the amount of the change,

$$V_w(E(w) - w^{\circ}) + V_r(r^{\circ} - E(r)) = E(k) - k^{\circ}, \tag{2}$$

where $(E(w), E(r), E(k))$ is the expected level of (w, r, k) and $(w^{\circ}, r^{\circ}, k^{\circ})$ is the equilibrium level of each (w, r, k). It is noteworthy that workers will have more utility with more wage than the equilibrium wage, but will have less utility with more rent than the equilibrium rent.

At equilibrium, since $E(\mathrm{w}) = \mathrm{w}^{\circ}$ and $E(r) = \mathrm{r}^{\circ}$, there is no incentive to move for workers. On the other hand, by the implicit function theorem, the above equilibrium equation, V(w, r ;s) = k, can be expressed as hedonic wage and rent compensation functions:

$$\mathrm{w}^{\circ} = \mathrm{w}^{\circ}(\mathrm{k},\ \mathrm{r}\ ;\ \mathrm{s}) \text{ and } \mathrm{r}^{\circ} = \mathrm{r}^{\circ}(\mathrm{k},\ \mathrm{w}\ ;\ \mathrm{s}). \tag{3}$$

At the given level of amenity, equilibrium wage and rent will be decided by the market mechanism. In this model, it is assumed that the unexpected change in the level of amenity endowment can only make a difference between the actual prices and equilibrium prices.

The equation (2) implies that the divergence from equilibrium makes the workers to move toward a better location in order to maximize their utilities until they get equalizing utilities in all locations. When we define the wage premium as $\rho_{w} \equiv E(\mathrm{w}) - \mathrm{w}^{\circ}$ and the rent premium as $\rho_{r} \equiv \mathrm{r}^{\circ} - E(\mathrm{r})$, we can derive some implications from the utility maximization hypothesis.

If $\rho_{w} \rangle\ 0$ with the amenity shock, this means that the workers temporarily enjoy the wage level giving a higher utility than any other workers living in different locations. The wage premium is the pull factor that makes the better location with amenity shock so desirable. On the other hand, the firm will have the productivity advantage enough to pay workers the relatively higher wages than they expected. In other words, the existence of the wage premium implies that the firm in the specific region with amenity shock has the extra productivity advantage to pay in excess of the compensating wage payment. If $\rho_w \langle 0$, the workers would have the willingness to move out toward better location in order to maximize their utilities. The negative of wage premium will be the push factor that makes the specific location so undesirable.

On the other hand, if $\rho_r \rangle 0$, with the amenity shock, the workers pays the less rent than the equilibrium rent. They will not have the willingness to move because they enjoy the better well-being with the fixed rent. The positive rent premium will become the pull factor that provides workers living in different locations with the willingness to move into the destination with the premium. On the contrary, the negativeness of rent premium will become the push factor that makes the workers move out of the living residence.

In the empirical hedonic wage and rent equation, the amenity shock will be expressed as the random shock or random variable. If amenity shocks exist in the specific region, they can be the wage premium in the wage equation and the rent premium in the rent equation. Since wage premium and rent premium are temporary disequilibrium phenomena to show the amenity advantage of a region over other regions, they provide workers with the incentive to move into the specific region with the amenity shock.

Just as the error terms go to zero on the average, this regional disequilibrium phenomena will be exhausted over time by migration. Since the regional disequilibrium is a local phenomenon at some point in time, the migration model can be compatible with the equilibrium wage and rent model which can be explained within an equilibrium framework if the local disturbances are excluded.

The hedonic wage and rent model assumes that individuals purchase goods because numerous local characteristics, including amenities, are desirable. The model also assumes that individuals purchase some bads such as air pollution and bad weather with the negative prices in order to get a compensation because they are not desirable. Since the goods and bads are compensated within the model, they will be capitalized in both labor and land markets. This capitalization can be revealed within the hedonic estimation technique to identify the change in wage and rent premiums that will result from the unexpected change of an identified attribute.

Even though the model assumes the complete capitalization by the complete flexibility of migration, the local disturbance can exist in the incomplete flexibility of migration by the invisible regional shocks. On the other hand, in the interregional wage and rent equilibrium model, amenity variation is assumed to be fully capitalized into both wage and rent. Therefore, since the regional shock will be represented as both wage and rent premiums, the migration behavior will be affected by both premiums or the net premium, the addition of rent premium and wage premium.

In this sense, the net premium derived from the disturbance terms of wage and rent hedonic equations could be a factor in explaining the push and pull phenomena in the workers' migration behavior. Therefore, this migration model shares both theoretical and empirical models within the special framework of hedonic compensation functions.

5. EMPIRICAL HYPOTHESES

In this study, there are two important hypotheses that we can derive from the previous section. The first hypothesis deals with the effect of the index for quality of life differences (QOLI) on the migration behavior of workers across areas.

According to Roback (1982) and Blomquist et al. (1988), the implicit price of amenity will be calculated with the sum of the rent differential and the negative of the wage differential.

Mathematically,

$$f_i = (dr / da)_i - (dw / da)_i, \tag{4}$$

where f_i is the implicit price of the amenity i, $(dr / da)_i$ is the rent differential in the equilibrium rent equation, and $(dr / da)_i$ is the wage differential in the equilibrium wage equation. The full implicit prices are used to construct QOLI across locations in the following manner:

$$QOLI_k = \sum_{i=1}^{n} f_i a_{ki} \quad i = 1,\ldots,n \text{ and } k = 1,\ldots k, \tag{5}$$

where a_{ki} is the quantity of amenity i observed in county k, n is the number of amenities, and k is the number of counties.

QOLI is used in comparing the bundle of amenities available across locations. From the chapter two, the interregional wage and rent equilibrium model implied that people move to desirable locations until both wage and rent compensation makes them indifferent to locations. The complete compensation blocks further migration across areas, but the change of demand for location-fixed amenities will induce migration for the utility maximization. In this sense, the first hypothesis is that QOLI is positively related to the in-migration and is negatively related to the out-migration since QOLI is a pull factor of migration. The first hypothesis is mathematically expressed in the following manner:

First Hypothesis: $$\begin{aligned} IM &= a_0^I + a_1^I Q + a_2^I X + e, \ \mathrm{H_0}: a_1^I = 0 \text{ against } \mathrm{H_A}: a_1^I \rangle\, 0 \\ OM &= a_1^O + a_1^O Q + a_2^O X + e, \ \mathrm{H_0}: a_1^0 = 0 \text{ against } \mathrm{H_A}: a_1^O \langle\, 0 \end{aligned}, \tag{6}$$

where IM is in-migration, OM is out-migration, X is the vector of other independent variables, Q is QOLI, and H_O, H_A are the null hypothesis and the alternative hypothesis respectively.

Contrary to the first hypothesis which relates the quality of life to the migration, the second hypothesis will relate the amenity shock to migration. Even though the second hypothesis is closely inter-related to the first hypothesis, it is different from the first one in the sense that the willingness to move or stay occurs due to disamenity or amenity shock rather than amenity differences across areas. Workers' willingness to move comes from their utility maximization behavior. When amenity shock happens in a specific urban area, workers will enjoy better utility with fixed wage and rent. The empirical counterpart of the amenity shock will be the net premium composed of wage and rent premiums that is a pull factor about the future migration behavior.

From the definition of wage premium in last section, we know that $\rho_{w'} \equiv E(w) - w^o$. In the wage regression:

$$\begin{aligned} w^o &= AX + \alpha_{w'} \\ E(w) &= \mathrm{AX}, \end{aligned} \qquad (7)$$

where A is a parameter vector of the hedonic wage regression equation, X is a vector of explainable variables, $\alpha_{w'}$ is the disturbance term. In the empirical model, the X will be composed of the personal and locational characteristics.

The actual wage will be given on the basis of personal ability and location environment. From the definition of wage amenity, we can see that

$$\rho_{w'} = E(w) - w^0 = AX - (AX + \alpha_{w'}) = -\alpha_{w'}. \tag{8}$$

From the above relationship, we can see that the wage premium, $\rho_{w'}$, is opposite in sign with the wage random shock, $\alpha_{w'}$.

In the rent equation:

$$\begin{aligned} r^o &= BY + \beta_r \\ E(r) &= BY \end{aligned},$$

where B is a parameter vector of the hedonic rent equation, Y is a vector of explainable variables composed of location characteristics and housing characteristics, and the β_r is the disturbance term or random rent shock. By the same way, the rent premium, ρ_r, is rewritten in the following manner:

$$\rho_r = r^o - E(r) = \beta_r. \tag{9}$$

It is noteworthy that the sign of rent premium and rent random shock are the same.

If Therefore the net premium, ρ_n, will be:

$$\begin{aligned}\rho_n &= \rho_r + \rho_w \\ &= \alpha_r - \alpha_w\end{aligned}, \tag{10}$$

The second hypothesis of this research is the main objective of this research and is related to the regional shock or amenity shock reduced to empirical wage, rent, and net premiums. As mentioned in last section, there are three parts in the second hypothesis. The first one is: if wage premium is less than zero, workers would have the willingness to move towards better locations in order to maximize their utilities. Since the wage premium is negatively related to the wage random shock, the coefficient of wage premium is negative in in-migration and is positive in out-migration. Mathematically this hypothesis will be:

$$\text{Second Hypothesis: } \begin{array}{l} IM = b_0^I + b_1^I WP + b_2^I X + e\text{, } \mathrm{H_0}: b_1^I = 0 \text{ against } \mathrm{H_A}: b_1^I \langle\, 0 \\ OM = b_1^O + b_1^O WP + b_2^O X + e\text{, } \mathrm{H_0}: b_1^0 = 0 \text{ against } \mathrm{H_A}: b_1^O \rangle\, 0 \end{array},$$

where *IM* is the in-migration variable or the willingness to stay, *OM* is the out-migration or the willingness to move, *WP* is the wage premium, *X* is the vector of other independent variables in the migration model.

The second part of the second hypothesis is: if rent premium is larger than zero, workers will have the willingness to move towards better location. Mathematically,

Second Hypothesis: $$IM = b_0^I + b_1^I RP + b_2^I X + e\text{ , } H_0{:}b_1^I = 0 \text{ against } H_A{:}b_1^I > 0$$
$$OM = b_1^O + b_1^O RP + b_2^O X + e\text{ , } H_0{:}b_1^0 = 0 \text{ against } H_A{:}b_1^O < 0\text{ ,}$$

where *RP* is the rent premium.

The third part of the second hypothesis is that net premium is positively related to the in-migration as the pull factor of migration and is negatively related to the out-migration. Mathematically,

Second Hypothesis: $$IM = b_0^I + b_1^I N + b_2^I X + e\text{ , } H_0{:}b_1^I = 0 \text{ against } H_A{:}b_1^I > 0$$
$$OM = b_1^O + b_1^O N + b_2^O X + e\text{ , } H_0{:}b_1^0 = 0 \text{ against } H_A{:}b_1^O < 0\text{ ,}$$

where *N* is the net premium. The second hypothesis implies that a correct measure of the price of urban attributes must include information from both the wage and the rent gradients and the net effect of the wage and rent premium could be one of decisive pull factors in migration.

CHAPTER FOUR: METHODS

1. INTRODUCTION

From the equilibrium model of labor and land markets, we derived the first hypothesis that better places with the expected change in ambulant amenities induce the population increase due to the demand for location-specific amenities. We also derived the second hypothesis that amenity shock provides households with the incentive to stay and disamenity shock provides households with the willingness to move towards areas with positive amenity shock.

From figure 3.2 in chapter 3, the amenity shock produced the rent premium with a constant wage. From figure 3.3, the amenity shock produced the wage premium with a constant rent. The next step will be how to measure the amenity shock within the empirical model.

2. THE MEASUREMENT OF AMENITY SHOCK

The hedonic wage and rent equations share the individual variables and location variables. The individual variables contain personal characteristics (e.g., age, education level, experience, occupation, etc.) The location variables include the amenity related characteristics (e.g., sun, wind, pollution level, etc.) The independent variable structure will be divided into two levels, person level and location level which involve hierarchical or nested data structure. Both workers and counties are units in the analysis; variables are measured at both levels. Such data have a hierarchical structure with individual workers nested within counties. The nested data structure demands to use the hierarchical or multilevel model.

In a hierarchical data structure, the error terms have two levels, which are person-related error and location-related error. The person error includes the disequilibrium factors in the labor market. The discrepancy of demand for labor and supply of labor might generate the person error. The person error is not related to the location choice since the disequilibrium factors are due to the discrepancy between the personal ability and the demand for labor at a specific time period. On the other hand, location error will capture the location-variable amenity shock. For example, a local county manages the financial budget so well that the authority builds the park with extra money. The local residents will benefit from the improved natural environment. The benefit will provide the workers the unanticipated better well-being and the compensation for the benefit will remain unchanged for the time being until firms and workers make a new adjustment. That is why the amenity or disamenity random shock temporarily exists and then it will provide the incentive to move toward better locations from other places which will induce the pull effect of migration. Empirically, the effect of the amenity random shock will be represented as the net premium which is the net value of rent premium minus wage premium.

In this study, a person error is the error that arises between firms and laborers and a location error is the error that arises between counties. A wage or rent premium is derived from the location error. It is hypothesized that location error includes the amenity shock, i.e., the unexpected change in the supply of amenity endowment. As explained in the previous section, amenity shock and disamenity shock will be pull factor and push factor respectively affecting the migration behavior of households. In this sense, the location error could be one of the important independent variables in the migration model.

In order to extract the location error from mixed errors composed of the person error and the location error, we need to develop the two-level models. The first level involves the person related micro level model to capture the individual effects. The second level is the macro level model to capture the location effects. Until now, the econometric model has recognized both errors as in the error component model or random effect models, but two errors were specified in the single level model by treating personal characteristics and location attributes as undivided independent variables under the equalizing level. The two-level model enables a decomposition of the variation of wage and rent into within and between county components. The multi-level approach has been used under the different titles in the field of education and sociology. This migration model is adopted from the Bryk and Raudenbush's hierarchical linear model (HLM) with their statistical package. The main advantage of HLM obviously is in its two-level model specification which makes it possible to derive both person and location errors at the different levels. Finally, in the migration model the location errors will be used as indicators to affect the willingness to move or stay.

3. THE SIMPLE TWO-LEVEL MODEL

We begin by considering the relationship between a single person-level explainable variable (say, experience[EXP]) and a one outcome variable (wage) within two hypothetical counties.

(1) $$Y_i = \beta_0 + \beta_1 X_i + u_i$$

The intercept, β_0, is defined as the expected wage of a worker whose EXP is zero. The slope, β_1, is the expected change in the wage associated with a unit increase in EXP. The error term, u_i, represents a unique effect associated with person i. Typically, we assume that u_i is normally distributed with a mean of zero and variance σ^2, that is, $u_i \sim N(0, \sigma^2)$.

Let us now consider two different regression lines as in Figure 4.3.

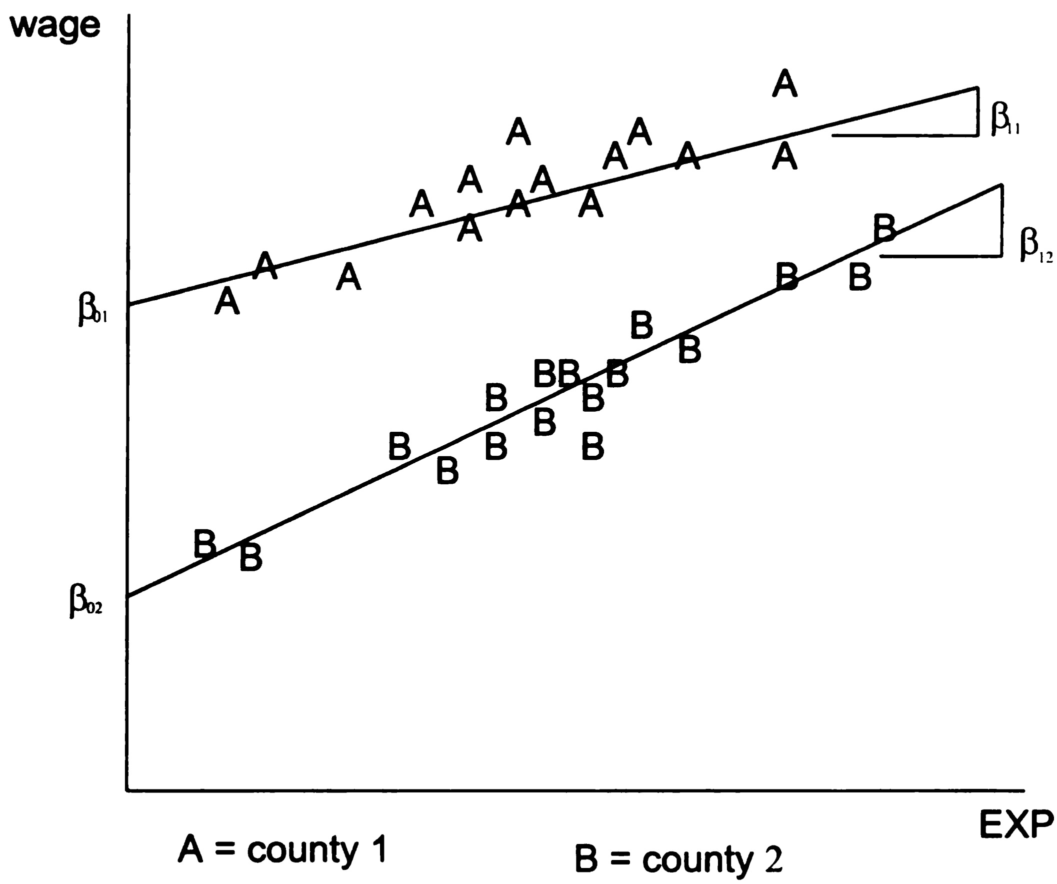

Figure 4.1-Scatterplot Showing the Relationship Wage and EXP within Two Hypothetical Counties

The two lines show that county 1 and county 2 differ in two ways. First, county 1 has a higher mean than does county 1. This difference is reflected in the two different intercepts, that is, $\beta_{01} > \beta_{02}$. Second, EXP is less predictive of wage in county 1 than in county 2, as indicated by comparing the two slopes, that is, $\beta_{11} < \beta_{12}$

If workers had been randomly assigned to the two counties, we could say that county 1 is both more "productive" and more "equitable" than county 2. The greater productivity is indicated by the higher mean level of the wage in county 1 (i.e., $\beta_{01} > \beta_{02}$). The greater equity is shown by the lower slope in county 1 (i.e., $\beta_{11} < \beta_{12}$).

We now extend from the two county model to J county model extracted randomly from a population. The extended relationship within any county j will be described by the equation

$$(2) \qquad Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + u_{ij}$$

where we assume that $u_{ij} \sim N(0,\sigma^2)$. From the above notion, we can notice that the intercept and slope are now subscripted by j, which allows each county to have a unique intercept and slope. It is often reasonable to assume that the intercept and slope have a bivariate normal distribution across the population of counties. Let

$$E(\beta_{0j}) = \gamma_0, \quad Var(\beta_{0j}) = \tau_{00}$$

$$E(\beta_{1j}) = \gamma_1, \quad Var(\beta_{1j}) = \tau_{11}$$

$$Cov(\beta_{0j}, \beta_{1j}) = \tau_{01}$$

,where

γ_0 is the average county mean for the population of counties;

τ_{00} is the population variance among the county means;

γ_1 is the average EXP slope for the population;

τ_{11} is the population variance among the slopes; and

τ_{01} is the population covariance between slopes and intercepts.

The main objective of HLM is to develop a model to predict β_{0j} and β_{1j} at the second location level. The HLM is similar to the random effects model in treating coefficients as random variables. However the HLM has a unique difference in regressing random coefficients on the independent variables at the different level. Specifically, we could use location characteristics (e.g., teacher-pupil ratio, visibility, total suspended particulates, crime rate, percent of possible sunshine, average wind speed, etc.) to predict the change of the expected wage due to the change of the local amenity level.

For instance, consider a simple location indicator variable, A_j, which takes on a value of one for the South region and a value of zero for the North region. We could be supposed to argue that A_j is positively related to the average wage (workers in the South region counties receive higher wage than do workers in the North region counties) and negatively related to the slope (EXP effects on the average wage is smaller in the South region than in the

North region counties). We represent these two hypotheses via two regression equations:

(3.1a) $$\beta_{0j} = \gamma_{00} + \gamma_{01} A_j + \nu_{0j},$$

and

(3.1b) $$\beta_{1j} = \gamma_{10} + \gamma_{11} A_j + \nu_{1j},$$

where

γ_{00} is the mean wage for the North region workers;

γ_{01} is the mean wage difference between North region and South region workers;

γ_{10} is the average EXP-wage slope in North region;

γ_{11} is the mean difference in EXP-wage slopes between North and South region counties (i.e., the North counties "equity" advantage);

ν_{0j} is the unique increment to the intercept associated with county level unit j holding A_j constant; and ν_{1j} is the unique increment to the slope associated with county level unit j holding A_j constant.

We assume ν_{0j} and ν_{1j} are random variables with zero means, variances τ_{00} and τ_{11} respectively, and covariance τ_{01}. Note these variance-covariance components. That is, they represent the variability in β_{0j} and β_{1j} remaining after controlling for A_j.

The second hypothesis is related to the degree of slope of the average wage between regions. The objective of the two-level model is to distinquish the person error and the location error in the wage and rent equations. Therefore, we need to revise the second hypothesis.

If we rewrite two hypotheses, the regression equation will be:

(3.2a) $$\beta_{0j} = \gamma_{00} + \gamma_{01} A_j + v_{0j},$$

(3.2b) $$\beta_{1j} = \gamma_{10},$$

If we also substitute Equation (3.1a) and (3.1b) into Equation (2), yielding the single prediction equation for the outcome

(4) $$Y_{ij} = \gamma_{00} + \gamma_{01} A_j + \gamma_{10} X_{ij} + u_{ij} + v_{oj},$$

where u_{ij} is the person error and v_{oj} is the location error.

It is not possible to estimate the parameters of this regression equation directly, because it is not the typical linear model assumed in standard ordinary least squares (OLS). Efficient estimation requires that the random errors are independent, normally distributed, and have constant variance. In contrast, the random error in equation (4) is of a more complex form, $u_{ij} + v_{oj}$. These errors are dependent within each county because the component v_{oj} is common to every workers within county j. The errors also have unequal variances, because $u_{ij} + v_{oj}$ depends on v_{oj} which varies across counties. Though standard regression analysis is inappropriate, such models can be estimated by iterative maximum likelihood procedures which Bryk and Raudenbush used in making a statistical package.

4. THE COMPLETE TWO-LEVEL MODEL

The hedonic wage and rent equations will be used in the usual manner to do the first level approach.

$$\begin{aligned} W_{ij} &= \beta_{oj}^{w} + \beta_{1j}^{w} R_{ij} + \beta_{2j}^{w} AGE_{ij} + \beta_{3j}^{w} SEX_{ij} + \beta_{4j}^{w} MARRIED_{ij} + \beta_{5j}^{w} EXP_{ij} + \beta_{6j}^{w} EDU_{ij} \\ &+ \beta_{7j}^{w} UNION_{ij} + \beta_{8j}^{w} PROF_{ij} + \beta_{9j}^{w} TECH_{ij} + \beta_{10j}^{w} CRAFT_{ij} + \beta_{11j}^{w} OPER_{ij} + u_{ij}^{w} \end{aligned} \tag{5}$$

$$\begin{aligned} R_{ij} &= \beta_{0j}^{r} + \beta_{1j}^{r} W_{ij} + \beta_{2j}^{r} DUPLEX_{ij} + \beta_{3j}^{r} ROOMS_{ij} + \beta_{4j}^{r} ELECTR_{ij} + \beta_{5j}^{r} HEAT_{ij} \\ &+ \beta_{6j}^{r} RENTER_{ij} + \beta_{7j}^{r} FURN_{ij} + u_{ij}^{r} \end{aligned} \tag{6}$$

The second level of the wage equation will be;

$$\begin{aligned} \beta_{0j}^{w} &= \gamma_{00}^{w} + \gamma_{01}^{w} CRIME_{j} + \gamma_{02}^{w} CCOAST_{j} + \gamma_{03}^{w} CDD_{j} + \gamma_{04}^{w} HDD_{j} + \gamma_{05}^{w} HUMID_{j} \\ &+ \gamma_{06}^{w} LAKE_{j} + \gamma_{07}^{w} PRECIP_{j} + \gamma_{08}^{w} SITE_{j} + \gamma_{09}^{w} SUN_{j} + \gamma_{010}^{w} TEACH_{j} \\ &+ \gamma_{011}^{w} TSP_{j} + \gamma_{012}^{w} VIS_{j} + \gamma_{013}^{w} WIND_{j} + \gamma_{014}^{w} UNEMP_{j} + v_{oj}^{w}, \end{aligned} \tag{7}$$

$$\beta_{1j}^{w} = \gamma_{10}^{w}, \tag{8}$$

Combining the first and second level of the wage equation,

$$
\begin{aligned}
W_{ij} = {} & \gamma^{w}_{00} + \gamma^{w}_{01} CRIME_j + \gamma^{w}_{02} CCOAST_j + \gamma^{w}_{03} CDD_j + \gamma^{w}_{04} HDD_j + \gamma^{w}_{05} HUMID_j \\
& + \gamma^{w}_{06} LAKE_j + \gamma^{w}_{07} PRECIP_j + \gamma^{w}_{08} SITE_j + \gamma^{w}_{09} SUN_j + \gamma^{w}_{010} TEACH_j \\
& + \gamma^{w}_{011} TSP_j + \gamma^{w}_{012} VIS_j + \gamma^{w}_{013} WIND_j + \gamma^{w}_{014} UNEMP_j + \gamma^{w}_{10} R_{ij} + \gamma^{w}_{10} AGE_{ij} \\
& + \gamma^{w}_{10} SEX_{ij} + \gamma^{w}_{10} MARRIED_{ij} + \gamma^{w}_{10} EXP_{ij} + \gamma^{w}_{10} EDU_{ij} + \gamma^{w}_{10} UNION_{ij} \\
& + \gamma^{w}_{10} PROF_{ij} + \gamma^{w}_{10} TECH_{ij} + \gamma^{w}_{10} CRAFT_{ij} + \gamma^{w}_{10} OPER_{ij} X_{ij} + u^{w}_{ij} + v^{w}_{0j}
\end{aligned}
\tag{9}
$$

, where v^{w}_{0j} will be expressed EBWAGE or OLWAGE.

The second level of the rent equation will be;

$$
\begin{aligned}
\beta^{r}_{0j} = {} & \gamma^{r}_{00} + \gamma^{r}_{01} CRIME_j + \gamma^{r}_{02} CCOAST_j + \gamma^{r}_{03} CDD_j + \gamma^{r}_{04} HDD_j + \gamma^{r}_{05} HUMID_j \\
& + \gamma^{r}_{06} LAKE_j + \gamma^{r}_{07} PRECIP_j + \gamma^{r}_{08} SITE_j + \gamma^{r}_{09} SUN_j + \gamma^{r}_{010} TEACH_j \\
& + \gamma^{r}_{011} TSP_j + \gamma^{r}_{012} VIS_j + \gamma^{r}_{013} WIND_j + \gamma^{r}_{014} UNEMP_j + v^{r}_{oj},
\end{aligned}
\tag{10}
$$

(11) $\beta^{r}_{1j} = \gamma^{r}_{10}$,

Combining the first and second level of the rent equation,

$$
\begin{aligned}
R_{ij} = {} & \gamma^{r}_{00} + \gamma^{r}_{01} CRIME_j + \gamma^{r}_{02} CCOAST_j + \gamma^{r}_{03} CDD_j + \gamma^{r}_{04} HDD_j + \gamma^{r}_{05} HUMID_j \\
& + \gamma^{r}_{06} LAKE_j + \gamma^{r}_{07} PRECIP_j + \gamma^{r}_{08} SITE_j + \gamma^{r}_{09} SUN_j + \gamma^{r}_{010} TEACH_j \\
& + \gamma^{r}_{011} TSP_j + \gamma^{r}_{012} VIS_j + \gamma^{r}_{013} WIND_j + \gamma^{r}_{014} UNEMP_j + \gamma^{r}_{10} W_{ij} + \gamma^{r}_{10} DUPLEX_{ij} \\
& + \gamma^{r}_{10} ROOMS_{ij} + \gamma^{r}_{10} ELECTR_{ij} + \gamma^{r}_{10} HEAT_{ij} + \gamma^{r}_{10} RENTER_{ij} + \gamma^{r}_{10} FURN_{ij} \\
& + u^{r}_{ij} + v^{r}_{0j}
\end{aligned}
\tag{12}
$$

, where v^{r}_{0j} will be expressed EBRENT or OLRENT.

5. EMPIRICAL RESIDUALS

The residuals will be specified and they will be used as the empirical counterpart of the location errors which represent the amenity shocks in the wage and rent equations. There are two residuals, least squares residual and empirical Bayes residual resulting from the two-level model. The difference between two residuals is explained in the appendix A. Among two residuals, the empirical Bayes residual will be adopted since it generates more efficient estimator for residual and thus it is a better fitted estimator in the migration equation.

5.1 Least Squares Residual (OLWAGE)

These residuals are based on the deviation on an ordinary least squares estimate of a level-1 coefficient, $\hat{\beta}_{0j}^{w}$, from its predicted or "fitted" value based on the level-2 model, i.e.,

OLWAGE = $\hat{\beta}_{0j}^{w} - (\hat{\gamma}_{0j}^{w} + \sum_{s=1}^{S} \hat{\gamma}_{0s}^{w} A_{sj})$, where A_{sj} is a vector of level 2 predictors.

These least squares residuals are denoted in the HLM/2L files by the prefix OL before the corresponding variable names.

5.2 Empirical Bayes Residual (EBWAGE)

These residuals are based on the deviation of the empirical Bayes estimates of a randomly varying level-1 coefficients from its predicted or "fitted" value based on the level-2 model. These residuals are denoted in the HLM/2L residual files by the prefix EB before the corresponding variable names. Like the same manners, the EBRENT and OLRENT can be derived.

5.3 Net Premium (NET)

The net premium is the net effect of EBRENT and EBWAGE and will be used as the most important explanation variable in testing two hypotheses of this migration model. On the other hand, NET is the opposite concept of QOLI since the latter is a visible and expected variable, but the former is an invisible and unexpected variable. In the following chapter, NET will be empirically calculated as the difference between EBRENT and EBWAGE after considering the equivalent unit.

6. DATA TO IMPLEMENT THE EMPIRICAL MODEL

The data which will be used in this model come from three sources. The main source is extracted from the Panel Study of Income Dynamics (PSID) which is annually released by Institute for Social Research in the

University of Michigan. PSID is a panel survey data composed of individual-level data and family-level data. It is operated by the Inter-University Consortium for Political and Social Research. Since county information is related to personal privacy, personal and county code are not open to the public use and is temporarily extracted from the secondary data tape only for the research use. The 1987 data set of PSID has been chosen because it is the only data set containing the information about personal and housing characteristics which are necessary to regress the hedonic equations. The original data observation of 1987 data of PSID was 6026 individuals.

The second source is the amenity data set obtained from an earlier study by Blomquist et al. (1988). The data are composed of the amenity variables by county. The number of the observation of counties is 253 counties where each county has a population exceeding 100,000 individuals.

The third source is 1993 National Economic, Social, and Environmental Data Bank (NESE). The crime variable describes the number of serious crimes known to police and it is extracted from 1988 data of NESE. The economic variable is the unemployment rate for the civilian labor force in the county and it is extracted from 1987 data of NESE.

The merged aggregate data consist of observations on 6026 individuals residing in 254 urban counties. There are a lot of missing values in the original PSID data. After removing the missing values, the final aggregate data are composed of 2024 individuals residing in 123 counties.

6.1 Amenity Data

All amenity variables except the crime variable and unemployment rate come from the data set developed by Blomquist et al. The choice of amenity variables are based on the variables which Blomquist et al. (1988) used for calculation of quality of life index. In my study, unemployment rate is added as amenity variable since it is one of important variables showing the location-specific characteristics. A number of county level amenity variables were included in the wage and rent hedonic equations. These amenity variables can be classified into three groups; climate, social, and environmental variables.

6.1.1 Climate Data

A number of county level climate variables were included in the wage and rent equations. Climate variables include heating and cooling degree days, average humidity, annual precipitation, and percentage of possible sunny days.

6.1.2 Social and Economic Data

Two kinds of county level social variables and one kind of economic variable were included in the wage and rent equations. Social variables include the pupil-teacher ratio in the county and the number of serious crimes. Economic variables include the unemployment rate for civilian labor force in the county.

6.1.3 Environmental Data

A number of county level environmental variables were included in both wage and rent equations. Environmental variables include a dummy variable which is equal to 1 if the county touches a Great Lake or ocean, a number of pollution variables including the number of Superfund sites in the county, the visibility in miles within the county, and the total suspended particulates that occurs on average in the county.

6.2 Wage Data

The wage sample in the PSID data includes all household heads between the ages of 24 and 60 who are working full time. The dependent variable in the wage equation for the present study is the average hourly wage for the head of the household. Average hourly earnings for head is the generated variable appended in the PSID data. The wage equation also includes the worker's personal characteristics. The choice of personal characteristics is based on Blomquist et. al's variables for comparison. However, race variable is not available in PSID data. EDU is dummy variables with 8 distinct values and is used with discrete value as an equivalent variable to schooling. The vector of worker characteristics, their description, and mean values are reported in table 4.1.

6.3 Rent Data

The housing sample in the PSID data includes all housing units for which the value of the unit or contract rent is reported. For renters, the rent is recorded on an annual base. For owners, reported house value is converted to annual rent using a 6.33 percent discount rate. The annual rent is the dependent variable in the rent equation.

The rent equation includes a vector of housing characteristics. Housing control variables are very limited in PSID data. I tried to use all useful variables among available housing variables. The vector of housing characteristics, their description, and mean values are reported in the table 4.1.

Table 4.1 - Description and Mean of Variables in Wage and Rent Data Set

Variables	Description	Mean
WAGE	Average hourly wage	12.28
AGE	Age of head	38.47
SEX	Dummy variable for sex of head (=1 if male)	.76
MARRIED	Dummy variable for marriage (=1 if married)	.61
UNION	Dummy variable for union (=1 if enrolled in union)	.20
EXP	Years worked since 18 years old	17.56
EDU	Completed education level (from 1 = 0-5 grades to 8 = college and advanced degree)	5.15
PROF	Dummy variable for occupation (=1 if professional)	.09
TECH	Dummy variable for occupation (=1 if technician)	.09
CRAFT	Dummy variable for occupation (=1 if craftsman)	.17
OPER	Dummy variable for occupation (=1 if operator)	.12
RENT	Annual rent for housing	6969.16
DUPLEX	Dummy variable for housing unit (=1 if duplex)	.07
ROOMS	Actual number of rooms	5.59
ELECTR	Dummy variable for fuel (=1 if electricity)	.22
HEAT	Dummy variable for heating payment (=1 if pay the heating)	.34
RENTER	Dummy variable for housing status (=1 if renter)	.44
FURN	Dummy variable for furnishing (=1 if furnished)	.04
CRIME	Number of serious crimes known to police per 10,000	679.11

Table 4.1 - Description and Mean of Variables in Wage and Rent Data Set-
Continued

Variables	Description	Mean
CCOAST	If county touches an ocean or Great Lake(=1 if touches either)	.29
CDD	Number of cooling degree days	1138.8
HDD	Number of heating degree days	4434.64
HUMID	Average humidity	68.02
LAKE	Square miles of surface water of lake in county	2.34
PRECIP	Average annual precipitation(inches)	32.84
WIND	Average wind speed(miles/hour)	8.75
SUN	Percent of possible sunshine	60.56
TEACH	Teacher-pupil ratio	.08
TSP	Total suspended particulates	75.87
VIS	Visibility(miles)	16.42
SITE	Number of National Priority List(NPL) sites in the county	3.12
UNEMP	1987 county unemployment rate	5.60

6.4 Migration Data

Migration related variables are also obtained from the PSID. Migration variables are divided into two kinds of movement, actual experienced movement and future expected movement. In-migration (IM) is described as those moved since spring of 1986 and the questionnaire was "Have you moved any time since the spring of 1986?" Out-migration (OM) is described as "might move" and the questionnaire was "Do you think you (head) might move in the next couple of years?"

IM is related to the actual movement. On the other hand, OM is related to the willingness to move in the future. IM shows the actual movement from other places to the present residence. The important question in this regression is what is the pulling force of movement of the household into present living location. OM shows the movement from the living place to the destination. Another important question in this regression is what is a pull of population movement toward the destination. IM and OM will be used as dependent variables in the following empirical migration model. The migration variables, their description, and mean values are reported in the table 4.2.

Table 4.2 - Description and Mean of Variables in Migration Data Set

Variables	Description	Mean
IM	Dummy variable for actual movement(=1 if moved since spring of 1986)	.258
OM	Dummy variable for future movement(=1 if might move)	.410

CHAPTER FIVE: RESULTS

1. DERIVATION OF INDEXES OF QOL AND PREMIUMS

1.1 Introduction

In order to test two hypotheses we need to derive the quality of life index (QOLI) and premiums. QOLI will be estimated by using ordinary least squares (OLS) method with a Box-Cox transformation. On the other hands, wage, rent, and net premiums will be estimated by using hierarchical linear model.

1.2 Derivation of QOLI

This study will generate several variables according to the model which has been set up in Chapter 3 and Chapter 4. QOLI is described as the index of quality of life and it is generated from the equation (5) in Chapter 3. In estimating the coefficients of wage and rent equations, a Box-Cox search was done over functional forms of:

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

where Y is either rent or wage and the X_i are the independent variables in rent and wage equations. In the choosing the functional forms, λ=.2 and γ=1 in the hedonic rent equation, λ=.1 and γ=1 in the wage hedonic equation. The method of the calculation for the QOLI is mainly followed by the way of Blomquist, Berger, and Hoehn (1988). The empirical results of transformed OLS estimation is shown in table 5.1. The results for OLS estimation with transformation will be presented in table 5.3 for the wage equation and in table 5.4 for the rent equation in the next section for comparison with HLM estimates.

As seen in table 5.1, the adjusted R^2's for the wage and rent equations are .408 and .593 respectively. For the 14 amenity variables, 5 variables have a wrong sign in wage equation and 6 variables have a wrong sign in rent equation. Among variables with unexpected sign in the wage equation, only visibility is significant. It might be due to multicollinearity with TSP, humidity, and precipitation. Among variables with unexpected sign in the rent equation, CCOAST, PRECIP, SITE, VIS are significant.

Table 5.1-Parameter Estimates of Transformed OLS Equation

Variables	Dependent Variables Wage	 Rent
Intercept	2.209	29.161
	(1.185)**	(5.428)***
CRIME	.161E-03	.777E-04
	(.766E-04)**	(.350E-03)
CCOAST	-.112	-.457
	(.040)***	(.185)***
CDD	.117E-04	-.792E-03
	(.361E-04)	(.167E-03)***
HDD	.144E-04	-.766E-03
	(.158E-04)	(.723E-04)***
HUMID	-.163E-02	-.043
	(.391E-02)	(.018)***
LAKE	-.674E-02	.205
	(.998E-02)	(.046)***
PRECIP	-.391E-02	-.091
	(.256E-02)*	(.012)***
SITE	-.189E-02	.104
	(.434E-02)	(.020)***
SUN	-.013	-.596E-02
	(.407E-02)***	(.019)
TEACH	-1.605	7.273
	(1.165)*	(5.347)*
TSP	-.102E-02	-.015
	(.981E-03)	(.454E-02)***
VIS	.626E-03	-.023
	(.151E-02)***	(.691E-02)***
WIND	-.029	.678
	(.015)**	(.067)***
UNEMP	-.202E-02	-.316
	(.011)	(.049)***
RENT	.430E-04	
	(.256E-05)***	
WAGE		.129
		(.759E-02)***
AGE	.327E-02	
	(.0237E-02)*	
SEX	.221	
	(.047)***	
MARRIED	.053	
	(.041)*	
EXP	.545E-02	
	(.228E-02)***	
EDU	.120	
	(.011)***	
UNION	.381	
	(.037)***	

Table 5.1-Parameter Estimates of Transformed OLS Equation-continued

Variables	Dependent Variables Wage	 Rent
PROF	.334 (.055)***	
TECH	.142 (.054)***	
CRAFT	.227 (.042)***	
OPER	.069 (.047)*	
DUPLEX		-.576 (.259)**
ROOMS		.798 (.041)***
ELECTR		.660 (.169)***
HEAT		.447 (.266)*
RENTER		-1.963 (.284)***
FURN		-1.845 (.373)***
Adjusted R^2	.408	.593

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

The wage coefficients for the 14 amenity variables are adjusted to generate the annual full implicit prices of amenity variables and the results are presented in table 5.2. Among full implicit prices of amenities, humidity, Superfund site, TSP, visibility, wind, and unemployment rate have a wrong sign. Perhaps this result is mainly due to non-random sampling of PSID data and secondly due to multicollinearity between similar variables.

Table 5.2 - Parameter Estimates and Full Implicit Prices

Amenity Variables	Yearly Rent Equation[a]	Hourly Wage Equation[b]	Full Implicit Prices(Yearly)[c]
CRIME	-.00008	.0002	-.324
	(.00035)	(.00008)**	
CCOAST	-.457	-.112	180.938
	(.185)***	(.040)***	
CDD	-.0008	.000012	-.163
	(.0002)***	(.000036)	
HDD	-.0008	.00002	-.325
	(.0001)***	(.00002)	
HUMID	-.0432	-.0016	2.224
	(.0178)***	(.0039)	
LAKE	.205	-.007	11.542
	(.046)***	(.009)	
PRECIP	-.091	-.0039	6.387
	(.012)***	(.0026)*	
SITE	.104	-.002	3.343
	(.020)***	(.004)	
SUN	-.006	-.013	21.049
	(.019)	(.004)***	
TEACH	7.274	-1.605	2810.804
	(5.34)*	(1.165)*	
TSP	-.015	-.001	1.605
	(.005)***	(.001)	
VIS	-.023	.0006	-1.319
	(.007)***	(.0015)***	
WIND	.677	-.029	47.645
	(.067)***	(.015)**	
UNEMP	-.316	-.002	2.113
	(.049)***	(.011)	

Note: Standard errors are shown in parentheses. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

[a]Control variables which are included in the rent equation, but which are not reported include: WAGE, DUPLEX, ROOMS, ELECTR, HEAT, RENTER, AND FURN.

[b]Control variables which are included in the wage equation, but which are not reported include: RENT, AGE, SEX, MARRIED, EXP, EDU, UNION, PROF, TECH, CRAFT, and OPER.

[c]The full implicit prices is the sum of the annual rent and wage differentials. To obtain an annual full implicit prices, the wage coefficient are multiplied by (37.85)(42.79), the product of hours per week and weeks per year.

1.3 Derivation of Wage and Rent Premiums

On the contrary to the OLS estimation used in deriving QOLI, each premium is estimated by using HLM or two-level model. A two-level model consists of two sub-models at level 1 and level 2. Since hedonic wage and rent equations consists on data on person and housing characteristics within counties, the level-1 model would represent the relationships among the person-level and housing-level variables and the level-2 model would capture the influence of county-level factors.

The estimates of the level-1 coefficients for each county unit j are obtained from empirical Bayes estimation in which posterior distribution is generated by using prior distribution and likelihood function. The estimates of level-1 variables is called as an empirical Bayes or shrinkage estimates in the sense that variance and covariance are shrunk toward a predicted value rather than the grand value.

Substitution of the level-2 equations for level-1 estimators into their corresponding level-1 term yields a single combined equation linear model with a complex error structure. Because of the unbalanced nature of the data which varies across the J county units, maximum-likelihood estimates for variance and covariance is used through iterative computing technique such as the EM algorithm[6].

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[6] Because EM algorithm involves an iterative simulation of the full posterior distribution, it is computationally very intensive, particularly with large data and complex models.

1.3.1 Wage Premium

According to equations (5), (7), and (8) in the chapter 4, the combined wage equation is,

$$
\begin{aligned}
W_{ij} = {} & \gamma^{w'}_{00} + \gamma^{w'}_{01} CRIME_j + \gamma^{w'}_{02} CCOAST_j + \gamma^{w'}_{03} CDD_j + \gamma^{w'}_{04} HDD_j + \gamma^{w'}_{05} HUMID_j \\
& + \gamma^{w'}_{06} LAKE_j + \gamma^{w'}_{07} PRECIP_j + \gamma^{w'}_{08} SITE_j + \gamma^{w'}_{09} SUN_j + \gamma^{w'}_{010} TEACH_j \\
& + \gamma^{w'}_{011} TSP_j + \gamma^{w'}_{012} VIS_j + \gamma^{w'}_{013} WIND_j + \gamma^{w'}_{014} UNEMP_j + \gamma^{w'}_{10} RENT_{ij} + \gamma^{w'}_{10} AGE_{ij} \\
& + \gamma^{w'}_{10} SEX_{ij} + \gamma^{w'}_{10} MARRIED_{ij} + \gamma^{w'}_{10} EXP_{ij} + \gamma^{w'}_{10} EDU_{ij} + \gamma^{w'}_{10} UNION_{ij} \\
& + \gamma^{w'}_{10} PROF_{ij} + \gamma^{w'}_{10} TECH_{ij} + \gamma^{w'}_{10} CRAFT_{ij} + \gamma^{w'}_{10} OPER_{ij} X_{ij} + u^{w'}_{ij} + v^{w'}_{0j}
\end{aligned} \tag{2}
$$

,where $v^{w'}_{0j}$ is empirical Bayes residual (EBWAGE).

The results of the above HLM estimation are reported in table 5.3 together with the results of OLS estimation without transformation from the previous section.

The value of R^2 for OLS estimation is .361 but the R^2 for HLM estimation is not available. The average shrinkage coefficient[7] in HLM is .242. The value of .242 means that the group means of the intercept little vary across Level-2 units (holding constant the sample size per county group). As reported in table 5.3, the standard errors of amenity variables in HLM estimation have increased compared to those of amenities variables in OLS estimation. On the contrary to this result, the standard errors of variables of person characteristics have decreased compared to the results in OLS estimation.

---

[7] The definition of shrinkage coefficient is in the appendix. Bryk and Raudenbush (1992) point out that the shrinkage estimators or empirical Bayes estimators are very sensitive to the model specification.

Table 5.3-Paramenter Estimates of Wage Equation

Variables	OLS Estimation	HLM Estimation
Intercept	10.686	11.898
	(6.589)**	(8.119)*
CRIME	.148E-02	.142E-02
	(.915E-03)*	(.115E-02)*
CCOAST	-.883	-.962
	(.479)**	(.638)*
CDD	.225E-03	.487E-03
	(.430E-03)	(.556E-03)
HDD	.256E-03	.303E-03
	(.189E-03)*	(.235E-03)*
HUMID	-.014	-.002
	(.047)	(.060)
LAKE	-.064	-.091
	(.119)	(.149)
PRECIP	-.020	-.031
	(.301)	(.038)
SITE	-.023	-.035
	(.052)	(.066)
SUN	-.143	-.163
	(.049)***	(.060)***
TEACH	-18.564	-16.879
	(13.902)*	(17.216)
TSP	-.898E-02	-.119E-01
	(.012)	(.140E-01)
VIS	.026	.027
	(.018)*	(.023)
WIND	-.423	-.486
	(.175)***	(.213)***
UNEMP	.085	.057
	(.129)	(.159)
RENT	.618E-03	.625E-03
	(.305E-04)***	(.310-E-04)***
AGE	.056	.057
	(.028)**	(.028)**
SEX	2.282	2.219
	(.559)***	(.555)***
MARRIED	-.627	-.669
	(.489)*	(.488)*

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test.

Table 5.3-Parameter Estimates of Wage Equation-continued

Variables	OLS Estimation	HLM Estimation
EXP	.040	.040
	(.027)*	(.027)*
EDU	1.028	1.036
	(.129)***	(.129)***
UNION	2.689	2.750
	(.445)***	(.445)***
PROF	2.390	2.321
	(.653)***	(.650)***
TECH	.770	.686
	(.642)	(.639)
CRAFT	1.434	1.442
	(.498)***	(.495)***
OPER	.243	.254
	(.564)	(.562)
Adjusted R^2	.361	

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test.

1.3.2 Rent Premium

According to equations (6), (10), and (11) in the chapter 4, the combined wage equation is,

$$
\begin{aligned}
R_{ij} = {} & \gamma_{00}^{r} + \gamma_{01}^{r} CRIME_j + \gamma_{02}^{r} CCOAST_j + \gamma_{03}^{r} CDD_j + \gamma_{04}^{r} HDD_j + \gamma_{05}^{r} HUMID_j \\
& + \gamma_{06}^{r} LAKE_j + \gamma_{07}^{r} PRECIP_j + \gamma_{08}^{r} SITE_j + \gamma_{09}^{r} SUN_j + \gamma_{010}^{r} TEACH_j \\
(3) \qquad & + \gamma_{011}^{r} TSP_j + \gamma_{012}^{r} VIS_j + \gamma_{013}^{r} WIND_j + \gamma_{014}^{r} UNEMP_j + \gamma_{10}^{r} WAGE_{ij} + \gamma_{10}^{r} DUPLEX_{ij} \\
& + \gamma_{10}^{r} ROOMS_{ij} + \gamma_{10}^{r} ELECTR_{ij} + \gamma_{10}^{r} HEAT_{ij} + \gamma_{10}^{r} RENTER_{ij} + \gamma_{10}^{r} FURN_{ij} \\
& + u_{ij}^{r} + v_{0j}^{r}
\end{aligned}
$$

, where v_{0j}^{r} will be expressed as empirical Bayes residual (EBRENT).

The results of the above HLM estimation are shown in table 5.4 together with the results of OLS estimation for comparison.

The average shrinkage coefficient in HLM is .656. The value of .656 means that the group means of the intercept vary substantially across Level-2 units (holding constant the sample size per county group). As reported in table 5.4, the standard errors of amenity variables in HLM estimation have increased compared to those of amenities variables in OLS estimation. On the contrary to this result, the standard errors of variables of housing characteristics have decreased compared to the results in OLS estimation.

Table 5.4-Parameter Estimates of Rent Equation

Variables	OLS Estimation	HLM Estimation
Intercept	-449.132	8742.283
	(4131.85)	(8203.439)
CRIME	-.477	-.191
	(.568)	(1.227)
CCOAST	-101.14	453.424
	(300.405)	(688.828)
CDD	-1.175	-2.009
	(.271)***	(.578)***
HDD	-1.057	-1.109
	(.117)***	(.244)***
HUMID	-69.561	-172.335
	(28.946)***	(62.304)***
LAKE	222.731	209.324
	(74.479)***	(155.885)*
PRECIP	-64.852	-37.327
	(18.931)***	(38.324)
SITE	209.478	249.244
	(31.999)***	(70.237)***
SUN	63.927	76.803
	(30.607)**	(58.788)*
TEACH	14269.6	16809.884
	(8673.01)**	(17375.915)
TSP	-16.343	-20.647
	(7.362)***	(14.843)*
VIS	-41.376	-67.190
	(11.208)***	(24.636)***
WIND	1136.07	855.573
	(109.482)***	(214.062)***
UNEMP	-460.113	-355.591
	(79.918)***	(161.268)**
WAGE	239.460	218.928
	(12.345)***	(11.740)***
DUPLEX	-503.193	-705.285
	(420.519)*	(398.656)**
ROOMS	1195.36	1186.34
	(67.067)***	(63.690)***
ELECTR	413.814	546.409
	(274.348)*	(267.835)**
HEAT	11.900	446.080
	(430.824)	(410.487)
RENTER	-1496.07	-1972.005
	(461.229)***	(441.605)***
FURN	-165.187	310.813
	(605.624)	(570.875)
Adjusted R^2	.536	

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

EBWAGE is described as empirical Bayes residuals for the wage equation and represents the wage premium. EBWAGE is generated from the equation (2) in this Chapter. EBRENT is described as empirical Bayes residuals for the rent equation and represents the rent premium. EBRENT is generated from the equation (3) in this Chapter. NET is described as the net premium. According to the equation (10) in Chapter 3, NET is equal to wage premium plus rent premium. The index of Net Premium (NETI) is defined as the data series of NET and is used as the equivalent norm of QOLI. The generated variables, their description, and mean values are reported in table 5.5.

Table 5.5- Generated Variables and Data

Variables	Description	Mean
OLRENT	Least squares residuals for rent equation, rent premium	-71.471
OLWAGE	Least squares residuals for wage equation, wage premium	420.484
EBRENT	Empirical Bayes residual for rent equation, rent premium	-6.219
EBWAGE	Empirical Bayes residual for wage equation, wage premium	1.466
NETI	Index of Net premium	-7.684
QOLI	Index of quality of life	1379.049

Note: The variables, OLRENT, OLWAGE, EBRENT, EBWAGE, NET, and QOLI are reported on an yearly base.

2. COMPARISON OF QUALITY OF LIFE AND NET PREMIUM

QOLI contains a variation in a set of amenities used as independent variables in the wage and rent equations. On the other hand, NETI contains variations in a set of amenities omitted in the wage and rent equations. The omitted part of a set of amenities contains the information of an amenity shock which shows unexpected change in the endowment of amenities at the specific location. In this sense, both indexes are expected to have a different ranking order.

Before estimating migration equation using both variables in the following section, the ranking of both indexes in 123 urban counties will be reported in table 5.6. Both indexes are reported on an annual base for comparison and they are indexed with 1986 dollars.

Table 5.6- Ranking of Quality of Life and Net Premium sorted by QOLI

	NETI	QOLI	Rank by QOLI	Rank by NETI
Los Angeles, CA	2387.61965	1931.781	1	22
Ventura, CA	4013.08816	1775.1649	2	11
Orange, CA	3768.8195	1734.1824	3	12
Charleston, SC	-4759.6812	1642.2553	4	121
San Diego, CA	2980.93072	1601.5173	5	17
San Bernardino,	630.026955	1571.6925	6	40
Santa Cruz, CA	1898.72374	1492.1427	7	24
Orleans, LA	-1929.086	1459.9766	8	94
Monterey, CA	1198.05962	1422.7872	9	28
San Mateo, CA	4154.70235	1407.732	10	10
Alameda, CA	366.27177	1322.584	11	47
San Francisco, C	5987.77484	1321.2244	12	5
Santa Clara, CA	4210.44811	1308.2532	13	9
Maricopa, AZ	384.116945	1306.561	14	46
Sacramento, CA	477.708608	1268.9488	15	44
Pima, AZ	-1840.5283	1267.3698	16	92
Ector, TX	2970.41876	1255.8095	17	18
Fresno, CA	440.739607	1244.4336	18	45
East Baton Rouge, LA	-568.43066	1196.4359	19	69
Yolo, CA	-236.07836	1186.847	20	59
Norfolk, VA	-2339.1645	1184.5717	21	101
Harris, TX	-2668.7795	1175.2308	22	105
Contra Costa, CA	-607.21696	1173.1829	23	70
Lexington, SC	-3251.689	1170.9561	24	112
Taylor, TX	-2571.6955	1167.7479	25	103
Stanislaus, CA	-1134.3827	1129.7346	26	82
Richland, SC	-1584.661	1070.3557	27	88
Kern, CA	3542.42164	1068.1501	28	14
Travis, TX	188.427032	1028.0279	29	51
Bexar, TX	483.031574	1015.7822	30	43
Shelby, TN	-1437.5151	1014.4137	31	87
Clayton, GA	1016.28566	1010.9617	32	29
Tarrant, TX	724.490223	993.28423	33	37
Dallas, TX	-1681.4309	993.00815	34	91
Clark, NV	-3087.4786	968.42071	35	110
Greenville, SC	-2192.6166	964.50308	36	99
Brazoria, TX	1976.74286	951.14447	37	23
Wake, NC	-648.82196	938.46416	38	71
Cumberland, NC	-1645.7582	867.16016	39	90
Guilford, NC	-996.48039	835.3765	40	78
Knox, TN	-1616.83	819.90923	41	89
Nassau, NY	11923.4553	732.9198	42	1

Table 5.6- Ranking of Quality of Life and Net Premium sorted by QOLI-Continued

COUNTY	NETI	QOLI	Rank by QOLI	Rank by NETI
Knox, TN	-1616.83	819.90923	41	89
Nassau, NY	11923.4553	732.9198	42	1
Chesterfield, VA	-1084.8103	702.38473	43	79
Cumberland, NJ	254.21545	697.23503	44	50
Jefferson, AL	897.878915	690.5243	45	33
Westchester, NY	-416.06724	680.27629	46	66
Rockland, NY	3599.73343	670.65906	47	13
Suffolk, NY	3122.3478	670.28161	48	16
Bergen, NJ	7795.67347	629.07074	49	3
Lane, OR	-864.92948	619.62261	50	73
Washington, DC	1653.50312	618.87889	51	25
Davidson, TN	-2930.6331	615.86249	52	109
Middlesex, NJ	652.873013	579.64956	53	39
Delaware, PA	-2843.0912	547.87953	54	108
Anne Arundel, MD	-334.15709	542.98896	55	63
St. Charles, MO	-4055.7225	508.62007	56	119
Burlington, NJ	133.184915	506.57295	57	53
St. Louis, MO	-90.573731	503.53902	58	58
Hudson, NJ	-80.180385	491.79155	59	57
Passaic, NJ	5238.38902	480.42317	60	7
Union, NJ	6583.63284	471.66197	61	4
Clackamas, OR	-897.69611	450.39641	62	75
Washington, OR	167.642692	436.34491	63	52
Mercer, NJ	952.285695	423.30905	64	30
Baltimore city,	-847.08374	422.67431	65	72
Camden, NJ	-403.67277	419.304	66	65
Montgomery, MD	-1297.5907	418.48236	67	86
Montgomery, PA	8725.22122	408.49268	68	2
Philadelphia, PA	-990.68827	392.04551	69	77
Butler, OH	913.095892	386.57781	70	32
Lancaster, PA	273.147153	381.63566	71	49
Essex, NJ	5521.22413	371.14152	72	6
Lackawanna, PA	-1914.9044	366.53188	73	93
Luzerne, PA	-3215.9773	345.4843	74	111
Hamilton, OH	2559.73906	337.69181	75	20
Wyandotte, KS	86.3294554	321.33293	76	55
Snohomish, WA	543.276417	316.94871	77	42
Richmond, VA	130.110641	312.46078	78	54
King, WA	1211.26246	308.46348	79	27
Prince George's,	-1278.7668	301.62182	80	85
Cuyahoga, OH	-989.81797	295.72502	81	76
Arapahoe, CO	-3713.2006	294.94048	82	117
Lycoming, PA	-1115.5363	263.0133	83	80
Montgomery, OH	-887.41508	255.2838	84	74
Richland, OH	-1194.2573	235.32085	85	83
Greene, OH	-440.8735	232.65809	86	67

Table 5.6- Ranking of Quality of Life and Net Premium sorted by QOLI-Continued

COUNTY	NETI	QOLI	Rank by QOLI	Rank by NETI
Washoe, NV	-307.05026	232.31016	87	61
Marion, IN	815.420402	211.66456	88	35
Westmoreland, PA	878.921844	205.2056	89	34
Boulder, CO	-1125.2894	201.90932	90	81
Erie, NY	-3313.973	191.90537	91	115
Weld, CO	-2693.0896	179.89094	92	106
Denver, CO	-361.36879	176.04927	93	64
St. Louis city,	4711.64697	171.98208	94	8
Adams, CO	734.416526	170.56328	95	36
Lake, IL	29.0359624	164.96498	96	56
Allegheny, PA	2945.53306	160.85603	97	19
Lucas, OH	-2319.5382	150.38067	98	100
Jefferson, CO	-261.61535	135.24015	99	60
Porter, IN	-3292.3724	132.85253	100	114
Oakland, MI	-1952.1976	58.57195	101	95
Du Page, IL	927.887757	50.67833	102	31
Wayne, MI	-4078.5494	46.16519	103	120
Monroe, NY	-2160.4894	34.00946	104	98
Cook, IL	2519.01547	30.2699	105	21
Salt Lake, UT	-3437.7621	23.18864	106	116
Rock Island, IL	-2648.5117	19.0056	107	104
Elkhart, IN	-1219.6669	6.51491	108	84
Stark, OH	3267.39647	-2.98857	109	15
Douglas, NE	-2100.9758	-23.03314	110	97
Macomb, MI	-5131.7175	-27.85426	111	122
Franklin, OH	1305.64555	-46.89267	112	26
St. Joseph, IN	-331.92036	-72.50948	113	62
Onondaga, NY	321.438351	-116.2874	114	48
Milwaukee, WI	-2799.2318	-129.0554	115	107
Scott, IA	694.825744	-189.9298	116	38
Black Hawk, IA	-3268.9545	-230.393	117	113
Saginaw, MI	543.330597	-237.1358	118	41
Minnehaha, SD	-3968.0784	-268.4486	119	118
Genesee, MI	-6986.8708	-281.3078	120	123
Ramsey, MN	-2418.9466	-546.9624	121	102
Washington, MN	-1953.2368	-577.4755	122	96
Hennepin, MN	-561.39877	-584.7109	123	68

Table 5.7- Ranking of Quality of Life and Net Premium sorted by NETI

COUNTY	NETI	QOLI	Rank by NETI	Rank by QOLI
Nassau, NY	11923.4553	732.9198	1	42
Montgomery, PA	8725.22122	408.49268	2	68
Bergen, NJ	7795.67347	629.07074	3	49
Union, NJ	6583.63284	471.66197	4	61
San Francisco, C	5987.77484	1321.2244	5	12
Essex, NJ	5521.22413	371.14152	6	72
Passaic, NJ	5238.38902	480.42317	7	60
St. Louis city,	4711.64697	171.98208	8	94
Santa Clara, CA	4210.44811	1308.2532	9	13
San Mateo, CA	4154.70235	1407.732	10	10
Ventura, CA	4013.08816	1775.1649	11	2
Orange, CA	3768.8195	1734.1824	12	3
Rockland, NY	3599.73343	670.65906	13	47
Kern, CA	3542.42164	1068.1501	14	28
Stark, OH	3267.39647	-2.98857	15	109
Suffolk, NY	3122.3478	670.28161	16	48
San Diego, CA	2980.93072	1601.5173	17	5
Ector, TX	2970.41876	1255.8095	18	17
Allegheny, PA	2945.53306	160.85603	19	97
Hamilton, OH	2559.73906	337.69181	20	75
Cook, IL	2519.01547	30.2699	21	105
Los Angeles, CA	2387.61965	1931.781	22	1
Brazoria, TX	1976.74286	951.14447	23	37
Santa Cruz, CA	1898.72374	1492.1427	24	7
Washington, DC	1653.50312	618.87889	25	51
Franklin, OH	1305.64555	-46.89267	26	112
King, WA	1211.26246	308.46348	27	79
Monterey, CA	1198.05962	1422.7872	28	9
Clayton, GA	1016.28566	1010.9617	29	32
Mercer, NJ	952.285695	423.30905	30	64
Du Page, IL	927.887757	50.67833	31	102
Butler, OH	913.095892	386.57781	32	70
Jefferson, AL	897.878915	690.5243	33	45
Westmoreland, PA	878.921844	205.2056	34	89
Marion, IN	815.420402	211.66456	35	88
Adams, CO	734.416526	170.56328	36	95
Tarrant, TX	724.490223	993.28423	37	33
Scott, IA	694.825744	-189.9298	38	116
Middlesex, NJ	652.873013	579.64956	39	53
San Bernardino,	630.026955	1571.6925	40	6
Saginaw, MI	543.330597	-237.1358	41	118
Snohomish, WA	543.276417	316.94871	42	77
Bexar, TX	483.031574	1015.7822	43	30

Table 5.7- Ranking of Quality of Life and Net Premium sorted by NETI-Continued

COUNTY	NETI	QOLI	Rank by NETI	Rank by QOLI
Sacramento, CA	477.708608	1268.9488	44	15
Fresno, CA	440.739607	1244.4336	45	18
Maricopa, AZ	384.116945	1306.561	46	14
Alameda, CA	366.27177	1322.584	47	11
Onondaga, NY	321.438351	-116.2874	48	114
Lancaster, PA	273.147153	381.63566	49	71
Cumberland, NJ	254.21545	697.23503	50	44
Travis, TX	188.427032	1028.0279	51	29
Washington, OR	167.642692	436.34491	52	63
Burlington, NJ	133.184915	506.57295	53	57
Richmond, VA	130.110641	312.46078	54	78
Wyandotte, KS	86.3294554	321.33293	55	76
Lake, IL	29.0359624	164.96498	56	96
Hudson, NJ	-80.180385	491.79155	57	59
St. Louis, MO	-90.573731	503.53902	58	58
Yolo, CA	-236.07836	1186.847	59	20
Jefferson, CO	-261.61535	135.24015	60	99
Washoe, NV	-307.05026	232.31016	61	87
St. Joseph, IN	-331.92036	-72.50948	62	113
Anne Arundel, MD	-334.15709	542.98896	63	55
Denver, CO	-361.36879	176.04927	64	93
Camden, NJ	-403.67277	419.304	65	66
Westchester, NY	-416.06724	680.27629	66	46
Greene, OH	-440.8735	232.65809	67	86
Hennepin, MN	-561.39877	-584.7109	68	123
East Baton Rouge, LA	-568.43066	1196.4359	69	19
Contra Costa, CA	-607.21696	1173.1829	70	23
Wake, NC	-648.82196	938.46416	71	38
Baltimore city,	-847.08374	422.67431	72	65
Lane, OR	-864.92948	619.62261	73	50
Montgomery, OH	-887.41508	255.2838	74	84
Clackamas, OR	-897.69611	450.39641	75	62
Cuyahoga, OH	-989.81797	295.72502	76	81
Philadelphia, PA	-990.68827	392.04551	77	69
Guilford, NC	-996.48039	835.3765	78	40
Chesterfield, VA	-1084.8103	702.38473	79	43
Lycoming, PA	-1115.5363	263.0133	80	83
Boulder, CO	-1125.2894	201.90932	81	90
Stanislaus, CA	-1134.3827	1129.7346	82	26
Richland, OH	-1194.2573	235.32085	83	85
Elkhart, IN	-1219.6669	6.51491	84	108

Table 5.7- Ranking of Quality of Life and Net Premium sorted by NETI-Continued

COUNTY	NETI	QOLI	Rank by NETI	Rank by QOLI
Prince George's,	-1278.7668	301.62182	85	80
Montgomery, MD	-1297.5907	418.48236	86	67
Shelby, TN	-1437.5151	1014.4137	87	31
Richland, SC	-1584.661	1070.3557	88	27
Knox, TN	-1616.83	819.90923	89	41
Cumberland, NC	-1645.7582	867.16016	90	39
Dallas, TX	-1681.4309	993.00815	91	34
Pima, AZ	-1840.5283	1267.3698	92	16
Lackawanna, PA	-1914.9044	366.53188	93	73
Orleans, LA	-1929.086	1459.9766	94	8
Oakland, MI	-1952.1976	58.57195	95	101
Washington, MN	-1953.2368	-577.4755	96	122
Douglas, NE	-2100.9758	-23.03314	97	110
Monroe, NY	-2160.4894	34.00946	98	104
Greenville, SC	-2192.6166	964.50308	99	36
Lucas, OH	-2319.5382	150.38067	100	98
Norfolk, VA	-2339.1645	1184.5717	101	21
Ramsey, MN	-2418.9466	-546.9624	102	121
Taylor, TX	-2571.6955	1167.7479	103	25
Rock Island, IL	-2648.5117	19.0056	104	107
Harris, TX	-2668.7795	1175.2308	105	22
Weld, CO	-2693.0896	179.89094	106	92
Milwaukee, WI	-2799.2318	-129.0554	107	115
Delaware, PA	-2843.0912	547.87953	108	54
Davidson, TN	-2930.6331	615.86249	109	52
Clark, NV	-3087.4786	968.42071	110	35
Luzerne, PA	-3215.9773	345.4843	111	74
Lexington, SC	-3251.689	1170.9561	112	24
Black Hawk, IA	-3268.9545	-230.393	113	117
Porter, IN	-3292.3724	132.85253	114	100
Erie, NY	-3313.973	191.90537	115	91
Salt Lake, UT	-3437.7621	23.18864	116	106
Arapahoe, CO	-3713.2006	294.94048	117	82
Minnehaha, SD	-3968.0784	-268.4486	118	119
St. Charles, MO	-4055.7225	508.62007	119	56
Wayne, MI	-4078.5494	46.16519	120	103
Charleston, SC	-4759.6812	1642.2553	121	4
Macomb, MI	-5131.7175	-27.85426	122	111
Genesee, MI	-6986.8708	-281.3078	123	120

The results of ranking of QOLI in this study are different from the results of Blomquist et al. (1988) using a different data year and data set. PSID data of this study are obtained from the controlled sampling as longitudinal survey data. On the other hand, Blomquist et al.'s data were obtained through the random sampling procedures. The coefficient of correlation between QOLI of this study and QOLI of Blomquist et al. is .29. The value of correlation coefficient indicates there are some degree of relationship between two indexes. The difference between two indexes mainly come from different sampling procedures and different sizes of coefficients between two studies. In my study, some variables such TSP, SITE, WIND, UNEMP have an unexpected sign. Compared to Blomquist et al.'s study, CRIME and TEACH have relative low values in their full implicit prices. For example, even though the values of full implicit price of teach-pupil ratio (TEACH) in both studies are highest among full implicit prices of other variables, the values of TEACH relative to CCOAST are 15 in this study and 45 in the Blomquist et al.'s study.

In QOLI, the top-ranked county is Los Angeles, California and the bottom-ranked county is Hennepin, Minnesota. It is interesting that among top 15 ranked counties, ten counties are in California state. The reason is that average amount of full implicit prices[8] of HDD and SUN are -1444.26

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[8] The average amount of full implicit price is the product of average value of amenity variable and full implicit price of amenity variable.

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and 1274.73 respectively. In other words, sun-belt areas have a high value of QOLI.

In NETI, the top-ranked county is Nassau, New Jersey and the bottom-ranked county is Genesee, Michigan in NETI. As expected, QOLI and NETI have quite a different ranking order. The coefficient of correlation between two variables is .31. Since both indexes are not much correlated each other, both indexes can be used as separate independent variables in the migration model.

3. ESTIMATION OF THE MIGRATION MODEL

The migration model in this study will try to find an unknown determinant of the willingness to move or stay across urban counties. The first hypothesis shows the role of the index of quality of life in the actual migration and the second hypothesis suggests the role of net premium as a pull factor in the future migration.

In testing two hypotheses, the first hypothesis is related to the statistical importance of the QOL in migration and the second is related to the statistical importance of the wage, rent, and net premiums in migration. QOL was derived in the section one in chapter five and wage, rent, and net premiums were derived in chapter 4. The estimation of migration equations will be followed accord in the next section.

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3. ESTIMATION OF THE MIGRATION MODEL

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3.1 Estimation for the First Hypothesis

The first hypothesis presupposes the incomplete compensation of amenities through wage and rent due to the unexpected changing demand for the amenities. This presupposition implies that QOLI will directly affect the migration behavior. Migration equations are estimated with the use of two kinds of dependent variables, IM and OM. IM represents the actual in-migration for the head of the household. OM represents the expected out-migration or the willingness to move. It is noteworthy that two kinds of dependent variables need to be distinguished between a household's desire to move out (OM) and the actual act of in-migration (IM). Before deciding on actual movement of a household, there must be sufficient incentive to move; usually this incentive results from a feeling of stress or dissatisfaction. If a household's current state is judged to be satisfactory, no action is taken. If a household is unsatisfactory, it searches for change and concludes the search when and if an acceptable alternative place is found. Therefore, there is a significant gap between willingness to move and actual movement.

In the migration equation for testing the first hypothesis, the most important independent variable in this study is QOLI. The criterion of choice for other independent variables was what are possible variables among available personal variables to measure the mobility. For that reason,

RENTER, EDU, SEX, and MARRIED are chosen as explanatory variables for the in-migration equation.

Since dependent variables are dichotomous with two alternatives, a logit model was used. The results of the testing of the first hypothesis will be reported in table 5.8.

As reported in table 5.8, the R^2 for the IM and OM equations are .165 and .137 respectively. The independent variables, RENTER, EDU, and SEX increase the probability of moving and MARRIED decreases the probability of moving as expected. Table 5.8 also shows that all independent variables except QOLI in the out-migration equation are statistically significant.

Property ownership provides a key to geographical mobility. Empirical result shows that home owners stayed put and renters moved. Renters have much higher mobility than home owners. More educated people moved more frequently than less educated people. The result also shows that there is higher persistence among the married and greater transiency among the unmarried.

The coefficient of the index of quality of life is positive and significant in the in-migration equation while it is negative and insignificant in out-migration to represent the willingness of moving in the future. The first hypothesis expected that QOLI is positively related to the in-migration. Actual movers considered QOLI as significant determinant in deciding the preferred location to live. Thus this result refutes the null hypothesis of the first hypothesis and are in favor of the alternative hypothesis of that amenity

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variations are important in the actual migration decisions. QOLI takes the systematic portion of in-migration. By contrast, QOLI is not significant in the out-migration model to explain the households' willingness to move. This result supports the first hypothesis which stresses on the role of the systematic portion of the amenity variation in the actual migration decision.

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Property ownership provides a key to a perception of mobility. Empirical result shows that home owners stayed put and renters moved. Renters have much higher mobility than home owners. More educated people moved more frequently than less educated people. The result also shows that there is higher persistence among the married and greater transiency among the unmarried.

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Table 5.8- Testing the First Hypothesis

Variables	Dependent Variables IM (In-Migration)	OM (Outmigration)
Intercept	-2.656	-3.601
	(.249)***	(.287)***
RENTER	1.860	2.053
	(.129)***	(.149)***
EDU	.0776	.130
	(.035)***	(.039)***
SEX	.486	.721
	(.158)***	(.172)***
MARRIED	-.527	-.184
	(-.150)***	(.159)***
QOLI	.164E-03	-.172E-03
	(.869E-04)**	(.961E-04)
NUMBER OF CASES	2024	2024
LIKELIHOOD FUNCTION	-985.21	-860.95
R-SQUARED	.165	.137

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

3.2 Estimation for the Second Hypothesis

The second hypothesis states the theoretical importance of the wage, rent, and net premiums in migration. Before testing the effect of net premium on the migration, the effect of the wage premium and rent premium on the migration variables will be reported in table 5.9.

IM is "moved since spring 1986." That means IM represents the actual in-migration. From following table 5.9, we can see that WAGEPREMIUM is positively related to IM and the coefficient of the WAGEPREMIUM is statistically significant at a 5% level in explaining the in-migration. We can also see that RENTPREMIUM is positively related to OM with a wrong sign, but its coefficient is not statistically significant.

The wage premium is the unsystematic portion of wage variations which do not apply the discounted compensation due to the existence of a regional shock. As demonstrated in section 2 of chapter 3 through a graphical explanation, the wage premium with a positive value gives households unexpected benefit and provides them the incentive to stay. The positive sign of the coefficient of WAGEPREMIUM in in-migration means that wage premium with a positive value is a pull factor of migration. And the statistical importance of WAGEPREMIUN in in-migration means that the wage premium due to the regional shock is an important factor to explain the in-migration. This result supports the second hypothesis which stresses

5.2 Estimation for the Second Hypothesis

The second hypothesis states the theoretical importance of the wage, rent, and net premiums in migration. Before testing the effect of net premium on the migration, the effect of the wage premium and rent premium on the migration variables will be reported in table 5.3.

IM is "moved since spring 1986". That means IM represents the actual in-migration. From following table 5.3 we can see that WAGEPREMIUM is positively related to IM and the coefficient of the WAGEPREMIUM is statistically significant at a 5% level in explaining the in-migration. We can also see that RENTPREMIUM is positively related to IM with [illegible], but its coefficient is not statistically significant.

The wage premium is the unexpected portion of wage variations which do not apply the determined compensation due to the existence of a regional shock. As demonstrated in section 2 of chapter 3 through a graphical explanation, the wage premium with a positive value gives households unexpected benefit and provides them the incentive to stay. The positive sign of the coefficient of WAGEPREMIUM in in-migration means that wage premium with a positive value is a pull factor of migration. And the statistical importance of WAGEPREMIUM in in-migration means that the wage premium due to the regional shock is an important factor to explain the in-migration. This result supports the second hypothesis which stresses on the role of regional shock, or the unsystematic portion of amenity variations in migration.

On the other hand, the RENTPREMIUM is not statistically significant in the in-migration equation. It means that the in-migration is affected by the wage variation, but is not affected by the rent variation. OM is related to the future moving possibility and is the indicator of the willingness to move. The coefficient of RENTPREMIUM in out-migration is statistically important at a 5% level as we see in table 5.9. The negativity of coefficients of RENTPREMIUM in out-migration means that the rent premium is a pull factor of migration which discourages the incentive to move out from the origin to the destination.

Since each premium affects the household's movement independently, we need to add both premiums to have a complete effect. Since the wage premium and rent premium are pull factors of migration, the net premium (NET) was calculated as conceptually derived in the equation (10) in chapter 3. However, since net premium is the sum of wage and rent premiums, we need to test the equality of their coefficients in order to add two variables in both migration equations.

The t statistic to the null hypothesis of equal coefficients is 1.334 in in-migration equation and .580 in out-migration. Therefore, we cannot reject the null hypothesis that the coefficients of wage premium and rent premium are equal. The net premium can be justified in adding wage premium and rent premium in both in-migration and out-migration equations.

The results for the index of net premium (NETI) on the migration variables will be followed in table 5.10.

Table 5.9- Parameter Estimates for Migration Model using Premiums

Variables	Dependent Variables IM (In-Migration)	 OM (Outmigration)
Intercept	-2.595	-3.775
	(.248) ***	(.288) ***
RENTER	1.870	2.036
	(.130) ***	(.148) ***
EDU	.080	.142
	(.036) ***	(.040) ***
SEX	.508	.715
	(.158) ***	(.172) ***
MARRIED	-.531	-.193
	(-.150) ***	(.159) *
WAGEPREMIUM	.113E-02	.417E-03
	(.711E-03) **	(.763E-03)
RENTPREMIUM	-.111E-04	-.706E-03
	(.301E-03)	(.339E-03) **
NUMBER OF CASES	2024	2024
LIKELIHOOD FUNCTION	-985.54	-860.32
R-SQUARED	.165	.139

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test.

Table 5.10- Parameter Estimates for Migration using Net Premium

Variables	Dependent Variables IM (In-Migration)	OM (Outmigration)
Intercept	-2.550	-3.728
	(.245) ***	(.285) ***
RENTER	1.872	2.038
	(.130) ***	(.148) ***
EDU	.074	.137
	(.036) **	(.039) ***
SEX	.497	.704
	(.158) ***	(.172) ***
MARRIED	-.527	-.190
	(-.150) ***	(.159)
NETI	.202E-04	-.371E-04
	(.193E-04)	(.216E-04) **
NUMBER OF CASES	2024	2024
LIKELIHOOD FUNCTION	-986.43	-861.1
R-SQUARED	.165	.138

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

The signs of the estimate for the net premium are compatible with the expectation which is hypothesized in the second hypothesis of the theoretical model. The existence of the positive net premium in the region induces the workers from other regions to move in. The areas with the positive net premium will flourish with the ample endowment of amenity which is not fully compensated into the wage and rent due to the unsystematic portion of amenity variations. On the other hand, the existence of the negative net premium will provide the workers at the present location with the willingness to find the better location. The households' movement between the better and worse locations and the wage and rent adjustment through compensation process will decrease the size of the net premium under the dynamic setting, which needs more study in the future.

The effect of net premium on the actual in-migration is not statistically significant, but the net premium in the future out-migration equation is significant at a significance level of 0.05 which is statistically acceptable. It is noteworthy that the estimate of quality of life in the actual in-migration was significant, but was not significant in the future out-migration.

From these empirical results, the second hypothesis about the net premium is refuted in the actual in-migration model, but is accepted in the future out-migration model. Just as in testing the first hypothesis, the second hypothesis is partially accepted. The comparison of testing the two hypotheses is reported in table 5.11.

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Table 5.11- Empirical Results on the Testing of Two Important Hypotheses

	In-Migration Model	Out-Migration Model
First Hypothesis on Importance of QOLI	Accepted	Not Accepted
Second Hypotheses on Importance of WAGEPREMIUM	Accepted	Not Accepted
Second Hypotheses on Importance of RENTPREMIUM	Not Accepted	Accepted
Second Hypotheses on Importance of NETI	Not Accepted	Accepted

From the above results, we can see that each hypothesis is partially accepted. The component of the amenity set can be divided into two parts, set of amenities and set of amenity shocks. The set of amenity contains the information of a systematic portion of amenity variation and the set of amenity shock contains the information of an unsystematic portion of amenity variation. While the systematic portion of amenity variation explains the actual in-migration, the unsystematic portion of amenity variation explains both in-migration and out-migration.

We have two kinds of choice from the above results in combining the both hypotheses. The first choice is the appropriate combination of WAGEPREMIUM, RENTPREMIUM, and QOLI in each migration equation. The results are presented in table 5.12. The second choice is the combination of QOLI and NETI. The positive low correlation between QOLI and NETI

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Second Hypotheses on Importance of NETI	Not Accepted	Accepted

From the above results, we can see that each hypothesis is partly accepted. The component of the amenity is mostly divided into two parts: set of amenities and set of amenity shocks. The set of amenity contains the information of a systematic portion of amenity variation and the set of amenity shock contains the information of an unsystematic portion of amenity variation. While the systematic portion of amenity variation explains the actual in-migration, the unsystematic portion of amenity variation explains both in-migration and out-migration.

We have two kinds of choice from the above results in combining the both hypotheses. The first choice is the appropriate combination of WAGEPREMIUM, RENTPREMIUM, and QOLI in each migration equation. The results are presented in table 5.12. The second choice is the combination of QOLI and NETI. The positive low correlation between QOLI and NETI makes it possible to regress the two variables as separate independent variables in the migration equations. The results are reported in table 5.13. This combined estimation also supports the above empirical findings that quality of life differences across counties significantly affect the actual decision to move and net premium differences across counties a significantly affects the willingness to move showing the future out-migration.

makes it possible to regress the two variables as separate independent variables in the migration equations. The results are reported in table 5.13. This combined estimation also supports the above empirical findings that quality of life differences across countries significantly affect the actual decision to move and net premium differences across countries significantly affects the willingness to move showing the [illegible] non-migration

Table 5.12-Parameter Estimates for Migration using QOL, Wage & Rent Premiums

Variables	Dependent Variables IM (In-Migration)	OM (Out-migration)
Intercept	-2.667	-3.689
	(.250) ***	(.292) ***
RENTER	1.860	2.053
	(.130) ***	(.149) ***
EDU	.078	.140
	(.035) ***	(.039) ***
SEX	.500	.717
	(.158) ***	(.172) ***
MARRIED	-.528	-.193
	(-.150) ***	(.159)*
QOLI	.143E-03	-.125E-03
	(.882E-04) **	(.100E-04)*
WAGEPREMIUM	.103E-04	
	(.203E-04)*	
RENTPREMIUM		-.524E-03
		(.333E-03) **
NUMBER OF CASES	2024	2024
LIKELIHOOD FUNCTION	-984.23	-859.69
R-SQUARED	.166	.140

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

Table 5.13 - Parameter Estimates for Migration using QOL and Net Premium

Variables	Dependent Variables IM (In-Migration)	OM (Out-migration)
Intercept	-2.637	-3.657
	(.252) ***	(.290) ***
RENTER	1.861	2.054
	(.130) ***	(.150) ***
EDU	.075	.136
	(.036) **	(.039) ***
SEX	.489	.713
	(.158) ***	(.172) ***
MARRIED	-.526	-.190
	(-.150) ***	(.159)
QOLI	.150E-03	-.133E-03
	(.911E-04) **	(.101E-03)
NETI	.103E-04	-.279E-04
	(.203E-04)	(.226E-04) *
NUMBER OF CASES	2024	2024
LIKELIHOOD FUNCTION	-985.09	-860.18
R-SQUARED	.166	.139

Standard errors are in parenthesis. Levels of significance are denoted by asterisks. *** means the estimate is significant at the α=0.01 level. ** means the estimate is significant at the α=0.05 level. * means the estimate is significant at the α=0.10. Based on the t distribution and one-tailed test

CHAPTER SIX: SUMMARY AND CONCLUSIONS

1. INTRODUCTION

The main objective of this study was to estimate the effect of regional shock or amenity shock on the migration behavior. The conceptual framework was a interregional equilibrium model, where error terms of wage and rent hedonic equations contain the information about the amenity shock, a unsystematic portion of amenity variations. The empirical framework was a hierarchical linear model, where location error was estimated by extracting only the location error from the error terms mixed with person and location errors in the hedonic wage and rent models. The wage, rent, and net premiums were estimated across urban counties in the sample.

2. IMPLICATIONS

When labor and rent markets work perfectly, wage and rent will be adjusted enough to compensate for the difference of amenity endowment and its variation. In the equilibrium framework of the interregional equilibrium model, amenity variation is related to migration due to the changing

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2. IMPLICATIONS

When labor and rent markets work perfectly, wage and rent will be adjusted enough to compensate for the difference of amenity endowment and its variation. In the equilibrium framework of the interregional equilibrium model, amenity variation is related to migration due to the changing

demand for amenities. However, this research assumes that future migration decision is related to the amenity shock due to the exogenous shock by technology shift or federal government's policies and due to the changing supply for amenities induced by the policy change or natural environmental change.

This study divides amenity variation into two groups, the systematic portion and the unsystematic portion of amenity variations. The error terms of wage and rent hedonic equations contain the unsystematic variation of amenities which is renamed as amenity shock in this study. The two-level model has been developed to measure the location error which contains the information about the unanticipated change of location-variable amenities. This two-level approach has been used as much fertile empirical ground for extraction of location variation from the general variation which contains person related variation and location related variation.

The empirical results support the importance of amenity differences as pull factor for the actual move in the migration behavior and the importance of wage premium and rent premium as the pull factor for the potential move. Thus, while systematic variation in amenity endowment significantly affects the decision to move, once a household has decided to move, amenity shock, which takes the unsystematic portion of amenity variations, becomes important in deciding the potential move in the future. This evidence will shed new light on the debate about the effects of amenity on migration by

CHAPTER SIX: SUMMARY AND CONCLUSIONS

1. INTRODUCTION

The main objective of the study was to estimate the effect of regional shock or amenity shock on the migration decision. The theoretical framework was a interregional equilibrium model where error terms of wage and rent hedonic equations contain the information about the amenity shock, a unsystematic portion of amenity variations. The empirical framework was a hierarchical linear model where location error was estimated by extracting only the location error from the error terms mixed with person and location errors in the hedonic wage and rent models. The wage, rent and net premiums were estimated across urban counties in the sample.

2. IMPLICATIONS

When labor and rent markets work perfectly, wage and rent will be adjusted enough to compensate for the difference of amenity endowment and its variation. In the equilibrium framework of the interregional equilibrium model, amenity variation is related to migration due to the changing

demand for amenities. However, this research assumes that future migration decision is related to the amenity shock due to the exogenous shock by technology shift or federal government's policies and due to the changing supply for amenities induced by the policy change or natural environmental change.

This study divides amenity variation into two groups, the systematic portion and the unsystematic portion of amenity variations. The error terms of wage and rent hedonic equations contain the unsystematic variation of amenities which is renamed as amenity shock in this study. The two-level model has been developed to measure the location error which contains the information about the unanticipated change of location-variable amenities. This two-level approach has been used as much fertile empirical ground for extraction of location variation from the general variation which contains person related variation and location related variation.

The empirical results support the importance of amenity differences as pull factor for the actual move in the migration behavior and the importance of wage premium and rent premium as the pull factor for the potential move. Thus, while systematic variation in amenity endowment significantly affects the decision to move, once a household has decided to move, amenity shock, which takes the unsystematic portion of amenity variations, becomes important in deciding the potential move in the future. This evidence will shed new light on the debate about the effects of amenity on migration by

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The results from the first hypothesis and the second hypothesis show that both systematic portion and unsystematic portion of amenity variation have an important role in explaining the migration behavior of households. This results also send us the implication of that environmental policies and others that protect and improve areas' amenities would induce the in-migration and thus regional development.

3. SHORTCOMINGS AND FUTURE RESEARCH

Hedonic wage and rent compensation functions in the equation (3) in chapter 3 and the following wage premium and rent premium are assumed that the same occupational group has an identical preference. However, as the level of utility, k, changes with tastes or skills, the hedonic prices of the amenities can change. Some workers within the same occupational group have greater desires to obtain urban goods and avoid urban bads and will be willing to accept lower wages to live in desirable cities. Other workers within the same occupational group will not have strong preferences for amenities and will not be willing to give up much in wages to locate in areas with greater urban goods and fewer urban bads.

Since the sample used to estimate the wage equation includes both workers with strong preferences for amenities and those with weak more specifically dividing amenity variation into systematic and unsystematic variations.

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Since the sample used to estimate the wage equation includes both workers with strong preferences for amenities and those with weak preferences, the estimated hedonic prices will be overestimates for those with weak preferences and underestimates for workers with strong preferences. The estimates can be thought of as average over the same occupational group with different tastes.

Another important assumption is that a worker is a representative of a household who analyzes the benefits and costs to make a decision to move across cities. Since human capital such as education and work experience would be cost, he thinks that the positive compensation should be realized. By virtue of the hedonic pricing approach, we can evaluate the locational attributes. The amenities such as available sunshine and moderate temperature would be negatively compensated by wage. Furthermore, the disamenites such as crime rate and pollution would be positively compensated. The limitation of this assumption is that the complete compensation seems to be impossible because hedonic wage and rent regressions are vulnerable to the model specification by the existence of omitted locational attributes.

This study also assumes that the error terms of wage and rent hedonic equations contain the information about unexpected variation of amenity endowment. This assumption excludes the existence of omitted locational attributes and measurement error, thus only considering the existence of stochastic error. It might be a strong assumption in deriving the conclusion from the explanation about migration behavior of households across urban areas.

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The households' movement between the better and worse locations and the wage and rent adjustment through compensation process will change the size of the net premium under the dynamic setting, which needs more study in the future.

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APPENDIX

DIFFERENCE BETWEEN OLS RESIDUAL AND EB RESIDUAL

APPENDIX

This appendix describes the difference between OLS residual and empirical Bayes Residual. The below procedures are drawn from Bryk and Raudenbush (1992, pp. 33-44).

Let's suppose that we have a simple ANOVA model. Level-1 model is

$$Y_{ij} = \beta_{0j} + r_{ij}$$

for Level-1 unit $i = 1,\ldots,n_j$ and Level-2 units $j = 1,\ldots,J$, where we assume

$$r_{ij} \sim N(0,\sigma^2).$$

Averaging across the n_j observations within county j yields a Level-1 model with the sample mean as the outcome

$$\bar{Y}_{.j} = \beta_{0j} + \bar{r}_{.j}$$

where

$$\bar{r}_{.j} = \sum_{i=1}^{n_j} r_{ij} / n_j .$$

Suppose that we are interested in using information about a Level-2 variable, W_j, to predict β_{0j}. The Level-2 model becomes

$$\beta_{0j} = \gamma_{00} + \gamma_{01} W_j + u_{0j}$$

where we assume $u_{0j} \sim N(0,\tau_{00})$.

This model suggests two alternative estimators of β_{0j}. First, we have the sample mean $\hat{\beta}_{0j} = \bar{Y}_{.j}$. Second, we have the OLS estimator of β_{0j} given W_j:

$$\hat{\beta}_{0j} = \hat{\gamma}_{00} + \hat{\gamma}_{01} W_j .$$

Bayes estimation optimally combine these two estimators in a composite estimator

$$\beta^{*}_{0j} = \lambda_j \bar{Y}_{.j} + (1-\lambda_j)(\hat{\gamma}_{00} + \hat{\gamma}_{01} W_j)$$

where

$$\lambda_j = V_j^{-1} / (V_j^{-1} + \tau_{00}^{-1}).$$

β^*_{0j} is called as an empirical Bayes or shrinkage estimator. Since the data is not balanced across counties and thus the sample sizes n_j are unequal, β^*_{0j} is shrunk with weighting scale depending on the size of λ_j. With unbalance nested data, Bayes estimator generates the most efficient estimator since it involves an iterative calculation of the posterior density.

Corresponding to the empirical Bayes estimator β^*_{0j} is the empirical Bayes residual, u^*_{0j}. This is an estimate of the deviation of β^*_{0j} from its predicted value based on the Level-2 model. The empirical Bayes residual is

$$u^*_{0j} = \beta^*_{0j} - \hat{\gamma}_{00} - \hat{\gamma}_{01} W_j .$$

It is useful to compare these to the OLS residual, $\hat{u}_{0j}$. The latter is an estimate of the deviation of the OLS estimator of β_{0j} from its predicted value based on the Level-2 model. In this instance,

$$\hat{u}_{0j} = \overline{Y}_{.j} - \hat{\gamma}_{00} - \hat{\gamma}_{01} W_j .$$

It can be shown easily that u^*_{0j} is a value of $\hat{u}_{0j}$ "shrunk" toward zero:

$$u^*_{0j} = \lambda_j \hat{u}_{0j} .$$

Thus, if the shrinkage coefficient λ_j is unity, no shrinkage occurs. In contrast, if $\lambda_j = 0$, shrinkage toward the predicted value is complete.