New Estimates on Climate Demand: Evidence from Location Choice

by

Michael Cragg, Columbia University
Matthew Kahn, Columbia University

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Michael Cragg and Matthew Kahn[1]
Department of Economics and SIPA
Columbia University

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Introduction

Pro-environment interest groups argue that the environment is highly valued by the general public. Business and development interests counter that the opportunity cost of achieving high levels of environmental quality is very high. Economists can contribute to this debate by cutting through the rhetoric and examining what people's behavior reveals about their actual demand. What people are willing to deny themselves in order to gain access to a better environment is a revealed choice measure of environmental preferences.

Measuring willingness to pay involves estimating a well-specified demand system for the environment. The "environment" is ambiguous. There are some features of the environment which are nonpurchased pure public goods (the climate) and other public goods which may be rivalrous or purchased (pollution, crime, schooling and infrastructure). This paper develops and applies a qualitative choice model for estimating the demand for pure public goods like climate. Our method uses migrants' state location choices to reveal their willingness to tradeoff private consumption for pure public goods. We present a discrete choice utility maximization framework that has embedded in it hedonic wage and rental regressions. These hedonic regressions identify the implicit prices people pay for amenities while estimates of the utility index provide measures of marginal utility from amenity increases. Thus, in one integrated framework we address two key questions in environmental economics: how much do people pay for non-market environmental goods? and how much would they be willing to pay?

Migration data offers a revealed preference methodology to quantify the income/amenities tradeoff. Migrants are attractive because they are "small" and take equilibrium prices as exogenous when choosing their utility maximizing state. We model each state as representing a bundle of human capital factor prices, land and housing attribute prices, and a vector of local public goods. Some states offer a high return to education and a low price per room of a housing unit but cold winter temperatures. Other states offer a low return to human capital but have excellent amenities. Assuming that people live and work in the same state, people must simultaneously choose the local labor market where they will supply their skills and the set of local public goods they will consume.

Estimating a 48 dimensional conditional logit model, we identify individual willingness to tradeoff income for amenities. Our conditional logit model has the structural interpretation of identifying the willingness to trade off private consumption for public goods consumption. After estimating the model, we simulate the migration probabilities and present goodness of fit tests. Finally, we measure preference intensities by calculating willingness to pay for changes in a location's amenities vector.

This paper builds on Graves' (1979) migration research on climate demand and on Rosen's (1974) research agenda of identifying structural demand parameters for capitalized non-market amenities. Graves (1979,1982,1985) has used aggregated migration net flow data to quantify migratory elasticities with respect to local amenities. Our research extends this earlier migration research along two dimensions. First, the opportunity cost of locational choice can be further disaggregated.[2] Second, earlier reduced form research's coefficient estimates could not be used for calculating consumer surplus from amenities. One of the only empirical papers to attempt to identify structural parameters is Quigley (1982). His contribution was to combine knowledge of the non-linear budget constraints with an explicit parameterization of the utility function to estimate structural parameters. Our discrete choice method closely mirrors this methodology. Our estimates of willingness to pay for amenities builds on Bartik, Butler, and Liu's (1992) estimates of amenities demand as revealed by the initial decision of whether to move.

Our research also adds to the hedonic quality of life literature. Migration data offers an additional source of information that has not been exploited in equilibrium hedonic studies. In the 1980s, several studies pointed out the inherent difficulties of conducting the "standard" hedonic two stage identification procedure. In the absence of available instruments, willingness to pay could not be identified (McConnell and Phillips (1987), Epple (1987), Palmquist (1991), and Brown and Rosen (1981)). In the aftermath of this critique, the empirical literature of the late 1980s and 1990s has focused on the more modest goal of simply estimating environmental goods' implicit prices (Roback (1982), Blomquist et. al. (1988), Gyourko and Tracy (1989, 1991). The hedonic literature has ranked locations based on index weights generated by how much people pay for each attribute. Our paper offers an alternative method for ranking locations based on how much people are willing to pay for each attribute.

This paper is organized as follows. Section 2 presents our alternative methodology. Section 3 presents our estimated models and section 4 demonstrates how the quality of life rankings change based upon a willingness to pay versus amount paid criteria. Finally, section 5 concludes.

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[2] Some migration studies have proxied for economic opportunity using mean per-capita state income. Others have disaggregated income by age group. By working with micro data, we estimate hedonic wage and rental regressions to impute each person's wage and rental across space.

Section 2 - A Migration Method for Valuing Environmental Quality

The hedonic "equilibrium" approach for estimating demand for non-market goods makes no use of migration data. The methods we present are based upon the characteristics approach to demand theory (Lancaster (1971, 1979). Similar to a product differentiation model in industrial organization, we model each geographical location as a bundle of attributes. Utility maximizing consumers will maximize a random utility function by making a discrete choice from a high dimensional choice set (McFadden (1981)). For each person, each location represents a bundle of income opportunities, rental prices for a quality adjusted housing unit, and a fixed set of exogenous environmental amenities. The basic idea for measuring climate demand is to use the income-amenities tradeoff implicit in the discrete choice of location by migrants.

We model a migrant's choice of location in a classic utility maximizing framework: location choice is a function of consumption (income net of the cost of amenities and housing costs) and the local environmental quality. Locational choice is also a function of a random taste shock. This yields stochastic location demand functions which are a function of hedonic prices and local quality of life. By measuring demand for amenities, we are able to measure the consumer surplus associated with a change in local amenities.

The demand analysis is based upon migrants' rather than the population's choice of location for two reasons. First, the data demands for modelling location choice are onerous. A complete history of location choice, family structure, and household earnings is required. This would not be a problem if amenities, rents, income and the distribution of the population did not change. Second, because equilibrium hedonic prices are a function of the supply and demand for public goods, land and labor, the hedonic prices are therefore endogenous to the locational choice of the entire population invalidating their inclusion as regressors in a structural model of environmental demand. We overcome this endogeneity problem and avoid the problem of jointly modelling both hedonic prices and location choice by assuming that migrants are "small". Thus, they have no impact on equilibrium prices. It is this assumption that allows us to model and measure the demand for environmental quality separately from a hedonic equilibrium model.

2.1 Model

The basic assumption underlying our estimation of the amenities demand system is that every location offers a bundled set of amenities of whose characteristics z_i both the household and econometrician are fully aware. Each household h within an age-education strata maximizes the common random utility function

$$\max_{i,c} U(z_i,c \mid X_h) + \epsilon_{ih}$$
$$s.t.\ c = y_i(X_h,Z_i) - r_i(X_h,Z_i) \tag{1}$$

where c is composite consumption valued in dollars, X_h is a vector of household characteristics, bundle of amenities z_i in location i, and $y_i(X_h,z)$ and $r_i(X_h)$ are the incomes and rents in location i for a household with attributes X_h that chooses location i. Thus, the only type of Tiebout sorting for which we allow is differences in preferences across age and education. The error term represents idiosyncratic variation in preferences across households. Composite consumption is defined net of housing costs. Substituting the maximal value for C,

$$V_{ih} + \epsilon_{ih} = \max_C U_{ih} = V(z_i, y_i(X_h) - r_i(X_h) | X_h) + \epsilon_{ih} \tag{2}$$

then the discrete choice problem involves choosing the location j such that

$$V_{jh} - V_{ih} > \epsilon_{jh} - \epsilon_{ih} \quad \forall\, i \tag{3}$$

McFadden (1978) has shown that if the residuals have a type-I extreme-value (Weibull) distribution then the probability that location j is chosen is the conditional multinomial logit

$$\Pi_j(p,z,X_h) = \frac{\exp(V_{jh})}{\sum_{k=1}^{n} \exp(V_{kh})} \tag{4}$$

where z is the vector $(z_1,\ldots,z_n)$. The n equations specified in (4) are a system of probabilistic demand functions for choosing each of the possible locations of the individual with characteristics X_h. McFadden (1981) and Small and Rosen (1981) show that the $\pi_j(p,z,X_h)$ are well-behaved demand equations satisfying the usual properties. If one chooses a conditional indirect utility function which is additively separable in composite consumption and the environmental attributes consumed then a closed form solution for the consumer surplus associated with the quality of life vector (existing environmental amenities) z exists. McFadden (1981) shows that such a utility function is

$$V_{ih} = \beta\left[y_i(X_h,Z_i) - r_i(X_h,Z_i)\right] - \alpha(z_i,X_h) \tag{5}$$

where β is the marginal utility of income. For this to be a well defined preference system, α must be convex and homogenous of degree one.

By using the revealed state location choice of migrants as a method for measuring the demand for environmental goods, we make a number of implicit assumptions. First, we implicitly assume that migration is a sequential decision. Households choose to move locally or out-of-state and conditional on moving out-of-state they choose a new location. Second, the model implicitly assumes that within states, cities are relatively homogenous from the perspective of wages, rentals and pure public goods like climate. It would be unreasonable to study the demand for education and other localized public goods by examining state level choice.

2.2 Empirical Implementation

This paper presents a state level analysis. Any discrete choice research project must tradeoff tractability for realism. States are both a convenient geographical unit of observation and also a reasonable unit of analysis for studying climate demand. To implement the proposed model, data on regional migration, regional environmental goods, regional wages and rentals and hedonic prices must be collected and constructed.

We use the 5% PUMS samples of the 1990 Census of Population and Housing to measure individual state to state migration. The PUMS indicates a household's location at the time of interview and five years previously. If the previous state of residence is different from the current state and the head of household is a male between 30 and 60, we include this family in our data. While the PUMS provides data on the age of the family members, their marital status, the household size, educational attainment of family members, we simply describe a family by the head of household's age and education.[3] Table 1 provides summary statistics on our sample. We use the Census because it is the largest available data set which provides a geographically representative data set on migrants. Since we will be focusing on the locational choice of the set of people who chose to move, it is relevant to compare this group to the set of people who chose not to switch states between 1985 and 1990. Table 1 presents the summary statistics for the two groups. Movers are younger, and have roughly 1 more year of education. Movers have a much higher probability of having finished college than non-movers but weeks worked, hours worked and marital status are quite comparable across the two groups.

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[3]This data selection rule is adopted because we do not know the migrant's marital status in 1985, the base year.

Our primary focus is on environmental attributes which are nonpurchased pure public goods (the climate). These are distinct from other public goods which may be rivalrous or purchased (pollution, crime, schooling and infrastructure). The environmental variables in our model are summer and winter temperature, yearly rainfall, adjacency to the coast, inland recreational water and forest coverage. The summary statistics are presented in Table 2. The climate data is taken from the National Oceanic Administration's CD ROM which covers all monitoring stations from 1900 to 1989.

The model, equations (1-5), indicates that utility maximizing individuals know what their wages, rents, weeks worked, and environmental bundle would be in all 48 states. To reconstruct the information available to each of our movers, we must impute expected private consumption in each state. To impute wage rates for each individual in the migration data set we use coefficient estimates of the regression

$$\log(W_h) = \sum_{j=1}^{n} \delta_{jh}\{\gamma_{0j} + \gamma_{1j}*HS_k + \gamma_{2j}*BA_h + \gamma_{3j}*GBA_h + \gamma_{4j}*EXP + \gamma_{5j}*EXP^2 + p_w*Z_j\} + \epsilon_h \tag{6}$$

where δ_{jh} is equal to one if household h lives in state j, HS, BA, and GBA are dummy variables indicating high school completion, college education and graduate education respectively, *EXP* measures potential labor market experience, and Z_j is the vector of environmental amenities data. To estimate this regression we use the 1989, 1990 and 1991 NBER extracts of the CPS. Our sample consists of men aged 30-60 who worked at least 30 hours per week and were neither self-employed nor handicapped and earned between $2.00 and $500 per hour. We assume that the econometrician calculates wages exactly as individuals do. People assume that their wage will be the average wage for an individual with the same simple set of characteristics.[4] This implicitly assumes that people have myopic expectations about the wage process rather than rational expectations. Thus, we are following the Freeman (1975, 1976) myopic occupational choice methodology and not attempting to estimate a rational expectations model of location choice based

[4]Thus, we are implicitly assuming that there is no spatial selection on unobservables. Intuitively, this means that controlling for observables, the average man in Iowa's wages are representative of what the average man in New York would earn if he moves to Iowa. Given the set of variables in the Census, it is extremely difficult to implement an interesting selection correction. Borjas, Bronars and Trejo (1992) use panel data from the National Longitudinal Survey of Youth to explore spatial selection and report some evidence that high ability individuals are moving to more dispersed wage distributions.

on discounted expected present value.

The hedonic wage regression presented in equation (6) is different from the typical hedonic wage regression because it recognizes that there is significant variation in returns to education and work experience across regions. An individual's wage can be high to compensate for low levels of local amenities or because his human capital has a higher marginal product in that geographical location. Unlike Blomquist et al.(1988) and Gyourko and Tracy (1989, 1991), we allow factor prices to vary across states.[5] Table 3 presents the magnitude in the variation in the returns to human capital. The variation in average returns to human capital varies dramatically across states. Relative to a worker who did not finish high school, the average college graduate earns 55% more with a standard deviation of 9 percentage points. The coefficient estimates p_w represent the price of amenities that are capitalized into wages. Table 5 presents our estimates of environmental capitalization into wages. We present two sets of wage regression results. Column (1) presents results where we have included state specific factor prices while in column (2) we have estimated a more "traditional" quality of life regression that restricts the price of human capital to be equal across space. The key point for wages is that when we allow human capital spatial price variation the coefficients on the amenities are individually insignificant. Also the coefficient signs are counter-intuitive (for example February has a positive effect on wages and July temperature has a negative effect on wages). When we drop state specific factor prices, the t-statistics soar and February temperature has the "right sign" but July temperature has the "wrong sign". This empirical ambiguity of whether amenities are capitalized into wages has been found by previous researchers (Blomquist, Berger and Hoen (1988) and Gyourko and Tracy (1991)).[6]

To impute weeks worked for each person, we estimated a probit model of whether a person worked for the full year, and then conditional on not working for the full year, we estimated a linear regression to impute weeks worked.

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[5]Beeson (1991) and Kahn (1995) present evidence on how the returns to human capital vary across cities.

[6]Henderson (1982) provides theoretical insights on the relevant factors that affect whether amenities are capitalized into rents rather than wages.

$$W = 52*Pr(worked \geq 50\ weeks) + (1-Pr(worked < 50\ weeks))*E(Weeks|worked < 50\ weeks) \quad (7)$$

We account for differential state unemployment rates by multiplying weekly wages by expected annual weeks worked.

We have now summarized how we impute wages and weeks worked. To simplify our imputation of private consumption, we abstract from modelling housing. We assume that the minimum level of housing consumption for every household is a new rented home with four rooms and two bedrooms. To impute the cost of housing in each state, we use coefficient estimates of the rental regression

$$\log(R_h) = \sum_{j=1}^{n} \delta_{jh}\{\alpha_{0j} + \alpha_{1j}*HOUSE_h + \alpha_{2j}*ROOMS_h + \alpha_{3j}*BROOMS_h + \alpha_{4j}Y1_h + ... + \alpha_{10j}Y7_h + p_r*Z_j\} + \xi_h \quad (8)$$

where δ_{jh} is equal to one if household h lives in state j, *HOUSE* indicates whether the rental unit was a house, *ROOMS* indicates the number of rooms in the unit, *BROOMS* indicates the number of bedrooms, and *Y1*,...,*Y7* are a set of dummy variables corresponding to the year interval when the unit was built, and Z_j is the vector of environmental amenities. Our sample consists of the set of all rental units in the 1990 PUMS data set. The dependent variable is gross rent which is not top-coded.

This housing rental regression is different from the typical hedonic regression because the price of housing varies spatially. Table 4 shows that the spatial variation in the typical rental unit is large and substantial. It is important to allow the price of rental units to vary across space because this controls for the "cost of living". Cities where land is cheap will feature lower prices for a four room house. Our methodology controls for this.

We find significant evidence that environmental attributes are capitalized into rentals. The right two columns of Table 5 present our estimates. Similar to our wage regressions, we present two specifications. The rental column (1) presents our estimates with state specific housing prices while rental column (2) does not. The key point is that, unlike our wage estimates presented in Table 5, we estimate very similar coefficient values for both specifications. Unlike the wage regressions, our coefficient estimates are much more intuitive. February temperature, proximity to the beach and forest and water access raise rents and July temperature and rainfall lowers rents.

We use our imputations of wages, rents, and weeks worked and combine this with state tax data to impute expected composite consumption net of taxes;

$$c_{ki} = (1 - \tau_i)(y_i(X_k,Z_i) * W_i(X_k)) - r_i(X_k,Z_i) \tag{9}$$

where the τ_i are average state tax rates based upon data from the *Statistical Abstract of the U.S.* We assume that taxes are used to purchase local public goods and that people who pay different taxes get different services. For each income level, the disutility of foregone private consumption paid in taxes is offset by the utility gain from purchased public goods. This assumption nets out the impact of local produced public services such as education, crime and safety.[7]

Our final data set of state-to-state movers contains 30,236 men. For each person in each of their 47 potential destination states, we have imputed person specific predicted incomes and rentals. Using equation (9) we use these to predict private consumption for each potential destination. Note that in specifying the net composite consumption we are calculating it net of state taxes and net of the cost of environmental goods implicitly priced in wages and rentals by using estimates which have been corrected for the capitalization of amenities.

Representing each location as a private consumption level and a six dimensional amenities vector, we model locational choice generated by utility maximization of a common utility function as specified in equation (5). We estimate this utility function separately for our six age/education cells. The location choice models estimated assume a convex budget set with a utility function that is quadratic in private consumption and linear in environmental public goods. The model is estimated via maximum likelihood for three sub-groups of the population: three age groups 30-39 years, 40-49 years and 50-60 years of age for both high school and college graduates separately.

Section 3 - Estimated Models

Two specifications of the migration model of environmental demand are estimated. The first model imposes that utility is linear in private consumption and environmental amenities. The second model allows the marginal utility of income to vary with income. The estimates from the models are presented in table 6. Table 6 presents estimates from twelve separate conditional logit estimates. In

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[7]Blank (1988) suggests that women eligible for welfare are less likely to leave more generous states. Our approach does not allow for migration to be explained by arbitraging spatial variation in transfer payments. If this were the major cause of migration, then our model should have little predictive power for the movement of less educated people. Walker (1993) finds little evidence that generous states are welfare magnets.

eleven of the twelve sets of estimates, we find that holding environmental attributes constant people are moving to states that offer higher private consumption.[8] Interestingly, we find that for each human capital group the magnitude of the coefficient on private consumption (the marginal utility of private consumption) falls across age cohorts.

The model yields mostly intuitive signs with respect to the environmental variables. Note that for both education groups, we find that the marginal utility from increased February temperature increases with age and that marginal disutility from summer temperature sharply rises for those aged 50-60.[9] We find that the summer and winter temperature, rain and coast variables have the expected signs. Surprisingly, we find no evidence that people of any age or education group are moving to highly forested states. We find mixed results for inland water recreation. It has the wrong sign but is statistically insignificant for college graduates but it has a positive and significant effect on high school graduates' migration decisions.

To judge the explanatory power of our model, for each of the six age-education cells, we simply graph the actual and the predicted probabilities of moving to each state.[10] These goodness of fit graphs are presented in Figures 1-6. These figures present some simple facts for where migrants actually move versus where our model predicted they would go. An excellent model would feature a simple 45 degree line. This would indicate that the predictions of the model just match the actual probabilities. Given that we have placed our model's predictions on the vertical axis and the actual migration probabilities on the horizontal axis, any data points that lie above the 45 degree line indicate that our model has over predicted migration to that state. To improve our reader's understanding of our data, we graph the data by each of destination states' initials. Thus, Texas is represented as "TX".

Sorting through these six Figures, the first obvious fact is that our model does a much better job

[8] Note that for men aged 50-60 who did not complete college we find in the linear private consumption model that increased private consumption does increase one's probability of moving to that state but in the model that includes consumption and consumption squared we find a counter-intuitive sign. However, an F-test shows that a quadratic term adds no additional explanatory power.

[9] It is also relevant to note that our estimates of the marginal utility from environmental attributes do not appear to be sensitive to the inclusion of the square of private consumption.

[10] These predictions are based on the linear private consumption models presented in Table 6.

explaining high school graduate rather than college graduate migration rates. For example, Figure 1 presents high school graduates aged 30-40. The most popular migration target states are Georgia, Texas, California and Florida. For these states, our model does a good job of predicting the actual data. Contrasting this figure with figure 4, college graduates aged 30-40 is striking. Figure 4 is more of a "cloud". There is much more dispersion around the 45 degree line. For example, our model underpredicts migration to Florida and California. The model does a much better job predicting New Jersey, Ohio, Massachusetts, and Illinois migration rates. Our model does the best job for the older migrants. Note that for high school graduates, Florida is a huge outlier. California and Texas are the second largest destination states but their migration flows are not even close to that of Florida. In contrast, the college graduates age 50-60, California and Florida are much closer. Contrasting Figure Six and Figure Four indicates that we have much more success predicting older college graduates' propensities of moving to Florida and California than younger college graduates.

To simulate the magnitudes of our parameters we introduce the simple concept of the iso-probability which is analogous to an indifference curve. We use the logit specification in equation (4) and ask; "if an environmental good's quantity increased by one standard deviation, how much private consumption could we take away from that person such that his probability of moving to a given state is left unchanged?". Table 7 presents these quantities for all of our environmental amenities. This table translates Table 6's utility estimates into "marginal rates of substitution" which may be compared across amenities and age-education categories. Table 7 shows that households place a high value on climate and that the relative valuation for college and noncollege graduates is very similar. The attribute most valued by households is February temperature. College graduates age 30-40 are willing to pay three thousand dollars for a standard deviation (10.4 degrees) increase in February temperature while people aged 50-60 are willing to pay over 8,800 dollars for the same increase. This growth in willingness to pay may reflect increased demand for health inputs over the life cycle and that climate is a normal good. Thus, for a typical college educated 50 year old this represents roughly 10 percent of a household's budget. Surprisingly, our estimate of willingness to pay for February temperature is even larger for non-college graduates. They are willing to pay over $13,000 for the increase. Other than the large premium placed on living in a coastal region, the other coefficient estimates are much smaller.

Section 4 - Contrasting Revealed Preference vs. Hedonic Quality of Life Rankings

Estimates from our conditional logit specifications of state locational choice can be used to rank state quality of life. These rankings can be compared to the "hedonic" approach for ranking quality of life.

Each method recognizes that a state is a Lancastrian bundle. To rank a state, we need to compute index weights of how to collapse the vector of environmental attributes into a scalar index. The hedonic quality of life ranking is based upon the concept of how much you implicitly pay for as indicated from hedonic wage and rental regressions. In contrast, our method uses index weights based upon willingness to pay.

Table 8a constructs the migration quality of life ranking by taking our estimates in Table 6 and creating a willingness to pay based on how much money would a person have to be compensated to not move if the attributes of the state were changed to the national average. Note that for all 6 age/education categories, California and Florida are the top ranked states. For example, Florida is ranked first for college graduates aged 50-60 at $17,398. This indicates that for the probability of moving to Florida to remain unchanged when Florida's attributes are changed to the national average, the typical person in this age-education strata needs to be given $17,398 a year. Note that we are not simply discovering a "big state effect"; Oregon is the fourth best state and Pennsylvania and Illinois are ranked very low around.

Table 8b constructs the hedonic quality of life ranking using our estimates in Table 5. Unlike the migration approach, this table reports how much private consumption a person would receive if a state's attributes were moved to the national average. The key point to note is that Florida is no longer ranked first but instead is now ranked 47th!. California is still ranked very high. The reason for this change in ranking across the two methods is that the magnitude of the July temperature is much larger than the February coefficient in our rental regressions (Table 5) while in the conditional logit estimates (Table 6) and the marginal rates of substitution estimates (Table 7) the February temperature effects are much larger than those for July temperature. Figures 7-12 present graphs for each age-education group of the willingness to pay index versus the hedonic quality of life index. The indices are not highly positively correlated.

Is there a fundamental concern that the hedonic model is not consistent with our results? The answer to this question rests on an investigation of the underlying assumptions of the two models. Rosen's (1974) hedonic model as implemented in the quality of life literature (Gyourko and Tracy (1991) and Blomquist, Berger and Hoehn (1988)) assumes that there is a common set of preferences and no barriers to mobility. Through geographic arbitrage, implicit prices arise such that people are exactly indifferent over location choice. Under the assumptions of this model, observed migration is idiosyncratic and unexplainable by consumption differentials across locations; the economy is in a long run equilibrium. In both models, amenities are assumed to be fixed over time. The difference arises in that our model assumes state by state "island economies" (factor prices differ in equation (6)).[11] The year to year productivity shocks change the full price of public goods consumption, thereby generating migration. That the economy is in tantamont, allows us to measure revealed choice demand for public goods. To reconcile the two models, shocks would have to stop, the migration process would continue until the national economy achieves a steady state where people are indifferent about their location.

Section 6 - Conclusion

In this paper, we develop an alternative to the hedonic method for ranking quality of life which implicitly measures the demand for public goods. Our revealed preference method is based upon migrants' locational choice. Although the method is computationally intensive, through our state level climate model, we have found that the models are tractable and the results are consistent with economic intuition. By focusing on valuing climate -- a pure public good which varies across states but far less so within a state -- this allowed us to estimate a 48 dimensional problem. The ensuing quality of life rankings are believable but contrasting them with more "standard" hedonic rankings yields a surprising lack of correlation. In particular, Florida is ranked much higher in our index than in the hedonic index. This lack of conformity suggests that "methodology matters" and merits a greater scrutiny between the two metrics.[12]

While our state level analysis is too spatially aggregated to tackle valuation problems of local public goods such as air quality, proximity to Superfund sites, crimes and school quality, our paper is suggestive that such estimation is feasible. A city-level set of migration estimates would predict willingness to pay for local public goods. Future work developing methods to estimate what consumers are willing to pay for environmental goods is critical to undertaking cost-benefit analysis of legislation geared towards increased provision of local public goods like the Clean Air or Clean Water Act.

[11]The standard hedonic price regression imposes factor price equalization thereby ruling out local labor market shocks.

[12] The literature valuing technological innovation is currently struggling with whether hedonic methods or willingness to pay methods should be used for ranking brand quality for such goods as computers, stereo equipment, medical equipment, pharmaceuticals, televisions and VCRs (see Trajtenberg (1990) for a discussion).

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Table 1 - Summary Statistics on Census Data

	Movers		Stayers			
	Mean	S.D.	Mean	S.D.	Minimum	Maximum
Age	40.42	8.09	40.20	8.00	30	60
Years of schooling	12.11	2.71	11.14	2.81	1	17
Weeks in year	46.05	13.20	46.81	12.37	0	52
Av. hours per week	44.27	14.10	43.25	12.97	0	99
Annual household income	34,974	32,573	30,403	28,501	0	197,869
Dropout	0.09	0.29	0.16	0.36	0	1
High school graduate	0.48	0.50	0.56	0.50	0	1
College educated	0.35	0.48	0.23	0.42	0	1
Post-college schooling	0.08	0.27	0.05	0.21	0	1
Married	0.81	0.39	0.79	0.41	0	1
Number of Observations	30,236		122,071			

Data are a five percent sample of the PUMS Census of Population and Housing Data
Sample includes male heads of household who were between 30 and 60.

Table 2 - Summary Statistics on Environmental Data

	Mean	S.E.	Minimum	Maximum
Average February temperature	33.7	10.4	15.2	62.5
Average July temperature	74.2	5.2	64.1	83.0
Average rainfall in 1980s	35.9	13.3	9.5	58.5
Significant coastal beach	0.5	0.5	0.0	1.0
Percent of state which is forest covered	41	23	1	90
Percent of state which is inland water	3	3	0	13

Table 3 - Cross-State Variation in the Price of Human Capital

	Education Premium			Experience Premium		
	High School	College	Post-College	10 Years	20 Years	30 Years
Average	0.28	0.55	0.68	0.19	0.26	0.21
Standard deviation	0.06	0.09	0.11	0.02	0.04	0.07
Minimum	0.18	0.34	0.41	0.14	0.18	0.08
Maximum	0.44	0.76	0.91	0.23	0.34	0.36
25th	0.25	0.48	0.60	0.17	0.24	0.16
50th	0.27	0.55	0.69	0.19	0.26	0.20
75th	0.30	0.59	0.77	0.20	0.28	0.25

Values are expressed in log differences and therefore are approximately percentage changes
Estimates are based upon equation 13 using data from the 1989, 1990 and 1991 NBER CPS extraction
Regression includes all full-time working males 30-60 who were not self employed with wages between $2 and $500
Regression includes 170,498 observations and has an R-squared of 0.2377

Table 4 - Cross-State Variation in the Price of Housing

	Premium for			Unit Age Premium					
	House	Additional Room	Additional Bedroom	2-5 Years	6-10 Years	11-20 years	21-30 years	31-40 years	> 41 years
Average	0.07	0.09	0.07	0.32	0.07	0.05	0.08	0.06	-0.02
Standard deviation	0.07	0.06	0.07	0.14	0.15	0.13	0.11	0.11	0.10
Minimum	-0.06	-0.05	-0.08	-0.05	-0.29	-0.26	-0.12	-0.20	-0.19
Maximum	0.27	0.22	0.23	0.80	0.34	0.36	0.37	0.37	0.30
25th	0.02	0.05	0.02	0.25	-0.04	0.00	0.01	0.00	-0.08
50th	0.06	0.08	0.07	0.31	0.07	0.04	0.08	0.05	-0.02
75th	0.11	0.11	0.11	0.39	0.18	0.13	0.14	0.13	0.04

Values are expressed in log differences and therefore are approximately percentage changes
Estimates are based upon equation 14 using data from the 1990 PUMS data set
Regression includes all rental units in the PUMS
Regression includes 122,915 observations and has an R-squared of 0.2685

Table 5 - Percent Increase in Wages and Rentals for a One S.D. Increase in Amenity

	Wages				Rentals			
	(1)		(2)		(1)		(2)	
	wage change	t-statistic	wage change	t-statistic	rental change	t-statistic	rental change	t-statistic
Average February temperature	0.05	1.10	-0.01	-3.21	0.10	13.79	0.10	48.50
Average July temperature	-0.03	-0.54	-0.06	-23.47	-0.19	-16.39	-0.15	-48.90
Average rainfall in 1980s	0.03	0.42	0.00	1.55	-0.08	-6.64	-0.08	-24.50
Significant coastal beach	-0.05	-1.18	0.03	18.52	0.06	7.60	0.04	22.25
Percent of state area which is forest covered	0.02	0.29	-0.02	-7.72	0.03	2.21	0.00	-1.17
Percent of state which is inland water	0.05	1.07	0.00	-1.89	0.06	7.18	0.05	24.12

Estimates are based upon coefficient estimates of equations (13) and (14) using data from the CPS and PUMS
Specification (1) differentiates returns to human capital or housing attributes by state while (2) does not.

Table 6 - Coefficient Estimates						
	30 - 40 Years		40 - 50 Years		50 - 60 Years	
At least a college degree	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic
Composite Consumption	1.84E-04	36.0	1.50E-04	24.7	1.09E-04	11.4
Average February temperature	0.054	28.5	0.065	25.1	0.092	24.5
Average July temperature	-0.049	-12.0	-0.041	-7.5	-0.083	-10.2
Average rainfall in 1980s	-0.003	-1.6	-0.014	-5.7	-0.001	-0.2
Significant coastal beach	0.662	20.3	0.626	13.7	0.009	0.7
Percent of state area which is forest covered	-0.009	-9.4	-0.006	-4.2	-0.008	-3.4
Inland recreational water as a percentage of state	-0.029	-4.7	-0.004	-0.5	-0.010	-0.8
Number of observations	6,836		3,823		1,363	
Log Likelihood	-24,602		-13,619		-4,903	
Composite Consumption	5.03E-04	13.1	4.14E-04	7.7	1.29E-04	1.6
Consumption squared	-6.846E-09	-8.4	-4.947E-09	-5.0	-3.751E-10	-0.3
Average February temperature	0.056	29.3	0.066	25.4	0.092	24.5
Average July temperature	-0.054	-13.0	-0.043	-8.0	-0.083	-10.2
Average rainfall in 1980s	-0.002	-1.0	-0.013	-5.4	-0.001	-0.3
Significant coastal beach	0.600	18.0	0.575	12.3	0.008	0.6
Percent of state area which is forest covered	-0.010	-9.8	-0.006	-4.5	-0.008	-3.4
Inland recreational water as a percentage of state	-0.026	-4.1	0.003	0.4	-0.009	-0.7
Number of observations	6,836		3,823		1,363	
Log Likelihood	-24,564		-13,606		-4,903	
Completed high school but	30 - 40 Years		40 - 50 Years		50 - 60 Years	
did not complete college	coefficient	t-statistic	coefficient	t-statistic	coefficient	t-statistic
Composite Consumption	1.59E-04	17.4	1.40E-04	12.9	7.48E-05	4.7
Average February temperature	0.063	36.5	0.075	30.9	0.097	29.9
Average July temperature	-0.019	-5.1	-0.019	-3.8	-0.069	-11.2
Average rainfall in 1980s	-0.011	-7.2	-0.011	-5.0	-0.001	-0.3
Significant coastal beach	0.624	20.9	0.558	13.6	-0.044	-4.4
Percent of state area which is forest covered	-0.002	-2.3	-0.004	-3.1	-0.005	-2.9
Inland recreational water as a percentage of state	-0.019	-3.7	0.003	0.4	0.022	2.5
Number of observations	8,190		4,513		2,263	
Log Likelihood	-29,863		-16,142		-8,055	
Composite Consumption	1.57E-04	4.0	1.14E-04	2.2	-1.07E-04	-1.7
Consumption squared	1.011E-10	0.1	7.607E-10	0.5	5.653E-09	3.0
Average February temperature	0.063	36.1	0.075	30.4	0.095	28.8
Average July temperature	-0.019	-5.1	-0.019	-3.7	-0.068	-11.0
Average rainfall in 1980s	-0.011	-7.2	-0.011	-5.1	0.000	-0.1
Significant coastal beach	0.624	20.8	0.560	13.6	-0.040	-4.1
Percent of state area which is forest covered	-0.002	-2.3	-0.004	-3.1	-0.005	-2.8
Inland recreational water as a percentage of state	-0.019	-3.7	0.002	0.3	0.020	2.2
Number of observations	8,190		4,513		2,263	
Log Likelihood	-29,863		-16,141		-8,051	
Estimates are based upon the college PUMS sample merged with CPS imputations and environmental data						

Table 7 - Willingness to Pay				
College	Standard Dev.	age 30 - 40	age 40 - 50	age 50 - 60
Average February temperature	10.4	$3,053	$4,542	$8,867
Average July temperature	5.2	-$1,383	-$1,413	-$3,948
Average rainfall in 1980s	13.3	-$215	-$1,210	-$109
Significant coastal beach	0.5	$1,808	$2,106	$40
Percent of state area which is forest covered	23	-$1,180	-$886	-$1,648
Percent of state which is inland water	3	-$402	-$72	-$234
Non-College				
Average February temperature	10.4	$4,139	$5,594	$13,486
Average July temperature	5.2	-$607	-$705	-$4,819
Average rainfall in 1980s	13.3	-$924	-$1,015	-$142
Significant coastal beach	0.5	$1,972	$2,014	-$293
Percent of state area which is forest covered	23	-$295	-$637	-$1,647
Percent of state which is inland water	3	-$308	$49	$754
Estimates from table 6 - linear specification 1				
Willingness to pay is defined as the value in $s and individual is willing to pay for a one standard deviation increase in the amenitites variable				

Table 8a - Quality of Life Rankings

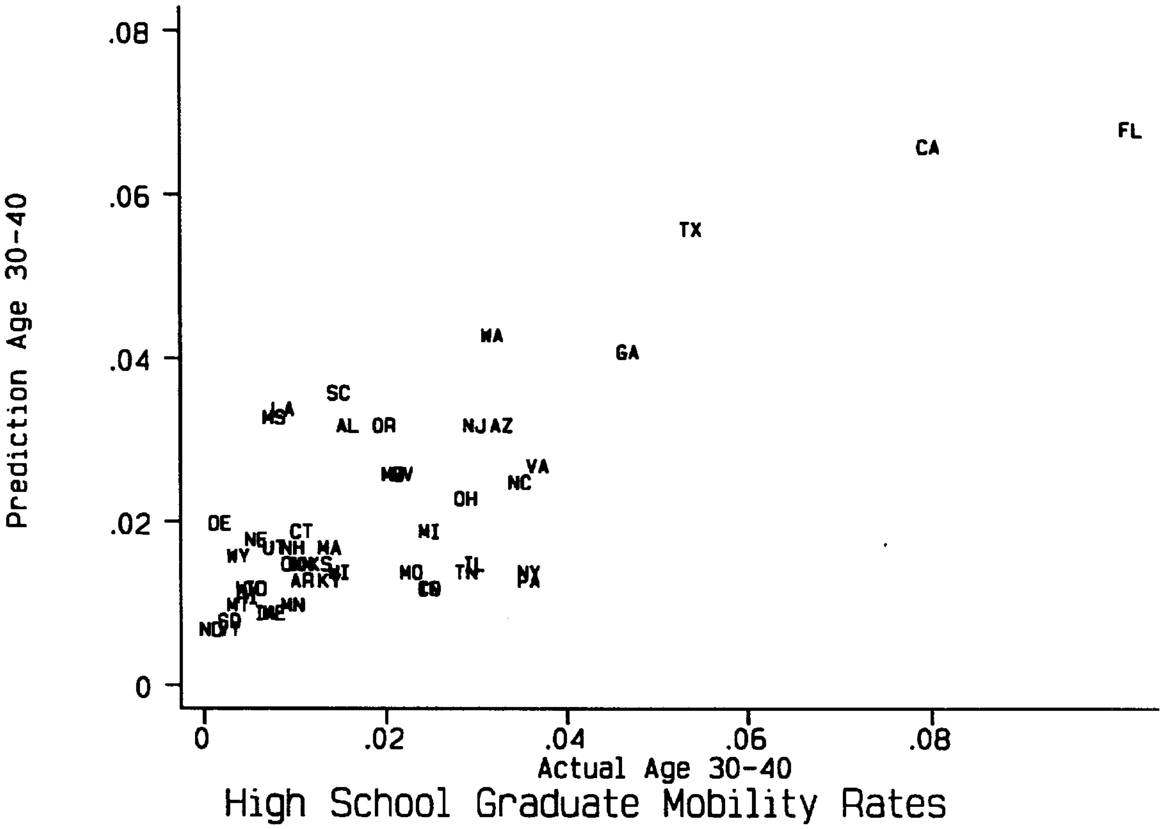
Willingness to pay for the deviation in state's attributes from the average

	High School Graduates			College Graduates		
	30-40	40-50	50-60	30-40	40-50	50-60
1	FL 10,758	FL 15,144	FL 30,355	CA 7,063	FL 10,702	FL 17,398
2	TX 8,947	TX 11,629	CA 19,578	FL 6,839	CA 10,031	CA 13,878
3	CA 8,817	CA 10,758	TX 15,909	TX 6,566	TX 9,285	TX 10,461
4	GA 6,146	LA 8,563	LA 15,239	OR 5,419	OR 6,207	OR 9,622
5	LA 5,942	GA 7,478	AZ 12,837	WA 4,897	WA 5,796	WA 9,116
6	AZ 5,323	AZ 7,318	OR 11,520	LA 3,536	LA 5,225	AZ 7,969
7	MS 5,204	MS 6,390	WA 11,427	GA 3,409	AZ 5,081	LA 7,710
8	SC 5,101	SC 6,334	GA 10,729	MS 3,292	GA 4,949	NM 6,256
9	AL 5,049	AL 6,177	MS 9,043	AL 2,772	SC 4,067	GA 6,206
10	OR 4,752	OR 5,107	AL 9,035	SC 2,709	MS 3,831	NV 5,653
11	WA 4,271	NC 4,776	SC 8,860	AZ 2,032	AL 3,628	MS 5,323
12	NC 3,384	WA 4,662	NM 7,828	OH 1,847	NV 3,300	AL 4,937
13	VA 2,552	NV 3,000	NC 7,211	NV 1,677	NC 3,029	SC 4,676
14	NV 2,198	NM 2,762	NV 6,915	NC 1,600	NM 2,966	NC 2,728
15	NM 2,105	VA 2,629	AR 4,196	NM 1,571	VA 1,936	TN 1,549
16	MD 1,487	MD 2,037	TN 3,692	VA 1,351	MD 1,584	AR 1,491
17	NJ 1,148	OK 1,309	OK 3,066	NJ 1,264	NJ 1,099	OK 1,474
18	OH 767	NJ 1,246	RI 2,103	MD 1,171	OH 981	ID 1,465
19	OK 335	NE 729	DE 1,168	NE 279	NE 569	NE 1,397
20	NE 158	AR 555	NE 1,165	OK -412	OK -208	VA 212
21	AR -148	OH 134	VA 985	MA -474	ID -425	CO 147
22	TN -947	TN -516	ID 366	MI -605	UT -469	DE -460
23	UT -1,157	UT -1,158	MD 357	ID -696	CO -830	KY -620
24	MA -1,206	KS -1,466	KY -78	CO -774	MA -1,171	MD -696
25	ID -1,446	DE -1,614	NJ -1,048	KS -937	AR -1,556	UT -758
26	KS -1,517	KY -1,915	UT -1,169	NY -941	KS -1,570	NJ -965
27	MI -1,787	MA -1,930	CO -2,163	WY -1,027	MI -1,574	MT -1,629
28	CO -1,834	ID -2,081	WV -2,689	MT -1,226	WY -1,704	WY -1,782
29	KY -1,861	CO -2,689	KS -3,700	UT -1,411	MT -1,747	RI -1,816
30	NY -1,903	MO -2,727	MO -3,779	WI -1,418	NY -1,944	OH -1,880
31	DE -2,208	MI -3,358	CT -4,728	TN -1,505	TN -1,976	KS -1,900
32	MO -2,483	NY -3,376	OH -4,760	AR -1,508	DE -2,389	WV -2,038
33	WV -2,487	WV -3,476	MT -5,115	IN -1,797	WI -2,734	MO -2,584
34	WI -2,895	RI -3,622	IN -5,206	IL -2,041	KY -2,822	IN -2,683
35	MT -3,057	IN -4,006	PA -5,332	DE -2,041	MO -3,269	PA -3,214
36	NH -3,081	MT -4,172	MA -5,342	KY -2,078	IN -3,542	CT -3,487
37	WY -3,184	IL -4,269	WY -5,773	MO -2,088	MN -3,603	IL -3,796
38	IN -3,365	WY -4,348	IL -6,659	MN -2,341	NH -3,660	MA -3,992
39	IL -3,689	WI -4,718	NY -10,016	NH -2,466	WV -3,709	NY -6,359
40	PA -3,791	PA -5,022	MI -11,481	SD -2,525	IL -3,816	SD -6,525
41	ME -3,902	CT -5,298	SD -11,643	IA -2,629	SD -3,845	IA -6,569
42	MN -4,221	NH -5,332	IA -11,755	PA -3,047	RI -3,946	MI -6,843
43	CT -4,372	SD -5,668	VT -13,029	WV -3,077	ME -4,086	NH -8,933
44	RI -4,466	ME -5,779	ME -13,039	ME -3,203	PA -4,393	VT -8,936
45	SD -4,532	MN -5,987	NH -13,590	CT -3,471	IA -4,900	WI -9,542
46	IA -5,017	IA -6,239	WI -15,410	ND -3,604	CT -5,003	ME -9,549
47	ND -6,758	ND -8,684	ND -17,298	RI -4,185	ND -5,668	ND -9,825
48	VT -7,126	VT -9,283	MN -18,780	VT -5,765	VT -7,705	MN -12,290

Table 8b - Quality of Life Rankings

Amount paid for the deviation in state's attributes from the average

	High School Graduates			College Graduates		
	30-40	40-50	50-60	30-40	40-50	50-60
1	WI 2,306	WI 2,572	MI 2,597	OH 3,122	OH 3,614	OH 3,757
2	MI 2,286	MI 2,570	OH 2,585	WI 3,006	WI 3,385	MI 3,451
3	CA 2,281	OH 2,542	MN 2,572	MI 2,957	MI 3,358	MN 3,390
4	MN 2,231	MN 2,541	WI 2,535	MN 2,837	MN 3,277	WI 3,359
5	OH 2,138	CA 2,344	CA 2,350	CA 2,439	ND 2,699	ND 2,764
6	OR 2,065	WY 2,158	OR 2,107	WY 2,378	WY 2,542	CA 2,538
7	WY 1,959	OR 2,102	ND 2,072	ND 2,281	CA 2,517	WY 2,459
8	ND 1,802	ND 2,045	WY 1,998	OR 2,116	TX 2,312	TX 2,415
9	WA 1,765	WA 1,689	WA 1,681	TX 1,996	OR 2,159	OR 2,175
10	CO 1,529	NV 1,621	CO 1,631	CO 1,864	CO 2,004	CO 2,015
11	NY 1,486	CO 1,621	MT 1,608	NY 1,757	SD 1,943	NY 1,914
12	NV 1,465	NY 1,574	NV 1,556	NV 1,748	NV 1,911	NV 1,864
13	NH 1,456	MT 1,557	NY 1,553	MT 1,645	NY 1,881	MT 1,804
14	MT 1,447	NH 1,494	NH 1,493	SD 1,641	MT 1,773	NH 1,624
15	TX 1,132	TX 1,344	TX 1,312	WA 1,590	NH 1,624	WA 1,481
16	SD 1,073	SD 1,261	SD 1,200	NH 1,575	WA 1,496	IA 1,477
17	NM 899	NM 993	NM 1,043	NM 1,215	IA 1,426	NM 1,384
18	ID 878	ID 868	ID 867	IA 1,167	NM 1,321	KS 1,293
19	IA 574	IA 827	IA 807	NE 1,053	NE 1,233	NE 1,249
20	ME 514	NE 602	NE 614	KS 921	KS 1,226	ID 836
21	VA 503	VA 560	KS 605	ID 849	ID 839	VA 823
22	UT 498	KS 532	VA 562	VA 709	VA 788	NJ 571
23	NE 456	UT 514	UT 514	UT 527	NJ 576	UT 539
24	NJ 380	NJ 419	ME 424	NJ 517	UT 543	AZ 506
25	KS 337	ME 402	NJ 420	AZ 329	AZ 472	IL 204
26	MA 295	MA 209	MA 196	ME 189	IL 165	ME 52
27	AZ -16	AZ 103	AZ 82	IL -29	ME 11	DE 0
28	MD -121	MD -180	MD -194	MA -53	IN -194	SD 0
29	IL -382	IL -249	IL -214	IN -302	MA -206	IN -137
30	GA -385	GA -376	GA -375	MD -309	GA -334	MA -197
31	IN -484	IN -396	IN -392	GA -349	MD -398	GA -328
32	SC -621	MS -597	MS -591	MS -534	MS -499	MD -439
33	MS -632	SC -660	SC -648	SC -813	SC -871	MS -474
34	PA -818	PA -891	PA -881	MO -982	MO -920	SC -878
35	AL -898	AL -939	AL -955	AL -1,030	OK -1,028	MO -887
36	MO -1,081	MO -1,034	MO -1,027	PA -1,066	AL -1,093	OK -983
37	VT -1,085	WV -1,148	OK -1,122	OK -1,079	PA -1,173	AL -1,141
38	WV -1,098	OK -1,149	WV -1,181	WV -1,397	WV -1,557	PA -1,175
39	OK -1,181	VT -1,254	VT -1,248	VT -1,508	VT -1,724	WV -1,649
40	NC -1,205	NC -1,411	NC -1,414	NC -1,949	NC -2,230	VT -1,887
41	KY -1,774	KY -1,901	KY -1,941	KY -2,102	KY -2,269	NC -2,271
42	LA -2,226	AR -2,464	AR -2,481	AR -2,781	AR -2,950	KY -2,395
43	TN -2,267	TN -2,476	CT -2,524	TN -2,843	TN -3,086	AR -3,004
44	AR -2,338	LA -2,528	TN -2,528	LA -2,996	LA -3,282	TN -3,233
45	CT -2,348	CT -2,558	DE -2,569	CT -3,069	DE -3,382	CT -3,509
46	FL -2,387	FL -2,648	LA -2,596	DE -3,127	CT -3,398	LA -3,604
47	DE -2,477	DE -2,782	FL -2,616	FL -3,541	FL -3,906	FL -3,917
48	RI -3,652	RI -4,411	RI -4,475	RI -5,474	RI -6,601	RI -6,655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Actual Age 30-40
High School Graduate Mobility Rates
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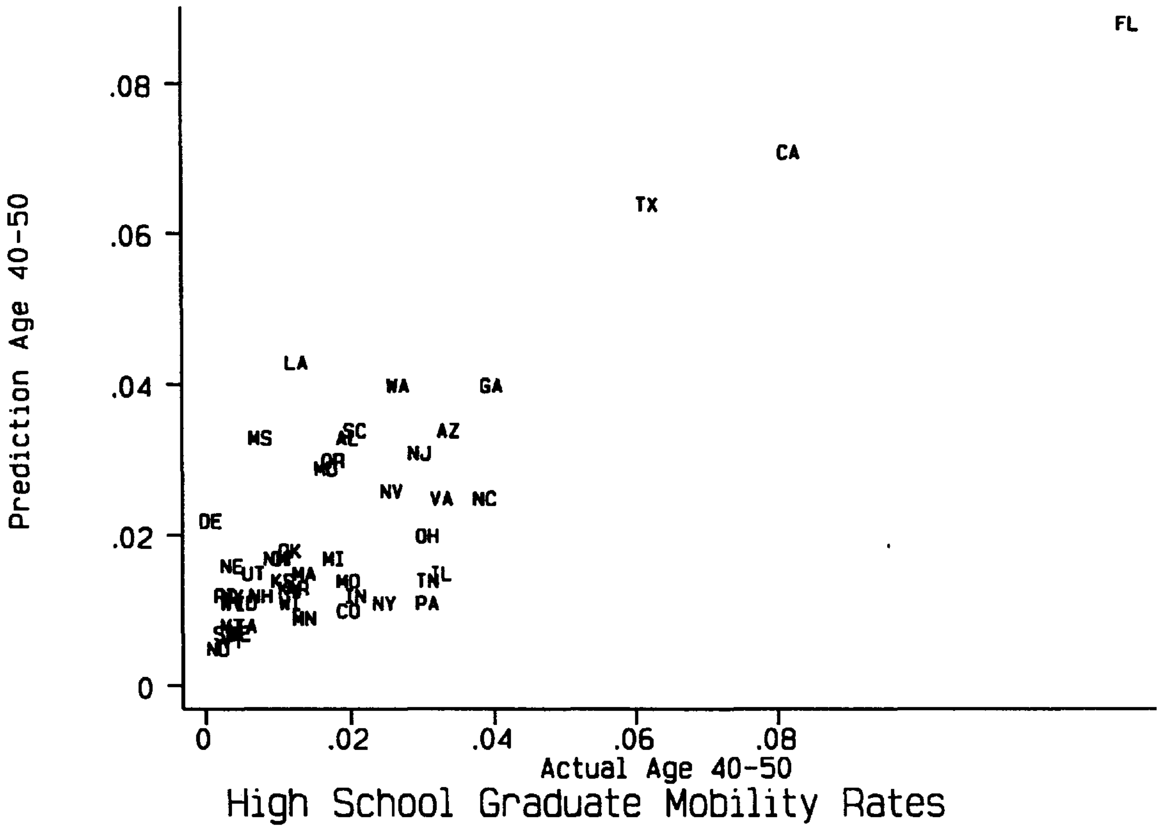
Figure 1



Prediction Age 40-50
Actual Age 40-50
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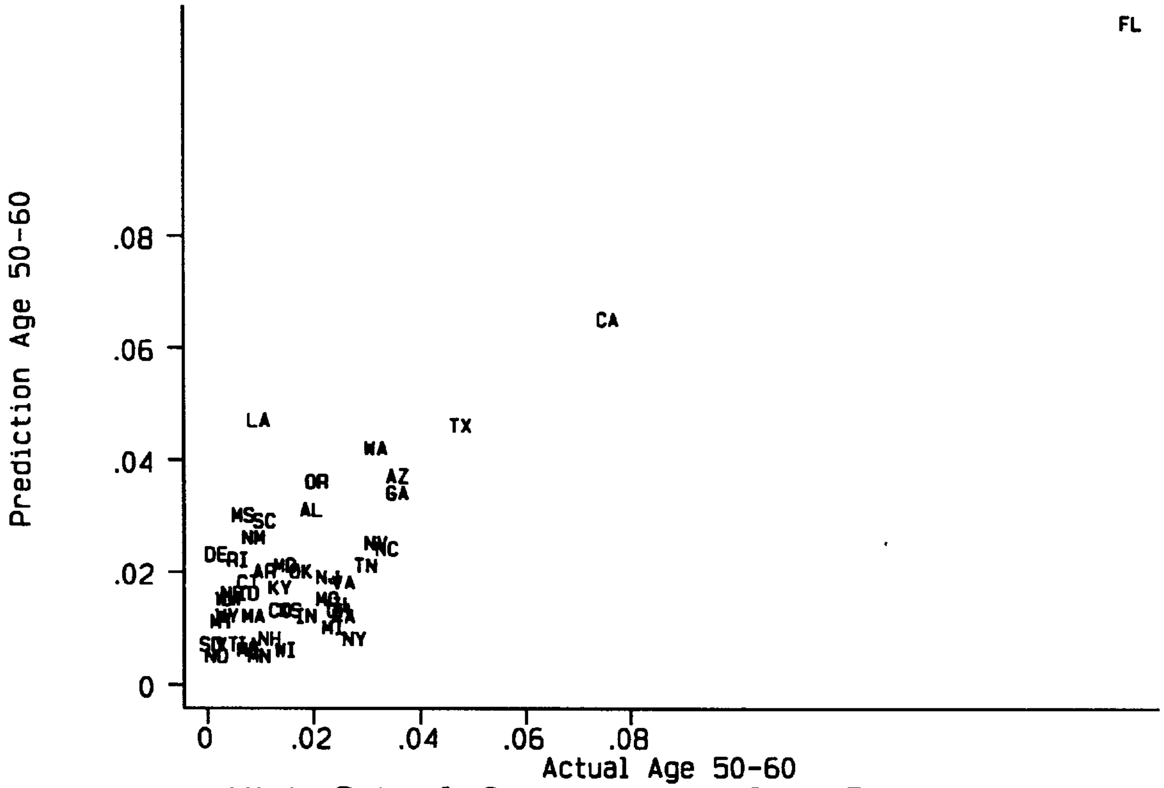
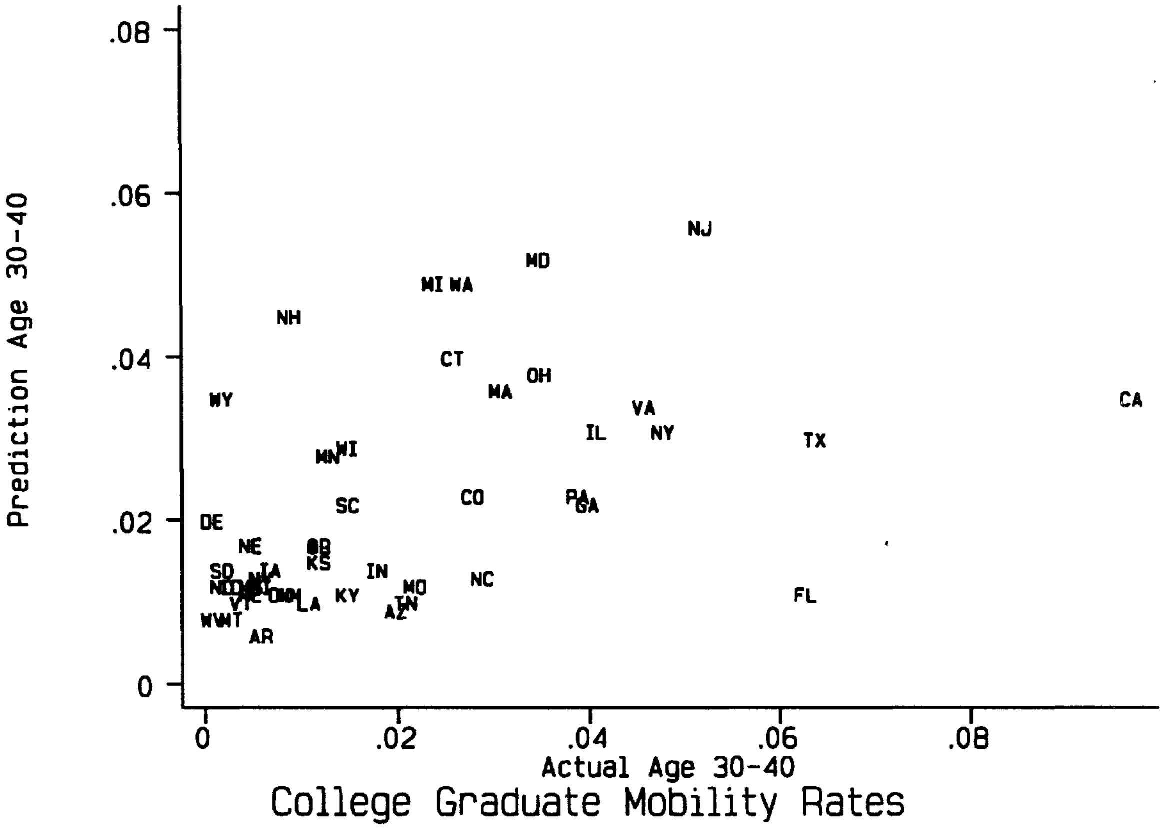
High School Graduate Mobility Rates

Fiugre 2



High School Graduate Mobility Rates

Fiugre 3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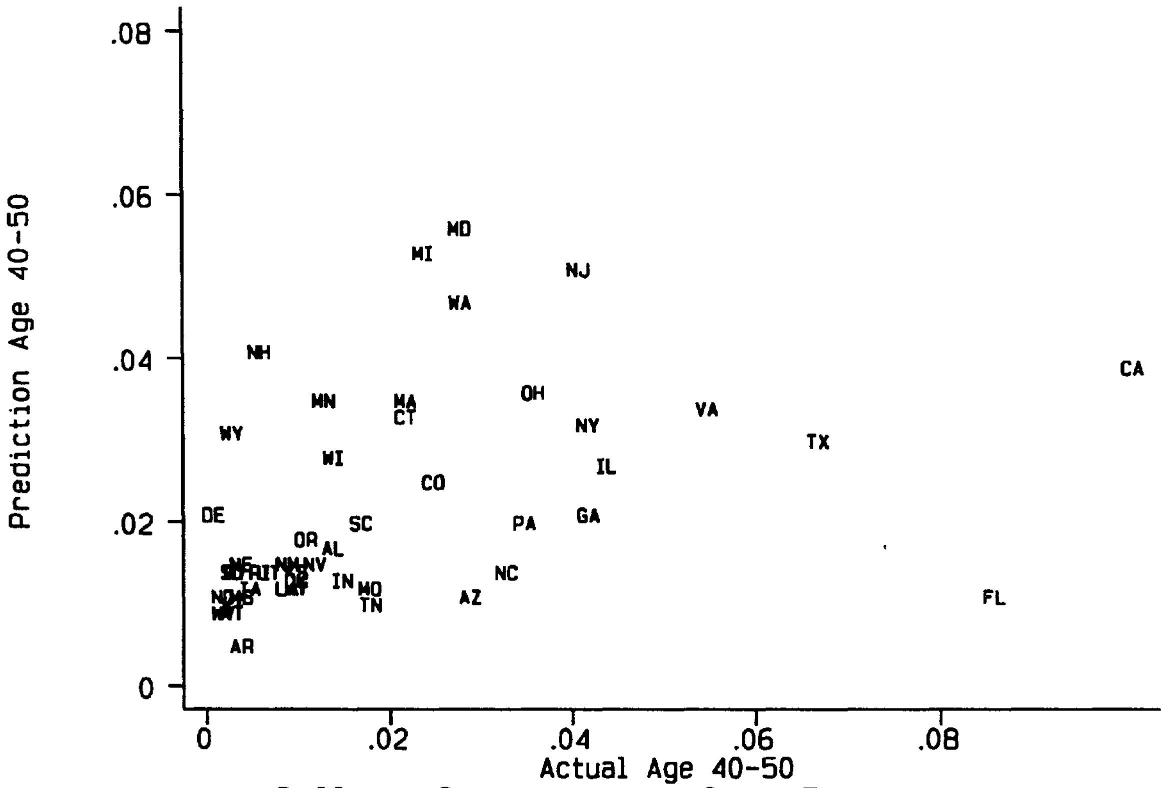
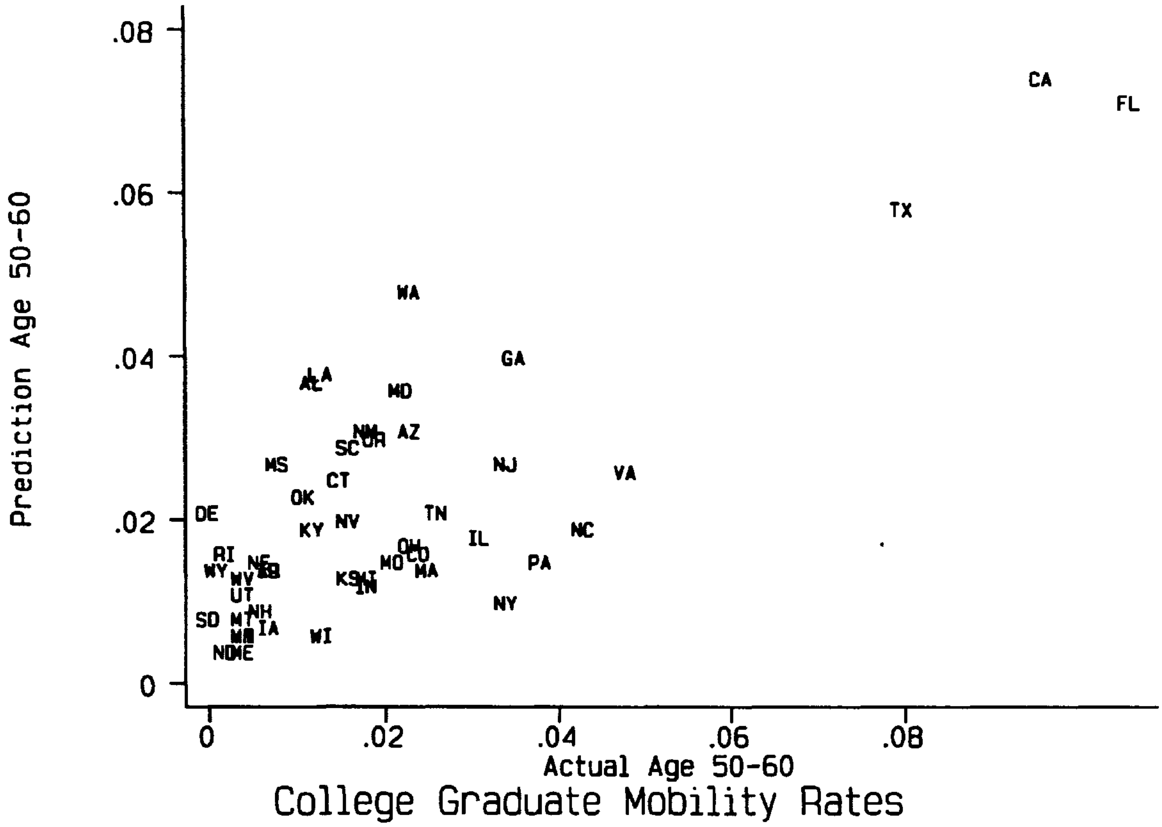
Actual Age 30-40
College Graduate Mobility Rates

Fiugre 4



College Graduate Mobility Rates

Fiugre 5



.08
.06
.04
.02
0
Prediction Age 50-60
0
.02
.04
.06
.08
Actual Age 50-60
College Graduate Mobility Rates
CA
FL
TX
WA
GA
MD
AZ
SC
NJ
VA
MS
CT
OK
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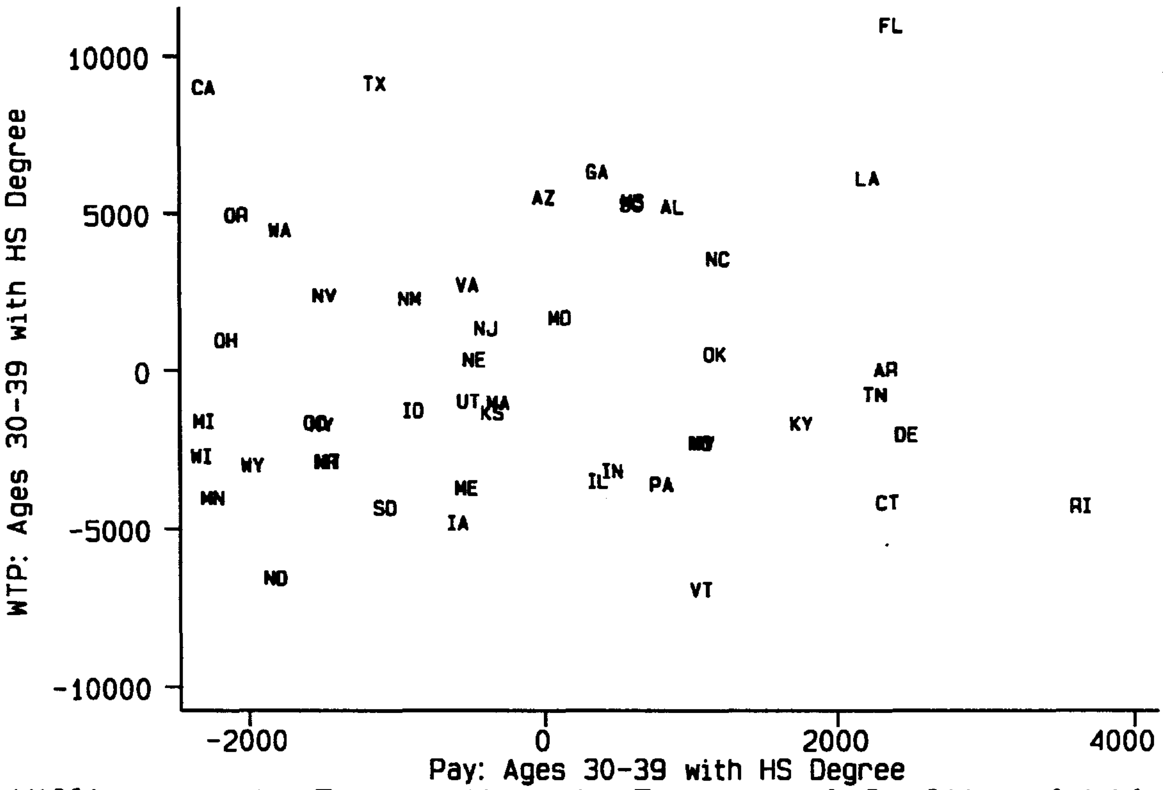
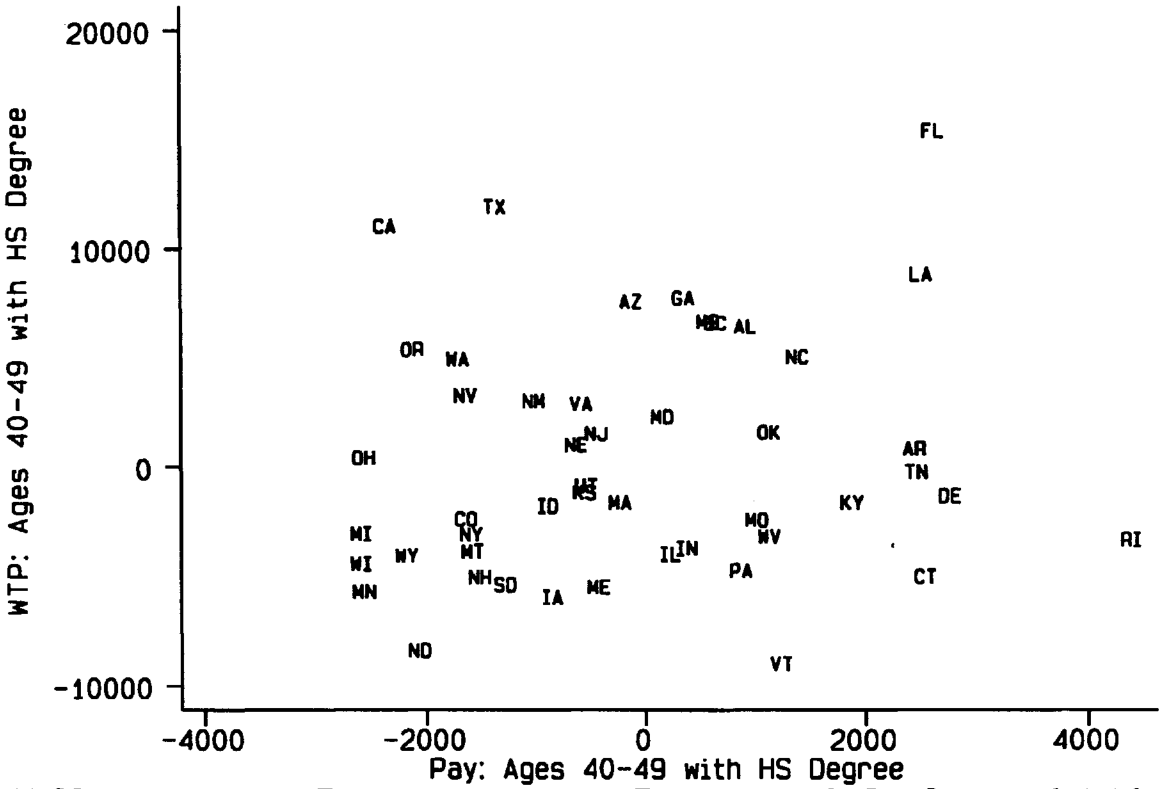
Fiugre 6



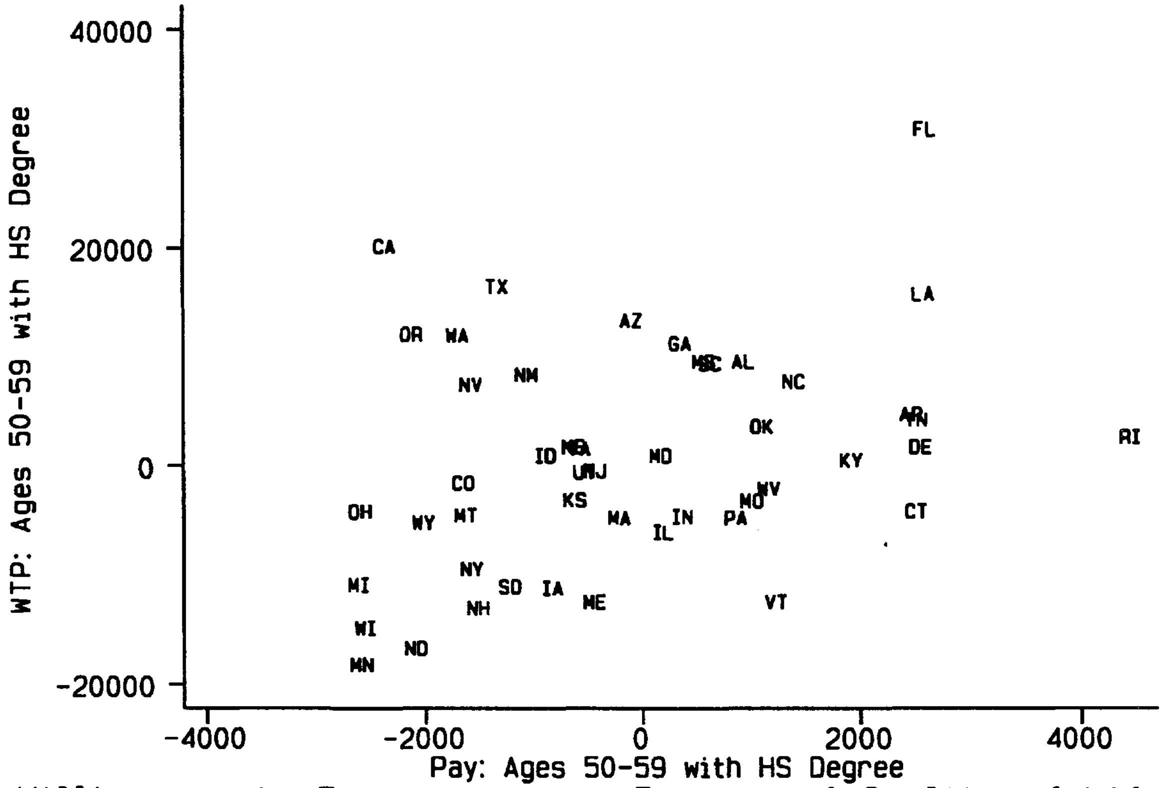
Willingness to Pay vs Hedonic Ranking of Quality of Life

Fiugre 7



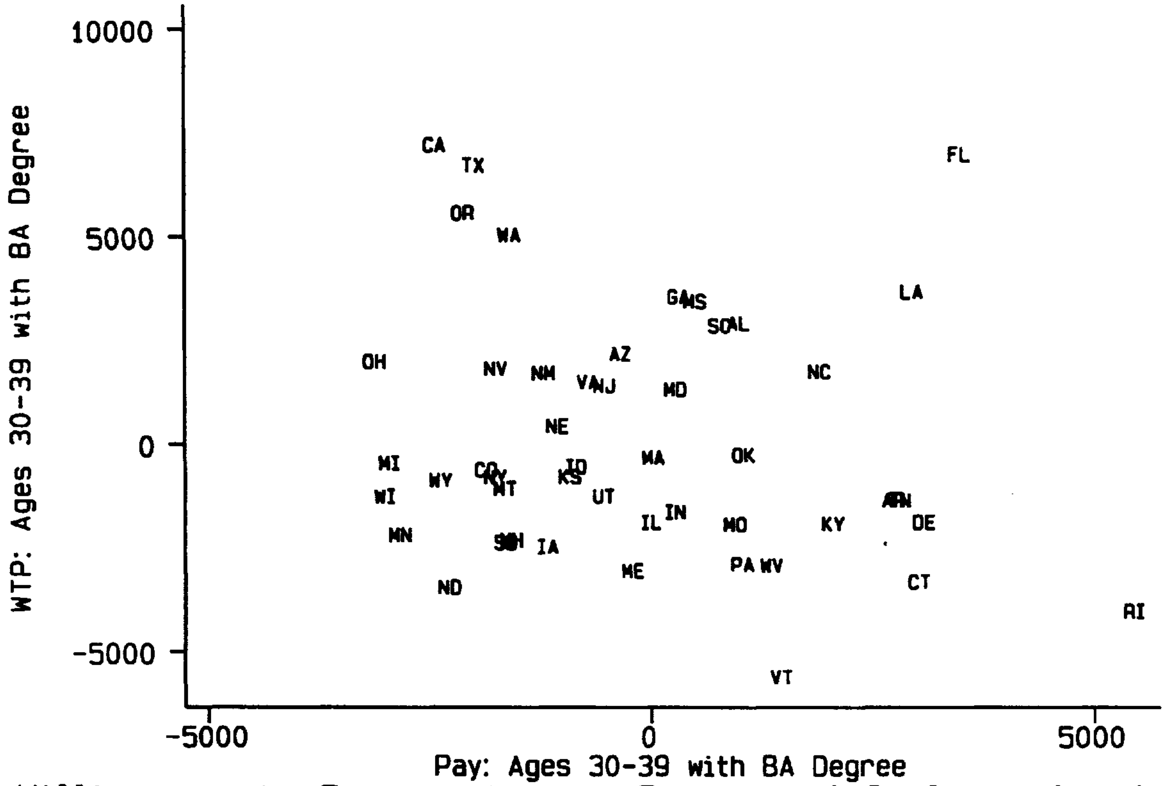
Willingness to Pay vs Hedonic Ranking of Quality of Life

Fiugre 8



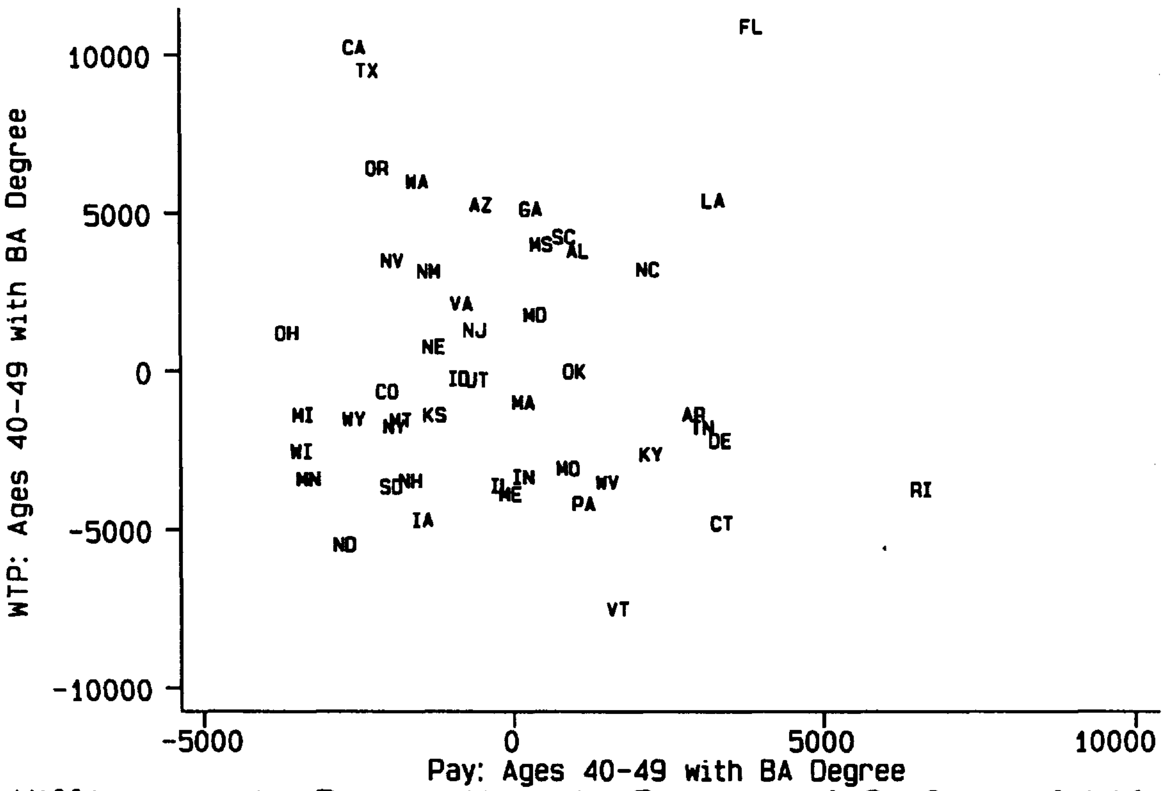
Willingness to Pay vs Hedonic Ranking of Quality of Life

Fiugre 9



Willingness to Pay vs Hedonic Ranking of Quality of Life

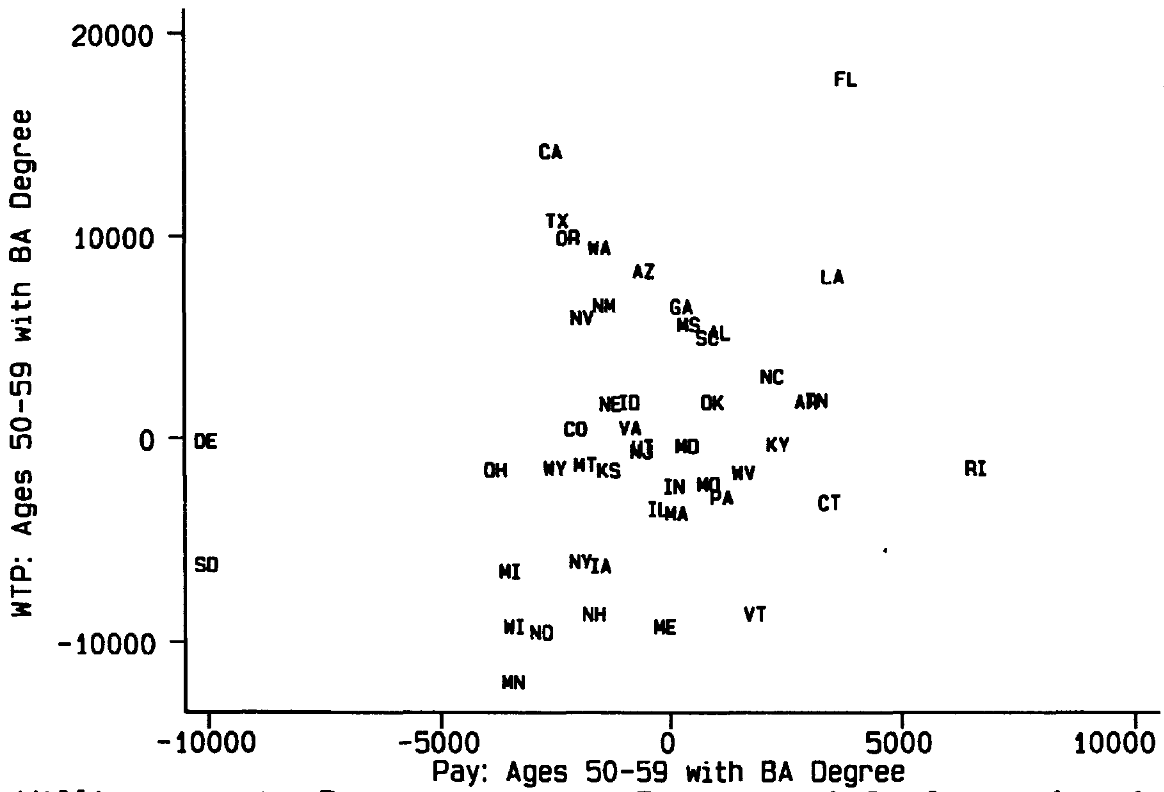
Fiugre 10



Willingness to Pay vs Hedonic Ranking of Quality of Life

Fiugre 11

Stata™



Willingness to Pay vs Hedonic Ranking of Quality of Life

Fiugre 12

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