



The changing values of amenities : how, when, and why amenities change in value : an economic analysis  
by JeRome Richard Patton

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Applied Economics  
Montana State University  
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**Abstract:**

It is obvious that people compare the desirability of potential locations' natural amenities and attributes when deciding where to live. What is less obvious is how large an effect these variables have on a person's decision and how their significance tends to change over time. The purpose of this thesis is to explore the changing significance of natural amenities on population movement over time by asking the question, "Have people reacted differently to relatively constant climatic and topographical factors over the last one hundred years?" In this thesis a model is developed based on utility maximization that is tested empirically using county level data. The results indicate that amenities influence migration patterns and that these influences change over time with respect to changes in income and the price of an amenity's compliments and substitutes.

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APPROVAL

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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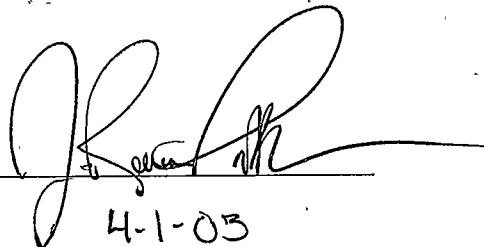
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4-1-03

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ABSTRACT

It is obvious that people compare the desirability of potential locations' natural amenities and attributes when deciding where to live. What is less obvious is how large an effect these variables have on a person's decision and how their significance tends to change over time. The purpose of this thesis is to explore the changing significance of natural amenities on population movement over time by asking the question, "Have people reacted differently to relatively constant climatic and topographical factors over the last one hundred years?" In this thesis a model is developed based on utility maximization that is tested empirically using county level data. The results indicate that amenities influence migration patterns and that these influences change over time with respect to changes in income and the price of an amenity's compliments and substitutes.

## INTRODUCTION

Everyone chooses to live somewhere. What is interesting is that people prefer different places and that people decide to move. It is evident that people compare the desirability of potential locations' natural amenities and attributes when deciding where to live. For instance, *Sperling's BestPlaces*, a web resource, considers both weather and leisure opportunities, among other attributes, when comparing cities. What is less obvious is how large an effect these variables have on a person's decision and how their significance changes over time.

The purpose of this economic research is to explore the changing significance of natural amenities on population movement over time by asking the question: Have people reacted differently to relatively constant climatic and topographical factors over the last one hundred years? To answer this question I develop a model based on utility maximization and test it empirically using county level data.

In this model, migration is simply a specific example of rational choice given unchanging preferences. Demand for amenities, and thus migration patterns, shift with changes in prices of complements, prices of substitutes, and incomes. My model predicts that as the price of an amenity's complements (substitutes) goes down (up), people migrate toward those amenities. Additionally, as incomes increase people migrate toward normal amenities and away from inferior amenities.

To test this theory, I use a cross section of 3,111 counties' climate and topographical characteristics and a panel of county level population data from 1900 to 2000. I regress

population change for each decade on the associated amenities. Doing this yields a prediction of an amenity's contribution to the county's population growth rate. By comparing each amenity's contribution at ten-year increments from 1900 to 2000, I can investigate the changing effect an amenity has on migration patterns.

The results suggest that amenities do influence migration decisions to an important extent. Furthermore, the influence of amenities on migration changes in a way that fits what one would expect from changes in the prices of amenity substitutes and complements. The interesting idea is not that some places have amenities that are more noteworthy than those that other places have; what is interesting is that the relationship between amenities and population growth changes over time. This project develops the foundation for economic explanations for these changes.<sup>1</sup>

The thesis proceeds as follows. Section 2 provides background and rationale for this research. Section 3 introduces the data. Section 4 introduces the theory and model. Section 5 presents the empirical framework and methods. Section 6 presents empirical findings. Section 7 concludes the paper and discusses topics for further research. Following the conclusion are a data appendix, a historical appendix, and a bibliography.

## BACKGROUND

People have always been interested in comparing the places they may choose to live. Naturally, these decisions have potentially significant effects on people's well being, as well as their bank accounts, and involve deciding how to allocate a large percentage of their resources. Over time, real incomes increase and people consume greater amounts of normal goods, including attributes and amenities associated with particular places. Consequently, as people become wealthier, they are more concerned with living in places with nicer amenities. Accordingly, the topic "Best Places to Live" receives a great deal of attention in the popular press (Real Estate Journal 2002). Likewise, migration and amenity topics have also been gaining popularity in scholastic research (Graves, Arthur, and Sexton 1999). Background information on the history of migration in the United States can be found in appendix C.

It is easy for potential movers to obtain information on amenities. Using any Internet search engine, a "best places to live" query will yield hundreds of results. Two examples are *CNN Money's* "Best Places to Live 2000" and *The Real Estate Journal's* "Best Places Feature." Both are search guides vowing to "help you find the top cities and metro areas" by linking personal criteria with over forty statistical measurements. These sites aid potential movers in sorting through a huge amount of data, and in the end, provide a ranking of areas most suitable to the individual.

By using a weighted measurement, the "best places" sites attempt to allow the program user to adjust the relative importance placed on a particular amenity or attribute.

This allows people with different utility functions to use the same guide and raw data to find a place that suits their individual needs. *Sperling's* website, the data source for many "Best Places" websites, groups 70 categories of important data into nine major subcategories: weather, crime, arts and culture, economy, education, health, housing, leisure, and transportation.

Recent economic research on migration begins with Larry A. Sjaastad's article "The Costs and Returns of Human Migration" (1962). Sjaastad examines migration in terms of personal human capital formation. Sherwin Rosen's article "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition" (1974) develops a theory of hedonic prices: an entire set of prices that guides consumer and producer location decisions in characteristics space. His analysis formally introduces the idea that goods can be valued for their utility-bearing attributes and that locations can be treated as a bundle of these attributes. He states, "The economic content of the relationship between observed prices and observed characteristics becomes evident once price differences among goods are recognized as equalizing differences for the alternative packages they embody" (Rosen 1974, page 54).

Later thinking branches into two different directions (Graves 1980). One is a theory of disequilibrium describing migration as motivated by income and employment differentials. The other theory, compensating differentials, correlates migration with changes in demand for location-fixed amenities, as market rents and wages adjust to keep utility constant over space. Graves finds, "income and unemployment differentials no longer systematically represent utility differentials in the U.S. At the theoretical level,

improvements in information transfer combined, with high mobility rates reduce the likelihood of such persistent spatial utility differentials in the future” (page 228).

My theory employs these findings. Although differences in wages and the cost of living exist, these differentials may be irrelevant to the potential mover. The differentials represent utility equalization across space when levels of amenities are different. Hence, the differentials cannot motivate migration because the marginal mover realizes no utility gain.

Because people value amenities, there exists a willingness to pay for them; people are willing to give up something in exchange for better amenities. Additionally, at any given time there exists a supply of places, each with its own bundle of amenities. Recent literature suggests that places with better amenities are associated with smaller income differentials (Graves, Arthur, and Sexton 1999). In other words, people will take a job with a relatively lower wage, or in area with a relatively higher cost of living because they value the surrounding amenities. In this respect, the price of consuming amenities, the income differentials, are negatively associated with greater quantities of amenities.

One can envision a market for amenities. Amenities are allocated by a pricing mechanism (the income differentials) and potential movers are price takers. When a potential mover examines his options, the limiting constraint is the existing set of places, each with its own bundle of attributes and corresponding income differential. Based on the given preferences of the consumer, a place is chosen that maximizes utility. Changes in income and the prices of substitutes and complements may change what the consumer considers the optimal place, without relying on changing preferences.

## DATA

The data section begins by providing reasons for the theoretical variables used and then relates them to the corresponding empirical data. In this way a connection can be easily drawn from theoretical tests to the actual regressions. Following is a more detailed look at each variable, including summary statistics, and the meaning of potential tests that can be examined.

A perfect data set would include a panel of all places with completely described amenities, attributes, and population characteristics. Understandably, collecting these data is impossible. Instead I rely on subsets of population, places, and amenity descriptions. As a proxy for migration, this investigation uses Census data on county level population from 1900 to 2000.<sup>2</sup> As a proxy for attributes, I use county level climatic and topographical data. The population data are collected from the U.S. Census Bureau website, and the amenity data are from an Economic Research Service publication entitled *Natural Amenities Drive Rural Population Change*, written by David McGranahan (2002).

I choose to use data at the county level because they provide a better proxy for the heterogeneous characteristics of places than do state level data. In addition, data at a smaller level of aggregation are not available for the entire country or entire time period in which I am interested. Different types of data at the city level exist and future analysis at this level may also prove to be insightful.

Amenity data are chosen to provide a relatively constant measure of the *niceness* of a county. These data approximate the quality of time spent in a county by capturing a proxy for comfortable weather and attractive landscape. Warmer winters and more days with clear skies (as opposed to overcast days) typify counties with nicer winters. This information is captured by data measuring average January temperatures and hours of January sunlight. Cooler summers typify counties with nicer summers. Because humidity has the effect of increasing discomfort in heat, this information is captured by two sets of data, July temperatures and July humidity.<sup>3</sup>

However, climatic data do not tell the whole story. People also value the physical nature of their surrounding geography. For example, whether a county is made up predominantly of mountains or plains, or is close to water, affects a county's desirability. To estimate the effects of geography, a variable measuring topographic variation is included. This variable places every county into a topographic category, ranging from flat plains to mountains, providing a test of the effects of different geography on migration. To account for the effect of water on the relative niceness of a place, a measure of water area inside a county serves as a proxy for proximity to water.

The variable winter sunshine measures hours of clear winter skies with sunshine; its proxy is average hours of January sunlight from 1941 to 1970. This variable has a mean and median of 152 hours, a maximum of 266 hours at La Paz County, AZ, and a minimum of 48 hours at 8 separate counties in Washington. The standard deviation is 33 hours. Its coefficient is interpreted as the additional county level population growth rate that can be explained by a one-hour increase in average January sunshine.

The second variable is warm winters. Its proxy is average county level January temperature measured in degrees Fahrenheit from 1941 to 1970. The mean and median for this variable is 33 degrees. The maximum is 67.2 degrees at Dade County, FL and the minimum is 1.1 degree at Kittson County, MN. The standard deviation is 12 degrees. The coefficient can be interpreted as the additional county population growth rate which can be explained by a one-degree increase in average January temperature.

The third variable is humid summers. Its proxy is average July relative humidity from 1941 to 1970, measured in percent. Relative humidity is measured by dividing the amount of actual water vapor in the air by the amount of potential water vapor the air could possibly hold at the given temperature. The mean and median of this variable is 56 percent and 59 percent. The maximum is 80 percent at 10 separate counties in Louisiana, minimum is 14 percent at 5 separate counties in Nevada, and the standard deviation is 15 percent. The coefficient can be interpreted as the additional growth rate that can be explained by a one percentage point increase in average July relative humidity.

The fourth variable is hot summers. Its proxy is county level average July temperature from 1941 to 1970 measured in degrees Fahrenheit. The variable's mean and median is 76 degrees. The maximum is 93.7 degrees at La Paz and Yuma counties, Arizona. The minimum is 55.5 degrees at San Juan, CO. The standard deviation is 5.4 degrees.

The fifth variable is proximity to water. Its proxy is water surface area measured as percent of county area. This variable is measured by dividing a measurement of the county's water area by the county's total area. This variable is modified in two ways.

Because coastal counties and counties bordering the Great Lakes extend three miles into the water, their measurements include relatively large amounts of surface water area. The data I collected included measurements that were limited to 250 square miles in an effort to reduce outlier problems associated with county boundaries extending two miles into the ocean and Great Lakes. The second modification was to take the logarithm of the percentage of water surface area. This is done to strengthen the effect of rivers and lakes among counties with relatively small amounts of water and reduce the effects of greatly endowed counties on the coast and Great Lakes. This modification assumes decreasing utility in water area; for example, the difference between 5 percent and 10 percent in water surface area gives as much value as the difference between 10 and 20 percent.

The mean value of county water surface area, as a percentage of total area, is 4.5 percent. The median is 4.6 percent. The maximum is 75 percent at Essex County, MA, and the minimum is 0 percent at 31 separate counties. The standard deviation is 1.8 percent. The coefficient can be interpreted as the additional population growth rate that can be explained by a one-percentage point increase in water surface area.<sup>4</sup>

The sixth variable distinguishes mountainous counties from all other counties by including a dummy variable. If a county has more than 25 percent of its area delineated as mountainous, the whole county is considered mountainous. In total, there are 281 counties (9.03 percent) that are considered mountainous. The mountainous coefficient can be interpreted as the additional growth rate a county receives from being mountainous.

Two control variables are included in the regression, the county's previous decade's population ( $Pop_{t-1}$ ) (measured in millions) and the county's density ( $Pop_{t-1}/area$ ). The county's previous population ( $Pop_{t-1}$ ) is used as a control for influences correlated with having a larger population. It is an important control for variables that may have influenced migration in previous periods, allowing for a cleaner test of amenities affecting a particular decade's growth rate.

The coefficient for ( $Pop_{t-1}$ ) is interpreted as the additional growth rate that can be attributed to a one million person increase in a county's base population. County level population means range from 26,811 people to 89,928 people while median populations range from 16,636 to 24,784 people. The model has no predictions for this variable.<sup>5</sup>

The second control variable is degree of *crowdedness*; its proxy is density. It represents both the positive and negative affects of people living closely together. Density is calculated for a county by population in t-1 by the county's area. Although the base year population changes from one decade to the next, county area is constant throughout the study's time period.

County area has a mean of 951 square miles, a median of 611 square miles, a maximum of 20,062 square miles for San Bernardino County, CA, and a minimum of 1.8 square miles for Manassas Park City, VA. The standard deviation is 1,303 square miles. The coefficients on density are interpreted as the additional county level population growth rate which can be attributed to a one million person per square mile increase.

It is important to note that this data set, although useful, cannot explain all aspects of migration for the last hundred years in America. Although the data include time series

and regional controls, the regressions have no explicit control for other exogenous effects, for instance exogenous labor demand shocks. Fortunately, data separated by region, state, and time can be used to control for these events.

## THEORETICAL FRAMEWORK

The theoretical model is quite simple and designed to guide the empirical analysis. The theory starts with the assumption that people make rational decisions when choosing a place to live. Potential movers examine possible locations comparing expected benefits and costs. In doing this, many attributes that make up the specific place are considered; for example, the cost of moving, employment and education opportunities, living costs, transportation, school and daycare quality, culture, crime, transportation, healthcare, recreation, and climate. Potential movers also determine the relative importance of each attribute (an importance weight) and compare the quality of each attribute across the individual places. Then to make comparisons, the weighted values of the attributes and their associated expected costs are added up and the place with the greatest net value is chosen.

Each place  $i$  has a bundle of attributes  $A_i = (a_{1i}, a_{2i}, \dots, a_{ni})$ . Each attribute has an associated weight placed upon it by the individual:  $W = (w_1, w_2, \dots, w_n)$ . The value of a place ( $V_i$ ) is the sum of the weighted attributes  $V_i = \sum_{j=1}^n w_j a_{ji}$ . To put this in an easily testable framework, the weighting is analogous to the individual's willingness to pay. People who are maximizing utility choose the place with the largest total value by choosing the largest value  $V_i$  among  $\{V_1, V_2, \dots, V_n\}$ .

An intuitive model can demonstrate how amenities change value when income and the prices of complements and substitutes change. A representative person's utility is a function of a vector of goods, including amenities:  $U = f(\mathbf{x})$ . The person spends income

I on these goods:  $I = \sum_{k=1}^n P_k x_k$ . When the price  $P_1$  of a good  $x_1$  goes down, the resulting

effect is increased demand for complements and decreased demand for substitutes.

Likewise, when income goes up, the resulting effect is increased demand for normal goods and decreased demand for inferior goods. As the demand for goods increases or decreases, so does the respective willingness to pay, which is analogous to a change in the associated weights  $W = (w_1, w_2, \dots, w_n)$  placed upon the attributes  $A_i = (a_{1i}, a_{2i}, \dots, a_{ni})$  of a given place  $i$ .

Figure 9 presents an example of this process. For simplicity, assume a place  $i$  with an amenity, surfing waves ( $a_{1i}$ ), and a complementary technology, surf boards ( $x_1$ ). Also assume a person to whom the amenity is a normal good, which is a surfer  $U = U(a_1)$ . A shock occurs: as the price ( $P_{x_1}$ ) of the complementary technology ( $x_1$ ) goes down, the demand for an amenity shifts out, increasing the area under the demand curve—the willingness to pay or amenity weight—from  $w_0$  to  $(w_0 + w_1)$ . As the willingness to pay increases, the value ( $V_i$ ) associated with the places that have the amenity ( $a_{1i}$ ) also increases.

Starting at equilibrium, place  $i$  with increased value  $V_i$  provides relatively greater utility than places without the amenity, and therefore attracts people. Because people have different preferences some have a relatively greater attraction ( $w_i$ ) to the amenity ( $a_{1i}$ ) and not everyone's value ( $V_i$ ) will increase the same amount given an identical price change. In this way, some people have a greater incentive to move.

Additional migration causes greater density (crowding) and reduces the associated utility gain for other potential movers (assuming crowding has a negative effect on

utility). As crowding reduces the incentive for people to move, additional migration, due to the price change, slows and stops. When utility is equalized across places, the growth rate returns to the steady state. By regressing amenities on growth rates, a connection can be made between changing growth rates, changing values of amenities, and changes in income and the prices of complements and substitutes. Given this theoretical model and acknowledging that we cannot explain behavior by modeling changing tastes and preferences, I maintain that the weight attached to the attributes changes in response to the price of complements or substitutes or to changes in income.

Now assume that a person's demand for an amenity or attribute is downward sloping, having both a choke price and a quantity associated with zero price, and that once a person moves to a place, any quantity of the amenity may be consumed for free. For simplicity, this is an example of a pure public good, although the theory is not limited to this particular case. The entire area under the demand curve is consumer surplus. Demand for amenities, and thus migration motivations, shift with changes in prices of complements, prices of substitutes, and incomes. As the price of an amenity's complements goes down, demand shifts out. In this way, holding preferences constant, the value associated with an amenity increases and people migrate toward those amenities. Additionally, as incomes increase people migrate toward normal amenities.

Examples to which this theory applies include air conditioning, all-wheel drive vehicles, and the Internet. As the price of air conditioning fell from an essentially infinite level, the cost incurred by living in a hot climate was reduced, affecting migration patterns in hot and humid areas. Likewise, as snow-and-ice-handling vehicle technology

improves and becomes cheaper, the cost of living in areas with dangerous winter driving is reduced. Finally, increased Internet technology reduces the cost of communicating from distant locations, possibly increasing the populations of remote, but desirable, places to live.<sup>6</sup>

Using the theoretical model described above, I will develop a set of predictions about whether specific coefficients ( $B_i$ ) are positive or negative. Also, a test of significant change between an amenity's coefficients over time will be developed.

## EMPIRICAL FRAMEWORK

To test my predictions I rely on empirical analyses that are designed to correspond to the theoretical model. Because I want to determine when and by how much the migration effects of the amenities change over time, for each specification, I run a set of ten identical regressions, decade by decade, and compare the amenity's contribution to migration patterns over the last hundred years.

To test for robustness, the results from two different specifications are compared. A vector of state dummy variables is added to the general model to separate regional migration influences. Equation (1) below presents the general model, while equation (2) adds a vector of state control dummy variables (S) to control for constant differences across states.

$$(1) \text{Population}_t / \text{Population}_{t-1} = B_{0t} + B_{1t}(\text{Population}_{t-1}) + B_{2t}(\text{Population Density}_{t-1}) + \\ B_{3t}(\text{January Sun}) + B_{4t}(\text{January Temperature}) + B_{5t}(\text{July Humidity}) + \\ B_{6t}(\text{July Temperature}) + B_{7t}(\text{Log Percent Water}) + B_{8t}(\text{Mountainous}) + e$$

and

$$(2) \text{Population}_t / \text{Population}_{t-1} = B_{0t} + B_{1t}(\text{Population}_{t-1}) + B_{2t}(\text{Population Density}_{t-1}) + \\ B_{3t}(\text{January Sun}) + B_{4t}(\text{January Temperature}) + B_{5t}(\text{July Humidity}) + \\ B_{6t}(\text{July Temperature}) + B_{7t}(\text{Log Percent Water}) + B_{8t}(\text{Mountainous}) + \\ B_{st}(S) + e$$

This model is designed to predict the change in a county's population over a ten year time period that can be attributed to the amenities of interest. This produces coefficients ( $B_{it}$ ) that measure amenity  $i$ 's marginal contribution to the population growth rate for the decade ( $t$ ). The resulting coefficients are described as the additional growth rates brought about by a one-unit increase in the amenity.

At a basic level, the sign of  $B_{it}$  indicates whether the amenity is positively or negatively associated with population growth. For example, a positive coefficient on the January temperature variable suggests that people are attracted to higher winter temperatures, as expected if the willingness to pay ( $w_{\text{winter temperature}}$ ) is positive. Similarly, a negative coefficient means that people are repelled by an amenity. A test of the sign of  $B_{it}$  (for example,  $H_0: B_{it} = 0$  vs.  $H_a: B_{it} > 0$ ) examines whether an amenity  $i$  is a "good" (i.e., associated with positive population change) or not.

Based on the assumption that people living in the United States value mild seasons, mountains, and water, theory predicts positive coefficients ( $B_{it} > 0$ ) associated with winter sunshine ( $B_{\text{January Sun}}$ ), winter temperature ( $B_{\text{January Temperature}}$ ), mountainous counties ( $B_{\text{Mountainous}}$ ), and water area ( $B_{\text{Percent Water}}$ ). Likewise, negative signs are predicted for summertime temperature ( $B_{\text{July Temperature}}$ ) and humidity ( $B_{\text{July Humidity}}$ ).

Because the model is estimated separately by decade,  $B_{it}$  can vary across time, which allows for a changing value ( $w_t$ ) of the associated amenity ( $a_{it}$ ) across time. For example  $B_{i1} < B_{i2}$  implies that people are moving toward an amenity at an increasing rate. Theory tells us that when migration is towards an amenity, all else equal, it is because the amenity's value is increasing. This relates directly to an outward shift of the demand

curve and increased willingness to pay ( $w_i$ ). Therefore, an increasing coefficient (i.e.  $B_{it} > B_{it-1}$ ) indicates the relative value of an amenity is increasing.

I am interested in whether people reacted differently to relatively constant climatic and topographical factors over the last one hundred years. This is a test of the hypothesis:  $H_0: B_{it} = B_{it-1}$  against  $H_a: B_{it} \neq B_{it-1}$ . In other words, has the effect of an amenity on population growth rate changed substantially from one decade to the next (i.e. is the growth rate constant, increasing, or decreasing)? To create a legitimate test of the hypothesis ( $H_0: B_{it} = B_{it-1}$  against  $H_a: B_{it} \neq B_{it-1}$ ) data from the last five decades are pooled together in equation (3), which also includes year dummy variables and amenity-year interaction terms.

$$(3) \text{Population}_t / \text{Population}_{t-1} = B_{0t} + B_{1t}(\text{Population}_{t-1}) + B_{2t}(\text{Population Density}_{t-1}) + \\ B_{3t}(\text{January Sun}) + B_{4t}(\text{January Temperature}) + B_{5t}(\text{July Humidity}) + \\ B_{6t}(\text{July Temperature}) + B_{7t}(\text{Log Percent Water}) + B_{8t}(\text{Mountainous}) + \\ B_{st}(S) + B_{At}(A*t) + B_{yt}(\text{Year}) + e,$$

Where A represents a vector of amenity variables and  $A*t$  represents the interaction between the amenity variables and a set of year dummies.

The resulting coefficients and standard errors from a regression utilizing pooled data provide an unambiguous test of statistically significant differences between  $B_{it}$  and  $B_{it-1}$ . When the interaction terms are statistically significant, the resulting estimated

coefficients are consistent with the idea that the value of an amenity changes over this time period.

I assume that varying preferences do not explain changing migration patterns, and thus the value of an amenity adjusts with regard to changes in the prices of its complements and substitutes or changes in income. Because theory predicts opposite changes in migration patterns for each amenity's income and substitution effects, there is no clear prediction of the resulting coefficient's sign. As a consequence, only the results of empirical testing can provide support as to whether the income or substitution effect has received more emphasis over time.

Note that population change can be measured many ways. This model uses a measurement equivalent to the growth rate as the dependent variable. For each county this measurement is computed by dividing population in time period  $t$  by the population in the previous decade  $t-1$ . Using this measurement is useful because it gives a separate measurement of population change for each decade. This helps control for a county's previous population that, in turn, allows for comparison between counties with different population sizes.<sup>7</sup>

Note also that measuring population change in this manner exaggerates migration among counties with relatively smaller populations, so standard errors from an OLS regression may be biased because of heteroskedasticity. For example, the growth rate associated with a 5000 person migration would be much greater for Gallatin County, Montana, than it would be for Los Angeles County, California. To account for this problem, a generalized least squares (GLS) regression technique, weighted least squares

(WLS), is used in place of ordinary least squares (OLS). Each county's population in  $t-1$  is used as the weight. By using GLS in this manner more weight is given to counties with relatively larger population bases. These GLS estimates are discussed in the next section.

## EMPIRICAL FINDINGS

As preliminary tests of the data, three regressions were run to get an idea of how amenities would predict population. The first test regressed county level population in 1900 on the amenity variables, and the results indicated that people lived in areas that were negatively associated with hours of January sun and January temperature and positively associated with July temperature. I ran the same regression again, this time with county level population in 2000 and the results were opposite; people resided in places that were positively associated with hours of January sun and January temperature and negatively associated with July temperature.

The third test regressed the differences between population in 1900 and 2000 on the amenities. The results indicated that over the last hundred years people moved to counties that were positively correlated with hours of January sun, January temperature, and July humidity and that people had migrated away from July temperature. These preliminary tests explain a broad outlook of changing migration patterns over the century. The results that follow help to fill in the details by looking at how the attraction of amenities has changed from decade to decade.

A brief overview of the regression results provides evidence that amenities account for some level of population migration. In general, the coefficients are significant and robust to regional control. Therefore, population growth rates can be compared across the decades as well as between amenities with confidence.<sup>8</sup> The adjusted  $R^2$  statistic from equation (3) is 0.1411 and the F-test p-value is 0.000. These statistics suggest that

14% of the sample variation in the county's growth rates can be explained by the independent variables and that the independent variables are jointly significant.

The results indicate that over the last hundred years people have been moving toward counties that have less population, more winter sun, warmer winter temperatures, and more water. People tended to move away from summer humidity and temperature until around the 1960's when counties in the South and West with warmer more humid summers experienced positive population growth rates. Because massive events in the earlier half of the century—World War I (1914-1918), The Great Depression (1929-1940), and World War II (1939-1945)—tended to dominate migration patterns in a myriad of complicated ways, coefficients during the second half of the century give a more convincing argument as to the real influence of amenities on migration. What follows is a brief discussion of the regression results, an overview of findings, an examination of the individual variables of interest, and an assessment of the results.

Presented here are the results of estimating equations (1), (2), and (3) from the empirical framework section. Equation (1) and (2) are similar except (2) includes a vector of state control variables. For clarity, the results from these two regressions are presented on one set of graphs (Graphs A-H) allowing the reader to quickly analyze each amenity's changing coefficients across the century while comparing the effects of the state control specification. Table one presents more detailed results from equation (1), table two presents the results from equation (2), table three presents the results from equation (3).

Each equation, (1) and (2), yields a set of ten comparable regressions, one for each decade. Each regression has eight variables of interest, the previous decade's population,

county density, hours of sunny winter days, winter temperature, summer humidity, summer temperature, proximity of water, and mountainous terrain. Each variable has an associated coefficient, estimated by the weighted least squares regression technique. The meaning of the coefficient is interpreted as the additional population growth rate that can be attributed to a one-unit increase in that variable over the previous ten years. The variables of interest are separated into five sections: Dependent and Control Variables, Climate, Landscape, Depression and World War II, and Movement of Ethnic Minorities.

#### Dependent and Control Variables

The dependent variable is a measure of county level population growth rate. It is the percent change in a county's population from one decade to the next. Because the dependent variable is a rate of change, the independent variable's coefficients are describing their additional contribution to the percent change in population over the previous ten-year period.

The previous decade's population is used to control for preexisting variables that may influence migration in the period of interest. Results are presented on Graph A.

This variable has no real economic predictions, although it helps to separate earlier shocks from the effects of variables during the time period of interest.

The second control variable is degree of *crowdedness*, its proxy is density. This variable captures changing responses to population density by predicting the additional population growth rate that can be attributed to an additional one million people per

square mile in the previous decade. The broad nature of this variable suggests possible correlation with other omitted variables.

Graph B indicates that people have been moving away from density at a decreasing rate. The effect during the Great Depression is consistent with the idea that people moved from farms toward cities as agricultural commodity prices fell. Likewise, the negative but increasing growth rates associated with greater density are consistent with the theory that density in itself is not a good, technology has encouraged dispersion, and that filling-in is increasing density at a faster rate than technology can disseminate it. Hence, as population increases over time, living in less dense counties (a good) becomes relatively more costly and people *choose* to live in greater density.<sup>9</sup>

#### Climate Variables

The first climate variable is clear winter skies with sunshine. Its proxy is average hours of January sunlight. Graph C presents results supporting winter sunshine's positive affect on migration rates ( $B_{3t} > 0$ ). This variable, like others, reports a contradicting movement during the 1930's and 1940's, the general trend is that the coefficients remain positive. For example, the estimated coefficient for January Sunshine from equation (1) during the 1980's is .0011 meaning that for an additional standard deviation of sun light (33.1 hours) the regression predicts a .0364 percentage point increase in the county level population growth rate. To put this in perspective, between 1980 and 1990 average county population increased from 72,464 to 79,452 people, this corresponds to an

average county growth rate of 9.643 percent or 6,988 people per year. Given this example, the .0364 percentage point increase in the growth rate that can be attributed to a county having one standard deviation of winter sunlight above average relates to an additional 26 people per year. Results from equation (3) support these findings; the January sunlight coefficient is positive and the interaction terms are negative and statistically different than zero. This finding supports the theory's prediction that sunny winters are a good and have decreased in value over the last five decades.

The second variable is warm winters. Its proxy is average January temperature. Theory suggests people migrate toward warmer winters as incomes increase, but away as technology that reduces the discomfort of cold weather gets cheaper. Graph D presents results supporting the income effect's positive affect on migration rates ( $B_{4t} > 0$ ). For example, in 1980 equation (1) yielded 0.005876 for the coefficient on January temperature. This means that for an additional standard deviation of January temperature (12 degrees F) the regression predicts a .070512 percentage point increase in the county level population growth rate. Using the example above, this corresponds to an additional 51 people per year. Results from equation (3) support the idea that warmer winter temperatures are a good; the coefficient is positive and the interaction terms are statistically significant.<sup>10</sup>

The third and fourth variables are summer humidity and temperature. Their proxies are Average July humidity and Average July temperature, respectively. Theory suggests people move away from summer heat and humidity as incomes increase, but toward areas

with greater amounts of heat and humidity as the price of compensating technology decreases.

Graphs E and F present seemingly contradictory results; in each case the coefficients supplied by equation (1) are negative and equation (2) are positive. These contrasting results show that when state effects are held constant the resulting coefficients are of opposite sign. This result may be due to the heterogeneous nature of country wide temperature and humidity compared to the relatively homogeneous nature of state temperature and humidity. The results from equation (3) suggest that people migrate away from warmer summer temperature and humidity and that they do so with statistically significant differences over time.<sup>11 12 13</sup>

### Landscape Variables

The first landscape variable, percent of water area, is a proxy for proximity to water. Graph G shows the effect of a one-percent increase in water area. The results indicate that people migrated toward greater amounts of water, at a decreasing rate, across the century ( $B_{7t} > 0$ ). The results from equation (3) support this finding. Percent water coefficient is positive and the interaction terms are all negative and statistically significant.

The second landscape variable distinguishes mountainous counties. The coefficient is interpreted as the additional growth rate that can be attributed to a county from being mountainous. Theory suggests that if mountains are considered goods, people will move

toward them as incomes increase and as the price of complementary mountain technology decreases. Specifically, as transportation technology has become better in the last three decades, theory predicts migration towards mountainous places.

Graph H indicates that mountains have had mixed influences on migration over the century. The results from equation (2) results show positive coefficients increasing in the 1950's, 1970's, and 1980's. These results support the idea that mountains are goods and their relative value has sporadically increased over the century.

The fact that results change when state controls are removed is evidence that mountains are valued differently throughout the country. The results indicate that the effects of different mountain ranges on population are not the same, mountains are heterogeneous.<sup>14</sup>

### Black Diaspora

An additional set of regressions uses state level black population growth rates as the dependent variable. This tests for migration differences that could be attributed to being black, and the serious discrimination that occurred throughout the south, and elsewhere, for most of the century. In particular, two tests are developed. The first examines whether differences exist between what black people have historically considered amenities was significantly different than non-blacks. The second test examines if there were significant migration rate changes during 1950's, 1960's and 1970's, the time period of "Black Diaspora."

Results indicate that black people are attracted to the same amenities as non-black people and that the growth rates were statistically different during the 1950's, 1960's, and 1970's, indicating a major shock in the 1950's that affected blacks differently than the population as a whole. Results are summarized on Table 7.

### The Great Depression

For almost each amenity a clear and atypically signed effect occurred during the 1930's, the decade of the Great Depression. It is not surprising that as the growth rate of income changes direction so do the growth rates of amenities that are considered goods. I attribute part of the reason for these dramatic migration changes to this income effect.

Also, these moving patterns are not entirely surprising when one thinks about the characteristics of the marginal mover during this time period. Before the Depression, the better farmland had been settled leaving less valuable land for new immigrants. During the Depression incomes fell, causing a reduction in demand for some commodities. This shift resulted in lower commodity prices and brought about the closing of some farmland. This probably happened on the least productive land; the people moving out had previously farmed less productive land, and their moving patterns were directly opposite of the previous decade's migration patterns.

Migration during the Great Depression is a complex topic, and with different data a better understanding of migration in this time period could be developed. In particular, the question of why growth rates that are associated with amenities are large and in

opposite direction during the Great Depression could be addressed. An ideal data set would include yearly migration rates and information as to the origin of migration. With this information one could decipher when, where, and to what extent migration happened.

### World War II

Because the current data set use population separated by decades, the effects of World War II get lost in the middle of the 1940's. Population totals for the year 1945 would add clarity to the current tests. With these data, migration rates before, during, and after the war could be separated, most likely finding that migrants were attracted to industry that supported the war effort.

### Air Conditioning

Although a test of air conditioning's effect on summertime amenities may be partly captured by comparing the regional differences in growth rates, a more precise test is needed to be more convincing. Helpful data would include statistics on air conditioner sales during the 1960's and 1970's. With this information, a more precise hypothesis could be tested, which would strengthen the argument for air conditioning's effect in changing the value of summer humidity and temperature.

## CONCLUSION

While recognizing the limitations, the data used in this study do a good job of answering some broad questions, for example: Have people reacted differently to relatively constant climatic and topographical factors over the last one hundred years? However, these data do not do as good a job of answering specific questions; capturing events that happened in between decades or tests of specific correlation are beyond the scope of county and decade level data. Consequently, this paper's implications suggest paths for future research. Three examples of proposed future research are given.

First, this work could be extended to consider the relationships between specific innovations, for example, the Internet, recreation equipment, vehicle technology, and migration patterns. With additional research, one could examine in more detail the connection between amenity-driven migration patterns and other factors, such as wage rates, property values, and associated cost of living differentials.

Second, this work would benefit from a better understanding of the relationship between a places wage rates, cost of living differentials, and given set of amenities. One way to attempt this is to use a cross section of metropolis level data and test if amenities and other attributes explain the income differential. Because data can be more precise at the metropolis level than at the county level, tests of amenity value can be more accurate and believable.

Third, geographic information system (GIS) technology is creating data sets that may be linked together at greater levels of detail. This would make it possible to measure the

value of urban amenities, including city parks, architecture, planning, and trail systems. GIS technology works well for this because it can connect broad economic shocks to detailed information. For example, the effects brought about by the creation of new parks or trail systems can be linked to individual city parcels which, when coupled with tax data can be linked to very specific data about changes in the sale price and physical nature of the property.

The results of this thesis indicate that over the last hundred years people have been moving toward counties that have lower population, more winter sun, warmer winter temperatures, and more water. Also, people migrate towards amenities at different rates over time. These results support the hypothesis that the values people place on amenities are constantly changing with respect to both changing incomes and the changing prices of complementary technology. By empirically testing my hypothesis, this thesis contributes new knowledge about the changing significance of natural amenities on population movement. This information, while interesting in its own right, will also lay a foundation for further exploration in this area.

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<sup>1</sup> To illustrate these changes, consider that prior to the 1960's, migration patterns in the Northeast and South were increasingly away from summer humidity and temperature. The combination of these attributes can be especially uncomfortable and it is typical to think of them repelling people. However, during the 1960's and 1970's the price of air conditioning decreased, and correspondingly, the cost of living in warm, humid places diminished. As a result, migration patterns changed dramatically. People started migrating toward places that were warmer and more humid, indicating they were less repelled by hot weather when it could be conditioned relatively cheaply. In this respect, air conditioning reduced the value of a naturally cool and dry summer.

<sup>2</sup> Including a variable to control for income is important to account for potential omitted variable bias. As a test of robustness a regression was run including county level income for the decades that data was available. The results indicated no significant changes in the regression results with the inclusion of an income control variable. These results are in the same nature of Graves (1980) earlier findings. The results from this regression are reported on table five.

Also, note the time periods that may include migration patterns correlated with income are defined by historical irregularity and significance—The Great Depression (1929-1940), World War I (1914-1918) and World War II (1939-1945). Examining the effects these events had on migration patterns is a topic worthy

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of investigation, but beyond the scope of this paper. Given that the problematic time periods are easily identified, results corresponding to these time periods can be discounted accordingly.

<sup>3</sup> No market based data or perfect measures of willingness to pay for amenities exist. Consequently climate and geographic characteristics were selected because they are relatively constant and available during the scope and duration of interest.

<sup>4</sup> Twelve counties with zero water area are dropped from the regression because log 0 is undefined.

<sup>5</sup> For ease of interpretation, the coefficients for previous population and previous density are reported in terms of millions of people.

<sup>6</sup> Note that increasing energy prices in the 1970's could reduce the effect of technology dependent on energy.

<sup>7</sup> A set of regressions using difference in natural logs as the dependent variable was run yielding similar results. The results from this regression are reported on table six.

<sup>8</sup> An effect of the GLS technique is each regression's  $R^2$  is extraordinarily high (.95 to .99). The  $R^2$  measurement is the coefficient of determination; it is a measurement of a regression's "goodness of fit." The fact that it is high usually means the sample regression line fits the data almost perfectly, with relatively small residuals, hence predicting the dependent variable precisely. In this case,  $R^2$  is misleading because of the GLS technique; additional weight is given to higher populations whose growth rate changes are relatively small and well predicted by the model, therefore  $R^2$  is high. To produce a better measurement of  $R^2$ , adjusted  $R^2$  measurements the pooled regression set (equation (3)) is used and reported on table three.

<sup>9</sup> In regressions that control for regional differences, direction and sign of coefficients are comparable between the Northeast, South, and West, although they vary in magnitude. The Northeast's coefficients are smaller than the South's and West's. This result supports the filling-in theory because the Northeast is denser, and correspondingly, people in the Northeast face greater costs to live in less density.

<sup>10</sup> Controlling for regional differences provides information on separate regional effects. For each region the growth rates associated with warmer winters tend to be positive and decreasing over time. Of interest is the greater magnitude of the West's coefficients indicating that warmer winters have a greater effect there than in the Northeast and South.

<sup>11</sup> These results support the theory that humid summers repelled migration until the sixties when the price of complementary technology decreased. The falling price resulted in increased demand for humid places and relatively greater attraction to humid places. The results of which can be seen by examining humidity's negative but increasing growth rates on Graph E and F.

<sup>12</sup> During the 1960's and 1970's, population growth rates associated with increases in July temperature in the South and West increased dramatically, while growth rates in the Northeast fell.

<sup>13</sup> Graph F presents results for summer temperature. The contradicting results between regionally and state controlled regressions indicate differences in reactions to summertime temperature, most likely due to the compounding nature of temperature and humidity.

<sup>14</sup> The results regressions with regional controls suggest that migration in the Northeast has been consistently away from mountains, at a slightly decreasing rate; this suggests that mountains in the Northeast are not considered a good. Mountainous counties in the south have been attracting people, also at a decreasing rate; this indicates mountains in the South are a good, but, becoming less important. Positive coefficients for the West indicate attraction towards mountains for all but two decades.

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APPENDICES

APPENDIX A:

DATA

## Data Descriptions

Variable name	Definition	Units of Measurement	Source
Population	Number of people in county	Person	U.S. Census Bureau
GROWTH RATE (dependant variable)	Population in t divided by population in t-1	Percent	U.S. Census Bureau
POPt-1	Population in the previous decade	Millions of people	U.S. Census Bureau
POPt-1/SQUAREMILE	Population in t-1 divided by area	Density	U.S. Census Bureau
JANUARY SUNSHINE	Average hours of January sunlight from 1941 to 1970	Hours	Economic Research Service
JANUARY TEMPERATURE	Average January temperature from 1941 to 1970	Degrees F	Economic Research Service
JULY HUMIDITY	Average July relative humidity from 1941 to 1970	Percent	Economic Research Service
JULY TEMPERATURE	Average July temperature from 1941 to 1970	Degrees F	Economic Research Service
LOG (PERCENT WATER)	Log of the percent county area considered water times 100	Percent	Economic Research Service
MOUNTAINOUS	Defines whether a county is mountainous or not	Dummy variable	Economic Research Service

Summary Statistics

Population Statistics

	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Mean	26810.7	31245.2	34542.7	39705.0	42584.1	48670.9	57572.0	65100.9	72464.0	79452.4	89927.1
Median	16635.5	17679.0	17781.0	17679.0	18647.0	18648.0	18408.0	18649.0	21725.0	22261.0	24784.0
Maximum	2050600.0	2762522.0	3053017.0	3982123.0	4063342.0	4508792.0	6038771.0	7032075.0	7477503.0	8863164.0	9519338.0
Minimum	4.0	65.0	37.0	52.0	43.0	58.0	47.0	64.0	66.0	52.0	67.0
Std. Dev.	73562.9	94542.8	108145.4	135389.7	144023.6	169319.3	204474.9	229315.3	236930.6	264728.7	293514.8
Observations	2814.0	2940.0	3057.0	3089.0	3089.0	3092.0	3097.0	3104.0	3107.0	3109.0	3109.0

Amenity Statistics

	January Sunlight Mean Hours	January Temp. Degrees F	July Humidity Percent	July Temp. Degrees F	County Area Square Mile	Mountains Dummy	Water Area Percent	Water Area Natural log*100
Mean	151.6	32.9	56.1	75.9	951.3	0.1	4.6	4.6
Median	152.0	33.1	59.0	76.4	611.0	0.0	0.9	4.5
Maximum	266.0	67.2	80.0	93.7	20062.2	1.0	75.0	8.9
Minimum	48.0	1.1	14.0	55.5	1.8	0.0	0.0	0.0
Std. Dev.	33.1	12.0	14.6	5.4	1302.7	0.3	11.3	1.8
Observations	3111.0	3111.0	3111.0	3111.0	3111.0	3111.0	3111.0	3111.0

Correlation Coefficients

	JANUARY SUNSHINE	JANUARY TEMPERATURE	JULY HUMIDITY	JULY TEMPERATURE	LOG (PERCENT WATER)	MOUNTAINOUS
JANUARY SUNSHINE	1.0000	0.2891	-0.1785	0.4478	-0.2310	-0.1882
JANUARY TEMPERATURE	0.2891	1.0000	0.2776	0.7210	0.0660	-0.0171
JULY HUMIDITY	-0.1785	0.2776	1.0000	0.1680	0.2967	-0.1191
JULY TEMPERATURE	0.4478	0.7210	0.1680	1.0000	-0.0654	-0.3117
LOG (PERCENT WATER)	-0.2310	0.0660	0.2967	-0.0654	1.0000	-0.1102
MOUNTAINOUS	-0.1882	-0.0171	-0.1191	-0.3117	-0.1102	1.0000

APPENDIX B:  
TABLES AND GRAPHS

Table One: Results From Equation (1) Coefficients and Standard Errors

	1900's	1910's	1920's	1930's	1940's	1950's	1960's	1970's	1980's	1990's
POPt-1	-0.0162	-0.0066	0.0056	-0.0122	-0.0140	-0.0243	-0.0201	-0.0182	-0.0151	-0.0101
<i>Standard Error</i>	<i>0.0065</i>	<i>0.0052</i>	<i>0.0050</i>	<i>0.0011</i>	<i>0.0017</i>	<i>0.0024</i>	<i>0.0014</i>	<i>0.0010</i>	<i>0.0008</i>	<i>0.0006</i>
POPt-1/SQUAREMILE	1.4700	-4.5100	-6.7300	-1.1400	-3.1200	-6.9500	-4.8800	-4.9000	-1.0400	-0.8550
<i>Standard Error</i>	<i>0.1450</i>	<i>0.1120</i>	<i>0.1540</i>	<i>0.0690</i>	<i>0.1070</i>	<i>0.1800</i>	<i>0.1810</i>	<i>0.1760</i>	<i>0.1950</i>	<i>0.1790</i>
JANUARY SUNSHINE	-0.0004	0.0002	0.0031	0.0007	0.0005	0.0018	0.0009	0.0006	0.0011	0.0004
<i>Standard Error</i>	<i>0.0002</i>	<i>0.0002</i>	<i>0.0002</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
JANUARY TEMPERATURE	0.0064	0.0056	0.0094	0.0036	0.0119	0.0071	0.0054	0.0079	0.0059	0.0039
<i>Standard Error</i>	<i>0.0007</i>	<i>0.0006</i>	<i>0.0008</i>	<i>0.0002</i>	<i>0.0004</i>	<i>0.0005</i>	<i>0.0004</i>	<i>0.0003</i>	<i>0.0002</i>	<i>0.0002</i>
JULY HUMIDITY	-0.0068	-0.0039	-0.0049	-0.0006	-0.0073	-0.0063	-0.0035	-0.0051	-0.0035	-0.0039
<i>Standard Error</i>	<i>0.0007</i>	<i>0.0006</i>	<i>0.0008</i>	<i>0.0002</i>	<i>0.0004</i>	<i>0.0005</i>	<i>0.0003</i>	<i>0.0003</i>	<i>0.0002</i>	<i>0.0002</i>
JULY TEMPERATURE	-0.0072	-0.0058	-0.0122	0.0016	-0.0103	-0.0023	-0.0024	0.0006	-0.0032	0.0021
<i>Standard Error</i>	<i>0.0012</i>	<i>0.0012</i>	<i>0.0014</i>	<i>0.0004</i>	<i>0.0006</i>	<i>0.0010</i>	<i>0.0007</i>	<i>0.0006</i>	<i>0.0005</i>	<i>0.0004</i>
LOG(PERCENTWATER)	0.2868	0.2533	0.3875	0.0856	0.0813	0.1678	0.0831	0.0026	-0.0189	-0.0100
<i>Standard Error</i>	<i>0.0153</i>	<i>0.0172</i>	<i>0.0224</i>	<i>0.0073</i>	<i>0.0115</i>	<i>0.0185</i>	<i>0.0132</i>	<i>0.0104</i>	<i>0.0081</i>	<i>0.0068</i>
MOUNTAINS	0.1556	0.0246	0.1579	0.0499	-0.0299	-0.0058	-0.0792	-0.0601	0.0071	-0.0232
<i>Standard Error</i>	<i>0.0136</i>	<i>0.0134</i>	<i>0.0165</i>	<i>0.0051</i>	<i>0.0081</i>	<i>0.0130</i>	<i>0.0099</i>	<i>0.0081</i>	<i>0.0066</i>	<i>0.0058</i>
C	1.5373	1.2506	1.0512	0.6335	1.8203	1.0192	1.1227	1.0024	1.2200	1.0241
<i>Standard Error</i>	<i>0.1026</i>	<i>0.1044</i>	<i>0.1303</i>	<i>0.0410</i>	<i>0.0635</i>	<i>0.0960</i>	<i>0.0704</i>	<i>0.0570</i>	<i>0.0457</i>	<i>0.0393</i>

Table Two: Results From Equation (2) Coefficients and Standard Errors (State coefficients omitted)

	1900's	1910's	1920's	1930's	1940's	1950's	1960's	1970's	1980's	1990's
POPt-1	-0.0124	0.0585	-0.0304	-0.0156	-0.0451	-0.0721	-0.0476	-0.0450	-0.0223	-0.0122
<i>Standard Error</i>	<i>0.0116</i>	<i>0.0087</i>	<i>0.0073</i>	<i>0.0016</i>	<i>0.0030</i>	<i>0.0043</i>	<i>0.0022</i>	<i>0.0013</i>	<i>0.0010</i>	<i>0.0007</i>
POPt-1/SQUAREMILE	-0.2560	-6.3500	-10.0000	-2.7000	-2.8000	-8.1000	-5.7700	-4.0100	-0.9230	-1.0800
<i>Standard Error</i>	<i>0.2550</i>	<i>0.1790</i>	<i>0.1790</i>	<i>0.0773</i>	<i>0.1520</i>	<i>0.2530</i>	<i>0.2410</i>	<i>0.2030</i>	<i>0.2190</i>	<i>0.1930</i>
JANUARY SUNSHINE	0.0002	0.0008	0.0049	0.0006	0.0006	0.0031	0.0015	0.0012	0.0016	0.0004
<i>Standard Error</i>	<i>0.0003</i>	<i>0.0003</i>	<i>0.0003</i>	<i>0.0001</i>	<i>0.0002</i>	<i>0.0003</i>	<i>0.0002</i>	<i>0.0001</i>	<i>0.0001</i>	<i>0.0001</i>
JANUARY TEMPERATURE	-0.0035	-0.0026	0.0069	0.0063	0.0036	0.0033	0.0040	0.0097	-0.0025	0.0011
<i>Standard Error</i>	<i>0.0019</i>	<i>0.0017</i>	<i>0.0020</i>	<i>0.0006</i>	<i>0.0012</i>	<i>0.0019</i>	<i>0.0014</i>	<i>0.0010</i>	<i>0.0008</i>	<i>0.0006</i>
JULY HUMIDITY	-0.0009	0.0029	0.0068	0.0009	0.0011	0.0027	0.0040	0.0005	0.0008	0.0005
<i>Standard Error</i>	<i>0.0014</i>	<i>0.0011</i>	<i>0.0012</i>	<i>0.0004</i>	<i>0.0006</i>	<i>0.0009</i>	<i>0.0006</i>	<i>0.0004</i>	<i>0.0003</i>	<i>0.0002</i>
JULY TEMPERATURE	0.0238	0.0164	0.0188	0.0077	0.0142	0.0098	0.0062	-0.0013	0.0096	0.0056
<i>Standard Error</i>	<i>0.0025</i>	<i>0.0021</i>	<i>0.0023</i>	<i>0.0007</i>	<i>0.0013</i>	<i>0.0019</i>	<i>0.0014</i>	<i>0.0010</i>	<i>0.0008</i>	<i>0.0006</i>
LOG(PERCENTWATER)	0.2201	0.1837	0.1979	0.0100	0.0741	0.0678	0.0084	-0.0597	-0.0390	-0.0150
<i>Standard Error</i>	<i>0.0160</i>	<i>0.0158</i>	<i>0.0184</i>	<i>0.0059</i>	<i>0.0116</i>	<i>0.0195</i>	<i>0.0141</i>	<i>0.0098</i>	<i>0.0080</i>	<i>0.0066</i>
MOUNTAINS	0.1880	0.0871	0.2685	0.0626	0.0405	0.1347	0.0055	0.0415	0.0501	-0.0032
<i>Standard Error</i>	<i>0.0140</i>	<i>0.0119</i>	<i>0.0132</i>	<i>0.0042</i>	<i>0.0084</i>	<i>0.0144</i>	<i>0.0112</i>	<i>0.0078</i>	<i>0.0063</i>	<i>0.0050</i>

Table Three: Results From Equation (3) Coefficients and Standard Errors for Amenity-Year Interaction Terms

	Amenity Slope	A*Year 2 (1960's)	A*Year 3 (1970's)	A*Year 4 (1980's)	A*Year 5 (1990's)
Constant	1.1936				
Standard Error	0.1370				
P>[t]	0.0000				
Year Dummy		-0.2835	0.1242	-0.2686	-0.1802
Standard Error		0.1499	0.1499	0.1499	0.1499
P>[t]		0.0590	0.4070	0.0730	0.2290
JANUARY SUNSHINE	0.0011	-0.0007	-0.0009	-0.0007	-0.0011
Standard Error	0.0002	0.0002	0.0002	0.0002	0.0002
P>[t]	0.0000	0.0030	0.0010	0.0090	0.0000
JANUARY TEMPERATURE	0.0060	-0.0015	0.0025	0.0004	-0.0008
Standard Error	0.0010	0.0009	0.0009	0.0009	0.0009
P>[t]	0.0000	0.1030	0.0070	0.6600	0.3770
JULY HUMIDITY	-0.0015	0.0013	-0.0018	0.0002	-0.0004
Standard Error	0.0006	0.0005	0.0005	0.0005	0.0005
P>[t]	0.0080	0.0170	0.0010	0.6610	0.5100
JULY TEMPERATURE	-0.0089	0.0053	0.0026	0.0055	0.0076
Standard Error	0.0018	0.0022	0.0022	0.0022	0.0022
P>[t]	0.0000	0.0170	0.2350	0.0140	0.0010
PERCENTWATER	0.4203	-0.0101	-0.0216	-0.0242	-0.0323
Standard Error	0.0031	0.0042	0.0042	0.0042	0.0042
P>[t]	0.0000	0.0160	0.0000	0.0000	0.0000
MOUNTAINS	-0.0464	0.0587	0.1328	0.0650	0.0922
Standard Error	0.0166	0.0229	0.0229	0.0229	0.0229
P>[t]	0.0050	0.0100	0.0000	0.0050	0.0000
Adjusted R^2	0.1411				
Prob > F	0.0000				
Prob > F (interactions only)	0.0000				

Table Four: Equation (1) with County Level Per Capita Income Variable: A Test of Robustness (popt-1 in Millions)

	1960's	1970's	1980's	1990's
POPULATION in t-1	-0.0211	-0.0187	-0.0147	-0.0097
<i>Standard Error</i>	0.0014	0.0010	0.0008	0.0006
POPULATION t-1/SQUAREMILE	-5.5800	-4.8900	-1.2700	-1.1500
<i>Standard Error</i>	0.1920	0.1730	0.2000	0.1890
JANUARY SUNSHINE	0.0008	0.0006	0.0011	0.0005
<i>Standard Error</i>	0.0001	0.0001	0.0001	0.0001
JANUARY TEMPERATURE	0.0055	0.0076	0.0060	0.0039
<i>Standard Error</i>	0.0004	0.0003	0.0002	0.0002
JULY HUMIDITY	-0.0033	-0.0050	-0.0037	-0.0040
<i>Standard Error</i>	0.0003	0.0003	0.0002	0.0002
JULY TEMPERATURE	-0.0010	0.0017	-0.0030	0.0023
<i>Standard Error</i>	0.0007	0.0006	0.0005	0.0004
LOG(PERCENTWATER)	0.0688	-0.0058	-0.0184	-0.0069
<i>Standard Error</i>	0.0130	0.0102	0.0080	0.0068
MOUNTAINS	-0.0743	-0.0539	0.0077	-0.0225
<i>Standard Error</i>	0.0097	0.0080	0.0065	0.0058
INCOME in t	0.0000	0.0000	0.0000	0.0000
<i>Standard Error</i>	0.0000	0.0000	0.0000	0.0000
C	0.9194	0.8055	1.1787	0.9723
<i>Standard Error</i>	0.0723	0.0587	0.0468	0.0410

Mean	3245.751	8183.733	15286.04	22700.89
Median	3213	8053	14863	21833
Maximum	8547	19335	48084	90901
Minimum	1332	2706	5496	6606
Std. Dev.	762.5248	1872.327	3547.126	5706.679
Observations	3051	3051	3055	3055

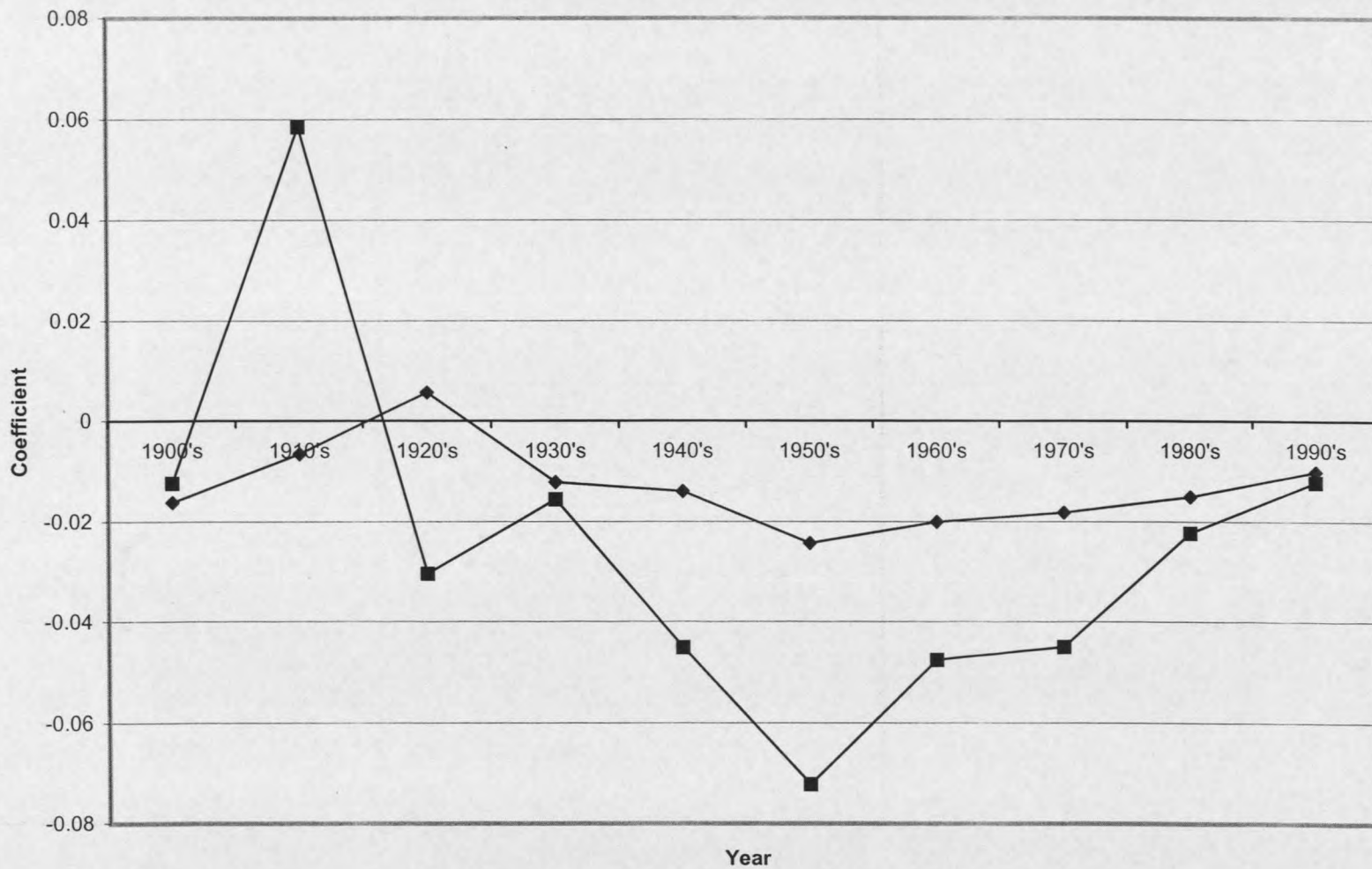
Table Five: Equation (1) with Difference in Logs as the Dependant Variable: A Test of Robustness (Pop t-1 in Millions)

	1900's	1910's	1920's	1930's	1940's	1950's	1960's	1970's	1980's	1990's
POPt-1	0.0101	0.3140	0.3650	0.0179	0.2060	0.1950	0.0765	-0.0659	0.0280	-0.0092
<i>Standard Error</i>	0.1300	0.0622	0.0571	0.0221	0.0291	0.0267	0.0166	0.0134	0.0107	0.0091
POPt-1/SQUAREM	3.4200	-11.2000	-12.5000	-1.0900	-7.1500	-11.2000	-6.1100	-9.0100	-3.0200	-2.4600
<i>Standard Error</i>	6.4600	3.0500	3.6300	1.8500	2.5100	2.5700	2.0800	1.9400	1.7800	1.6400
JANUARY SUNSH	0.0019	0.0004	0.0014	-0.0001	0.0001	0.0008	0.0003	0.0004	0.0007	0.0003
<i>Standard Error</i>	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
JANUARY TEMPEI	0.0057	0.0004	0.0050	0.0052	0.0065	0.0056	0.0050	0.0079	0.0068	0.0056
<i>Standard Error</i>	0.0009	0.0006	0.0006	0.0003	0.0004	0.0005	0.0004	0.0004	0.0003	0.0003
JULY HUMIDITY	-0.0002	-0.0004	-0.0022	-0.0004	-0.0008	-0.0006	0.0002	-0.0021	-0.0006	-0.0012
<i>Standard Error</i>	0.0006	0.0003	0.0004	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002
JULY TEMPERATL	-0.0078	0.0006	-0.0054	-0.0091	-0.0142	-0.0147	-0.0101	-0.0113	-0.0104	-0.0079
<i>Standard Error</i>	0.0022	0.0013	0.0015	0.0008	0.0011	0.0012	0.0009	0.0009	0.0007	0.0007
LOG(PERCENTW#	-0.0349	0.0274	-0.0294	0.0246	0.0339	0.0769	0.0693	0.0608	0.0556	0.0412
<i>Standard Error</i>	0.0135	0.0084	0.0096	0.0048	0.0068	0.0076	0.0060	0.0055	0.0046	0.0044
MOUNTAINS	-0.0573	0.0065	-0.0094	0.0470	-0.0478	-0.0730	-0.0099	0.0556	-0.0009	0.0249
<i>Standard Error</i>	0.0224	0.0139	0.0157	0.0080	0.0112	0.0125	0.0098	0.0090	0.0075	0.0072
C	0.9015	-0.0826	0.2478	0.5633	0.8617	0.7729	0.4783	0.7014	0.4440	0.4717
<i>Standard Error</i>	0.1467	0.0900	0.1015	0.0515	0.0726	0.0810	0.0635	0.0583	0.0488	0.0467
Adjusted R <sup>2</sup>	0.1574	0.0139	0.0824	0.1378	0.1000	0.1102	0.1229	0.2276	0.2202	0.1641

Table Six: Equation (1) with Black Population included: Coefficients and Standard Errors (Popt-1 in Millions)

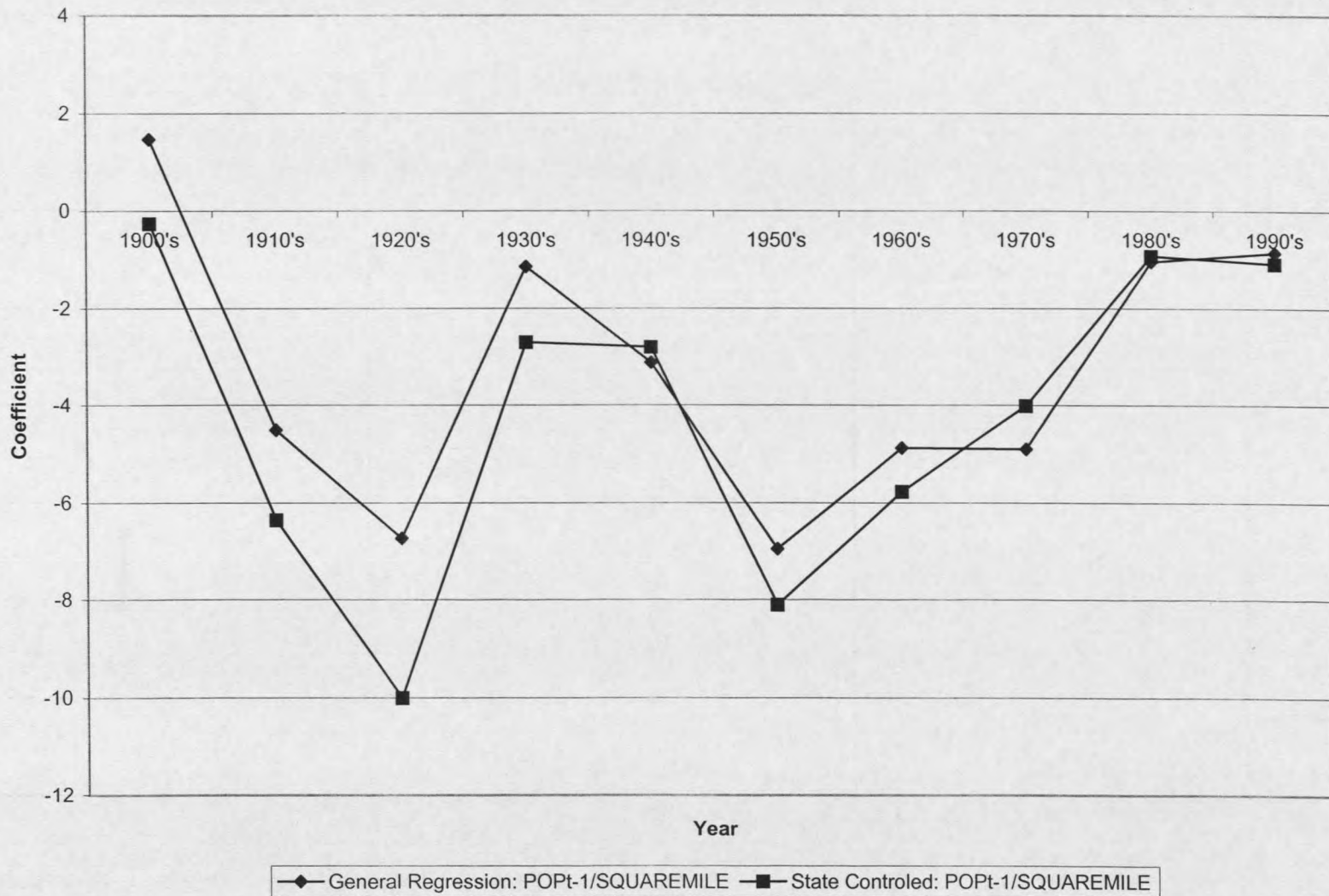
	1900's	1910's	1920's	1930's	1940's	1950's	1960's	1970's	1980's
POPt-1	0.0209	-0.1300	-0.3900	-0.0778	-0.0778	-0.3210	0.1680	-0.0014	0.0871
<i>Standard Error</i>	0.0065	0.0067	0.0109	0.0053	0.0053	0.0146	0.0094	0.0024	0.0025
POPt-1/SQUAREMILE	4.3900	7.6800	-8.1000	-5.3900	-5.3900	6.0500	4.7100	-0.7460	-0.1800
<i>Standard Error</i>	0.9470	0.9990	1.5800	0.7640	0.7640	1.5800	0.7690	0.1840	0.1920
JANUARY SUNSHINE	0.0007	0.0013	0.0001	0.0000	0.0000	0.0003	-0.0001	0.0008	0.0007
<i>Standard Error</i>	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
JANUARY TEMPERATURE	0.0023	-0.0002	0.0007	0.0015	0.0015	0.0028	-0.0006	0.0037	0.0040
<i>Standard Error</i>	0.0004	0.0004	0.0007	0.0003	0.0003	0.0006	0.0004	0.0002	0.0002
JULY HUMIDITY	-0.0001	-0.0006	-0.0023	-0.0016	-0.0016	-0.0086	-0.0078	-0.0015	-0.0003
<i>Standard Error</i>	0.0001	0.0002	0.0003	0.0001	0.0001	0.0003	0.0002	0.0001	0.0001
JULY TEMPERATURE	-0.0007	-0.0067	-0.0126	-0.0076	-0.0076	-0.0318	-0.0252	-0.0057	-0.0050
<i>Standard Error</i>	0.0008	0.0010	0.0015	0.0006	0.0006	0.0013	0.0008	0.0003	0.0003
LOG(PERCENTWATER)	0.0097	0.0169	0.0190	0.0171	0.0171	0.0745	0.0731	0.0167	0.0125
<i>Standard Error</i>	0.0024	0.0029	0.0044	0.0019	0.0019	0.0055	0.0044	0.0019	0.0021
MOUNTAINS	0.0044	-0.0102	-0.0582	-0.0339	-0.0339	-0.0922	-0.0403	-0.0157	-0.0059
<i>Standard Error</i>	0.0047	0.0056	0.0086	0.0037	0.0037	0.0101	0.0078	0.0033	0.0037
C	0.9196	1.4811	2.4972	1.7638	1.7638	4.2536	3.3688	1.4276	1.1275
<i>Standard Error</i>	0.0620	0.0738	0.1122	0.0448	0.0448	0.0948	0.0615	0.0243	0.0264
Adjusted R <sup>2</sup>	0.9962	0.9934	0.9828	0.9965	0.9965	0.9716	0.9815	0.9964	0.9953

Graph A: Coefficients for POpt-1

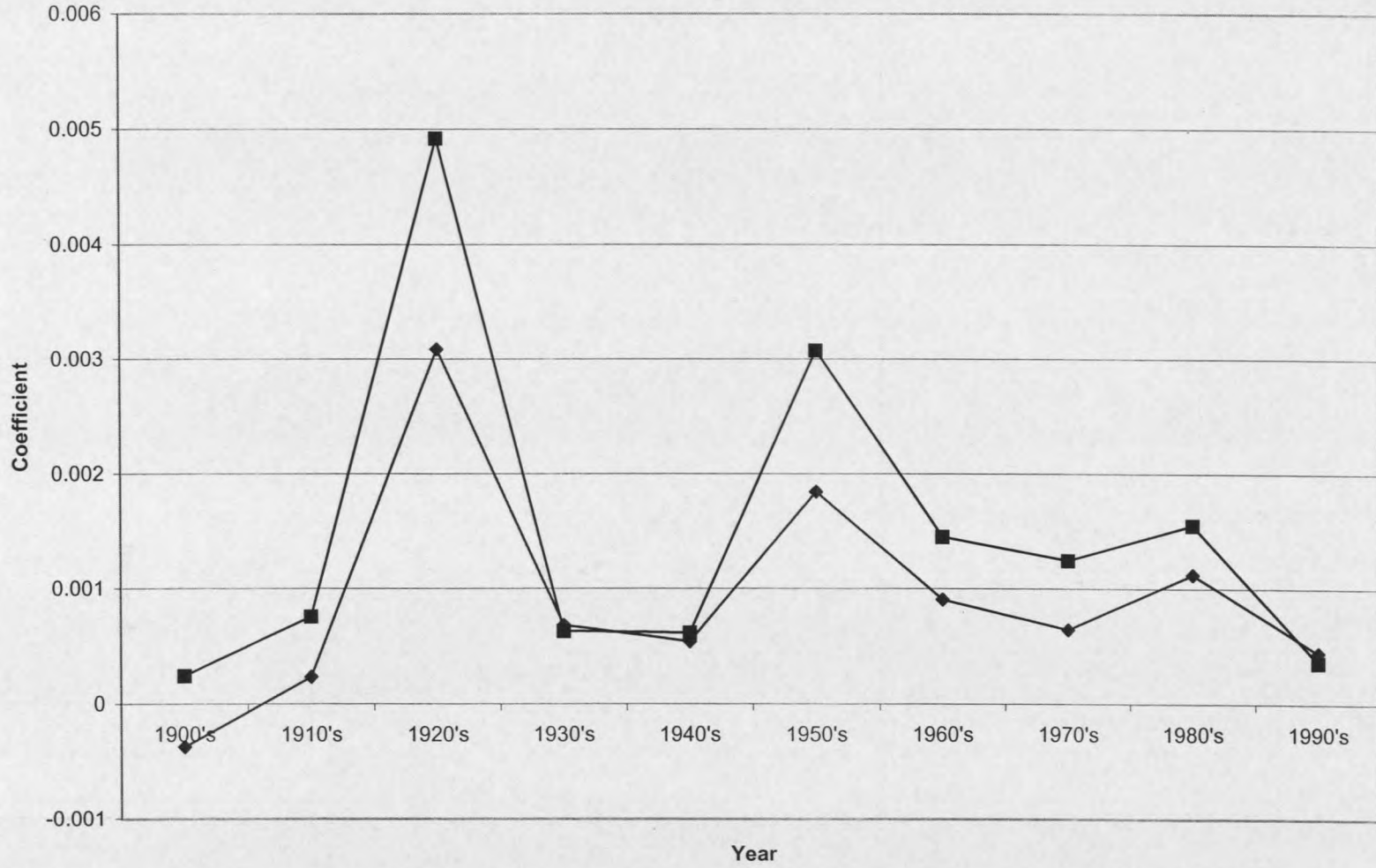


◆ General Regression: POpt-1    ■ State Controlled: POpt-1

Graph B: Coefficients for Density

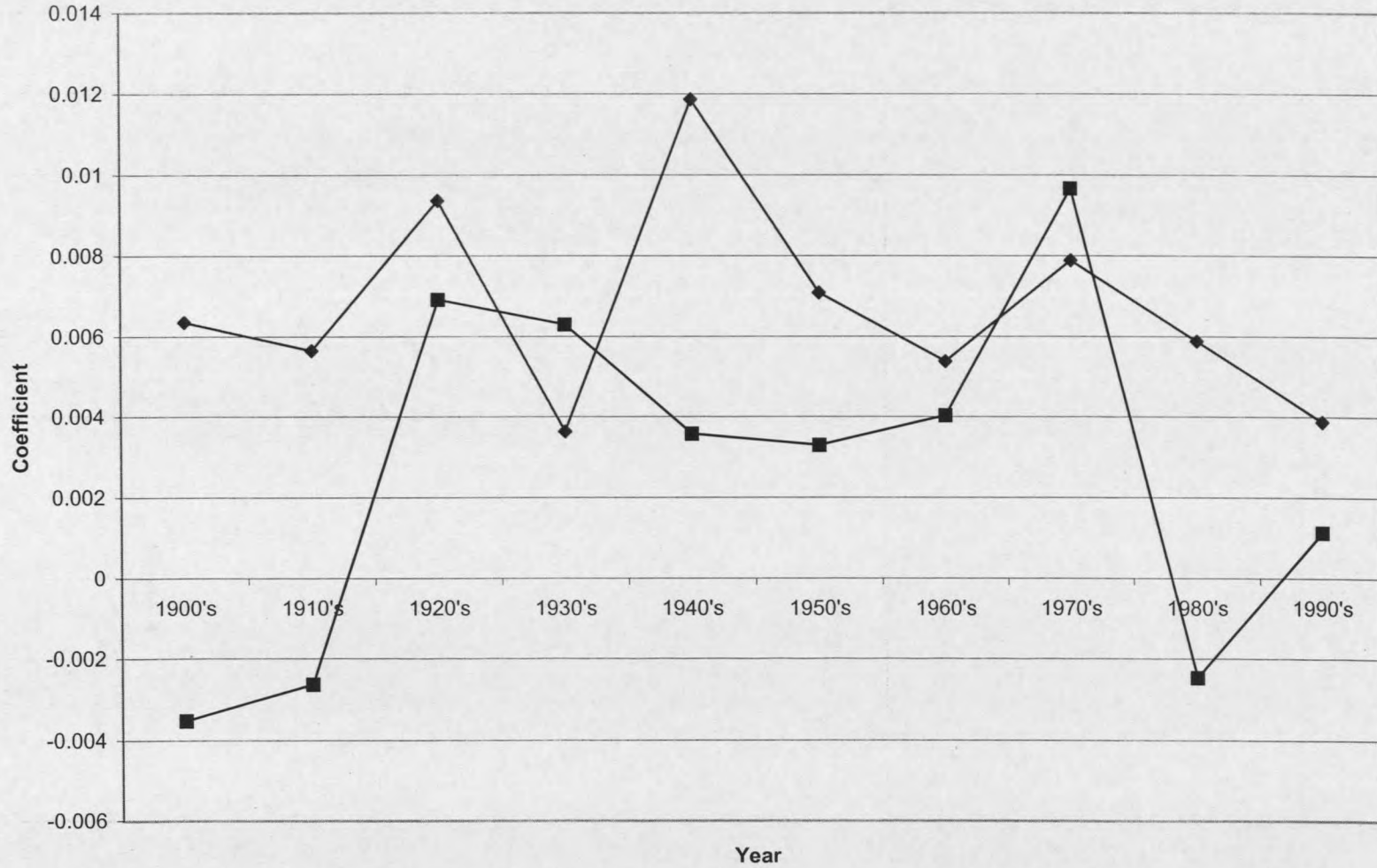


Graph C: Coefficients for Hours of January Sunshine



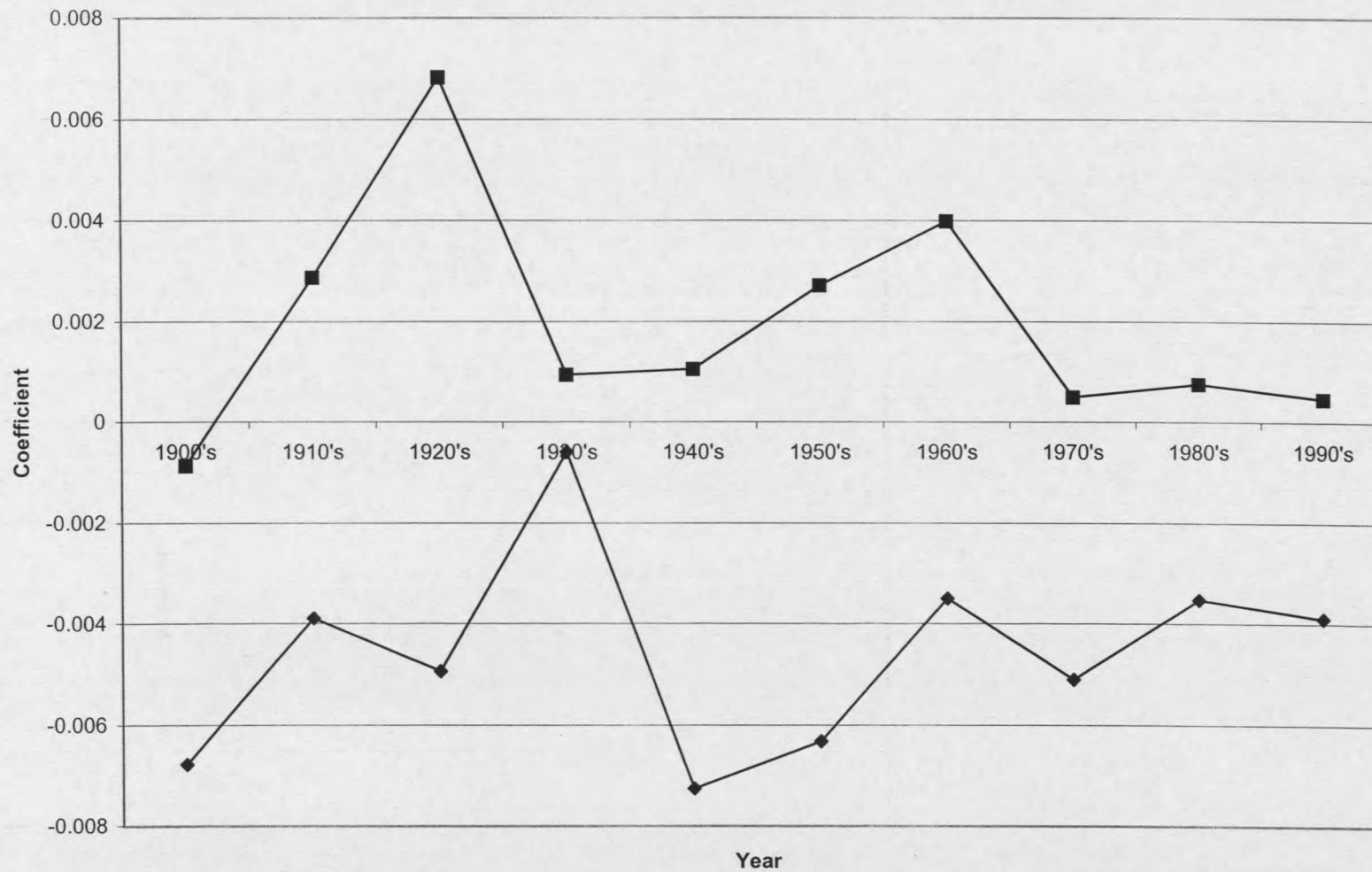
◆ General Regression: JANUARY SUNSHINE    ■ State Controlled: JANUARY SUNSHINE

Graph D: Coefficients for January Temperature



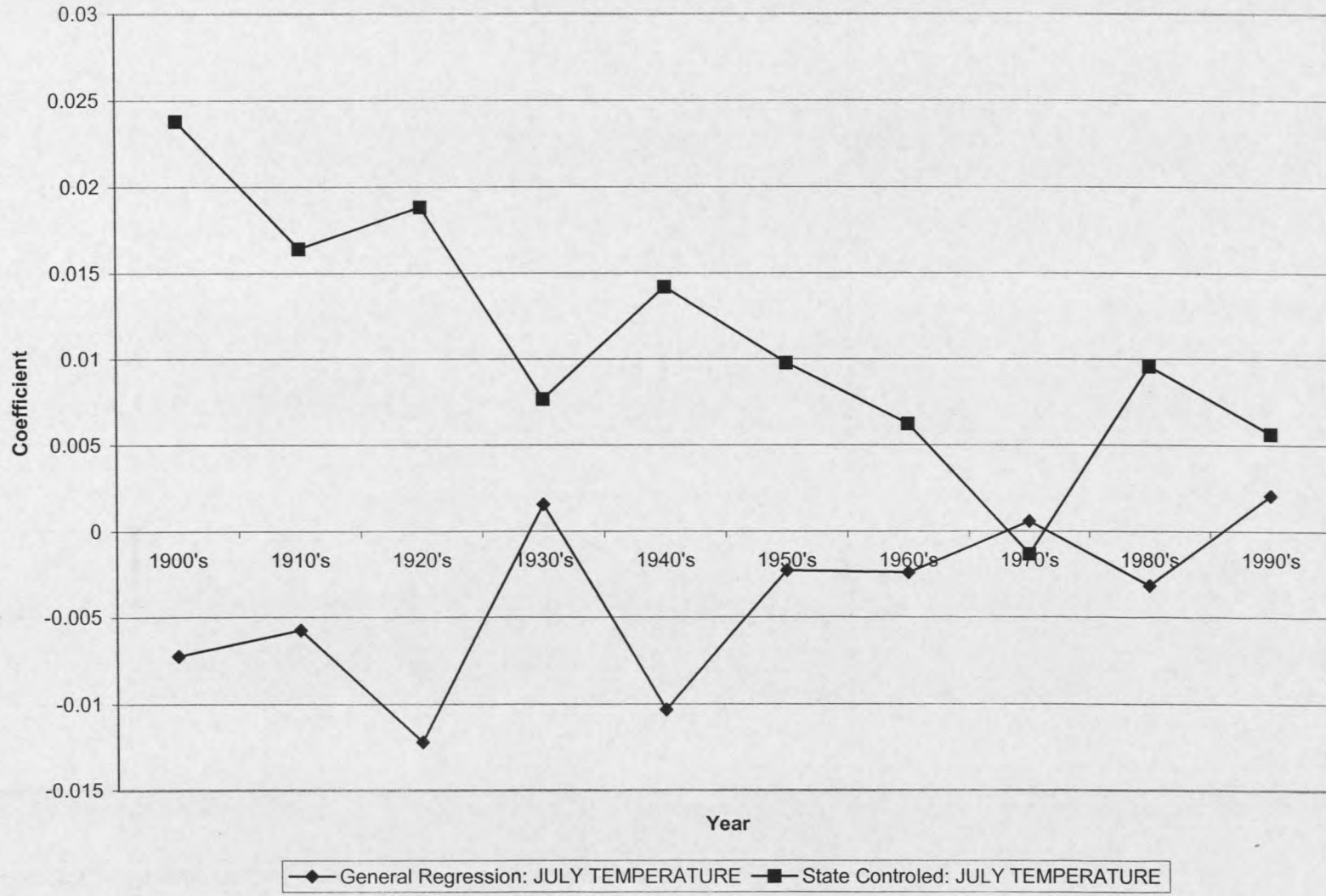
◆ General Regression: JANUARY TEMPERATURE    ■ State Controlled: JANUARY TEMPERATURE

Graph E: Coefficients for July Humidity

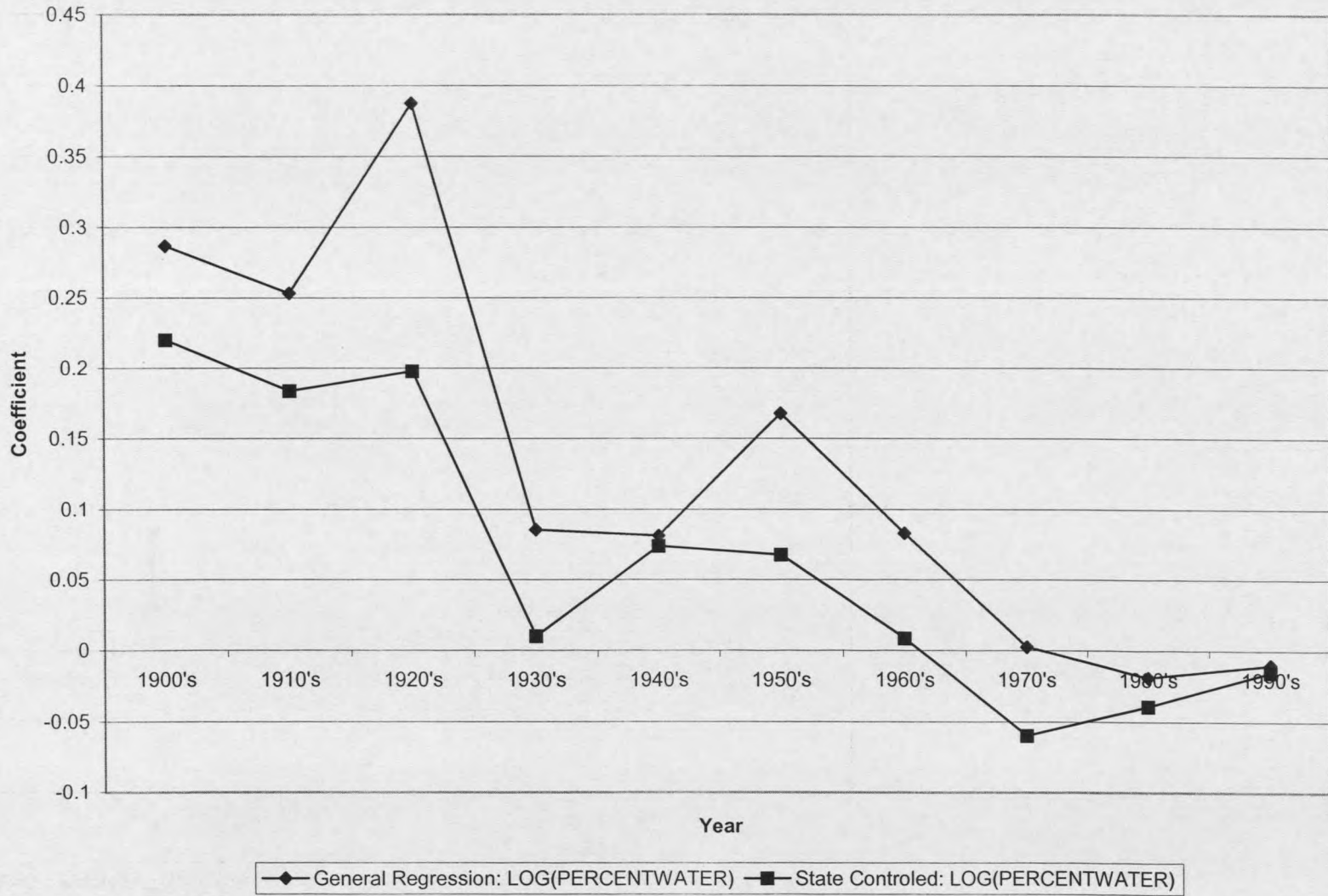


◆ General Regression: JULY HUMIDITY    ■ State Controlled: JULY HUMIDITY

Graph F: Coefficients for July Temperature



Graph G: Coefficients for Log Percent Water



Graph H: Coefficients for Mountainous Counties

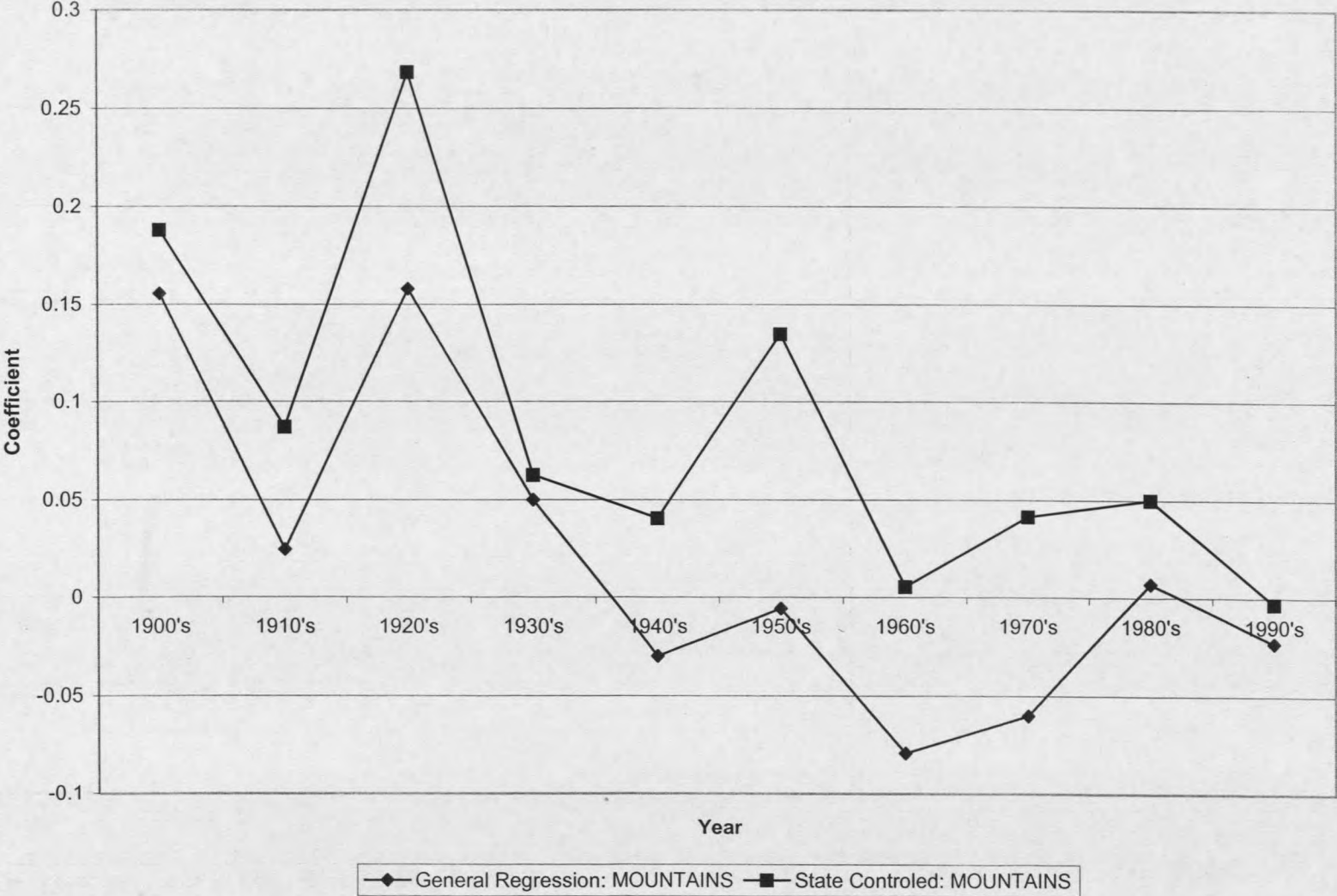
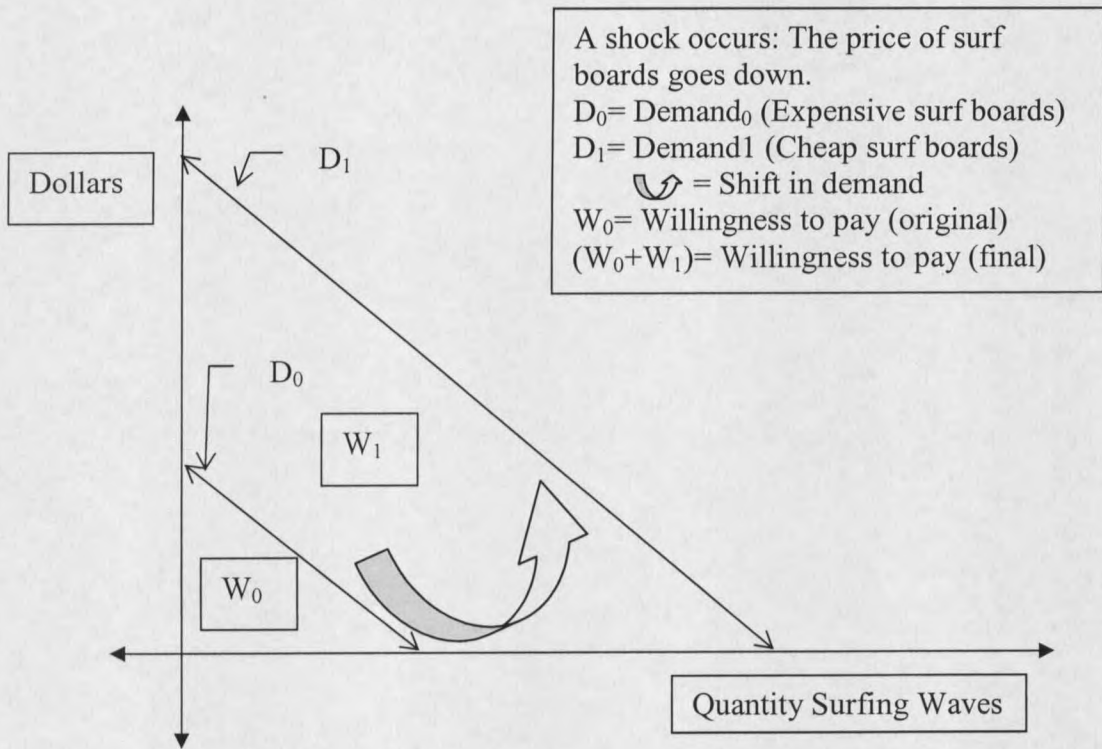


Figure 9: Lowering the Price of Complementary Technology Increases the Willingness to Pay



APPENDIX C:

HISTORY OF MIGRATION IN THE UNITED STATES

The following text is based largely on Garkovich's *Population and Community in Rural America* (1989) and my discussion focuses on historical examples that illustrate how technological innovation can affect the values of amenities. Garkovich describes population migration in the United States by roughly breaking it down into three periods: The Era of Rural Dominance (1650-1880), The Urban Era (1880-1970), and The Era of Residential Diversity (1960-present), which overlaps the Urban Era. Because issues surrounding immigration and in particular Black migration play an important role in the United States migration history, short sections on these topics are included.

#### The Era of Rural Dominance (1650-1880)

The Era of Rural Dominance encompasses a dynamic time period for migration throughout the United States. As the nation's territory was expanding, land use policies encouraged privatization of land, and city builders were pushing westward. Responding to catalysts like these, a cycle-like process of development occurred. Increased demand for new technology created incentives for a multitude of inventions and innovations, which in turn, reduced the cost of westward migration and resulted in even more migration. Garkovich describes the period's great technological innovation and economic development:

The Power of cities rested, in great part, on the pace of technological innovation under-girding their economic expansion. Technological innovations during the first half of the nineteenth century were oriented towards basic needs—food, clothing, housing, and agricultural tools—plows, scythes, threshers, reapers, and hay rakes—increasing the

productivity of farm workers. Food processing innovations—flower mills, assembly line meat processing plants, ice boxes, free-standing stoves, and improved methods for canning meats fruits and vegetables—broadened the range of food products available to all persons in any location, in any season.

By the civil war (1861 to 1865) the textile industry produced the bulk of cloth and clothing in the United States. By mid-century, U.S. rifle manufactures, developed the “American system” of interchangeable parts, which later enabled machine shops to build the milling machines and metal working tools that would be the basis of fully mechanized factories in the next fifty years (Pursell, 1967). Finally, innovations in the construction industry—uniformly sized lumber, windows, doors, stairs, and flooring—reduced building costs. The cities provided the capital, land, workers, and transportation routs, enabling these emergent industries to thrive (Garkovich 1989, page 32).

Transportation and communication innovations were other important hallmarks of the time. Railroads stretched across the county, enabling improved movement of people, water, and other goods. For example, by 1873 railroad mileage grew to 75,000 miles, more than doubling its distance from the year 1865. Other inventions included the steam engine (1769), telegraph (1861), and telephone (1876).

Technological innovation and economic development during the Era of Rural Dominance reduced the costs of people living farther from the east coast. Each invention, while being a function of demand for new innovation, also acted to increase real income and reduce the costs associated with migration.

### The Era of Urban Growth (1880-1970)

The beginning of The Era of Urban Growth marked the transition from a rural to a more urban society. By the end of the nineteenth century, the majority of viable farm land had been homesteaded and land prices were beginning to increase. Between 1870 and 1895, a series of depressions struck the farm economy and urban opportunity began to appeal to the marginal farmers: "An important signal of this increasing emphasis on urban opportunities was the decline in the proportion of gainful workers in agriculture, fishing, and forestry, from 72.3 percent in 1830 to 35.9 percent in 1900" (Garkovich 1989, page 83). With greater opportunity, people migrated to urban areas creating larger cities and new suburbs.

As in earlier time periods, this movement created a cycle of demand and invention, this time focusing on relatively more urban objectives. People migrating from rural to urban places increased the demand for additional urban goods and services. Innovation responded to increased demand with new inventions, most importantly improvements in communication and transportation technology. These innovations, in turn, altered the costs and benefits of living in the new environment. For example, in 1908 Henry Ford's first Model T rolled off the assembly line and sold for \$850. In 1925, using a mechanically moving assembly line the Ford Motor Company produced a car every ten seconds and dropped the price to \$360 (Shaw 1999). Other innovations, including mass production technology, rural delivery, mail-order catalogs, magazines, newspapers, radio,

television, improved roads, commuter railroads, and fixed-line streetcars helped transform the society from rural to urban and suburban.

Throughout the urban era, westward migration continued. This movement can be recognized by noticing the westward movement of the nation's population centroid starting west of Cincinnati, Ohio, in 1880 and ending eight miles north of Olney, Illinois, in 1950. Two major events helped to push migration westward, The Great Depression (1929-1940) and World War II (1939-1945).

While hundreds of thousands of thousands of urban workers experienced unemployment during the depression years, opportunities still existed in the cities to attract migrants. When America entered the World War II, manufacturing employment exploded. Increasingly, employment opportunities and well-paid jobs became synonymous with city life. It could be argued that, during this stage, the "urban frontier" replaced the western frontier, attracting millions of migrants to the unfolding economic opportunities found in industrializing urban areas (Garkovich 1989, page 86).

Migration from farms to urban areas marked the transition from a rural to a more urban or metropolis society. This movement, while dependent on new invention, also spurred innovative solutions for living in denser environments that would influence growth in later decades.

#### The Era of Residential Diversity (1960-Present)

The phrase, "Era of Residential Diversity," refers to the growing variation of residential choices, diminished differentials in rural-urban social and economic structures, and changes in migration patterns. Three changes are of particular relevance to

the restructured population of rural America: Continued diffusion of urban influences into rural areas, changes in attitude toward urban living, and continued structural transformations of the economy, encouraging dispersed instead of urban living.

During this era, rural areas that were reporting negative population growth rates for the previous decades started to approach states of slow population growth. Not only did many non-metro places experience lower outward migration, but they also experienced greater inward migration from urban areas.

Transportation and communication innovation led to social and economic diversity, in effect bringing some of the benefits of the city to the country. Highways and interstate systems allowed "foot-loose" manufacturing firms to leave historical hubs of industry, such as Chicago, Pittsburgh, and Indianapolis. Advances in computer technology reduced the cost of living in rural areas and allowed people and businesses more freedom when choosing where to locate by reducing the cost of communication and transferring information. An increase in the standard of living "facilitated the expression of residential preferences for smaller places and enabled people to consider *noneconomic* factors in their migration decision making. People continue to make trade-offs in their decisions as to place of work and place of residence, but personal values and preferences now have freer expression" (Garkovich 1989, page 160). As incomes grew and technology made living in rural areas less costly, people chose to move back to more rural areas.

### Immigration

Although smaller than in previous decades, immigration played an important part in the distribution and redistribution of America's population. According to Garkovich, 18 million migrants arrived in America between 1880 and 1910, representing 28 percent of total U.S. population growth between 1880 and 1890 and 38 percent between 1900 and 1910.

The composition of immigrants in the urban era was changing, Southern and Eastern Europeans began to make up a larger proportion of immigrants. At the end of the Era of Rural Dominance (1881 to 1890), Southern and Eastern Europe's immigrants represented 18 percent of all American immigrants. During the beginning of the Urban Era (1901 to 1910), the proportion of Southern and Eastern European immigrants rose to 71 percent. Contrasting with earlier immigrants from Northern and Western Europe, "...these immigrants were primarily of peasant stock, poor, and illiterate... and clustered in the largest cities" (Garkovich 1989, page 87).

The massive changes in the migration population's characteristics helped to prompt restrictive immigration laws. The first, in 1917, was replaced by a more restrictive quota system in 1921. The act was made stricter in 1924 and again in 1929, effectively stopping the tide of Southern and Eastern European immigration. The passage of these laws brought to an end three hundred years of "free immigration," slowing immigration from 9 million a year, between 1901 and 1910, to one million a year or less in years 1930 to 1950.

### Black Migration

Historically, black migration has been from the rural South to the urban Northeast and West. During the 1880's more than 30,000 Southern blacks moved to Illinois, New Jersey, New York, and Pennsylvania. The migration increased to over 70,000 in the 1890's. At that time, 80 percent of blacks lived in rural areas and 90 percent lived in the South. Later, after the beginning of World War I, "The Great Migration" accounted for nearly one million black migrants leaving the rural South for urban areas in the Northeast. By 1970, only 20 percent of blacks lived in rural areas and 53 percent lived in the South.

During the early 1970's, a counter stream of black migration into the South began to occur. Between 1970 and 1973, migration back into the South was one and one half times South-to-non-South migration. Twenty five percent of this movement was from urban to rural areas.

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