The Effect of Population Density on Housing Prices: A Cross State Analysis

Senior Thesis

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Abstract:

This paper examines how various factors affect the price we pay for a house. I examine if what are considered to be amenities do indeed have a positive effect on the value of the house and disamenities have a negative effect on the value of the house. My study covers various states across the United States, these states are then compared to one another to see the effect of the bundle of amenities across these states, my main variable of interest is population density. I use a quadratic hedonic pricing model on my data. I then compare the results across states to determine if variables are valued the same on a state to state basis. I find the population density to have a both a positive and negative impact on housing prices. This indicates that households view population density differently depending on the state and the level of population density.

Table of Contents

I. Introduction

Hedonic pricing is a useful tool because it can elicit how much value individuals place on certain amenities. It is especially useful for pricing amenities for which it is hard to put an exact price tag on. For example when you are asked if you would rather live in an area with more or less pollution, you are going to answer the area with less pollution. If that question were rephrased into how much are you willing to pay to live in an area with less pollution, it is hard to put an exact dollar amount on the value of less pollution. The benefit of the hedonic method is that it does not rely on survey respondents to answer questions, rather it is a revealed preference method of assessing how people value an amenity. The revealed preference method is a method where the preferences of individuals are shown through their purchasing history. In the case of housing, the preferences are revealed through how much people pay for houses with certain characteristics. Policymakers can use this pricing method if they want to determine how much money to spend on reducing pollution by building a park for they can measure how much people living in an area near the park will benefit due to the change in pollution levels. The policy makers will then be able to calculate the net benefit to the residents based on prior research which has shown the effects of pollution on housing prices.

In my research I will be examining the value of individual houses across states. My research will provide a view of how households across states values population density as either an amenity or disamenity. There is an ongoing debate between whether or not population density is an amenity or disamenity. This debate stems from two pertinent arguments regarding the nature of density. Those in favor of density argue that density is desirable because it brings people together and knowledge will be shared among people. This sharing of knowledge is formerly known as knowledge spillover. Agglomeration is also a product of density, agglomeration is where firms and people are located near each other resulting in an economies of scale effect. This economies of scale effect based on agglomeration is good because firms will become more efficient and workers more productive.

The argument against density is based on the negative externalities of density. These externalities include congestion, pollution and crime rates. Typically people value these factors as economic bads. This means that people would expect to be compensated for having to experience these resources, think of them as the opposite of an economic good which you have to pay for.

Based on the highlights both for and against density, it appears that the actual effects of density on housing prices depend on which factors dominate the other in the eyes of the consumer. The effects of these variables are ambiguous, in my study I am going to attempt to answer how consumers generally regard density through their revealed preferences.

My research will build off of prior hedonic pricing research that has been completed by my forbearers. My research will add to the field by offering a cross state comparison, with a focus on whether density is an amenity or disamenity and determine whether the housing market is homogeneous. Research has been done that has concluded that the U.S. housing market is not heterogeneous, conflicting research has been done that has determined that there are differences between cities. Previously, research has collected data at the Metropolitan Statistical Area (MSA) level or in certain neighborhoods of cities. Instead, I examine the relationship at the Public Use Microdata Areas (PUMA) level. I am using population density and climatic data gathered at the PUMA level. I am using the PUMA level because this includes rural areas and not just urban areas. I believe that rural areas need to be included in my analysis because I want to fully represent each state and the inclusion of both rural and urban areas will allow me to do so. All household and individual data is gathered from the American Community Survey (ACS) 2013. Climatic data is gathered from PRISM Climate Group (1981-2010) 30 year Climate Normals. Population density data was obtained from 2012 ESRI Demographic Data. Population density is measured in, population/mi^2.

II. Literature Review

Roback (1982) examined how much residents are willing to pay to for various amenities. Roback found the density variable positively impacted land prices with an increase in population density by 100 people/square leading to an increase in land price of $6.30. Roback used SMSAs (Standard Metropolitan Statistical Areas) for her unit of measure in calculating density.

Blomquist et al. (1988) used individual housing data instead of using groups of housing, which is what Roback previously did. Blomquist et al. ran two different regressions, the first regression included only physical housing attributes. The second regression included a variety of amenities ranging from weather related amenities such as precipitation and sunshine to other community related variables, such as violent crime rates and teacher-pupil ratio. To model for density in their study they used a proxy for density which was a dummy variable for whether or not the resident lived in the central city. They found that a person who lived in a central city location would pay $40.75 per year to do so. This indicates that central city location is an amenity in this paper because people are willing to pay to be there rather than being subsidized for living in the central city location.

Sirmans et al. (2006), run a meta regression analysis of the nine most used housing characteristics in hedonic house price regressors, which are square footage, lot size, age, bedrooms, bathrooms, garage, swimming pool, fireplace, and air conditioning. What they are looking for specifically is how the coefficients vary in terms of geographical location, time, data source, median income, the number of regressors in the hedonic price equation, and the use of control variables. What they found was that most variation between the coefficients was due to the geographical location of the house especially for the characteristics of square footage, lot size, age, bathrooms, swimming pool, and air conditioning. This paper shows that different hedonic estimates do experience some significant variation, but not as much as is traditionally believed. This is important because it means that to some extent most hedonic methods for calculating housing prices although different in many cases have generally the same results, which is important for the sake of consistency and reliability of the hedonic method.

Linneman (1978) reviews the standard estimation procedures for fitting hedonic functions along with the evaluation in the difference in the national housing market among cities. In this paper he compares Los Angeles and Chicago with the national average in an attempt to see if the housing market is homogeneous. A homogeneous housing market is one in which people value amenities the same across the whole market and preferences are not assumed to vary. He notes the potential biases that face the hedonic pricing method. These biases include functional form owner-renter selection sample bias as well as the omitted variable bias. He confronts those various biases in his paper through his research of comparing Chicago and Los Angeles with one another and national averages in housing prices and amenity variables. In his analysis he considers both physical household characteristics along with a variety of neighborhood traits such as if the neighborhood is considered bad or if the school quality is considered bad. He uses Chicago because he defined it as an older city and Los Angeles as a newer city to see if there is a difference between the two areas and how they compared to the national average.

Linneman runs a hedonic pricing method which comprised of two parts. First was the housing structural vector, which comprised of the physical characteristics of the house. The second part was the non-structural vector, which comprises of neighborhood amenities not directly related to the house. These vectors comprised of an agglomeration of the different physical housing characteristics along with an agglomeration of the various neighborhood traits. In his analysis he attempts to see if the two areas differed from the national average in pricing of amenities, but he found that with 95% confidence that he could not reject the null hypothesis which was, the functional specification (difference in cities) was the same as the national model. This supports the claim that the nation as a whole is a homogeneous housing market, which means that preferences are generally the same across cities. For example somebody in New York values sunlight as much as somebody in Oregon. However, Dunse et al. (2013) argue against this conclusion.

Dunse et al. (2013) examine the effect of density on housing prices in five different cities throughout England. They decide on the five cities based on the variation in terms of housing density, geographic location economic prosperity of the city and the size of the metropolitan area. Dunse et al. (2013) then construct a hedonic pricing model to include attributes that represented the physical aspects of the housing units, the location, neighborhood externalities, and dwelling type, mix and density. They decide to test their main variable of density in the hedonic model non-linearly. They hadn't found any suggestions in economic theory that the relationship between housing prices and density should be either linear or nonlinear. Dunse et al. (2013) decide that the nonlinear quadratic relationship between housing prices and density fit their data best. I will be testing a nonlinear method in my paper as well. In their estimation, they model density through the actual dwelling density which is defined as: The dwelling density for the census output area of each house in their data.

What they find in their results is that dwelling density is statistically significant across all areas. Density is found to have differing effects on the price of the house depending on where it is located. For example the relationship between dwellings per hectare is convex in some areas. Meaning that at a certain point as housing prices decrease with increasing density a point of inflection is reached and the housing prices then increase with increases in density. This relationship is similar to that of a u-shape. In London the opposite is found to be true. The relationship between housing prices and density is concave. Meaning that as density increases housing prices increase, until a point of inflection is reached where increases in density are met with decreases in housing prices. This forms an upside down u-shape. These contrasting relationships between density and housing prices highlight the ambiguity with the relationship between these two factors. The paper concludes that each city must be taken into account individually when implementing policy changes to the housing market.

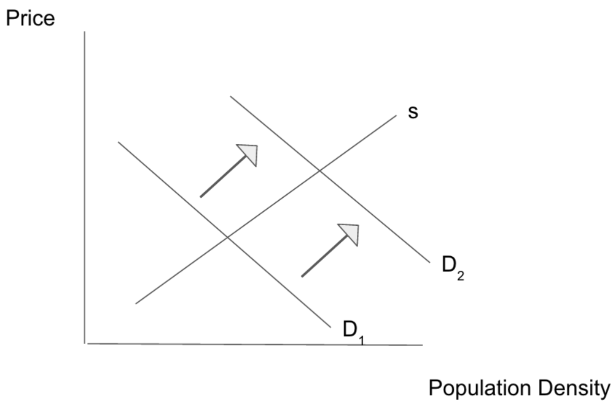
This previous literature builds the base off of which my paper stands. My main focus will be on the impact of density on the value of a house examining how households value population density and whether there is a nonlinear relationship in how they value density. Density is a factor that has been previously studied and many researchers disagree on the effects that density has on the price of housing and whether to consider it an amenity or disamenity. The literature also disagrees on whether the value of this amenity, along with others varies across space. I add to the literature by addressing these disagreements I previously stated between the literature.

III. Theoretical Model

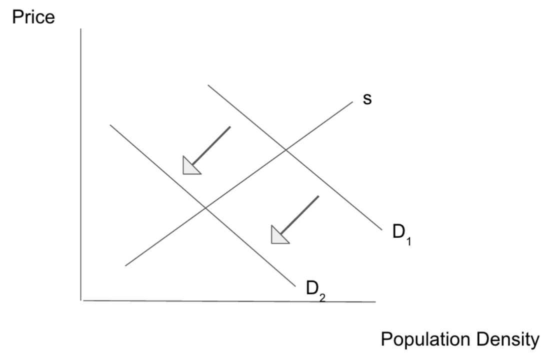
The idea of the hedonic housing price model is rooted in the theory of supply and demand. The housing market is comprised of buyers and sellers. On one side, there is the demand, the buyer, and on the other side, is the supply, the seller. A house is sold at the point where the buyer and seller agree on a fair price to pay for the house. This housing value they agree upon is based on the physical characteristics of the house along with other characteristics of the surrounding environment such as the school district and crime rate. When buying a house the buyer considers all of these factors when determining how much to offer for the house. The seller is also going through this calculation and deciding what price to sell the house for, trying to get a sense for what the demand will be for his house. The agreed upon price would indicate how much the buyer values the environment the house is located in as well as the actual physical components of the house.

The hedonic pricing model attempts to quantify the exact amount that each characteristic is worth based on the current value of a property. This is referred to as the revealed preferences method of estimating value because the preferences for certain amenities are revealed through the agreed upon price. The below graphs illustrate the relationship between population density and housing prices. If population density is an amenity then housing prices will increase with increases in density, this is illustrated in Graph 1. If increases in population density result in lower prices population density is considered a disamenity, this is illustrated in Graph 2.

Figure(1)

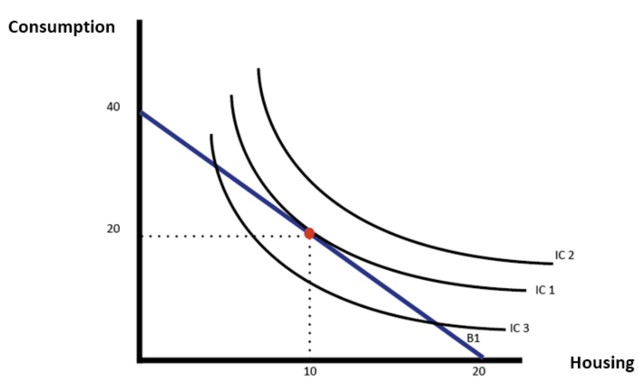


Figure(2)



When purchasing a house individuals are attempting to maximize their own utility subject to a budget constraint. This means that given a certain income individuals choose the optimal combination of both housing and consumption of other goods and services. This relates to the idea of individuals are willing to pay to live in better school district and low crime rates neighborhood. To consume these amenities the individual must give up some housing to stay on the same level of utility. Figure (1) below illustrates this concept. The concept of utility maximization is important because it follows the idea that the housing value directly represents the utility of living in a given housing unit in a given geographical region with certain surrounding amenities.

Figure (3)



(Economics Help, 2012)

My study in particular will examine how residents value certain amenities. The revealed value of these amenities will be compared between 7 states to see if there are differences in value placed on certain amenities, with a specific focus on the density variable. I will determine the value they place on these amenities based on how much they are paying for housing. I hypothesize that an increase in the level of population density will result in a quadratic relationship to housing prices and this relationship may differ or be constant from state to state. This hypothesis is derived from the economic concept of housing being considered a normal good, as well as density being shown to have both positive and negative effects on housing prices. The conflicting literature between whether density should differ between areas makes it hard for me to know which one will be right and I will proceed in attempt to see which way my results follow.

IV. Econometric Model & Data

I have decided to use the quadratic form to model population density. The use of this model allows population density to increase and decrease depending on the amount of population density. The quadratic modeling of density is important because it denotes how people value density compared to housing prices and allows for the relationship to change. I have decided to include a quadratic equation because based on Dunse et al. (2013) paper, they showed that density may not always have a strictly linear relationship with housing prices.

Other amenities are necessary to give a complete estimate of the price of a house, I have included variables to represent the physical component of the house, the community aspect of a house and weather related variables. According to economic theory, housing prices should increase as amenities increase. Amenities will have a positive effect on the household because people naturally want more of them. As incomes increase people will want to consume both more physical housing and other neighborhood amenities, such as a safer environment or an area with more educated people.

Throughout this paper a pair of underlying assumptions must be noted. First of all housing prices may not be the only factor that are affected by various amenities. For example somebody may be willing to not only pay more to live in an area that is educated, they may be willing to accept lower wages to live in that area. This would mean that by solely focusing on the housing prices that the real effect of education on the value of an area is being underrepresented. This means that my research will serve as a lower bound for how we value certain amenities.

Another concept that must be noted is that the housing market for the United States is considered homogeneous as in Linneman (1978). This means that amenities and other variables should have similar impacts throughout the United States since the market is considered homogeneous. To put this in direct terms with my research, density according to Linneman is valued equally by everyone across the 7 states I will be studying, from a person living in an apartment complex in California, to a farmer living in Arkansas. This idea is contrary to Dunse et al. (2013) paper. I will be expanding on this idea to see if the market truly is homogeneous, or if preferences need to be taken on state by state basis as suggested by Dunse et al. (2013).

Where my research will differ from prior research is that I will be evaluating individual households, but grouping characteristics such as precipitation, temperature and density which are normally gathered at the county level to the smaller defined PUMA level. I will then categorize my data based on the corresponding state of the data observation. My research will also offer a comparison of amenities across states, while at the same time determining if density is valued the same across states.

Density, as I have mentioned has been examined previously, but in the prior papers a proxy was used for density such as whether or not a house is in the city center, or density was measured at a different level than the PUMA. The examination of density is a variable that can be somewhat manipulated by city planners or urban economists. While weather, or other variables that are not able to be changed.

The formation of my econometric model is based upon prior literature which suggests population density will be quadratically related to housing prices. This model below (Equation 1) is a quadratic hedonic pricing model which will be used to calculate the value households place on certain amenities across various states.

Equation: $lnHV= \alpha_0+\beta_1 D_{1i}+\beta_2 D^2{}_{2i}+\beta_3 X_{3i}+\beta_4 C_{4i}+\beta_5 I_{5i}\varepsilon_i$ (1)

Explanation of the Model:

lnHV: Log Housing Value

D: Density (Population/mi^2)

D^2: Density squared

X: Housing Physical Characteristics Aggregate:

I.e. (Number of Bedrooms, Number of Rooms, Decade House was Built, etc…)

C: Community Characteristics Aggregate:

I.e. (Average Yearly Precipitation, Average Temperature and Population Density)

I: Individual Characteristics Aggregate:

I.e. (Total Earnings, Commute Time to Work and Level of Education Completed)

ε: Error Term

The variables that I use are based on Blomquist et al. (1988) paper. They serve as a good base of variables that cover the wide range of factors that go into accurately calculating the value of a house. I gathered the physical household data along with the individual characteristic data from the 2013 American Community Survey. The climate data was generated from PRISM Climate Group, which was downloaded into GIS, then converted into PUMA data. Density data was downloaded from 2012 ESRI demographic data, this too was converted from GIS. Table 1 in the appendix provides a description of the variables along with their mean values.

V. Results

After running the quadratic hedonic equation across each of the 7 states I obtained a variety of results which can be found in Table 3 in the Appendix. Below I will discuss some of those results and what they mean, I will mainly focus on population density in my analysis. A breakdown of the parameter estimates can be found in Table 3 in the appendix.

The semi log model measured the effects of my variables as a percentage change in the value of a house. For (lnJWMNP), which measures time of commute and (lnPERNP), which measures earnings, I used the double log model because the double log form gives an elasticity and is easier to interpret conceptually. I will go into more detail when I explain the coefficients for the variables.

The vector of physical variables directly related to the components of the house are all considered statistically significant across all states for the most part. The number of rooms and bedrooms both have a strong effect on the price of the house. For example, as the number of rooms and bedrooms increases the price of the house should also rise because the house becomes larger. My data coincides with this theory, all states have increasing housing value with the addition of a room, and there is some slight variation between states. For example, the addition of a bedroom in Arizona will increase the value of the house by about 7% while in California the addition of a bedroom will increase the value of a house by almost 18%.

The age variable measures the age of the house, in decade built. I would expect as the house gets older, the value of the home would be lower. My analysis shows that all the parameter estimates are negative for every state, which means that houses built prior to 2010-2013 will be worth less than in 2010-2013, which is what we would expect. There is a slight abnormality with the housing decade variable because as the house gets older the value should depreciate. None of the states have a smooth pattern relating the decade the house was built and the value of the house. This abnormality may be due to a sampling bias, the data may be loaded with high price houses for one decade and lower housing prices in another.

The next set of variables represents the amount of land the house is located on. The results shows positive coefficients in front of the dummies representing houses located on 1-10 acres and houses occupying 10 or more acres. With a larger coefficient in front of the 10 or more acre variable than the less than one acre, or the 1-10 acre house. One factor in the value of a house is the amount of land that comes with it. Thus as the amount of land increases you are buying more square footage so this increases the value of the house. All states follow this pattern correctly with the exception of Alaska, but the result is insignificant for houses on 10 or more acres.

The coefficient on the precipitation variables for the 7 state pooled model implies that an increase in rain of one millimeter will decrease the value of the house by .056%. To put this in a more practical matter an increase in precipitation of 1 foot will decrease the price of the house in that area by about 17%. The other weather variable indicates that an increase in the mean temperature of one degree Celsius affects the value of the house by approximately 3%. The coefficient is negative so this shows that people prefer cooler weather rather than warm.

The next variable (lnJWMNP) is the commute time to work from the location of the house. This variable is positive indicating that people prefer to live somewhat away from where they work on average between the 7 states. lnJWMNP can be interpreted as a 10% increase in the commute of the individual will increase the value of the house by approximately 0.30%. This result is consistent with theory and can be seen when people locate in suburbs to avoid the disamenities of a more crowded central business district. Another reason for this may be due to the fact that many poorer families rely more on public transportation to get them to and from work, so they are not able to afford to live farther away from their job. This variable is interesting because it is not significant in states where the coefficient is positive, but it is significant in Arizona and California where this variable is negative.

The variable (lnPERNP) represents the total earnings of the individual. This number is significantly related to the value of the house. This number shows that on average across the states, as a person's income increases by ten percent the value of the home increases by 0.39%.

The next group of variables show the relationship between level of education of the person answering the ACS 2013 and the value of their house. The regression shows that compared to dropping out of high school an individual who has completed a bachelor’s degree would have a house that is valued at almost 20% higher than the dropout. Where the number are a little obscure is that an individual who completes their high school degree will live in a house that has a value almost 9% less than one who drops out.

The variables of specific interest are the population density and the density^2 variables, these variable measures how a particular household in a particular state value population density.

These variable gives the graph a curved shape. If the coefficient on the squared term is negative then the graph is concave (upside down U-shaped). A positive coefficient means the graph is convex, (U-shaped).

Refer to the Appendix Table 2, along with the corresponding density graphs to see visually the relationship between population density and housing prices. These graphs along with the table will show how housing prices and population density interact with one another. The inflection point was determined through differentiating the hedonic model with respect to density. When I did so, I was left with a constant term which stemmed from population density, this term gives the value of the slope of the graph when population density is equal to zero. The next term is the density squared term, this variables when set to zero gives the maximum level of density before the function changes from positively sloped to negatively sloped, it is the apex of the nonlinear function. I will provide an example of an interpretation of the density term below.

Population density in the state of California can be interpreted as follows. When population density is equal to 0 people/mi^2 the slope of the line is equal to 0.00044395, this indicates a positive relationship between population density and housing prices. Housing prices will continue to increase until the inflection point is reached at the point where the slope of the graph is equal to 0, this occurs at the inflection point of 74,790 people/mi^2. After this point as population continues to increase, the housing price will fall. See Appendix Table 2, Graph E for a visual interpretation.

On a state by state basis Arizona, Arkansas, California and Missouri all have significant negative coefficients in front of both the density and density^2 variable. This means that they are all concave, where they differ are in the mean density in each state, with California having the highest average density of 4,769.95 people/mi^2. They also have very different inflection points for the turnaround point where the relationship between population density and housing price goes from positive to negative, table 2 in the appendix has these inflection points.

My study of population density coincides with the research done by Dunse et al. (2013), my research has revealed that population density varies from state to state within my 7 states of observation. This means for a policy maker going forward that each individual state must be looked at independently when assessing the effects of population density on housing prices, it cannot be assumed that density affects every situation similarly. My study also shows that density can be valued as both an amenity and disamenity. Density in some states is related to increases in house prices, until a certain point of population density is reached, then density is viewed as a disamenity and housing prices begin to decline with increases in density. This can be thought of conceptually as the positive effects of density such as knowledge spillover and agglomeration dominating the negative effects, after the inflection point the negative effects such as congestion and crime dominate the positive effects of population density.

VI. Conclusion

The limitations on my data are that I would like to include more variables to paint a clearer picture of the components to accurately price a house. A major limitation of my data is that I was only able to obtain individual data from households for 7 states making this research more data driven. Ideally I would have every state, this would allow me to more fully examine the United States as a whole and compare the valuation of amenities across the whole nation. This paper serves as a platform to do so going forward.

I would also like to add a variable to depict crime because based on prior literature crime is an important variable that is considered when valuing a home and higher crime rates may also be associated with more populated areas. In the paper by Glaesar and Sacerdote (1999) they found that larger cities tended to have higher crime rates, so this could be considered a negative effect associated with density in the form of cities.

My data may be somewhat biased due to the absence of wages in my analysis, wages would also be impacted by amenity levels depending on the amenity. For example living near a coast may result in increases in the house price. People may also be willing to accept lower wages to live in an area that is close to the coast, so the inclusion of wages would more accurately depict how much people are willing to pay for housing alone. The inclusion of wages would strengthen my results, this makes my estimates of amenities on housing prices serve as a lower bound.

My study can be used in the future as a complement to prior research done in hedonic pricing. I have done the research to comprise a dataset and lay down research that compares the effects of population density across 7 states. This research can be built upon in the future to give a view of the whole United States housing market and whether or not it is truly homogeneous and if households across the U.S. value population density the same. The density variable can be interpreted a couple different ways, one way is that density in and of itself is considered desirable because people like to interact with other people and agglomeration may result. Another way to look at the positive value attributed to density is that density is a product of a desirable amenity or area. Density in the latter sense would serve as a proxy for some kind of amenity. Density was also shown to have a dark side, this relates to some of the negative externalities associated with density such as pollution and crime. My research provides some evidence that population density is valued positively up until a certain point at which point the negatives of population density outweigh the positives, though there is some variation in how households value density across states.

Appendix

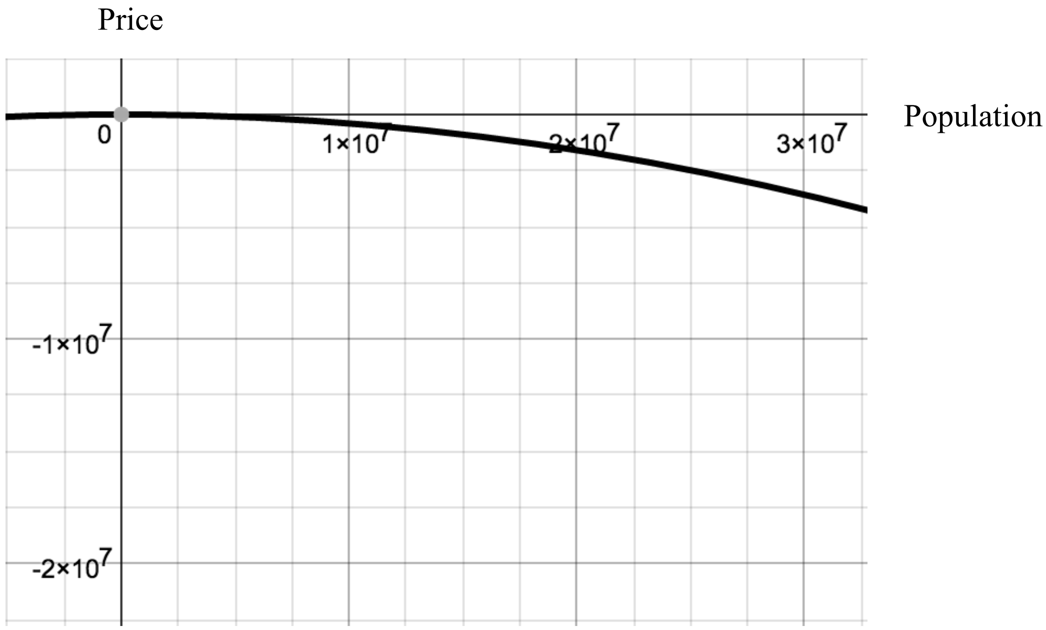
Means										
Variable	**Description**	**Data Source**	Alabama	Alaska	Arizona	Arkansas	California	Missouri	Montana	7 State
POPDENS_CY	Population/mi^2	ESRI Demographic Data 2012	324.655	136.592	2,150.070	201.654	4,769.950	729.371	105.972	2,693.870
densitysq	Population/mi^2	ESRI Demographic Data 2012	724,294.560	729,075.340	11,935,298.220	253,766.650	115,801,773.000	2,234,198.830	367,513.840	55,295,479.820
BDSP	# of Bedrooms in Unit	ACS 2013	3.232	3.127	3.176	3.022	3.257	3.058	3.185	3.189
RMSP	# of Rooms in Unit	ACS 2013	6.866	6.071	6.261	6.541	6.454	6.854	2.750	6.543
y1939	Built in 1939 or Earlier	ACS 2013	0.064	0.013	0.011	0.068	0.087	0.156	0.147	0.082
y1940_1949	Built in 1940s	ACS 2013	0.063	0.013	0.047	0.045	0.067	0.058	0.049	0.059
y1950_1959	Built in 1950s	ACS 2013	0.080	0.024	0.077	0.081	0.170	0.109	0.096	0.125
y1960_1969	Built in 1960s	ACS 2013	0.111	0.034	0.081	0.090	0.135	0.124	0.074	0.116
y1970_1979	Built in 1970s	ACS 2013	0.180	0.254	0.175	0.243	0.165	0.163	0.184	0.175
y1980_1989	Built in 1980s	ACS 2013	0.123	0.137	0.157	0.150	0.145	0.099	0.124	0.137
y1990_1999	Built in 1990s	ACS 2013	0.179	0.149	0.186	0.177	0.108	0.132	0.154	0.139
y2000_2009	Built in 2000s	ACS 2013	0.185	0.188	0.257	0.128	0.114	0.138	0.152	0.152
a1_10	Built on 1-10 Acres	ACS 2013	0.306	0.271	0.124	0.340	0.085	0.174	0.228	0.155
a10_more	Built on 10 or More Acres	ACS 2013	0.055	0.016	0.007	0.096	0.018	0.128	0.213	0.048
mean_precip	Average Precipitation (mm)	PRISM Climate Group (1981-2010)	1,427.980	0.000	273.144	1,282.780	487.847	1,085.780	535.672	708.984
mean_temp	Average Temperature (C)	PRISM Climate Group (1981-2010)	17.207	0.000	20.560	15.828	16.444	12.939	5.642	16.079
jwmnp	Commute Time to Work (min)	ACS 2013	24.784	15.982	24.914	22.464	30.601	23.919	17.451	26.868
pernp	Earnings ($)	ACS 2013	$42,578.49	$48,075.73	$45,123.65	$39,448.08	$63,309.38	$40,996.78	$37,107.12	$51,964.32
hs_degree	High School Degree Obtained	ACS 2013	0.278	0.295	0.224	0.330	0.188	0.291	0.293	0.234
some_col	Some College Completed	ACS 2013	0.356	0.394	0.370	0.335	0.321	0.333	0.372	0.338
bachelor	Bachelor's Degree Obtained	ACS 2013	0.177	0.157	0.193	0.156	0.197	0.193	0.207	0.190
grad_plus	Graduate or Higher Degree Obtained	ACS 2013	0.108	0.083	0.120	0.091	0.182	0.112	0.079	0.142
valp	Value of House ($)	ACS 2013	$172,925.91	$297,674.00	$210,573.66	$135,925.96	$500,166.82	$162,370.84	$236,519.31	$327,408.71

Table 1: Descriptive Statistics and Variable Means.

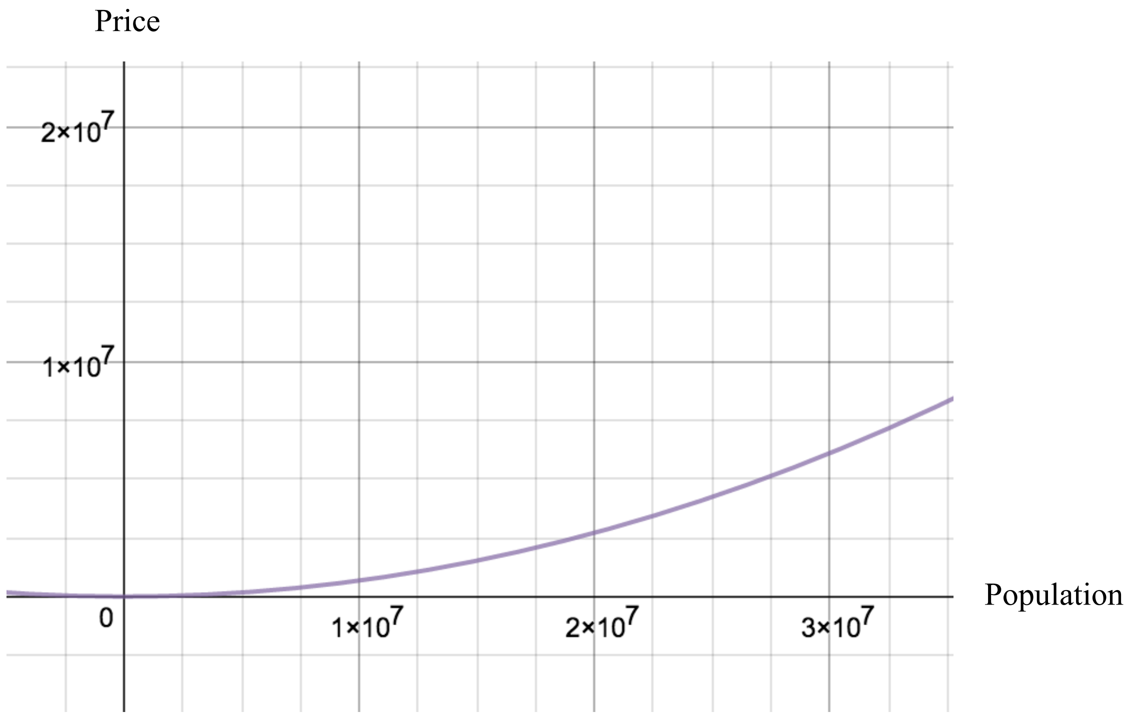
Table 2: Inflection Points and Graphs of Population Density

Inflection Points			
State	**Inflection Point (People/mi^2)**	**Slope When Density=0 (People/mi^2)**	**Mean Population Density**
Alabama	-3,187.66	0.00002531	324.65
Alaska	-729.35	0.00000989	136.59
Arizona	5,296.67	0.00017479	2,150.07
Arkansas	2,412.77	0.00044395	201.65
California	74,790.70	0.00003216	4,769.95
Missouri	4,719.84	0.00023316	729.37
Montana	1,996.02	-0.00013054	105.97
7 State	74,210.50	0.00006204	2,693.87

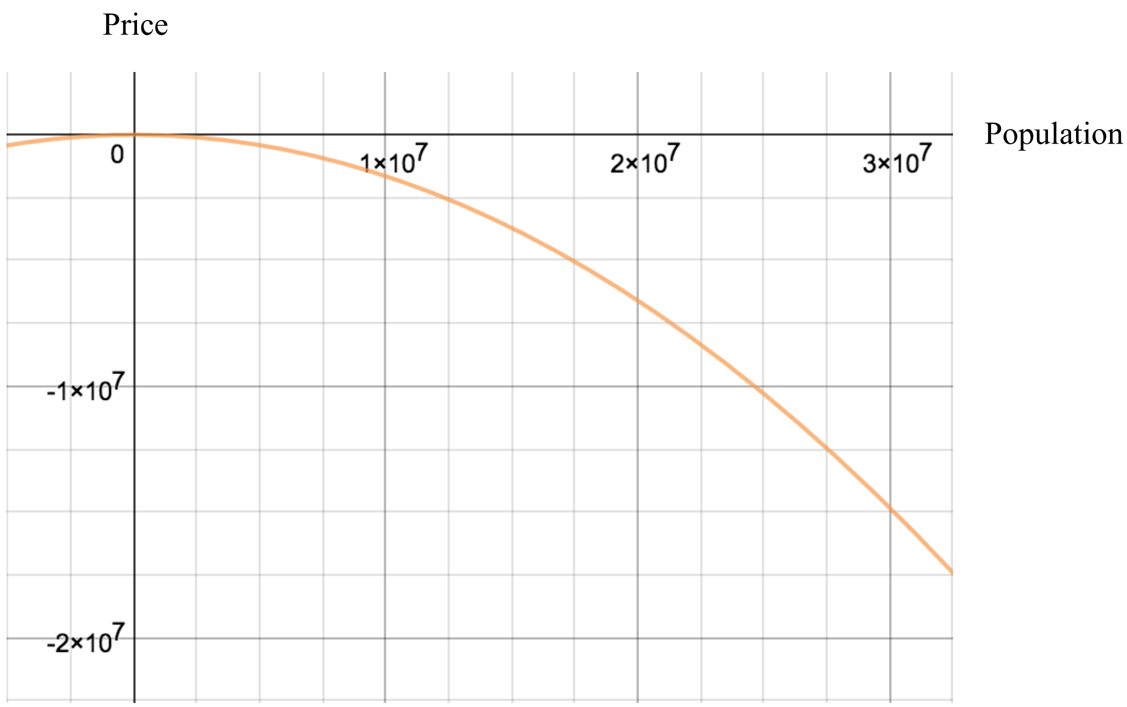
A. Alabama Graph



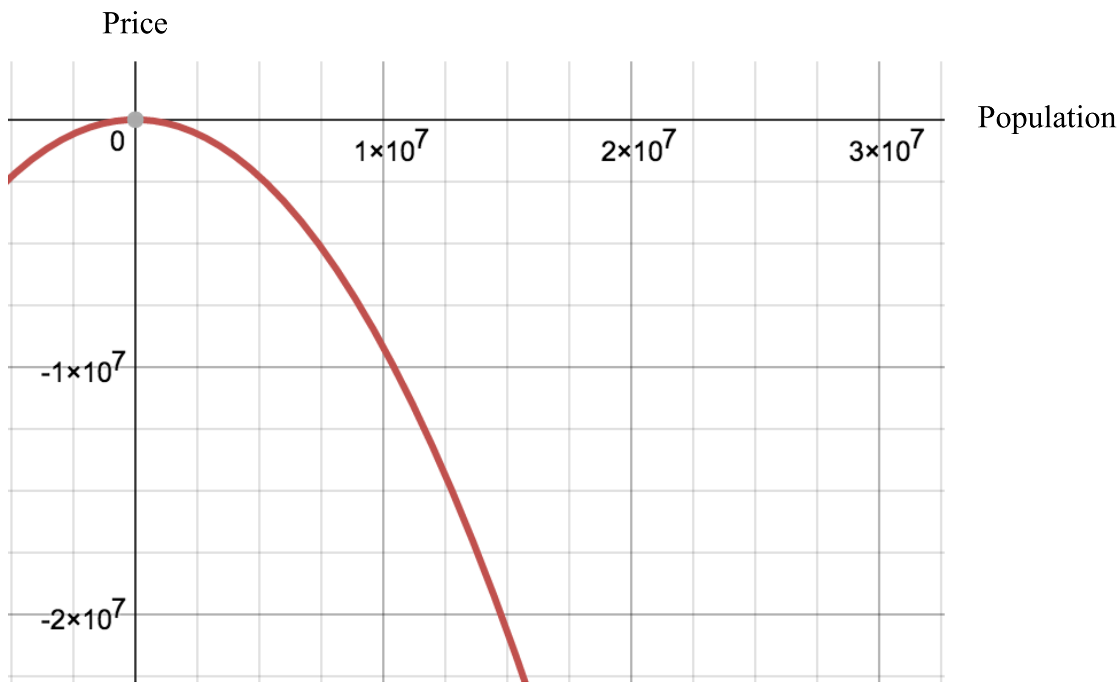
B. Alaska Graph



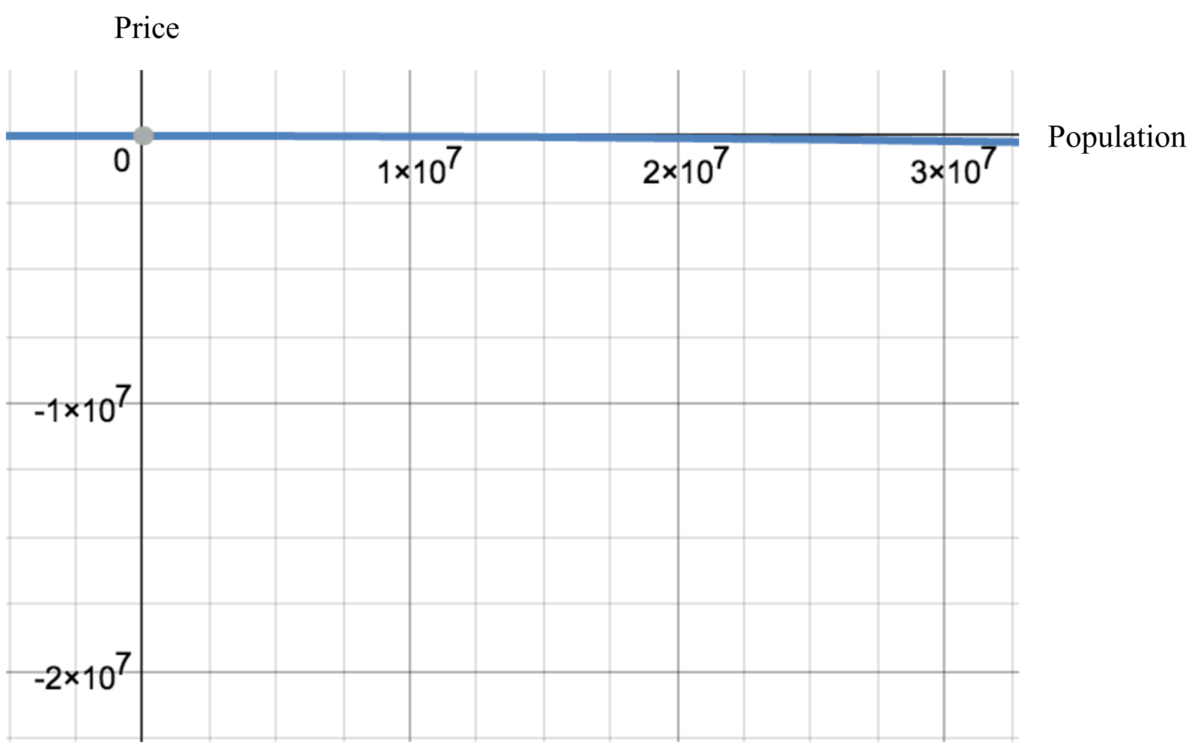
C. Arizona Graph



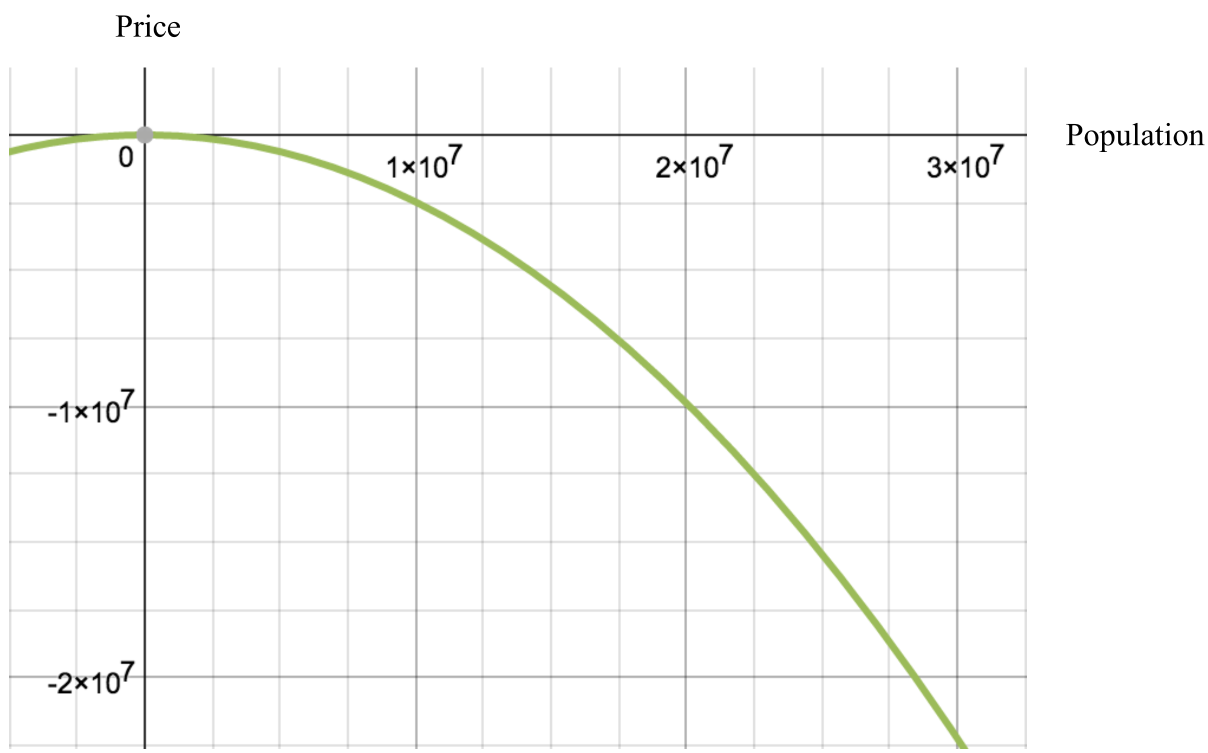
D. Arkansas Graph



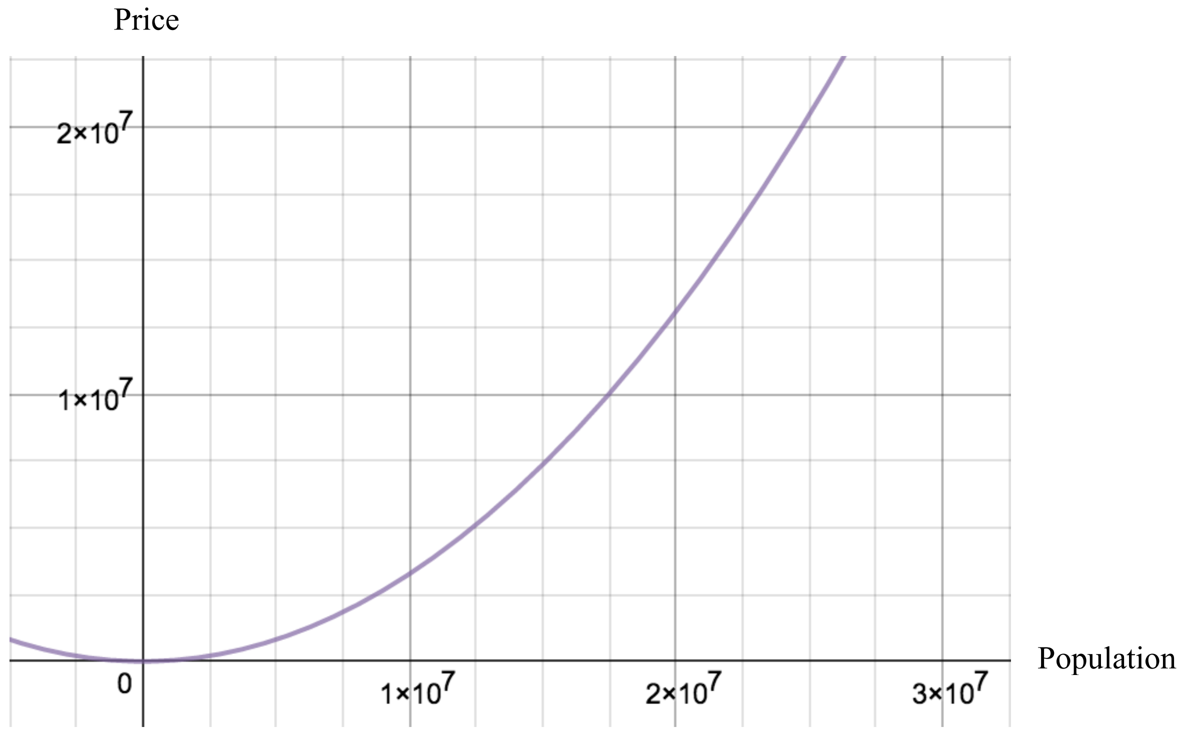
E. California Graph



F. Missouri Graph



G. Montana Graph



H. 7-State Pooled Graph

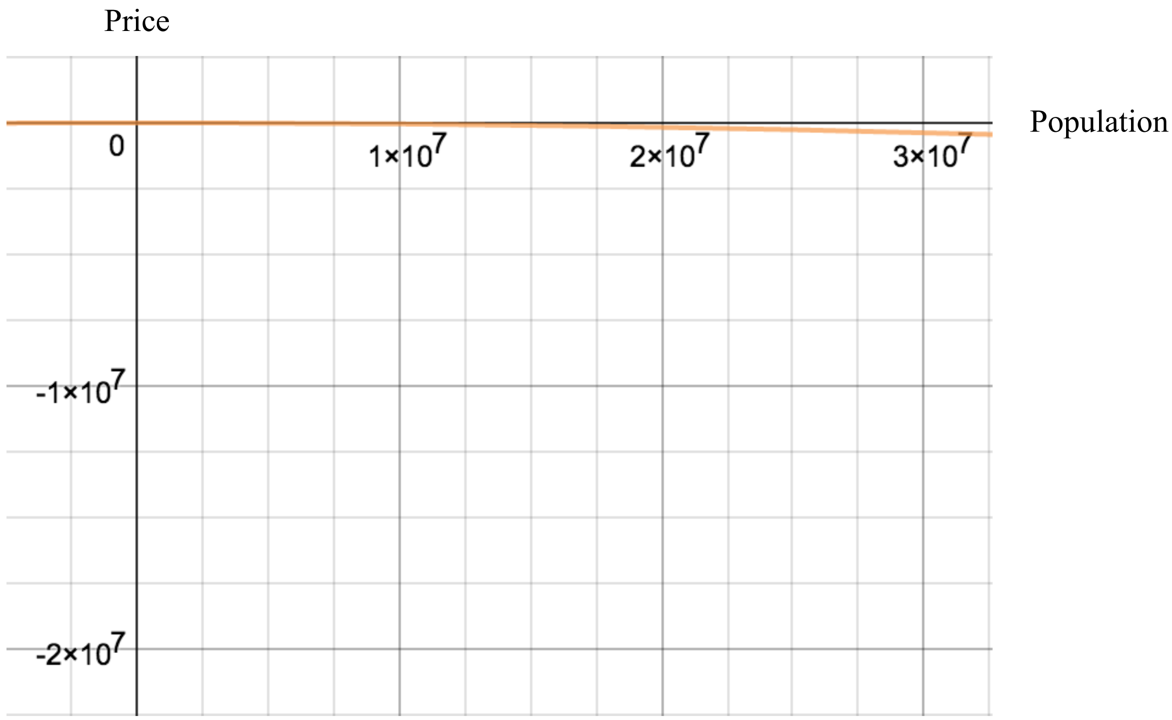


Table 3: Hedonic Model Parameter Estimates

Note: Dependent Variable= lnHousingValue

OLS Parameter Estimates								
	Alabama	Alaska	Arizona	Arkansas	California	Missouri	Montana	7 State
Variable	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Intercept	10.33703	11.68996	9.56244	12.31257	11.32608	10.49437	10.44411	11.23751
POPDENS_CY	-0.00002531	0.00000989	0.00017479***	0.00044395***	0.00003216***	0.00023316***	-0.00013054	0.00006204***
densitysq	-3.97E-09	6.78E-09	-0.0000000165056***	-0.0000000919663***	-0.00000000021467***	-0.000000024709***	3.27E-08	-0.00000000041824***
BDSP	0.14793***	0.08154***	0.07394***	0.22732***	0.17794***	0.17024***	0.08575***	0.1802***
RMSP	0.13466***	0.13802***	0.1332***	0.1211***	0.10082***	0.10622***	0.10063***	0.10395***
y1939	-0.47949***	-0.80235***	-0.52305***	-0.52657***	-0.02583	-0.66023***	-0.46232***	-0.25771***
y1940_1949	-0.22481***	-0.7707***	-0.2956***	-0.81133***	-0.08929*	-0.36442***	-0.41515**	-0.11959***
y1950_1959	-0.48654***	-0.53313***	-0.75929***	-0.56621***	-0.13492***	-0.74892***	-0.29448*	-0.22431***
y1960_1969	-0.44218***	-0.69445***	-0.91032***	-0.46824***	-0.21336***	-0.5589***	-0.52109***	-0.3068***
y1970_1979	-0.8726***	-0.77658***	-0.86089***	-0.27576***	-0.38089***	-0.47114***	-0.64952***	-0.45742***
y1980_1989	-0.50753***	-0.63591***	-0.48036***	-0.30959***	-0.2983***	-0.33771***	-0.50947***	-0.2538***
y1990_1999	-0.48046***	-0.40894***	-0.29084***	-0.29422***	-0.23111***	-0.33029***	-0.33554**	-0.23177***
y2000_2009	-0.23307***	-0.07917*	-0.42318***	-0.03793	-0.24107***	-0.07038	0.021	-0.19887***
a1_10	0.17623***	0.1505***	0.28861***	0.15837***	0.09152***	0.20259***	0.29857***	0.10914***
a10_more	0.25992***	-0.01025	0.33802***	0.15121***	0.19106***	0.29507***	0.44999***	0.13025***
mean_precip	-0.00026859**	0	0.00244***	0.00031677	0.00026147***	-0.00146***	0.00092058***	-0.00055714***
mean_temp	0.0215***	0	0.03285***	-0.17791***	-0.01184***	0.10833***	0.02595	-0.02811***
lnjwmnp	0.00363	0.007	-0.03847***	0.00053247	-0.03947***	0.00739	0.00847	0.03008***
lnpernp	0.01601*	-0.00354	0.01128	0.01695*	0.0171***	0.02396***	-0.00739	0.03859***
hs_degree	0.00646	-0.05918	-0.00697	0.01555	0.00609	-0.04625*	0.00747	-0.08867***
some_col	0.02702	-0.03572	0.08337***	0.02582	0.03176**	-0.00011252	0.06918	-0.01484
bachelor	0.01405	0.01561	0.16719***	0.06582*	0.39499***	0.08423***	0.10579	0.19579***
grad_plus	-0.02016	-0.03678	0.20166***	0.08188*	0.34566***	0.08032***	0.03101	0.23689***
N	18315	2713	25043	11321	72683	25927	3014	159016
Mean PopDens_CY	324.65	136.59	2150.07	201.65	4,769.95	729.37	105.97	2693.87

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