STAT – S670
Exploratory Data Analysis

Mini Project

House Prices and Population Growth

Team Vermont

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Executive Summary

The aim of the project is to study the relationship between population and house prices across decades. The trends across the states over time are not constant. States like West Virginia, Mississippi have shown a drop in house prices from 1975 to 2019, and at the same time, states like California and Washington have shown a significant increase in house prices across the same time period. There is variance across regions too. The South showed slight decrease in prices across years, but all other states showed some increase. In terms of density, the general trend is that price goes up with increase in population density. So, states with higher population density have more expensive housing. Across time periods we see that as population increases, prices generally increase as well. However, between 2000 and 2010 we see that increase in population did not bring about an increase in prices. The next few sections explore these trends in deeper detail.

House Prices Over Time

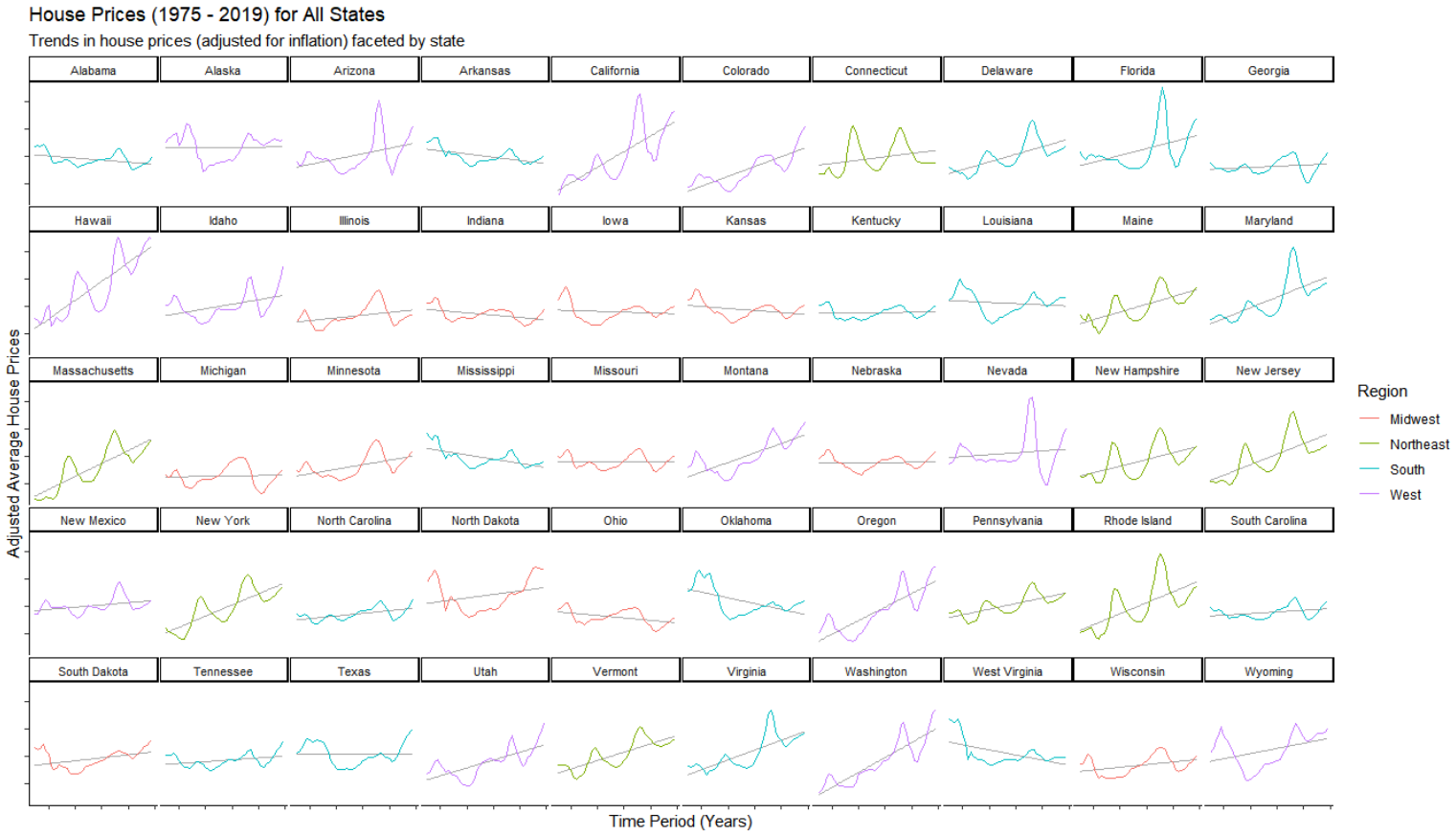

Figure 1

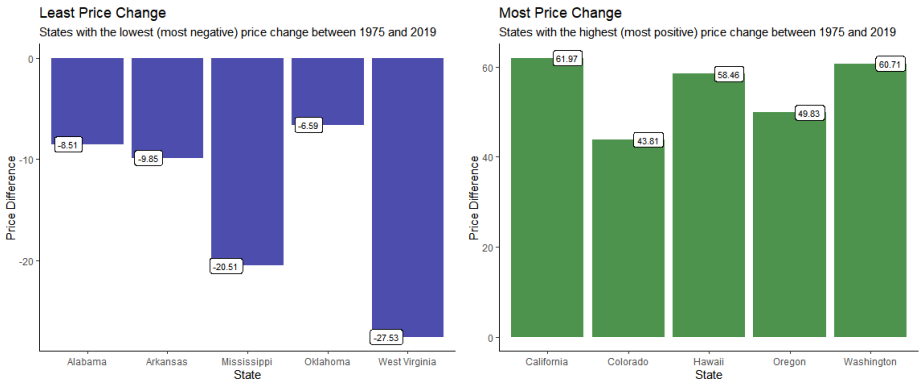

Figure 2

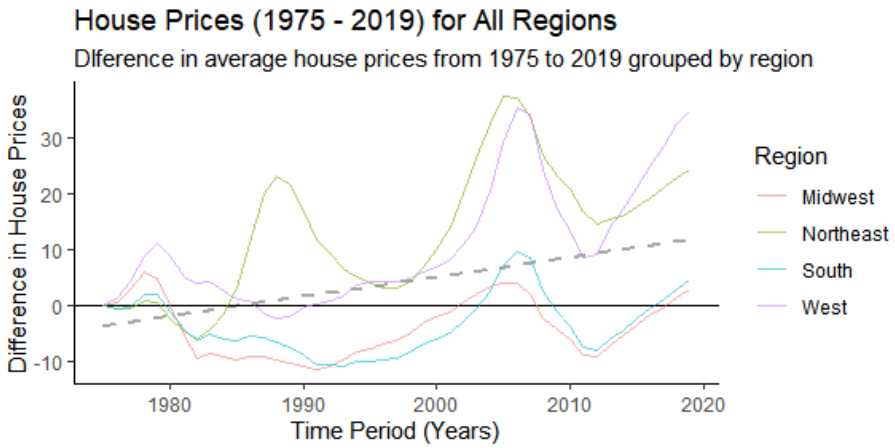

Figure 3

- From Figure 1 we see that all the states have different trends
- There is no uniform trend, house prices have gone up over time and come down as well

- From Figure 2 we see states with the maximum price drop and price increase from 1975 to 2019
- The state with the biggest drop in house prices is West Virginia, with a price drop of about 32%
- The biggest increase in house prices was seen in the state of California, with a change of more than 200%
- California is called the 'Silicon Valley', the boom in technology and tech-related jobs might be the reason for this huge increase in prices

- From Figure 3 we see that the Northeast and the West regions have the highest change in average prices over the years
- For a very long time (1990 - 2000), average house prices in the Midwest and South were significantly lower than what they were in 1975, but around 2019 prices eventually went above the 1975 average
- Between 2000 and 2010, there were two significant periods of recession, and the housing market was in a bubble, leading to an increase in house prices
- Towards the end of the decade, the housing market crashed and house prices plummeted

Population Density and Changes in House Prices

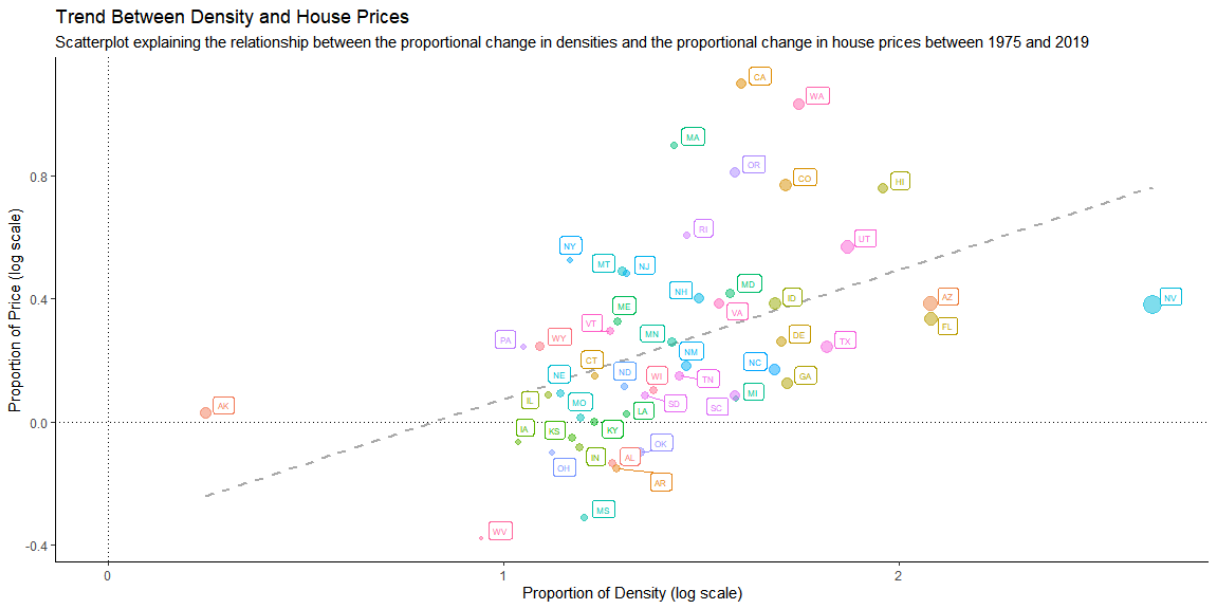

Figure 4

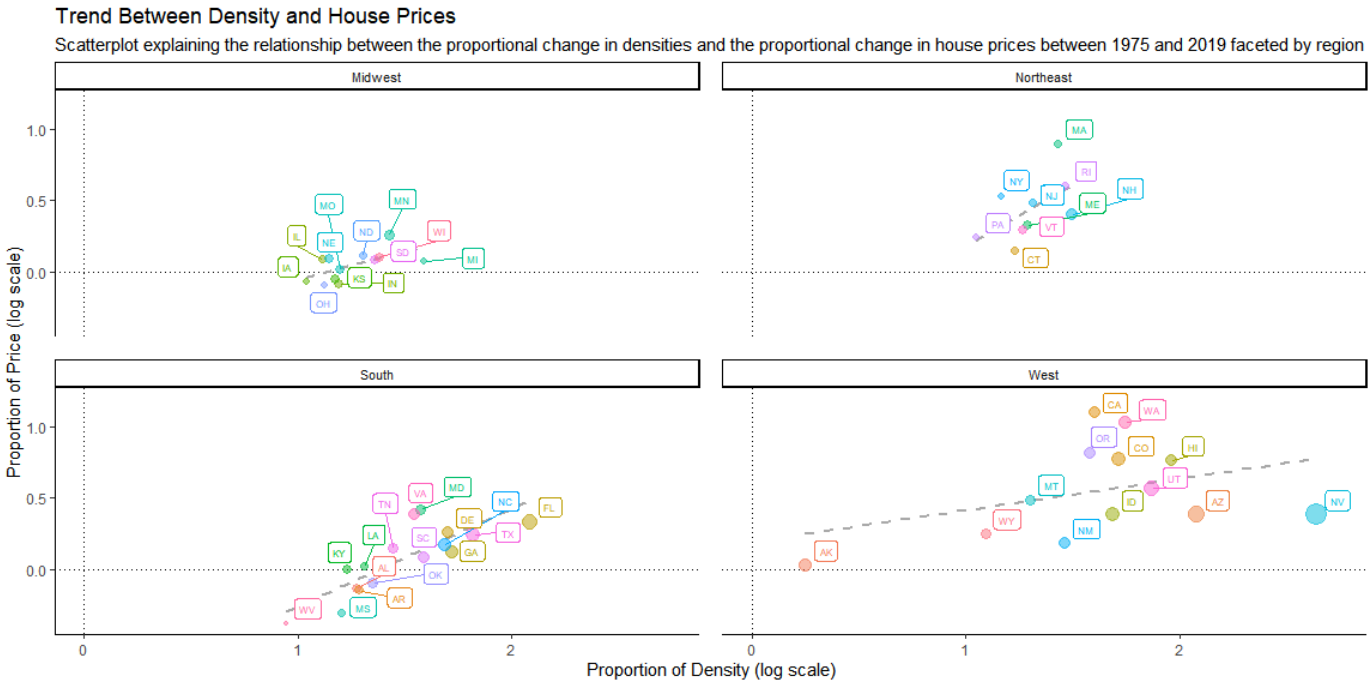

Figure 5

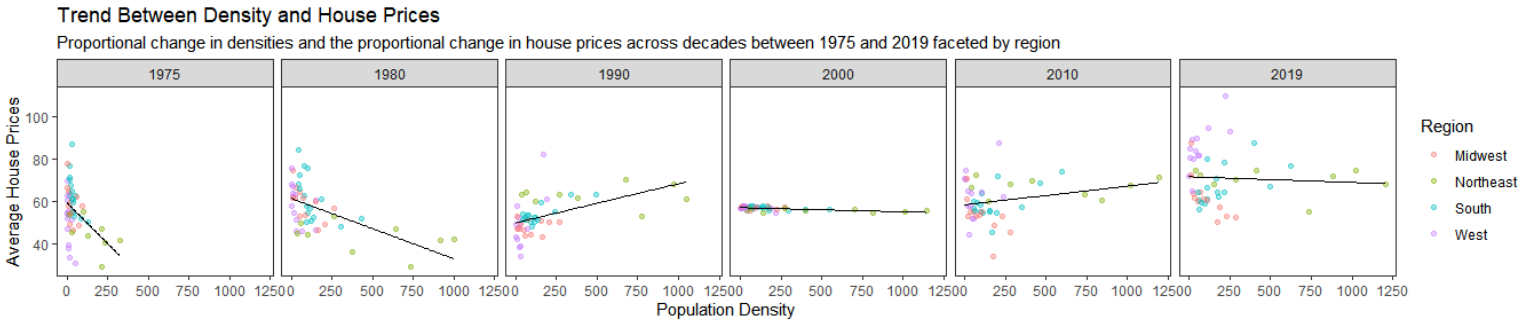

Figure 6

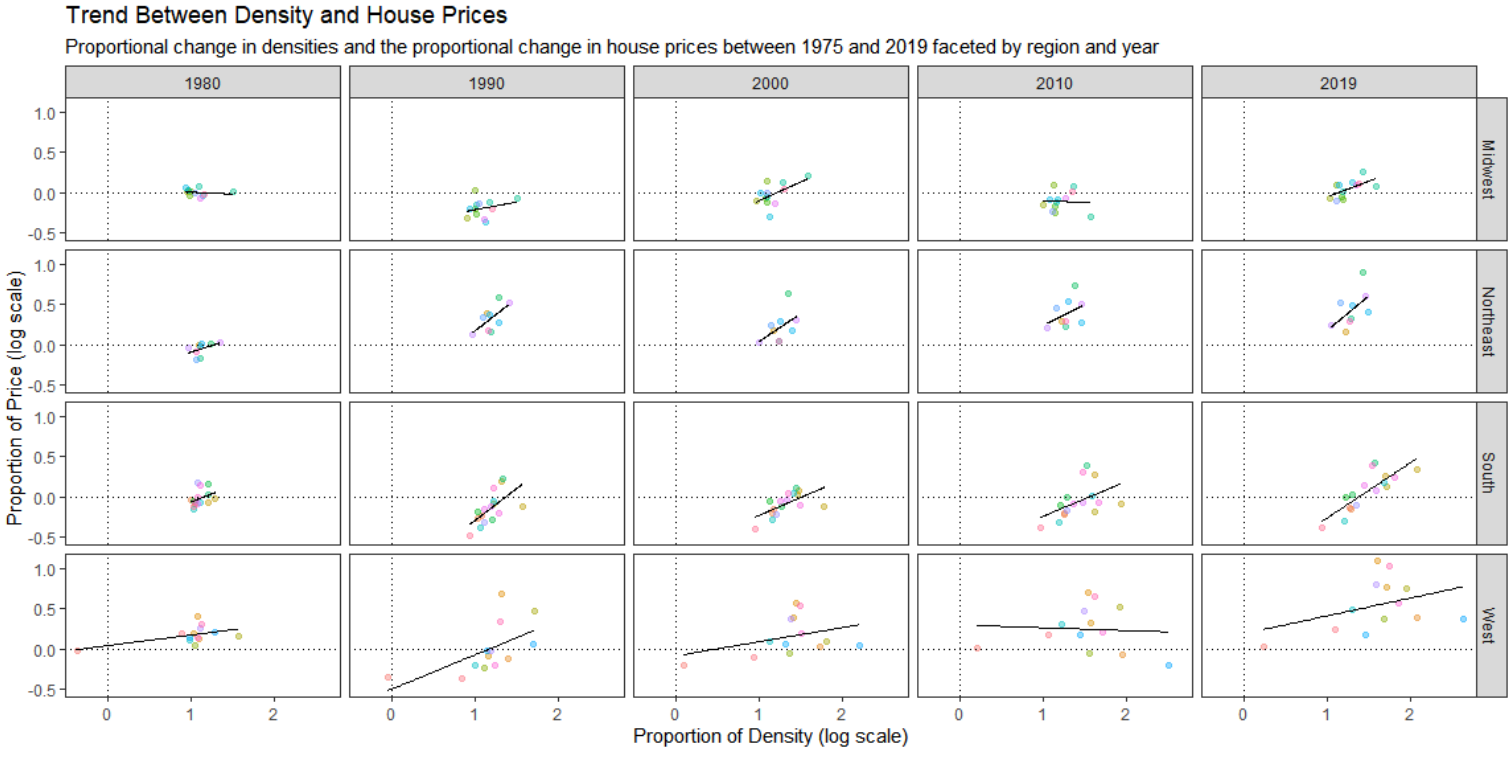

Figure 7

- Figure 4 shows the proportional change in house prices versus the proportional change in population density from 1975 to 2019, figure 5 is a similar graph, with the data faceted by region
- Since the graphs shows proportions, the axes are taken as log scales, as log scales represent proportions better
- For all states, population density has gone up over the years
- Price change with change in density has varied for different states
- Figure 6 shows the relation between house prices and population density faceted by years
- Figure 7 shows the proportional change in house prices versus the proportional change in population density faceted by region and year, with log-scaled axes

- The relationship does vary by region
- In the Northeast, prices have increased constantly across the years, for very small changes in population density
- In the West, states like California and Washington show a large increase in price from 1975 to 2019, but the population density did not increase much
- Arkansas did not show major changes in either population density or house prices
- Nevada shows a great increase in population density, but house prices did not go up as much
- In the Midwest, population density has not changed much, and neither have the house prices
- The South is a mixed bag in terms of the relation between population density and house prices
- House prices in some southern states (West Virginia, Arizona etc.) decreased from the 1975 prices across the years, while prices in other southern states increased over time

- The general trend across all states is that increase in population density increases the average house prices, and house prices have generally increased over time from 1975 to 2019
- In the 1990s almost all states showed some drop in house prices as compared to the previous years
- There are no clear outliers as such, but there are states where the relation between density and house prices is a little different than the general behavior

Changes in Population and Changes in House Prices

For all time periods:

- The first two plot show the highest and lowest percentage changes in population and house prices for all states
- The third plot shows the proportional change in house prices versus the proportional change in population
- The fourth plot shows the above relation faceted by region
- The third and fourth plot are plotted on the log scale as the show proportions

YEAR RANGE 1990 – 2000

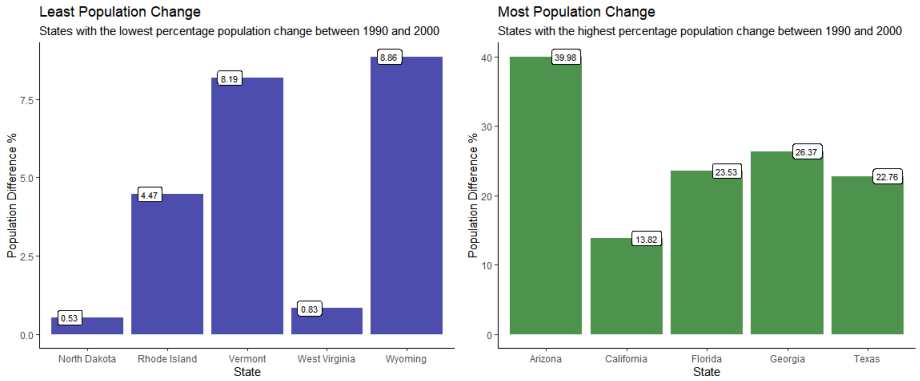

Figure 8

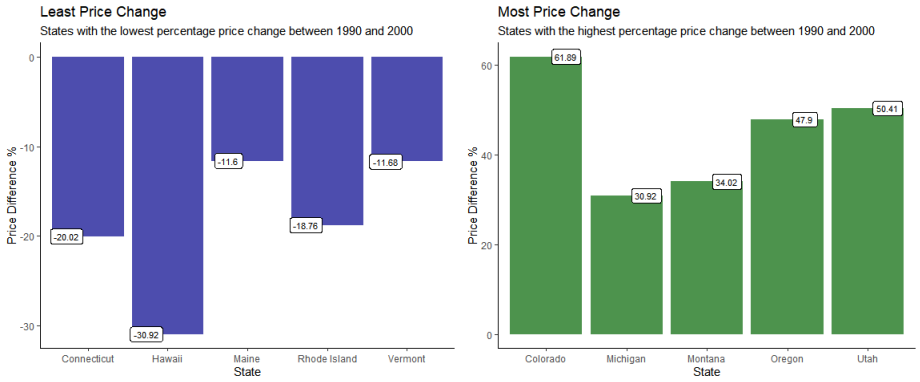

Figure 9

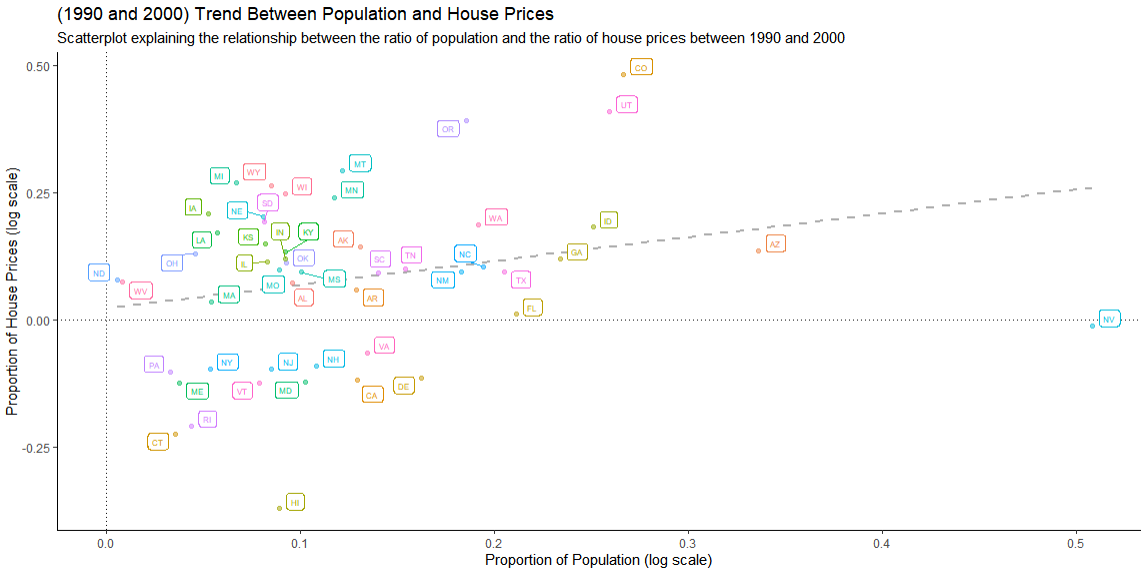

Figure 10

Figure 11

- North Dakota (0.53%) and Arizona (39.98%) showed the least and most change in population respectively
- Hawaii (-30.92%) and Colorado (61.89%) showed the least and most change in house prices respectively

- 28% of the states (14 out of 50) experienced a drop in house prices from 1990 to 200, but all states showed an increase in population during this time period
- More than 50% of these states (8) are from the Northeast region
- Nevada showed the largest proportional change in population, but showed a slight drop in house prices over the years
- Hawaii showed the largest proportional change (house prices dropped) between these years

YEAR RANGE 2000 – 2010

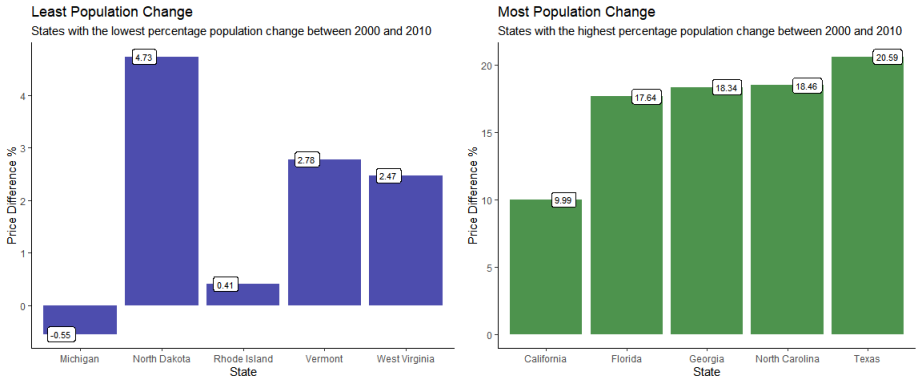

Figure 12

Figure 13

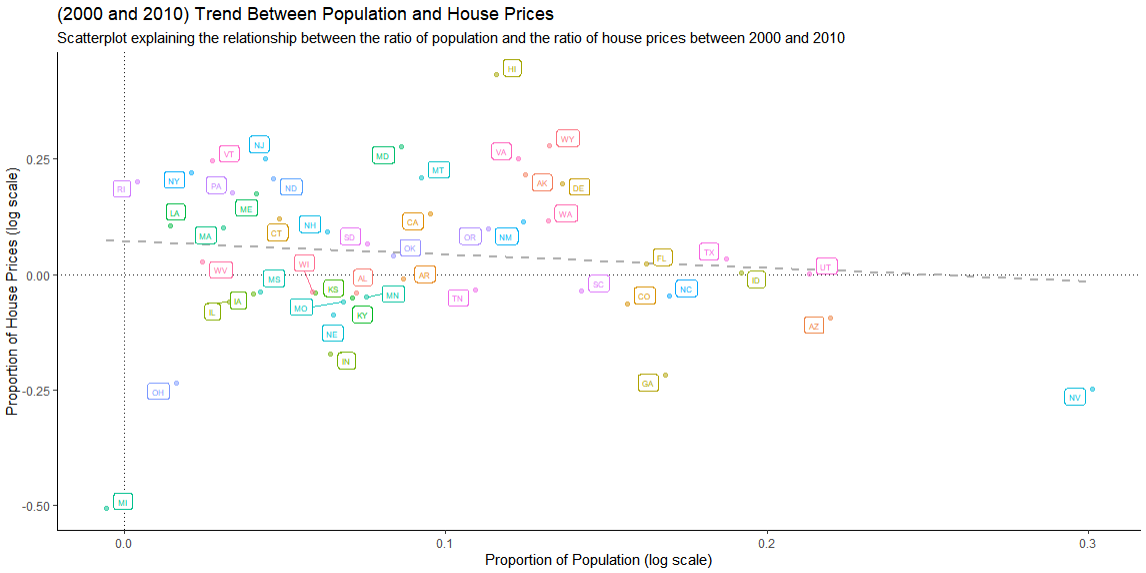

Figure 14

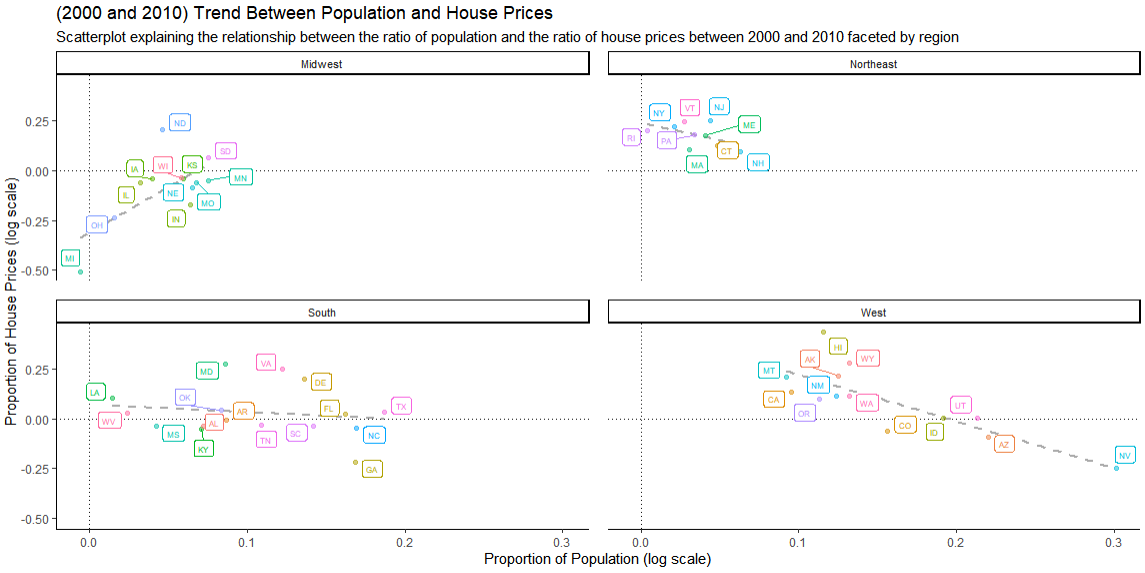

Figure 15

- Michigan showed a slight decrease in population (-0.55%) from 2000 to 2010, while Texas experienced the biggest increase (20.59%)
- Michigan (-39.77%) showed the largest decrease in house prices as well and Hawaii (54.19% showed the greatest increase)

- Almost all states in the Midwest experienced a drop in house prices from 2000 to 2010
- In this period too, Nevada showed a significant increase in population but a decrease in house prices
- In the previous period Hawaii had a large price drop, but in this period, it had the largest proportional increase in house prices from 2000 to 2010

YEAR RANGE 2010 – 2019

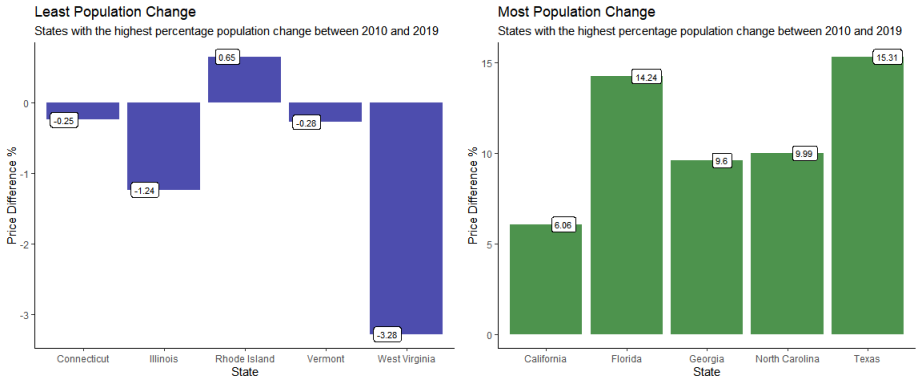

Figure 16

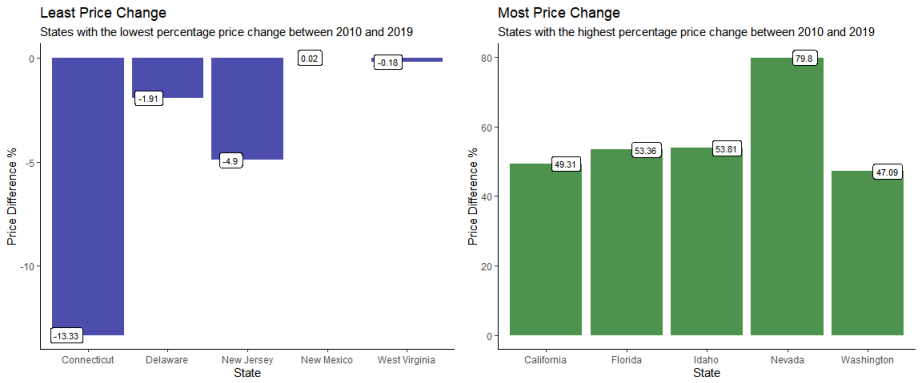

Figure 17

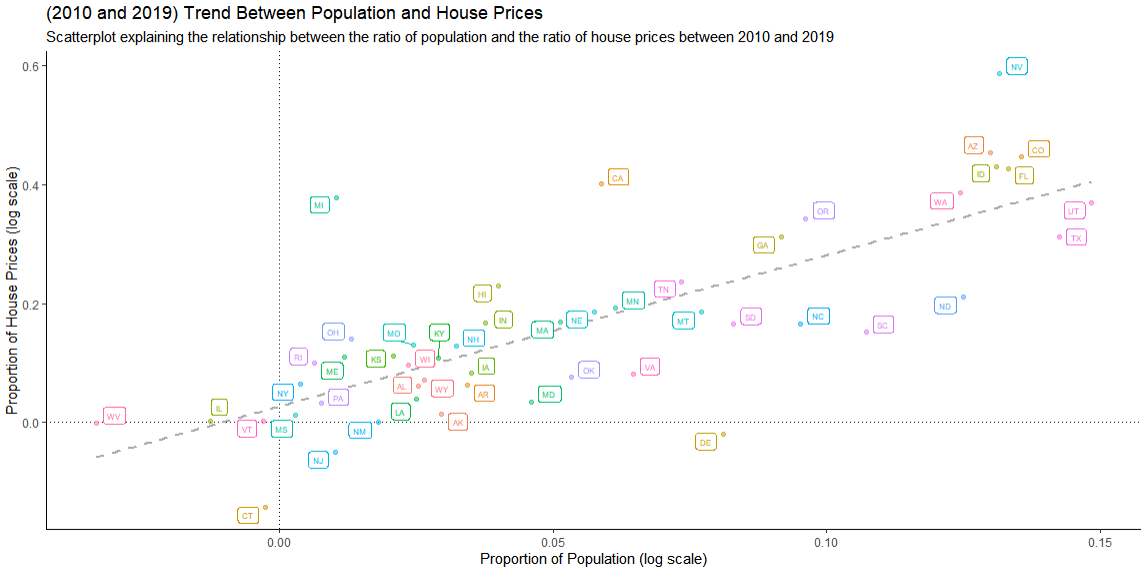

Figure 18

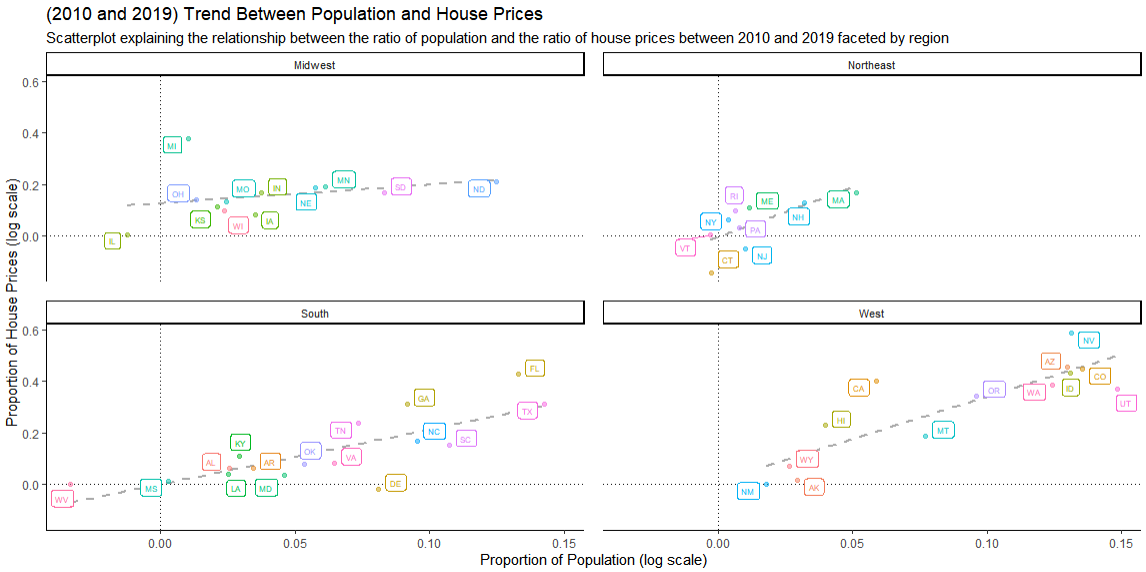

Figure 19

- Quite a few states (8%) showed a decrease in population during this period
- West Virginia (-3.28%) and Texas (15.31%) had the most significant population decrease and increase respectively
- The house prices dropped the most in Connecticut (-13.33%) and increased the most in Nevada (79.8%)

- Over the last two periods Nevada kept showing an increase in population but a decrease in house prices but in this period, it showed the highest increase in house prices
- Michigan had the largest drop in house prices in the last period, but showed a significant increase in house prices from 2010 to 2019
- Quite a few states like Illinois, West Virginia etc. showed little to no change in house prices from 2010 to 2019
- The highest proportional price change was seen in this period
- Just 6% (3) states had a drop in house prices between 2010 and 2019

Conclusions

All in all, the above research shows that it is not a very straightforward task to predict changes in house prices just by seeing the change in population. There are variations based on time periods, population density, region and state as well.
It would be a good idea to do this task region-wise and separately for separate time periods. In general, the trends seen across regions are clearer to see and easier to interpret through simple mathematical models like a linear model.
The changes across time periods are also important factors to consider. As seen in the above plots, house prices dropped across all regions in the late 200s and early 2010s probably because of the recession and the bursting of the real-estate bubble. But, from 2010 to 2019, as the market recovered, there was a steady increase in house prices for all regions.
Hence, just population is not the best indicator for estimating house prices. Other factors need to be taken into consideration as well.