Capstone Project 1

Statistical Analysis

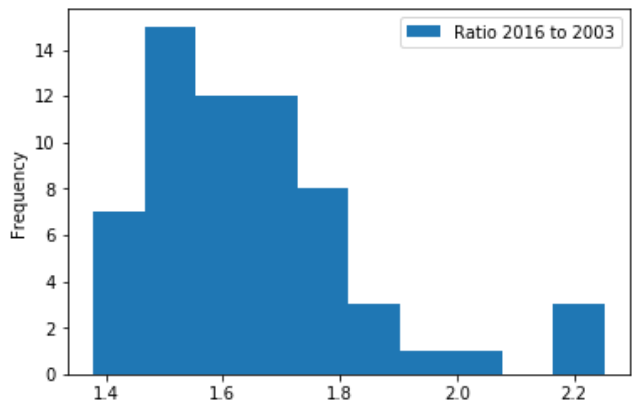
Background

The project examines the movement of house prices for 62 major cities in the UK in the period from 2003/4 to 2015/16 (the start and end years vary depending on availability of data) and which factors influence house price dynamics.

The data set includes information on indicators for each city, including average house prices, housing stock, population, employment, average wages and other data. Each of these factors was correlated to house prices across the 62 cities, in order to identify the factors where there is a relationship of statistical significance.

Preliminary analysis

The preliminary analysis involved examining the movement of house prices for the cities and understanding their progression over the period 2003-2016.

Histogram of price ratio 2016 / 2003	Summary statistics
	count 62.000000 mean 1.650260 std 0.189578 min 1.378782 25% 1.521207 50% 1.612781 75% 1.730193 max 2.251657

The analysis shows that prices have increased in all of the cities from 2003 to 2016. The highest increase was a factor of 2.25x, the lowest 1.38x and the mean 1.65x.

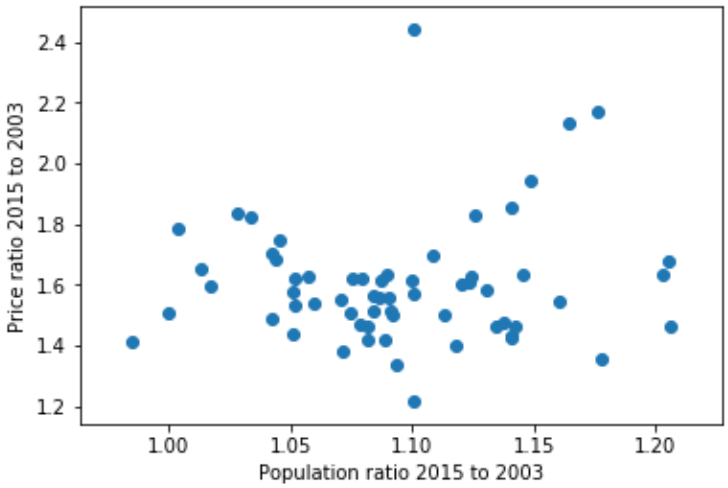
Next, the influence of economic and demographic factors on house prices was analyzed.

Population as a factor

This analysis correlates the population with house prices for each city.

- Null hypothesis: population does not have an effect on house prices
- Alternative hypothesis: changes in population do have an effect on prices. The economic argument would be that higher population growth in a city creates increased demand for housing, pushing up prices.

Scatter plot and linear regression result




```
LinregressResult(slope=0.37103332013346124, intercept=1.1931777645276085,
rvalue=0.092847457785237966, pvalue=0.47290774247213752,
stderr=0.51367355101313694)
```

The very low correlation and p-value lead us to accept the null hypothesis and conclude that population growth is not a factor in determining house price movements.

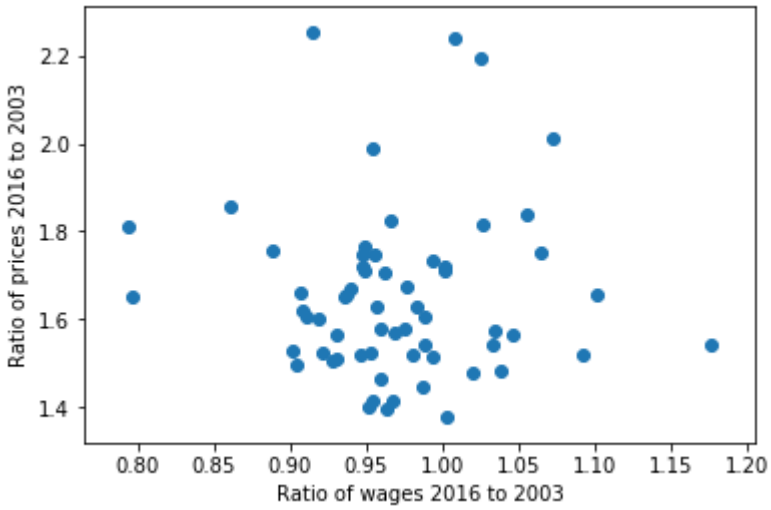
Wages as a factor

This section analyzes the influence on average wages on house prices for each city.

- Null hypothesis: wages have no influence on house prices
- Alternative hypothesis: wages do influence prices, i.e. a city with higher average wages is likely to also have higher house prices

As seen from the chart below, there is no statistically significant relationship between wages and house prices, with a p-value of 0.92. Hence we can accept the null hypothesis and conclude that wages also do not have an effect on prices.

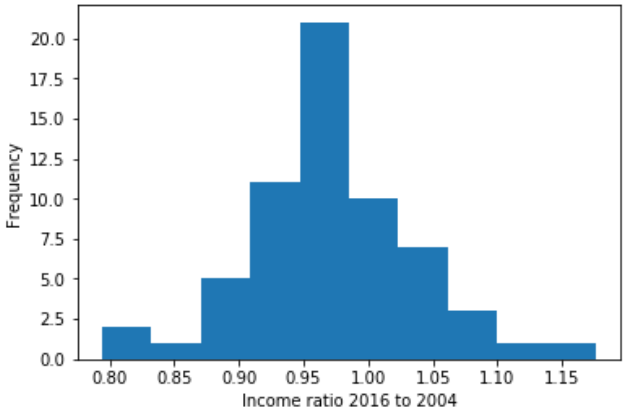
Scatter plot and linear regression result



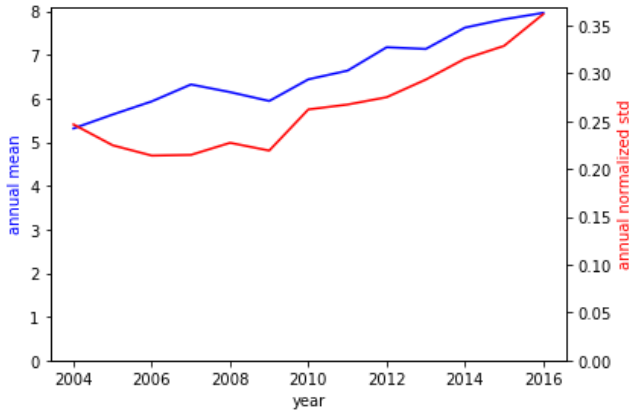

```
LinregressResult(slope=-0.035757244278745728, intercept=1.6849196164412457,
rvalue=-0.012221228489308327, pvalue=0.92489058588920314,
stderr=0.37769489708513054)
```

A closer analysis of the relationship reveals that, in fact, wages have on average remained constant in the period 2003-2015, while house prices have increased by an average of 60% by 2015. Houses have become increasingly harder to afford for the average UK worker. Averaged over the 62 cities, 5.3 annual salaries were needed to buy a house, whereas by 2016 this figure has has increased to 8.0 years. The standard deviation of prices (normalized by the mean price in each year) has also increased, meaning that the variation between cities has become more extreme.

Average wage ratio 2016 to 2004



Average no. of annual wages needed to buy a house



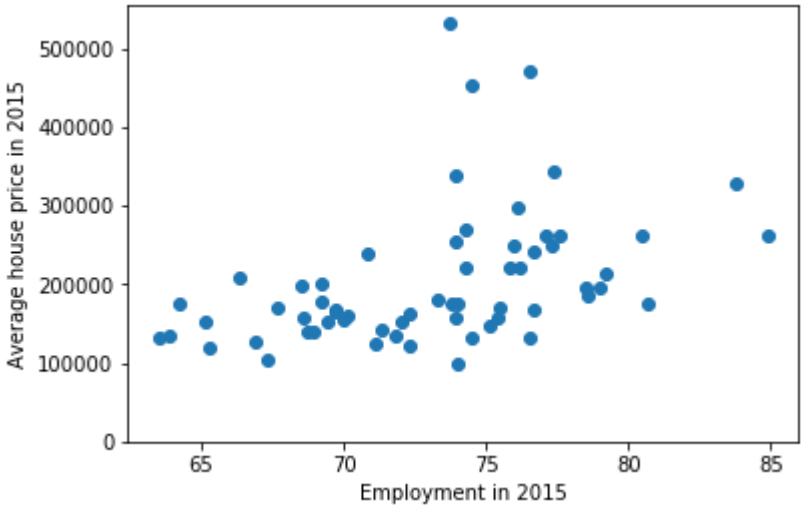
Employment as a factor

This section analyzes the influence of the employment rate in a city on its house prices.

- Null hypothesis: employment does not influence prices
- Alternate hypothesis: employment does correlate with prices, based on the economic argument that higher employment indicates a healthier economy and can drive up house prices

The results for 2015 show that there is a positive correlation, with a p-value of 0.0005, hence statistically significant and we can reject the null hypothesis. The slope of the regression line corresponds to an average price increase of GBP 7,733 for each percentage point of higher employment. Apart from the three outliers that have average prices far above the average (London, Cambridge and Oxford), for the rest of the cities the employment rate is a significant factor in determining house prices.

Scatter plot and linear regression result




```
LinregressResult(slope=7733.6974025245236, intercept=-362057.43026893004,
rvalue=0.42952884043601064, pvalue=0.00049429854700009746,
stderr=2099.0970972822956)
```

Housing stock as a factor

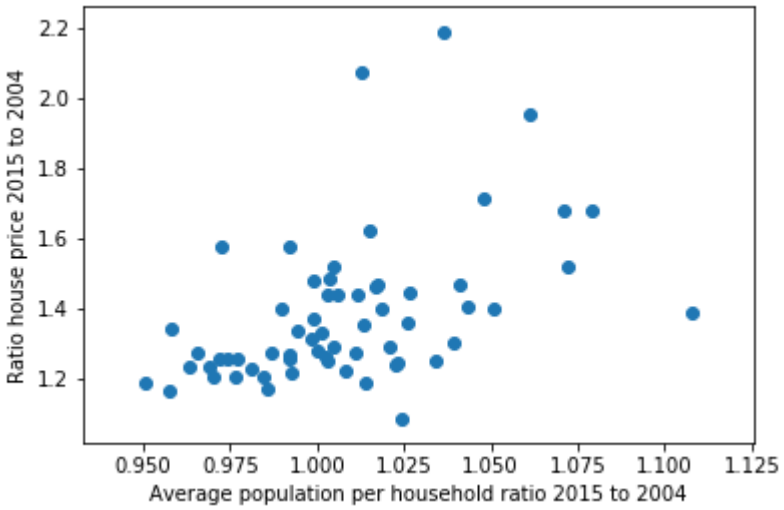
This section analyzes the influence of housing stock on house prices, in the context of housing stock relative to the population.

- Null hypothesis: housing stock (calculated as population divided by housing stock) does not have an effect on house prices

- Alternate hypothesis: housing stock does have an effect on housing, under the economic argument that housing stock that does not keep up with population growth would lead to an increase in prices.

The results show a positive correlation, with a p-value of 0.0001, hence statistically significant to lead us to reject the null hypothesis. However the causality can be argued both ways, i.e. that a shortage of housing stock has the effect of pushing up prices, or alternatively that an increase in prices has forced a higher number of people to share a house on average.

Scatter plot and linear regression result




```
LinregressResult(slope=3.1068752996035132, intercept=-1.75002443887797,
rvalue=0.46741261437630005, pvalue=0.00012805166967188908,
stderr=0.7586113399376806)
```

Conclusion

The analysis leads to the following key take-away remarks:

1. House prices across the 62 major cities in the UK have risen by an average of 65% from 2003 to 2016
2. As wages have on average remained at the same level, owning a house has become increasingly difficult to afford for the average worker, needing 8.0 annual wages to buy a house compared to 5.3 annual wages in 2003
3. Population on its own does not correlate to house prices. However, population taken in combination with the housing stock in a city does have a statistically significant correlation with house prices
4. Employment is an important factor in determining house prices in a city
5. The 3 most expensive cities (London, Cambridge and Oxford) can be considered outliers as their prices are not explained by the factors covered in this analysis