SENIOR CAPSTONE: EFFECTS ON HOME PRICES

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Abstract. The home prices can be affected by many events within the economy. The three main influences looked at in this paper are gross domestic product, inflation rates, and unemployment rates. There will be a comparison on how each variable effects the home price through regression analysis.

1. Introduction

Home prices fluctuate when economic influences change the economy. Gross domestic product, inflation rates, and unemployment rates are three economic changes that can effect home prices in different ways. When potential home buyers are more willing to invest in a house then the GDP increases causing the price of homes to also increase. Inflation rates can cause a huge impact on home prices. If the inflation rate is high the price of a home tends to decrease because the demand of houses declines, therefore the price tends to lower. Unemployment rate causes home prices to decrease because if people become unemployed they are less likely to buy a house, so prices decrease to entice buyers to purchase a cheaper home. These all have direct effects on the home price which intentionally decide how much the home will be priced as.

1.1. Gross Domestic Product. The Gross Domestic Product (GDP) effects home prices in a substantial way. For example, in 2013, real estate construction contributed just 925 billion dollars, or 5.8 percent, to the nation’s economic output as measured by GDP (Amadeo). This fact describes that there is a huge market that can raise or lower the GDP by billions. Through research of many economists, the relationship between house prices and GDP is broken down into two ways: through private residential investment and consumption spending on housing services (NAHB). Private residential investment means single family homes and apartment buildings. Once an investment is made into these properties it becomes a main aspect to keep the home or

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building well taken care of. Therefore the second way home prices affect GDP is through consumption spending which entails renters utilities and the owners renting capabilities of how much they could rent the unit for (NAHB). When people build or buy a house they tend to spend a great deal of money, whether it be through construction or buying the property, it is usually the biggest investment in someone's life. When a person builds a house they create jobs for construction workers and they increase the value of that land. Once the house or apartments are built the expense of utilities and upkeep of the buildings creates another set of jobs. The declines in real estate sales and construction have a trickle down effect and impact a variety of factors, including the unemployment rate, home values, individual equity and consumer spending (Cullinan) Once the trickle down effect happens the amount of consumers buying properties or houses would decrease therefore decreasing the GDP growth.

1.2. **Inflation Rates.** The United States has a fluctuation of inflation rates that Americans reasonably panic when approached with the word. The definition of inflation is consistently described as a stagnating economy, rising prices, a falling dollar and an income that just can’t keep up with the cost of living(Bell). It is known by means that the cause of inflation is the devaluation of currency, frequently brought about by the introduction of more currency into the economy (Gallagher). Realistically, inflation does cause the price of the dollar to decrease and prices to go up, but in some cases this does not cause conflict. For example, through an economist standpoint of supply and demand so if inflation is high, an oversupply of housing will bring home prices down. Interest rates tend to go up with inflation. Mortgage rates reflect interest rates. If mortgage rates go up too high, people won't take out home loans. Demand will decrease; home prices will fall (Gallagher). Homeowners buy their houses in three ways: full amount up front with no payments ever, which is very rare, mortgages with fixed rates, or mortgages with variable rates. Although, when one pays their mortgage in full then there is no interference of inflation rates because homeowners are not investing any more money into paying a loan back. With loaning money and obtaining a mortgage, homeowners begin to realize the impact of the inflation of a dollar. Mortgages are loans from a bank for a home purchase that has interest attached with the loan for the bank to ensure people are paying. In a fixed rate mortgage the interest rate is set at a percentage and does not fluctuate or change with the economy to keep it supported. This is the ideal mortgage when
the economy goes through an inflation because when the value of the
dollar decreases, the homeowner borrowing the money is still paying
the same amount. Through a study, economists have shown that home
prices look remarkably stable when corrected for inflation. Over the 100
years ending in 1990 real home prices rose only 0.2 percent a year, on
average (Shiller). This statistic gives proof that although it seems that
housing prices are increasing- meaning the market is improving- is ac-
tually just keeping up with the inflation. Many homebuyers and home
sellers neglect to realize the prices change through the inflation of a dol-
lar. A good example is given in NY times, a home selling for 200,000
dollars today will sell for around 250,000 dollars in 2023, though the
real price corrected for inflation would be unchanged (Shiller). The
set amount paid helps the homeowner in a substantial way because
as the price of a dollar decreases, all prices for goods and services are
increasing, but the loan is staying the same so it does not cause un-
reasonable mortgage payments. Another way homeowners purchase a
house is through variable rate mortgages, which have the home pur-
chasers seeing their borrowing costs climb periodically along with the
broader inflation in the economy (Bell). With the inflation of the dol-
lar, prices tend to rise causing the interest rates to also rise ensuring
the value of the dollar is included. This leads to larger payments and
decreases affordability of a home loan causing homeowners to regret
the decision and investment of buying a house (Bell). When one can
not afford their house through the hard times, they begin to sell and
down size. Since prices are high, the unestablished rate still causes it
hard to even buy a cheaper home because the interest rate is so high
that purchasing a cheap home with high inflation is like buying a more
expensive home prior to the inflation. Realizing the inflation rate is
high can help a person thinking about buying a home comprehend that
chances are they will be facing rising home prices and higher interest
rates, which increase the cost of borrowing making it hard for someone
to really desire to buy a home during this time (Keefer).

1.3. Unemployment Rate. Another factor involving the change of
home prices is the unemployment rate. The decrease has become ap-
parent by the unemployment and home price shocks at the national,
regional and state levels (Owusu-Ansah). This impacts many people
and changes the flow of the economy, especially through home purchas-
ing. When one becomes unemployed they are less likely to buy a house
at any given time. When a huge group of people become unemployed in
a certain area then most likely no one will be buying houses, therefore
the home prices begin to decrease to entice buyers to purchase cheaper
houses. When one loses a job the loss becomes a major financial constraint to afford many desired items and while a home is most peoples expensive asset then that is the first asset they contemplate on selling. When the unemployment rate in a region increase then the market to sell a home decreases, therefore causing the prices of homes to decrease to entice anyone to try and move houses. Some homeowners when becoming unemployed can not make ends meet and do not pay their mortgage loan allowing their house to fall into foreclosure. Studies have shown that 45 percent of mortgages fall into foreclosure as a direct result of unemployment (Martinez). When houses go into foreclosure, the value of the house decreases drastically and is sold at a ridiculously low rate. Overall whether a homeowner decides to change houses, stay in their current house, or allow their house to go into foreclosure the home price is affected directly by the unemployment rate. Researchers has shown that the increase in the unemployment reduced the number of buyers, weakens the homeowners tendency to change houses and generates poorer matching quality, so the home price decreases through this rate of change (Gan).

2. Graphs

In this section, we use graphs to compare each of the three variables, GDP, inflation rate, and unemployment rate to home price. The three variables that effect the home price can be represented in graphs with the comparison of each variable to home price and then each variable with each other. Since the data is determined in different intervals and some are much larger than others, we standardized the variables using the formula $\frac{\text{first quantity} - \text{mean}}{\text{standard deviation}}$. This will essentially give us the same numbers just in a standardized form to better compare the data. These graphs below are represented with y(home price), x1(GDP), x2(inflation rate), and x3(unemployment rate).
Figure 1. This graph shows that there is a high positive linear correlation between the GDP and the median home price.
Figure 2. The graph suggests that the relation between median home prices and the inflation rates are not linear.
Figure 3. This represents the comparison between home prices and unemployment rates. The graph indicates that the two variables have a scattered comparison with each other. Therefore, unemployment rate and median home prices do not have a linear relation as seen in the graph.
3. Regression Analysis

R Console

> anova(z)
Analysis of Variance Table

Response: homeprice

          Df Sum Sq Mean Sq  F value    Pr(>F)
GDP           1 28.656  28.656 618.13 < 2.2e-16 ***
Residuals    29  1.344   0.046
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> summary(z)

Call:
  lm(formula = homeprice ~ GDP)

Residuals:
          Min       1Q   Median       3Q      Max
-0.35436 -0.13480 -0.04068  0.17979  0.39376

Coefficients:
                Estimate Std. Error   t value  Pr(>|t|)
(Intercept)   -0.001828   0.038671   -0.047 0.963500
GDP            0.977450   0.039315   24.862  < 2e-16 ***
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2153 on 29 degrees of freedom
Multiple R-squared:  0.9552,    Adjusted R-squared:  0.9536
F-statistic: 618.1 on 1 and 29 DF,  p-value: < 2.2e-16

Figure 4. The p-value is $2.2 \times 10^{-16}$ which shows the data is statistically significant because it is much less than $\alpha$ of 0.05. The R-squared value is between 0 and 1, with 1 showing a strong linear relation. The R-squared value is 0.9552, therefore showing a strong linear relation.
FIGURE 5. We have that $\alpha = .05$ and our p-value is 0.02246, meaning our data is statistically significant. However, the small R-squared of 0.167 closer to 0 means that the linear correlation between home price and inflation rate is moderate.
R Console

> anova(j)
Analysis of Variance Table

Response: homeprice

  Df Sum Sq Mean Sq F value Pr(>F)
unemploy   1  0.106 0.10599  0.1028 0.7508
Residuals 29 29.894 1.03083

> summary(j)

Call:
  lm(formula = homeprice ~ unemploy)

Residuals:
  Min      1Q  Median      3Q     Max
-1.4233 -0.7322 -0.3322  1.0335  1.7306

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.2349     0.7549   0.311    0.758
unemploy     -0.0373     0.1163  -0.321    0.751

Residual standard error: 1.015 on 29 degrees of freedom
Multiple R-squared:  0.003533,  Adjusted R-squared:  -0.03083
F-statistic: 0.1028 on 1 and 29 DF,  p-value: 0.7508

Figure 6. The comparison of the large p-value of 0.7508 and the very small R-squared of 0.003533 indicates that the relation between the median home price and unemployment rate is not linear. This does not mean that there is no correlation between the two variables, but the relation is not linear.
R Console

> anova(fit)
Analysis of Variance Table

Response: homeprice

       Df Sum Sq Mean Sq  F value Pr(>F)
GDP     1 28.6556 28.6556 730.1432 <2e-16 ***
inflationrate 1  0.2797  0.2797   7.1260 0.0127 *
unemploy 1  0.0051  0.0051   0.1292 0.7220
Residuals 27  1.0597  0.0392

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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 '*' 0.05 '.' 0.1 ' ' 1

> summary(fit)

Call:
lm(formula = homeprice ~ GDP + inflationrate + unemploy)

Residuals:
    Min      1Q  Median      3Q     Max
-0.47982 -0.11099  0.00824  0.12902  0.31806

Coefficients:
                       Estimate Std. Error t value Pr(>|t|)
(Intercept)   -0.355185   0.219664  -1.617   0.1175
GDP            1.036915   0.042800  24.227   <2e-16 ***
inflationrate  0.103282   0.039124   2.640   0.0136 *
unemploy       0.008644   0.024046   0.359   0.7220

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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1981 on 27 degrees of freedom
Multiple R-squared:  0.9647,    Adjusted R-squared:  0.9608
F-statistic: 245.8 on 3 and 27 DF,  p-value: < 2.2e-16

> 

Figure 7. As seen above the p-value of unemployment is an indication that the interaction exists between unemployment rate and at least one of the two other variables, GDP and inflation rates. However, the higher multiple R-squared tells us that the model appears to be statistically useful for predicting median home prices.
R Console

> anova(fit2)
Analysis of Variance Table

Response: homeprice

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<th></th>
<th>Df</th>
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<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
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<td>7.3547</td>
<td>0.0113 *</td>
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<td>0.0380</td>
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</tbody>
</table>

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> summary(fit2)

Call:

lm(formula = homeprice ~ GDP + inflationrate)

Residuals:

Min       1Q   Median       3Q      Max
-0.45204 -0.10007  0.00675  0.12610  0.30702

Coefficients:

|             | Estimate | Std. Error | t value | Pr(>|t|) |
|-------------|----------|------------|---------|----------|
| (Intercept) | -0.28742 | 0.11098    | -2.590 | 0.0151 * |
| GDP         | 1.03372  | 0.04121    | 25.083 | <2e-16 *** |
| inflationrate | 0.09867 | 0.03638   | 2.712 | 0.0113 *   |

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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.195 on 28 degrees of freedom
Multiple R-squared:  0.9645,    Adjusted R-squared:  0.962
F-statistic: 380.5 on 2 and 28 DF,  p-value: < 2.2e-16

> 

Figure 8. We leave out the unemployment rate variable, since it was the least correlating factor for home prices to see if we could get a more accurate prediction. Excluding this variable allows us to see that this is a better prediction.
R Console

> anova(fit, fit2)
Analysis of Variance Table

Model 1: homeprice ~ GDP + inflationrate + unemploy
Model 2: homeprice ~ GDP + inflationrate

Res.Df RSS Df Sum of Sq  F Pr(>F)
1 27 1.0597
2 28 1.0647 -1 0.0050714 0.1292 0.722

Figure 9. The high p-value for this anova tells us that we can use the simple model $fit2 = y \cong x_1 + x_2$. 
4. Conclusion

Through analysis of the variables correlating to median home prices, we have come to the conclusion of a final formula that will work to determine the median home price. Utilizing the GDP and inflation rate at the time we can find the median home price. The formula used to find this is:

\[
\text{Median home price} = 1.03372 \cdot \text{GDP} + 0.09867 \cdot \text{Inflation Rate} - 0.28742
\]

This formula is in the form \( y = \beta_1 x_1 + \beta_2 x_2 + \beta_3 \), where \( \beta_1, \beta_2, \beta_3 \in R \). Therefore by placing any of the known values in for GDP and inflation rate we can determine the average price of a home in that specific area.

In the future to find a more accurate model, other options of models should be used. In this finding we only used linear models, but if we were to use nonlinear models then unemployment rate could possibly be more correlated with the data. Also including more variables that correspond to the median home price could more accurately define the price. Furthering the research for this analysis could potentially find an exact formula to determine the median home price for any area.
References


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