Consumer Confidence and Monetary Policy:

A U.S. Housing Market Investigation*

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Abstract:

In researching an effect of consumer confidence on the housing price index a positive significant effect was found. Controlling for other monetary effects the only significant effect that was found was of the mortgage rate and it was negative, as predicted by theory. Researching whether these effects stay the same during the financial crisis by testing for a break in the data reveals that the only variable that is significant after the break is the consumer confidence. This means that it had a bigger and more apparent effect in the crisis time with evidence suggesting it might have been affecting the housing prices only in this period and not in previous quieter times. All monetary variables at the disposal of the FED do not seem to have a significant diminished effect during the crisis. In trying to determine where the break in the data exactly occurred, evidence suggests that it happened deeper into the crisis, midway through 2008.

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Introduction:

During the year of 2007 the financial crisis hit the U.S. economy ensuing from an asset bubble of rising housing prices that ended up dragging along global financial markets to an international meltdown and mutual panic. High unemployment and bankruptcies were only some of the immediate results of the irresponsible behaviour of investors with regards to the dealings of mortgage-backed assets (Sorkin, 2008). People with low income who did not seem to have any future capabilities of repaying their loans were given mortgages with high interest rates only to satisfy the greedy investors who wanted to make a high return despite the equivalently high and negligent risk (Shiller, 2008).

This crisis that started in the U.S. and later evolved in Europe into the euro crisis, affecting largely the world's most traded financial markets, which in their nature are intangible, stemmed from a very tangible market – the housing market. It is interesting to observe that despite the fact that many markets are still suffering from the grave consequences of the crisis and its firm hand is felt globally, the main core origin of the crisis seems to be actually on its way to a full recovery (Wiseman, 2013). The housing market in the U.S. shows an upturn with regards to its prices for over a year now and while this is no proof for salvation and an absolute end to a financially bad period it still serves as a sign of hope and possible change in the global economic landscape.

In the period following the start of the crisis and the bankruptcy of the Lehman Brothers the Federal Reserve System (FED) tried to stimulate back the economy by well-known tools, one of them being a low interest rate. This was also reflected in a lower mortgage rate that was intended in encouraging people to buy houses and turn around the trend of declining housing prices. However, despite the FED's efforts the turnaround only came much later. Housing prices have only recently started rising and gained stability in a moderate yet constant growth. This calls for an inspection with regards to other factors, not part of the FED's policy that triggered such a turnaround in the housing market.

Inline with theories of consumer confidence and irrationality (see theoretical framework part) it is assumed that not only tangible, real and rational factors may determine the market's result. Evident from the housing market in the U.S., there seem to be other aspects at play, which once noticed should be taken into account in future policy designs. These may shed light on other asset markets and possibly on similar markets in different economies. It is also important to find out whether these effects exist in non-turbulent times as well and which role they play in shaping the market's reality.

In this analysis of the housing market I will look at variables that are inherent to any central bank's policy and are often used and regarded as conventional means for not only a stimuli for a specific market but the whole economy. Together with these I will add to my model a variable that reflects the consumer confidence and check whether it affects the housing price, in which way and magnitude and whether it stays constant or evolves over time and in specific periods.

This leads to the paper's research question:

"Does people's confidence in the economy affect the housing prices in the U.S. and has this relationship remained the same through the recent global financial crisis?"

The research question will be investigated using time series regression analysis. To begin answering this question I will first acknowledge papers researching the effects of certain factors on the housing prices. Most research relates to monetary policy tools and therefore it will be included in the analysis. I will use it as a base for control on which variables will be added to account for people's confidence in the economy. A paper by Kenneth N. Kuttner (Kuttner, 2012) will be used to connect the monetary effects on the housing prices with this research and I will rely on it for drawing the initial assumptions needed in creating the model. The period researched is from January of 1987 until October of 2013 extending existing research by using data from the period of the financial crisis. This way of looking at more recent data and comparing it with figures from before the crisis will help explain how the relationships between monetary factors and people's confidence with the housing market function under different economic conditions and how they might have developed, changed or have remained the same during the recent turbulent times. I will be assisted in creating the model by theories on monetary policy (Burda & Wyplosz, 2009) as well as the famous animal spirit theory (Keynes, 1936), both conceived by Keynes or by successors following his ideas.

This research will further help establish a better intuition as to how to address FED's policy measures regarding the housing market in the future and might also lead to new insights concerning routine monetary policy tools in situations that they have not been tested yet before; a better understanding of the different ways that both existing and new FED policy measures affect distinct markets in the economy, gives the government (and the FED) more weapons in the fight against economic downturns in said markets.

It is structured as follows: the next section will entail the theoretical framework, giving an explanation with regards to the factors used in the model and why they are in it, as well as introduce hypotheses. Following this, the data and methodology part will explain the data gathering process and the statistical methods used to test the hypotheses and answer the research question. In the results part the actual statistical analysis will be performed while giving it context and interpretation in the conclusion section following immediately thereafter. The analysis of the results will test the hypotheses and aggregate the findings into an answer to the research question, which will come in the conclusion part. Lastly implications and limitations of the research are considered.

Theoretical Framework:

Kuttner (2012) states that the level of the interest rate set by the FED, which has never been observed to be so low, has allowed people to refinance their homes with mortgages at a much lower interest rate leading to a net wealth increase as interest payments would eventually go down. Moreover, the prospect of having a low interest-rate mortgage sparked demand for houses by both prospective investors and people looking to move out of rented houses and apartments. A scientific analysis can be found in the paper by Kuttner, who recently researched the connection between specifically the interest rates in the U.S. and the housing prices, focusing on the pre-crisis period (Kuttner, 2012). In his findings there is a negative relationship between interest rates and the housing prices but this relationship does not fully capture the rise of the housing bubble (i.e. the increase of the housing prices is too large in magnitude to be explained solely based on the changes in the level of the interest rate).

To add to this, Kuttner concludes that as the interest rate cannot solely explain the rise of the bubble surrounding the housing market, other variables take part in causing housing prices to rise. In another article referring to this paper: "Looking back it is clear that there were other developments that contributed to the housing boom like financial innovation, global demand for safe assets, poor governance, industry structure, housing policy, and misaligned creditor incentives (Backworth, 2012)." This enforces the reasoning for other influences shaping the housing market's price beside for the interest rate and other monetary policy tools.

In trying to find more explanations for the collapse and possible recovery of the housing market and what steers said market in other more quiet times as well, an essential theory of John Maynard Keynes plays an imperative role in establishing the reasoning for the introduction of confidence into the model. 'Animal Spirits' is a term used by Keynes to define human emotions that help drive the economy (Keynes, 1936). Based on this it is believed that the confidence, (essentially the faith) of people in the economy, its future prospects and direction, help in determining market prices and specifically for this research, the housing market. Optimism, pessimism and irrational thoughts and fears can, according to the animal spirits theory, influence people's decisions. Purchasing a house can occur due to good word of mouth about the market or the belief that the economy is doing well and irrespective of the buyers' capabilities of paying back the mortgage on the house and their specific financial situation. People may believe that if the market will rise in value their asset will be worth more in the future assigning them higher capital gains. This sets a higher demand in the market that would otherwise not exist to this extent and in a sense creates a price for the market that deviates from its so-called fundamental value. Price deviations from fundamentals have been seen empirically and may be attributed to sentiment in other asset markets (Coakley & Fuertes, 2006). Market sentiment (which in this context can be connected to an irrational behaviour as depicted in the animal spirit theory) is an important factor during transition times between low and high points of the market. Furthermore, in an investigation into the U.K. housing market it was revealed that intrinsic bubbles (which are irrational in nature) play a part in shaping the actual housing prices (Black, Fraser, & Martin, 2006) and an earlier research on the non-financial sector in the U.S. attributed a part of the variance in stock prices to non-fundamental components (Galeotti & Schiantarelli, 1994). Following from this, people's faith in the economy is expressed as consumer confidence, which is expected (when high) to encourage market prices to rise and specifically the housing market.

Earlier research specifically aimed at testing effects of consumer confidence on the economy reveals that some connections have been already established. Mishkin (1978) finds that the consumer confidence index actually signals financial distress and points to movements in balance sheets that are felt by consumers and affect their purchases of durables. The effect of consumer confidence is later even said to affect GDP and cause by non-fundamental attributes a positive effect on output (Matsusaka & Sbordone, 1995). It is difficult however, to say with absolute certainty that consumer confidence does not signal some other important variable's effect and therefore it is recommended to include in models dealing with this variable, as many other variables that (empirically or theoretically) might be relevant for control (Ludvigson, 2004). This contributes as support and reason to the inclusion of other variables, later to be explained, in the model. The variation in the index can be partly explained by economic aggregates, some of which will be included in the model (e.g. income and interest rates) but is presumed to have other idiosyncratic features only belonging to the consumer sentiment itself (Fuhrer, 1993). It has also been shown that the consumer confidence has an effect on household spending in general (Carroll, Fuhrer, & Wilcox, 1994) and therefore should attest even if only in part as to the changes in the housing prices. This leads to the first hypothesis (for now hypotheses will be written in words, but changed to more conventional and testable form in the Methodology section of the paper once all variables were introduced):

$$H_1: Consumer\ Confidence\ effects\ positively\ housing\ prices$$

To include Kuttner's findings in the model and control for their effects, a simple known theory for the use and effects of monetary policy tools is introduced. In this way a better analysis of the effect of consumer confidence on housing prices can be made while taking into account the monetary effects. As was also seen in the research by Kuttner, the assumption that monetary policy can influence the real market is due to a specific variable: the interest rate. "Historically, interest rates declines do tend to precede periods of house price appreciation" (Kuttner, 2012). How the interest rate influences the real/goods market can be explained by using the macroeconomic IS-LM model (Burda & Wyplosz, 2009). The IS-LM (Investment - Saving / Liquidity preference – Money Supply) model is a model created by several influential economists based on the ideas of John Maynard Keynes in the field of macroeconomics. It attempts to explain how general equilibrium (simultaneous equilibrium in the money and the goods market) arises due to the acclimatisation of the goods market (via saving and investing) and the money market (via demand and supply of money) to the interest rate. For this research, the IS curve is of interest, as it looks at the goods (real) market. The IS curve shows, (for different levels of interest rate) all levels of output where investment and saving (and more generally accepted, output and spending) of a country are equal. Lower interest rates mean cheaper borrowing of money, thereby making investments more attractive. Investments can have two effects on output, a direct effect and an indirect effect. Investing has naturally a direct effect leading to higher output, but it also indirectly increases output through the Keynesian multiplier. This multiplier essentially demonstrates how any sum of investment continues to be reinvested as it passes on from agent to agent (once deducting some saving rate) and therefore creates a ripple wave that should increase investment overall many times fold. It is through these two effects that the interest rate (and therefore implicitly monetary policy) influences the real market and why it is included in the model.

Additional research that uses the mechanism of interest rates as an engine to stimulate the economy confirms the eventual effect on asset prices, causing them to rise (Gilchrista & Leahy, 2002). Through overnight short-term interest rates the central bank can affect the public's expectations regarding the future and in turn raise (financial) asset prices including equities and mortgages (Bernanke & Reinhart, 2004). This reasoning conveys the cornerstone of economics of monetary policy. However, beside for the interest rate Kuttner includes more monetary variables in his model that also bear significance for this analysis. Firstly, Kuttner admits that money supply could point out to credit conditions in the economy thereby affecting the housing prices. "Base money may serve as a proxy for credit conditions". – Allowing for the increase in money supply would serve the increasing demand for credit arising from the low interest rates (Kuttner, 2012). Furthermore, Lastrapes (2002) strengthens this claim by conducting an analysis that finds empirical proof for the positive effect of money supply on the housing prices. Secondly, the interest rate on its own is different than the specific mortgage rate, which directly relates to the borrowing capabilities for house purchases (which convey long term rates). Protebra (1984) describes it as being a future cost despite of the purchase happening in the present, therefore affecting the housing prices already today notwithstanding the effect of payments being smaller or larger not yet taking place. In light of this information the mortgage rate and the money supply are included in the model as well.

Since money supply and the borrowing rates are nominal variables one has to include wages and the price level to account for any real change that might have happened through time. An inclusion of wages in the model would indicate somewhat the change of purchasing power and since the price of houses is many times reflected as a multiple of some index of wages, (OECD, 2005) or simply used for comparison (Willett, 2014) it should be included in the model. This would represent another angle in which inclination of people for purchasing a house is evaluated and serves as a demand side factor in the housing market investigation. A consumer price index should be included as well to represent the price level as an additional proxy for inflation and possible changes in purchasing power, thereby making the interpretation easier since all variables in the model would be nominal.

As is explained with the theories above, apart for the expectation of a possible influence of the consumer confidence on the housing prices the FED still has its power in shaping the housing prices to some extent. As is seen however, this power has diminished in ability to make wanted changes in the economy (and the housing market in particular) once the financial crisis that was ignited in 2007 has hit the U.S. (Kenny, 2013). This could mean that for the period of the crisis beginning halfway through the year of 2007 (Krugman, 2007), the effect of the FED's monetary tools and the consumer confidence on the housing price has not remained the same as in the years preceding the crisis. This lays the foundation for the second hypothesis:

$$H_2: There\ is\ a\ break\ in\ the\ data\ \ in\ the\ second\ quarter\ of\ 2007\ with\ regards$$
$$to\ the\ effect\ of\ all\ variables\ on\ housing\ prices$$

In periods of crisis, consumer confidence reaches severe low levels since people have a harder time believing the economy will regain stability in the near future and uncertainty is at very high levels (Inklaar & Yang, 2012). Furthermore, it appears that monetary policies tend to have a lesser effect in stimulating the economy in these hard times (Akerlof & Shiller, 2009). This serves as the last thread connecting the theories and the variables affecting the housing prices and which call for examining the relationship of consumer confidence with the housing prices in the period of the financial crisis. Since it is assumed that there still exists an engine driving the housing market even in times of economic turbulence, taking into account the decreased effect of the monetary policy it could be that consumer confidence might play a bigger role in said times. This leads to the third and fourth hypotheses:

$$H_3\text{: The effect of consumer confidence on housing prices increased in magnitude in the period of the financial crisis}$$

$$H_4\text{: The effect of monetary variables on housing prices decreased in magnitude in the period of the financial crisis}$$

After all theories and hypotheses have been introduced the next section will explain the variables and the statistical methods used in the paper.

Data and Methodology:

As was mentioned in the Theoretical Framework, I will analyse the effect of consumer confidence, controlling for several monetary variables, on housing prices. Housing prices are given as a housing price index, which I will also use as a suitable proxy for housing prices in the model. As was explained, the monetary variables most fitting to control for with regards to the housing market are the interest rate, the mortgage rate, the monetary supply, consumer price index and personal disposable income.

Data will be obtained from 'S&P Dow Jones Indices' regarding the housing price index (the S&P/Case-Shiller Seasonally Adjusted Home Price Index, seasonally adjusted to account for the effect of the season on housing prices[†]) and from 'Board of Governors of the Federal Reserve System'[‡] concerning the monetary variables. The data of the housing price index are given on a quarterly basis from the first quarter of 1987 until the third quarter of 2013 and uses a base observation (=100) as the first quarter of the year 2000. Using a Piecewise Cubic Hermite Interpolating Polynomial method (PCHIP) the data were interpolated from quarterly to monthly data resulting with monthly data starting in January 1987 until October 2013, which accounts for 322 observations in total. Following from Kuttner's research the interest rate used is of short-term nature. Therefore the same reasoning is applied in this research and the interest rate with a maturity of 3 months is used ('Market yield on U.S. Treasury securities at 3-month constant maturity, quoted on investment basis'). The mortgage rate chosen for the model is regarded by the FED as conventional ('Contract rate on 30-year, fixed-rate conventional home mortgage commitments') and the monetary base is given as M1 to account for money supply in cash and short-term deposits ('M1; Seasonally adjusted'). Both borrowing rates and the money supply have 322 observations for said period. The consumer price index that is used is 'The Consumer Price Index For All Urban Consumers' with the base observation (=100) being an average of the years 1982-1984. The data are again extracted monthly. An indicator for wage is expressed as the variable for disposable personal income, seasonally adjusted and also taken in monthly observations.

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† http://www.standardandpoors.com/indices/sp-case-shiller-home-price-indices/en/us/?indexId=spusa-cashpidff--p-us----
‡ http://www.federalreserve.gov/releases/h15/data.htm

As a measure for consumer confidence, the Consumer Sentiment index created by the University of Michigan[§] is used (therefore from now onwards I will use 'consumer confidence' and 'consumer sentiment' interchangeably). This is regarded as a good indicator of consumer confidence and has been used in numerous scientific papers concerning other asset markets (Lemmon & Portniaguina, 2006), (Otoo, 1999). After thorough examination it is considered as a good indicator for prediction of consumer spending (Eppright, Huth, & Taube, 1994). It is composed of five variables that are given equal weights and are posed as questions in a consumer survey and belong to three major topics: personal finance situation, the state of the economy as a whole and buying conditions in particular (University of Michigan, 2014). One could also look at the division of questions into two categories of present and future components (Dominitz & Manski, 2004). Two questions ask the surveyed to state whether they are better off financially today compared with (1) a year ago and (2) what they expect would be a year ahead. Looking ahead for two periods of a (3) year and (4) five years the surveyed have to answer if they believe the future will be good or bad financially and with respect to unemployment. The last question (5) asks the surveyed to relate to prices of durables and define the period as good or bad in absolute manner and not relative to a specific time. These questions comprising the index are specifically aimed at the ability of the surveyed audience to assess market conditions for major durables, houses being one of them. This innately connects the consumer sentiment index to houses and through buying conditions to the changes in housing prices. This could lead to reverse causality in the model. This problem will be addressed later and I shall try to resolve it to the best of my ability. Data of the consumer sentiment is also extracted on a monthly basis and has as its base (=100) the first quarter of 1966.

In order to get a better interpretation I will look at the natural logarithm of the variables, which hold absolute levels. These variables are the money supply and the personal disposable income. This method is used to avoid the problem of scaling and to be able to better account for relative magnitudes. Interpretation of the coefficients will be easier since in small values it can be translated as change in percentage points. It further may correct for non-linearity in the time series, which may be observed for M1 (See appendix 1, graph 3). As the interest rate and the mortgage rate are already percentage based, I will leave them as they are. The indices (housing price index, consumer sentiment and the consumer price index) are also left untouched as they are already altered and the only thing that could be done is to divide their values by hundred to reach the same percentage point interpretation. However, this will only

[§] http://research.stlouisfed.org/fred2/series/UMCSENT/

create the coefficients of these variables as a multiple of 100 (than what they would otherwise have been) and therefore it is regarded as redundant and the indices are eventually not altered.

Due to the aim of the research (specifically the second and third hypotheses regarding the financial crisis) and the nature of the data, ordinary least squares regression (OLS) on a time series analysis is preferred. By performing this regression, I look for an effect of consumer confidence on the housing price index controlling for the aforementioned monetary variables. With this regression I could check for the significance level and sign of the consumer sentiment thereby relating the findings to the first hypothesis. In order not to bear the risk of failing to reject a false null hypothesis I use a significance level of 10% throughout all the tests in the paper. Diagnostic tests for stationarity (Augmented Dickey-Fuller test), serial correlation (Breusch-Godfrey test for serial correlation) and heteroskedasticity (Breusch-Godfrey-Pagan test for heteroskedasticity) will be performed to see if the assumptions of OLS are not violated with the data, as this might impair some of the conclusions that can be drawn concerning the outcomes of the model. Furthermore, I will take measures to correct and adapt the models if such violations are found.

Another violation that may occur and could result in a careless interpretation is reverse causality, as mentioned earlier. It could be that changes in the housing price affect how people view the economy and this effect would be translated, even if only partially, to the values used in this model for the consumer sentiment. This poses a big problem in the design of the model, as it might be that both variables affect each other in different ways and in different periods creating some sort of a cycle. To try and isolate then the singular and one-sided affect of the consumer sentiment on the housing price I will use a lag of the consumer sentiment. Using the time dimension would serve as a tool to help get rid of a part (though not completely) of the reverse causality issue. This is reasoned since even if there was a possibility for the housing price index to affect the consumer sentiment, it would not be that the housing price index of a current period would have an effect on a previous period's consumer sentiment value. To determine exactly how far should be the lag in the model I will rely on the nature of the market itself. The housing market does not update its prices over night yet does not wait too long either. Therefore, I shall use a lag of one period (one month).

Due to the attempt of this paper to analyse and isolate an effect of the consumer confidence on housing prices from an effect of the usual monetary variables at the disposal of the FED, these monetary variables will be used in the model with a lag as well. Using the same reasoning for the consumer confidence this method is better for interpretation and manages to deal somewhat with the issue of reverse causality. The interest rate, mortgage rate and money supply are put in the model with one lag (stemming from the market nature to respond to changes) and by doing this I assume that the current housing price cannot affect the previous period's level of monetary tools by the FED. It should be mentioned though that the FED might use models for prediction into the future and by doing so will adapt its present levels of for instance the money supply. This could cloud the interpretation of the effect (if found) of these variables on the housing price but for the scope of this paper I shall assume that any adjustments made by the FED using this reasoning (if such existed) would not be to the detriment of the model as a whole. The consumer price index and the wage index would be kept at the same period and would not be used in the model with a lag. The reasoning for this is that both variables attempt to capture purchasing power and real changes in the value of money. As these mostly would be important at the point itself of purchase of the house, they are regarded as influential in only corresponding periods and are left unaltered.

The model to test the first hypothesis will be of the following form:

$$HPI = \beta_0 + \beta_1 \times CS + \beta_2 \times IR + \beta_3 \times MR + \beta_4 \times \ln(M1) + \beta_5 \times \ln(DPI) + \beta_6 \times CPI + \varepsilon$$

Where HPI is the housing price index, β_0 is a constant, CS is the consumer sentiment index, IR is the level of the interest rate, MR is the level of the mortgage rate and ln(M1) is the natural logarithm of money supply. CS, IR, MR and ln(M1) are all lagged by one month. CPI is the consumer price index, ln(DPI) is the natural logarithm of disposable personal income and ε is the error term.

The first hypothesis as mentioned in the previous section is translated to a more testable form and looks like this:

$$H_0: \beta_1 = 0$$

$$H_a: \beta_1 > 0$$

A significant positive coefficient could be translated as the consumer sentiment having an effect that goes in the same direction as the movements of the housing price index.

To address the second and third hypotheses a dummy variable is added to the model for the crisis period. Initially this dummy variable will only be added to one independent variable at a time to investigate separately the possibility of a break in the data only for one variable. Once all six models with individual breaks were examined the full model with a dummy assigned to all the explanatory variables is constructed. In examining a structural break in the data a look at the graphs of the variables is vital (see appendix 1). In order to account for a break, levels of the variables in the examined crisis period should also be present in non-crisis periods to achieve a better testimony. CS has lower levels in said crisis period but these can also be witnessed during the early 90s. CPI, ln(DPI) and MR seem to have a trend and therefore reach new levels for the crisis period. However, since the slope does not seem to change for these variables and the trend maintains its path, any relation that would be found with HPI that is different than the pre-crisis period would not be considered problematic in this regard. The maintained path of the variables suggests only that they are trend variables and that since the trend is not broken any effect in the crisis that would be found would not be related to any 'new information' that was introduced during the crisis period or any new characteristics of the variables. For ln(M1) and IR we do witness some changing patterns in the crisis period. IR reaches new low levels in the crisis period and then maintains a new pattern of mean reverting tendency very close to a zero interest rate. Ln(M1) has a positive slope but during the crisis period this slope increases by what seems as a considerable amount. These could pose as a problem in the interpretation if a statistically significant structural break was found. Notwithstanding, as I look at the effects of the variables on HPI and check whether they change during the crisis period (and since HPI also changes its movement pattern in the crisis period completely), this relationship may maintain its nature all the same. A break (if one was found) would still attest to a change in relationships between the variables, even if e.g. ln(M1) and HPI change levels and slopes in the crisis period but do not change in the same direction.

The regression equation for the full model with the break is therefore:

$$\begin{aligned} HPI = {} & \beta_0 + \beta_1 \times CS + \beta_2 \times IR + \beta_3 \times MR + \beta_4 \times \ln(M1) + \beta_5 \times \ln(DPI) + \beta_6 \times CPI + D \times \gamma_0 \\ & + D \times \gamma_1 \times CS + D \times \gamma_2 \times IR + D \times \gamma_3 \times MR + D \times \gamma_4 \times \ln(M1) \\ & + D \times \gamma_5 \times \ln(DPI) + D \times \gamma_6 \times CPI + \varepsilon \end{aligned}$$

D is the dummy variable (taking the value of 1 starting from the period of the crisis, 0 otherwise) and $\gamma_{1\text{-}6}$ stand for the difference in effect that the variables have on the housing price index during the crisis.

Since the crisis did not hit the economy over night I will examine two different points in time for its inception. The first point in time to be considered as the beginning of the crisis is midway through 2007 (Krugman, 2007) and so July 2007 will be the first observation to be considered as the financial crisis. In the other alternative I will use the bankruptcy of the big bank of the Lehman Brothers as the point of inception. This means that in this scenario the first period of the crisis will be September 2008 (Elliott & Treanor, 2013). If the coefficients (in either model) are found to be significant, the model not only gains explanatory power compared with the model without the dummy variable but the interpretation of a break in the data is confirmed. To test this a Chow Break test is performed on the full model (with the dummy variables) and the restricted model (without the dummy variables) for both break points in the data. The formula for the Chow Break test is included in appendix 2.

The second hypothesis as expressed here for the model containing all dummy variables in testable terms:

$$H_0: \gamma_0 = \gamma_1 = \gamma_2 = \cdots = \gamma_6 = 0$$

$$H_a: At\ least\ one\ of\ the\ aforementioned\ coefficients\ is\ not\ equal\ to\ zero$$

Where γ_0 to γ_6 are the coefficients during the period of the crisis for those variables that have been included in the final model. It should be mentioned that since 12 different models will be looked at first (6 for each point of break in the data) before looking at the models where all variables have the dummy variable assigned to them, the second hypothesis will be also investigated using a testable form such as this:

$$H_0: \gamma_0 = \gamma_x = 0$$

$$H_a: At\ least\ one\ of\ the\ aforementioned\ coefficients\ is\ not\ equal\ to\ zero$$

Where γ_x is the coefficient for the variable of interest and the constant is also assigned the dummy variable.

Finding that γ_1 is significantly larger than 0 means that the effect of consumer confidence on housing prices was larger during the years of the crisis and would therefore refer to the third hypothesis. As can be seen from the graph of the consumer sentiment (see appendix 1, graph 5) it has low values of confidence both in the period of the crisis and in previous non-crisis periods. This allows for interpretation that would be more in line with an effect that is present only in the financial crisis if the coefficient was found to be significant. Low values of consumer confident do not immediately have a larger impact on the housing price index but only in a crisis period.

The third hypothesis in testable terms:

$$H_0: \gamma_1 = 0$$

$$H_a: \gamma_1 > 0$$

As referred to in the previous section I expect the monetary tools at the use of the FED (interest rate, mortgage rate and moneys supply) to have a lesser effect on the housing price during the crisis. The interest rate and the mortgage rate are expected to have a negative relationship with respect to the housing price. Therefore, it would be suspected that during the crisis the coefficient would be smaller in magnitude rendering the gamma coefficient to be positive in the hypothesis. To represent the fourth hypothesis for the interest rate and the mortgage rate in testable form:

$$H_0: \gamma_x = 0$$

$$H_a: \gamma_x > 0$$

Money supply is expected to be positive in its effect on housing prices. This would mean that if its effect were to diminish in the crisis the gamma coefficient for money supply should be negative. The fourth hypothesis then tested for the money supply in testable form is:

$$H_0: \gamma_4 = 0$$

$$H_a: \gamma_4 < 0$$

All these tests for the third and fourth hypotheses will be investigated both in the model where only one variable (the variable in question) is assigned the dummy variable and in the full model as described above (for both points of the start of the crisis).

Results:

Since this research deals with time-series data one has to make sure that the data does not follow a random walk. Stationarity is of high importance to be able to draw the right conclusions and not only get ‘statistical relationships’. Unit root tests (augmented Dicky-Fuller test) are performed on all variables as they are used in the model (see appendix 3). After looking at the graphs of the variables the appropriate unit root test is chosen (intercept or intercept with a trend). Variables that are found to be non-stationary have another test performed on them, though this time by taking first differences. All variables satisfy then the requirement of stationarity and therefore the model will be of first differences for all variables.

Before running the model I use a correlogram to check for auto-correlation in the dependent variable, HPI (of first difference).

Table 1: Correlogram

D(HPI) – First Difference of the Housing Price Index, before inclusion of auto correlated terms:

Sample: 1987M01 2013M10
Included observations: 320
Q-statistic probabilities adjusted for 6 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|******|	.|******|	1	0.855	0.855	236.10	0.000
.|***** |	**|. |	2	0.657	-0.276	375.86	0.000
.|**** |	.|. |	3	0.495	0.059	455.61	0.000
.|*** |	*|. |	4	0.354	-0.088	496.40	0.000
.|** |	.|. |	5	0.243	0.022	515.75	0.000
.|* |	.|* |	6	0.191	0.104	527.73	0.000
.|* |	.|* |	7	0.205	0.153	541.53	0.000
.|** |	.|* |	8	0.276	0.191	566.78	0.000
.|*** |	.|* |	9	0.363	0.093	610.37	0.000
.|*** |	.|* |	10	0.460	0.192	680.81	0.000
.|**** |	.|* |	11	0.564	0.192	786.76	0.000
.|**** |	.|. |	12	0.604	-0.025	908.70	0.000

Table 1 shows high levels of auto-correlation. To deal with this I include a lag of the dependent variable as an independent variable. This is done to prevent any correlation of the error terms, which is a violation of OLS. To check for the optimal number of included lags of the dependent variable in the model I run another correlogram of the residuals and I add additional lags until there is evidence of independent error terms. The model that is chosen is one with five lags and the one that also has the lowest value of the Akaike and Schwarz criterion (see Table 2 for this correlogram). This creates a model with 316 observations for correction of adding lags. A Breusch Godfrey serial correlation LM test is performed and shows no serial correlation. A heteroskedasticity test of Breusch Pagan Godfrey is performed and reveals non-equal variances. To correct for that the model is run again with White heteroskedasticity consistent standard errors. The tests are shown in appendix 4.

Table 2: Correlogram

D(HPI) – First Difference of the Housing Price Index, after inclusion of auto correlated terms:

Sample: 1987M01 2013M10
Included observations: 316
Q-statistic probabilities adjusted for 11 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|. |	.|. |	1	0.025	0.025	0.1920	0.661
*|. |	*|. |	2	-0.141	-0.142	6.5758	0.037
.|* |	.|* |	3	0.102	0.112	9.9354	0.019
*|. |	*|. |	4	-0.121	-0.154	14.681	0.005
.|. |	.|. |	5	-0.058	-0.014	15.766	0.008
.|** |	.|** |	6	0.300	0.265	44.961	0.000
*|. |	**|. |	7	-0.179	-0.221	55.341	0.000
*|. |	.|. |	8	-0.079	0.030	57.401	0.000
.|. |	*|. |	9	0.022	-0.103	57.555	0.000
*|. |	.|. |	10	-0.089	0.005	60.137	0.000
.|. |	.|. |	11	0.059	0.065	61.287	0.000
.|**** |	.|**** |	12	0.554	0.510	162.81	0.000

When analysing the first model (see table 3), only the lagged consumer sentiment and the mortgage rate are significant. The consumer confidence variable has a positive affect on HPI (though of very small magnitude, approximately 0.01 index points), as suspected. The coefficient of the mortgage rate has a negative sign, also as expected. The mortgage rate's coefficient though has a much higher magnitude of about 0.15 index points. The interest rate is not significant but follows an expected negative sign. Money supply and DPI (though not significant) both have a positive sign, which is as expected as well. CPI is not significant and has a positive sign, as expected. All lagged HPI terms are significant and have altering signs (first one positive, second one negative etc.). This suggests mean reverting tendencies, which beside for the period of the house bubble seem to model well the HPI behaviour as can be seen in the graph. After observing the model, despite some of the variables being insignificant they are kept in the model for reasons of suspected relationship with HPI as explained in the previous sections.

Table 3: First Basic Model

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.016939	0.033168	-0.510706	0.6099
D(CS(-1))	0.011344	0.004100	2.766793	0.0060
D(IR(-1))	-0.029904	0.066926	-0.446822	0.6553
D(MR(-1))	-0.147658	0.078151	-1.889385	0.0598
D(LN_M1(-1))	1.286697	2.876446	0.447322	0.6550
D(LN_DPI)	0.026552	2.299324	0.011548	0.9908
D(CPI)	0.060942	0.053231	1.144877	0.2532
D(HPI(-1))	2.178377	0.079430	27.42522	0.0000
D(HPI(-2))	-2.446575	0.195005	-12.54623	0.0000
D(HPI(-3))	2.087574	0.238712	8.745155	0.0000
D(HPI(-4))	-1.314254	0.190336	-6.904901	0.0000
D(HPI(-5))	0.428722	0.084472	5.075320	0.0000

R-squared	0.948422	Mean dependent var	0.264639
Adjusted R-squared	0.946555	S.D. dependent var	1.211096
S.E. of regression	0.279983	Akaike info criterion	0.329056
Sum squared resid	23.83064	Schwarz criterion	0.471679
Log likelihood	-39.99089	Hannan-Quinn criter.	0.386033
F-statistic	508.1763	Durbin-Watson stat	1.938872
Prob(F-statistic)	0.000000	Wald F-statistic	239.5994
Prob(Wald F-statistic)	0.000000		

After the inclusion of all variables for control and lagged HPI to fix the autocorrelation, consumer sentiment is still significant and positive. An increase of one index point in the consumer confident results in an increase of about 0.01 index point for HPI. Despite it being significant, it seems that this effect is of very small magnitude and therefore possibly negligible. This leads to the rejection of the first hypothesis and the establishment of a causal relationship (though of miniscule degree) between consumer confident and the housing price index.

Next, I take the model and begin with the dummy variable for the crisis, starting from July 2007. Six models are run giving each time only one of the independent variables (and the constant) the dummy variable to check for break in the data. Results are given in tables in appendix 5.

CS is the only added significant variable and its effect during the crisis is of about 0.026 additional index points compared with a now decreased effect in the non-crisis period that went down to 0.005 (and still significant as well). All other variables are not significant.

Lastly I run the model with all variables assigned the dummy variable for the crisis (see table 4).

Table 4: Full Model 2007

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.011750	0.031403	-0.374177	0.7085
D(CS(-1))	0.004110	0.002445	1.681037	0.0938
D(IR(-1))	-0.059295	0.043050	-1.377357	0.1694
D(MR(-1))	-0.054284	0.039599	-1.370845	0.1715
D(LN_M1(-1))	0.477795	1.242136	0.384656	0.7008
D(LN_DPI)	2.693319	1.821556	1.478582	0.1403
D(CPI)	0.038221	0.032014	1.193898	0.2335
D(HPI(-1))	2.138407	0.084946	25.17361	0.0000
D(HPI(-2))	-2.327042	0.212286	-10.96183	0.0000
D(HPI(-3))	1.931353	0.264766	7.294559	0.0000
D(HPI(-4))	-1.210625	0.206512	-5.862239	0.0000
D(HPI(-5))	0.399695	0.088065	4.538614	0.0000
D(DUMMY_2007)	67.75707	57.80899	1.172085	0.2421
D(D_2007_CS_LAG)	0.027612	0.012600	2.191527	0.0292
D(D_2007_IR_LAG)	0.010171	0.204805	0.049662	0.9604
D(D_2007_MR_LAG)	-0.399133	0.313248	-1.274176	0.2036
D(D_2007_LN_M1_LAG)	-1.230078	4.396178	-0.279806	0.7798
D(D_2007_LN_DPI)	-7.028257	3.905830	-1.799427	0.0730
D(D_2007_CPI)	0.030069	0.074032	0.406162	0.6849

R-squared	0.950813	Mean dependent var	0.264639
Adjusted R-squared	0.947832	S.D. dependent var	1.211096
S.E. of regression	0.276618	Akaike info criterion	0.325882
Sum squared resid	22.72565	Schwarz criterion	0.551702
Log likelihood	-32.48939	Hannan-Quinn criter.	0.416096
F-statistic	318.9559	Durbin-Watson stat	1.932680
Prob(F-statistic)	0.000000	Wald F-statistic	3035.113
Prob(Wald F-statistic)	0.000000		

Here some interesting things occur. The coefficient for CS(-1) is still significant but barely so and its coefficient for the crisis period is significant, positive and of larger magnitude than was seen earlier not taking into consideration the break in data. However, taking into account all the other variables as having a break in the data its effect is increased to about 0.028 (an increase of 0.002). The effect now is almost 0.03 index points higher of HPI for a one point index higher of the CS. This seems to suggest an affect that is apparent in more turbulent times rather than in 'normal times'. None of the other dummy variables are significant but for the ln(DPI). Its sign is negative and from this we can suspect that maybe additional disposable income in a period of crisis does not go towards purchasing a house. This would attest to the negative sign and can be interpreted as money being spent elsewhere in the economy and not on the housing market, which in turn leads to a decrease in the HPI. One would suspect as much, since in uncertain times the goods that are most needed and that have a more stable value would be bought. All other coefficients in the crisis period are unfortunately insignificant. In trying to answer the third hypothesis it seems that consumer confidence does seem to affect more during crisis times. Despite IR being positive as initially expected by the fourth hypothesis it is also insignificant. MR though having a negative and significant effect in the original model loses its significance level in both periods in the full model and its coefficient for the crisis period is negative, which was not as defined in the fourth hypothesis. This seems to suggest a much lower ability than expected by the FED to generate stimuli for the housing market. M1 is of the right sign (negative) but is also not significant.

This analysis so far does not seem to show that there is a break in the data, but for the CS variable (and possibly ln_DPI). However, a chow break test is performed all the same to test for joint significance of the added dummies. The test follows an F distribution with (7, 297) degrees of freedom and the calculation is shown in appendix 2. The test statistic of 2.06 is significant at the 5% significance level, pointing out an additional explanatory power of the dummies. It seems that there is a break in the data with respect to the variables in the model.

Performing the exact same procedures on the different suggested point of break in the data yields similar results (see appendix 6). All variables have insignificant dummies when tested individually but for CS (so not for ln_DPI in this model). This time the coefficient for CS (for after 2008) is larger in magnitude (0.034>0.026) and more significant (0.0104<0.0518) than in the 2007 break, attesting to a stronger effect deeper into the crisis period.

For the full model with all dummies assigned (see table 5), the dummy for CS is significant as before and the CS coefficient is no longer significant. Comparing once again p-values and magnitudes of the coefficient for the dummy of the crisis we find again higher magnitude (0.036>0.028) and higher significance level (0.0198<0.0292) in the 2008 full model compared with 2007 full model. So far the findings suggest that it is possible that CS only had an effect during the crisis period and even if it did have an effect in the more ‘normal times’ it was much smaller as compared with the recent years of the crisis. Next the chow break test is performed again. It follows the same distribution as before with the same degrees of freedom and the test statistic of 2.62 is found to be significant at the 5% significant level as well (see appendix 2), although slightly more than with the previous break (2.62>2.06).

Table 5: Full Model 2008

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.010690	0.031044	0.344346	0.7308
D(CS(-1))	0.003474	0.002779	1.249845	0.2123
D(IR(-1))	-0.015780	0.058870	-0.268055	0.7888
D(MR(-1))	-0.074946	0.046792	-1.601691	0.1103
D(LN_M1(-1))	-0.818813	1.405871	-0.582424	0.5607
D(LN_DPI)	0.576747	2.504249	0.230308	0.8180
D(CPI)	-0.006315	0.042178	-0.149714	0.8811
D(HPI(-1))	2.127078	0.081474	26.10738	0.0000
D(HPI(-2))	-2.310890	0.204193	-11.31718	0.0000
D(HPI(-3))	1.911102	0.256719	7.444347	0.0000
D(HPI(-4))	-1.201855	0.202197	-5.943976	0.0000
D(HPI(-5))	0.407025	0.086558	4.702328	0.0000
D(DUMMY_2008)	28.90642	76.42840	0.378216	0.7055
D(D_2008_CS_LAG)	0.036103	0.015411	2.342666	0.0198
D(D_2008_IR_LAG)	0.062687	0.994162	0.063055	0.9498
D(D_2008_MR_LAG)	-0.318887	0.342034	-0.932327	0.3519
D(D_2008_LN_M1_LAG)	0.747548	5.399286	0.138453	0.8900
D(D_2008_LN_DPI)	-5.917936	6.138450	-0.964077	0.3358
D(D_2008_CPI)	0.092036	0.138380	0.665099	0.5065

R-squared	0.951425	Mean dependent var	0.264639
Adjusted R-squared	0.948481	S.D. dependent var	1.211096
S.E. of regression	0.274893	Akaike info criterion	0.313376
Sum squared resid	22.44320	Schwarz criterion	0.539195
Log likelihood	-30.51334	Hannan-Quinn criter.	0.403589
F-statistic	323.1777	Durbin-Watson stat	1.923584
Prob(F-statistic)	0.000000	Wald F-statistic	10862.19
Prob(Wald F-statistic)	0.000000		

These similarities between the two full models with different breaks suggest that the break exists and that regarding it starting in 2007 or 2008 does not matter much with respect to the analysis of the effect of CS on HPI. Some aspects seem to suggest that September 2008 is a better point in time than July 2007 in trying to capture the change in consumer confident with respect to its effect on the housing prices. These are the significance levels and magnitudes of CS when tested individually and in the full model in both breaks and the chow break test for the full models.

Discussion and Conclusion:

In researching an effect of consumer confidence on the housing price index a positive significant effect was found of about 0.01 index points. Controlling for other monetary effects the only significant effect that was found was of the mortgage rate and was much higher in magnitude, a negative effect of about 0.15 index points.

Looking at whether there is a break in the data during the recent financial crisis reveals several things. The only variable that is significant after the break in both examined break points is the consumer confidence. All monetary variables at the disposal of the FED do not seem to have a significant diminished effect during the crisis. The investigation suggests that the break might have started already in 2007 but that the 2008 alternative shows stronger responses of the housing prices caused by consumer confidence. In examining the chow break tests they are both significant and put the 2008 model as a better point for the break. Both extended models with the breaks show significantly increased explanatory power in the investigation of the housing prices. The effect of consumer confidence during the crisis varies (depending on the break point) between 0.028-0.036 index points, which is over all despite it being significant, not a big effect.

In the attempt to answer the research question most findings attest to the following. There is an effect of consumer confidence on the housing prices and this effect changes its nature and influence during the financial crisis that sprouted in 2007-2008. However, some limitations should be taken into account. As no research can account for all possible control variables and cover all fronts, there are limitations to the study of the U.S. housing market. As I have only looked at monetary variables and consumer sentiment, there could have been other factors that have influenced the U.S. housing prices (and might be better at explaining changes in the U.S. housing price). Since the economy is shifting nowadays to a more service oriented economy that relies heavily on innovative technology in many industries, inclusion of an innovation index could improve the model and account for differing and evolving consumption habits. These in turn would point to how purchasing activities might vary with time and could refer to the housing market as well. Kuttner (2012) also refers to innovation as he suggests more factors that could explain the change in housing prices and strengthens the claim for adding this index in future research.

Since significant autocorrelation was found, which explained a large part of the variance in the model (the adjusted R^2 of the model increased tenfold when adding the first lag of the housing price in the model). This autocorrelation could be caused by many different economic factors that have not been included in the model and therefore their unaccounted impact on the housing prices could have been the cause for this autocorrelation. A more thorough investigation into factors influencing the housing price could therefore be imperative in creating a better model to understand what drives it.

A second limitation of the research concerns the interpolation of the data. As quarterly data for the house index was used and yet monthly data for all other variables, the quarterly data was interpolated into monthly data as explained in the data section. This interpolation could have had an effect on the results. Using more accurate data for all variables would give more accurate results as well. Moreover, using more or less data points for the same period (quarterly or semi-annually/annually) might change the results of the regressions. Another limitation concerns the limited timeframe of the data. Research including data from previous years (preceding 1987) could offer possibly more accurate results and further research into future data when these were available could offer more perspective.

A key focus in this research was the recent financial crisis, not taking into account other economic events. As I have used data going back till 1987, data from years following the dotcom burst (and the economic decline following it) and data from the years of the Asian financial crisis (which had a worldwide effect) was used as well. The data also cover the period of the effect of Black Monday: the day when worldwide stock markets crashed. All of these crises might have had an effect on the US housing market. Not taking into account these crises' effects in the building of the models and the testing procedures could therefore have caused having a less representing result.

The issue of reverse causality has been partly resolved by using lags of the independent variables in question. Nonetheless, this still may be inherent to the relationship between consumer confidence and the housing prices. Using the time dimension in a relationship that is as intricate as this (along the lines of: 'what came first? – the chicken or the egg?') might be insufficient in capturing the right magnitudes of effects and the general conclusion of existence of such effects at all. Possibly the use of lags going further into the past would offer a more extensive investigation as well as researching more on the nature of possible effects for each variable on housing prices and adapting the model with the appropriate lags for each variable.

Suggestions for further research include the comparison of the recent crisis with other U.S. or global crises. This can be done where crisis years are given the same dummy and compared to non-crisis years. This way, the relation between the crisis and the effect of consumer confidence on the housing market can be investigated more thoroughly and used for later comparison with this paper's findings. A research could also include data from different countries, making it possible to draw a broader conclusion that could be externally valid worldwide. This research could also be tested on other markets, e.g. different asset markets.

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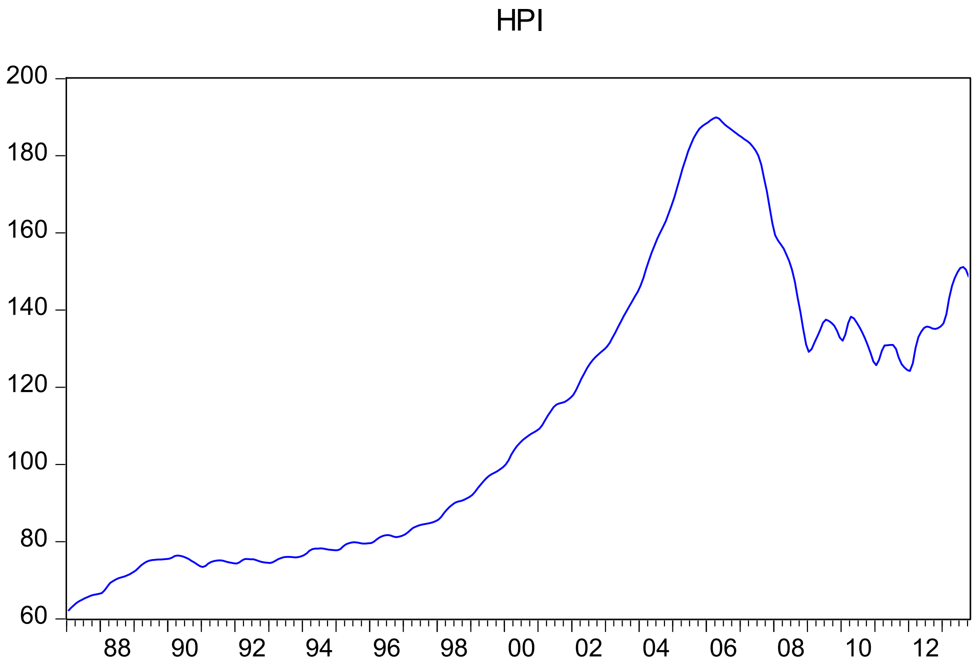
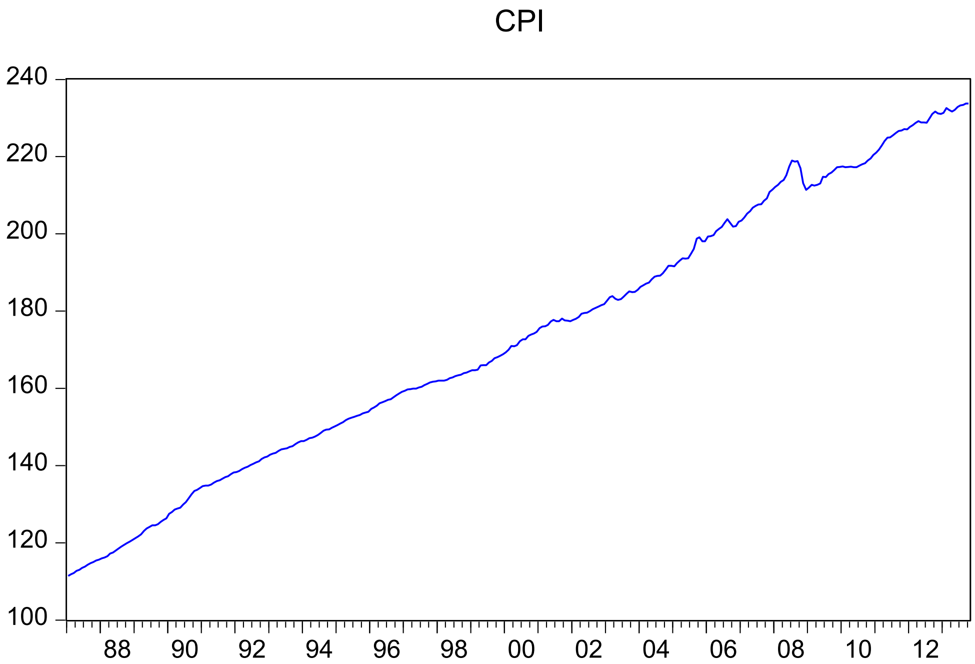
Appendix 1: Graphs

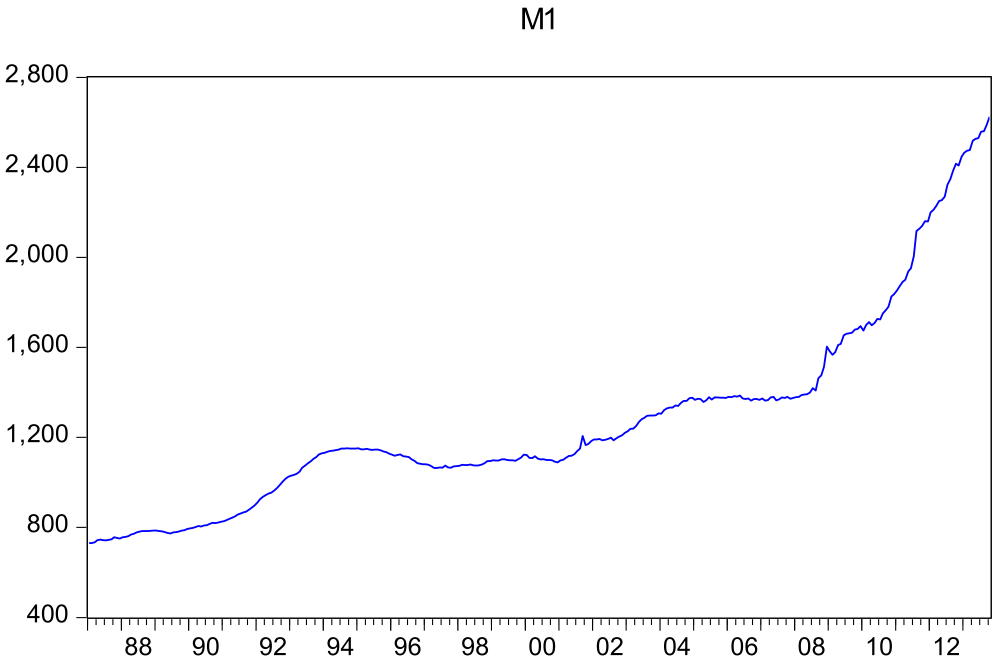
Graph 1 - Housing Price Index



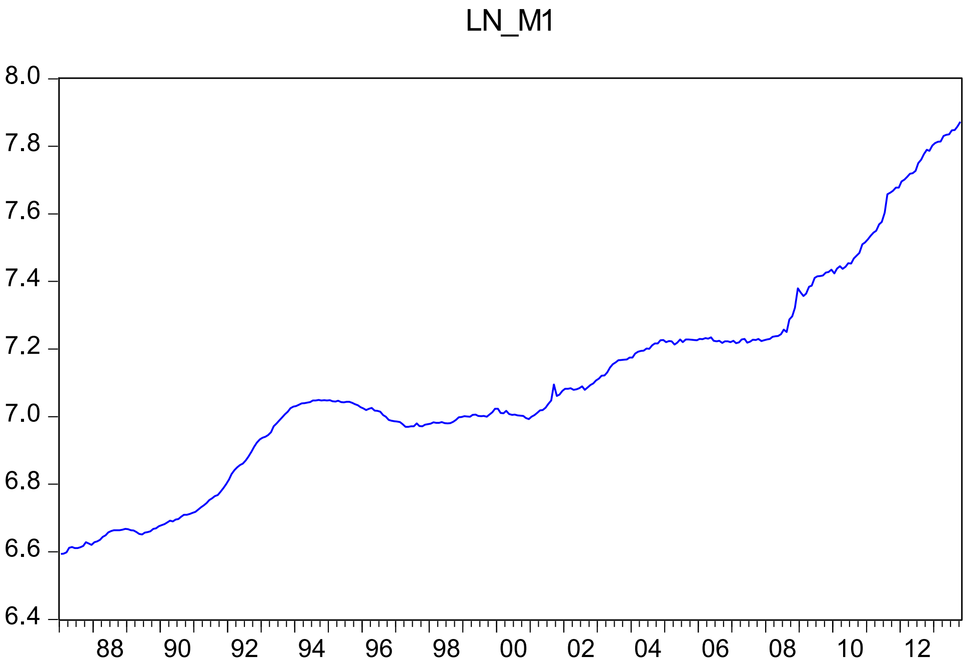
Graph 2 - Consumer Price Index



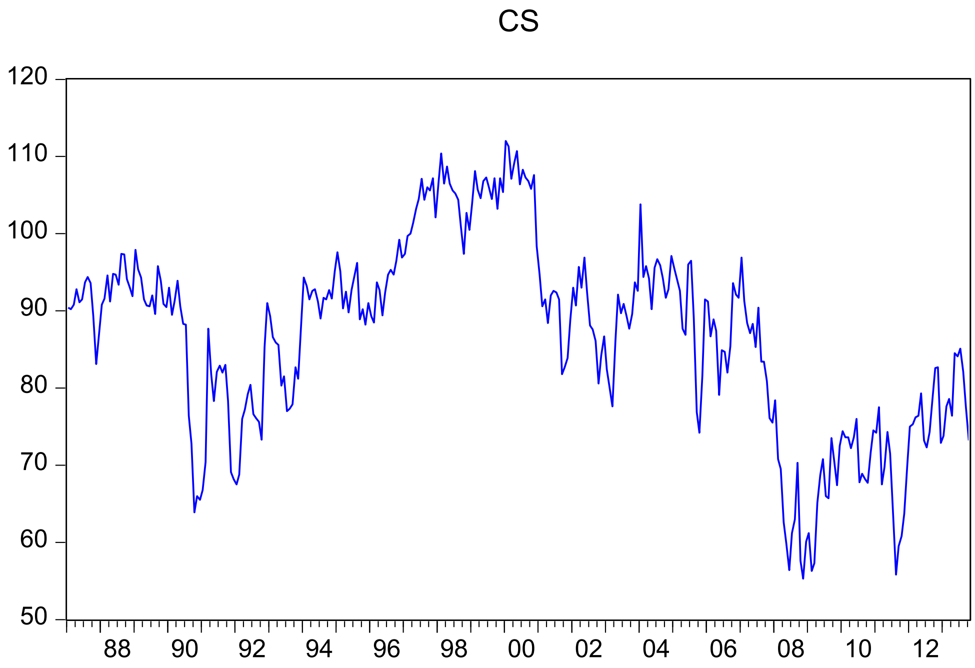
Graph 3 - Money Supply



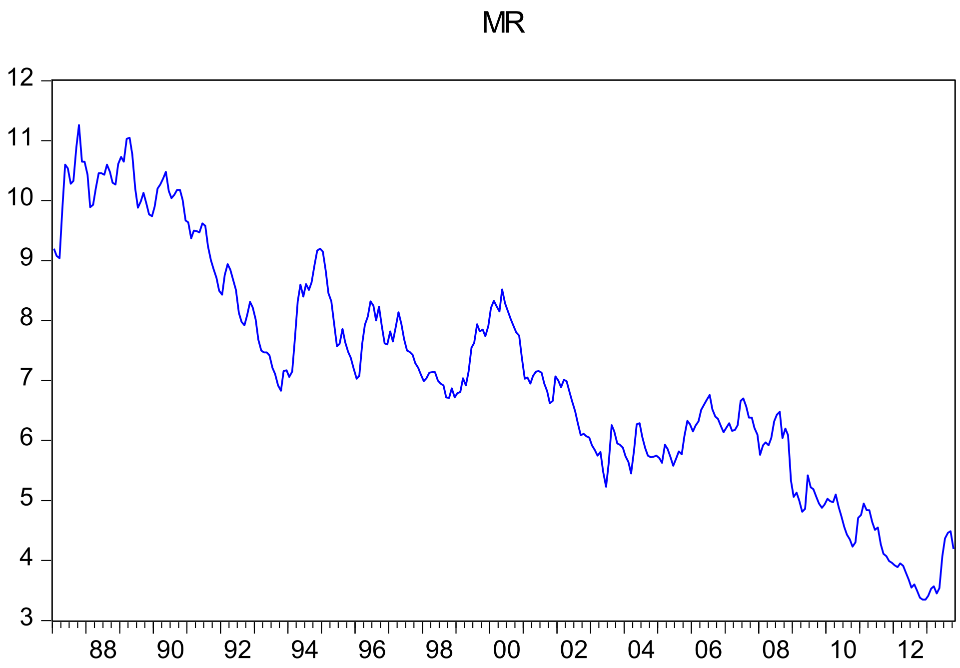
Graph 4 - Logarithm of Money Supply



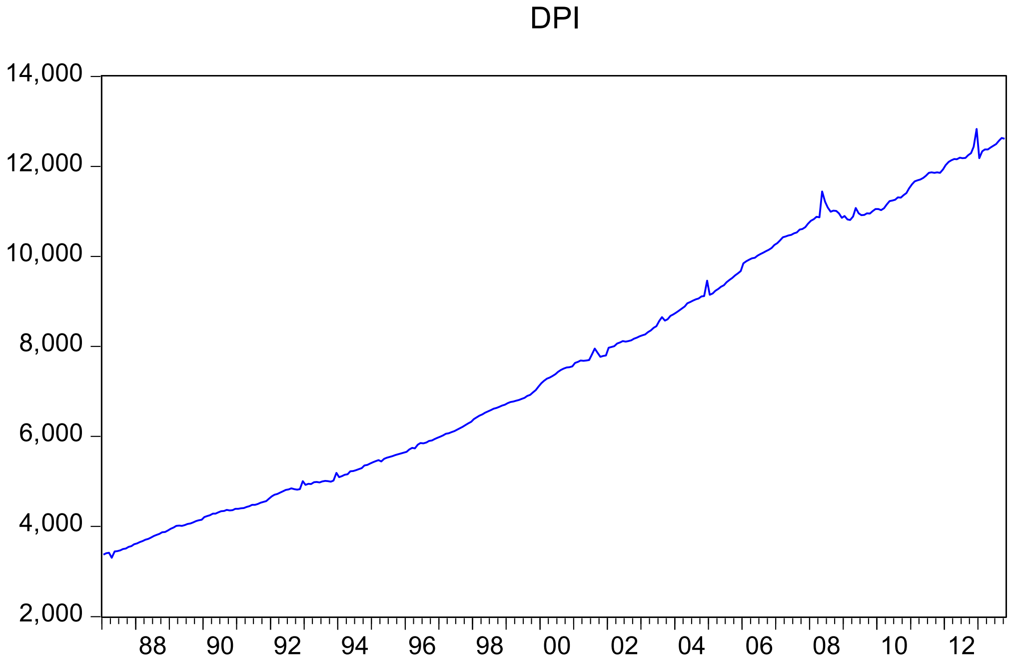
Graph 5 - Consumer Sentiment Index



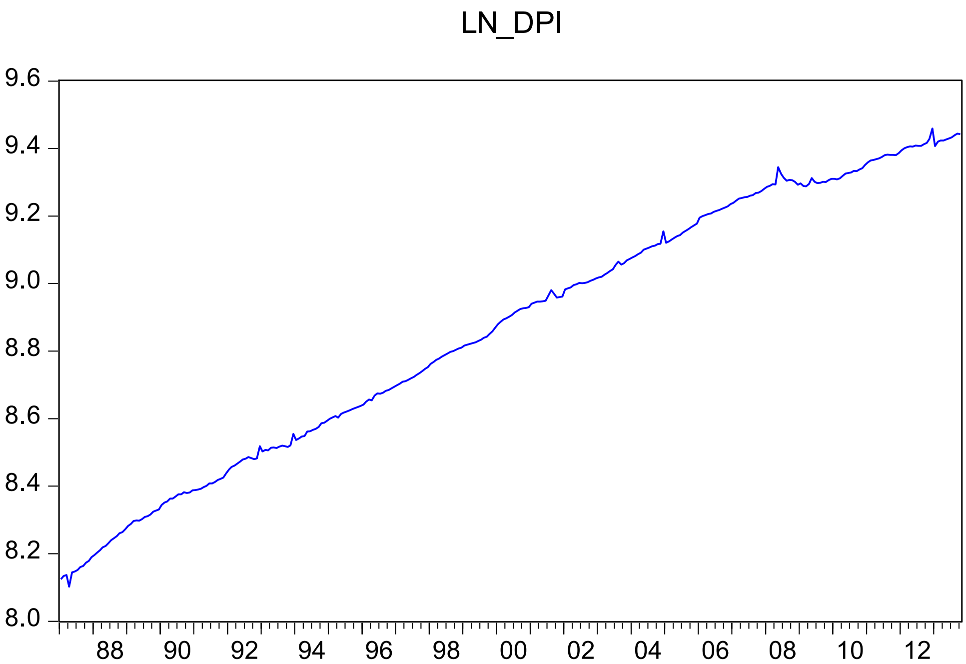
Graph 6 - Mortgage Rate



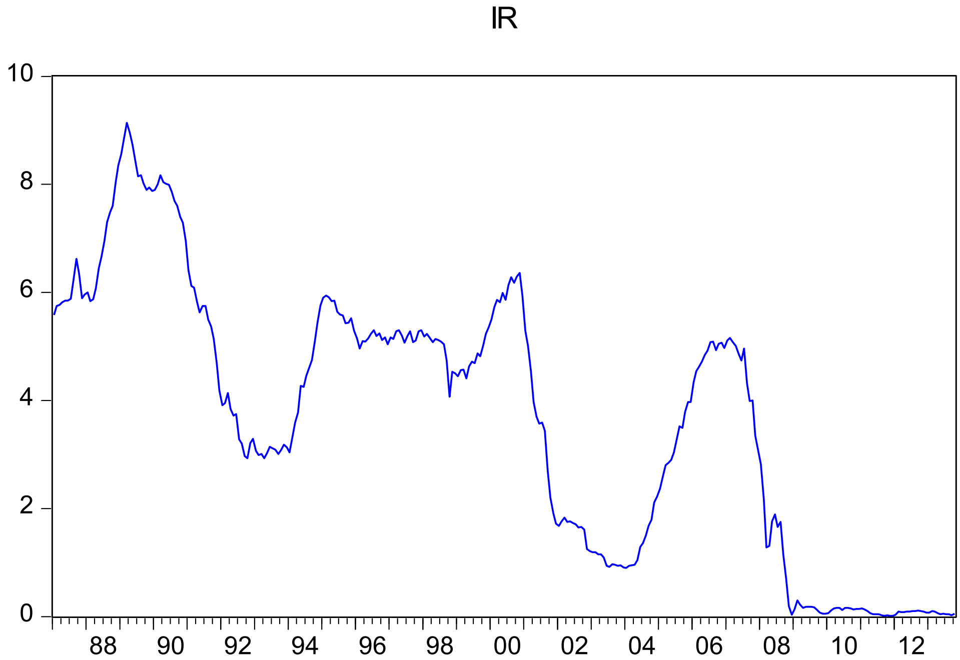
Graph 7 - Disposable Personal Income



Graph 8 - Logarithm of Disposable Personal Income



Graph 9 - Interest Rate



Appendix 2: Chow Break Tests

General Formula

$$\frac{(R_f^2 - R_r^2)/q}{(1 - R_f^2)/(n - p - 1)} \sim F(q, n - p - 1)$$

Where R_f^2 is the R^2 of the full model and R_r^2 is the R^2 of the restricted model, q is the amount of dummy-coefficients added to create the full model from the restricted model (including the dummy constant, 7 for this paper), p is the number of coefficients in the full model not including the constant (18) and n is the number of data points (316).

2007 Chow Break Test:

Filling in the R^2 for the full and restricted models for the first break in 2007:

$$\frac{(0.950813 - 0.948422)/7}{(1 - 0.950813)/(316 - 18 - 1)} = 2.063004 \sim F(7{,}297)$$

The critical value for a significance level of 10% for the F(7,297) distribution is 1.73709060[**].

2008 Chow Break Test:

Filling in the R^2 for the full and restricted models for the first break in 2008:

$$\frac{(0.951425 - 0.948422)/7}{(1 - 0.951425)/(316 - 18 - 1)} = 2.622940 \sim F(7{,}297)$$

[**] Precisely calculated using the statistical calculator here: http://www.danielsoper.com/statcalc3/calc.aspx?id=4

Appendix 3: Unit Root Tests

HPI – Housing Price Index: with intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.488009	0.0089
Test critical values:	1% level	-3.451421	
	5% level	-2.870712	
	10% level	-2.571728	

CS – Consumer Sentiment Index: with intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-18.17038	0.0000
Test critical values:	1% level	-3.450617	
	5% level	-2.870359	
	10% level	-2.571538	

Ln_DPI – Logarithm of Disposable Personal Income: with trend and intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.01744	0.0000
Test critical values:	1% level	-3.987088	
	5% level	-3.423975	
	10% level	-3.134992	

CPI – Consumer Price Index: with trend and intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.92415	0.0000
Test critical values:	1% level	-3.987088	
	5% level	-3.423975	
	10% level	-3.134992	

Ln_M1 – Logarithm of Money Supply: with trend and intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.632150	0.0000
Test critical values:	1% level	-3.987180	
	5% level	-3.424019	
	10% level	-3.135019	

IR – Interest Rate: with trend and intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.979462	0.0000
Test critical values:	1% level	-3.987180	
	5% level	-3.424019	
	10% level	-3.135019	

MR – Mortgage Rate: with trend and intercept

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.05287	0.0000
Test critical values:	1% level	-3.987088	
	5% level	-3.423975	
	10% level	-3.134992	

Appendix 4: Diagnostic tests of first model

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.826577	Prob. F(1,303)	0.3640
Obs*R-squared	0.859695	Prob. Chi-Square(1)	0.3538

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.710702	Prob. F(11,304)	0.0024
Obs*R-squared	28.22618	Prob. Chi-Square(11)	0.0030
Scaled explained SS	132.3753	Prob. Chi-Square(11)	0.0000

Appendix 5: Dummy Models 2007

Dummy for Consumer Sentiment:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.008710	0.032048	-0.271773	0.7860
D(CS(-1))	0.004644	0.002461	1.887162	0.0601
D(IR(-1))	-0.019293	0.067868	-0.284271	0.7764
D(MR(-1))	-0.132425	0.077556	-1.707470	0.0888
D(LN_M1(-1))	0.768356	2.740109	0.280411	0.7794
D(LN_DPI)	-0.248107	2.289457	-0.108369	0.9138
D(CPI)	0.055859	0.046473	1.201963	0.2303
D(HPI(-1))	2.138209	0.082915	25.78803	0.0000
D(HPI(-2))	-2.341814	0.207176	-11.30352	0.0000
D(HPI(-3))	1.953927	0.257873	7.577094	0.0000
D(HPI(-4))	-1.229012	0.200377	-6.133493	0.0000
D(HPI(-5))	0.406077	0.085592	4.744312	0.0000
D(DUMMY_2007)	-2.398254	1.148942	-2.087358	0.0377
D(D_2007_CS_LAG)	0.025985	0.013308	1.952556	0.0518

R-squared	0.949784	Mean dependent var	0.264639
Adjusted R-squared	0.947622	S.D. dependent var	1.211096
S.E. of regression	0.277174	Akaike info criterion	0.314949
Sum squared resid	23.20126	Schwarz criterion	0.481343
Log likelihood	-35.76197	Hannan-Quinn criter.	0.381422
F-statistic	439.3843	Durbin-Watson stat	1.937668
Prob(F-statistic)	0.000000	Wald F-statistic	1890.361
Prob(Wald F-statistic)	0.000000		

Dummy for Interest Rate:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014533	0.034246	-0.424362	0.6716
D(CS(-1))	0.011285	0.004126	2.735032	0.0066
D(IR(-1))	-0.042334	0.059548	-0.710926	0.4777
D(MR(-1))	-0.138935	0.081356	-1.707743	0.0887
D(LN_M1(-1))	1.205561	2.927299	0.411834	0.6808
D(LN_DPI)	0.051238	2.329720	0.021993	0.9825
D(CPI)	0.059449	0.052848	1.124907	0.2615
D(HPI(-1))	2.174899	0.079795	27.25613	0.0000
D(HPI(-2))	-2.442299	0.194931	-12.52904	0.0000
D(HPI(-3))	2.084044	0.238702	8.730745	0.0000
D(HPI(-4))	-1.313003	0.190678	-6.885961	0.0000
D(HPI(-5))	0.428181	0.084698	5.055393	0.0000
D(DUMMY_2007)	-0.360112	0.945517	-0.380862	0.7036
D(D_2007_IR_LAG)	0.045065	0.194420	0.231791	0.8169

R-squared	0.948473	Mean dependent var	0.264639
Adjusted R-squared	0.946255	S.D. dependent var	1.211096
S.E. of regression	0.280769	Akaike info criterion	0.340725
Sum squared resid	23.80706	Schwarz criterion	0.507118
Log likelihood	-39.83450	Hannan-Quinn criter.	0.407198
F-statistic	427.6125	Durbin-Watson stat	1.950021
Prob(F-statistic)	0.000000	Wald F-statistic	1859.957
Prob(Wald F-statistic)	0.000000		

Dummy for Mortgage Rate:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014409	0.032345	-0.445486	0.6563
D(CS(-1))	0.011157	0.004060	2.747816	0.0064
D(IR(-1))	-0.058506	0.063242	-0.925113	0.3556
D(MR(-1))	-0.069938	0.045901	-1.523645	0.1286
D(LN_M1(-1))	0.327028	2.676356	0.122191	0.9028
D(LN_DPI)	-0.199038	2.276894	-0.087416	0.9304
D(CPI)	0.059966	0.051524	1.163839	0.2454
D(HPI(-1))	2.179694	0.078089	27.91310	0.0000
D(HPI(-2))	-2.430924	0.196607	-12.36439	0.0000
D(HPI(-3))	2.056526	0.243537	8.444397	0.0000
D(HPI(-4))	-1.283331	0.194837	-6.586672	0.0000
D(HPI(-5))	0.417907	0.085315	4.898392	0.0000
D(DUMMY_2007)	2.172982	2.046910	1.061591	0.2893
D(D_2007_MR_LAG)	-0.353151	0.305701	-1.155215	0.2489

R-squared	0.948943	Mean dependent var	0.264639
Adjusted R-squared	0.946745	S.D. dependent var	1.211096
S.E. of regression	0.279484	Akaike info criterion	0.331550
Sum squared resid	23.58965	Schwarz criterion	0.497944
Log likelihood	-38.38495	Hannan-Quinn criter.	0.398024
F-statistic	431.7677	Durbin-Watson stat	1.925021
Prob(F-statistic)	0.000000	Wald F-statistic	1838.452
Prob(Wald F-statistic)	0.000000		

Dummy for Money Supply:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.015841	0.034047	-0.465286	0.6421
D(CS(-1))	0.011278	0.004119	2.737734	0.0066
D(IR(-1))	-0.032675	0.065705	-0.497298	0.6193
D(MR(-1))	-0.142020	0.078397	-1.811562	0.0710
D(LN_M1(-1))	1.183567	1.480782	0.799285	0.4248
D(LN_DPI)	0.025122	2.350975	0.010686	0.9915
D(CPI)	0.060850	0.053847	1.130053	0.2594
D(HPI(-1))	2.177380	0.081677	26.65830	0.0000
D(HPI(-2))	-2.445720	0.197394	-12.39006	0.0000
D(HPI(-3))	2.086968	0.240601	8.673976	0.0000
D(HPI(-4))	-1.313713	0.191477	-6.860952	0.0000
D(HPI(-5))	0.428350	0.084920	5.044175	0.0000
D(DUMMY_2007)	-0.173486	35.08330	-0.004945	0.9961
D(D_2007_LN_M1_LAG)	0.004359	4.861059	0.000897	0.9993

R-squared	0.948464	Mean dependent var	0.264639
Adjusted R-squared	0.946245	S.D. dependent var	1.211096
S.E. of regression	0.280794	Akaike info criterion	0.340901
Sum squared resid	23.81127	Schwarz criterion	0.507295
Log likelihood	-39.86243	Hannan-Quinn criter.	0.407375
F-statistic	427.5328	Durbin-Watson stat	1.949052
Prob(F-statistic)	0.000000	Wald F-statistic	2319.571
Prob(Wald F-statistic)	0.000000		

Dummy for Disposable Personal Income:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.023758	0.033483	-0.709548	0.4785
D(CS(-1))	0.011348	0.004060	2.795330	0.0055
D(IR(-1))	-0.040838	0.067790	-0.602420	0.5473
D(MR(-1))	-0.145626	0.081266	-1.791981	0.0741
D(LN_M1(-1))	1.293096	2.919542	0.442911	0.6581
D(LN_DPI)	2.587336	2.056164	1.258331	0.2092
D(CPI)	0.062663	0.053131	1.179386	0.2392
D(HPI(-1))	2.177926	0.079387	27.43435	0.0000
D(HPI(-2))	-2.451303	0.194553	-12.59966	0.0000
D(HPI(-3))	2.099569	0.237753	8.830883	0.0000
D(HPI(-4))	-1.326111	0.188445	-7.037138	0.0000
D(HPI(-5))	0.430621	0.082502	5.219554	0.0000
D(DUMMY_2007)	51.54227	44.50264	1.158185	0.2477
D(D_2007_LN_DPI)	-5.581290	4.805313	-1.161483	0.2464

R-squared	0.948784	Mean dependent var	0.264639
Adjusted R-squared	0.946579	S.D. dependent var	1.211096
S.E. of regression	0.279921	Akaike info criterion	0.334672
Sum squared resid	23.66340	Schwarz criterion	0.501065
Log likelihood	-38.87815	Hannan-Quinn criter.	0.401145
F-statistic	430.3496	Durbin-Watson stat	1.967586
Prob(F-statistic)	0.000000	Wald F-statistic	2960.451
Prob(Wald F-statistic)	0.000000		

<u>Dummy for Consumer Price Index:</u>

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.015875	0.031404	-0.505519	0.6136
D(CS(-1))	0.011280	0.004111	2.743998	0.0064
D(IR(-1))	-0.032642	0.068065	-0.479573	0.6319
D(MR(-1))	-0.142065	0.081731	-1.738197	0.0832
D(LN_M1(-1))	1.187083	2.900060	0.409330	0.6826
D(LN_DPI)	0.024445	2.349852	0.010403	0.9917
D(CPI)	0.061005	0.037945	1.607740	0.1089
D(HPI(-1))	2.177347	0.081614	26.67859	0.0000
D(HPI(-2))	-2.445653	0.199743	-12.24402	0.0000
D(HPI(-3))	2.086891	0.244608	8.531588	0.0000
D(HPI(-4))	-1.313652	0.196214	-6.695006	0.0000
D(HPI(-5))	0.428312	0.088917	4.816975	0.0000
D(DUMMY_2007)	-0.087857	18.48784	-0.004752	0.9962
D(D_2007_CPI)	-0.000261	0.089073	-0.002928	0.9977

R-squared	0.948464	Mean dependent var	0.264639
Adjusted R-squared	0.946245	S.D. dependent var	1.211096
S.E. of regression	0.280794	Akaike info criterion	0.340901
Sum squared resid	23.81127	Schwarz criterion	0.507295
Log likelihood	-39.86242	Hannan-Quinn criter.	0.407375
F-statistic	427.5328	Durbin-Watson stat	1.949116
Prob(F-statistic)	0.000000	Wald F-statistic	3111.462
Prob(Wald F-statistic)	0.000000		

Appendix 6: Dummy Models 2008

Dummy for Consumer Sentiment:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001191	0.030687	-0.038808	0.9691
D(CS(-1))	0.004223	0.002864	1.474613	0.1414
D(IR(-1))	0.021220	0.066392	0.319622	0.7495
D(MR(-1))	-0.148834	0.074901	-1.987067	0.0478
D(LN_M1(-1))	0.725906	2.656557	0.273251	0.7848
D(LN_DPI)	-1.118847	2.500003	-0.447538	0.6548
D(CPI)	0.039315	0.045978	0.855076	0.3932
D(HPI(-1))	2.131059	0.078832	27.03276	0.0000
D(HPI(-2))	-2.322888	0.196907	-11.79689	0.0000
D(HPI(-3))	1.932833	0.246730	7.833802	0.0000
D(HPI(-4))	-1.223174	0.194268	-6.296322	0.0000
D(HPI(-5))	0.413241	0.084237	4.905699	0.0000
D(DUMMY_2008)	-2.430406	0.837394	-2.902345	0.0040
D(D_2008_CS_LAG)	0.034252	0.013288	2.577708	0.0104

R-squared	0.950435	Mean dependent var	0.264639
Adjusted R-squared	0.948301	S.D. dependent var	1.211096
S.E. of regression	0.275372	Akaike info criterion	0.301903
Sum squared resid	22.90054	Schwarz criterion	0.468297
Log likelihood	-33.70067	Hannan-Quinn criter.	0.368376
F-statistic	445.4592	Durbin-Watson stat	1.933729
Prob(F-statistic)	0.000000	Wald F-statistic	10657.07
Prob(Wald F-statistic)	0.000000		

Dummy for Interest Rate:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.011598	0.033771	-0.343439	0.7315
D(CS(-1))	0.011467	0.004095	2.799974	0.0054
D(IR(-1))	-0.025812	0.066901	-0.385822	0.6999
D(MR(-1))	-0.147277	0.078203	-1.883263	0.0606
D(LN_M1(-1))	1.284451	2.931902	0.438095	0.6616
D(LN_DPI)	-0.027852	2.322514	-0.011992	0.9904
D(CPI)	0.054689	0.052499	1.041714	0.2984
D(HPI(-1))	2.166201	0.080437	26.93034	0.0000
D(HPI(-2))	-2.429923	0.193894	-12.53225	0.0000
D(HPI(-3))	2.073797	0.237189	8.743218	0.0000
D(HPI(-4))	-1.305715	0.189256	-6.899209	0.0000
D(HPI(-5))	0.425043	0.083912	5.065335	0.0000
D(DUMMY_2008)	-0.463020	1.099236	-0.421220	0.6739
D(D_2008_IR_LAG)	0.118723	0.613129	0.193635	0.8466

R-squared	0.948563	Mean dependent var	0.264639
Adjusted R-squared	0.946348	S.D. dependent var	1.211096
S.E. of regression	0.280524	Akaike info criterion	0.338976
Sum squared resid	23.76547	Schwarz criterion	0.505370
Log likelihood	-39.55821	Hannan-Quinn criter.	0.405449
F-statistic	428.4015	Durbin-Watson stat	1.938277
Prob(F-statistic)	0.000000	Wald F-statistic	10327.83
Prob(Wald F-statistic)	0.000000		

Dummy for Mortgage Rate:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.013558	0.032878	-0.412382	0.6804
D(CS(-1))	0.011397	0.004071	2.799758	0.0054
D(IR(-1))	-0.052604	0.063053	-0.834278	0.4048
D(MR(-1))	-0.088723	0.047564	-1.865350	0.0631
D(LN_M1(-1))	0.276785	2.630010	0.105241	0.9163
D(LN_DPI)	0.005620	2.279914	0.002465	0.9980
D(CPI)	0.059057	0.051988	1.135971	0.2569
D(HPI(-1))	2.175476	0.078954	27.55388	0.0000
D(HPI(-2))	-2.430404	0.194409	-12.50147	0.0000
D(HPI(-3))	2.059948	0.240274	8.573331	0.0000
D(HPI(-4))	-1.288970	0.192442	-6.697962	0.0000
D(HPI(-5))	0.420859	0.084571	4.976383	0.0000
D(DUMMY_2008)	1.846155	2.133256	0.865416	0.3875
D(D_2008_MR_LAG)	-0.321553	0.324985	-0.989440	0.3232

R-squared	0.948903	Mean dependent var	0.264639
Adjusted R-squared	0.946703	S.D. dependent var	1.211096
S.E. of regression	0.279595	Akaike info criterion	0.332342
Sum squared resid	23.60833	Schwarz criterion	0.498736
Log likelihood	-38.51005	Hannan-Quinn criter.	0.398815
F-statistic	431.4076	Durbin-Watson stat	1.919308
Prob(F-statistic)	0.000000	Wald F-statistic	10479.99
Prob(Wald F-statistic)	0.000000		

Dummy for Money Supply:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.015267	0.034168	-0.446815	0.6553
D(CS(-1))	0.011299	0.004153	2.721030	0.0069
D(IR(-1))	-0.033726	0.066046	-0.510646	0.6100
D(MR(-1))	-0.137594	0.075368	-1.825636	0.0689
D(LN_M1(-1))	-0.556488	1.669843	-0.333258	0.7392
D(LN_DPI)	0.132199	2.345064	0.056373	0.9551
D(CPI)	0.061573	0.054076	1.138649	0.2558
D(HPI(-1))	2.177054	0.083186	26.17094	0.0000
D(HPI(-2))	-2.443979	0.197418	-12.37974	0.0000
D(HPI(-3))	2.083724	0.240365	8.669003	0.0000
D(HPI(-4))	-1.309804	0.191815	-6.828486	0.0000
D(HPI(-5))	0.426609	0.085739	4.975698	0.0000
D(DUMMY_2008)	-22.40388	36.96364	-0.606106	0.5449
D(D_2008_LN_M1_LAG)	3.055710	5.102459	0.598870	0.5497

R-squared	0.948675	Mean dependent var	0.264639
Adjusted R-squared	0.946466	S.D. dependent var	1.211096
S.E. of regression	0.280217	Akaike info criterion	0.336788
Sum squared resid	23.71353	Schwarz criterion	0.503182
Log likelihood	-39.21253	Hannan-Quinn criter.	0.403261
F-statistic	429.3907	Durbin-Watson stat	1.946274
Prob(F-statistic)	0.000000	Wald F-statistic	11530.11
Prob(Wald F-statistic)	0.000000		

Dummy for Disposable Personal Income:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014147	0.033820	-0.418307	0.6760
D(CS(-1))	0.011453	0.004082	2.805366	0.0054
D(IR(-1))	-0.024178	0.067262	-0.359461	0.7195
D(MR(-1))	-0.147744	0.078761	-1.875853	0.0616
D(LN_M1(-1))	1.111146	2.867862	0.387448	0.6987
D(LN_DPI)	-0.023905	2.705960	-0.008834	0.9930
D(CPI)	0.060207	0.053247	1.130704	0.2591
D(HPI(-1))	2.170093	0.080848	26.84157	0.0000
D(HPI(-2))	-2.434021	0.195936	-12.42254	0.0000
D(HPI(-3))	2.076504	0.238827	8.694603	0.0000
D(HPI(-4))	-1.307787	0.189886	-6.887232	0.0000
D(HPI(-5))	0.426259	0.084225	5.060923	0.0000
D(DUMMY_2008)	-0.795383	56.17776	-0.014158	0.9887
D(D_2008_LN_DPI)	0.058747	6.038165	0.009729	0.9922

R-squared	0.948547	Mean dependent var	0.264639
Adjusted R-squared	0.946332	S.D. dependent var	1.211096
S.E. of regression	0.280567	Akaike info criterion	0.339284
Sum squared resid	23.77279	Schwarz criterion	0.505678
Log likelihood	-39.60687	Hannan-Quinn criter.	0.405757
F-statistic	428.2625	Durbin-Watson stat	1.942344
Prob(F-statistic)	0.000000	Wald F-statistic	11753.52
Prob(Wald F-statistic)	0.000000		

Dummy for Consumer Price Index:

Dependent Variable: D(HPI)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003641	0.031420	0.115866	0.9078
D(CS(-1))	0.010191	0.003850	2.646842	0.0086
D(IR(-1))	-0.029845	0.068701	-0.434410	0.6643
D(MR(-1))	-0.129727	0.078668	-1.649041	0.1002
D(LN_M1(-1))	0.467165	2.782721	0.167881	0.8668
D(LN_DPI)	0.145991	2.263748	0.064491	0.9486
D(CPI)	0.008948	0.044380	0.201620	0.8403
D(HPI(-1))	2.162571	0.079798	27.10040	0.0000
D(HPI(-2))	-2.432139	0.196526	-12.37567	0.0000
D(HPI(-3))	2.076313	0.241465	8.598817	0.0000
D(HPI(-4))	-1.304473	0.193856	-6.729086	0.0000
D(HPI(-5))	0.423597	0.087192	4.858209	0.0000
D(DUMMY_2008)	-24.69611	20.98560	-1.176812	0.2402
D(D_2008_CPI)	0.111561	0.095891	1.163423	0.2456

R-squared	0.949150	Mean dependent var	0.264639
Adjusted R-squared	0.946962	S.D. dependent var	1.211096
S.E. of regression	0.278916	Akaike info criterion	0.327484
Sum squared resid	23.49391	Schwarz criterion	0.493877
Log likelihood	-37.74244	Hannan-Quinn criter.	0.393957
F-statistic	433.6217	Durbin-Watson stat	1.907568
Prob(F-statistic)	0.000000	Wald F-statistic	12777.69
Prob(Wald F-statistic)	0.000000		