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Did Monetary Policy Fuel the Housing Bubble?

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Abstract

Some observers say the 1998–2006 housing boom led to the global financial crisis and the 2007–2009 recession. The causes of the housing boom, however, are a matter of considerable debate. This study attempts to settle this debate by identifying the major contributing factors to the housing boom and quantifying which factors were primary drivers and which merely played a supporting role. Specifically, we raise and answer three fundamental questions: Did monetary policy create the housing bubble? Are there other factors besides monetary policy that caused the housing bubble? Did monetary policy combine with other factors, such as changing regulations, the expanded role of GSEs, the increased pace of financial innovation, some sort of structural change, and rising international capital flows, to create the bubble?

Our statistical analysis supports the hypothesis that monetary policy and global saving glut are statistically correlated with residential development and increased financial innovation. Moreover, we found a structural change is statistically associated with the rise in housing starts, home prices, and the use of alternative mortgage products. The combined effect of monetary policy with other contributing factors is not statistically meaningful. Additional studies might investigate this hypothesis using different techniques/datasets, but our results suggest that this hypothesis should not be ruled out.

JEL Codes: E3, E5
Keywords: Monetary policy; Global saving glut; Regulation; Housing bubble

I. Introduction

The recent US recession and financial crisis has been tied to the collapse of the housing sector. Many economists agree that the 1998–2006 housing boom led to the global financial crisis and the Great Recession (2007–2009). The causes of the housing boom, however, are a matter of considerable debate. A group of economists, including

Taylor (2008, 2010), blamed easy monetary policy during the 2002–2004 period for fueling the housing bubble. On the other hand, Bernanke (2010) and Greenspan (2010) defended monetary policy and suggested that the "global saving glut" and changes in financial regulations along with financial innovations are responsible for the housing bubble. This debate raises essential questions. Did monetary policy fuel the housing bubble? Did the global saving glut play a key role in the bubble? What role did changes in key banking regulations, financial innovation, and government-sponsored enterprises (GSEs) play in fueling the bubble? Did these factors—easy monetary policy, global saving glut, GSEs, and financial innovations—combine to create the bubble?

This study sheds light on two aspects. First, we explain theoretically how the aforementioned factors might have contributed to the housing bubble. We also discuss some very important issues, such as why the Federal Reserve followed a policy of easy money and whether it was necessary. We highlight the role of regulations, GSEs, financial innovations, and the global saving glut in the bubble. Structural changes, which might have contributed to the bubble, also need to be considered.[1] Second, we quantify the role these factors played econometrically. Specifically, we test the relationship between the housing bubble and (1) monetary policy, (2) the global saving glut, and (3) structural change. In addition, we examine whether (4) a combination of all these factors contributed to the housing bubble.

The key findings of our study suggest that monetary policy and the global saving glut are statistically correlated with residential development and increased financial innovation. We also found that a structural change is statistically associated with the rise in housing starts, home prices, and the use of alternative mortgage products. The combined effect of monetary policy with other contributing factors is not statistically meaningful.

II. Potential Factors Behind the Housing Bubble: A Theoretical Analysis

This section of the study discusses, theoretically, the role of monetary policy, GSEs, regulations, financial innovations, the global

[1]Silvia and Iqbal (2009) believed that a structural change, caused by the information technology revolution, was responsible for recent bubbles-busts, including the housing bubble-bust, see section, "A Structural Change and the Housing Bubble" of this paper for more detail.

saving glut, and structural change in the housing bubble. Before we discuss the role of these factors, let's quickly recap the housing bubble, bust, and consequences. Home prices—the S&P/Case-Shiller national home price index is used as a measure of home prices—in the United States increased more than 120% between January 1998 and April 2006. By comparison, home prices increased only 12.2% between January 1990 and December 1997. Housing starts increased approximately 39% between January 2000 and January 2006 compared with a 10.1% increase during the 1990s. After the housing bubble burst, by April 2009 housing starts had plummeted more than 78% from their peak (January 2006). By January 2009, home prices had plunged more than 31% from their peak (April 2006). Consequently, the United States was thrown into a severe recession (what has become known as the Great Recession), which ultimately resulted in 8.7 million net job losses and the unemployment rate more than doubling to a peak of 10.1 percent. By March 2009, the S&P 500 Index had dropped more than 50% from its October 2007 peak. Overall, the US economy experienced the severest contraction since the Great Depression.

A. Monetary Policy and the Housing Bubble

An often-repeated criticism of monetary policy as it relates to the housing bubble is that easy monetary policy during the 2002–2004 period fueled housing speculation, resulting in an unprecedented bubble (Taylor, 2008, 2010). The Federal Reserve reduced the federal funds rate target (fed funds) to less than 2.00% during December 2001–October 2004 (35 months). Thereafter, the Fed began a slow, methodical, and highly predictable process of raising the fed funds rate by quarter point (25 basis points) increments over the next 20 months (between November 2004 and June 2006). Taylor (2008 and 2010) suggested that easy monetary policy was the major cause of the housing bubble. Before we agree or disagree with the Taylor's view we must ask: Why did the Federal Reserve ease monetary policy during the 2002–2004 period? Federal Reserve Board Chairman Ben Bernanke answered this question at the January 2010 American Economics Association Convention. Bernanke defended the Federal Reserve's policy and suggested the lower fed funds rate during the 2002–2004 period was a necessary step due to several factors: the weak recovery from the 2001 recession that followed the bursting of the tech bubble, the uncertainty that followed the September 11

terrorist attack, and the risk of deflation. He also pointed out that the run up in housing was not exclusive to the United States. Most other industrialized countries also experienced housing booms during this period, and their booms could not be traced to the Fed's monetary policy decisions (for more details, see Bernanke, 2010).

We now have a sharp difference of opinions as to whether monetary policy contributed to the housing bubble. On one hand, Taylor (2008, 2010) argued easy monetary policy contributed to the housing bubble. Bernanke (2010), on the other hand, disagreed with the Taylor's view and instead pointed the blame toward structural factors, such as the global saving glut, changes in regulations regarding GSEs, and the rapid pace of innovation in the mortgage market. Given the clear split in these views, we begin our analysis by testing the relationship between monetary policy and the housing bubble (see Section III for details).

B. Financial Innovation, GSEs, Regulations, and the Housing Bubble

Other factors, such as the pace of financial innovation, the changing role of GSEs, and changes in regulations governing mortgage finance are also potential contributors to the bubble. For instance, Greenspan (2010) noted that subprime mortgages in the United States were only 7% of total originations by 2002. With the price of homes rising at an accelerating pace since 1998, subprime lending was seen as increasingly profitable to investors. Starting in late 2003, financial firms, belatedly drawn to this market, began packaging and pooling subprime-adjustable rate home mortgages with other mortgages into mortgage-backed securities (MBS) of great complexity. The risk of these securities was underestimated by the rating agencies because of a lack of competition, poor accountability, or, more likely, an inherent difficulty in assessing risk due to the complexity of the securities. Therefore, the credit ratings of these securities were inflated. Financial firms clearly found receptive buyers for these securities. Another factor contributing to the surge in these securities' demand was the large-scale purchases of subprime securities by Fannie Mae and Freddie Mac, the major US GSEs. Pressed by the Department of Housing and Urban Development (HUD) and Congress to expand "affordable housing commitments," GSEs chose to meet this request by investing heavily in subprime

securities.[2] Furthermore, these firms accounted for an estimated 40% of all subprime mortgage securities (almost all adjustable-rate), newly purchased and retained on investors' balance sheets during 2003–2004 period (FHFA, 2009 (revised), Historical Data Table 5b, Part 2, and 14b, Part 2).[3] This proportion has been estimated to be five times the share of newly purchased and retained mortgages held by GSEs in 2002. Greenspan (2010) noted that a significant proportion of the increased demand for subprime MBS during the 2003–2004 period was effectively politically mandated, and hence, driven by highly inelastic demand.

Taylor (2008) also suggested that the enormous swing from boom to bust would be expected to have had impacts on the financial market as falling home prices led to increased delinquencies and foreclosures. These effects were amplified by several complicating factors, including the use of subprime mortgages, especially the adjustable rate variety, which led to excessive risk taking. In addition, Taylor said that in the United States, this was encouraged by government programs designed to promote homeownership, a worthwhile goal, but, in retrospect, overdone. Taylor concluded that excessive risk taking and low interest rate (easy) monetary policy decisions are connected. However, Bernanke (2010) disagreed with the notion that easy monetary policy persuades adjustable-rate mortgage (ARM) borrowers. Additionally, Bernanke provided empirical evidence using the Fed's principal macroeconometric model, which simulated the effect on the economy and on mortgage rates of a monetary policy that followed the original 1993 Taylor rule, taking into account the feedback effects of tight monetary policy on the economy. The findings indicated that the initial ARM rate would have been approximately 0.71 percentage points higher than in the baseline and that the initial monthly payment for an ARM borrower would have increased by only about

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[2] In October 2000, HUD finalized a rule for "significantly increasing the GSEs' affordable housing goals" for each year from 2001 to 2004. In November 2004, the annual housing goals for 2005 and beyond were raised further (Office of Policy Development and Research, 2001).

[3] The *FHFA Annual Report to Congress 2008* (FHFA, 2009) was originally published May 18, 2009, but then updated to include a significant reclassification effective September 3, 2009. Greenspan (2010) estimated, prior to the revision, that the share was only 25%. Data newly reclassified by Fannie Mae account for almost all of the revision.

$75. As a result, Bernanke concluded that moderately tighter monetary policy would have not dissuaded many potential ARM borrowers.

Consequently, financial innovations, the GSEs, and changes in regulations did contribute to the housing bubble. The source of these factors, however, is debatable.[4]

C. The Global Saving Glut and the Housing Bubble

Some argue that global factors fueled the housing bubble. Greenspan (2010), for instance, said that the saving rate of the developing world soared from 24% of nominal GDP in 1999 to 34% by 2007, far outstripping its investment rate. Whether it was a glut of excess intended saving (the so-called global saving glut) or a shortfall of investment intentions, the result was the same: a fall in global real long-term interest rates and their associated capitalization rates. Accordingly, asset prices, particularly house prices, in nearly two dozen countries moved dramatically higher. The gain in US home prices was high by historical standards but not greater than the global peak average (IMF, 2008). Furthermore, Greenspan suggested that the rate of global housing appreciation was accelerated by the heavy securitization of American subprime and Alt-A mortgage bonds that found willing buyers at home and abroad. Bernanke (2010) also pointed out that capital inflows from emerging markets to industrial countries could help to explain asset price appreciation and low long-term global real interest rate—the so-called global saving glut hypothesis. Bernanke provided empirical evidence of the relationship between capital inflows and home price appreciation for 20 industrial countries. The results suggested that the relationship is highly significant, both statistically and economically, explaining approximately 31% of the variability in house price appreciation across countries (for more details, see Bernanke, 2010).[5]

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[4] Given that financial innovations, the role of the GSEs, and changes in regulations are qualitative variables and that it is hard to find quantitative time series measures for these variables, we are leaving the empirical proof of this hypothesis to future research.

[5] Bernanke (2010) cautioned that this simple relationship requires more interpretation before any strong conclusions about causality can be drawn. In particular, we need to better understand why some countries draw stronger capital inflows than others.

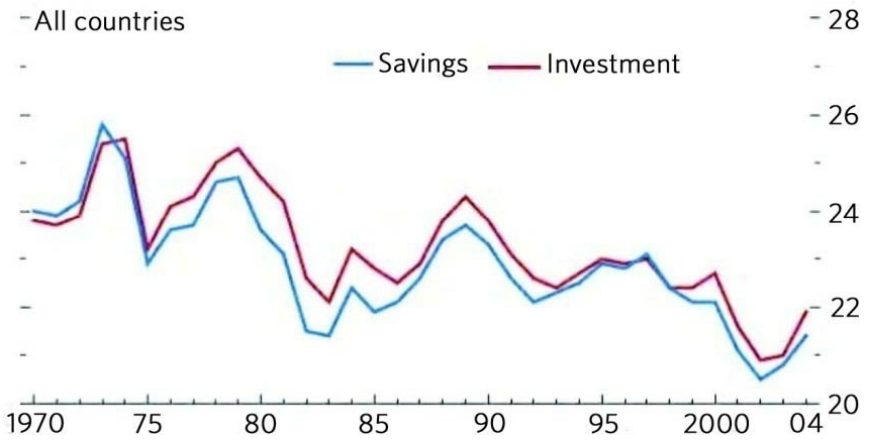

Figure 1. Global savings and investment as a share of world GDP. Source: *World Economic Outlook*, IMF, September 2005, Ch. 2, p. 92.

Taylor (2008), however, disagreed with the global saving glut hypothesis and suggested that there is actually no evidence for a global saving glut. Taylor illustrated (see Figure 1) that there seems to be a saving shortage. Figure 1 shows that the global saving rate—world saving as a fraction of world GDP—was very low in the 2002–2004 time period, especially when compared with the 1970s and 1980s. Additionally, Taylor argued that this alternative explanation does not stand up to empirical testing using data that has long been available. As a result, there is mixed evidence that a global saving glut fueled the housing bubble. We test, econometrically, whether or not the global saving glut hypothesis is statistically significant (see Section III for details).

In conclusion, on one hand, one group of economists believed easy monetary policy fueled the housing bubble and disagreed with the global saving glut hypothesis (for more details, see Taylor, 2008). On the other hand, some economists defended the monetary policy and suggested that the global saving glut caused the housing bubble (for more details, see Bernanke, 2010; Greenspan, 2010). Furthermore, both groups, to some extent, agreed that subprime ARM, along with GSEs and changing regulation, played a vital role in the housing bubble. Taylor (2008) said that easy monetary policy persuaded subprime ARM borrowing. Bernanke (2010), however, disagreed with Taylor's notion and suggested that monetary policy during the 2002–2004 period did not encourage ARM borrowers. Overall, we have seen mixed evidence as to whether monetary policy

and the global saving glut fueled the house bubble. In addition, there is debate on who/what contributed to the emergence of the subprime ARM borrowing. Before we quantify the aforementioned hypotheses, there is one more potential contributor to the housing bubble to examine: a structural change caused by the information technology (IT) revolution.

D. A Structural Change and the Housing Bubble

Silvia and Iqbal (2009) asserted that structural changes were the major cause of recent bubble busts, including the housing bubble bust. Silvia and Iqbal suggested that the IT revolution caused a structural change in the world of investing whereby technological advancement broke down informational barriers, gave investors access to financial products around the world, and created a large pool of capital. Although the size and flow of this large pool of invisible capital is hard to measure, we can certainly see the effects in markets (for more details, see Silvia and Iqbal, 2009).

Silvia and Iqbal believe that the large invisible capital flow is the root cause of the recent housing bubble bust and recession as well as the 2000-2001 IT sector bubble bust, but the process and behavior of the two cycles were different, as were the consequences.[6] Houses are expensive products that require mortgages from financial institutions, a feature that enabled the housing sector to have the capacity to absorb trillions of dollars in capital. Mortgage payments created a flow of income for the lender, which created an opportunity for securitization. This opened the door for investors to invest in the housing sector. Thus, a massive flow of capital into the housing sector was easy and contributed to the creation of a large housing bubble. Therefore, the housing bust is more severe than the IT bubble bust, in terms of not only capital loss but also spreading to various other industries and countries (Silvia and Iqbal, 2009).

An important note here is that structural change and the global saving glut are two different hypotheses.[7] That is, the structural change hypothesis stresses that the IT revolution created a large pool of capital that subsequently moved into the housing sector and

[6] Here we do not provide details about the IT sector bubble bust because the focus of this paper is the housing bubble. However, details about the IT bubble bust can be found in Silvia and Iqbal (2009).

[7] We are thankful to the respected referee for pointing out this issue.

inflated related asset and securities prices. Furthermore, the large capital pool contains investors from all over the world, including both developed and developing nations (for more details, see Silvia and Iqbal, 2009). The global saving glut hypothesis, however, suggests money came from developing countries into the developed world. Furthermore, the potential source of the global saving glut is higher saving rates of the developing countries (for more details, see Bernanke, 2010). We extend Silvia and Iqbal's idea of a structural change and test the notion econometrically in the next section.

III. Econometrics of the Housing Bubble

A. The Data

The objective of this paper is to identify possible contributors to the housing bubble. First, we define the quantitative measure(s) of the bubble. Our first measure is US housing starts.[8] We use housing starts as a proxy for the housing bubble and as a dependent variable. Housing starts increased more than 38% during the January 2000–

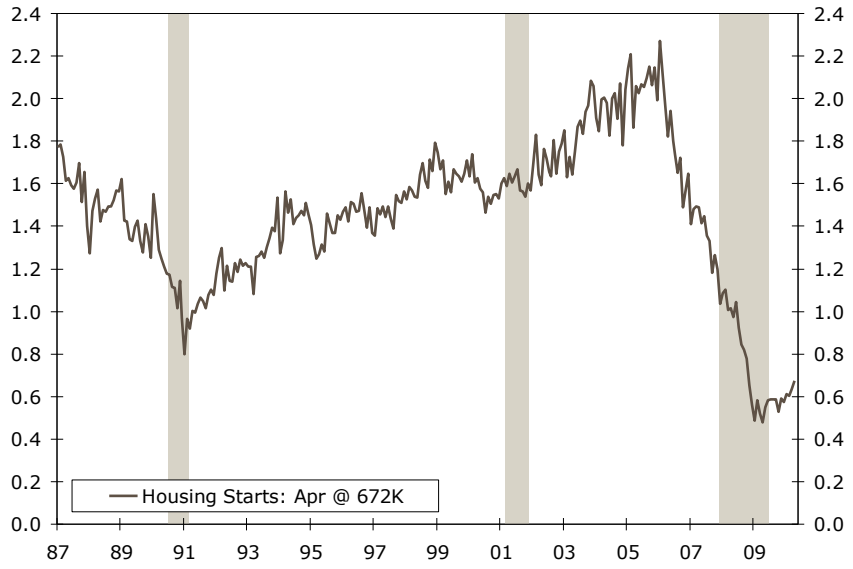

Figure 2. Housing starts. Seasonally adjusted annual rate, in millions.

[8] The housing starts data shows the number of privately owned new houses/residential buildings on which construction has been started in a given period; we plot the series in Figure 2. The source of the housing starts data is the US Department of Commerce Census Bureau (2013).

January 2006 period but only 10.1% during the 1990s. Furthermore, after the housing bubble burst, housing starts dropped more than 78% by April 2009 from their peak in January 2006. Therefore, housing starts reflect both the housing bubble and bust.

Our second measure of the housing bubble is home prices. Home prices dramatically increased during the first half of the last decade (particularly during the 2002–2006 period). Our first measure of home prices is the Federal Housing Finance Agency (FHFA) US house price index (HPI). The FHFA index is a weighted, repeat-sales index, which measures average price changes from repeat sales and refinancing of the same properties.[9] FHFA also produces a purchase-only home price index, FHFA Purchase-only, which excludes refinancing. Another measure of house prices is the S&P/Case-Shiller index of house prices. The FHFA and S&P/Case-Shiller national home price indices follow the same fundamental repeat-valuation approach and cover approximately the same geographical area. One key difference is that the S&P/Case-Shiller HPI includes foreclosed homes and shows a much larger decline in national home prices. The FHFA HPI excludes foreclosed homes and therefore shows a smaller decline in national house prices. Another key difference between the S&P/Case-Shiller and the FHFA Purchase-only house price indices is that the Purchase-only index includes transactions on all houses with values under the conforming loan limit (except for foreclosure transactions), whereas Case-Shiller tracks prices on all houses (including those with higher and more volatile average prices). Both indices are correct, but the inclusion of higher priced and more volatile homes makes the S&P/Case-Shiller series much more volatile. Despite the problem in measuring house prices, the basic picture is clear. House prices rose slowly from 1990 to 2003, rose rapidly until 2006 or 2007, and then dropped off a cliff. [10]

As mentioned earlier, some economists suggest that nonconventional mortgages played a vital role in the housing bubble

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[9] One benefit of using the FHFA HPI is that it covers a large geographical area, including 9 Census Bureau divisions, all 50 states, the District of Columbia, and nearly every metropolitan statistical area (MSA).

[10] There are other measures of house prices, such as the median existing home price from the National Association of Realtors (NAR) and an index computed by Fannie Mae. We focus exclusively on the following three measures of house prices and use these indices as dependent variables: FHFA HPI, FHFA Purchase-only, and S&P/Case-Shiller HPI. We plot all three indices in Figure 3.

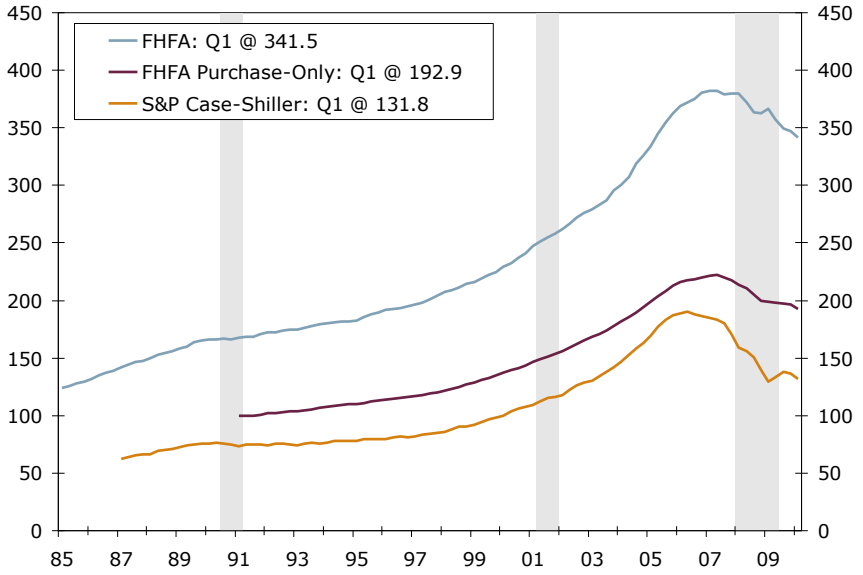

Figure 3. Home price indexes.

and bust. One possible proxy for nonconventional mortgages is the ratio of the S&P/Case-Shiller HPI to FHFA HPI.[11] Because FHFA includes only conventional mortgages and Case-Shiller includes both conventional and nonconventional mortgages, we plotted the ratio in Figure 4. Therefore, the difference between both indices is nonconventional mortgages. If the growth rates of both Case-Shiller and FHFA indices are positive and the ratio is equal to one, then the growth rate of nonconventional mortgages is insignificant, or nonconventional mortgages did not play a vital role in the housing bubble. From Figure 4, the ratio is greater than one during the 2002–2005 period (peaking around 2003)[12], which may imply that the growth rate of the Case-Shiller HPI was higher than that of the FHFA HPI. One possible explanation for the Case-Shiller's higher growth rate is that near the end of the housing boom, the value of the properties attached to nonconventional mortgages increased faster than those associated with conventional mortgages.

[11] The ratio is equal to the S&P/Case-Shiller HPI (year-over-year percent change) divided by FHFA HPI (year-over-year percent change).

[12] During that time the growth rates of Case-Shiller and FHFA were positive.

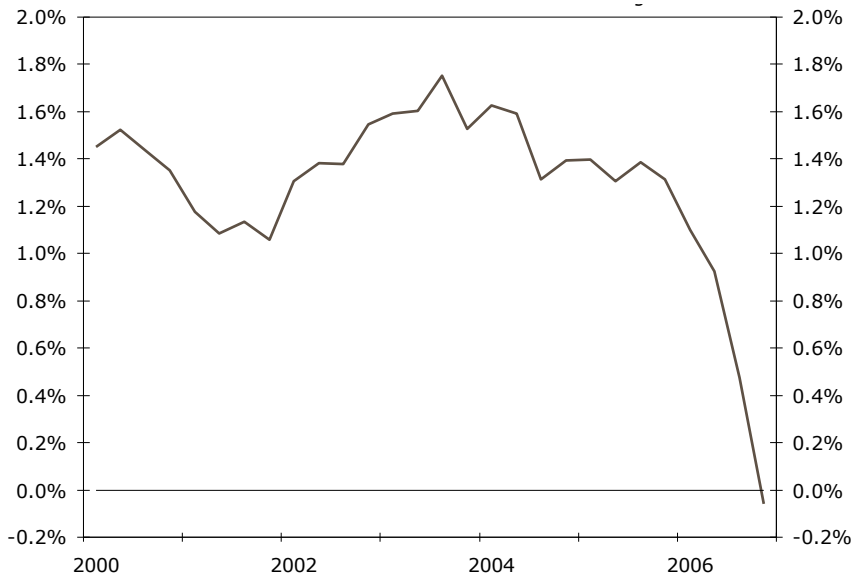

Figure 4. Ratio of S&P Case-Shiller HPI to FHFA HPI. Both series are year-over-year percent change.

Consequently, the ratio is a good proxy for price changes for nonconventional mortgages, and we use it as a dependent variable.[13]

Now that we have defined the quantitative measurements of the housing bubble, we present our explanatory variables, the possible contributors to the housing bubble. The first potential contributor is monetary policy, which has been previously mentioned as a possible source of the bubble, but there is mixed evidence about its specific role. We use the fed funds rate as a proxy for monetary policy and as an explanatory variable. Another potential way to examine whether, during the early 2000s, monetary policy was loose (easy) or tight is to utilize the Taylor rule, also known as the natural interest rate. That is, first estimate the Taylor rule and then compare the actual fed funds rate to it.[14] This approach, however, is not useful in the present case

[13] If the growth rates of the Case-Shiller and FHFA indices are negative and the ratio is greater than one, then the value of the nonconventional mortgages depreciates at a faster rate than that of conventional mortgages. Exactly this happened during 2007–2009 (especially after summer 2007), when the foreclosure rate of subprime mortgages was very high and the value of those properties depreciated at a faster rate than that of prime mortgages. Therefore, the Case-Shiller index shows a larger decline than the FHFA HPI.

[14] We are thankful to the respected referee for pointing out this issue.

for at least two major reasons. First, we use actual interest rates because when investors and households make decisions such as whether to buy/sell securities and to apply for a mortgage, they care about the interest rate that they are going to pay/receive and may not care whether the rate is lower/higher than the natural interest rate. A second major flaw in utilizing this method is that the estimated Taylor rule has some limitations because it is not forward looking, and the data revisions may change the path of the estimated Taylor rule (for a detailed discussion about the limitations of the estimated Taylor rule, see Bernanke, 2010; Gokke et al., 2009). The second potential contributor to the bubble is the so-called global saving glut hypothesis. Bernanke (2010) used the US current account balance as a percentage of GDP (Current Account_GDP) as a proxy for the global saving glut. We follow Bernanke's approach and use Current Account_GDP as an explanatory variable; we plot fed funds and Current Account_GDP in Figure 5. The final potential contributor to the bubble is a structural change, as explained by Silvia and Iqbal (2009). As a proxy for structural change, we use a dummy variable equal to one if there is a structural change and zero otherwise. We use the 2001:Q4–2006:Q3 time period as a structural change; thus,

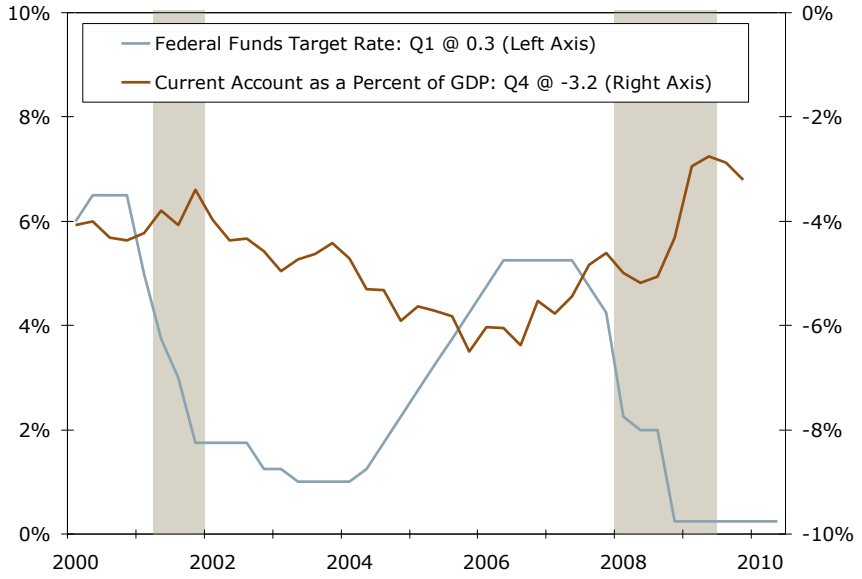

Figure 5. Potential contributors to the housing bubble.

the dummy variable is equal to one for the 2001:Q4–2006:Q3 period and zero otherwise.[15]

Another way to validate the structural change hypothesis is application of the Hodrick-Prescott (H-P) filter (Hodrick and Prescott, 1997) to the housing sector data.[16] The H-P filter extracts the long-run trend component of a series, and once this trend is estimated, we can identify, at any point of time, whether the current value of a series is below the trend growth (slowdown) or above the trend (boom) (for more details, see Hodrick and Prescott, 1997). That is, we extract the long-run trend series for housing starts and house prices and then compare these series with the actual (log of) housing start and house price series to identify whether they show a boom (or structural change).[17]

Based on the H-P filter, the results for housing starts and house prices are plotted in Figures 6–9. Each of the graphs presents a long-run trend based on the H-P filter along with the actual (log form) of the series. From Figures 7–9, all three measures of home prices show

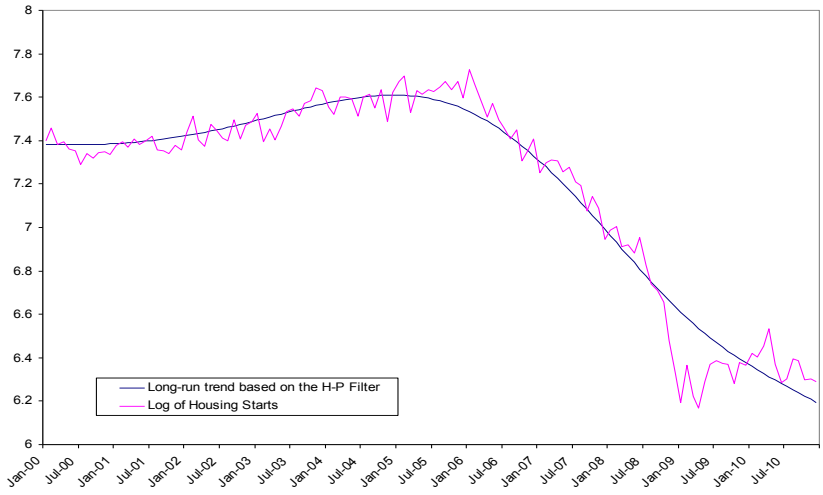

Figure 6. Decomposing housing starts using the H-P filter.

[15] During that time period, housing starts and home prices (our proxies for the housing bubble) rose at a faster rate. Bernanke (2010) also used the same time period for his analysis of the housing boom. Therefore, we consider the 2001:Q4–2006:3Q period as a structural change.

[16] We are thankful to the respected referee who suggested employing the H-P filter.

[17] In the H-P filter analysis we employ the log form of a time series.

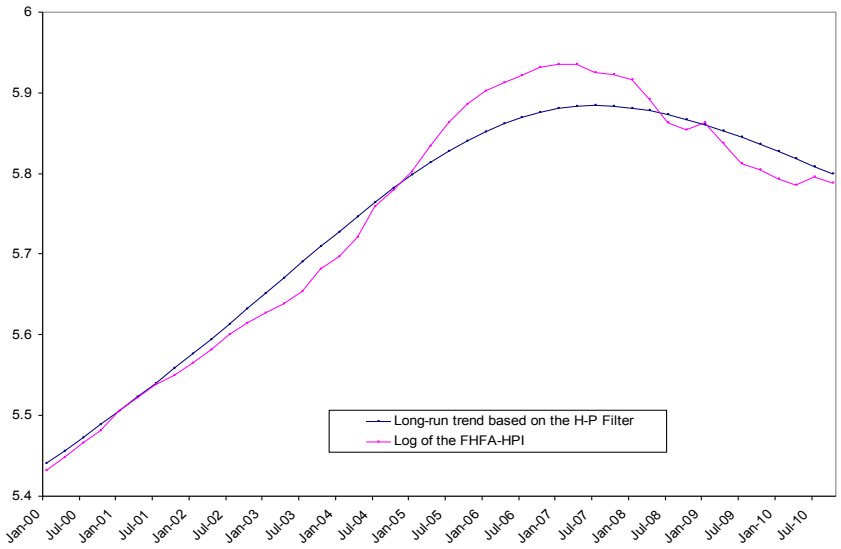

Figure 7. Decomposing the FHFA-HPI using the H-P filter.

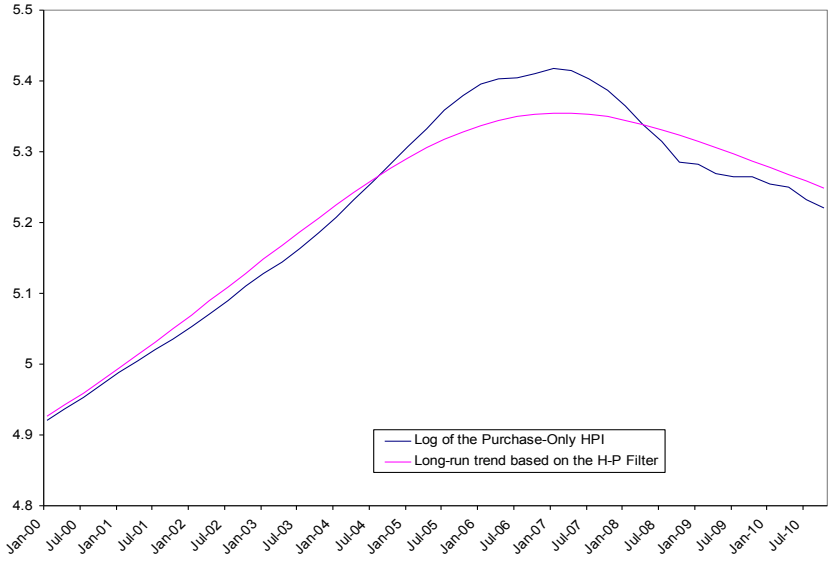

Figure 8. Decomposing the purchase-only HPI using the H-P filter.

a clear pattern of a boom (or structural change). That is, the actual (log form) series stayed well above the long-run trend series for the 2004–2008 period (for the Case-Shiller HPI) as well as for the 2005–

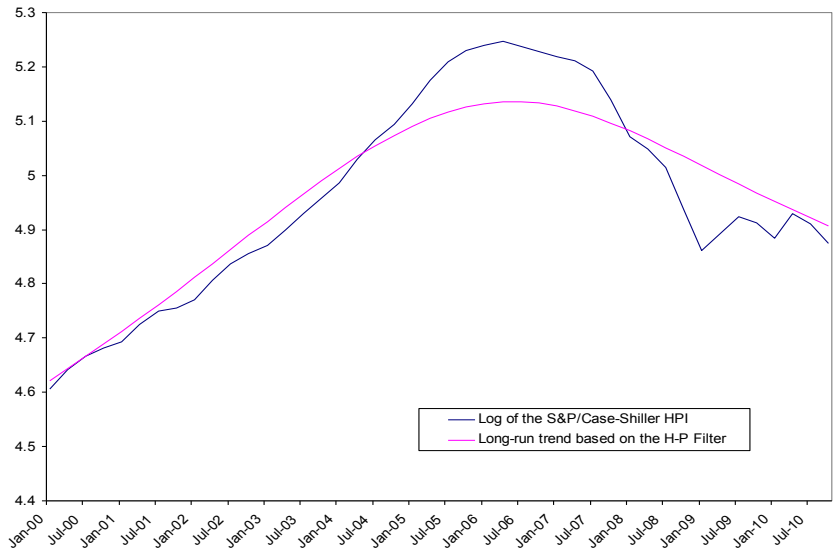

Figure 9. Decomposing the S&P/Case-Shiller-HPI using the H-P filter.

2008 period (for FHFA and Purchase-only indices). The housing starts graph, Figure 6, also shows that the log of housing starts wasabove the long-run trend during 2006. Overall, the H-P filter analysis validates the structural change hypothesis.

This study uses a quarterly dataset due to availability of the time series data. The fed funds and housing starts data are converted into a quarterly time series; we use the average of three months as the quarterly value. The year-over-year percent change (YoY) of housing starts and HPIs (dependent variables) are used for two major reasons. First, using a percent form of the dependent variables helps to explain the estimated coefficients because fed funds and Current Account_GDP (independent variables) are already in percent form. That is, all variables share the same measurement scale, which is percent form. Second, the relationship between the measures of housing bubble and easy monetary policy/global saving glut may not be instantaneous because monetary policy actions and the global saving glut may take some time to affect the housing sector. For instance, if the Federal Reserve changes the fed funds target rate today, it may take a while for that change to channel through the economy, and the same logic is true for the global saving glut. As a result, using a YoY (change from the last year) form of the dependent variables vs. the current form of the independent variables (the fed

funds rate and Current Account_GDP) would allow us to capture that effect. Bernanke (2010) used the 2001:Q4–2006:Q3 time period for his analysis, and we follow his approach by using the same time period. For the structural change analysis, the 2000:Q1–2009:Q4 time period is utilized because we use a dummy variable that is equal to one for the 2001:Q4–2006:Q3 period. If we used the 2001:Q4–2006:Q3 period for the structural analysis, then the econometric test results would not be reliable.[18]

B. The Results: The Individual Factor's Contribution to the Bubble

This section of the study discusses results based on regression and correlation analysis.[19] First, we estimate the individual factor's contribution to the housing bubble. This regression analysis is based on the 2001:Q4–2006:Q3 period, and results are reported in Table 2. It is worth mentioning that because all data series are in percent form (first difference), we may not face the nonstationary issue. This implies that results based on ordinary least squares (OLS) are reliable. The first regression analysis tests the relationship between the fed funds (a proxy for monetary policy) and housing starts (a proxy for the housing bubble). The regression results find a statistically significant relationship between these two variables, and the fed funds rate explains 49% of the variation (R-squared = 0.49) in housing starts. The estimated coefficient indicates a negative relationship between the fed funds rate and housing starts. This implies that a reduction in fed funds is associated with an increase in housing starts. The correlation analysis also finds a statistically significant correlation coefficient (–0.7) between the fed funds rate and housing starts.

The relationship between the fed funds rate and home prices (another measure of the housing bubble) is statistically insignificant for all three HPIs (Case-Shiller, FHFA, and FHFA Purchase-only). That may indicate that easy monetary policy is not statistically associated with home prices. We also run a regression analysis between the fed funds rate and the S&P-FHFA house price ratio—a proxy for the nonconventional mortgages—and the relationship is

[18] In that case, dummy and intercept both have the same value, one, and thereby there would be a "Dummy Variable Trap" (for more details about the dummy trap, see Greene, 2007, Ch. 20).

[19] All results based on the correlation analysis are reported in Table 1.

Table 1. Correlation Analysis

Time Period		Housing Starts	S&P/ Case-Shiller	FHFA	FHFA-Purchase Only	Ratio (CS/ FHFA)
2001:Q4–2006:Q3	Fed Funds	–0.7*	–0.19	0.35	–0.05	–0.83*
	CA_GDP	0.48**	–0.32	–0.62*	–0.41***	0.40***
2000Q1:–2009:Q4	Structural Change	0.7*	0.68*	0.67*	0.67*	0.30***

* Significant at 1%. ** Significant at 5%. *** Significant at 10%.
CA_GDP: Current account balance as a percent of GDP.
Ratio (CS/FHFA): Ratio of S&P/Case-Shiller(YoY) and FHFA(YoY).
Structural Change: A dummy variable equal to 1 if there is a structural change, otherwise 0. We used the 2001:Q4–2006:Q3 period as a structural change, and this dummy is equal to 1 for that time period and 0 otherwise.

Table 2. Regression Analysis: Individual Factors' Contribution to the Housing Bubble

Time Period	Explanatory Variable	Estimate	Dependent Variables				
			Housing Starts	S&P/ Case-Shiller	FHFA	FHFA-PO	Ratio
2001:Q4–2006:Q3	Fed Funds	Coefficient	–3.93	–0.45	0.55	–0.05	–0.17
		t-value	–4.17	–0.8	1.57	–0.22	–6.26
		R-squared	0.49	0.03	0.12	0	0.69
	CA_GDP	Coefficient	4.42	–1.27	–1.62	–0.58	0.13
		t-value	2.32	–1.42	–3.35	–1.88	1.84
		R-squared	0.23	0.1	0.38	0.16	0.16
2000Q1–2009:Q4	Structural Change	Coefficient	25.07	14.27	6.59	7.2	6.94
		t-value	6.04	5.7	5.52	5.63	1.93
		R-squared	0.49	0.46	0.44	0.45	0.09

CA_GDP: Current account balance as a percent of GDP.
FHFA-PO: FHFA-Purchase Only.
Ratio: Ratio of S&P/Case-Shiller and FHFA.
Structural Change: A dummy variable equal to 1 if there is a structural change, otherwise 0. We used the 2001:Q4–2006:Q3 period as a structural change, and this dummy is equal to 1 for that time period and 0 otherwise.

statistically significant.[20] The fed funds rate explains 69% (R-squared = 0.69) of the variation in the ratio. Furthermore, the negative coefficient indicates that a low fed funds rate (easy policy) may encourage issuance of nonconventional mortgages. The correlation analysis also confirms this conclusion and finds a strong and statistically significant correlation coefficient (–0.83) between the fed funds rate and the ratio.

The next step is to test the global saving glut hypothesis by testing the relationship between Current Account_GDP (a proxy for global saving glut) and housing starts. The relationship is statistically significant with a positive coefficient, and the result indicates that the global saving glut is responsible for 23% (R-squared = 0.23) of the variation in housing starts. In other words, the positive relationship validates the global saving glut hypothesis. The correlation analysis results also find a positive, statistically significant correlation coefficient (0.48) between housing starts and Current Account_GDP.

The relationship between Current Account_GDP and the Case-Shiller HPI is not statistically significant. However, we find a statistically significant relationship between the Current Account_GDP and FHFA HPI as well as Current Account_GDP and FHFA Purchase-only. Both coefficients, however, have negative signs, which imply that the global saving glut did not boost home prices in the United States. The relationship between Current Account_GDP and the ratio is statistically significant with R-squared = 0.16. The positive coefficient indicates that global saving glut may boost nonconventional mortgages. Current Account_GDP has a positive, statistically significant correlation coefficient (0.4) with the ratio.

We also test Silvia and Iqbal's structural change hypothesis by using the 2000:Q1–2009:Q4 time period for the regression analysis (see Table 2 for results). The results confirm that the structural change is statistically significant and has a positive relationship with housing starts, home prices (Case-Shiller, FHFA, and FHFA Purchase-only), and the ratio. Additionally, structural change explains 49% of the variation in housing starts, 46% in the Case-Shiller HPI, 44% in the FHFA HPI, 45% in the FHFA Purchase-only, and 30% in the ratio. This implies that a structural change did contribute to the

[20] To show a decline in home prices, we change the ratio sign from positive to negative when the Case-Shiller and FHFA indices (YoY) are negative.

Table 3A. Regression Analysis: A Combination of the Factors and the Housing Bubble

Time Period	Estimate	Housing Starts[D]			
		FF	**CA**	**SC**	**R-squared**
2000:Q1–2009:Q4	Coefficient		1.56	26.35	0.5
	t-value		0.64	5.67	
	Coefficient	2.43		28.11	0.55
	t-value	2.31		6.77	
	Coefficient	4.36	7.2	36.42	0.62
	t-value	3.62	2.72	7.44	
2001:Q4–2006:Q3	Coefficient	–4.15	–0.5		0.49
	t-value	–2.97	–0.22		
Time Period	**Estimate**	**S&P/Case-Shiller[D]**			
		FF	**CA**	**SC**	**R-squared**
2000:Q1–2009:Q4	Coefficient		–0.83	13.59	0.47
	t-value		–0.56	4.85	
	Coefficient	2.45		17.35	0.65
	t-value	4.48		8.05	
	Coefficient	3.41	3.67	21.47	0.71
	t-value	5.41	2.58	8.37	
2001:Q4–2006:Q3	Coefficient	–2.11	–3.79		0.46
	t-value	–3.35	–3.64		
Time Period	**Estimate**	**FHFA[D]**			
		FF	**CA**	**SC**	**R-squared**
2000:Q1–2009:Q4	Coefficient		–1.51	5.35	0.51
	t-value		–2.27	4.25	
	Coefficient	1.47		8.43	0.75
	t-value	6.78		9.89	
	Coefficient	1.62	0.58	9.1	0.76
	t-value	6.07	0.99	8.35	
2001:Q4–2006:Q3	Coefficient	–0.33	–2.01		0.4
	t-value	–0.77	–2.85		

CA: Current account balance as a percent of GDP.
D: Dependent variable.
FF: Federal funds target rate.
SC: Structural change. A dummy variable equal to 1 if there is a structural change, otherwise 0. We used the 2001:Q4–2006:Q3 period as a structural change, and this dummy is equal to 1 for that time period and 0 otherwise.

housing bubble. The correlation analysis also validates the hypothesis that a structural change is associated with the housing bubble.

Table 3B. Regression Analysis:
A Combination of the Factors and the Housing Bubble

Time Period	Estimate	FHFA-Purchase Only[D]			
		FF	**CA**	**SC**	**R-squared**
2000:Q1–2009:Q4	Coefficient		–0.83	6.52	0.47
	t-value		–1.11	4.61	
	Coefficient	1.47		9.04	0.72
	t-value	5.88		9.2	
	Coefficient	1.9	1.63	10.92	0.76
	t-value	6.63	2.59	9.34	
2001:Q4–2006:Q3	Coefficient	–0.63	–1.32		0.41
	t-value	–2.68	–3.44		
Time Period	**Estimate**	**Ratio[D]**			
		FF	**CA**	**SC**	**R-squared**
2000:Q1–2009:Q4	Coefficient		1.11	7.85	0.1
	t-value		0.52	1.95	
	Coefficient	0.17		7.16	0.09
	t-value	0.18		1.86	
	Coefficient	0.72	2.04	9.51	0.1
	t-value	0.59	0.77	1.93	
2001:Q4–2006:Q3	Coefficient	–0.23	–0.14		0.77
	t-value	–6.67	–2.45		

CA: Current account balance as a percent of GDP.
D: Dependent variable.
FF: Federal funds target rate.
Ratio: Ratio of S&P/Case-Shiller and FHFA.
SC: Structural change. A dummy variable equal to 1 if there is a structural change, otherwise 0. We used the 2001:Q4–2006:Q3 period as a structural change, and this dummy is equal to 1 for that time period and 0 otherwise.

This section validates the hypothesis that easy monetary policy and global saving glut are, statistically, associated with housing starts and nonconventional mortgages. Moreover, a structural change also contributed to the housing bubble. In other words, easy monetary policy, the global saving glut, and structural change did, individually, contribute to the housing bubble.

C. The Results: A Combination of the Contributors

This section tests whether a combination of these potential factors plays a role in the bubble. The basic idea is to test whether a combined effect of these factors on the bubble is statistically

significant. We test whether a combination of easy monetary policy, global saving glut, and structural change caused the housing bubble. The results are reported in Tables 3A and 3B. First, we test a combination of monetary policy and global saving glut using the fed funds rate and the Current Account_GDP as explanatory variables and housing starts as the dependent variable. The results indicate that the fed funds rate is statistically significant and Current Account_GDP is statistically insignificant. This means that a combination of monetary policy and global saving glut is not statistically significant as a contributor to the housing bubble. We also test for a combined monetary policy and global saving glut effect on home prices, but the relationship is not statistically or economically significant. This indicates there is no evidence of a combined monetary policy and global saving effect on home prices. Moreover, the statistical results do not find a combined effect of both factors on nonconventional mortgages. One major reason for the statistically insignificant relationship is suggested by Greenspan (2010), namely, easy monetary policy does not accommodate the global saving glut hypothesis. As a result, monetary policy and global saving glut individually contributed to the housing bubble, but the combined effect of these factors is not statistically or economically meaningful.

In the next step, we test the combined effect of monetary policy, the global saving glut, and structural change.[21] First, we use Current Account_GDP and structural change as explanatory variables, but the results are not statistically or economically meaningful. This indicates that global saving glut and structural change do not have a combined effect on housing starts, home prices, or nonconventional mortgages. Second, we use the fed funds rate and structural change as independent variables, but the conclusion is not different from the previous step. Finally, we utilize the fed funds rate, Current Account_GDP, and structural change as explanatory variables but draw the same conclusion: there is no combined effect of these factors on the housing bubble.

Our statistical analysis suggests that easy monetary policy and global saving glut encouraged housing starts and nonconventional mortgages. Moreover, a structural change is associated with the rise in housing starts, home prices, and nonconventional mortgages. The

[21] We use the 2000:Q1–2009:Q4 time period for this analysis.

combined effect of these factors on the housing bubble, however, is not statistically meaningful.

IV. Concluding Remarks

The collapse of the housing sector was a potential contributor to the recent US recession and financial crisis. The causes of the housing boom, however, are debatable. In this study, we attempt to identify major contributing factors to the housing boom and to quantify which were primary drivers and which merely played a supporting role. Specifically, we raise and answer three fundamental questions: (1) Did monetary policy create the housing bubble? (2) Are there other factors, other than monetary policy, that caused the housing bubble? (3) Is monetary policy combined with other factors (regulations, GSEs, financial innovations, structural change, and the global saving glut hypothesis) responsible for the bubble?

The conclusion of our statistical analysis is consistent with the hypothesis that easy monetary policy and the global saving glut are connected with housing starts and nonconventional mortgages. Moreover, a structural change is statistically associated with the rise in the housing starts, home prices, and nonconventional mortgages. We suggest that a further investigation into this hypothesis using different techniques/datasets is needed, but our results suggest that this hypothesis should not be ruled out.

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