The Housing Price Bubble, Monetary Policy, and the Foreclosure Crisis in the U.S.

John F. McDonald[a],[*] and Houston H. Stokes[b]

[a]*Heller College of Business, Roosevelt University, Chicago, Illinois, 60605, USA*
[b]*Department of Economics, University of Illinois at Chicago, Chicago, Illinois, 60607, USA*

This article presents a monthly vector autoregressive (VAR) model of housing prices, the federal funds rate, foreclosures, the unemployment rate, and the mortgage interest rate for the U.S. for the period 2000(1) to 2010(8). Impulse response functions show that negative shocks to the federal funds rate increased housing prices. The interaction effect between the foreclosure rate and housing prices shows that an initial shock to the foreclosure rate produced further increases in the foreclosure rate through a reduction in housing prices.

*Corresponding author. Email: jmcdonald@roosevelt.edu.

I.   Introduction

It is generally agreed that the bursting of the housing price bubble led to the large increase in the foreclosure rate and the severe financial crisis and deep recession in the US. A great deal of research is being devoted to understanding the underlying causes of the very large housing price increase that took place from 2000 to 2006 and the causes and consequences of the resulting financial crisis and recession. One focus of that research agenda is the monetary policy of the Federal Reserve Bank, which held the federal funds rate at very low levels during 2001 to 2004, and then sharply increased this rate from 2004 to 2006. Was the federal funds rate a cause of the huge increase and subsequent fall in housing prices? It is clear that the huge increase in foreclosures that started in 2006 was the fuse that set off the financial crisis, and it is likely that there was an interaction between foreclosures and housing prices that made matters worse. Furthermore, the resulting recession produced a large increase in the unemployment rate that may have resulted in more foreclosures and housing price declines. The purpose of this paper is to examine these questions by estimating a time-series model using monthly data for the critical period of 2000 to 2010.

II.   Expected Causes and Consequences

Our earlier article [McDonald and Stokes (2011)] presents results for a two-variable vector autoregressive (VAR) model for housing prices and the federal funds rate in which negative shocks in the federal funds equation have a positive effect on housing prices, and positive shocks in housing prices increase the federal funds rate. However, this study left out explicit roles for the foreclosure rate, the mortgage interest rate, and the unemployment rate. We expect that negative shocks to housing prices will increase foreclosures, and that positive shocks to foreclosures will reduce housing prices. In addition, it is possible that the mortgage interest rate, rather than the federal funds rate, was the key interest rate during the time in question. Also, the effects of the general economic recession should be included in the model. The ability-to-

pay theory of foreclosures states that negative shocks to households, such as an increase in unemployment, are prime causes of foreclosures.

The VAR method treats all variables as endogenous and allows for complex lagged interaction effects among the variables. Our earlier study found feedback from housing prices to the federal funds rate, so the VAR method is used in this study as well. As discussed by Enders (2004, p. 292), identification in the model is achieved by imposing the restriction that contemporaneous "innovations" or "shocks" in the variables in the model do not have contemporaneous effects on the other variables. In this work the Choleski decomposition is used to impose this identifying restriction where the most exogenous variable is assumed to be first in the variable vector. The Monte Carlo Integration approach with 800 draws is used to establish 95% confidence intervals for the effect of random shocks of the series once the VAR model is inverted.

III.   Data

The study makes use of five monthly time-series variables; the federal funds rate, the S&P/Case-Shiller home price series for ten major metropolitan areas, the interest rate on standard 30-year home mortgages, the unemployment rate, and the foreclosure rate series provided by Zillow. All data are from January 2000 to August 2010. The federal funds rate for the Friday closest to the end of the month in question is used. The Zillow foreclosure rate series is a weighted average of the current and past two months for the percentage of all homes foreclosed on in a given month (with the heaviest weight on the most recent month). Foreclosures include those sold at a sheriff's sale or forfeited to the bank.

Graphs of the five variables (levels and natural log levels) are shown in Figure 1, and means and standard deviations are shown in Table 1.

Figure 1

Fed Funds, C_S Index, Mortgage Rate, Foreclosure Rate, Unemp
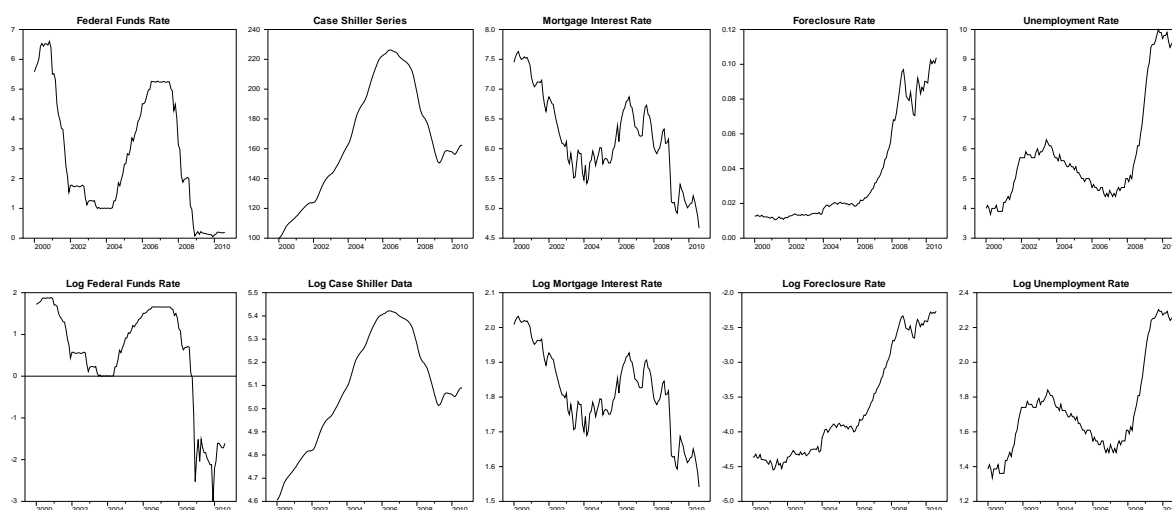
Raw and Log Data

Table 1

Variables, Means, and Standard Deviations

	Mean	Standard Deviation
Ln Federal Funds Rate	0.426	1.241
Ln Mortgage Rate	1.802	0.106
Ln Foreclosure Rate	-3.595	0.772
Ln Unemployment Rate	1.743	0.256
Ln House Price Index	5.119	0.214

IV.   Empirical Results

This section reports two sets of empirical results. One-way Granger causality tests are reported first. Five equations are estimated; each of the five variables was the dependent variable with eight lags of itself and the other four variables on the right-hand side of the equation. These results are

suggestive, but as noted above, a VAR model is used because feedback effects among some of the variables are to be expected. Impulse-response functions derived from inverting the VAR model are reported next, and the existence of feedback effects is confirmed. See Enders (2004, pp. 264-280) for an introduction to VAR models and their transformation to vector moving average (VMA) equations and impulse-response functions. Doan (2010) discusses the details of the Monte Carlo procedure used to obtain 95% confidence intervals for the impulse-response functions.

The results of the one-way Granger causality tests are displayed in Table 2. The table contains the F tests that result from the exclusion of eight lagged values of the variable listed on the left-hand column. Note that exclusion of the lagged values of the dependent variable results in a statistically significant decrease in explanatory power in the equations for all five variables. The only off-diagonal elements in Table 2 that are statistically significant are the effects of lagged values of the natural log of the federal funds rate on the natural log of the housing price index, and the lagged values of the natural log of the housing price index on the natural log of the federal funds rate.   None of the other 18 effects of lagged values is statistically significant. Table 2 also reports the standard error of estimate (SEE) and the Durbin-Watson statistic for each equation. All five Durbin-Watson statistics are very close to 2.00, results that indicate an absence of first-order autocorrelation in the error terms of the estimated equations. While the Granger results indicate the presence or absence of causality, they do not show the sign of the effect or the timing of the effect.

Table 2
One-way Granger Causality Tests: F Statistics[a]

Lagged Values of These Variables	Ln Fed Funds Rate	Ln Mort- gage Rate	Ln Fore- closure Rate	Ln Unem- ployment rate	Ln House Price Index
Ln Fed Funds	8.69*	1.09	1.06	0.71	3.32*
Ln Mortgage	1.11	19.68*	0.16	0.69	0.60
Ln Foreclosure	1.25	0.96	118.80*	1.11	1.85
Ln Unempl.	0.92	0.94	0.82	36.79*	1.76
Ln House Price	2.69*	1.12	1.06	1.10	13,216*
SEE	0.210	0.023	0.050	0.023	0.0025
Durbin-Watson	2.01	2.06	2.00	2.01	2.05

[a]Critical values for F test are 2.04 (95%) and 2.72 (99%).

*Statistically significant at the 98% level or higher.

The next set of results displays the impulse-response functions that are derived from the VAR model and show how each series in the model reacts dynamically to its own shocks and the shocks from other series. The five equations of the VAR model are of the form:

$$x_{it} = a + \sum_{k=1}^{m} \gamma_i B^k x_{it} + \sum_{j=1, j\neq i}^{5} \sum_{i=1}^{m} \delta_{ji} B^k x_{jt} + e_{it} \qquad (1)$$

where $m = 8$ and B is the lag operator defined such that $B^k x_{it} \equiv x_{i,t-k}$

Using the Cholesky decomposition, exact identification for a model with 5 variables requires diagonalizing the VAR error covariance matrix which allows calculation of a transformed VMA form of the model that expresses each of the five variables in the model as a function of their own and the other four variable shocks. Inspection of these impulse response functions provides insight into the dynamic patterns of the series. The estimated impulse-response functions can be sensitive to the ordering of the variables if there are contemporaneous relationships of the variables because of the necessary identifying restrictions. However, the results reported in this paper are not

sensitive to the ordering of the variables. See Enders (2004, pp. 274-277) for a more detailed discussion of identifying restrictions and ordering of variables. Figure 2 plots impulse response functions out to 20 months. Responses to positive shocks to lagged values of each variable are discussed in turn.

Figure 2

Impulse Response Functions log VAR(8) Model

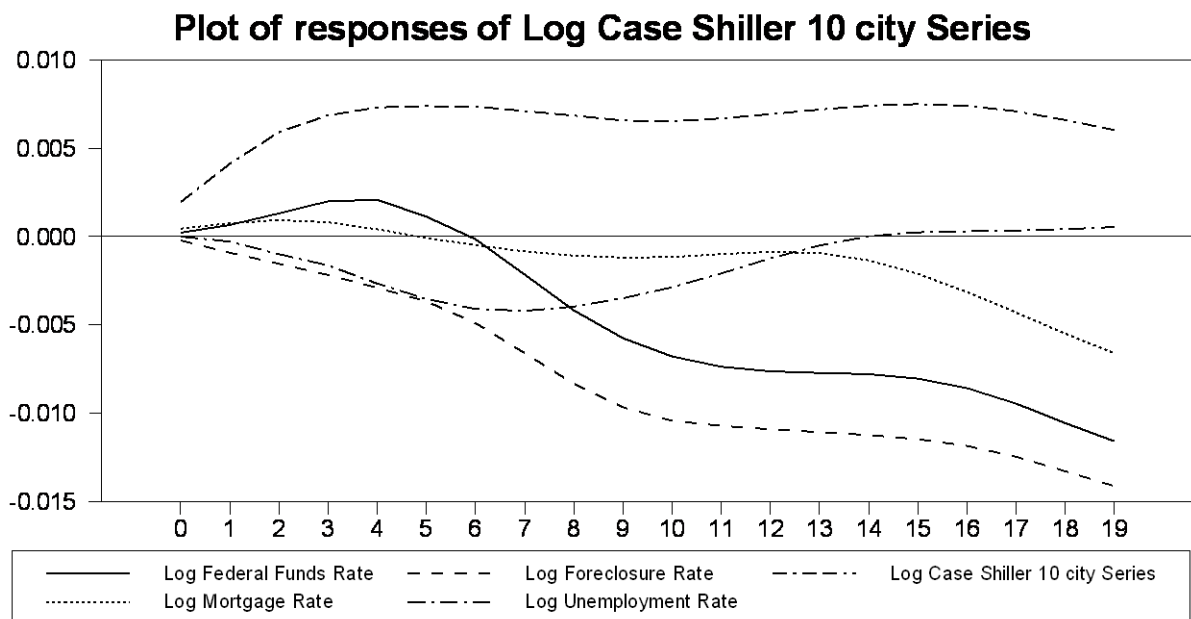*2 SD Bounds set by Monte Carlo Integration -*
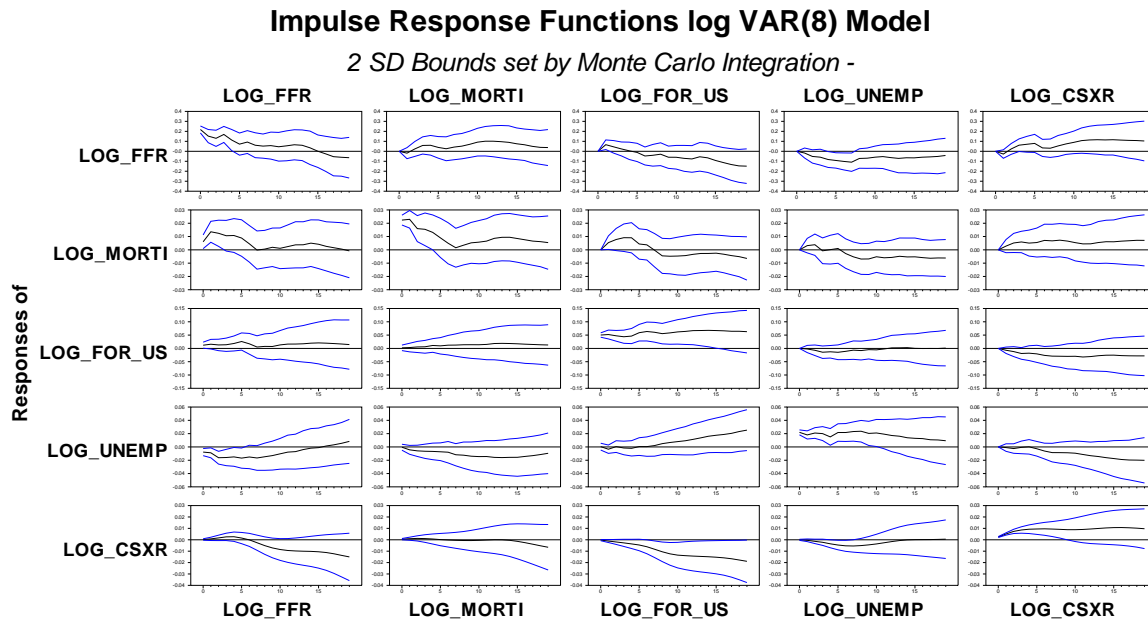
Shocks to the federal funds rate have statistically significant mappings that are negative effects on both the housing price index and the unemployment rate. The impact on the housing price index replicates the earlier findings in McDonald and Stokes (2011). The maximum effect of -0.01 occurs at 10 months. The negative effect on the unemployment rate in the first five months is not as expected, and suggests that reductions in the federal funds rate during 2001-2004 and beginning in 2007 were not effective at reducing the unemployment rate. Shocks to the mortgage interest rate have no effects on any of the other variables, given that these other variables are included in the model. This result indicates that the federal funds rate, rather than the mortgage interest rate, was the more influential interest rate during this time period.

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Shocks to the foreclosure rate have a negative effect on the house price index as expected. The effect increases throughout the 20 months that are charted. Shocks to the unemployment rate have a negative effect on the federal funds rate. Presumably this is a policy response to the unemployment rate, but as noted above, this policy was not effective. Shocks to the unemployment rate also have a negative effect on the house price index as expected. The recession as measured by the unemployment rate has a negative impact on the demand for owner-occupied housing. Lastly, shocks to the house price index have a positive impact on the federal funds rate (a policy response) and a negative impact on the foreclosure rate. Both effects are as expected. Note that shocks to the foreclosure rate caused housing prices to fall, and shocks to the housing price caused foreclosures to decrease. In other words, housing prices and foreclosure rates move in opposite directions, and their movements reinforce each other. As shown in Figure 1, housing prices began to fall in the summer of 2006 and the foreclosure rate already had increased as early as 2004, with the rapid increase that began in 2006. It is reasonable to conclude that the increases in the foreclosure rate and the declines in housing prices were reinforcing each other beginning in 2006.

An important question to answer is how much of the variance of a series can be explained by the shocks from its own past or shocks from the past of the other 4 series in the model. Variance decomposition of the log of the housing price series produced the following results. At low lags most of the variance is coming from its own past; e.g., at lag 5 it was 83.59%. However as the lags increase other variables come into play. For example, at lag 10, 8.13% is explained by the log of the Federal Funds Rate, 31.54 % is explained by the log of the foreclosure rate, 10.39% is explained by the log of the unemployment rate and 49.22% by the log of the housing series. By lag 20 these percentages were 22.86%, 46.19% , 2.81% and 24.83% respectively, as the effect of the unemployment declines and the log of the Federal Funds Rate and the log of the foreclosure rate increase in importance. Shocks to the log of the mortgage rate explain only 4.96% of the variance in the house price series at lag 1, and

less than 4% thereafter. While this decomposition is most informative it does not illustrate the sign or the relative magnitude of the effects. To measure this we turn to Figure 3 where the cumulative responses of the series are shown. The effect of the log of the federal funds rate turns negative after lag 6 and increases. The effect of the log of the foreclosure effect is always negative. The effect of the log of the unemployment rate is initially negative, peaking at lag 7. After that it fades out to zero at lag 14. These results confirm the variance decomposition results.

Figure 3

Plot of responses of Log Case Shiller 10 city Series

Legend: Log Federal Funds Rate; Log Foreclosure Rate; Log Case Shiller 10 city Series; Log Mortgage Rate; Log Unemployment Rate

V.   Conclusions

This paper has employed the VAR method to examine the relationships between the federal funds rate, the mortgage interest rate, housing prices, the foreclosure rate, and the unemployment rate for the U.S. from 2000 to 2010. The results include the following.

- The federal funds rate was a cause of the house price index movements, both up and down. This result confirms the earlier result in McDonald and Stokes (2011). Also, positive shocks to the federal funds rate were causally

prior to reductions in unemployment. This result is not as expected, but suggests that conventional monetary policy was not effective at reducing unemployment during the 2000-2010 decade.

- The foreclosure rate is a cause of the movements in the house price index as expected.
- The unemployment rate caused changes in the federal funds rate (presumably a policy response), and also caused movements in house prices as expected.
- The house price index was a cause of the federal funds rate (presumably another policy response), and a cause of the foreclosure rate.

The basic story that emerges from this investigation is that the very low federal funds rate during 2001-2004 was a cause of the rapid increase in housing prices up through 2006. Housing prices began to fall rapidly in the middle of 2006, perhaps in part as a result of the increase in the federal funds rate during the prior two years, and the foreclosure rate began its rapid increase at or before the time when housing prices began to fall. Once underway, these trends in foreclosures and housing prices reinforced each other. The economy moved into a deep recession, and the resulting large increase in the unemployment rate added to the decline in housing prices. As of August 2010 housing prices remained depressed, unemployment remained high, and the foreclosure rate showed no signs to declining. One policy conclusion is that the federal funds rate should not have been set as such low rates during 2001-2004. Another is that much more aggressive policy measures should have been taken to stop the foreclosures.

References

Doan, T. (2010) *Rats User's Manual: Version 8.0*, Estima, Evanston, IL.

Enders, W. (2004) *Applied Econometric Time Series*, 2nd ed., Wiley, New York.

McDonald, J. and Stokes, H. (2011) Monetary policy and the housing bubble, *Journal of Real Estate Finance and Economics*, published online: June 18, 2011.