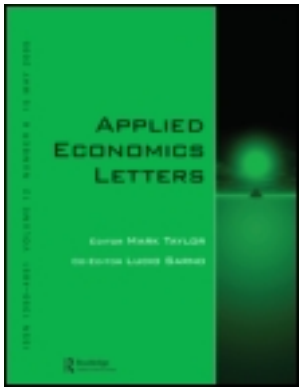

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The housing price bubble, the monetary policy and the foreclosure crisis in the US

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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 United States for the period of 2000(1)–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 the housing prices shows that an initial shock to the foreclosure rate produced further increases in the foreclosure rate through a reduction in housing prices.

Keywords: housing bubble; foreclosures; monetary policy; VAR model

JEL Classification: E32; E50

I. Introduction

It is generally agreed that the bursting of the housing price bubble led to a high increase in the foreclosure rate and severe financial crisis and deep recession in the United States. A great deal of research is being devoted to understand the underlying causes of the very high increase in the housing prices during the period 2000–2006 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 2001–2004 and then sharply increased this rate during 2004–2006. 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 high increase in the unemployment rate that may have resulted in more foreclosures and housing price declines. The purpose of this article is to examine these questions by estimating a time-series model using monthly data for the critical period of 2000–2010.

II. Expected Causes and Consequences

McDonald and Stokes (2013) present the 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 the 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

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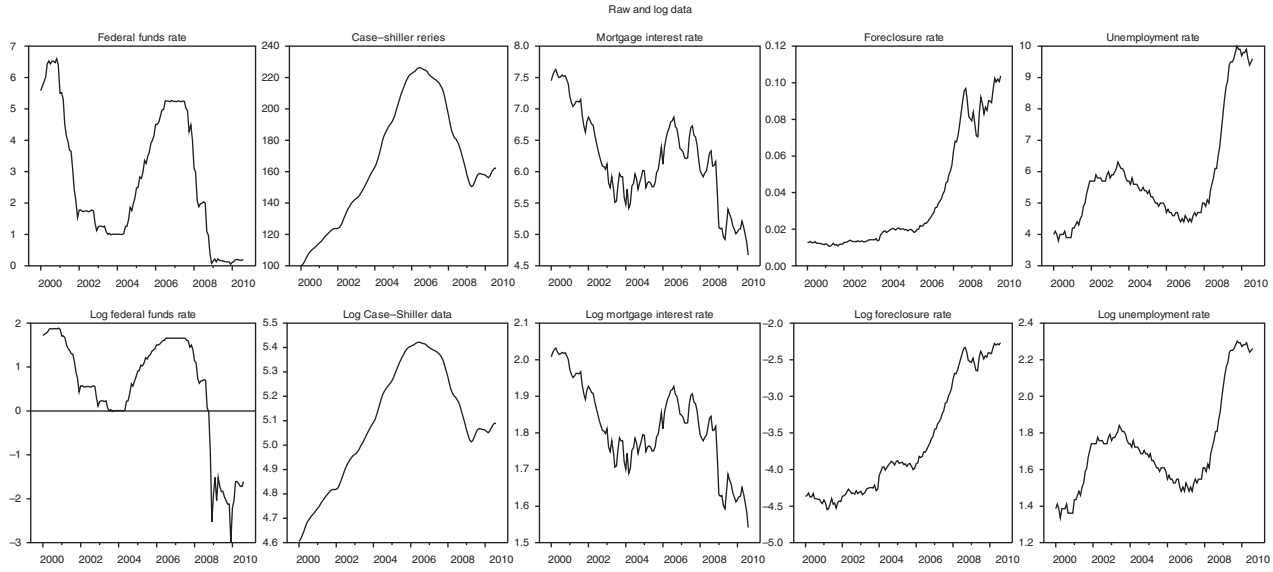

Fig. 1. Fed funds, C_S index, mortgage rate, foreclosure rate, unemp

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 10 major metropolitan areas, the interest rate on standard 30-year home mortgages, the unemployment rate and the foreclosure rate series provided by Zillow. All the 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 2 months for the percentage of all homes foreclosed 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 Fig. 1, and means and SDs are shown in Table 1.

Table 1. Variables, means and SDs

	Mean	SD
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 are 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

Table 2. One-way Granger causality tests: *F*-statistics[a]

Lagged values of these variables	ln fed funds rate	ln mortgage rate	ln foreclosure rate	ln unemployment 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 unemployment	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

Notes: [a]Critical values for *F*-test are 2.04 (95%) and 2.72 (99%).
*Statistically significant at the 98% level or higher.

inverting the VAR model are reported next, and the existence of feedback effects is confirmed. See Enders (2004, pp. 264–80) 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. Table 2 contains the *F*-tests that result from the exclusion of eight lagged values of the variables listed in 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 are statistically significant. Table 2 also reports the SE 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.

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

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

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 five 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 an 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 between the variables because of the necessary identifying restrictions. However, the results reported in this article are not sensitive to the ordering of the variables. See Enders (2004, pp. 274–7) for a more detailed discussion on identifying restrictions and ordering of variables. Figure 2 plots impulse-response functions for the period of 20 months. Responses to positive shocks to lagged values of each variable are discussed in turn.

Shocks to the federal funds rate have statistically significant mappings that have 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 (2013). The maximum effect of –0.01 occurs at 10 months. The negative effect on the unemployment rate in the first 5 months is not as expected and suggests that reductions in the federal funds rate during 2001–2004 and in the beginning of 2007 were not effective in 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.

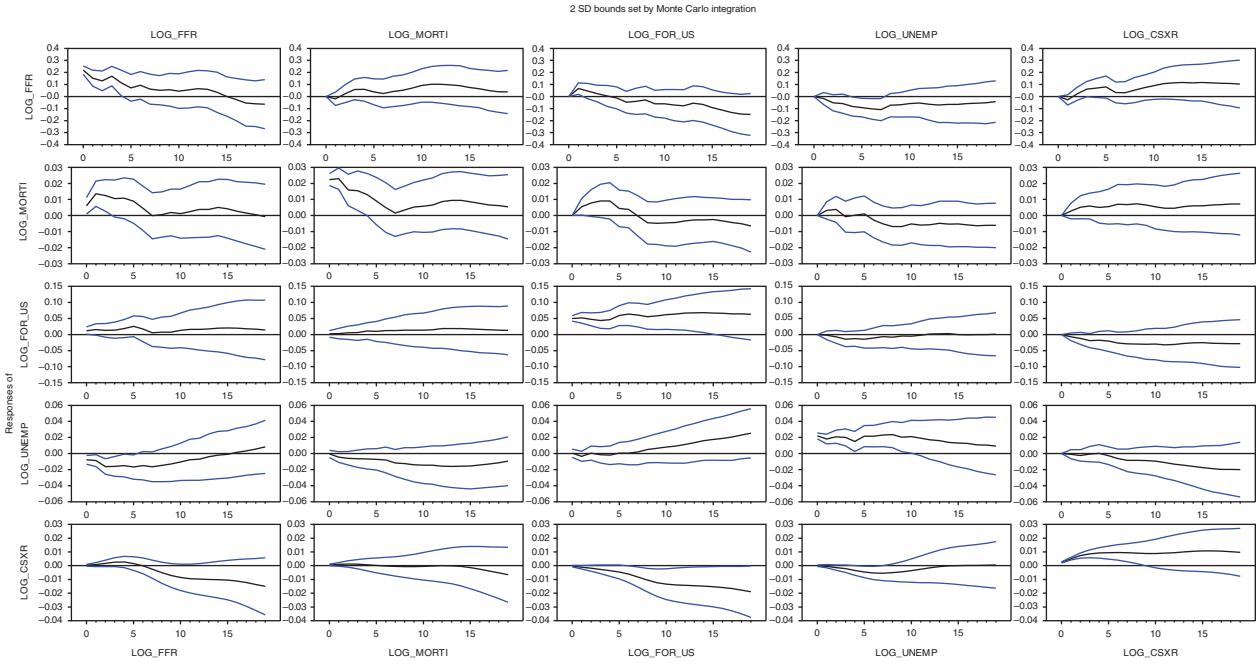

Fig. 2. Impulse response functions log VAR(8) model

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. Finally, 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 the 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 Fig. 1, housing prices began to fall in the summer of 2006 and the foreclosure rate had already increased in 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 in the beginning of 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 four 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 Fig. 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.

V. Conclusions

This article has employed the VAR method to examine the relationships among the federal funds rate, the

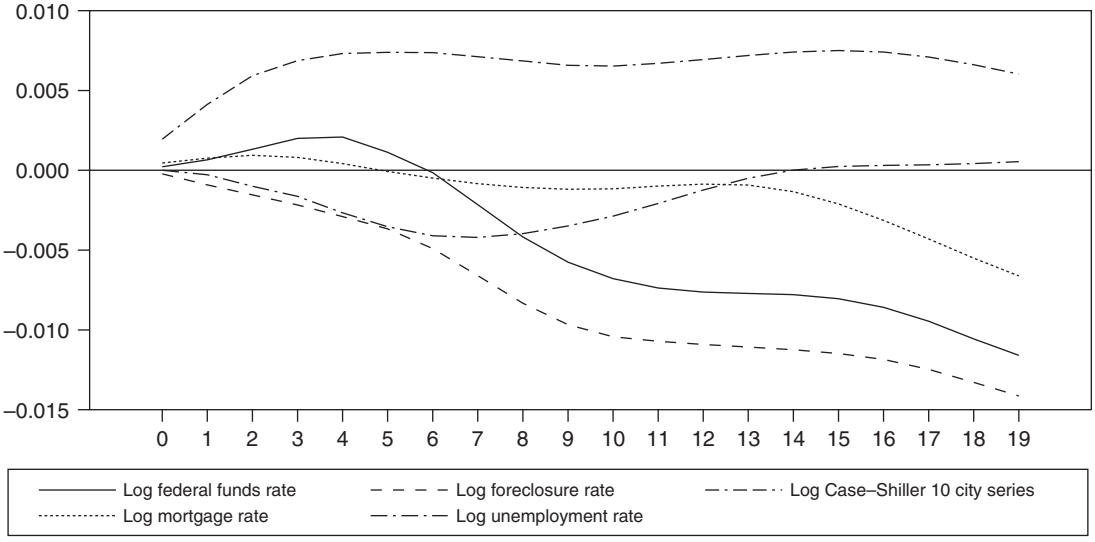

Fig. 3. Plot of responses of log Case-Shiller 10 city series

mortgage interest rate, housing prices, the foreclosure rate and the unemployment rate for the United States from 2000–2010. 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 (2013). Also, positive shocks to the federal funds rate were caused prior to reductions in unemployment. This result is not as expected, but suggests that conventional monetary policy was not effective at reducing unemployment during 2000–2010.
- 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 the 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 very low federal funds rate during 2001–2004 was a cause of the rapid increase in housing prices throughout 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 previous 2 years, and the foreclosure rate began to increase rapidly 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. In August 2010, housing prices remained depressed, unemployment remained high and the foreclosure rate showed no signs of 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.

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