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The Taylor Rule and House Price Uncertainty

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Abstract: The aim of this paper is to determine whether house price uncertainty has been an important determinant of the Taylor rule based interest rate during the years leading up to the financial crisis. A GARCH based specification has been used to produce a time-varying measure of volatility, the results indicate that it has had a significant negative effect on the interest rate, but that its addition only produces a slightly better fit to the actual interest rate.

Keywords: house prices, uncertainty, interest rates, Taylor rule

J.E.L. E43, R30.

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1 Introduction

The aim of this study is to determine the effect of house price uncertainty on monetary policy using a Taylor rule approach[1] and a measure of volatility to proxy uncertainty. In the light of the recent financial crisis there has been much debate on whether asset prices should have been considered more formally when determining the appropriate monetary policy. Theorists have not currently reached agreement on whether the central bank should specifically react to the movement in asset prices, Bernanke and Gertler (1999) suggests that this is because the central bank cannot make a distinction between asset price bubbles and normal movements.

Goodhart and Hoffman (2001) have also suggested reasons for asset prices playing an important role in monetary policy. First, asset prices and volatility can be affected by the future expected returns, which relate to the expected economic conditions, inflation and monetary policy. Even if asset prices have little effect on aggregate demand, they contain useful information for current and future economic conditions, so monetary policy makers should not ignore the information reflected by the asset prices. Second, persistent asset price volatility will result in financial instability, as suggested by the financial crisis. Therefore, if the central bank wants to retain economic stability, asset price stability should be considered as an objective

A number of studies have highlighted the importance of asset prices in general and house prices in particular as determinants of monetary policy, such as Filardo (2000), who indicated that house price inflation helps predict future consumer price inflation.

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[1] For an extensive review of the Taylor rule approach to determining interest rates see Clarida *et al.* (1999).

Whilst Smets (1997) derived an optimal monetary policy rule, which included stock prices under the assumption that the stock market can affect aggregate demand. From the empirical perspective, there is evidence that central banks have reacted to asset prices volatility when deciding on monetary policy such as Semmler and Zhang (2007), who found that the central bank reacted to stock price volatility in order to stabilize the economy. Most of this literature has assessed assets assuming an absence of uncertainty, the contribution of this study is to determine whether the uncertainty surrounding housing assets, as proxied by their price volatility can affect the interest rate.

After the introduction, there is a discussion of the theoretical approach, followed by the estimation of the empirical model. Finally we draw conclusions and the policy implications are discussed.

2. Empirical Model

The variables used in the empirical analysis are inflation based on the consumer price index (cpi), the output gap, volatility of house prices and federal funds rate, where all the data is monthly. Instead of GDP we have used industrial production, as there is no monthly data for GDP. This is similar to the approach used by Clarida *et al.* (1998). The interest rate, CPI and Industrial Production Index are taken from the database of the Federal Reserve, whilst the house price data is the Standard and Poor's Case-Shiller house price index. To generate the output gap, we have used the Hodrick Prescott (HP) filter to produce the output trend, the output gap is the difference between the output and its output trend. We measure the volatility of house prices by using the exponential generalized autoregressive conditional heteroskedastistic (EGARCH) model, developed by Nelson (1991), as follows:

$$\Delta lhp_t = \phi + u_t \tag{1}$$

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - c \right] \tag{2}$$

Where *lhp* are a logged house price index, ϕ is a constant, *u* denotes the residual, σ^2 is the conditional variance and *c* is a constant. In addition Bollerslev-Wooldridge standard errors are employed in this model, which are robust to non-normality. Miles (2009) uses a similar measure to represent house price uncertainty when determining housing investment. The model is estimated from 1987M01 to 2007M01, ending just before the beginning of the financial crisis. The descriptive statistics for the data are shown in Table 1.

The model is estimated using the Generalised Method of Moments (GMM). The instruments include 12 lags for inflation, volatility of house prices, and output gap, which follows the Clarida *et al*. (1998) approach. The version of the Taylor rule model used in this study[2] is as follows:

$$i_t = \bar{a} + \beta_\pi \pi_{t+1} + \beta_y y_{t+1} + \beta_\sigma \sigma^2{}_t + v_t \tag{3}$$

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[2] An alternative version of the Taylor rule involves including a lagged interest rate as a further explanatory variable, but this produced a similar result in terms of the house price volatility variable.

Where i denotes the nominal federal reserve rate, π is the inflation rate, and y is the output gap. σ^2 is the volatility of the house price returns. v is the residual. $\beta_\pi, \beta_y, \beta_\sigma$ denotes the response of monetary policy to inflation, output gap, and the volatility of the housing market respectively. This model also shows a forward-looking behaviour for the central bank because expectations for the future plays an important role when setting the policy rate as suggested by Fuhrer(1997). We assume the first two standard parameters are positive as in Taylor (1993).We also assume the policy rate reacts to the house price uncertainty negatively, as the central banks usually try to boost the economy by easing monetary policy and increasing the supply of credit to the market in the event of economic uncertainty. Therefore, if there is asset price volatility and it is likely to increase in the future, the central bank will stimulate the economy by decreasing the policy rate

3. Results and Discussion

Table 2 contains the results of the EGARCH model, with all parameter estimates being significant and as expected the asymmetric term suggesting a negative shock produces greater volatility than a positive shock. To test whether there are any remaining ARCH effects in the EGARCH model, we carried out the Lagrange multiplier test to determine whether the standardized residuals exhibit additional ARCH. The results suggest that the null of no remaining ARCH is accepted, so there is no ARCH left in the standardized residuals

For the augmented model, the coefficient on inflation is 1.24, which is consistent with the Taylor principle and implies that including house price volatility in the Taylor rule, suggests central banks have a stronger reaction to inflation. The response of the interest rate to the output gap is 0.49 and significant, with little difference to that in the first model. The coefficient on house price volatility is -0.96 and significant, which means that if the volatility in the housing market increases, central banks will ease monetary policy. The intuition behind this finding is that the more volatile house prices are, the more uncertainty there will be in the market. In a more uncertain environment, there is less incentive to invest. With less investment and less liquidity, the aggregate demand will be adversely affected, motivating Central banks to react by decreasing the policy rate. This will encourage investors to invest and it will also inject more liquidity into the market. As Clarida et al. (1999) have said, monetary policy is an art more than a science, which appears to be supported by these results, as the conventional Taylors rule has not been the only factor affecting the Federal reserves decision making.

By comparing the augmented model with the standard model, it is apparent the reaction of the interest rate to inflation is larger with house price volatility included than that in the first Model, implying that the volatility of house prices may also create a threat to inflation and therefore the central bank reacts more strongly in order to control it. Secondly, compared with the benchmark model, the standard errors in the augmented Taylor rule, which reacts to the house price volatility are reduced, which suggests that the augmented Taylor rule outperforms the benchmark model.

Finally, Figures 3 and 4 provide a comparison between the actual value and the fitted value for both models. For Figure 3, which is based on the traditional Taylor rule, the fitted values are a good approximation with the actual rate fitting very well from 1990 to 1992 and from 2000 to 2002, which coincide with the recession periods for the US. After 2002, compared with the fitted value, the actual value is lower by about 2% and monetary policy is relatively loose. Figure 4 is the difference between the actual rate and fitted value for the augmented model and the difference between the two values is smaller than the previous conventional model, suggesting overall a better fit to the data.

4. Conclusion

This study provides evidence that house price volatility has had a significantly negative effect on interest rates over the last twenty years, indicating the Federal Reserve has considered asset price uncertainty when deciding on interest rate policy. The augmented Taylor rule also shows a better goodness of fit than that shown by the traditional Taylor rule, although both rules show that monetary policy after 2002 is too loose. However even when considering asset price volatility, as noted by Taylor the interest rates were arguably too low between 2002 and 2005 leading up to the financial crisis. Although the Federal Reserve seems to have considered house price volatility when determining interest rates, in the future they may want to consider including a more formal measure of it in their Taylor rule.

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Figure 1. Federal Fund Interest rate.

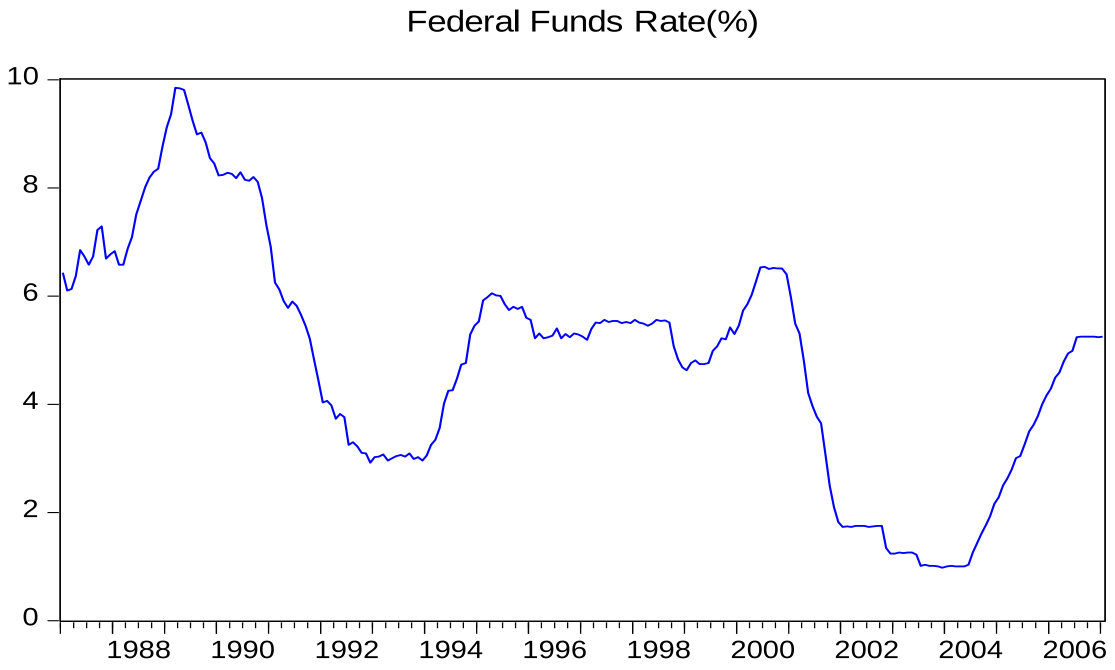

Figure 2. House Price Volatility (EGARCH model)

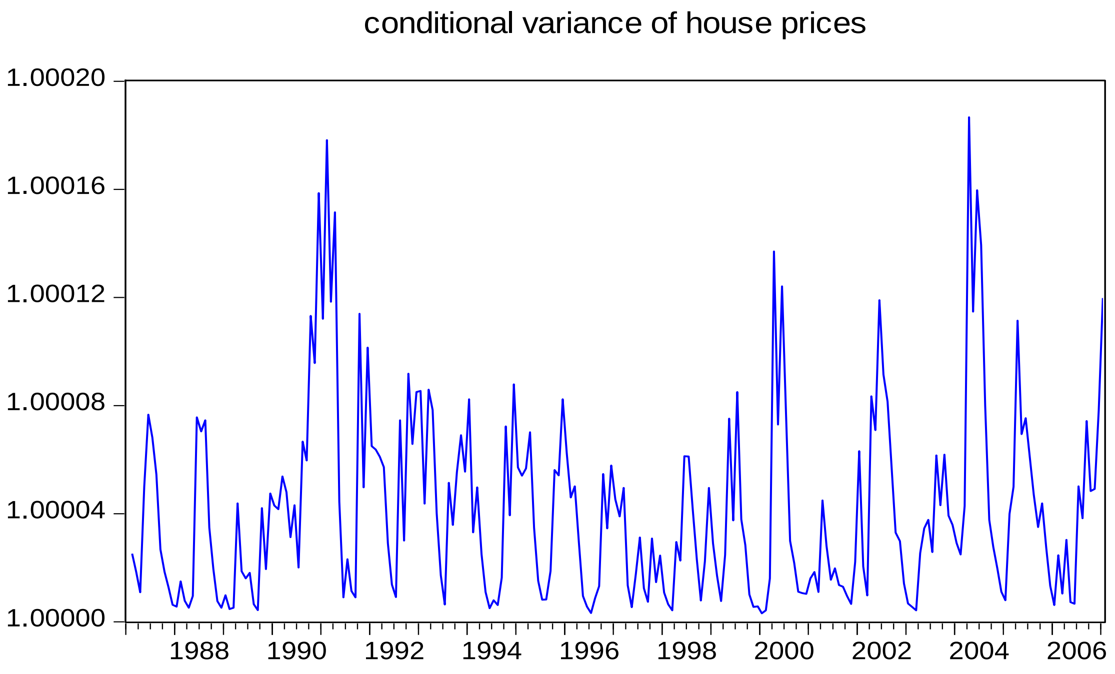

Figure 3. Actual and Fitted values for Standard Taylor Rule

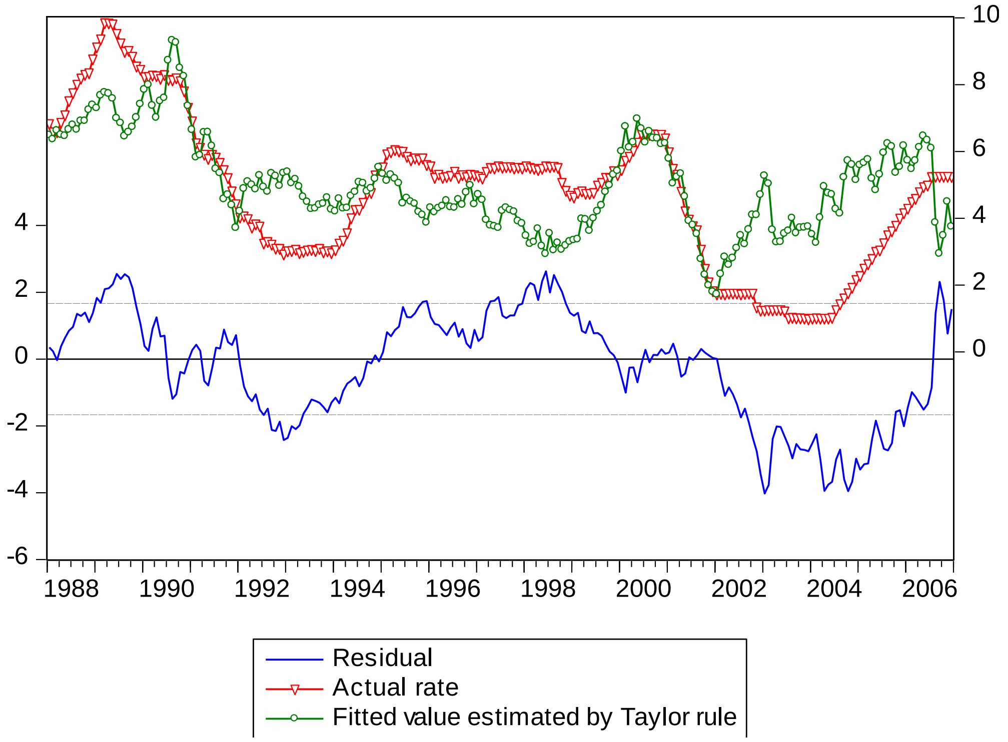

Figure 4. Actual and Fitted values for Augmented Taylor Rule

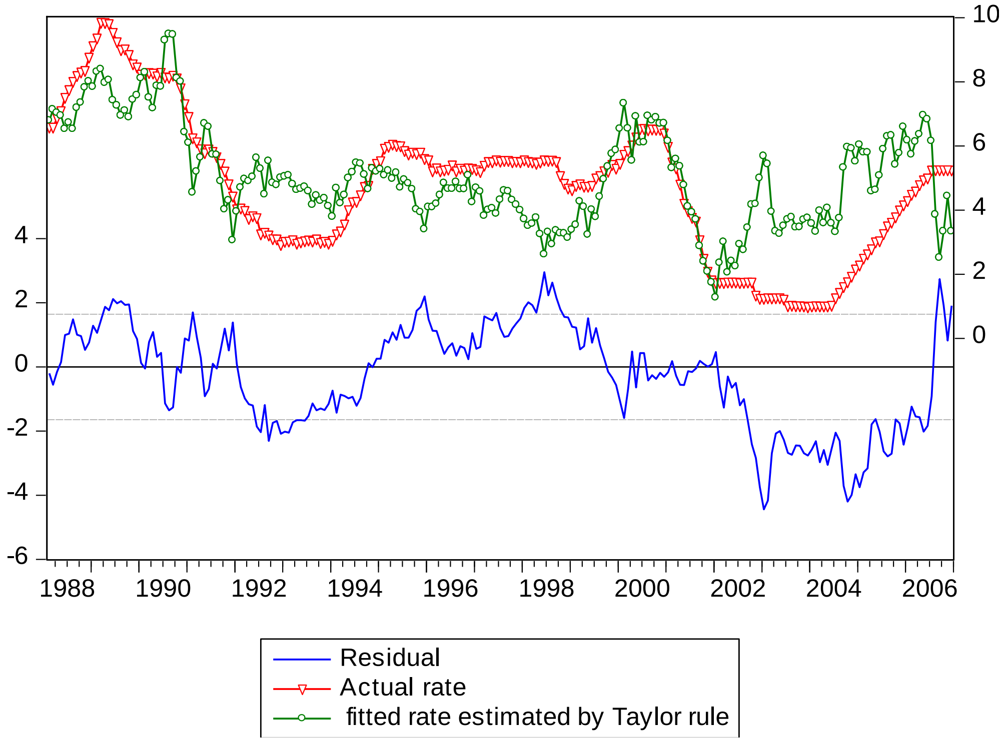

Table 1. Descriptive statistics

	Conditional variance of house price returns	**Inflation rate (%)**	**Federal funds rate (%)**	**Output gap**
Mean	1.000042	3.097233	4.861958	-0.002118
Median	1.000033	2.973670	5.240000	0.069008
Maximum	1.000187	6.379590	9.850000	2.676128
Minimum	1.000003	1.069220	0.980000	-3.056078
Std. Dev.	3.54E-05	1.084628	2.179838	1.061654
Skewness	1.412684	0.601562	0.017000	-0.134456
Kurtosis	5.240830	3.118204	2.477379	3.344331
Probability	0.000000	0.000671	0.253741	0.385047
Sum	240.0100	743.3359	1166.870	-0.508275
Sum Sq. Dev.	2.99E-07	281.1638	1135.655	269.3792
Observations	240	240	240	240

Table 2. EGARCH results for the House Price Uncertainty

Parameters	Coefficient	Prob.
c	0.078* (0.0001)	0.0001
ω	-3.554* (0.3480)	0.0000
β	2.877* (0.1473)	0.0000
γ	-0.064* (0.0115)	0.0000
α	0.881* (0.0461)	0.0000
LM test for remaining ARCH effect	20.284	

Notes: A * (**) indicates significance at the 1% (5%) levels. The remaining ARCH test has a chi-squared (12) critical value of 21.026. Model estimated using Bollerslev-Wooldridge standard errors.

Table 3 Results for the traditional Taylor rule and augmented Taylor rule.

$$i_t = \bar{a} + \beta_\pi \pi_{t+1} + \beta_y y_{t+1} + v_t \quad \text{(model 1)}$$

$$i_t = \bar{a} + \beta_\pi \pi_{t+1} + \beta_y y_{t+1} + \beta_\sigma \sigma^2_{\ t} + v_t \ \text{(model 2)}$$

Coefficients	**Model 1**	**Model 2**
β_π	1.154* [6.55]	1.241* [8.44]
β_y	0.443* [3.44]	0.496* [4.67]
β_σ	-	-0.96** [-2.22]
J-statistic	16.023	20.286

Notes: t-statistics in parentheses, *(**) indicates significance at the 1% (5%) level.

HAC standard errors have been employed in the estimates.