Monetary Policy in Times of Financial Stress

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Abstract

Some studies argue that the Fed reacts to financial market developments. Using data covering the period 1985:Q1 - 2008:Q4 and employing an augmented Taylor rule specification, we re-examine that conjecture. We find that evidence in favour of such a reaction is largely driven by the Fed's behaviour during the 2007-2008 financial crisis.

Keywords: Monetary Policy; Taylor Rule; Financial Crisis.

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1. Introduction

The 2007-2008 crisis was of a greater order of magnitude as compared to previous recent episodes of financial distress. It led to nominal rates that reached the zero lower bound in December 2008 and the adoption of non-conventional monetary policies (e.g. large scale asset purchases) aiming, at least initially, to stabilise financial markets. Moreover, it has rekindled the academic debate of the late 1990s on whether the appropriate response of monetary policy to financial developments is proactive (Cecchetti et al. 2000) or reactive (Bernanke and Gertler, 1999).

In a recent theoretical paper, Curdia and Woodford (2010) argue that the standard Taylor rule can be improved by incorporating credit risk measures but the optimal size of adjustment depends on the source of the variation in credit spreads. As an empirical matter, there is evidence for changes in the Fed's stance during the Greenspan era in times of heightened financial and economic uncertainty (Alcidi et al., 2011; Gnabo and Moccero, 2013). Consistent with that evidence, studies covering the recent crisis period find that monetary policy focus shifted from price stabilisation towards financial stability (Baxa et al., 2013; Martin and Milas, 2013).

This paper contributes to the existing literature by providing a comprehensive examination of the Fed's response to financial market developments. We not only consider the possibility of an indirect reaction and that of a direct reaction, but also test whether the response is asymmetric, varying across the business cycle. Furthermore, we isolate the impact of the 2007-2008 crisis in an effort to examine how important it is for the overall findings. Finally, we consider four alternative dimensions of financial markets stress, related to credit risk, stock market illiquidity, whether markets are generally depressed (bear markets) and overall deterioration in financial conditions. Our bottom line is that evidence that the Fed has in the past reacted to financial market developments is largely driven by the Fed's behaviour during the 2007-2008 financial crisis.

2. Methodology

Following Clarida et al. (2000), the empirical analysis in this paper is based on a forward-looking Taylor rule. Future inflation is proxied by a survey-based measure of one-year-ahead inflation forecast, allowing us to employ OLS estimation instead of GMM with ex post inflation data (Nikolsko-Rzhevskyy, 2011).

In order to examine whether the Fed reacts *directly* to financial market developments, the standard Taylor rule regression model is augmented by financial factors:

$$i_t = \left(1-\sum_{j=1}^{n}\rho_j\right)\left(\alpha+\beta\pi_{t+4}+\gamma\hat{y}_t+\mu x_t\right)+\sum_{j=1}^{n}\rho_j i_{t-j}+\varepsilon_t \qquad (1)$$

where i_t is the short term interest rate, ρ denotes the degree of policy inertia, π_{t+k} is the expected inflation rate *k* periods ahead, $\hat{y}_t$ represents the contemporaneous output gap, x_t is a financial market variable, and ε_t is the error term.[1]

It is well-known that deteriorating financial conditions tend to coincide with weak economic performance. Hence, if the Fed reacts *asymmetrically* to financial market developments, in line with the "Greenspan-Bernanke put" conjecture, its response should vary across the business cycle, being stronger during recessions. Eq. (2) tests the asymmetric reaction hypothesis:

$$i_t = \left(1-\sum_{j=1}^{n}\rho_j\right)\left(\alpha+\beta\pi_{t+4}+\gamma\hat{y}_t+\mu^R D^R x_t+\mu^{NR}\left(1-D^R\right)x_t\right)+\sum_{j=1}^{n}\rho_j i_{t-j}+\varepsilon_t \qquad (2)$$

where D^R is a dummy variable that takes the value of 1 to indicate US recessions as classified by the NBER and zero otherwise. μ^R and μ^{NR} are the reaction parameters to the financial variable during recessions and expansions, respectively.

We also investigate the possibility of the Fed reacting *indirectly* to financial market developments by changing its response to inflation and the output gap during periods of high vs. low financial stress. To do so, we construct four financial stress dummy variables, as described in Section 3 below, and estimate Eq. (3):

$$i_t = \left(1-\sum_{j=1}^{n}\rho_j\right)\left(\alpha+\beta^D D^X\pi_{t+4}+\beta^{ND}\left(1-D^X\right)\pi_{t+4}+\gamma^D D^X\hat{y}_t+\gamma^{ND}\left(1-D^X\right)\hat{y}_t\right)+\sum_{j=1}^{n}\rho_j i_{t-j}+\varepsilon_t \qquad (3)$$

where D^X is a dummy that takes value 1 if financial market stress is intense and zero otherwise. The reaction coefficients to inflation and the output gap during intense financial stress are denoted by β^D and γ^D, respectively.

Finally, we isolate the impact of the recent recession/financial crisis on the Fed's direct and indirect response to financial market developments by re-estimating Eqs. (2) and (3) and replacing the recession and financial stress dummies with the dummy variable $D^{07\text{-}08}$ that takes the value of 1 only during 2007:Q4 - 2008:Q4.

[1] With our quarterly data, *n* is set to 2 to account for serial correlation, while *k* is equal to 4.

3. Data

We use quarterly data over the sample period 1985:Q1 - 2008:Q4. The end of the sample period corresponds to the point in time when the zero lower bound was reached. The data on the effective Federal Reserve funds rate (i_t), real GDP (y_t), the spread between the Moody's Baa corporate bond yield and Aaa corporate bond yield (*CSPR*), and the year-on-year percentage change in the S&P 500 stock price index (*SP500*) is collected from the FRED database. In addition, we use the Citi Financial Conditions Index (*FCI*) and the aggregate stock market illiquidity index (*LIQ*)[2]. The measure of expectations for one-year-ahead annual average inflation is provided by the Survey of Professional Forecasters.

To construct financial market stress variables, we use the historical data on each financial variable and set threshold values that capture elevated stress levels. The first dummy D^{FCI} takes value 1 when the Citi FCI is below its historical average. Similarly, the credit spread dummy D^{CSRP} takes value 1 when the credit spread is above its historical average. The stock market stress is represented by the dummy D^{SP500} that takes value 1 when the S&P500 index is below its 2-year moving average. Finally, D^{LIQ} identifies financial stress when the aggregate stock market liquidity index is below its historical average less one standard deviation.

Figure 1 plots the dummies and related financial variables. The past episodes of financial stress such as the stock market crash in 1987 are captured quite well. In addition, periods of heightened financial instability tend to coincide with US recessions. The stock market and credit spread stress dummies capture all three recessionary episodes, while the last recession that commenced on December 2007 was associated with elevated levels in all our measures of financial stress.

4. Results

4.1 Direct reaction

Table 1 reports the estimates of Eqs. (1) and (2) during 1985:Q1 – 2008:Q4. The results indicate that the "Taylor principle" holds across the augmented Taylor rule specifications, with the inflation coefficient estimates exceeding unity. Both the inflation and the output gap coefficients are highly significant. Moreover, all four financial variable coefficients in columns 1-4 of Table 1 are statistically significant with their signs indicating that the Fed eases monetary policy when financial markets deteriorate.

[2] The Citi FCI is available at: http://www.princeton.edu/~mwatson/publi.html. The aggregate stock market liquidity index is available at: http://faculty.chicagobooth.edu/lubos.pastor/research/liq_data_1962_2011.txt

The empirical findings reported in columns 5-8 of Table 1 indicate that this direct response to financial markets is also asymmetric. Specifically, the Fed appears to respond more robustly to financial variables during recessions. On the other hand, the response coefficients are significantly smaller in magnitude and statistically insignificant during expansions. Furthermore, the standard errors of the regressions decrease as compared to the previous symmetric specifications.

4.2 Indirect reaction

The estimates of Eq. (3) are presented in Table 2 columns 1 to 4. The results indicate a moderate change in the response to inflation during periods of financial stress. In particular, the inflation coefficient declines mildly but remains statistically significant in all specifications apart from the case of the stock market liquidity stress dummy. Meanwhile, the Fed's reaction to the output gap typically becomes insignificant when financial stress peaks but the Wald test does not indicate any significant change. Hence, overall, our findings do not provide strong evidence in favour of a sharp change in the Fed's response to inflation and output developments in times of financial stress.

4.3 2007-2008 financial crisis

The inclusion of earlier episodes of financial stress that were not as severe as the most recent one may attenuate the effect of the 2007-2008 crisis on our previous estimates of the indirect monetary policy reaction to financial variables. Replacing the financial stress dummies with the $D^{07\text{-}08}$ variable that captures only the most recent crisis, the results in Table 2 column 5 indicate a major change in the monetary policy response to inflation. Specifically, the inflation parameter decreases substantially, turning negative and statistically insignificant during the 2007-2008 crisis, with the Wald test identifying significant structural change. [3] On the other hand, the response to output remains highly significant over 2007-2008 and appears to increase in magnitude, albeit not sufficiently for the Wald test to identify a significant shift.

Finally, the results in Table 3 indicate that constraining the recession dummy variable to be equal to 1 only during the latest recession/crisis, as $D^{07\text{-}08}$ does, leads to similar findings with those in Table 1 (columns 5-8). Specifically, during the recent crisis all four financial market variables are significant at the 5% level or less. On the other hand, prior to 2007:Q4 only the Citi FCI is significant and exhibits a notably lower coefficient. Thus, the evidence

[3] This is in line with recent evidence by Baxa et al. (2013) for the US and Martin and Milas (2013) for the UK.

for a direct response of monetary policy to financial markets that we previously identified is largely driven by recent developments.

5. Robustness checks

Our results are robust to a series of robustness tests (available upon request). First, we used the Chicago National FCI, the spread between Moody's Baa corporate bond and 10-year US Treasury yields, and spread between 3-month LIBOR and US Treasury bill rates as alternative financial market variables. Second, we used real-time data on GDP to calculate the output gap. Finally, we used a GMM estimation approach instead of OLS.

6. Conclusions

Using an augmented Taylor rule empirical framework, this paper examines whether the Fed responds to financial market developments. We find that evidence in favour of such a reaction is largely driven by the Fed's behaviour during the 2007-2008 financial crisis. These findings highlight the exceptional character of the recent episode of financial turmoil.

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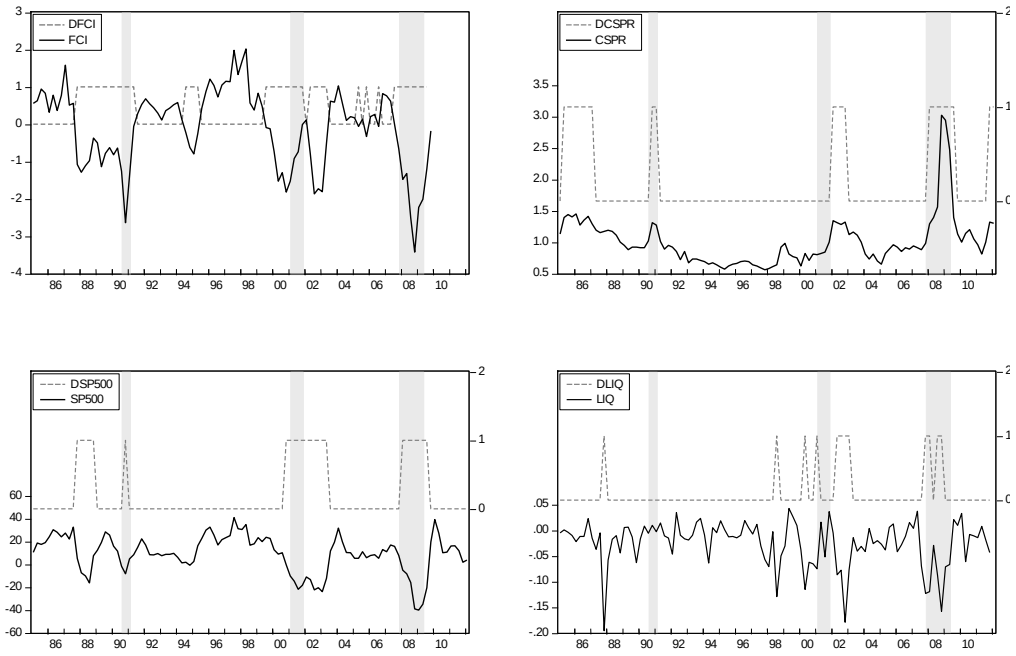
Figure 1: Financial market variables and financial stress dummies



Notes: This figure plots four financial market variables, *X*, along with the corresponding dummies, *DX*, that identify periods of intense financial stress; *X*: City financial conditions index (*FCI*), Baa – Aaa corporate spread (*CSPR*), annual stock returns (*SP500*), and stock market illiquidity (*LIQ*). The shaded areas denote recessionary periods in the US based on the NBER business cycle dates.

Table 1: Direct reaction to financial market developments

	FCI (1)	*CSPR* (2)	*SP500* (3)	*LIQ* (4)	*FCI* (5)	*CSPR* (6)	*SP500* (7)	*LIQ* (8)
α	-1.32 *(1.04)*	1.61 ***(1.38)***	-1.25 *(0.98)*	-0.18 *(1.13)*	-0.79 *(0.99)*	0.25 *(1.01)*	-0.33 *(1.04)*	0.06 *(1.06)*
ρ_1	1.44*** *(0.09)*	1.35*** ***(0.09)***	1.40*** *(0.10)*	1.47*** *(0.09)*	1.38*** *(0.08)*	1.32*** *(0.07)*	1.38*** *(0.09)*	1.39*** *(0.10)*
ρ_2	-0.57*** *(0.08)*	-0.48*** ***(0.08)***	-0.54*** *(0.09)*	-0.58*** *(0.08)*	-0.50*** *(0.07)*	-0.44*** *(0.06)*	-0.50*** *(0.08)*	-0.51*** *(0.08)*
β	2.17*** *(0.37)*	2.34*** ***(0.44)***	1.96*** *(0.34)*	1.90*** *(0.41)*	2.10*** *(0.38)*	1.98*** *(0.33)*	1.84*** *(0.38)*	1.75*** *(0.37)*
γ	1.07*** *(0.34)*	0.91** ***(0.44)***	0.84*** *(0.31)*	1.04*** *(0.37)*	1.03*** *(0.29)*	1.03*** *(0.25)*	0.87** *(0.37)*	1.21*** *(0.27)*
μ	1.03** *(0.40)*	-3.67*** ***(1.21)***	0.05** *(0.02)*	0.19* *(0.11)*	-	-	-	-
μ^{NR}	-	-	-	-	0.19 *(0.25)*	-0.68 *(0.83)*	0.01 *(0.02)*	0.03 *(0.05)*
μ^{R}	-	-	-	-	2.60** (1.06)	-4.34*** *(1.09)*	0.24** *(0.10)*	0.52*** *(0.18)*
SE	0.34	0.33	0.35	0.35	0.31	0.29	0.33	0.32
$\mu^{NR} = \mu^{R}$	-	-	-	-	0.03	0.00	0.06	0.00

Notes: This Table reports OLS estimates of Eq. (1), Columns 1-4, and Eq. (2), Columns 5-8, over the period 1985:Q1 – 2008:Q4. The last row shows Wald test *p*-values of the null hypothesis that $\mu^{NR} = \mu^{R}$ in Eq. (2). Standard errors in parentheses: White (in *italic*) in the presence of heteroskedasticity; Newey-West (in ***bold italic***) in the presence of heteroskedasticity and serial correlelation. *SE* denotes the standard error of the regression. *, **, *** indicate statistical significance at 10%, 5% and 1% level respectively.

Table 2: Indirect reaction to financial market developments

	D^{FCI} (1)	D^{CSPR} (2)	D^{SP500} (3)	D^{LIQ} (4)	D^{07-08} (5)
α	-1.65 (1.24)	-1.64 ***(1.62)***	-1.26 (1.15)	-0.48 (1.17)	0.06 *(0.76)*
ρ_1	1.49*** (0.08)	1.43*** ***(0.08)***	1.45*** (0.08)	1.46*** (0.08)	1.29*** *(0.08)*
ρ_2	-0.60*** (0.07)	-0.53*** ***(0.07)***	-0.56*** (0.07)	-0.57*** (0.07)	-0.45*** *(0.07)*
β^{ND}	2.49*** (0.48)	2.38*** ***(0.59)***	2.22*** (0.40)	1.93*** (0.40)	1.73*** *(0.28)*
γ^{ND}	1.25** (0.59)	0.97** ***(0.44)***	1.03*** (0.39)	1.02*** (0.39)	1.26*** *(0.23)*
β^{D}	2.00*** (0.42)	1.69*** ***(0.56)***	1.72*** (0.46)	0.95 (0.69)	-1.41 *(1.02)*
γ^{D}	1.09** (0.44)	1.05 ***(1.22)***	0.75 (0.59)	1.02 (0.62)	1.99*** *(0.62)*
SE	0.36	0.35	0.35	0.35	0.31
$\beta^{ND} = \beta^{D}$	0.09	0.17	0.09	0.05	0.00
$\gamma^{ND} = \gamma^{D}$	0.83	0.94	0.70	0.99	0.26

Notes: This table (Columns 1-4) reports OLS estimates of Eq. (3) over the period 1985:Q1 – 2008:Q4. Column 5 shows estimates of Eq. (3) where the financial stress dummy variable is restricted to capture only the last financial crisis, i.e. takes value 1 during 2007:Q4 –2008:Q4. The last two rows show Wald test *p*-values of the null hypotheses that $\beta^{ND} = \beta^{D}$ and $\gamma^{ND} = \gamma^{D}$, respectively, in Eq. (3). See also Table 1 notes.

Table 3: Direct reaction to financial market developments and the 2007-2008 crisis

	FCI (1)	*CSPR* (2)	*SP500* (3)	*LIQ* (4)
α	-0.47 *(0.80)*	0.49 ***(1.24)***	-0.78 *(0.91)*	0.09 *(0.90)*
ρ_1	1.36*** *(0.08)*	1.32*** ***(0.07)***	1.38*** *(0.09)*	1.37*** *(0.09)*
ρ_2	-0.50*** *(0.07)*	-0.47*** ***(0.06)***	-0.52*** *(0.08)*	-0.50*** *(0.08)*
β	1.91*** *(0.30)*	1.89*** ***(0.31)***	1.90*** *(0.33)*	1.74*** *(0.32)*
γ	1.09*** *(0.24)*	1.07*** ***(0.28)***	0.82*** *(0.30)*	1.20*** *(0.24)*
μ^{NR}	0.48** *(0.20)*	-0.96 ***(0.98)***	0.03* *(0.02)*	0.03 *(0.05)*
μ^{R}	2.48** *(0.94)*	-3.77*** ***(1.05)***	0.21*** *(0.07)*	0.56*** *(0.15)*
SE	0.32	0.31	0.33	0.31
$\mu^{NR} = \mu^{R}$	0.04	0.01	0.02	0.001

Notes: This table reports OLS estimates of Eq. (2) over the period 1985:Q1 – 2008:Q4 where the recession dummy variable is restricted to capture only the last recession, i.e. takes value 1 during 2007:Q4 – 2008:Q4. See also Table 1 notes.