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Monetary Policy and Stock Market Volatility

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Abstract

We estimate forward-looking interest rate reaction functions in the spirit of Taylor (1993) for four major central banks augmented by implicit volatilities of stock market indices to proxy financial market stress. Our results suggest that the Bank of England, the Federal Reserve Bank and the European Central Bank systematically respond to an increase of the implicit volatility by a decrease in the interest rate. We take our results as strong evidence that central banks use interest rates to stabilize financial markets in periods of financial market stress.

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1 Introduction

Even before the financial crises 2007-2009 started there has been a heated debate whether or not central banks should respond to asset price developments. Proponents of a 'leaning against' approach argue that a central bank is able to (and then also should) actively counteract excessive asset price increases (Blanchard 2000, Bordo and Jeanne 2002, Borio and Lowe 2002, Borio and White 2003, Cecchetti et al. 2000 and Goodhart 2000) while advocates of the 'cleaning-up' approach are convinced that the central bank should rather 'mop up' the negative macroeconomic effects after the burst of a bubble (Bean 2003, Bernanke 2002, Bernanke and Gertler 1999, 2001).

The 'cleaning-up' view rests on two main arguments. First, it is difficult – if not impossible – to identify an asset price bubble in real time since a fundamental value of an asset price can not be determined. Second, even if identified in real time the central bank lacks proper tools to address asset price bubbles, because it is questionable whether the short-term interest rate is able to stabilize asset prices. The argument against a stabilization effect rests – in a qualitative sense – on the well-known Tinbergen rule and – in a quantitative sense – it is to fear that a required drastic increase in the policy rate potentially causes more harm than good.

The 'leaning vs. cleaning' debate is somewhat connected to the debate on inflation targeting being the proper strategy for central banks. This is because inflation targeting is criticized for neglecting the issue of financial stability and, therefore, being part of the problem of financial instability instead of contributing to its solution.[1] When studying the relation of monetary policy and financial stability one has to distinguish the aspect of asset price misalignments (or bubbles) from excessive asset price volatility (or financial market stress).

[1]See Woodford (2012) for a discussion and for putting forward the respective counter position.

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While much of the existing literature concerns the asset price misalignments and is of a normative nature trying to answer the question 'What central banks should do?', this paper provides a positive perspective and empirically analyzes whether central banks take asset price volatility into account. Hence, we estimate forward-looking central bank reaction functions for four major central banks augmented by implicit volatilities of stock market indices to proxy financial market stress.

In doing so our contribution differs significantly in its scope from the very few previous studies that have also augmented monetary policy reaction functions with asset price developments. Bohl et al. (2004) investigate the impact of adding asset prices into standard Taylor rules. They, however, only look at the ECB in its early years and some of its predecessors (namely, the Deutsche Bundesbank, the Banca d'Italia and the Banque de France) and cannot verify an explicit role of asset prices as separate arguments in policy rules but rather asset prices are found to be highly relevant as instruments in the GMM estimation. Wei (2011) instead reports a significant direct effect for the Federal Reserve Bank, but the study is limited to house price volatility only. Kontonikas and Montagnoi (2004) report asset price-augmented policy reaction functions for the Bank of England and find significant effects. However, they look at asset price inflation (i.e., misalignments) rather than asset price volatility like in our study. Furthermore, in contrast to all of the previous studies our study looks simultaneously at the most important central banks in a unified empirical framework.

2 The data set

To estimate the interest rate reaction function we apply monthly data up to December 2009.[2] The start of the sample period differs among the central

[2] We also performed the analysis with data up to 2011. However, results which are available upon request turned out to be less robust. This, however, is probably due to the fact that from 2009 on the central banks' policy rates exhibit no variation. As a

banks due to data availability and we use the following short-term interest rates as the central banks' instruments: European Central Bank (European Overnight Index Average, EONIA since 1999); Federal Reserve Bank (Federal Funds Rate since 1990); Bank of England (Overnight Interbank Rate since 2000); Bank of Japan (Uncollateralized Overnight Call Rate since 2001).

To account for the forward-looking nature and to accurately approximate central banks' information set, we apply inflation and growth expectations which are publicly available in a forecast poll by Consensus Economics. This data set has several advantages and is, therefore, suited to estimate central bank reaction functions (Gorter et al. 2008, Bleich et al. 2012a,b). First, the participants of this survey work with private sector institutions within the respective country. Hence, they should have an unbiased view concerning the expected economic development (Batchelor 2001).[3] Furthermore, the individual forecasts are published with the forecasters' name and its affiliation. This allows everybody to evaluate the track record of the individual forecaster which might affect the forecasters' reputation (Dovern and Weisser 2011). Second, the poll is conducted each month during the first week and published within the second week which makes it a *frequent* and *timely* source for monetary policy makers to get to know expected inflation and growth dynamics. Third, the forecasts are subject to the *real-time data critique* since they are not revised (Orphanides 2001).

Consensus Economics publishes the projections for two different time horizons, namely for the current year and for the next year. We use the methodology proposed by Gorter et al. (2008) and weight both forecast horizons with the remaining months at the time the forecast is made. This procedure yields a fixed forecast horizon of one year which is approximately

consequence traditional Taylor rules do not seem to describe adequately central banks' policy based on unconventional measures.

[3]The participants are professional forecasters and work for universities, international economic research institutes, investment and commercial banks. Further information can be found on www.consensuseconomics.com.

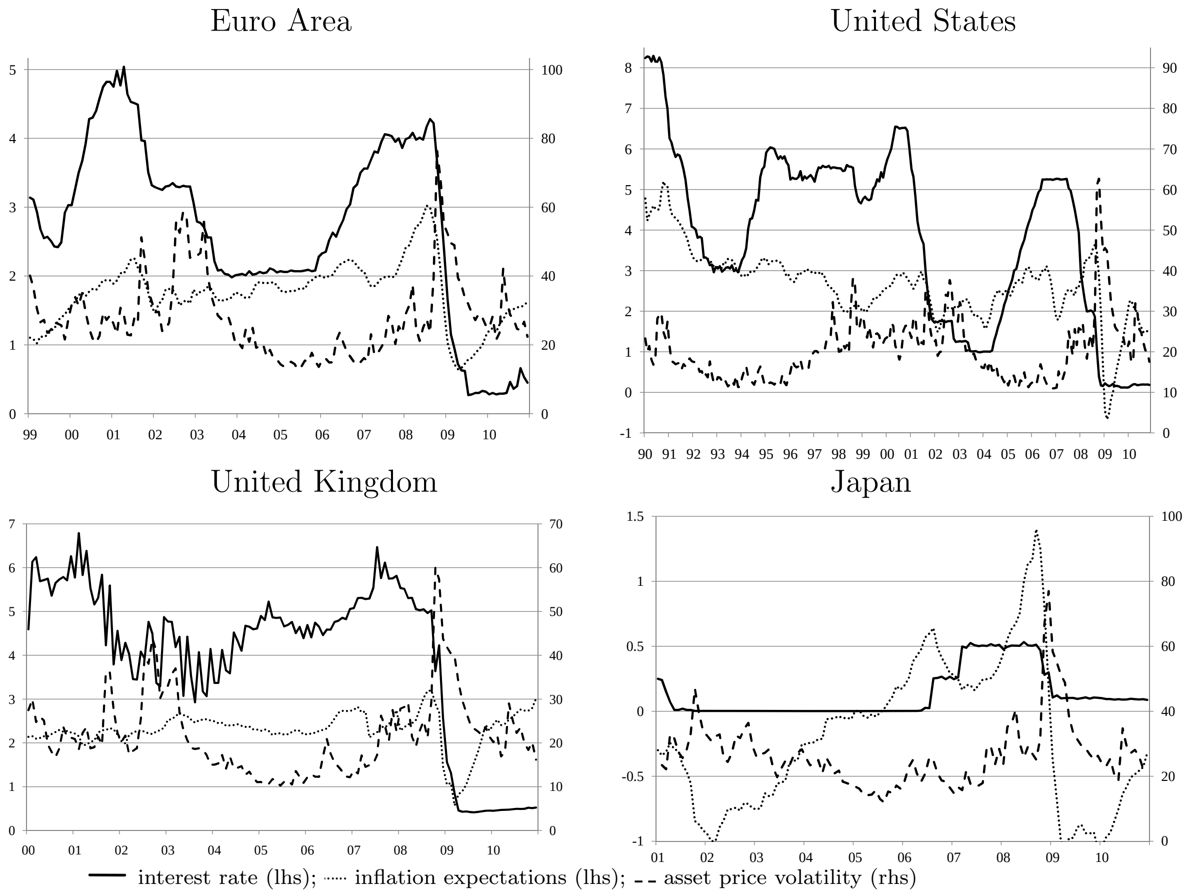
the time-lag inherent in the monetary policy transmission (George et al. 1999).

The most difficult variable to quantify in this framework is the expected output gap. We calculated it as follows. We use the industrial production index (y_t) and combine it with the real growth forecast to measure the expected contribution to industrial production $E_t(\Delta y_{t+k})$ for the period $t + k$. Subsequently, in order to calculate the output trend y^*_{t+k}, we apply a Hodrick-Prescott filter and define the expected output gap as $E_t(\tilde{y}_{t+k}) = y_t + E_t(\Delta y_{t+k}) - y^*_{t+k}$. A positive output gap refers to an upswing of the respective economy beyond the trend.

To proxy the expected asset price volatility we use the next 30-days implicit volatilities of the EURO STOXX 50 index for the Euro area, the S&P 500 for the United States, the Financial Times Stock Exchange Index for United Kingdom, and the Nikkei 225 for Japan. Implied volatilities are calculated in a forward looking manner and, thus, can be interpreted as expected future volatility of the underlying asset. Hence, all variables which enter our central bank reaction function are forward-looking and available to the central bank in real-time.

Figure 1 plots the short-term interest rate (solid line), the asset price volatility (dashed line), and the inflation expectations (fine dotted line). While Figure 1 reports that inflation expectations and the interest rate move in tandem, the figure also provides anecdotic evidence of an interest rate response to excess volatility. For example, between 2002 and 2004 the European Central Bank and the Bank of England lowered the interest rate while inflation expectations remained stable. This pattern is common among all four central banks during the financial crisis 2007-2009 where all central banks lowered interest rates while asset price volatility increased substantially and inflation expectations decreased. Hence, the next section analyzes whether central banks systematically responded to excess financial market volatility.

Figure 1: Interest Rates, Asset Price Volatility, and Inflation Expectations



Note: Figure 1 shows the short-term interest rate (solid line), the asset price volatility (dashed line), and the inflation expectations (fine dotted line).

3 Estimation results

Our empirical analysis is based on an augmented Taylor-type rule as presented in the following equation (Fendel et al. 2010, 2011, 2013a,b, Frenkel et al. 2013, Bleich and Fendel 2012):

$$i_t = \alpha_0 + \alpha_\pi E_t\pi_{t+12} + \alpha_{\tilde{y}_{t+12}} E_t\tilde{y}_{t+12} + \alpha_{vola} Vola_{t+1} + \rho i_{t-1} + \epsilon_t, \qquad (1)$$

where i_t, ρ and ϵ_t refer to the interest rate, the smoothing coefficient and the error term. Furthermore, $E_t\pi_{t+12}$, $E_t\tilde{y}_{t+12}$, and $Vola_{t+1}$ reflect the expected inflation rate, the expected output gap and the implied asset price volatility. To account for the endogeneity inherent in central bank reaction functions we apply a GMM estimator with the following instruments: the realized inflation rate (contemporaneous and up to its twelfth lag), the expected inflation rate (up to its twelfth lag) and the output gap (only first lag). Results based on variations in instruments are robust and available upon request.

Table 1 reports the results of Equation (1) and shows coefficients for the inflation rate and the output gap which are quite similar to those that have been reported in the literature so far. The inflation coefficient for the Federal Reserve and the Bank of England is significantly higher than unity indicating that the Taylor principle holds. A systematic responds to the expected output gap can be reported for the European Central Bank and the Bank of England. Interestingly, except for the Bank of Japan the coefficients concerning the asset price volatility are significantly negative. The negative albeit insignificant coefficient for the Bank of Japan might be attributed to the zero-interest-rate policy. Hence, if asset price volatility or alternatively financial market stress increases major central banks lower their short-term interest rates. More specifically, the coefficient of about $-.10$ reflects that if the asset price volatility increases by 10 units, central bank decrease their interest rate by about one percentage point.

Results based on a specification without the asset price volatility are qualitatively similar and available upon request. Including the asset price volatility in Equation (1) increases the goodness of fit substantially for the ECB and the Bank of England which underpins our argument that the asset price volatility is an ingredient in the reaction function for those central banks. In line with Clarida et al. (1998) we also instrumented the inflation rate and output gap using future realized values. Results based on the future realized values which are available upon request show that most central banks respond to asset price volatility but do not fulfill the Taylor principle anymore. As the application of expectations in central bank reaction func-

Table 1: Empirical Results

Central Bank	European Central Bank	Federal Reserve	Bank of England	Bank of Japan
Time period	1999-2009	1990-2009	2000-2009	2001-2009
α	3.20	.70	2.36	.24
	(2.11)	(2.81)	(1.32)	(.31)
α_π	.88	1.91*	1.60*	-.02
	(.85)	(.70)	(.42)	(.17)
$\alpha_{\tilde{y}}$	.36*	-.14	.17*	.02
	(.13)	(.11)	(.03)	(.01)
α_{vola}	-.09+	-.10+	-.12*	-.01
	(.06)	(.07)	(.04)	(.01)
ρ	.95*	.93*	.84*	.95*
	(.00)	(.02)	(.04)	(.03)
$\alpha_\pi > 1$	.56	.10	.08	.99
$\alpha_{\tilde{y}} > 0$	.00	.89	.00	.05
$\alpha_{vola} < 0$	.05	.08	.00	.28
R^2	.97	.92	.86	.92
Obs.	131	228	120	107
Hansen J	.74	.18	.38	.63

Note: Table 1 reports the estimates of Equation (1) $i_t = \alpha_0 + \alpha_\pi E_t \pi_{t+12} + \alpha_{\tilde{y}_{t+12}} E_t \tilde{y}_{t+12} + \alpha_{vola} Vola_{t+1} + \rho i_{t-1} + \epsilon_t$ based on *two-step feasible GMM* estimation with minimum asymptotic variance that are autocorrelation-consistent; as instruments we used the realized inflation rate (contemporaneous and up to its twelfth lag), the expected inflation rate (up to its twelfth lag) and the output gap (only first lag); the Hansen J statistic reports p-values under the null hypothesis that the instruments are uncorrelated with the error terms; $\alpha_\pi > 1$ represents the significance level of a Chi^2 test to test whether the *Taylor-principle* holds while $\alpha_{\tilde{y}} > 0$ ($\alpha_{vola} < 0$) reports the significance level under the null hypothesis that $\alpha_{\tilde{y}} \leq 0$ ($\alpha_{vola} \geq 0$); R^2 refers to the overall coefficient of determination; * (+) indicates significance at the one (ten) percent level.

tion seem to be more conventional in the recent past, we followed Gorter et al. (2008, 2010) and Gerlach and Lewis (2011) who proxy future inflation by means of survey data. Hence, our baseline results are based on market's expectations concerning the inflation rate and the output gap.

In addition to our baseline results, we estimated one specification based on the expected output growth rate rather than the expected output gap. While we still find that the Federal Reserve responds to asset price volatility.

the results are qualitatively different to our baseline results with respect to the Taylor principle which is not fulfilled in most cases. In addition, the goodness of fit is lower for the specification based on the expected growth rate favoring the specification based on the expected output gap. To be consistent with Clarida et al. (1998) we decided to use the specification based on the expected output gap and make the results based on the expected growth rate available upon request.

4 Conclusion

Based on an augmented Taylor-type rule this letter provides robust estimates that major central banks systematically respond to financial market stress. More precisely, we document that an increase in the implicit asset price volatility by 10 units yields a decrease in the short-term interest rate by about one percentage point. We conclude that while academics and policy makers still debate central banks already systematically stabilize financial markets using its interest rate policy. This does also include that central banks might respond to financial market stress due to a possible correlation between expected inflation and expected asset price returns meaning that central banks indirectly stabilize financial market by responding to inflation expectations. However, we leave it to future research whether such a monetary policy is eventually effective in stabilizing the financial market.

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