Shocking Markets: European Stock Markets and the ECB's Monetary Policy Surprises*

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Abstract

This paper contributes to the literature measuring the response of stock markets to monetary policy actions. We analyze the reaction of European stock market returns to unexpected interest rate decisions by the ECB. Endogeneity between interest rate changes and stock returns is taken into account using the identification through heteroskedasticity approach. Relying on different methods to extract monetary policy shocks, we find a negative and significant relation between unexpected ECB decisions and European stock markets performance. Moreover, monetary policy decisions of the ECB are well anticipated by the market implying that the central bank successfully communicates its monetary policy.

JEL Classification: E44, E47, E52

Keywords: Monetary Policy Shocks, European Stock Market, Identification through Heteroskedasticity, Principal Components Analysis

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Abstract

This paper contributes to the literature measuring the response of stock markets to monetary policy actions. We analyze the reaction of European stock market returns to unexpected interest rate decisions by the ECB. Endogeneity between interest rate changes and stock returns is taken into account using the identification through heteroskedasticity approach. Relying on different methods to extract monetary policy shocks, we find a negative and significant relation between unexpected ECB decisions and European stock markets performance. Moreover, monetary policy decisions of the ECB are well anticipated by the market implying that the central bank successfully communicates its monetary policy.

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1 Introduction

There is substantial interest in measuring the impact of monetary policy decisions on financial markets. To assess the transmission process of interest rate setting, central bankers closely observe asset prices as they may influence the real economy through the wealth and capital cost channels. Furthermore, portfolio decisions by financial market participants are affected by the consequences of monetary policy shocks on asset prices. This paper analyses European stock markets' response to unexpected monetary policy decisions by the European Central Bank (ECB). Estimating the response of major national stock markets in the European Monetary Union (EMU) deepens our knowledge on the nature of the transmission mechanism of monetary policy in the euro zone. It provides information about the extent of stock markets' reaction and whether monetary impulses spread unifomly across major EMU stock markets. Moreover, by developing a measure of monetary policy shocks, we are able to evaluate the predictabilty of the ECB's interest rate policy. We extract unexpected monetary policy decisions by using EURIBOR future and EONIA swap data as well as survey data covering the opinions of financial market experts. The approach suggested by Rigobon and Sack (2004), and Rigobon (2003) is applied, because this technique controls for the endogeneity of the variables in question.

Previous research has generally focused on the Federal Reserve's interest rate setting behavior and its effects on US financial assets.[1] Surprisingly, there is little research that estimates how euro area financial markets react to unexpected monetary policy decisions of the ECB. Napolitano (2006) uses Markov-switching models to distinguish between bull and bear markets' reaction to monetary policy. He finds small negative and asymmetric effects on euro area stock markets. Vähämaa (2005) focuses on bond market expectations around ECB decisions and finds asymmetries in the expectations implying that market participants attach higher probabilities for sharp yield increases than for sharp decreases around policy tightenings (and vice versa). Perez-Quiros and Sicilia (2002) estimate the reaction of the European yield curve to ECB's unexpected monetary policy decisions. Applying a simple OLS approach with an event study character they find limited impact of shocks on the yield curve. Our paper contributes to this literature by focusing specifically on European stock markets and applying an econometric approach which controls for the endogenous relationship between interest rates and stock prices.

The remainder of this paper is structured as follows: Section 2 gives a short introduction to the methodology used. Section 3 describes the dataset and presents the empirical results. Section 4 summarizes our findings and concludes.

[1] See, for example, Chen (2007), Crowder (2006), Davig and Gerlach (2006), Bernanke and Kuttner (2005), Gürkaynak et al. (2005), Rigobon and Sack (2004) and Thorbecke (1997).

2 Methodology

When empirically analyzing the link between monetary policy and financial markets the problem of endogeneity emerges as revealed by a model that describes the interaction between monetary policy and stock prices

$$\Delta i_t = \beta \Delta s_t + \gamma z_t + \epsilon_t \tag{1}$$

$$\Delta s_t = \alpha \Delta i_t + z_t + \eta_t \tag{2}$$

Equation (1) is a simplified version of a monetary policy reaction function where the change in the short-term interest rate (Δi_t) responds to stock returns (Δs_t), a vector of other variables z_t (assumed to be exogenous), and a monetary policy shock (ϵ_t). Stock returns, as shown in Equation (2), are explained by the change in the interest rate, other variables denoted by z_t, and the residual term (η_t). α is the parameter of interest in our investigation. We expect a negative value for this short-run elasticity following present value model of stocks.

Different strategies are available to deal with the endogeneity issue. Most frequently, an event-study methodology (Bernanke and Kuttner (2005), Bomfim (2003), Thorbecke (1997), Cook and Hahne (1989)) or impulse-response analysis based on VAR models (Crowder (2006), Peersman (2002), Evans and Marshall (1998), Christiano et al. (1999)) are applied. The event-study methodology is criticized because it assumes that the monetary policy shock is fully captured by some ad hoc window size around the chosen event. If this strict assumption does not hold the method is proven to be biased (Rigobon and Sack (2004)). The use of monetary VARs is challenged by Rudebusch (1998) because these exhibit fragile coefficient estimates, contradictory monetary shocks and innovations basically uncorrelated with financial market surprises. However, this view is not unanimously shared, see Sims (1998).

In this paper, we apply the identification through heteroskedasticity approach of Rigobon and Sack (2004), and Rigobon (2003), to estimate the impact of monetary policy shocks on stock returns. The technique posits that an increase in the variance of the shock in the monetary policy reaction Equation (1) reduces the bias introduced by simultaneous-equation problems in the OLS estimate of the asset price reaction Equation (2). Whereas in the traditional event-study approach it is assumed that the variance of the policy shocks σ_ϵ is strictly greater than the variability of the vector of exogenous variables σ_z and the variance of the asset price shock σ_η, a much weaker set of assumptions has to hold following the identification through heteroskedasticity technique. Applying this method, it is the change in the covariance of stock prices and interest rates which identifies the parameter of interest in times when the variance of the policy shock changes. Adapted to our paper, the basic assumption required is that the variance of monetary policy shocks is higher on

days when the ECB Governing Council meets than on other days. At the same time the variances of other shocks are supposed to remain constant over the observed period. Such an assumption is uncontroversial, as financial markets clearly focus their attention on what the ECB intends to do around the time the Governing Council meets and releases its interest rate decision.

Since we assume the variance of monetary policy shocks to be higher on certain days than on others we need to define two subsamples. Define F as the subsample containing the policy dates, i.e. the days on which the central bank makes its interest rate announcement. Subsample F^* then consists of the non-policy dates which we define as the day immediately preceding the policy date.

In order to identify α, we solve the reduced form of Equations (1) and (2) and estimate the covariance, as in Equation (3), for both subsamples respectively

$$\Omega_s = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix} \sigma_\epsilon^s + \beta^2\sigma_\eta^s + (\beta+\gamma)^2\sigma_z^s & \alpha\sigma_\epsilon^s + \beta\sigma_\eta^s + (\beta+\gamma)(1+\alpha\gamma)\sigma_z^s \\ . & \alpha^2\sigma_\epsilon^s + \sigma_\eta^s + (1+\alpha\gamma)^2\sigma_z^s \end{bmatrix} \tag{3}$$

with $s = \{F, F^*\}$. Assuming α, β and γ to be stable across the two set of data, we are able to identify α by subtracting the covariance matrices

$$\Delta\Omega = \Omega^F - \Omega^{F^*} = \frac{\sigma_\epsilon^F - \sigma_\epsilon^{F^*}}{(1-\alpha\beta)^2}\begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix}. \tag{4}$$

The estimator $\hat{\alpha}$ can now be obtained via

$$\hat{\alpha} = \frac{\Delta\hat{\Omega}_{1,2}}{\Delta\hat{\Omega}_{1,1}} \tag{5}$$

where $\Delta\hat{\Omega}_{i,j}$ represents the (i,j) element of the change in the $\hat{\Omega}$ matrix. Following Rigobon and Sack (2004) we use an instrumental variable approach to implement Equation (5).

Let T be the number of ECB Governing Council meetings. The change in interest rate and equally the change in asset prices are included in $2T \times 1$ vectors covering at first policy dates followed by non-policy dates

$$\Delta i = \left[\Delta i_{t(1)}, \Delta i_{t(2)}, ..., \Delta i_{t(2T)}\right] \tag{6}$$

$$\Delta s = \left[\Delta s_{t(1)}, \Delta s_{t(2)}, ..., \Delta s_{t(2T)}\right] \tag{7}$$

with the date indices, $t(k), k = 1, 2, ..., 2T$, placed in chronological order and $t(k) \in F \cup F^*$. For the vector of instruments consider

$$w_i = \left[\Delta i^*_{t(1)}, \Delta i^*_{t(2)}, ..., \Delta i^*_{t(2T)}\right]' \tag{8}$$

with

$$\Delta i^*_{t(k)} = \begin{cases} \frac{\Delta i_{t(k)}}{(T-1)}, & t(k) \in F \\ \frac{-\Delta i_{t(k)}}{(T-1)}, & t(k) \in F^* \end{cases}. \tag{9}$$

The variable w_i is a valid instrument: It is correlated with the regressor Δi_t because the subsample F outweighs F^* due to the heteroskedasticity of ϵ_t. At the same time the instrumental variable is not correlated with z_t and η_t. Those shocks are homoskedastic, thus the two subsamples cancel each other out. Using this instrument the parameter of interest can now be estimated by

$$\hat{\alpha} = (w_i' \Delta i)^{-1} (w_i' \Delta s). \tag{10}$$

Rigobon and Sack (2004) show Equation (10) to be unbiased and asymptotically normal distributed, even in small samples, when the instrument is adjusted for the number of parameters used.[2] The usual t-statistics can be used to assess whether $\hat{\alpha}$ is significantly different from zero.

3 Data and Empirical Results

We resort to daily data for a sample that runs from January 1, 1999 to February 28, 2007, i.e. since the period the ECB became responsible for monetary policy in the euro area. To describe the impact of monetary policy shocks on European stock markets we focus on the four largest national stock markets and select the German DAX 30, the French CAC 40, the Spanish $IBEX$ 35 and the Italian MIB 30. Furthermore, as a proxy for the aggregate European stock market, we choose the *Euro Stoxx* 50. We anticipate that while ECB monetary policy surprises potentially impact European stock market it is unlikely that repercussions will be felt in US markets (Ehrmann and Fratzscher (2003)). All stock market indices are sourced from Thomson Financial Datastream.

The EURIBOR is the benchmark money market rate for the euro area. We choose, the one month EURIBOR as the interest rate proxy, while interest rates with shorter maturities are neglected due to their high volatility. EURIBORs with maturities longer than one month may not be sensitive enough to monetary policy changes (Kleimeier and Sander (2006)).

While ECB's Governing Council meets twice per month, press releases announcing its monetary policy decisions are only published after the first monthly meeting.[3] The Council's decisions are made public at 1.45 p.m. C.E.T. Shortly thereafter, during the press conference, additional information is released to the market. We assume the news of an unexpected interest rate setting of the

[2] Following Rigobon and Sack (2004), it can be formally shown that the instrumental variables estimator is equivalent to the estimator in Equation (5).

[3] This procedure has been in place since November 8th, 2001. Before that time, the ECB published a press release following each one of its twice monthly meetings.

ECB to be priced in shortly after the information has hit the stock market, or at least until trading ceases the same day. Thus, we apply the daily closing prices of the above mentioned European stock price indicies. The EURIBOR is published already at 11 a.m. C.E.T. every weekday. Due to the central bank's above mentioned time schedule, the quotes of the day following the Governing Council meeting are used.

Since the objective of the paper is to analyze the impact of unexpected interest rate decisions on stock returns, we have to proxy monetary policy shocks around Governing Council meeting days. We rely on changes in expectations of market participants. These expectations are typically derived from futures and swaps heavily traded on financial markets as well as surveys of market economists (Rigobon and Sack (2004), Gürkaynak et al. (2002), Kuttner (2001)). We choose EONIA swaps and EURIBOR futures of different maturities (Bernoth and von Hagen (2004), Perez-Quiros and Sicilia (2002)). The EONIA swaps are made available from Reuters. The EURIBOR futures are provided by Thomson Financial Datastream. The swaps and future quotes used are daily closing prices.

In order to extract the shocks, a principal components analysis is used (Stock and Watson (2002)). This method captures the common variation pattern from a set of time series in the form of one or more linear combinations. Technically, this is been done by estimating the eigenvectors and their eigenvalues from the variance-covariance matrix of the time series. Whereas the eigenvectors form linear combinations of the variables, the eigenvalues indicate the proportion of total variance explained by each combination. These combinations (also known as principal components) are then ranked according to their contribution to the total variance of the original data. As we are interested in the combination which captures best the common variation of the EURIBOR and EONIA time series in all cases the first principal component is chosen (see Table 1 for our below defined principal components). Prior to extracting the principal components, all time series are standardized to prevent the most volatile from dominating the analysis.

[Insert Table 1 about here]

Following Perez-Quiros and Sicilia (2002), principal components analyses with three different data sets are used to account for shocks in the short-run, the long-run, and the overall-expectation of policy steps by the ECB. PC_{Short} is the principal component generated by the EONIA swap of one week and the EONIA swap of one month; PC_{Long} covers the EONIA swap of two and three month as well as the EURIBOR future of three month. Capturing the mixed expectations for short and long horizons, PC_{All} consists of all five time series. A monetary shock is identified when the rate exceeds the mean of the time series by at least twice its standard deviation on a day when the ECB Governing Council meets. To cross-check the shocks derived by the three principal

components analyses, we identify a shock when it is indicated by PC_{All} and at least by one of PC_{Short} or PC_{Long}.

As a robustness check we also rely on surveys from three sources. Reuters, Bloomberg and Observatorio del Banco Central Europeo (OBCE) ask financial market experts every month what decision they expect the ECB to take at their next meeting.[4] First, a interest rate decision is recorded as a shock if less than half the respondents expected the move in advance. Second, a decision is identified as a shock, when at least two measures out of the survey and principal components sources are indicating an unexpected interest rate step. See Table 2 for an overview of all identified shocks. During the period under consideration monetary policy shocks are rather rare events. Table 2 shows a concentration of shocks at the beginning of the sample period, in particular during the years 2000 and 2001.

[Insert Table 2 about here]

Table 3 presents the main empirical results. In general, stock markets react negatively (positively), and significantly, immediately after an unanticipated rise (cut) of the interest rate directly influenced by the ECB's Governing Council. The coefficients in Table 3 can be interpreted as the change in daily stock returns following an unexpected 100 basis point change in the policy rate. The estimate $\hat{\alpha}_{PC}$ for the *Euro Stoxx* 50 is -8.40, implying that an unexpected 25-basis point increase of the main lending rate results in a 2.1 percent decline in the *Euro Stoxx* 50 on the same day. The coefficients for the national stock indices produce similar responses, although the size of the response is slightly lower. In detail, a 1.56 percent to 2.32 percent fall of the respective indices follows an unexpected 25-basis point interest rate hike. With the exception of Italy, our findings are in favor of a homogenous reaction of major EMU stock markets to ECB's monetary policy shocks. Moreover, the estimated short-run elasticities are comparable to the ones in Rigobon and Sack (2004) for US stock market indices.

[Insert Table 3 about here]

As previously discussed, three different definitions of policy shocks are considered. In general, when relying on the surveys to proxy monetary policy shocks, the results are comparable to ones obtained using a principal components analysis. Not surprisingly, the same conclusion is obtained when the combination of survey data and principal components analysis is used. All coefficients

[4] While the Reuters and Bloomberg databases are wellknown, the OBCE is a group of researchers and financial market participants observing the ECB's monetary policy. See www.obce.org for more details. Due to data limitation we combine the three surveys. Reuters (available from January 1999 to December 2004) and OBCE (available from January 2005 to February 2007) data are connected. Out of the Bloomberg survey results (available from October 2000 to February 2007) two additional shocks, which are not recorded by the other respective source, are added.

exhibit the correct sign and with the exception of the Italian MIB 30 the estimated coefficients are statistically significant at the 5 percent or 10 percent level.

As a robustness check, we also implement a bootstrap technique to estimate t-values in small samples by resampling the observations. For each subsample (F, F^*) as many observation pairs are drawn with replacement as number of shocks were extracted by the respective shock definition. Thereafter, the point estimator and the t-values are calculated. Repeating the whole procedure a large number of times (i.e., 1000 resamples), we obtain an hypothetical empirical distribution for the t-statistic. These bootstrap-values reaffirm the earlier reported conclusions.[5]

4 Conclusion

This paper estimates the short-run impact of unexpected interest rate decisions of the ECB on returns in major European stock markets. Whereas the evidence in the literature for the US are to a certain degree inconclusive about the significance of the response of stock returns to the Fed's policies (Rigobon and Sack (2004)), our findings for Europe indicate a negative and significant response of European stock returns to monetary policy shocks induced by the ECB. Across all shock definitions, European stock markets fall between 1.56 percent and 2.32 percent on the day when an unanticipated interest rate hike of 25-basis points occurs. The findings show that unexpected monetary policy impulses by the ECB spread uniformly across major EMU stock markets.

The empirical findings confirm that, at least in the short-run, monetary policy is not neutral. Following an unexpected expansionary monetary policy, real effects evolve since increasing future cash flow, or the decreasing discount factor, are reflected in stock prices. Since it is essential for central bankers to assess the consequences of their decision for the real economy, our results contribute to the understanding of the transmission process of interest rate setting. In particular, the credit view, which stresses the importance of the financial positions, i.e. the balance sheet of the companies, is relevant to the findings of this paper. Consequently, in the euro area, interest rate hikes might have even stronger contradictory effects on the economy, when the balance sheets are already weak (Bernanke and Gertler (1995)).

Our results are also informative about the predictability of the ECB's policy, and the number of monetary shocks generated since the fledgling central bank became responsible for monetary policy in the euro area. Our shock definitions suggest that, since 1999, only between 14 and 19 unexpected interest rate decisions took place. This findings support the work of Perez-Quiros and Sicilia (2002), as well as Ehrmann and Fratzscher (2005), who conclude that, in most cases, the ECB successfully communicated its monetary policy.

[5] The results are not reported but available from the authors on request.

Future research might ask what are the sources of stock returns' reactions to monetary policy shocks. Tight money might increase the riskiness of stocks in general due to rising credit costs. Alternatively, negative returns could also represent a kind of overreaction of stocks to monetary policy shocks, which quickly disappears. As suggested in Bernanke and Kuttner (2005), an analysis of a broader class of assets might also be useful to obtain more detailed insights about the relationship between monetary policy shocks and stock market returns.

References

Bernanke, Ben S. and Mark Gertler (1995), Inside the Black Box: The Credit Channel of Monetary Policy Transmission, Journal of Economic Perspectives, 9(4), 24-48.

Bernanke, Ben S. and Kenneth N. Kuttner (2005), What Explains the Stock Market's Reaction to Federal Reserve Policy?, The Journal of Finance, 60(3), 1221-1257.

Bernoth, Kerstin and Jürgen von Hagen (2004), The Euribor Future Market: Efficiency and the Impact of ECB Policy Announcements, International Finance, 7(1), 1-24.

Bomfim, Antulio N. (2003), Pre-announcement effects, news, and volatility: monetary policy and the stock market, Journal of Banking and Finance, 27(1), 133-151.

Chen, Shiu-Sheng (2007), Does Monetary Policy Have Asymmetric Effects on Stock Returns?, Journal of Money, Credit and Banking, 39(2-3), 667-688.

Christiano, Lawrence J., Martin Eichenbaum and Charles Evans (1999), The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds, Review of Economics and Statistics, 78(1), 16-34.

Cook, Timothy and Thomas Hahn (1989), The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s, Journal of Monetary Economics, 24(3), 329-486.

Crowder, William J. (2006), The Interaction of Monetary Policy and Stock Returns, Journal of Financial Research, 29(4), 523-535.

Davig, Troy and Jeffrey R. Gerlach (2006), State-Dependent Stock Market Reactions to Monetary Policy, International Journal of Central Banking, 2(4), 65-83.

Ehrmann, Michael and Marcel Fratzscher (2003), Monetary Policy Announcements and Money Markets: A Transatlantic Perspective, International Finance, 6(3), 1-20.

Ehrmann, Michael and Marcel Fratzscher (2005), Communication and Decision-Making by Central Bank Committees: Different Strategies, Same Effectiveness?, ECB Working Paper No. 488, forthcoming, Journal of Money, Credit and Banking.

Evans, Charles L. and David A. Marshall (1998), Monetary Policy and the Term Structure of Nominal Interest Rates: Evidence and Theory, Carnegie-Rochester Conference Series on Public Policy, 49, 53-111.

Forni, Mario, Marc Hallin, Marco Lippi and Lucrezia Reichlin (2001), Coincident and Leading Indicators for the Euro Area, The Economic Journal, 111(471), 62-85.

Gertler, Mark and Simon Gilchrist (1994), Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms, The Quarterly Journal of Economics, 109(2), 309-340.

Gürkaynak, Refet S., Brain Sack and Eric T. Swanson (2002), Market-Based Measures of Monetary Policy Expectations, Federal Reserve Bank of San Francisco, Working Paper Series: 2006-04.

Gürkaynak, Refet S., Brain Sack and Eric T. Swanson (2005), Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements, International Journal of Central Banking, 1(1), 55-93.

Kleimeier, Stefanie and Harald Sander (2006), Expected versus Unexpected Monetary Policy Impulses and Interest Rate Pass-Through in Euro-Zone Retail Banking Markets, Journal of Banking and Finance, 30(6), 1839-1870.

Napolitano, Oreste (2006), Is the Impact of ECB Monetary Policy on EMU Stock Market Returns Asymmetric, Universita Degli Studi Di Napoli 'Parthenope', Instituto Di Studi Economici, Working Paper 3.2006.

Peersman, Gert (2002), Monetary Policy and Long Term Interest Rates in Germany, Economics Letters, 77(2), 271-277.

Perez-Quiros, Gabriel and Jorge Sicilia (2002), Is the European Central Bank (and the United States Federal Reserve) predictable?, European Central Bank, Working Paper Series, No. 192.

Rigobon, Roberto (2003), Identification through Heteroskedasticity, The Review of Economics and Statistics, 85(4), 777-792.

Rigobon, Roberto and Brian Sack (2004), The Impact of Monetary Policy on Asset Prices, Journal of Monetary Economics, 51(8), 1553-1575.

Rudebusch, Glenn D. (1998), Do Measures of Monetary Policy in a VAR Make Sense?, International Economic Review, 39(4), 907-931.

Sims, Christopher A. (1998), Comment on Glen Rudebusch's 'Do Measures of Monetary Policy in a VAR Make Sense?', International Economic Review, 39(4), 933-941.

Stock, James H. and Mark W. Watson (2002), Forecasting Using Principal Components From a Large Number of Predictors, Journal of the American Statistical Association, 97(460), 1167-1179.

Thorbecke, Willem (1997), On Stock Market Returns and Monetary Policy, Journal of Finance, 52(2), 635-654.

Vähämaa, Sami (2005), Option-Implied Asymmetries in Bond Market Expectations Around Monetary Policy Actions of the ECB, Journal of Economics and Business, 57(1), 23-38.

Table 1: Results for Principal Components Analysis, 1 January 1999 - 28 February 2007

		PC_{All}	PC_{Short}	PC_{Long}
Variance Prop.		0.496	0.664	0.614
Eigenvectors	EONIA swap 1 week	-0.307	0.707	
	EONIA swap 1 month	-0.506	0.707	
	EONIA swap 2 month	-0.534		-0.627
	EONIA swap 3 month	-0.502		-0.636
	EURIBOR future 3 month	-0.326		-0.445

Notes: Only the first principal component of each PC is stated above. *Variance Prop.* denotes the proportion of the variance of the time series explained by each first principal component. E.g., the first principal component of PC_{All} explains nearly 50 percent of the total variation of all five time series.

Table 2: Shocks Extracted by Different Definitions

Date of Press Meeting	Shock Definition		
	PC	SURVEY	COM
08.04.1999	x		x
07.10.1999	x		x
03.02.2000		x	x
27.04.2000	x	x	x
08.06.2000	x		x
20.07.2000	x		x
05.10.2000	x	x	x
04.01.2001	x		x
29.03.2001		x	
11.04.2001		x	x
10.05.2001	x	x	x
30.08.2001		x	x
17.09.2001	x	x	x
11.10.2001	x	x	x
10.10.2002	x		x
07.11.2002	x		x
06.03.2003	x	x	x
08.05.2003		x	
01.12.2005		x	x
02.03.2006		x	
06.04.2006	x	x	x
05.10.2006		x	
07.12.2006		x	x
No. of shocks	14	16	19

Notes: An x denotes that a monetary policy shock was identified by the respective shock definition. PC indicates shocks derived through the principal components analysis. $SURVEY$ states the shocks found from the survey results. COM denotes extracted shocks as combination of the survey and the principal components definition.

Table 3: Stock Returns after Monetary Policy Shocks, 1 January 1999 - 28 February 2007

Shock Definition	PC	SURVEY	COM
Point Estimator	$\hat{\alpha}_{PC}$	$\hat{\alpha}_{SUR}$	$\hat{\alpha}_{COM}$
Euro Stoxx 50	-8.40	-9.30	-7.66
	(-2.53)**	(-2.30)**	(-2.38)**
DAX 30	-7.78	-7.70	-7.01
	(-2.10)*	(-1.79)*	(-2.03)*
CAC 40	-6.98	-7.19	-6.33
	(-2.25)**	(-1.85)*	(-2.00)*
IBEX 35	-6.26	-6.48	-5.68
	(-2.02)*	(-1.77)*	(-1.91)*
MIB 30	-4.32	-3.61	-4.16
	(-1.31)	(-0.97)	(-1.38)

Notes: PC indicates shocks derived through the principal components analysis. $SURVEY$ states the shocks found from the survey results. COM denotes extracted shocks as combination of the survey and the principal components definition. t-values are in brackets. The one month EURIBOR is applied as proxy for the policy rate. *, ** denotes statistical significance at the 10 percent and 5 percent level, respectively.