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Monetary Policy Announcements and Money Markets: A Transatlantic Perspective*

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Abstract

This paper investigates how money markets in the USA, Germany (up to 1998) and the euro area (since 1999) react to monetary policy announcements by the Federal Reserve, Bundesbank and ECB. We find that interest rates respond strongly to domestic monetary policy throughout, whereas the response to foreign monetary policy varies across markets and over time: both the German and the euro area market react to Federal Reserve announcements, whereas US markets do not generally respond to European monetary policy. Whereas announcements by the Bundesbank increased the volatility of German money markets, such effects are rarely found for the ECB, and have basically disappeared for the Federal Reserve. Moreover, the general linkage of money markets has increased considerably over time: interest rate developments and volatility in either the USA or the euro area are generally mirrored in the other market to a much larger extent than

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prior to EMU. We interpret these results as evidence that euro area and US markets not only have become more interdependent over time, but that markets' understanding and anticipation of monetary policy decisions have improved over time.

I. Introduction

Meetings of the decision-making bodies of major central banks are generally monitored closely in the money markets all over the world. Whereas the impact of monetary policy on domestic money markets is generally well understood, it is less obvious to what extent money markets should react to foreign monetary policy decisions. In principle, there are three channels through which foreign announcements may affect domestic markets. First, foreign news may be relevant for domestic monetary policy authorities if these target 'external' variables, such as the exchange rate. Second, the integration of global financial markets might lead to spillover effects. A change in monetary policy in the USA, for instance, will affect money markets in other countries via capital flows and the elimination of arbitrage possibilities. A third channel works through real integration, namely if foreign monetary policy decisions change domestic macroeconomic conditions, for example, through effects on trade with the other country. In this sense, foreign monetary policy decisions may provide news not only about economic conditions abroad but also about the prospects of the domestic economy.

This paper investigates the degree of interdependence by focusing on the daily reaction of money market interest rates to both foreign and domestic monetary policy announcements in the USA and Germany up to 1998, and the USA and the euro area since 1999, explicitly allowing for spillover effects across countries.

Whereas a large literature exists on the response of US money markets to US monetary policy decisions (Roley and Sellon 1995; Thornton 1998; Kuttner 2001; Demiralp and Jorda 2002, 2003), relatively little is known about the response of euro area money markets to ECB monetary policy decisions (exceptions are Hartmann et al. 2001; Gaspar et al. 2001; Perez-Quiros and Sicilia 2002), and even less on the reaction of both markets to foreign monetary policy.[1] This paper's intended contribution is thus not only to look at market reactions to domestic monetary policy news, but to analyse the *spillover* of monetary policy decisions *across* markets and how

[1]To our knowledge, the only analyses of such spillovers have been conducted by Kim and Sheen (2000) for Australia and the USA, and by Gravelle and Moessner (2001) for Canada and the USA.

these spillovers have evolved over time. In particular, by comparing the situation before and after EMU, it tests whether EMU has changed the way domestic and foreign money markets react to European monetary policy. The results of the paper suggest that the linkages of money markets have increased strongly over time. Volatility in either the US or the euro area market is transmitted to the other market to a much larger extent than was the case prior to EMU. This effect is basically found for all maturities we analyse. Beyond that, interest rate changes in the euro area are reflected in the US market at the short end, and US developments carry over to the euro area at all maturities.

Regarding the effects of monetary policy announcements, we find that interest rates respond strongly to domestic monetary policy throughout, whereas the response to foreign monetary policy varies: both the German and the euro area market react to Federal Reserve announcements, whereas US markets do not generally respond to European monetary policy. Whereas announcements by the Bundesbank increased the volatility of German money markets, such effects are rarely found for the ECB, and have basically disappeared for the Federal Reserve. These results suggest that the markets' understanding of monetary policy strategies and decisions in the USA and the euro area has improved over time, resulting in less uncertainty and lower volatility in the markets on the days around policy decisions.

In the remainder of this paper, we describe the data and the econometric models underlying our analysis in Sections II and III. The results are reported in Section IV. Section V concludes.

II. The Data

A. Announcements and Surprises

To gauge the extent to which monetary policy affects money markets, it is crucial to properly model the arrival of new information. Announcements of monetary policy decisions are partly expected by the market. This expected part is thus already priced into the market prior to the announcement. At the point of the announcement, the market reacts merely to the *surprise component* contained in the news, i.e., to the deviation of the announced decision from its expected value. Analysing the reaction of markets to surprises in data releases is therefore a proxy to assess the importance of the underlying macroeconomic variable for the market. Kuttner (2001), for instance, finds that the announcement of Federal Reserve decisions on their own funds target rate affects market interest rates at the time of the announcement only to the extent that the decisions are unexpected. In this paper, we follow this strategy and investigate the surprise component of announcements.

We look at monetary policy announcements for the USA, Germany and the euro area during the period January 1993 to February 2002 (1993–1998 for Germany, 1999–2002 for the euro area, and 1993–2002 for the USA). We include announcements on days of scheduled and unscheduled meetings of the decision-making bodies of the three central banks. An important difference across the central banks is the frequency of meetings: FOMC meetings take place usually every six weeks, or eight times per year. By contrast, the Zentralbankrat of the Bundesbank and the Governing Council of the ECB have been meeting mostly every two weeks (although the ECB announced on 8 November 2001, that it would normally take interest rate decisions only at its first meeting of each month). This difference in frequency of meetings means that there is a much larger number of monetary policy announcements for the Bundesbank and the ECB than for the Federal Reserve, although the latter changed its policy rate somewhat more frequently during the 1993–2002 period than the Bundesbank and the ECB: 31 changes for the Federal Reserve, as compared to 13 for the Bundesbank, and 12 for the ECB (see Table 1).

The expectations data for monetary policy decisions originates from a Reuters poll of 25–30 market participants, conducted on Fridays before each meeting of the central bank decision making bodies. We use the mean of the survey as our expectations measure although using the median yields similar econometric results.[2]

Employing standard techniques in the literature (Gravelle and Moessner 2001), we test for unbiasedness and efficiency of the survey data. Tables 2 and 3 show the results for the respective tests for the forecasts of monetary policy announcements. We find that the survey expectations are of good quality as they prove to be unbiased and efficient for all three central banks.

The expectations data allow us to investigate the predictability of the monetary policy decisions. Since monetary policy rates are usually changed in discrete steps of (multiples of) 25 basis points, we define a forecast to be correct, or a monetary policy decision to be anticipated by the market, if the expectations lie within an interval of 12.5 basis points above or below the announced decision. Obviously, the markets anticipate the overwhelming majority of interest rate decisions – since in most cases, the decision to leave

[2]An alternative to this survey data is the use of market instruments, in particular the Fed funds futures rate for the USA (Kuttner 2001). One reason for our decision to nevertheless choose the survey data was the unavailability of a reliable market measure for monetary policy expectations for Germany. For a robustness test, see Section IV.B. All results reported in Tables 1, 2 and 3 are calculated on a subsample of data that contains FOMC meeting days only.

Table 1: Summary Statistics for Monetary Policy Announcements, Surveys, and Surprises

	Announcements		Survey		Surprise		Number of forecasts	
Monetary policy *announcements*	Number of meetings	Mean abs. announcements*	Mean abs. survey*	Std. Dev.	Mean abs. surprise*	Std. Dev.	'correct'	'false'**
Federal Reserve	78	0.144	0.120	0.211	0.049	0.112	65	13
Bundesbank	144	0.040	0.025	0.066	0.044	0.113	127	17
ECB	72	0.052	0.041	0.086	0.044	0.087	61	11
Monetary policy *changes*	Number of changes	Mean abs. changes*	Mean abs. survey*	Std. Dev.	Mean abs. surprise	Std. Dev.	'correct'	'false'**
Federal Reserve	31	0.363	0.281	0.334	0.102	0.173	23	8
Bundesbank	13	0.442	0.120	0.120	0.322	0.114	1	12
ECB	12	0.354	0.147	0.190	0.207	0.249	4	8

Notes: *Means are calculated from the absolute announcements, surveys and surprises.
**A 'correct' forecast is defined as an absolute surprise of within ± 12.5 basis points of the announcement or change.
Source: Federal Reserve, Bundesbank, ECB, Reuters, own calculations.

Table 2: Test of Unbiasedness of Expectations of Monetary Policy Announcements

	α	std. error	β	std. error	R^2	Wald test	p-value	# obs.
Federal Reserve	– 0.013	(0.013)	1.039	(0.060)	0.795	0.73	[0.483]	78
Bundesbank	– 0.015	(0.010)	0.988	(0.143)	0.251	1.190	[0.306]	144
ECB	– 0.006	(0.008)	1.164	(0.101)	0.381	1.970	[0.142]	73

Note: Following Gravelle and Moessner(2001), Table 2 shows the results for the test whether the expectations of monetary policy announcements are unbiased, based on the following equation:

$$A_{k,t} = \alpha + \beta E_{k,t} + \varepsilon_{k,t} \tag{A.1}$$

where $E_{k,t}$ denotes the expectation of the announcement and $A_{k,t}$ the actual announcement value, with k = Germany, USA or the euro area. The unbiasedness test is a Wald test of the joint hypothesis H_0: $\alpha = 0$ and $\beta = 1$. This hypothesis cannot be rejected at the 90% level for monetary policy announcements of all three central banks.

Source: Federal Reserve, Bundesbank, ECB, Reuters, own calculations.

Table 3: Test of Efficiency of Expectations of Monetary Policy Announcements

	R^2	Wald test	p-value	# obs.
Federal Reserve	0.078	0.920	[0.486]	72
Bundesbank	0.020	0.440	[0.851]	138
ECB	0.038	0.430	[0.854]	67

Note: The expectations are efficient if forecast errors of monetary policy decisions ($A_{k,t} - E_{k,t}$) cannot be predicted systematically on the basis of past announcements:

$$A_{k,t} - E_{k,t} = \zeta + \sum_{p=1}^{P} \psi_p A_{k,t-p} + \varepsilon_{k,t} \tag{A.2}$$

with the lag length usually chosen as $P = 6$. The hypothesis to be tested is H_0: $\psi_1 = \psi_2 = \ldots = \psi_P = 0$. The Wald tests show that this hypothesis cannot be rejected for either of the expectation series.

Source: Federal Reserve, Bundesbank, ECB, Reuters, own calculations.

interest rates unchanged was anticipated well (see first panel of Table 1). Looking only at the events when the central banks decided to change their policy interest rates (second panel of Table 1), it turns out that the ECB does somewhat worse than the Federal Reserve, but considerably better than the Bundesbank: for the ECB, 4 out of 12 changes have been anticipated correctly; for the Federal Reserve, this has been the case for 23 of the 31 changes, and for the Bundesbank for 1 out of 13 changes.

Finally, we construct the surprise component for each monetary policy announcement ($S_{k,t}$) by deducting the expectation of the announcement ($E_{k,t}$) from the actual announcement value of the variable ($A_{k,t}$): $S_{k,t} = A_{k,t} - E_{k,t}$, with k = Germany, USA in 1993–1998 and k = euro area, USA in 1999–2002. For days without FOMC meetings, $S_{k,t}$ is defined to be zero.

B. Interest Rate Data

The market interest rates that we use are interbank rates for Germany and the euro area, and treasury bill rates for the USA, all of which are available at maturities of 1, 3, 6 and 12 months. For Germany, we take the FIBOR, which is then continued by the EURIBOR for the euro area. The closing quotes for both are determined at 11:00 Central European Time (CET). For the US Treasury bill market, we use quotes that are determined at 17:30 Eastern Standard Time (EST). The time difference between EST and CET is usually 6 hours with the exception of one week in late March/early April when the difference is 7 hours due to the later transition to daylight saving time in the USA, hence there is no overlap in trading times. Figure 1 shows that the market interest rates follow the monetary policy rates closely, especially at the short maturities.

As to the frequency of the analysis, we use a daily frequency rather than intra-day or tick-by-tick data. The drawback of such an analysis on a lower frequency is that other events and news during the day may introduce some noise, thereby possibly making the measurement of announcement spill-overs less accurate. However, such noise occurs less frequently in money markets than in other financial markets. On the other hand, by using daily data, potential overshooting effects in the very short run are accounted for.

Table 4 shows the summary statistics for the interest rate series. It reveals strong evidence of negative skewness, excess kurtosis, non-normality and serial correlation. The econometric model therefore needs to take into account these specific data characteristics.

III. The Econometric Approach

We model the processes of interest rate changes in an exponential GARCH (EGARCH) framework to take into account the specific characteristics of the data described in the previous section. Moreover, a key advantage of this methodology is that it enables us to measure news and spillover effects both for the conditional means and the conditional variances. We employ a bivariate EGARCH(1,1) model[3] following Nelson (1991) in which the conditional mean equations for the changes in the market interest rates Δr_t

[3]As specification tests, we also tested EGARCH models with higher-order lags. However, the EGARCH (1,1) model proved sufficient to address the data characteristics described in Table 4, including the finding that it solved for the autocorrelation in the interest rates series.

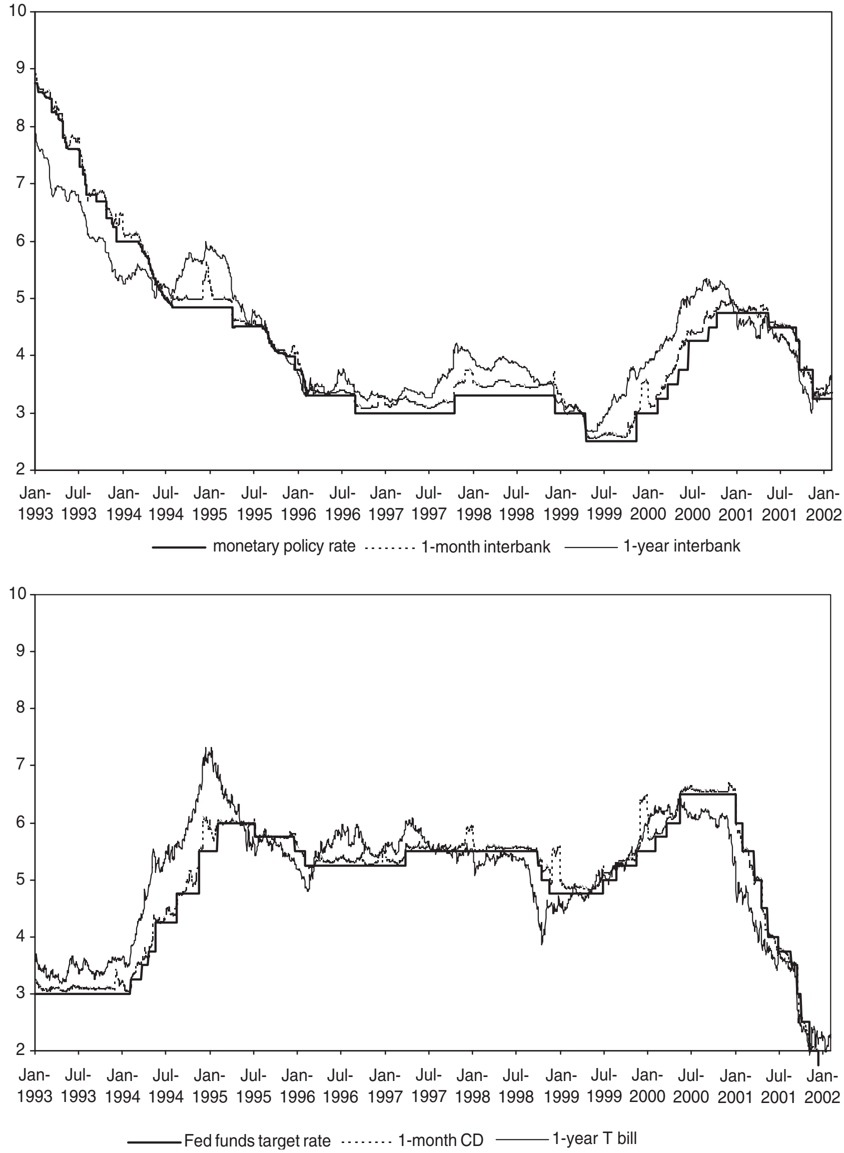

Figure 1: Monetary policy and market interest rates, Germany/euro area and USA, 1993–2002(in %)

for the USA and Germany/euro area (EA) are expressed as a function of past interest rate changes in both areas, the monetary policy surprises ($s_{k,t}$) as well as day-of-the-week effects (*Mon, Fri*):[4]

[4]Day-of-the-week effects were also tested for other days, but only the coefficients for the Friday and Monday dummies were found to be significant in some specifications. For

Table 4: Statistical Properties of the Daily Interest Rate Changes

	Germany	Euro Area	United States
1-month rates			
Mean	– 0.004***	0.000	– 0.001
Skewness	– 0.941***	– 1.221***	– 0.109**
Excess kurtosis	34.289***	59.578***	113.588***
Jarque–Bera	76851.253***	119407.250***	1274108.959***
Q(40)	151.514***	74.757***	166.347***
$Q^2(40)$	65.042***	61.276**	175.499***
3-month rates			
Mean	– 0.004***	0.000	– 0.001
Skewness	– 2.104***	0.007	– 0.305***
Excess kurtosis	23.581***	66.253***	20.086***
Jarque–Bera	37390.909***	147412.803***	39876.406***
Q(40)	225.439***	121.821***	485.267***
$Q^2(40)$	32.412	2.993	269.449***
6-month rates			
Mean	– 0.003***	0.000	– 0.001
Skewness	– 0.526***	– 1.130***	– 0.660***
Excess kurtosis	21.639***	19.876***	11.183***
Jarque-Bera	30585.217***	13439.419***	12520.985***
Q(40)	336.399***	143.626***	235.696***
$Q^2(40)$	25.171	22.313	208.629***
1-year rates			
Mean	– 0.003***	0.001	– 0.001
Skewness	0.652***	0.123	– 0.560***
Excess kurtosis	19.654***	7.114***	8.580***
Jarque–Bera	25284.445***	1701.723***	7393.886***
Q(40)	184.882***	74.448***	80.882***
$Q^2(40)$	68.984***	59.628**	121.081***

*/**/*** denotes significance at the 10/5/1% level. Jarque–Bera is the Jarque–Bera test statistic for normality; Q(40) is the Ljung–Box test statistic for serial correlation of up to 40th order; $Q^2(40)$ is the Ljung–Box test statistic for the squared interest rate changes.

$$\Delta r_t^{EA} = \alpha_1 + \beta_1^{EA}\Delta r_{t-1}^{EA} + \beta_1^{US}\Delta r_{t-1}^{US} + \gamma_1 s_{k,t} + \delta_1^M Mon + \delta_1^F Fri + \varepsilon_{1,t} \quad (1)$$

$$\Delta r_t^{US} = \alpha_2 + \beta_2^{EA}\Delta r_t^{EA} + \beta_2^{US}\Delta r_{t-1}^{US} + \gamma_2 s_{k,t} + \delta_2^M Mon + \delta_2^F Fri + \varepsilon_{2,t} \quad (2)$$

As to the conditional variance equations, each of the two conditional second moments is formulated as a function of a monetary policy announcement dummy variable ($n_{k,t}$), which is unity for those days when

parsimony, we estimate each model twice, once with the US announcement, and once with the European announcement. Since there is only minimal overlap of the meeting days, results are practically unchanged when we enter both surprises simultaneously.

an announcement is made and zero otherwise,[5] the day-of-the-week effects (*Mon, Fri*), as well as the past variance ($h_{1,t\text{-}1}$) and innovations ($\varepsilon_{1,t\text{-}1}$) in the euro area and past variance ($h_{2,t\text{-}1}$) and innovations ($\varepsilon_{2,t\text{-}1}$) in the USA. Note that the variance ($h_{1,t}$) and innovations ($\varepsilon_{1,t}$) of the euro area enter the conditional variance equation of the USA on the same business day because the interbank rates in Europe are set before the US markets open. The EGARCH approach accounts for the skewness, kurtosis and the time-varying volatility of the interest rate data by formulating a non-normal density for the residuals of the interest rate processes in the following way:

$$\begin{aligned}\ln(h_{1,t}) = \omega_1 &+ \theta^{EA}_{1,\varepsilon 1}\left[\left|\frac{\varepsilon_{1,t-1}}{\sqrt{h_{1,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right] + \theta^{EA}_{1,\varepsilon 2}\left[\frac{\varepsilon_{1,t-1}}{\sqrt{h_{1,t-1}}}\right] + \theta^{EA}_{1,h}\ln\left(h_{1,t-1}\right) \\ &+ \theta^{US}_{1,\varepsilon 1}\left[\left|\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right] + \theta^{US}_{1,\varepsilon 2}\left[\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right] + \theta^{US}_{1,h}\ln\left(h_{2,t-1}\right) \\ &+ \kappa_1 n_{k,t} + \varphi^M_1 Mon + \varphi^F_1 Fri \qquad (3)\end{aligned}$$

$$\begin{aligned}\ln(h_{2,t}) = \omega_1 &+ \theta^{EA}_{2,\varepsilon 1}\left[\left|\frac{\varepsilon_{1,t}}{\sqrt{h_{1,t}}}\right| - \sqrt{\frac{2}{\pi}}\right] + \theta^{EA}_{2,\varepsilon 2}\left[\frac{\varepsilon_{1,t}}{\sqrt{h_{1,t}}}\right] + \theta^{EA}_{2,h}\ln\left(h_{1,t}\right) \\ &+ \theta^{US}_{2,\varepsilon 1}\left[\left|\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right] + \theta^{US}_{2,\varepsilon 2}\left[\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right] + \theta^{US}_{2,h}\ln\left(h_{2,t-1}\right) \\ &+ \kappa_2 n_{k,t} + \varphi^M_2 Mon + \varphi^F_2 Fri \qquad (4)\end{aligned}$$

A further advantage of the EGARCH approach is that it does not require us to impose non-negativity constraints on the coefficients of the conditional second moments. Finally, the model is estimated via log likelihood estimation of the function

$$L(\mu) = \left[\frac{T}{2}\right]\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left(\ln|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t\right) \qquad (5)$$

with H_t as the time-varying conditional variance-covariance matrix, T the number of observations, and μ the vector of parameters of interest. The Simplex algorithm is used to get initial values and the BHHH algorithm to obtain the final parameter estimates.

[5]The alternative specification of using absolute announcement surprises yielded quite similar results to that of using announcement dummies.

IV. The Effects of Monetary Policy Surprises

We estimate these models for two subsamples: the time prior to EMU, i.e. January 1993–December 1998, and EMU, i.e. January 1999–January 2002. Tables 5 and 6 contain the corresponding results. We report results for the mean equations (1)–(2) in the upper panels, for the variance equations (3)–(4) in the lower panels. Three parameters of interest are listed: the foreign lag in each equation, the effect of Bundesbank/ECB surprises, and of Federal Resserve surprises, each for the European and US mean and variance equations. For each of these parameters, we have tested whether they are different for the two subsamples. The corresponding results are provided in Table 7.

A. General Market Linkages

The parameters β_1^{US} and β_2^{EA} provide us with a measure of general market linkages, namely the extent to which interest rate changes in one market spill over to the other market. For the volatility equations, the corresponding effects are given by parameters $\theta_{1,h}^{US}$ and $\theta_{2,h}^{EA}$. Markets do generally reflect the foreign developments, which can arise due to two reasons: due to a response to news which are relevant for both markets, or due to financial integration.

Comparing Tables 5 and 6, it turns out that the parameters are estimated to be higher under EMU, pointing to a stronger general linkage of markets. This is confirmed in Table 7, which shows that these differences are mostly highly significant. First, spillovers in the mean equation have become larger over time, in particular from the US market to the euro area market. Second, especially volatility spillovers have become considerably stronger in recent years. Interestingly, these volatility spillovers are consistently documented in both directions, i.e. both from the USA to Europe and vice versa.

Overall, these results suggest that general linkages between the euro area and the USA have intensified over time, and in particular since Stage 3 of EMU in 1999.

B. News Effects and the Yield Curve

While we have so far looked at the general linkage of the two money markets, we now analyse the specific effects of monetary policy news, both on domestic money markets and on foreign markets. A surprise about a monetary policy announcement implies that the policy rate is increased by

Table 5: Effects of Monetary Policy Surprises, 1993–1998

Maturity (months)	General market linkage: Foreign lag				News effects: European monetary policy surprise				News effects: US monetary policy surprise			
	Eur. mean eq. (β_1^{US})		US mean eq. (β_2^{EA})		Eur. mean eq. (γ_1)		US mean eq. (γ_2)		Eur. mean eq. (γ_1)		US mean eq. (γ_2)	
1	0.043***	(0.005)	0.265***	(0.037)	0.192***	(0.018)	0.021**	(0.008)	0.233***	(0.019)	0.550***	(0.052)
3	0.036***	(0.005)	0.068*	(0.035)	0.216***	(0.015)	– 0.002	(0.014)	0.048*	(0.025)	0.529***	(0.058)
6	0.097***	(0.007)	0.057	(0.038)	0.149***	(0.019)	– 0.019	(0.015)	0.154***	(0.013)	0.381***	(0.049)
12	0.099***	(0.008)	– 0.033	(0.052)	0.160***	(0.008)	– 0.012	(0.031)	– 0.019	(0.039)	0.392***	(0.052)
	Eur. var. eq. ($\theta_{1,h}^{US}$)		US var. eq. ($\theta_{2,h}^{US}$)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)	
1	0.000	(0.006)	0.257***	(0.013)	0.967***	(0.078)	– 0.713***	(0.062)	1.034***	(0.060)	1.330***	(0.077)
3	0.049***	(0.015)	0.046***	(0.014)	0.937***	(0.087)	0.136*	(0.075)	0.998***	(0.075)	0.263***	(0.086)
6	0.153***	(0.017)	0.000	(0.012)	1.255***	(0.072)	0.027	(0.075)	0.484***	(0.079)	0.139	(0.079)
12	0.228***	(0.021)	0.030***	(0.010)	1.055***	(0.065)	0.151**	(0.074)	– 0.070	(0.081)	0.011	(0.094)

*/**/*** denotes significance at the 10/5/1% level. Numbers in brackets are standard errors.

Table 6: Effects of Monetary Policy Surprises, 1999–2002

Maturity (months)	General market linkage: Foreign lag				News effects: European monetary policy surprise				News effects: US monetary policy surprise			
	Eur. mean eq. (β_1^{US})		US mean eq. (β_2^{EA})		Eur. mean eq. (γ_1)		US mean eq. (γ_2)		Eur. mean eq. (γ_1)		US mean eq. (γ_2)	
1	0.094***	(0.018)	0.208***	(0.059)	0.392***	(0.004)	0.062*	(0.035)	0.247***	(0.016)	0.571***	(0.018)
3	0.045***	(0.016)	0.033	(0.060)	0.308***	(0.012)	0.020	(0.066)	0.221***	(0.019)	0.459***	(0.091)
6	0.102***	(0.015)	0.062	(0.072)	0.267***	(0.014)	– 0.033	(0.049)	0.159***	(0.023)	0.373***	(0.101)
12	0.165***	(0.020)	0.091*	(0.053)	0.258***	(0.014)	0.009	(0.045)	0.143***	(0.028)	0.303***	(0.091)
	Eur. var. eq. ($\theta_{1,h}^{US}$)		US var. eq. ($\theta_{2,h}^{US}$)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)	
1	0.014	(0.009)	0.563***	(0.018)	– 0.373***	(0.031)	0.419***	(0.157)	1.059***	(0.102)	0.328*	(0.169)
3	0.229***	(0.021)	0.191***	(0.024)	0.059	(0.119)	0.296***	(0.099)	– 1.076***	(0.112)	– 0.075	(0.171)
6	0.218***	(0.020)	0.187***	(0.026)	0.354***	(0.093)	0.423***	(0.131)	– 0.236*	(0.132)	0.253	(0.176)
12	0.166***	(0.024)	0.116***	(0.020)	– 0.022	(0.102)	– 0.025	(0.113)	0.000	(0.139)	– 0.415**	(0.173)

*/**/*** denotes significance at the 10/5/1% level. Numbers in brackets are standard errors.

Table 7: *t*-statistics for Tests of Differential Effects of Monetary Policy Surprises, Pre-EMU versus Post-EMU

Maturity (months)	General market linkage: Foreign lag				News effects: European monetary policy surprise				News effects: US monetary policy surprise			
	Eur. mean eq. (β_1^{US})		US mean eq. (β_2^{EA})		Eur. mean eq. (γ_1)		US mean eq. (γ_2)		Eur. mean eq. (γ_1)		US mean eq. (γ_2)	
1	3.204***	(0.001)	2.506**	(0.012)	24.261***	(0.000)	12.748***	(0.000)	6.834***	(0.000)	11.289***	(0.000)
3	1.568	(0.117)	1.500	(0.134)	23.812***	(0.000)	3.313***	(0.000)	5.899***	(0.000)	– 2.407**	(0.016)
6	5.114***	(0.000)	4.330***	(0.000)	9.883***	(0.000)	0.627	(0.531)	10.107***	(0.000)	– 1.944*	(0.052)
12	7.696***	(0.000)	3.992***	(0.000)	5.857***	(0.000)	0.130	(0.897)	3.457***	(0.000)	– 2.757***	(0.006)
	Eur. var. eq. ($\theta_{1,h}^{US}$)		US var. eq. ($\theta_{2,h}^{US}$)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)	
1	– 0.053	(0.958)	5.216***	(0.000)	– 16.368***	(0.000)	12.409***	(0.000)	2.045**	(0.041)	– 8.357***	(0.000)
3	11.971***	(0.000)	11.929***	(0.000)	– 6.526***	(0.000)	2.269**	(0.023)	– 4.962***	(0.000)	– 1.554	(0.120)
6	9.018***	(0.000)	11.464***	(0.000)	– 6.286***	(0.000)	1.929*	(0.054)	– 3.543***	(0.000)	1.529	(0.126)
12	1.123	(0.261)	5.424***	(0.000)	– 3.892***	(0.000)	– 1.462	(0.144)	– 0.124	(0.901)	– 2.043**	(0.041)

*/**/*** denotes significance at the 10/5/1% level. Numbers in brackets are p-values.

more (or lowered by less) than the market had expected. Such a surprise should lead to an increase in market interest rates. Regarding the effect on the *domestic* market, three findings emerge. First, we do indeed find positive and highly significant effects of European surprises on European interest rates, as well as of US surprises on US interest rates.

Second, the responses of European interest rates to the European monetary policy surprises vary significantly over our two subsamples: they are generally lower in the 1993–98 than in 1999–2002.[6] This could indicate that the survey-based expectation measures have improved in quality over time. Nonetheless, the effects are significant for all maturities also in the first subsample, for both the USA and Europe.

Third, the effects of surprises vary across maturities: the longer the maturity, the smaller the effect. This is a well-known fact. Changes at the long end of the yield curve after a monetary tightening, for example, are driven by two factors: liquidity effects and inflation expectations. With a tightening, interest rates do generally increase – however, if the central bank can lower inflation expectations, nominal long-term rates are reduced. The second effect could even dominate the first, such that long-term rates could decrease following a tightening (Thornton 1998). The effect of a monetary policy decision on long rates can therefore be not only quantitatively different but also qualitatively different from that on shorter maturities.

Regarding the effects of monetary policy announcements on interest rates at the very short end, one would expect a coefficient of close to one: an unexpected change in the policy rates should be reflected one to one. Instead, the estimated coefficients are much smaller than one. One possible reason for this lies in the accuracy of our expectation measure. Since it is obtained from surveys, it need not capture the market expectations precisely. Since the surveys are generally conducted some days prior to the announcements, expectations can change in the meantime. However, the general significance of the regressors indicates that the measure performs relatively well. Söderström (2001) has furthermore shown that it is difficult for futures-based expectation measures to outperform the survey-based measures. Table 8 confirms this finding. In a robustness test, we calculate the effects of monetary policy surprises derived from financial markets. For the USA, we use the measures of surprise by Kuttner (2001), which are derived from the federal funds futures markets. For the euro area, our measures are taken from Würtz (2003), calculated from forward rates. The estimation period is identical to the one underlying Table 6. The results obtained are remarkably similar qualitatively; however, the coefficients

[6]Table 7 provides the formal test, testing the hypothesis whether the corresponding parameters are equal across the two subperiods.

Table 8: Effects of Monetary Policy Surprises as Measured by Futures and Forward Rates, 1999–2002

Maturity (months)	General market linkage: Foreign lag				News effects: European monetary policy surprise				News effects: US monetary policy surprise			
	Eur. mean eq. (β_1^{US})		US mean eq. (β_2^{EA})		Eur. mean eq. (γ_1)		US mean eq. (γ_2)		Eur. mean eq. (γ_1)		US mean eq. (γ_2)	
1	0.081***	(0.024)	0.241***	(0.050)	0.189***	(0.011)	− 0.005	(0.020)	0.293***	(0.031)	0.779***	(0.017)
3	0.044***	(0.016)	0.026	(0.079)	0.095***	(0.008)	− 0.037	(0.037)	0.245***	(0.024)	0.624***	(0.123)
6	0.103***	(0.015)	0.073	(0.070)	0.087***	(0.009)	− 0.057***	(0.020)	0.195***	(0.032)	0.534***	(0.119)
12	0.173***	(0.019)	0.109**	(0.050)	0.083***	(0.010)	− 0.060***	(0.017)	0.195***	(0.041)	0.466***	(0.121)
	Eur. var. eq. ($\theta_{1,h}^{US}$)		US var. eq. ($\theta_{2,h}^{US}$)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)		Eur. var. eq. (κ_1)		US var. eq. (κ_2)	
1	0.044***	(0.010)	0.619***	(0.030)	− 0.053	(0.091)	0.390***	(0.101)	1.213***	(0.112)	1.345***	(0.230)
3	0.325***	(0.023)	0.273***	(0.022)	0.148	(0.119)	0.002	(0.132)	− 0.101	(0.124)	0.126	(0.196)
6	0.198***	(0.018)	0.180***	(0.024)	0.492***	(0.133)	0.036	(0.130)	− 0.201	(0.127)	0.218	(0.173)
12	0.137***	(0.019)	0.057***	(0.018)	0.033	(0.108)	0.128	(0.090)	0.034	(0.143)	− 0.361**	(0.179)

*/**/*** denotes significance at the 10/5/1% level. Numbers in brackets are standard errors.

estimated in the mean equations increase only for the US case, whereas we find them to be even smaller for the euro area surprises. We take these results as evidence that our surprise measures are of high quality. Another explanation of the low coefficients for Germany and the euro area is that the Zentralbankrat meetings and Governing Council meetings were taking place fortnightly till November 2001. Policy decisions were therefore taken twice within one month. This means that a policy move that was expected for the next meeting, but occurs already at the present meeting, has to some extent been priced into the one month interest rates. In such a case, the market reaction to a surprise should be lower than one to one even at the shorter maturities.

Beyond the effect on the *domestic* market, our model allows us to analyse how markets react to *foreign* surprises. Looking at the first subsample of 1993–98, evidence of spillover effects is restricted to the low maturities: US rates react to Bundesbank surprises merely at the one-month maturity; German rates react somewhat more, namely up to a maturity of six months. Under EMU, this effect strengthens and broadens: the estimated responses become larger, are significantly different, and now extend to all maturities. It has to be noted that this effect is on top of the general market linkage: the overall reaction of euro area markets to Federal Reserve surprises does therefore consist of the reflection of the response in the US markets (through the linkage parameter β_1^{US}), plus the direct effect on the euro area markets (measured by γ_1).

C. News Effects on Market Volatility

The main focus in the announcement literature has been on the effects of news on the conditional mean of asset prices. But announcements may also have a significant effect on the conditional volatility of interest rates. The volatility effects of announcements depend on the heterogeneity of beliefs and expectations of market participants. Heterogeneity in the interpretation of a particular announcement would raise volatility, while markets may settle if the announcement is well understood, and helps to clarify market views. Fleming and Remolona (1997) show that volatility in the US bond market peaks just after the release of macroeconomic news. Lee (2002) shows that the effect of Federal Reserve announcements on interest rate volatility has decreased in the last decades.

The second panels of Tables 6–8 show the estimated coefficients of the variance equations, again for varying maturities. As stated above, volatility is generally transmitted significantly across markets, regardless of the sample period analysed. The effects of monetary policy surprises on market volatility differ over the subsamples, though. Bundesbank surprises led to higher volatility in all maturities, an effect which has been markedly reduced under EMU. For the USA, we confirm the finding by Lee (2002): whereas up to 1998, Federal Reserve surprises increased volatility in the 1- and 3-month maturities, this is no longer the case for the 3-month rates, and to a much smaller extent for the 1-month rates. In accordance with this reduced effect on domestic volatility, transatlantic volatility spillovers have also declined.

D. What Has Changed with EMU?

As shown in Table 7, most of the parameters of interest in this paper are significantly different across the two subperiods. First, in the post EMU period, foreign developments are generally reflected to a much larger extent in money markets. This effect shows up for both areas, the US and the euro area, and is most clearly seen for the variance equation. Increased volatility in one market does therefore lead to higher volatility in the other market to an extent that had not been seen prior to EMU, a finding that points to a stronger market interdependence in recent years.

Second, the effect of ECB monetary policy on euro area markets is stronger than the corresponding effect of the Bundesbank. Along with the reduced effect on euro area market volatility, this could imply that markets understand the ECB policy better (an interpretation which is also consistent with the results on the predictability of monetary policy announcements in Table 1), and accordingly react in a stronger fashion.

Finally, the stronger response of euro area markets to US announcements could be due to changing real integration of the two economies, in the sense that US monetary policy signals have better informational content for future economic developments in the euro area than they used to have, also because the EMU subsample comprises the recent recession, which affected both the USA and the euro area. This hypothesis is tested in a companion paper (Ehrmann and Fratzscher 2003).

V. Conclusions

This paper has investigated how money markets in the USA, Germany (up to 1998) and the euro area (since 1999) react to Federal Reserve, Bundesbank and ECB monetary policy announcements. Beyond an analysis of the response of domestic money markets, the main objective of the paper has been to analyse the extent to which monetary policy news spill over *across* markets, both in terms of the effect on the level and the volatility of foreign interest rates. First, the paper presented evidence that the general linkage of money markets has increased considerably over time: interest rate developments and volatility in either the USA or the euro area are generally mirrored in the other market to a much larger extent than prior to EMU. This finding indicates that euro area and US money markets have generally become more integrated and interdependent over time.

Second, we have found that interest rates respond strongly to domestic monetary policy throughout, whereas the response to foreign monetary policy varies across markets and over time: both the German and the euro area market react to Federal Reserve announcements, whereas US markets do not generally respond to European monetary policy. Regarding effects on the volatility of money markets, we find that announcements by the Bundesbank increased the volatility of German money markets, but that such effects are rarely found for the ECB, and have basically disappeared for the Federal Reserve. These findings suggest that the markets' understanding and anticipation of monetary policy decisions in the USA and the euro area has improved over time, resulting in less uncertainty and lower volatility in the markets in the days around policy decisions.

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