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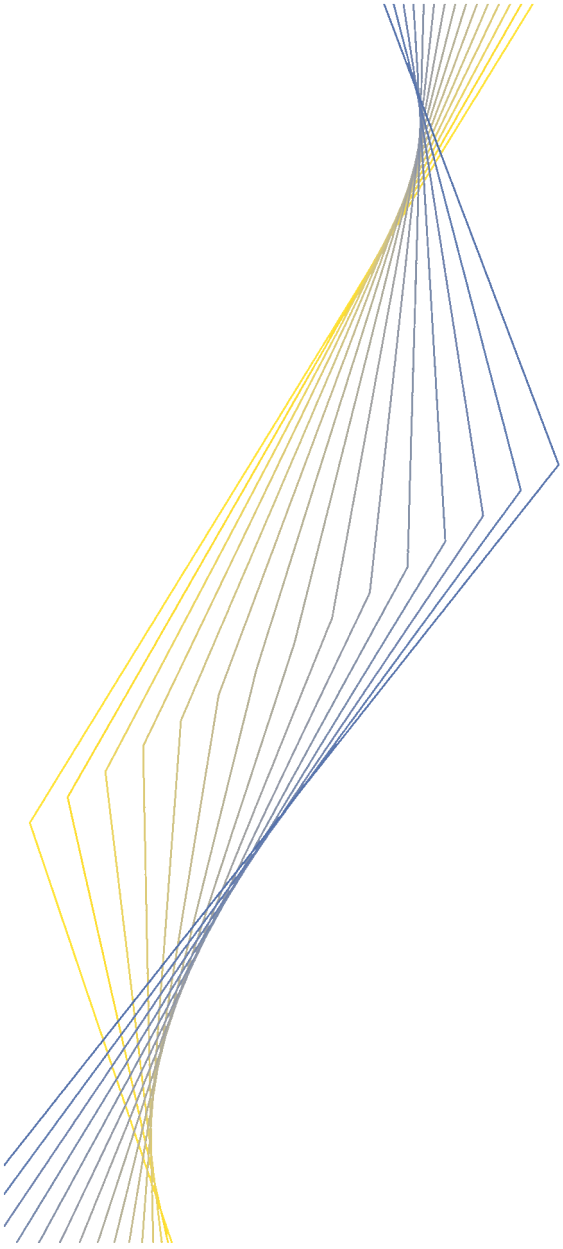

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INTERDEPENDENCE BETWEEN THE EURO AREA AND THE US: WHAT ROLE FOR EMU?[1]

BY MICHAEL EHRMANN[2]
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Contents

Abstract

This paper investigates whether the degree and nature of interdependence between the United States and the euro area have changed with the advent of EMU. Using real-time data, it addresses this issue from the perspective of financial markets by analysing the effects of monetary policy announcements and macroeconomic news on daily interest rates in the United States and the euro area. The paper finds that the interdependence of money markets has steadily increased over time, with the spillover effects from the United States to the euro area being somewhat stronger than in the opposite direction. Moreover, for the early stages of EMU, we find evidence that the markets were going through a learning process about the ECB monetary policy. Towards the end of our sample period, the importance attached to euro area consumer prices and M3 has reached levels that are remarkably similar to the role of German consumer prices and M3 for German interest rates prior to EMU.

JEL classification: E43, E52, F42
Keywords: interdependence; announcements; news; money markets; real-time data; United States; euro area.

Non-technical summary

News releases for the US economy are generally monitored closely also in European financial markets, and vice versa, reflecting economic and financial interdependence between the US and European economies. This paper models the degree of interdependence by focusing on the reaction of daily money market interest rates to macroeconomic news and monetary policy announcements in the US and the euro area, explicitly allowing for spillover effects across countries.

The analysis is conducted for two subperiods, 1993-1998 and 1999-2002. For the first subperiod, we analyse German and US data, and for the second subsample, we use data on the euro area and the US. This allows us to test whether EMU has changed the degree and nature of this interdependence. The euro area is larger and more closed than the economies of the single member countries. This could have two effects on the importance market participants attach to news. It could imply that the euro area markets are now focusing less on US developments and more on domestic news. Moreover, it may imply that the US markets now react more strongly to developments in the euro area than they did to news about individual member countries.

This paper analyses furthermore the way financial markets perceive central bank behaviour. If interest rates react to news, then this is most likely a reflection of the market's expectation about the future course of monetary policy. In this respect, the analysis of EMU is interesting in several dimensions. First, it is possible to see whether there has been a learning process in the markets about the monetary policy strategy of the European Central Bank (ECB). The creation of EMU brought about a structural change in the monetary policy regime, such that the markets could not rely on a track record and their experience, but had to learn about the way the ECB sets monetary policy. Second, this need to learn may have implied that the initial period of EMU was one of increased market uncertainty. It is interesting to see whether markets behave differently in such periods. Third, such an analysis can answer whether the ECB was or is perceived to behave like the German Bundesbank prior to EMU.

The empirical results of the paper suggest that the linkages of the euro area and US money markets have steadily increased over time. Beyond this general effect, there are times when European markets react to news about the US economy. For the early stages

of EMU, we find evidence that the markets were going through a learning process about the ECB monetary policy. Towards the end of our sample period, the importance attached to euro area consumer prices and M3 has reached levels that are remarkably similar to the role of German consumer prices and M3 for German interest rates prior to EMU. Throughout this learning process, the attention devoted to US announcements has decreased. Finally, we find evidence for nonlinearities of announcement and spillover effects. The reaction of interest rates and their volatility tends to be stronger when markets have difficulties in gaining a clear view of the future course of monetary policy.

1. Introduction

The release of economic news, i.e. of real-time data regarding the US economy is monitored closely also in European financial markets, and vice versa. These spillovers of news effects reflect economic and financial interdependence between the US and European economies. The aim of this paper is to investigate the degree of interdependence by focusing on the daily reaction of money market interest rates to macroeconomic news and monetary policy announcements in the US and the euro area, explicitly allowing for spillover effects across countries.

By comparing the interdependence between the US and Germany prior to EMU with the situation between the US and the euro area since 1999, this paper tests whether EMU has changed the degree and nature of this interdependence. With the advent of European Monetary Union (EMU), a new currency area has been created that is much larger and more closed than the economies of the single member countries. As a matter of fact, the euro area is similar to the US in both size and degree of openness. This could have two effects on the importance attached to news by market participants. On the one hand, it could imply that the euro area markets are now focusing less on US developments. On the other hand, it could also mean that the US markets do now react more strongly to developments in the euro area than they did to news about individual member countries.

The analysis of money market interest rates allows us to furthermore analyse the perception of monetary policy by financial markets. If interest rates react to news, then this is most likely a reflection of the market's expectation about the future course of monetary policy (Kearney, 2002). In this respect, the analysis of EMU is interesting in several dimensions. First, it is possible to evaluate whether there has been a learning process in the markets about the monetary policy strategy of the European Central Bank (ECB). The creation of EMU brought about a structural change in the monetary policy regime, such that the markets could not rely on a track record and their experience, but had to learn about the way the ECB would set monetary policy. Second, this need to learn may have implied that the initial period of EMU was one of increased market uncertainty. It is interesting to see whether markets behave differently in such periods. Third, such an analysis can answer whether the ECB was or is perceived to behave like the German Bundesbank prior to EMU.

The empirical results of the paper suggest that the linkages of money markets have steadily increased over time. Beyond this general effect, there are times when European markets react to news about the US economy. For the early stages of EMU, we find evidence that

the markets were going through a learning process about the ECB monetary policy. Towards the end of our sample period, the importance attached to euro area consumer prices and M3 has reached levels that are remarkably similar to the role of German consumer prices and M3 for German interest rates prior to EMU. Throughout this learning process, the attention devoted to US announcements has decreased. Finally, we find evidence for nonlinearities of announcement and spillover effects. The reaction of interest rates and their volatility tends to be stronger when markets have difficulties in gaining a clear view of the future course of monetary policy.

In the remainder of this paper, we provide a background discussion on the effects of news releases on interest rates in section 2. Sections 3 and 4 describe the data and the econometric models underlying our analysis. The results are reported in sections 5 to 7, with a focus on the effects of monetary policy announcements in section 5. Section 6 extends the analysis to macroeconomic announcements in general. In the subsequent section 7, we test for nonlinearities in the announcement effects. Section 8 concludes.

2. Some conceptual issues of news effects

To what extent monetary policy and macroeconomic news affect asset prices depends on a number of factors. To prepare the ground for the empirical analysis, this section provides a discussion of some of the key conceptual issues underlying the effects of news. For the purpose of this paper, we focus on five issues: the econometric identification of news effects, their economic determinants, the impact on the yield curve, spillovers, and the difference between mean and volatility effects.

2.1 Econometric identification of news effects

If economic fundamentals affect the market's view of the appropriate level of interest rates, the arrival of new information about those fundamentals is likely to lead to responses in market interest rates. In order to gauge the extent to which the underlying fundamentals affect markets, it is therefore crucial to properly model the arrival of new information. Releases of macroeconomic data, or the announcement of monetary policy decisions, are partly expected by the market. This expected part of the announcement is thus already priced into the market prior to the release. 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 figures from their 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 Federal Reserve decisions on the Fed funds target rate only affect market interest rates if these decisions are unexpected, while expected announcements have little or no effect on markets nowadays. Similar results are obtained by Roley and Sellon (1998) and Lange, Sack and Whitesell (2001), who furthermore show that markets have improved in their ability to anticipate US monetary policy decisions in the 1990s due to improved transparency and institutional changes. In this paper, we follow this strategy and investigate the surprise component of announcements.

2.2 Determinants of news effects

Which announcements are relevant for the market? First, market participants may give more importance to those announcement types that they believe will have the greatest impact on the behaviour of central banks. Kearney (2002) shows for the US that the market response to employment announcements reflects the expectations of the Fed's probable response.[1]

Second, the literature on herd behaviour and informational cascades (e.g. Banerjee 1992, Bikchandani et al. 1992) emphasises that what drives financial market outcomes is not so much the occurrence of news *per se*, but how this new information is processed and interpreted by market participants. The same news can have a vastly different effect on markets depending on the conditions of markets and market participants. It has been shown for bond markets (Fleming and Remolona, 1997) and for foreign exchange markets (Galati and Ho, 2001) that an announcement surprise is likely to have a larger effect under conditions of market uncertainty. Individual announcements tend to have a larger news content in such an environment than under conditions where there is a broad consensus about the course of monetary policy.

Similarly, the effect of announcements may depend on the position within the monetary policy cycle. Announcement surprises may have little effect on interest rates if the view about the course of monetary policy is unanimous. In other words, announcements tend to have the largest effect on money markets around turning points when there is no consensus yet among market participants about whether the next step will be a tightening or a

[1] For foreign exchange markets, Almeida et al. (1998) and Andersen and Bollerslev (1998) find that the variables that have the largest effect are news of inflation and monetary aggregates for Germany but mostly real sector variables for the US.

relaxation of the monetary policy stance. Demiralp and Jorda (2002) provide evidence that the market response to monetary policy decisions is markedly stronger when these decisions introduce a directional change in monetary policy, i.e. the first easing (tightening) after a sequence of tightenings (easings).

An important issue which, to our knowledge, has not been addressed in the literature yet is that markets may be most responsive to news if the released data is close to some declared or perceived (policy) target. An announcement surprise may have a significant effect on markets if this surprise changes the market's belief about the future course of monetary policy. Hence a surprise may have little impact on money markets if the announced value is far above or below a critical level, whereas it may have a larger relevance if the announcement is closer to this critical level. In this paper, we will test this hypothesis in the analysis of nonlinearities in section 7.

2.3 News effects and the yield curve

A widely researched area is the effect of announcements, and in particular of monetary policy changes, on the yield curve. For *monetary policy decisions*, resulting changes at the long end of the yield curve can at least in part be attributed to the market's views on the central bank's credibility or its ability to control inflation. Hence, for instance, a tightening of monetary policy can be compatible with a reduction in long-term interest rates if markets perceive the tightening as a credible step by monetary authorities to reduce inflation in the long run (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.

By contrast, for *macro announcements* a number of papers argue that the effects of news surprises at the short and medium maturities mainly reveal information about market participants' beliefs of the central bank's reaction function (see e.g. Haldane and Read, 2000). Fleming and Remolona (1999) find a hump-shaped impact effect of macroeconomic announcements on the yield curve in the US, i.e. the largest impact occurs at intermediate maturities between one and five years. This can be taken as evidence that markets expect monetary policy to react to news in the medium run. Data releases should, at least in normal circumstances, not lead to immediate monetary policy reactions. However, in the medium run, as more new information accumulates, monetary policy is likely to react, which implies that market interest rates at these maturities are affected.

Becker, Finnerty and Kopecky (1995) find that spillover effects of macro announcements for the US, UK, Japan and Germany have a smaller effect on the long end than at the short end of the yield curve. They interpret these results as being indicative of the presence of common international shocks to these countries.

2.4 News effects and interdependence

One important issue that has been given little attention in the literature so far is the relevance of news spillovers across markets. 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. A tightening of monetary policy in the target country, for instance, may force domestic authorities to adjust their own monetary policy stance in order to maintain the exchange rate target. Hence, foreign announcements may be relevant for domestic monetary policy decisions via this direct channel of targeting of external variables.

Secondly, the integration of global financial markets might lead to spillover effects. A change in monetary policy in the United States, for instance, will affect other money markets in other countries via capital flows and the elimination of arbitrage possibilities.

A third channel works through real integration, and implies that foreign announcements may reveal relevant information about domestic macroeconomic conditions. For instance, macroeconomic news in the US are relevant for the euro area if they provide information about the economic outlook of the euro area and thereby information about the likely stance of domestic monetary policy, and vice versa.

For interdependence in money markets, Gravelle and Moessner (2001) find that Canadian interest rates are strongly influenced by US macroeconomic news but only much less by Canadian news. They interpret these findings as reflecting the close integration between Canada and the US, but also revealing some market uncertainty about the reaction function of Canadian monetary policy. Kim and Sheen (2000) show similar results for Australian interest rates, which are found to be strongly affected by US news, in particular at the short end of the yield curve.

2.5 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 asset prices, both before and after announcements. The volatility effects of announcements depend on the heterogeneity of beliefs and expectations of market participants. Heterogeneity of expectations about an upcoming announcement may raise trading and uncertainty in markets, thereby increasing volatility prior to the announcement, whereas unanimity of expectations may have the opposite effect. Similarly, market participants may give different interpretations to particular announcements, thus raising volatility, while markets may settle immediately after other types of announcements.

Most of the analysis of volatility effects in the literature has focused on foreign exchange markets. The evidence for these markets mostly shows a higher degree of market volatility both before (Madura and Tucker, 1992) and after announcements (Ederington and Lee, 1995; Bonser-Neal and Tanner, 1996). A similar result is found for US bond markets (Fleming and Remolona, 1997). The explicit modelling of the conditional second moments in EGARCH and WLS frameworks allows us to test the volatility hypothesis also for money markets.

3. The data

3.1 Announcements and surprises

We look at monetary policy announcements as well as macroeconomic announcements for the US, Germany and the euro area during the period January 1993 (January 1999 for the euro area) to February 2002. Monetary policy announcements 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 10 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 Fed changed its policy rate somewhat more frequently during the

1993-2002 period than the Bundesbank and the ECB: 31 changes for the Fed, as compared to 13 for the Bundesbank, and 12 for the ECB (see Table 1).

Tables 1 to 3 around here

As to the macroeconomic announcements, we look at a set of 10 macroeconomic variables for each country which have been identified in the literature as the most relevant. The source for the data is Money Market Services (MMS) International. Table 4 lists the variables, the time period over which the data is available, the usual release time during the announcement day, as well as the lag with which the data becomes publicly available. Figure 1 show the release dates of the macro announcement for month T and reveal that, in general, macroeconomic data become available much more quickly in the US than in Germany or the euro area. Almost all the US announcements are released within the subsequent month, whereas most euro area and German announcements occur with a two-month lag.

Figure 1 and Tables 4 to 7 around here

The expectations data for monetary policy decisions originates from a Reuters poll of 25 to 30 market participants 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 (e.g. Gravelle and Moessner, 2001), we test for unbiasedness and efficiency of the survey data. We find that the survey expectations are of good quality as they prove to be unbiased and efficient. Tables 2 and 3 show the results for the respective tests for the forecasts of monetary policy announcements. The results show that the expectations are unbiased and efficient for the Fed, Bundesbank and ECB.

The expectations data allow us to investigate the predictability of the monetary policy decisions. 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

[2] An alternative to this survey data is the use of market instruments, in particular the Fed funds futures rate for the US (Kuttner 2001). One reason for our decision to nevertheless choose the survey data was the

overwhelming majority of interest rate decisions – since in most cases, the decision to leave interest rates unchanged was easily anticipated (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 approximately as well as the Fed: for the ECB, 9 out of 12 changes have been anticipated correctly; for the Fed, this has been the case for 24 of the 31 changes.

The expectations data for the macro announcements comes from MMS and is based on survey data of market participants. MMS collects the forecasts of about 40 money market managers every Friday for the announcements to be released during the subsequent week and reports the median of these forecasts. Unbiasedness and efficiency cannot be rejected at the 5% level for most of the macroeconomic announcement expectations, except for retail sales and the trade balance for Germany and retail sales and the unemployment rate for the US (Tables 6 and 7).[3]

Finally, we construct the surprise for each variable by deducting the expectation of the announcement ($E_{k,t}$) from the actual announcement value of the variable ($A_{k,t}$). Since the unit of measurement differs across variables, we will use in the econometric analysis below the standardised surprise ($S_{k,t}$), which is obtained by dividing the surprise by the sample standard deviation Ω_k of each announcement k:[4]

$$S_{k,t} = \frac{A_{k,t} - E_{k,t}}{\Omega_k}$$

3.2 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 US, 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

unavailability of a reliable market measure for monetary policy expectations for Germany. For a robustness test, see section 5.

[3] We decided to drop these two variables from our estimates. Furthermore, we dropped variables that turned out to be irrelevant in all our estimates.

[4] The expectations of monetary policy have not been standardised because the coefficients of the monetary policy surprises allow a meaningful interpretation without standardisation.

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 US. One advantage of this timing is that there is no overlap in trading times. US announcements therefore affect European markets only on the subsequent business day. European announcements mostly affect European interbank rates on the same day. In some cases like the monetary policy announcements in Germany and for the ECB, however, announcements occur after 11:00 CET so that the effect on these rates materialises only on the following day (see Table 4). Figure 2 shows that the market interest rates follow the monetary policy rates closely, especially at the short maturities.

Figure 2 and Table 8 around here

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 spillovers less accurate. However, such noise occurs less frequently in money markets than in other financial markets. Moreover, an important reason for using data on a daily frequency is that the *official* release times of announcements during the day, as given in Table 4, are not always the same as the *actual* release times. There is in particular evidence for Germany that the announcements are frequently "leaked" some time before the official release time. This fact has been given as a potential reason by some studies for why there is much less evidence for effects of German announcements (e.g. Andersen et al., 2001). The advantage of using data with daily frequency is therefore that it allows us to avoid this measurement problem.

Table 8 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.

4. The econometric approach

We model the processes of interest rate changes in exponential GARCH (EGARCH) and weighted least square (WLS) frameworks. Both methodologies take into account the specific characteristics of the data described in the previous section. Moreover, a key

advantage of these methodologies is that they enable us to measure news and spillover effects both for the conditional means and the conditional variances.

4.1 EGARCH modelling

As to the GARCH model, we employ a bivariate EGARCH model following Nelson (1991) in which the conditional mean equations for the changes in the market interest rates Δr_t for the US and Germany/euro area (EA) are expressed as a function of past interest rate changes in both areas, an announcement surprise of variable k ($s_{k,t}$) as well as day-of-the-week effects (*Mon, Fri*):[5]

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

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

where the announcement surprises ($s_{k,t}$) can be either macroeconomic announcements or monetary policy announcements, and they can originate either in the own area or abroad.

As to the conditional variance equations, each of the two conditional second moments is formulated as a function of an announcement dummy of variable k ($n_{k,t}$), which is unity for those days when an announcement is made and zero otherwise,[6] the day-of-the-week effects (*Mon, Fri*), as well as the past variance ($h_{1,t-1}$) and innovations ($\varepsilon_{1,t-1}$) in the euro area and past variance ($h_{2,t-1}$) and innovations ($\varepsilon_{2,t-1}$) in the US. Note that the variance ($h_{1,t}$) and innovations ($\varepsilon_{1,t}$) of the euro area enter the conditional variance equation of the US on the same business day because the interbank rates in Europe are determined 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:

[5] 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.

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

$$\log(h_{1,t}) = \omega_1 + \theta_{1,\varepsilon 1}^{EA}\left(\left|\frac{\varepsilon_{1,t-1}}{\sqrt{h_{1,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right) + \theta_{1,\varepsilon 2}^{EA}\left(\frac{\varepsilon_{1,t-1}}{\sqrt{h_{1,t-1}}}\right) + \theta_{1,h}^{EA}\log(h_{1,t-1})$$
$$+ \theta_{1,\varepsilon 1}^{US}\left(\left|\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right) + \theta_{1,\varepsilon 2}^{US}\left(\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right) + \theta_{1,h}^{US}\log(h_{2,t-1}) \qquad (3)$$
$$+ \kappa_1 n_{k,t} + \varphi_1^M Mon + \varphi_1^F Fri$$

$$\log(h_{2,t}) = \omega_1 + \theta_{2,\varepsilon 1}^{EA}\left(\left|\frac{\varepsilon_{1,t}}{\sqrt{h_{1,t}}}\right| - \sqrt{\frac{2}{\pi}}\right) + \theta_{2,\varepsilon 2}^{EA}\left(\frac{\varepsilon_{1,t}}{\sqrt{h_{1,t}}}\right) + \theta_{2,h}^{EA}\log(h_{1,t})$$
$$+ \theta_{2,\varepsilon 1}^{US}\left(\left|\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right) + \theta_{2,\varepsilon 2}^{US}\left(\frac{\varepsilon_{2,t-1}}{\sqrt{h_{2,t-1}}}\right) + \theta_{2,h}^{US}\log(h_{2,t-1}) \qquad (4)$$
$$+ \kappa_2 n_{k,t} + \varphi_2^M Mon + \varphi_2^F Fri$$

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

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

with H_t as the time-varying conditional variance-covariance matrix, T the number of observations, and θ 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.

4.2 Weighted Least Square (WLS) modelling

Subsequently, we extend the analysis to include the full set of macroeconomic announcements rather than only including a single announcement at a time as the EGARCH model of (1)-(4) had done. Estimation of these extended models in the EGARCH framework turned out to be not feasible, due to the large dimension of the parameter space. The maximum likelihood procedure proved unstable. For this reason, we adopt a different estimation methodology for the extended models. Following Andersen and Bollerslev (1998) and Andersen et al. (2002), we use a weighted least squares (WLS) approach. Analogously to the EGARCH model, we regress the first difference of the market interest

rates on its own lags, on the lagged change in market interest rates in the other country, as well as on the full set of surprises regarding the macroeconomic and monetary policy news. Furthermore, we allow for Monday and Friday effects like in the specification above.

$$\Delta r_t^{EA} = \alpha_1 + \sum_{l1=1}^{L1} \beta_{1,l1}^{EA}\ \Delta r_{t-l1}^{EA} + \beta_1^{US}\ \Delta r_{t-1}^{US} + \sum_{i=1}^{I} \gamma_{1i}^{EA}\ s_{i,t}^{EA} + \sum_{j=1}^{J} \gamma_{1,j}^{US}\ s_{j,t}^{US} + \delta_1^{M}\, Mon + \delta_1^{F}\, Fri + \varepsilon_{1,t} \quad (5)$$

$$\Delta r_t^{US} = \alpha_2 + \beta_2^{EA}\ \Delta r_t^{EA} + \sum_{l2=1}^{L2} \beta_{2,l2}^{US}\ \Delta r_{t-l2}^{US} + \sum_{i=1}^{I} \gamma_{2i}^{EA}\ s_{i,t}^{EA} + \sum_{j=1}^{J} \gamma_{2,j}^{US}\ s_{j,t}^{US} + \delta_2^{M}\, Mon + \delta_2^{F}\, Fri + \varepsilon_{2,t} \quad (6)$$

The disturbance terms in (5) and (6) will be heteroskedastic. To take account of this, we apply a three-step procedure: in the first step, we estimate equations (5) and (6) via ordinary least squares (OLS), and then in the second step estimate the time-varying volatility of $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ from the regression residuals, $\hat{\varepsilon}_{1,t}$ and $\hat{\varepsilon}_{2,t}$. As the third step, the estimates of this volatility, $\exp\left(\log\left[\hat{\varepsilon}_{1,t}^2\right] - \hat{\mu}_{1,t}\right)$ and $\exp\left(\log\left[\hat{\varepsilon}_{2,t}^2\right] - \hat{\mu}_{2,t}\right)$, are then used in the WLS estimation of (5) and (6). We iterate on these steps until convergence. The model for the volatility is formulated as

$$\begin{aligned} \log\left(\hat{\varepsilon}_{1,t}^2\right) = \omega_1 &+ \sum_{l3=1}^{L3} \theta_{1,l3}^{EA} \log\left(\hat{\varepsilon}_{1,t-l3}^2\right) + \theta_1^{US} \log\left(\hat{\varepsilon}_{2,t-1}^2\right) \\ &+ \sum_{i=1}^{I} \kappa_{1i}^{EA} n_{i,t}^{EA} + \sum_{j=1}^{J} \kappa_{1j}^{US} n_{j,t-1}^{US} + \varphi_1^{M}\, Mon + \varphi_1^{F}\, Fri + \mu_{1,t} \end{aligned} \quad (7)$$

$$\begin{aligned} \log\left(\hat{\varepsilon}_{2,t}^2\right) = \omega_2 &+ \sum_{l4=1}^{L4} \theta_{2,l4}^{US} \log\left(\hat{\varepsilon}_{2,t-l4}^2\right) + \theta_2^{EA} \log\left(\hat{\varepsilon}_{1,t}^2\right) \\ &+ \sum_{i=1}^{I} \kappa_{2i}^{EA} n_{i,t}^{EA} + \sum_{j=1}^{J} \kappa_{2j}^{US} n_{j,t}^{US} + \varphi_2^{M}\, Mon + \varphi_2^{F}\, Fri + \mu_{2,t} \end{aligned} \quad (8)$$

This specification needs to be somewhat more heavily parameterised than in the EGARCH framework, since we cannot model the volatility directly. Hence, more own lags are needed. All lag lengths (*L1* to *L4*) are therefore chosen according to the Schwarz information criterion.

As explained in Andersen et al. (2002), it is possible to estimate (5) and (6) using heteroskedasticity and serial correlation consistent standard errors. However, this estimator is designed to be robust to residual heteroskedasticity of unknown form, and as such might

be inferior to estimating a well-specified parametric volatility model in small samples. Additionally, this approach yields estimates of equations (7) and (8), which are of interest themselves.[7]

5. The effects of monetary policy surprises

The first step of the analysis consists of estimating the effects of monetary policy. We do so in the EGARCH framework of equations (1) to (4). As mentioned above, this framework needs parsimonious modelling, such that we include only the surprise component of monetary policy announcements in one country at a time. Table 9a reports the according results for the full sample, January 1993 - January 2002. In this case, we have stacked the ECB monetary policy surprises after those of the Bundesbank. The effects of German and euro area monetary policy surprises are listed in the left columns of this table, those for the US in the right columns.

Tables 9a-9d around here

The upper panel contains the coefficients of the mean equations (1) and (2), for varying interest rate maturities. A surprise regarding a monetary policy announcement implies that the policy rate is increased by more (or lowered by less) than the market had expected. Hence, such a surprise should lead to an increase in market interest rates. This is indeed the case: the coefficients of European surprises on European interest rates are positive and highly significant, as well as those of US surprises on US interest rates. There is some evidence of spillover effects in the low maturities: one month rates tend to react to surprises from across the Atlantic, and for the three month rates, we can still detect an effect of US surprises on European rates. The effects of surprises vary across maturities: in line with all other studies (see, e.g., Thornton, 1998), we find that the longer the maturity, the smaller the effect.

The second panel of table 9a shows the estimated coefficients of the variance equations, for varying maturities. For nearly all cases do we find significant effects on the volatility of money markets. In general, volatility increases after a monetary policy surprise. Interestingly, there is a large degree of transatlantic spillovers in both directions.

[7] The results are qualitatively robust when using OLS with heteroskedasticity and serial correlation consistent standard errors.

Tables 9b and 9c provide the results of split samples up to EMU and under EMU. The results for January 1993 – December 1998 are covered in table 9b, those for EMU, i.e. January 1999 – January 2002 in table 9c. The responses of interest rates to the European monetary policy surprises are generally lower in the first subsample than in the second. 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 US and Europe. The two subsamples differ mainly in two respects. On the one hand, spillover effects are somewhat more evident under EMU than before. For the mean equation, this is the case for US announcements which affect European rates in a more consistent fashion. For the variance equation, the US markets are relatively more affected by European announcements under EMU. On the other hand, the volatility effects of monetary policy are generally considerably smaller for the second subsample.

Regarding the effects of monetary policy announcements on interest rates at the very short end, one would expect a coefficient 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 9d confirms this finding. In a robustness test, we calculate the effects of monetary policy surprises derived from financial markets. For the US, 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 (2002), calculated from forward rates. The estimation period is identical to the one underlying Table 9c. The results obtained are remarkably similar qualitatively; however, the coefficients 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 could be non-linearities in the effects, e.g., depending on market uncertainty. Third, for the German and euro area case, the Governing Council meetings were taking place fortnightly. Policy decisions can therefore be 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.

6. The effects of macroeconomic announcements

6.1 Pre EMU

In this section, we will extend our analysis to include the effects of releases of macroeconomic news. Since the dataset comprises a variety of news releases, the econometric models are parameterised much more heavily than in the preceding section. All results presented here are therefore based on the WLS estimators discussed in section 3. Table 10 reports the results for Germany, i.e. the period 1993-1998, for 1-year interbank rates.[8] Most macro announcements have relatively larger effects on the long maturities, which is in line with the results in Fleming and Remolona (1999) and intuitive for the reasons explained in section 2.3.

Table 10 around here

The results for the mean equations show that several macro announcements reveal information to the markets. For Germany, news on German consumer prices, M3 and unemployment are regarded as important indicators for the future course of monetary policy. All variables have the expected sign: unemployment should enter with a negative sign, since higher than expected unemployment should eventually lead to a monetary policy easing. Interestingly, news on the Ifo index, which is probably the most important German sentiment indicator, does not affect interest rates significantly. For the US, we find US consumer prices, non-farm payrolls, industrial production, retail sales, as well as the NAPM and consumer confidence indicators to matter for interest rate levels.

Whereas announcements do generally matter in the own country, there is little evidence that news spill over to the other country. However, the lag of US interest rates matters for German rates the subsequent day. This implies that there has been a general linkage of markets: the German market has to some extent followed the developments in the US. On

[8] The lag lengths for this model were chosen to be 1 for the mean equations (5) and (6), and 2 for the variance equations (7) and (8), according to the Schwarz information criterion.

top of this general linkage, however, news on specific US variables does not have additional consequences for German rates.

The linkages are somewhat stronger, though, when looking at the variance equations. Here, volatility in one market is generally transmitted to the other country, in both directions. Additionally, there are some cases where foreign news can affect the volatility in the home market. Interestingly, news on nearly all announcements increases the volatility of interest rates (with the exception of news on German unemployment).

6.2 Changes over time

Beyond the static picture of the preceding section, we are interested in the evolution over time, to understand whether the degree and nature of the interdependence of markets has changed. In order to do so, we repeat the analysis of the preceding section, but perform rolling window regressions. The first window comprises the sample of January 1993 to December 1996. Subsequently, this window is moved in monthly steps. We extend the sample to January 2002 by extending the German interest rates with euro area rates after January 1999. Regarding the regressors, the same is done for the monetary policy decisions, as well as for the news on M3, since the German series is not continued after 1998. Accordingly, we can estimate the model for 62 windows, with the last one covering a sample from February 1998 to January 2002.[9]

Figures 3a to 3d represent the results of these regressions. Each graph contains the estimated parameters for one news variable, with their evolution over the 62 windows on the x-axis. The parameters are shown with confidence bands that test the significance of parameters at the 90% level.

Figures 3a to 3d around here

The parameters of the German mean equation are shown in figure 3a. Overall, the results do confirm the picture gained in the preceding section:[10] German news is important for German interest rates. However, the rolling window regressions reveal that US news have become more important over time. US monetary policy, the NAPM and the consumer

[9] We chose rolling-window rather than recursive estimation, because the former allows us to better identify the time dynamics in the coefficients. Due to the short sample available, the results of a recursive estimation continuously place strong weights on the initial periods, which are uninformative if learning processes are present.

[10] The sample period of table 9b corresponds to the first 24 windows.

confidence indices as well as retail sales have begun to move the German market. Note also that the importance of developments in the US market in general, as presented by the parameter on the US lagged interest rate changes, has continuously and considerably grown in size.

Interestingly, the same pattern can now be found in the US mean equation. The developments in the German and euro area markets, as measured by the lag of German and euro area interest rates, do spill over to the US. Again, their importance has continuously grown over time, and does now stand at a comparable magnitude to the one estimated in Germany and the euro area. Beyond that, however, news on specific German variables is still not capable of moving the US market. Regarding US news, most effects are estimated to be rather stable over time.

Turning to the variance equations, the parameters of which are depicted in figures 3c and 3d, we find transmission of volatility in both directions: the respective foreign lags are generally important. For the German and euro area market, only very few types of news affect the volatility in a consistent and significant way, whereas for the US, a clearer pattern emerges: a number of news leads to a higher volatility. An interesting finding in both the German and the US mean equation is that monetary policy increased volatility at the beginning of the sample, but that this effect has disappeared in the meantime.

6.3 EMU

The rolling window regressions of the preceding section have included the years of EMU, although with German variables. However, for the ECB's monetary policy, euro area developments should be of higher interest than German news. In this section, we will therefore extend the analysis to euro area macroeconomic news. However, one issue needs to be kept in mind. After the formation of EMU, markets first had to learn about the ECB's monetary policy. Gaspar et al. (2001) provide evidence for learning effects in the money market: looking at overnight rates, they find that the markets have adjusted to the changed operational framework within a couple of days after January 1st, 1999. Learning about the operational framework in which banks operate is much simpler than learning about the monetary policy reaction function of a central bank, though, not least because of the fewer events from which markets can learn. We would therefore expect that the market has taken considerably more time to learn about the relevant news. Rather than estimating one model

for the EMU period, we do thus consider it more revealing to perform rolling-window regressions again.[11]

Figures 4a to 4d around here

We estimate the models for 18-month windows.[12] Hence, the first window is estimated for January 1999 to June 2000, the last for August 2000 to January 2002. All in all, 20 windows are estimated in this fashion. Due to the small sample size, the results have to be interpreted with caution. Given the few news releases in each window, the precision of the estimates is likely to suffer. Nonetheless, in figures 4a to 4d the results are presented with confidence bands that test the significance of parameters at the 90% level again.

Looking at the parameters of the euro-area mean equation in figure 4a, the following points emerge. News on the ECB monetary policy moves the market – not unexpectedly, given the results of section 5, where the same test was conducted in the EGARCH framework. Somewhat surprisingly, we cannot detect a significant response of markets to news in the euro area HICP. However, the caveat about the short sample size of each window is likely to bite here. It is interesting, though, that the point estimate of this parameter is declining from a very high level. The initial coefficients for the euro area are in the range of 0.024 to 0.045. Towards the end of the sample, in the last window, they stand at 0.008, and have now reached the same order of magnitude than the corresponding German figure, which stood at 0.007 (see table 10).

The coefficients of euro area M3 are instead following an upward trend, at increasing levels of significance. Again, the number obtained for the last window compares favourably with the one estimated for Germany prior to EMU: 0.032 for the euro area, against 0.024 for Germany.

Looking at the effects of US news on the euro area interest rates, various issues arise. The lagged US interest rate changes have once more increased in importance. At the very end of the sample, US GDP and industrial production show a sizeable effect that had not been

[11] As a matter of fact, the estimation of the full sample 1999-2002 yields sometimes implausible counterintuitive results. It can be debated whether time variations found with 18-month windows can be interpreted as learning effects or whether they simply reflect noise in the estimates due to the short samples. However, given that many of our parameter estimates show a trending behaviour over time in the euro area, as opposed to the US, where most parameters are estimated to be relatively stable over time, we are confident that the time variation is not simply due to noisy estimates.

[12] The lag length, according to the Schwarz information criterion, is 1 for both mean equations and the US variance equation, and 2 for the euro area variance equation.

observed before. These windows comprise the beginning of the latest US recession in March 2001. In times of recessions, data on US output seems to be of higher importance for the euro area markets. This can be explained by two factors. First, it is likely that in times of recessions, spillovers in the real economy intensify, thus making US developments more important for the euro area economy. Second, in such a situation, the shorter publication lag of US figures compared to European data (see figure 1) becomes especially relevant: US data are then leading indicators for the euro area.

The volatility in the euro area market has also been subject to considerable changes. With the effects of HICP news returning to normal, their impact on the volatility of markets decreases. Interestingly, the effects of governing council meetings on the volatility of markets have at most times been insignificant. This is consistent with the findings of Gaspar et al. (2001) for the overnight rates. In this learning process, the importance of US news for the euro area volatility has generally declined. Whereas news on the US N.A.P.M. and the consumer confidence indicators, as well as on US CPI initially strongly affected euro area volatility, no effect can be found any longer.

There are thus several indications that US announcements are relatively more closely watched in the euro area in times of increased uncertainty. In the early periods of EMU, euro area market volatility was strongly influenced by US announcements, and with the 2001 recession, US output figures became important indicators for the euro area economy.

7. Nonlinearities

As discussed in section 2, the literature on herd behaviour and informational cascades stresses that, depending on how market participants process and interpret news, the same news can have a vastly different effect on markets under different market conditions.[13] The news content of an announcement may, under some circumstances, depend crucially on the deviation of the announcement from an objective or subjectively perceived benchmark. For instance, nonlinearities in the (perceived) monetary policy reaction function could lead to such situations. Assume that a CPI announcement is substantially beyond a (declared or market perceived) threshold at or above which a monetary policy reaction is likely to take place. In such a case, the market can easily anticipate the future course of monetary policy: a policy reaction is almost certain. If the announcement has been expected to be beyond this threshold, then additional surprise components, which move the CPI yet further away from

the threshold, are unlikely to change market participants' expectations of monetary policy. Since monetary policy had already been expected to react, this expectation is not likely to change, such that the announcement will have little or no effect on the level or the volatility of interest rates. By contrast, a surprise may have a larger effect if the announced CPI figure is closer to the benchmark. In this case, markets have to assess whether the surprise is likely to trigger a monetary policy reaction, in which case interest rate levels will adjust much more strongly. Due to the higher uncertainty this implies, also the interest rate volatility is likely to react more strongly.

It is easier to define such a benchmark for some variables than for others. We chose the mean of the announcements over the full period 1993-2002 for each variable as its benchmark. The intuition for using this benchmark is that if a macroeconomic variable is far below or far above its usual (potential) rate, the market has strong expectations about the direction of monetary policy, such that additional information (as measured by the surprises) may have less of an impact. By contrast, if announcements are close to their mean, surprises may give information about changes in the direction of the economy and of monetary policy, and hence have a larger effect.[14]

In order to test for the presence of such effects, the parameters for the news and spillover effects ($\gamma_i s_{i,t}$) in the mean equations (5)-(6) for the WLS estimations are modified in the following way

$$\Delta r_t^{EA} = \ldots + \sum_{i=1}^{I} \lambda_{1i}^{EA}\, s_{i,t}^{EA} + \sum_{i=1}^{I} \mu_{1i}^{EA}\, s_{i,t}^{EA}\, D_{i,t}^{EA} + \sum_{j=1}^{J} \lambda_{1,j}^{US}\, s_{j,t}^{US} + \sum_{j=1}^{J} \mu_{1,j}^{US}\, s_{j,t}^{US}\, D_{j,t}^{US} + \ldots \qquad (9)$$

$$\Delta r_t^{EA} = \ldots + \sum_{i=1}^{I} \lambda_{2i}^{EA}\, s_{i,t}^{EA} + \sum_{i=1}^{I} \mu_{2i}^{EA}\, s_{i,t}^{EA}\, D_{i,t}^{EA} + \sum_{j=1}^{J} \lambda_{2,j}^{US}\, s_{j,t}^{US} + \sum_{j=1}^{J} \mu_{2,j}^{US}\, s_{j,t}^{US}\, D_{j,t}^{US} + \ldots \qquad (10)$$

with $D_{i,t} = 1$ if the deviation of the announcement $A_{i,t}$ is in the top or bottom quartiles of its distribution, and $D_{i,t} = 0$ otherwise. Analogous specifications are used for the variance equations (7)-(8).

[13] Tests for asymmetric effects of positive vs. negative and small vs. large surprises did generally not deliver significant results.

[14] Note that the average, annualised *announced* CPI rate was 1.9% for Germany and 2.5% for the US in 1993-2002, and 2.4% for the euro area in 1999-2002. The average, annual *announced* M3 growth rate was 6.3% for Germany and 5.8% for the euro area over the same sample periods. See Table 5 for the summary statistics. Changing the benchmark from the mean to other definitions, such as the 2% inflation target for the euro area, does not change the econometric results significantly.

Tables 11a and 11b around here

Table 11a presents the results for Germany, and Table 11b for the US. The results for the US mean and variance equations are very compelling. Announcement surprises generally have a significantly larger effect on money markets in the US if deviations from the benchmark were small. This holds for five out of the seven macroeconomic variables. A similar result holds for the variance equation, where three of the macroeconomic announcement surprises increase market volatility relatively more if the deviation is small.

For Germany, there is less evidence of such nonlinear effects with respect to the German data. However, significant nonlinearities can be found in the variance equation for the effect of US variables on German money markets. As was the case for the US, the macroeconomic announcement surprises do generally increase market volatility relatively more if the deviation is small.

This points to nonlinearities in the way markets process information. When macroeconomic announcements are far from their long run average, markets have a relatively clear view of the future course of monetary policy. The arrival of new information does therefore not change their assessment of the future direction of interest rates. On the other hand, if the announced values are close to their long run averages, the markets will eventually have to change their expectations on the future course of monetary policy. This necessitates relatively strong changes in interest rates, and leads to market uncertainty, as reflected in the relatively strong increase in volatility.

8. Conclusions

This paper has investigated the degree and changing nature of interdependence between the US and the euro area from a financial market perspective. Specifically, it has analysed the effects of macroeconomic and monetary policy news on money market interest rates in the US and Germany prior to EMU, and the US and the euro area since 1999.

This approach has allowed us to address two closely related questions. First, the paper has investigated whether EMU changed the degree of interdependence between the US and the euro area. We find that the euro area and the US have become generally more interdependent over time, and in particular after the advent of EMU. Nevertheless, there is evidence that euro area financial markets react more strongly to news in the US than vice

versa. There are in particular some US macroeconomic announcements to which European markets react significantly, especially in times of increased uncertainty, like the initial period of EMU or the 2001 recession.

Second, the paper has analysed how the market perception of monetary policy in the US and in particular the euro area has evolved. The empirical results support the hypothesis that markets were going through a learning process about the ECB monetary policy at the beginning of the EMU period. Moreover, we find that the importance of euro area consumer prices and M3 has reached levels in recent years that are remarkably similar to the role of German consumer prices and M3 for German interest rates prior to EMU. In this regard, the results show a significant similarity in market perceptions of ECB and Bundesbank policies. Throughout this learning process, the importance given to US news has declined.

Finally, we find evidence for nonlinearities of announcement and spillover effects. When macroeconomic announcements are far from their long run average, markets have a relatively clear view of the future course of monetary policy. This has been shown to lead to a subdued reaction of interest rates and volatility.

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Appendix

Table 1: Summary statistics for monetary policy announcements, surveys, and surprises

	Announcement		Survey		Surprise			
Monetary policy *announcements*	**Number of meetings**	**Mean abs. announc.***	**Mean abs. survey***	**Std. Dev.**	**Mean abs. surprise***	**Std. Dev.**	**Number of forecasts "correct"**	**"false" ****
Federal Reserve	78	0.144	0.120	0.211	0.049	0.112	71	7
Bundesbank	144	0.040	0.025	0.066	0.044	0.113	132	12
ECB	73	0.058	0.041	0.086	0.051	0.105	70	3
Monetary policy *changes*	**Number of changes**	**Mean abs. changes***	**Mean abs. survey***	**Std. Dev.**	**Mean abs. surprise***	**Std. Dev.**	**Number of forecasts "correct"**	**"false" ****
Federal Reserve	31	0.363	0.281	0.334	0.102	0.173	24	7
Bundesbank	13	0.442	0.120	0.120	0.322	0.114	3	10
ECB	12	0.354	0.147	0.190	0.207	0.249	9	3

Notes:

* Means are calculated from the absolute numbers of the announcements, surveys and surprises.

** A "correct" forecast is defined as an absolute surprise of within 25 basis points of the announcement or change.

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

Table 2: Test of unbiasedness of forecasts of monetary policy announcements

	α	t-stats	β	t-stats	R^2	Wald test	p-value	# obs.
Federal Reserve	-0.013	(-1.01)	1.039	(17.19)	0.795	0.73	[0.483]	78
Bundesbank	-0.015	(-1.47)	0.988	(6.90)	0.251	1.190	[0.306]	144
ECB	-0.006	(-0.76)	1.164	(11.50)	0.381	1.970	[0.142]	73

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

Following Gravelle and Moessner (2001), Table 2 shows the results for the test of forecast unbiasedness of the monetary policy announcements ($A_{k,t}$) based on the following equation:

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

where $S_{k,t}$ is the announcement surprise. The unbiasedness test is a Wald test of the joint hypothesis H_0: $\alpha=0$ and $\beta=1$. This hypothesis is rejected at the 90% level for monetary policy announcements of all three central banks.

Table 3: Test of efficiency of forecasts of monetary policy announcements

	R^2	Wald test	p-value	# obs.
Federal Reserve	0.078	0.92	[0.486]	72
Bundesbank	0.020	0.44	[0.851]	138
ECB	0.038	0.430	[0.854]	67

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

The test for efficiency of the forecasts is conducted by testing whether forecast errors of monetary policy decisions ($A_{k,t}$ - $E_{k,t}$) can 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 $\psi_1 = \psi_2 = ... = \psi_P = 0$. The Wald tests show that this hypothesis can be rejected for all three monetary policy announcements.

Table 4: Macroeconomic announcements, release dates and times

Announcement	Period	# Observ.	Usual Release	intra-month min	intra-month max	lag: # of months
Euro Area						
Business confidence balance	06/05/1999 - 04/02/2002	31	12:00	2	8	1
Harmonised CPI M/M (%)	29/01/1999 - 28/02/2002	38	12:00	16	28	1
Purch. Managers Index, SA	02/08/1999 - 01/02/2002	31	10:00	1	3	1
GDP prel. Q/Q (%)	05/03/1999 - 29/11/2001	12	12:00	5	14	3
Industrial production M/M SA (%)	18/01/1999 - 19/02/2002	39	12:00	17	28	2
M3 Y/Y (%)	01/02/1999 - 27/02/2002	38	10:00	25	30	2
PPI M/M (%)	18/01/1999 - 04/02/2002	38	12:00	4	8	2
Retail Sales SA M/M (%)	12/04/2000 - 31/01/2002	23	12:00	1	9	3
Trade ex-EMU prelim.	21/01/1999 - 22/02/2002	39	12:00	19	30	2
Unemployment rate (%)	07/01/1999 - 05/02/2002	38	12:00	1	8	2
Germany						
GDP Q/Q (%)	09/03/1993 - 27/02/2002	37	08:00	23	10	2/3
Ifo Business Climate Index	24/03/1993 - 26/02/2002	107	10:00	15	27	1
PPI M/M (%)	18/03/1993 - 28/02/2002	108	08:00	17	27	1
Retail Sales, real SA M/M (%)	15/03/1993 - 14/02/2002	105	08:00	9	18	2
Trade Balance	16/03/1993 - 12/02/2002	109	08:00	10	16/29	2
M3 Y/Y (%)	18/03/1993 - 25/01/1999	70	09:30	18	26	1
Unemployment rate (%)	05/03/1993 - 06/02/2002	108	10:00	3	10	1
CPI M/M (%)	01/03/1993 - 25/02/2002	107	after 11:00	23	30	0
Industrial production SA M/M (%)	02/03/1993 - 08/02/2002	107	various	1	10	2
Manufacturing orders M/M (%)	04/03/1993 - 07/02/2002	108	after 11:00	1	10	2
USA						
Real GDP (S.A.A.R.) Advance Y/Y	27/04/1990 - 26/04/2002	49	08:30	26	31	1
Consumer confidence	30/07/1991 - 30/04/2002	130	10:00	24	31	0
CPI M/M (%)	22/02/1980 - 16/04/2002	267	08:30	12	21	1
Housing starts	18/03/1980 - 16/04/2002	262	08:30	16	20	1
Industrial production SA M/M (%)	15/02/1980 - 16/04/2002	267	09:15	13	17	1
N.A.P.M.	01/02/1990 - 01/05/2002	148	10:00	1	4	1
Nonfarm payrolls	07/02/1980 - 03/05/2002	268	08:30	1	9	1
PPI M/M (%)	15/02/1980 - 12/04/2002	267	08:30	9	16	1
Retail sales (%)	11/02/1980 - 12/04/2002	267	08:30	9	15	1
Trade balance	28/02/1980 - 17/04/2002	266	08:30	15	22	2
Unemployment rate (%)	01/02/1980 - 03/05/2002	268	08:30	1	10	1
Average workweek	05/11/1998 - 03/05/2002	43	08:30	2	8	1

Source: MMS.

Table 5: Summary statistics for macroeconomic announcements, surveys, and surprises

Announcement	Announcement		Survey		Surprise	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Euro Area						
Business confidence balance	-4.185	7.458	-4.519	7.802	0.333	1.000
Harmonised CPI M/M (%)	0.197	0.211	0.171	0.169	0.026	0.092
Purch. Managers Index, SA	53.000	5.345	53.213	5.456	-0.213	1.036
GDP prel. Q/Q (%)	0.542	0.320	0.542	0.337	0.000	0.074
Industrial production M/M SA (%)	0.223	0.815	0.169	0.669	0.055	0.591
M3 Y/Y (%)	5.829	0.971	5.707	0.950	0.122	0.409
PPI M/M (%)	0.174	0.367	0.156	0.303	0.018	0.145
Retail Sales SA M/M (%)	0.204	0.551	0.182	0.218	0.022	0.455
Trade ex-EMU prelim.	3.485	3.799	3.224	3.513	0.261	2.531
Unemployment rate (%)	9.326	0.831	9.356	0.817	-0.030	0.085
Germany						
GDP Q/Q (%)	0.346	0.641	0.322	0.607	0.024	0.212
Ifo Business Climate Index	95.009	5.256	95.048	4.325	-0.039	1.162
PPI M/M (%)	0.069	0.275	0.094	0.163	-0.026	0.215
Retail Sales, real SA M/M (%)	-0.795	3.044	-0.732	1.732	-0.063	2.781
Trade Balance	4.691	1.894	4.353	1.330	0.338	1.442
M3 Y/Y (%)	6.294	4.711	5.853	3.933	0.441	1.872
Unemployment rate (%)	6.009	31.292	3.126	20.475	2.883	23.194
CPI M/M (%)	0.159	0.231	0.154	0.187	0.005	0.128
Industrial production SA M/M (%)	0.183	1.945	0.197	0.815	-0.014	1.742
Manufacturing orders M/M (%)	0.278	2.401	0.128	0.889	0.150	2.185
USA						
Real GDP (S.A.A.R.) Advance Y/Y (%)	3.234	1.735	2.830	1.592	0.404	0.772
Consumer confidence	110.188	23.523	109.466	23.204	0.723	4.960
CPI M/M (%)	0.204	0.169	0.227	0.111	-0.023	0.119
Housing starts	1.503	0.152	1.489	0.134	0.013	0.069
Industrial production SA M/M (%)	0.209	0.490	0.161	0.347	0.048	0.253
N.A.P.M.	51.812	4.683	51.974	4.431	-0.162	1.933
Nonfarm payrolls	152.759	174.240	161.045	108.197	-8.286	118.643
PPI M/M (%)	0.102	0.420	0.165	0.193	-0.063	0.304
Retail sales (%)	0.318	0.921	0.332	0.502	-0.014	0.652
Trade balance	-16.349	8.676	-16.163	8.716	-0.186	1.837
Unemployment rate (%)	5.179	0.911	5.220	0.934	-0.042	0.143
Average workweek	34.376	0.191	34.386	0.190	-0.010	0.094

Source: MMS, own calculations.

Table 6: Tests of unbiasedness of forecasts of macroeconomic announcements

Announcement	α	t-stats	β	t-stats	R^2	Wald test	p-value	# obs.
Euro Area								
Business confidence balance	0.310	(1.34)	0.995	(36.98)	0.982	1.460	[0.250]	31
Harmonised CPI M/M (%)	0.000	(0.18)	1.131	(12.85)	0.821	2.710	[0.079]	38
Purch. Managers Index, SA	0.943	(0.49)	0.978	(27.43)	0.964	0.810	[0.456]	31
GDP prel. Q/Q (%)	0.000	(0.95)	0.928	(14.18)	0.953	0.610	[0.564]	12
Industrial production M/M SA (%)	0.001	(1.26)	0.887	(5.82)	0.507	0.890	[0.419]	39
M3 Y/Y (%)	0.003	(1.62)	0.948	(28.00)	0.959	1.490	[0.239]	38
PPI M/M (%)	0.000	(-0.34)	1.154	(14.43)	0.867	2.120	[0.136]	38
Retail Sales SA M/M (%)	0.001	(1.07)	0.940	(1.74)	0.168	0.590	[0.564]	23
Trade ex-EMU prelim.	0.737	(1.09)	0.828	(5.43)	0.584	0.750	[0.482]	39
Unemployment rate (%)	0.002	(1.00)	0.980	(57.13)	0.989	3.030	[0.061]	38
Germany								
GDP Q/Q (%)	0.000	(0.59)	0.996	(16.14)	0.891	0.210	[0.815]	37
Ifo Business Climate Index	3.638	(1.16)	0.961	(29.16)	0.929	0.720	[0.488]	107
PPI M/M (%)	0.000	(-1.39)	1.084	(8.39)	0.406	0.960	[0.385]	108
Retail Sales, real SA M/M (%)	-0.008	(-2.59)	0.848	(4.64)	0.221	3.440	[0.037]	105
Trade Balance	1.296	(2.54)	0.790	(7.38)	0.355	4.760	[0.010]	109
M3 Y/Y (%)	-0.001	(-0.28)	1.093	(19.02)	0.846	3.240	[0.045]	70
Unemployment rate (%)	2.801	(1.24)	1.026	(9.33)	0.451	0.860	[0.427]	108
CPI M/M (%)	0.000	(0.08)	1.025	(15.42)	0.694	0.160	[0.855]	107
Industrial production SA M/M (%)	-0.002	(-1.13)	0.953	(4.53)	0.166	0.760	[0.468]	107
Manufacturing orders M/M (%)	0.001	(0.63)	1.128	(4.73)	0.174	0.400	[0.673]	108
USA								
Real GDP (S.A.A.R.) Advance Y/Y (%)	0.005	(1.80)	0.976	(12.09)	0.802	5.120	[0.011]	36
Consumer confidence	2.198	(0.97)	0.986	(48.50)	0.956	1.380	[0.255]	112
CPI M/M (%)	0.000	(-1.69)	1.083	(10.78)	0.514	2.670	[0.073]	112
Housing starts	-0.009	(-0.12)	1.015	(20.69)	0.797	2.120	[0.125]	111
Industrial production SA M/M (%)	0.000	(0.58)	1.209	(18.27)	0.752	7.150	[0.001]	110
N.A.P.M.	1.813	(0.84)	0.962	(23.29)	0.831	0.850	[0.430]	111
Nonfarm payrolls	-39.765	(-2.00)	1.195	(11.62)	0.551	2.080	[0.129]	112
PPI M/M (%)	-0.002	(-4.76)	1.622	(11.78)	0.558	13.070	[0.000]	110
Retail sales (%)	-0.001	(-1.76)	1.331	(11.15)	0.530	3.890	[0.023]	109
Trade balance	-0.609	(-1.66)	0.974	(48.82)	0.956	1.430	[0.244]	109
Unemployment rate (%)	0.159	(2.13)	0.961	(68.19)	0.977	9.080	[0.000]	112
Average workweek	4.260	(1.60)	0.876	(11.33)	0.762	1.950	[0.155]	43

Source: MMS, own calculations.

For an explanation of the unbiasedness test, see description to Table 2 above.

Table 7: Tests of efficiency of forecasts of macroeconomic announcements

Announcement	R^2	Wald test	p-value	# obs.
Euro Area				
Business confidence balance	0.531	2.64	[0.063]	25
Harmonised CPI M/M (%)	0.175	0.880	[0.522]	32
Purch. Managers Index, SA	0.351	1.620	[0.198]	25
GDP prel. Q/Q (%)	too few observations			
Industrial production M/M SA (%)	0.252	1.460	[0.230]	33
M3 Y/Y (%)	0.275	1.450	[0.239]	32
PPI M/M (%)	0.121	0.530	[0.783]	32
Retail Sales SA M/M (%)	0.541	1.770	[0.212]	17
Trade ex-EMU prelim.	0.500	2.500	[0.071]	33
Unemployment rate (%)	0.132	0.640	[0.701]	32
Germany				
GDP Q/Q (%)	0.241	1.990	[0.128]	33
Ifo Business Climate Index	0.160	1.900	[0.095]	101
PPI M/M (%)	0.109	1.870	[0.094]	102
Retail Sales, real SA M/M (%)	0.200	4.230	[0.004]	99
Trade Balance	0.205	4.010	[0.001]	103
M3 Y/Y (%)	0.112	1.150	[0.346]	64
Unemployment rate (%)	0.100	1.760	[0.116]	102
CPI M/M (%)	0.028	0.460	[0.840]	101
Industrial production SA M/M (%)	0.078	2.040	[0.095]	101
Manufacturing orders M/M (%)	0.029	0.470	[0.828]	102
USA				
Real GDP (S.A.A.R.) Advance Y/Y (%)	0.167	1.460	[0.241]	32
Consumer confidence	0.053	0.920	[0.483]	106
CPI M/M (%)	0.066	1.170	[0.329]	106
Housing starts	0.034	0.580	[0.745]	105
Industrial production SA M/M (%)	0.076	1.350	[0.243]	104
N.A.P.M.	0.052	0.900	[0.496]	105
Nonfarm payrolls	0.023	0.390	[0.885]	106
PPI M/M (%)	0.057	0.990	[0.435]	104
Retail sales (%)	0.207	4.300	[0.001]	103
Trade balance	0.119	2.220	[0.047]	103
Unemployment rate (%)	0.131	2.480	[0.028]	106
Average workweek	0.273	1.820	[0.131]	37

Source: MMS, own calculations.

For an explanation of the efficiency test, see description to Table 3 above.

Table 8: 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 1/5/10% 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.

Table 9a: Effects of monetary policy surprises, 1993-2002

Maturity	European monetary policy surprise		US monetary policy surprise	
(months)	European mean eq.	US mean eq.	European mean eq.	US mean eq.
1	0.355*** (44.975)	0.067*** (8.088)	0.229*** (25.092)	0.556*** (44.578)
3	0.317*** (39.813)	-0.010 (-0.546)	0.134*** (8.684)	0.479*** (9.534)
6	0.210*** (19.174)	-0.024 (-1.323)	0.029 (1.571)	0.410*** (9.371)
12	0.203*** (16.257)	-0.019 (-0.669)	0.003 (0.145)	0.339*** (8.559)
	European var. eq.	US variance eq.	European var. eq.	US variance eq.
1	0.597*** (13.665)	-0.423*** (-8.773)	1.148*** (24.456)	1.210*** (22.729)
3	1.571*** (32.295)	0.199*** (4.042)	-0.517*** (-14.75)	0.279*** (4.625)
6	1.151*** (21.333)	0.161** (2.553)	0.201*** (3.538)	0.082 (1.137)
12	0.901*** (16.475)	0.185*** (3.211)	-0.062 (-0.953)	-0.173** (-2.257)

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

Table 9b: Effects of monetary policy surprises, 1993-1998

Maturity (months)	European monetary policy surprise				US monetary policy surprise			
	European mean eq.		US mean eq.		European mean eq.		US mean eq.	
1	0.192***	(10.475)	0.021**	(2.570)	0.233***	(12.494)	0.550***	(10.559)
3	0.216***	(14.766)	-0.002	(-0.152)	0.048*	(1.866)	0.529***	(9.146)
6	0.149***	(7.731)	-0.019	(-1.285)	0.154***	(12.136)	0.381***	(7.762)
12	0.160***	(9.721)	-0.012	(-0.402)	-0.019	(-0.482)	0.392***	(7.578)
	European var. eq.		US variance eq.		European var. eq.		US variance eq.	
1	0.967***	(12.453)	-0.713***	(-11.43)	1.034***	(17.162)	1.330***	(17.306)
3	0.937***	(10.802)	0.136*	(1.809)	0.998***	(13.226)	0.263***	(3.065)
6	1.255***	(17.530)	0.027	(0.363)	0.484***	(6.109)	0.139	(1.587)
12	1.055***	(16.115)	0.151**	(2.043)	-0.070	(-0.868)	0.011	(0.114)

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

Table 9c: Effects of monetary policy surprises, 1999-2002

Maturity (months)	European monetary policy surprise				US monetary policy surprise			
	European mean eq.		US mean eq.		European mean eq.		US mean eq.	
1	0.392***	(104.51)	0.062*	(1.778)	0.247***	(15.287)	0.571***	(31.994)
3	0.308***	(24.912)	0.020	(0.305)	0.221***	(11.830)	0.459***	(5.032)
6	0.267***	(19.313)	-0.033	(-0.685)	0.159***	(6.798)	0.373***	(3.710)
12	0.258***	(18.113)	0.009	(0.205)	0.143***	(5.159)	0.303***	(3.340)
	European var. eq.		US variance eq.		European var. eq.		US variance eq.	
1	-0.373***	(-11.85)	0.419***	(2.669)	1.059***	(10.412)	0.328*	(1.945)
3	0.059	(0.498)	0.296***	(2.987)	-1.076***	(-9.613)	-0.075	(-0.438)
6	0.354***	(3.816)	0.423***	(3.218)	-0.236*	(-1.786)	0.253	(1.435)
12	-0.022	(-0.215)	-0.025	(-0.223)	0.000	(-0.001)	-0.415**	(-2.403)

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

Table 9d: Effects of monetary policy surprises as measured by futures and forward rates, 1999-2002

Maturity (months)	European monetary policy surprise				US monetary policy surprise			
	European mean eq.		US mean eq.		European mean eq.		US mean eq.	
1	0.196***	(18.167)	-0.003	(-0.171)	0.293***	(9.586)	0.779***	(46.856)
3	0.074***	(10.295)	-0.041	(-1.599)	0.245***	(10.371)	0.624***	(5.070)
6	0.088***	(12.259)	-0.059***	(-3.219)	0.195***	(6.115)	0.534***	(4.484)
12	0.078***	(4.484)	-0.022	(-1.304)	0.195***	(4.743)	0.466***	(3.856)
	European var. eq.		US variance eq.		European var. eq.		US variance eq.	
1	-0.059	(-0.659)	0.365***	(3.665)	1.213***	(10.847)	1.345***	(5.848)
3	0.330***	(2.797)	0.108	(1.015)	-0.101	(-0.820)	0.126	(0.643)
6	0.068	(0.646)	0.010	(0.079)	-0.201	(-1.582)	0.218	(1.263)
12	0.757***	(5.286)	0.163	(1.362)	0.034	(0.239)	-0.361**	(-2.020)

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

Table 10: Effects of surprises, 1993-1998

	German mean eq.		US mean eq.		German var. eq.		US var. eq.	
Foreign Lag	0.089***	(6.910)	0.028	(0.579)	0.100***	(3.885)	0.053**	(2.183)
Ger. Mon. Pol.	0.294***	(16.099)	-0.040	(-1.097)	0.701**	(2.438)	0.441*	(1.841)
Ger. CPI	0.007**	(2.384)	-0.002	(-0.243)	-0.422	(-1.239)	0.270	(0.803)
Ger. M3	0.024***	(2.981)	-0.001	(-0.071)	-0.061	(-0.184)	0.020	(0.060)
Ger. Unemp.	-0.004*	(-1.752)	-0.004	(-0.803)	-1.215***	(-2.591)	-0.478	(-1.026)
Ger. Ifo	0.008	(0.488)	0.009	(0.306)	0.132	(0.399)	-0.287	(-0.880)
US Mon. Pol.	0.021	(0.585)	0.313***	(3.796)	0.006	(0.015)	0.315	(0.818)
US CPI	-0.001	(-0.170)	0.041*	(1.757)	0.168	(0.498)	0.845**	(2.537)
US Nonf. Payr.	0.003	(0.476)	0.080***	(4.778)	1.060***	(2.994)	1.443***	(4.141)
US Indus. Prod.	0.001	(0.156)	0.040**	(2.531)	-0.402	(-1.224)	0.451	(1.391)
US GDP	0.005	(0.379)	-0.011	(-0.297)	0.037	(0.067)	0.822	(1.535)
US Retail Sales	-0.002	(-0.172)	0.043*	(1.673)	0.702**	(2.104)	0.792**	(2.422)
US NAPM	-0.002	(-0.310)	0.062***	(3.051)	0.219	(0.686)	0.847***	(2.690)
US Cons. Conf.	-0.006	(-0.579)	0.111***	(3.739)	0.108	(0.332)	0.117	(0.361)

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

Table 11a: Deviations from announcement mean – nonlinear effects for Germany mean equation, 1993-2002

	German mean equation					German variance equation				
	small deviation		large deviation		sign.	small deviation		large deviation		sign.
Ger. Mon. Pol.	0.258***	(131.3)	0.164**	(2.193)		7.883***	(4.015)	9.747***	(2.614)	
Ger. CPI	0.002	(0.355)	0.007**	(2.062)		-0.102	(-0.107)	-0.654	(-1.205)	
Ger. M3	0.007	(0.429)	0.000	(0.034)		-0.005	(-0.002)	1.283	(1.545)	
Ger. Unemp.	-0.007	(-1.421)	-0.001*	(-1.750)		-0.091	(-0.127)	-0.906**	(-2.289)	
Ger. Ifo	0.017	(0.704)	0.009	(0.408)		1.291	(0.614)	3.884*	(1.769)	
US Mon. Pol.	0.149***	(49.53)	0.017	(0.242)	*	-29.38***	(-7.585)	6.855*	(1.763)	***
US NAPM	0.003	(0.371)	0.005	(0.356)		-0.186	(-0.196)	2.135**	(2.193)	*
US Nonf. Payr.	-0.003	(-0.243)	-0.004	(-0.701)		2.685**	(2.518)	0.893**	(2.046)	*
US Indus. Prod.	0.005	(0.460)	0.004	(0.930)		0.270	(0.213)	-0.853	(-1.071)	
US GDP	0.003	(0.099)	0.002	(0.337)		2.797	(1.451)	-0.775	(-0.636)	*
US Cons. Conf.	0.006	(0.285)	0.016	(0.755)		4.767***	(2.725)	0.825	(0.287)	
US Retail Sales	0.002	(0.243)	-0.004	(-0.388)		-0.050	(-0.042)	1.448***	(2.890)	
US CPI	-0.037	(-1.082)	-0.019***	(-2.840)		4.535**	(2.279)	0.870	(1.292)	*

*/**/*** denotes significance at the 1/5/10% level. Numbers in brackets are t-statistics. “sign.” indicates presence of significant nonlinear effects.

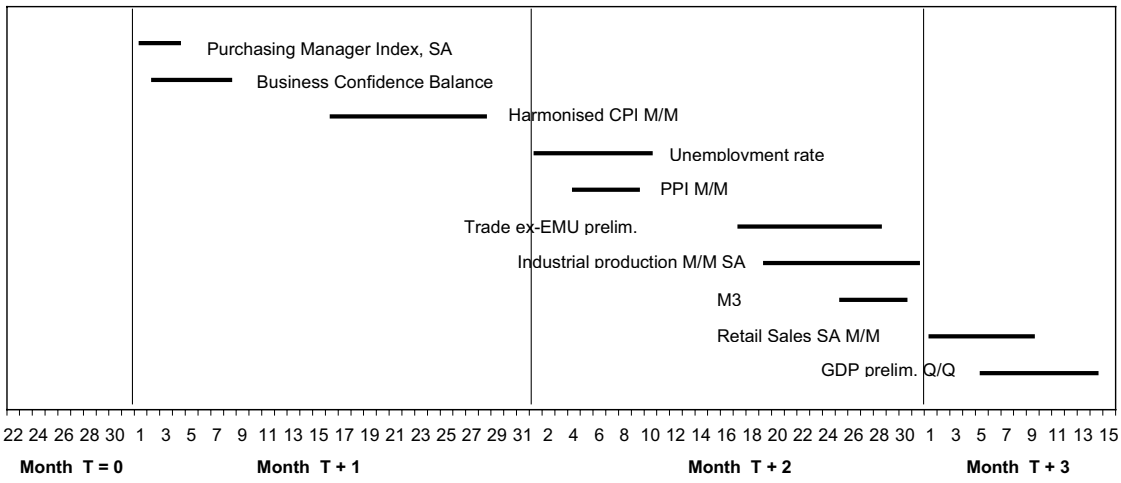
Table 11b: Deviations from announcement mean – nonlinear effects for US mean equation, 1993-2002

	US mean equation					US variance equation				
	Small deviation		large deviation		sign.	small deviation		large deviation		sign.
Ger. Mon. Pol.	-0.044	(-1.031)	0.040	(0.381)		1.319	(0.717)	7.913**	(2.293)	*
Ger. CPI	0.011	(0.656)	-0.013	(-1.349)		0.326	(0.361)	0.215	(0.419)	
Ger. M3	0.007	(0.219)	-0.012***	(-3.376)		-0.048	(-0.024)	-1.735**	(-2.236)	
Ger. Unemp.	-0.011	(-0.726)	0.000	(0.267)		0.678	(1.004)	-0.805**	(-2.146)	*
Ger. Ifo	0.086	(1.552)	0.037	(1.258)		4.256**	(2.118)	-1.259	(-0.605)	*
US Mon. Pol.	0.295	(1.162)	0.485**	(2.424)		6.317*	(1.713)	12.77***	(3.471)	
US NAPM	0.074***	(4.096)	0.035	(1.086)	*	0.673	(0.753)	2.814***	(3.070)	*
US Nonf. Payr.	0.114***	(3.451)	0.057***	(4.071)	*	3.044***	(3.020)	1.046**	(2.538)	*
US Indus. Prod.	-0.006	(-0.226)	0.044***	(3.028)	*	0.743	(0.618)	0.151	(0.200)	
US GDP	-0.082	(-0.705)	-0.001	(-0.077)		5.661***	(3.118)	-0.812	(-0.704)	***
US Cons. Conf.	0.159***	(5.457)	0.080**	(2.208)	*	0.183	(0.111)	-0.969	(-0.355)	
US Retail Sales	0.092**	(2.378)	0.023*	(1.890)	*	3.254***	(2.882)	0.231	(0.489)	**
US CPI	0.088***	(4.489)	0.023*	(1.758)	***	-2.349	(-1.233)	0.332	(0.520)	

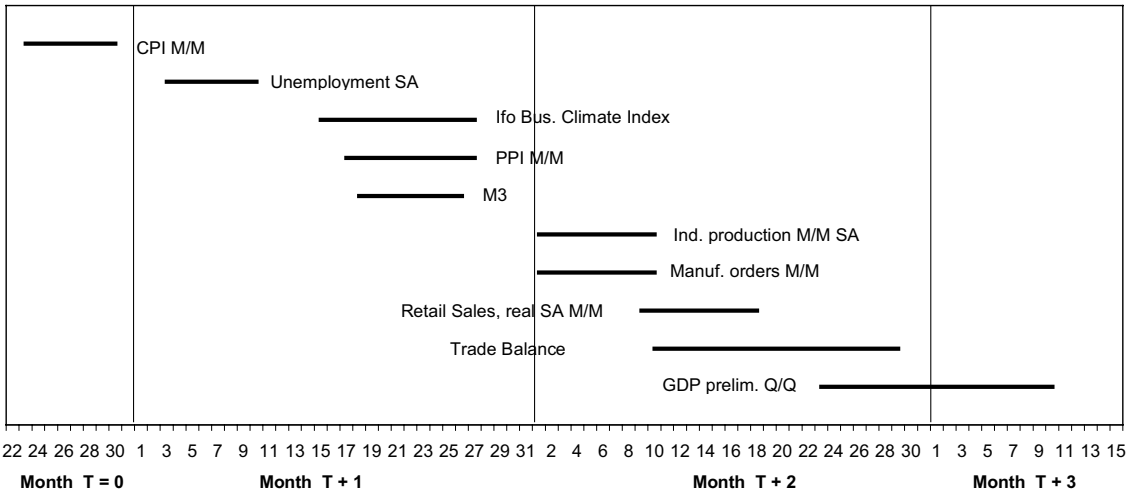
*/**/*** denotes significance at the 1/5/10% level. Numbers in brackets are t-statistics. “sign.” indicates presence of significant nonlinear effects.

Figure 1: Distribution of release days of macroeconomic announcements

Euro Area Macroeconomic Announcement Dates



German Macroeconomic Announcement Dates



US Macroeconomic Announcement Dates

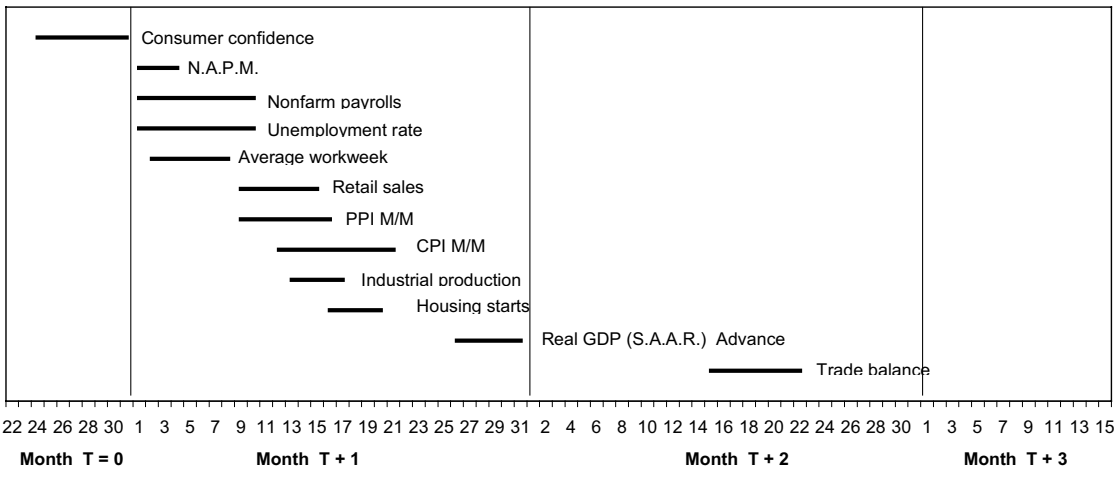


Figure 2: Monetary policy and market interest rates, Germany/euro area and US, 1993-2002 (in %)

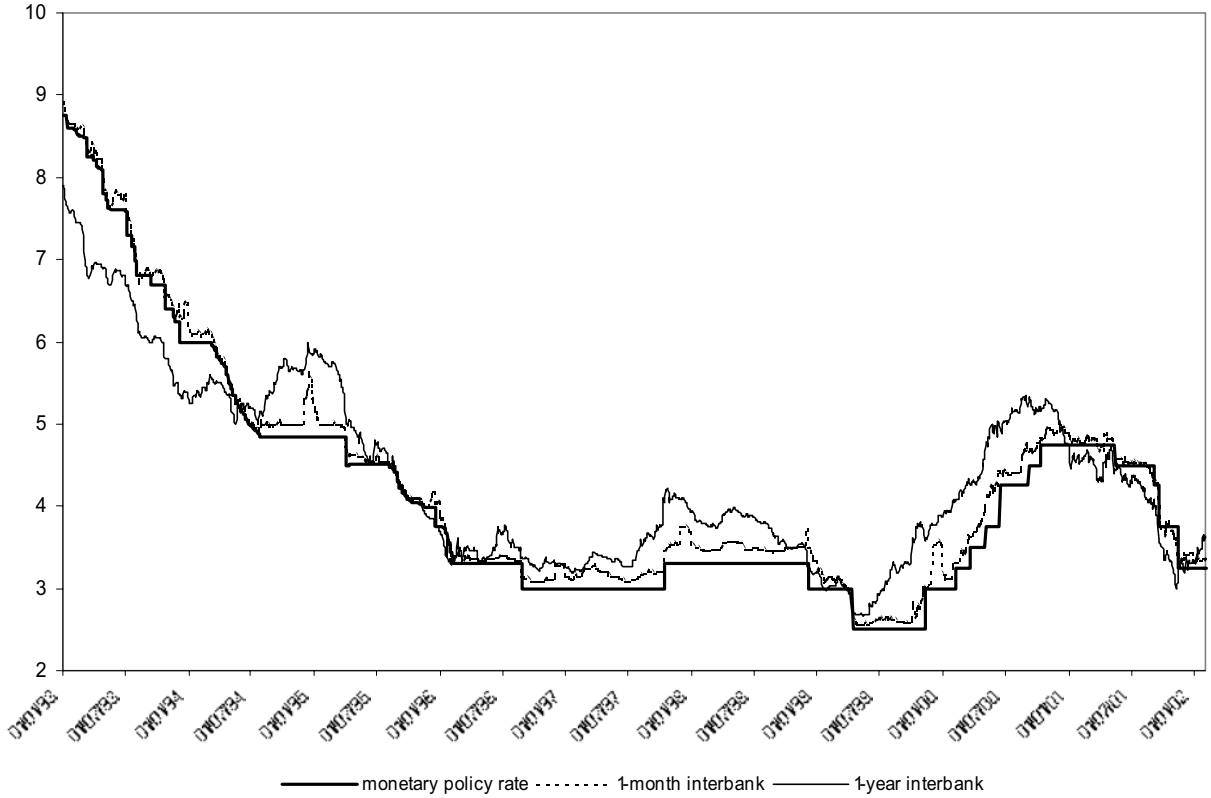
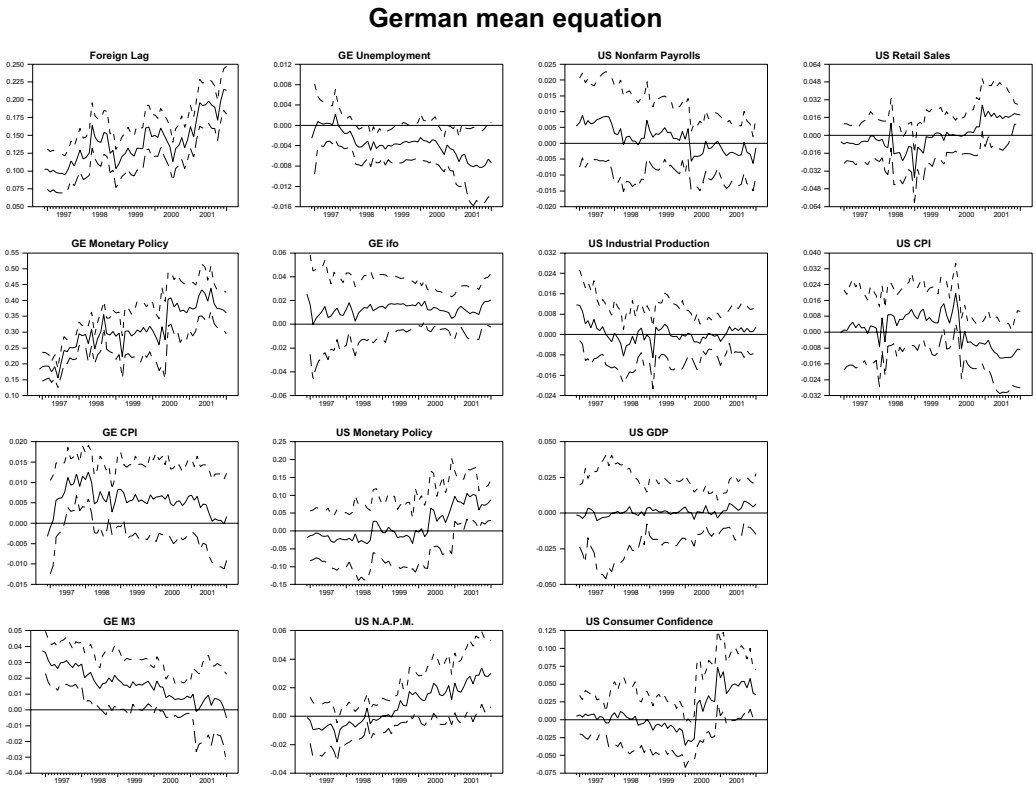


Figure 3: Rolling window parameter estimates of (5)-(7)
Germany and US, 1 year rates, January 1993 – January 2002



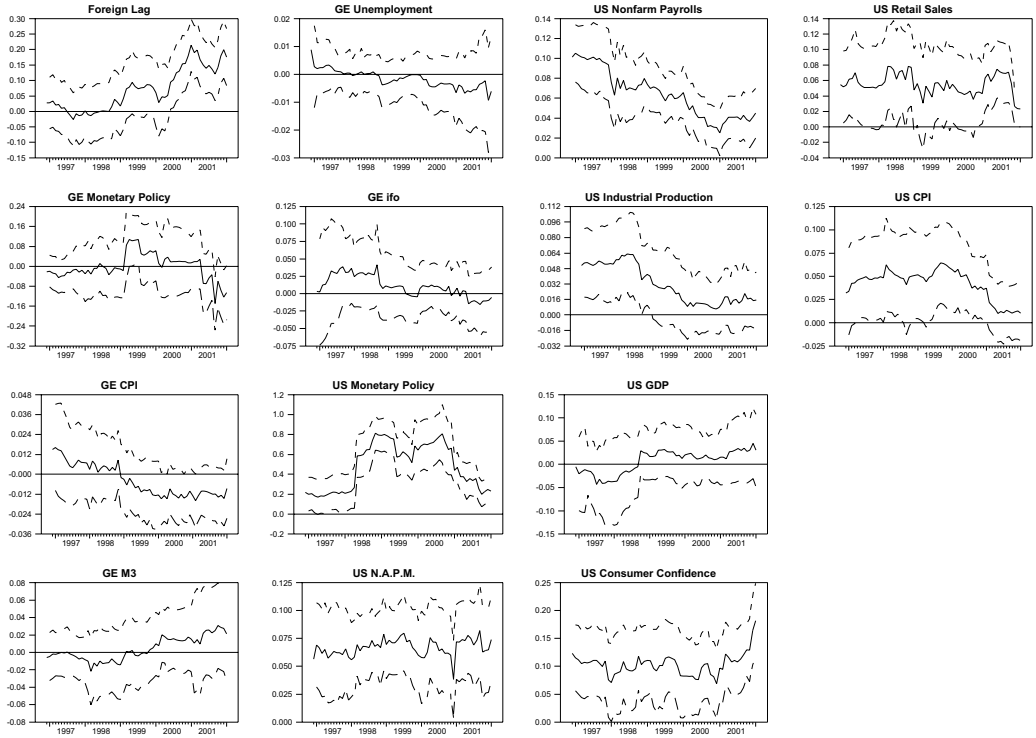
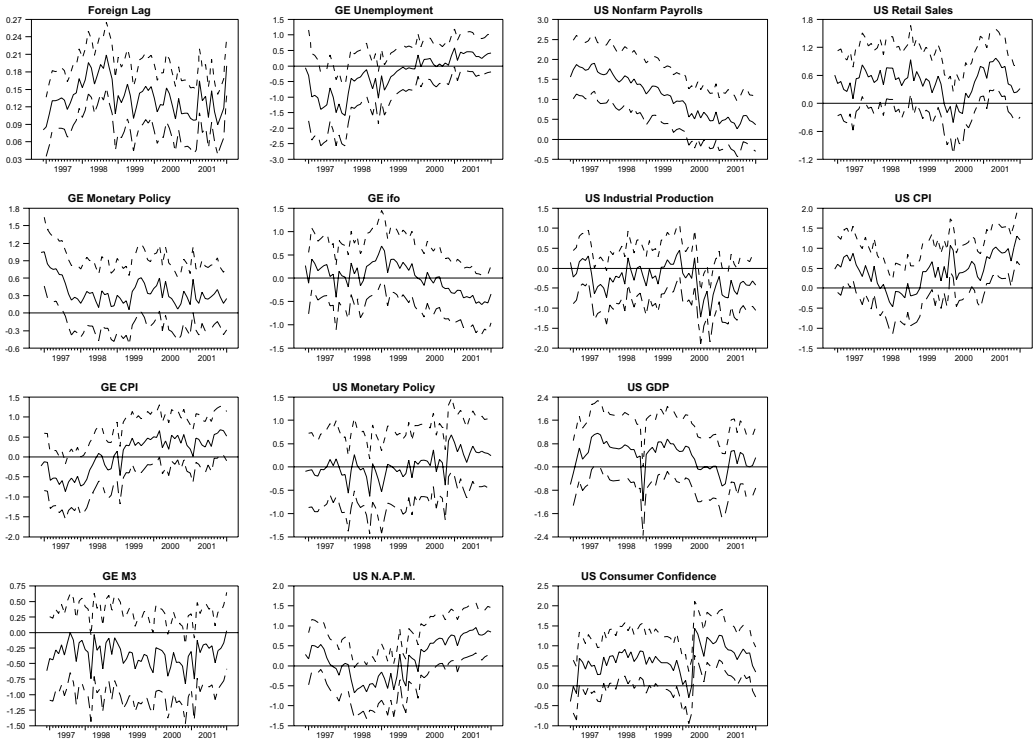
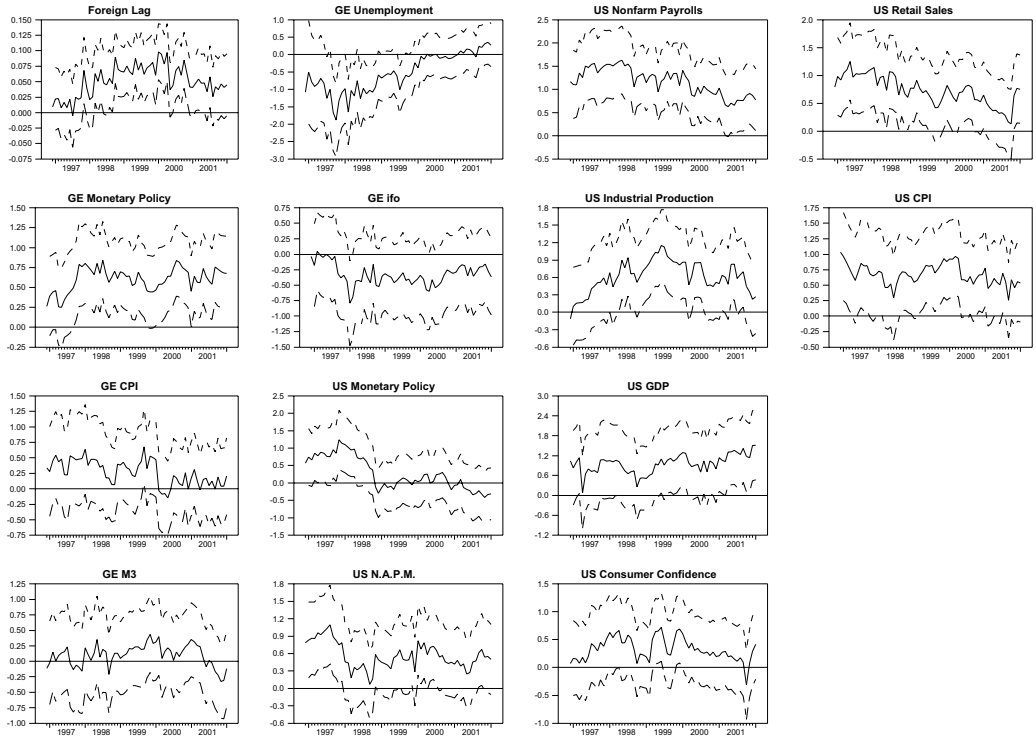


Figure 3 (continued)

German variance equation

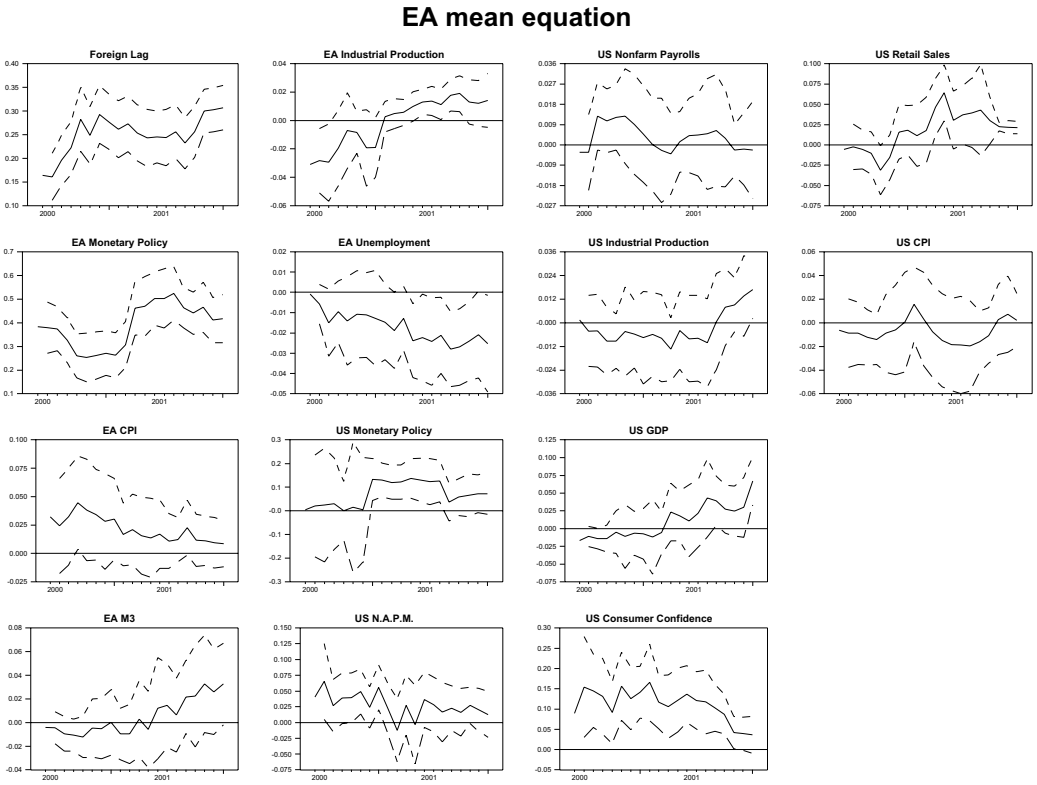


US variance equation



Note: x-axis values correspond to the end point of each rolling window; dotted lines: 90% confidence bands

Figure 4: Rolling window parameter estimates of (5)-(7)
Euro Area and US, 1 year rates, January 1999 – January 2002



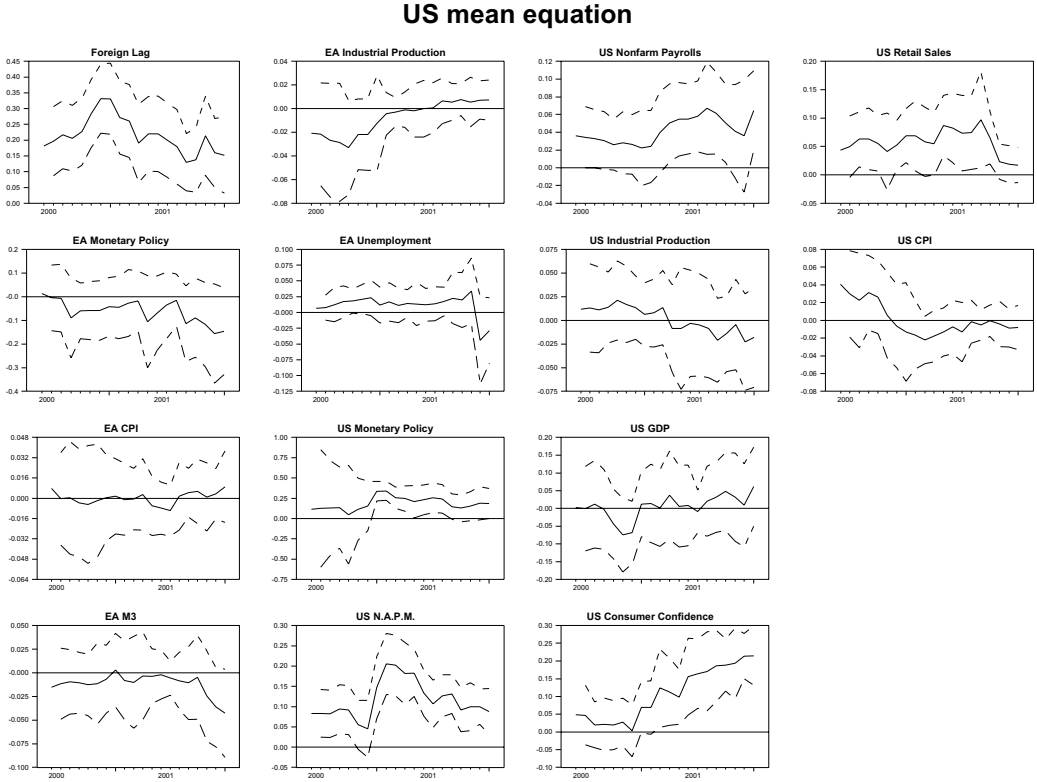
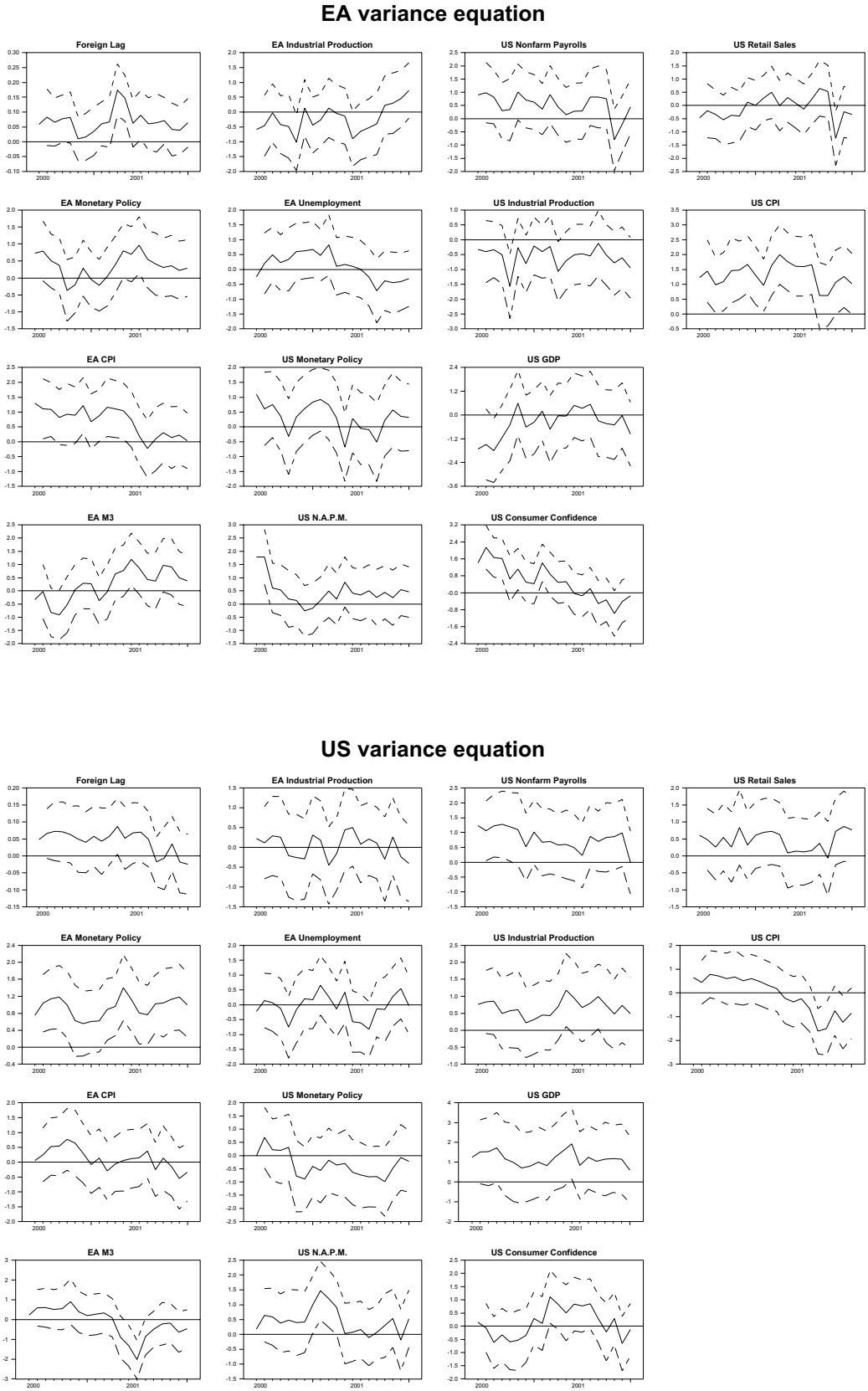


Figure 4 (continued)



Note: x-axis values correspond to the end point of each rolling window; dotted lines: 90% confidence bands

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