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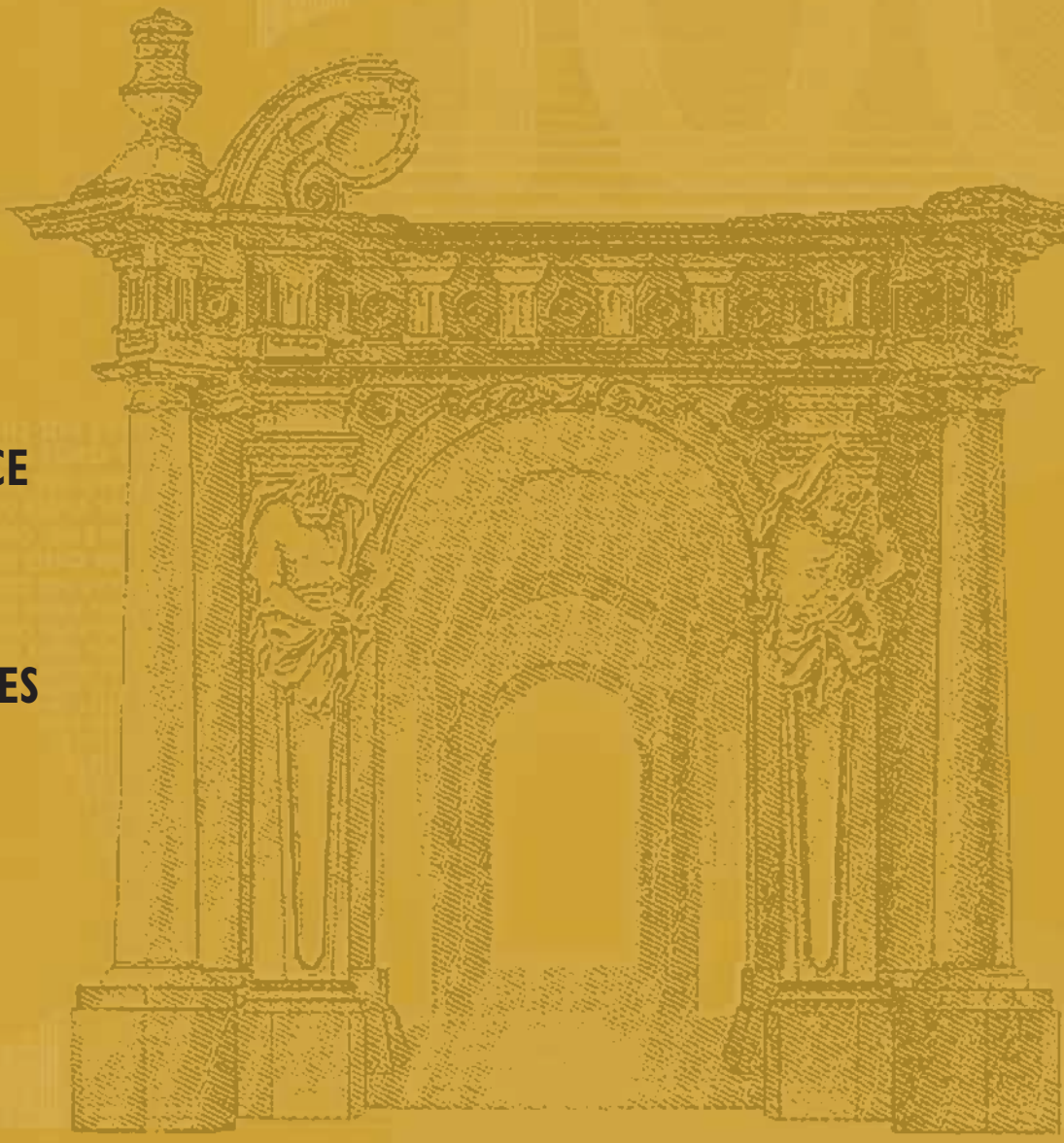

EQUAL SIZE, EQUAL ROLE? INTEREST RATE INTERDEPENDENCE BETWEEN THE EURO AREA AND THE UNITED STATES

by Michael Ehrmann
and Marcel Fratzscher

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In 2004 all publications will carry a motif taken from the €100 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=532985.

I This paper presents the authors' personal opinions and does not necessarily reflect the views of the European Central Bank. Note that the paper is a follow-up including new sections, and substantial additions and revisions to "Interdependence between the euro area and the US: What role for EMU?", ECB Working Paper 200, December 2002. We would like to thank Anna Maria Agresti, Sandrine Corvoisier, Jose Moreno and Jean Rodriguez for their assistance. We are also grateful to Alex Cukierman, Frank Diebold, Jon Faust, Linda Goldberg, Oscar Jorda, Simone Manganelli and seminar participants at the ECB, the European Summer Symposium in Macroeconomics (ESSIM), the ECB – CFS workshop "Capital Markets and Financial Integration in Europe", the Federal Reserve Bank of New York – ECB workshop on "Monetary Policy and the Money Market" and the International Research Forum in Monetary Policy for comments and discussions. We are grateful to Reuters and Standard & Poor's for providing some of the data series.

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International Research Forum on Monetary Policy

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CONTENTS

Abstract

This paper investigates whether the degree and the nature of economic and monetary policy 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. First, the paper finds that the interdependence of money markets has increased strongly around EMU. Although spillover effects from the United States to the euro area remain stronger than in the opposite direction, we present evidence that US markets have started reacting also to euro area developments since the onset of EMU. Second, beyond these general linkages, the paper finds that certain macroeconomic news about the US economy have a large and significant effect on euro area money markets, and that these effects have become stronger in recent years. Finally, we show that US macroeconomic news have become good leading indicators for economic developments in the euro area. This indicates that the higher money market interdependence between the United States and the euro area is at least partly explained by the increased real integration of the two economies in recent years.

JEL classification: E43, E52, F42

Keywords: interdependence; announcements; news; money markets; real-time data; United States; euro area.

Non-technical summary

There is extensive evidence that monetary policy and macroeconomic news move domestic asset prices significantly. Little attention, however, has been given to the question whether and why domestic asset prices react to *foreign* news. The aim of this paper is to help fill this gap by analysing the reaction of interest rates in the United States and the euro area to domestic as well as to foreign macroeconomic and monetary policy news. With the advent of 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 now react more strongly to developments in the euro area than they did to news about individual member countries.

Analysing and understanding news spillovers across markets allows us to address several closely-linked issues. Most importantly, the reaction of domestic asset prices to foreign news reflects the degree of financial interdependence between the two markets. The analysis of news spillovers, rather than that of co-movements in asset prices, has the important advantage of allowing to analyse the question *why* financial markets are interdependent and *why* the degree of interdependence may evolve over time. In particular, the analysis of news spillovers between these two economies over the past 10 years allows us to extract important information about the extent and reasons for time-variations in financial interdependence. By comparing the interdependence between the US and Germany prior to stage 3 of European Economic and Monetary Union (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.

In this paper, we look at a broad set of news about macroeconomic variables, as identified in the literature on announcement effects, as well as monetary policy news in the United States and the euro area. Using daily money market rates for the period 1993-2003, the empirical results of the paper suggest that the linkages of money markets have strongly increased with EMU. Developments in the euro area markets do generally spill over to the US and vice versa. Whereas European markets had been reacting to US developments also prior to EMU, the spillover from Europe to the US appears only with the start of EMU. In a breakpoint test, we date this increased linkage in June 1998, i.e. at a time when markets

were certain that EMU would become a reality. Spillovers from the US to Europe have strengthened, similarly around the formation of EMU: breakpoint tests detect this effect in May 1999. Our second main result is that beyond this general effect, European markets react to certain macroeconomic news about the US economy, namely those regarding retail sales, consumer confidence, industrial production and NAPM. Interestingly, these effects of individual US news on the euro area money market have generally become significant only since the advent of EMU.

In the third and final step of the analysis, we attempt to shed some light on the question *why* the US and euro area money markets have become so much more interdependent, and in particular why some US news have turned into such important determinants of euro area interest rates in recent years. We find that the correlation of US macroeconomic announcements and corresponding euro area and German announcements have increased strongly over the past five years. Since US announcements are almost always released before euro area and German announcements, what this suggests is that US announcements have developed strong leading indicator properties for the euro area economy over time. This indicates that investors may have started in recent years to pay increasing attention to US news in order to learn about the prospects of the euro area economy. In short, these findings suggests that the higher interdependence of US and euro area money markets in recent years may at least in part be explained by the increased real integration of the two economies.

1. Introduction

There is extensive evidence that monetary policy and macroeconomic news move domestic asset prices significantly. Announcements about the state and the prospect of the economy and about the stance of monetary policy have an effect on asset prices because they reveal information about the determinants of fundamental asset values of stocks, thereby moving stock prices (e.g. McQueen and Roley 1993). In money and bond markets, news alter interest rates along the yield curve as market participants not only adjust their views about the prospects of the economy, but also because they reassess their expectations about the reaction of monetary policy to such news. As a result, interest rates have been shown to react strongest to macroeconomic news at intermediate maturities as markets expect monetary policy to act in the medium-term (Fleming and Remolona 1999a). Similarly, the reaction of interest rates to news about monetary policy mirrors the change, or lack of change in policy rates, as well as the markets' views about the credibility and effectiveness of such a decision (Thornton 1998). Finally, exchange rates have also been shown to respond strongly to news about economic fundamentals and monetary policy (e.g. Anderson et al. 2003, Faust et al. 2003).

What most of the growing literature on announcement effects and asset prices shares is a focus on the link between domestic asset prices and *domestic* news. Little attention, however, has been given to the question whether and why domestic asset prices react to *foreign* news.[1] The aim of this paper is to help fill this gap by analysing the reaction of interest rates in the United States and the euro area to domestic as well as to foreign macroeconomic and monetary policy news. Analysing and understanding news spillovers across markets allows us to address several closely-linked issues. First, the reaction of domestic asset prices to foreign news reflects the degree of financial interdependence between the two markets. The analysis of news spillovers, rather than that of co-movements in asset prices, has the important advantage of allowing to analyse the question *why* financial markets are interdependent and *why* the degree of interdependence may evolve over time. The strength of news spillovers may result from the elimination of arbitrage opportunities, it may be due to the focus of domestic monetary authorities on foreign asset

[1] Two exceptions, looking at small open economies, are Gravelle and Moessner (2001), who look at the reaction of Canadian interest rates to US news, and Kim and Sheen (2000), who analyse the effect of US news on the volatility of Australian interest rates in a static framework. In Ehrmann and Fratzscher (2003), we look at the spillovers primarily of monetary policy shocks between the United States and the euro area.

prices, or it may reflect the degree of actual and perceived *real* integration of two economies.

By analysing news effects and spillovers between the United States and the euro area, we focus on the two largest economies in the world, and thus on two economies which should be relatively less dependent on foreign developments compared to small, open economies. In particular, the analysis of news spillovers between these two economies over the past 10 years allows us to extract important information about the extent and reasons for time-variations in financial interdependence. By comparing the interdependence between the US and Germany prior to stage 3 of European Economic and Monetary Union (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 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 now react more strongly to developments in the euro area than they did to news about individual member countries.

In this paper, we look at a broad set of news about macroeconomic variables, as identified in the literature on announcement effects (see e.g. Fleming and Remolona 1999b), as well as monetary policy news in the United States and the euro area. Using daily money market rates for the period 1993-2003, the empirical results of the paper suggest that the linkages of money markets have strongly increased with EMU. Developments in the euro area markets do generally spill over to the US and vice versa. Whereas European markets had been reacting to US developments also prior to EMU, the spillover from Europe to the US appears only with the start of EMU. In a breakpoint test, we date this increased linkage in June 1998, i.e. at a time when markets were certain that EMU would become a reality. Spillovers from the US to Europe have strengthened, similarly around the formation of EMU: breakpoint tests detect this effect in May 1999. Our second main result is that beyond this general effect, European markets react to certain macroeconomic news about the US economy, namely those regarding retail sales, consumer confidence, industrial production and NAPM. Interestingly, these effects of individual US news on the euro area money market have generally become significant only since the advent of EMU.

In the third and final step of the analysis, we attempt to shed some light on the question *why* the US and euro area money markets have become so much more interdependent, and in particular why some US news have turned into such important determinants of euro area interest rates in recent years. We find that the correlation of US macroeconomic announcements and corresponding euro area and German announcements have increased strongly over the past five years. Since US announcements are almost always released before euro area and German announcements, what this suggests is that US announcements have developed strong leading indicator properties for the euro area economy over time. This indicates that investors may have started in recent years to pay increasing attention to US news in order to learn about the prospects of the euro area economy. In short, these findings suggests that the higher interdependence of US and euro area money markets in recent years may at least in part be explained by the increased real integration of the two economies.

In the remainder of this paper, we proceed by providing a background discussion of key issues and the literature of announcement effects on interest rates in section 2. Sections 3 and 4 describe the data and the econometric model underlying our analysis. The benchmark results comparing the pre-EMU and post-EMU periods are reported in section 5. In section 6, we conduct a detailed analysis of the time variations of news effects and spillovers between the US and euro area/German markets, presenting also break tests to date the change in the interdependence between the two markets. Moreover, section 6 then attempts to explain these variations over time by analysing the correlation of news and the question of whether US announcements have developed into leading indicators for economic developments in the euro area. Section 7 summarises the results and provides conclusions.

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 four issues: the channels of spillovers, the econometric identification of news effects, their impact on the yield curve, and the difference between mean and volatility effects.

2.1 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. 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. In this paper, we test for this channel by analysing whether increased *real* integration between the US and euro area economies may account for the higher financial interdependence between their money markets. The paper tests whether US announcements are good leading indicators for euro area macroeconomic announcements and hence whether US news provide information about the economic outlook also of the euro area.

As to the literature, 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. However, none of these papers attempts to explain the degree of interdependence through any of the above mentioned channels.

2.2 Econometric identification of news effects

In order to gauge the extent to which economic fundamentals affect financial markets, it is 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 the announcement of Federal Reserve decisions on the Fed funds target rate only affects market interest rates if the decisions are unexpected, while the announcement of expected decisions has little or no effect on markets nowadays. In this paper, we follow this strategy and investigate the surprise component of announcements, although we extend the analysis to include not only monetary policy but also news about a broad set of relevant macroeconomic variables.

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 (1999a) 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 under 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.

2.4 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 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. For instance, a large degree of heterogeneity of expectations about an upcoming announcement may raise trading and uncertainty in markets, thereby increasing volatility prior to the announcement It has been shown for bond markets (Fleming and Remolona, 1999b) 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. Moreover, Fleming and Remolona (1999b) show that volatility in the US bond market peaks just after the release of macroeconomic news. The explicit modelling of the conditional second moments 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 2003. 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 8 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 1993-2003 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).

Table 1 around here

As to the macroeconomic announcements, we look at a set of 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 2 lists the variables, the usual release time during the announcement day, as well as some summary statistics. Figure 1 shows 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 2 to 4 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] The expectations data for the macro announcements comes from MMS and is also 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.

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 (see Tables 3 and 4).

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 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 somewhat worse than the Fed, but considerably better than the Bundesbank: for the ECB, 5 out of 13 changes have been

[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 unavailability of a reliable market measure for monetary policy expectations for Germany.

anticipated correctly; for the Fed, this has been the case for 23 of the 32 changes, and for the Bundesbank for 1 out of 13 changes.

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 $?_k$ of each announcement k:[3]

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

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. Following the argument by Fleming and Remolona (1999a) that news effects are more clearly identifiable at intermediate maturities, the results presented here are for one-year interest rates.[4] 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 US. One advantage of this timing is that there is no overlap in trading times.[5] US announcements therefore affect European markets only on the subsequent

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

[4] Testing for other maturities proved that the results were robust in terms of their significance. Results regarding the effects of monetary policy surprises on rates of different maturities can be found in the working paper version of this paper, Ehrmann and Fratzscher (2002).

[5] Regardless of the choice of timing, it is always possible that events concerning one economy happen outside our time window for that economy. Following such an event, we would interpret a reaction of markets to this event as a reaction to developments in the other economy (which has potentially reacted in the meantime), and thus overstate the interdependence. We opted to minimise this possibility for the US. By choosing the whole trading day as our time window for the US, any event that occurs within this time window will correctly be attributed as a US reaction to US events. Any US event that occurs after close of trading in the US and to which European markets react, will be attributed falsely as linkage from Europe to the US. However, we consider this effect to be of minor importance, for two reasons. First, most of the relevant events are likely to occur during trading hours in the US. Second, our main finding relates less to the level of interdependence, but rather to the fact that interdependence has significantly increased with EMU. We regard it as extremely unlikely that with the advent of EMU, more of these post-trading day events occur, and thus attribute our finding to an increased linkage, although we cannot exclude the other explanation.

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 2). Figure 2 shows that the market interest rates follow the monetary policy rates closely, especially at the short maturities.

Figure 2 and Table 5 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 2, 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., 2003). The advantage of using data with daily frequency is therefore that it allows us to avoid this measurement problem.

Table 5 shows the summary statistics for the 12-month 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

Following Andersen and Bollerslev (1998) and Andersen et al. (2003), we model the processes of interest rate changes in a weighted least square (WLS) framework. This methodology takes 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 model the changes in the market interest rates, $?r_t$, for the US and Germany/euro area (EA) as a function of past interest rate changes in both areas, the set of

surprises regarding macroeconomic and monetary policy news in both areas (s_i^{EA} and s_j^{US}) as well as day-of-the-week effects (*Mon, Fri*):[6]

$$\Delta r_t^{EA} = a_1 + \sum_{l1=1}^{L1} b_{1,l1}^{EA}\, \Delta r_{t-l1}^{EA} + b_1^{US}\, \Delta r_{t-1}^{US} + \sum_{i=1}^{I} g_{1i}^{EA}\, s_{i,t}^{EA} + \sum_{j=1}^{J} g_{1,j}^{US}\, s_{j,t-1}^{US} + d_1^M Mon + d_1^F Fri + e_{1,t} \quad (1)$$

$$\Delta r_t^{US} = a_2 + b_2^{EA}\, \Delta r_t^{EA} + \sum_{l2=1}^{L2} b_{2,l2}^{US}\, \Delta r_{t-l2}^{US} + \sum_{i=1}^{I} g_{2i}^{EA}\, s_{i,t}^{EA} + \sum_{j=1}^{J} g_{2,j}^{US}\, s_{j,t}^{US} + d_2^M Mon + d_2^F Fri + e_{2,t} \quad (2)$$

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

$$\begin{aligned} \log\left(\hat{e}_{1,t}^2\right) = w_1 &+ \sum_{l3=1}^{L3} q_{1,l3}^{EA} \log\left(\hat{e}_{1,t-l3}^2\right) + q_1^{US} \log\left(\hat{e}_{2,t-1}^2\right) \\ &+ \sum_{i=1}^{I} k_{1i}^{EA} n_{i,t}^{EA} + \sum_{j=1}^{J} k_{1j}^{US} n_{j,t-1}^{US} + j_1^M Mon + j_1^F Fri + m_{1,t} \end{aligned} \quad (3)$$

$$\begin{aligned} \log\left(\hat{e}_{2,t}^2\right) = w_2 &+ \sum_{l4=1}^{L4} q_{2,l4}^{US} \log\left(\hat{e}_{2,t-l4}^2\right) + q_2^{EA} \log\left(\hat{e}_{1,t}^2\right) \\ &+ \sum_{i=1}^{I} k_{2i}^{EA} n_{i,t}^{EA} + \sum_{j=1}^{J} k_{2j}^{US} n_{j,t}^{US} + j_2^M Mon + j_2^F Fri + m_{2,t} \end{aligned} \quad (4)$$

where the set of surprises regarding macroeconomic and monetary policy news enters in form of announcement dummies (n_i^{EA} and n_j^{US}), which are unity for those days when an

[6] 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. Estimation of these models in an EGARCH framework turned out not to be feasible, due to the large dimension of the parameter space: the maximum likelihood procedure proved unstable.

announcement is made and zero otherwise.[7] All lag lengths (*L1* to *L4*) are chosen according to the Schwarz information criterion.

As explained in Andersen et al. (2003), it is possible to estimate (1) and (2) 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 (3) and (4), which are of interest themselves.[8]

5. The effects of news on money markets

Using the framework as set out above, we analyse the response of money markets to news for the period prior to EMU, i.e. 1993-1998, as well as for EMU, i.e. 1999-2003, and will then compare the respective findings.

5.1 Pre EMU

For the period prior to EMU, i.e. 1993-1998, results are reported in the left-hand columns of Tables 6 and 7.[9] Table 6 displays the results for the German mean and variance equations in the left and right panels, table 7 analogously for the US.

Tables 6 and 7 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. Monetary policy itself

[7] The alternative specification of using absolute announcement surprises yielded quite similar results to that of using announcement dummies.
[8] The results are qualitatively robust when using OLS with heteroskedasticity and serial correlation consistent standard errors.
[9] The lag lengths for this model were chosen to be 1 for the mean equations (1) and (2), and 2 for the variance equations (3) and (4), according to the Schwarz information criterion.

strongly affects market rates, even at the one-year maturity, with a monetary tightening leading to increased interest rates.

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. Also here, a monetary tightening increases interest rates.

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

The picture is somewhat different when looking at the variance equations. As for the mean equation, volatility in the US is generally transmitted to Germany. However, additionally, there are some cases where foreign news can affect the volatility in the home market. For example, news on the US NAPM, non-farm payrolls or CPI tend to increase volatility in Germany. Interestingly, news on nearly all announcements increases the volatility of interest rates.

5.2 EMU

Repeating the same analysis for the time period 1999-2003 leads to a rather different picture.[10] The second columns of each panel in Tables 6 and 7 show results for a model that is identical to the one estimated in the previous section. From the estimates for the German mean equation, it appears that German news have generally decreased in their importance for the euro area market (with the exception of German unemployment). This is not surprising, since under EMU, monetary policy is conducted with a view to maintaining price stability for the euro area as a whole, such that German variables enter with a smaller weight into the decision making of the central bank than before.[11]

More surprisingly, the general linkage as measured by the US lag in the euro area mean equation has increased strongly (and significantly, as shown in the third column).

[10] We extend 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.

[11] Germany accounts for roughly 30% of euro area GDP.

Furthermore, several US news are now exerting an additional effect on euro area markets.[12] This effect is found for NAPM, consumer confidence, retail sales, industrial production and US monetary policy, and significantly different from the pre-EMU sample for the first three. On the other hand, the parameters in the variance equation are generally estimated to be the same as prior to EMU.

Another change becomes apparent for the US mean equation: developments in the euro area are now transmitted to the US markets, as measured by a significant foreign lag. Regarding own announcements and the volatility equation, no further changes can be detected when comparing the two periods.[13]

6 Explaining the changing news effects and market interdependence

Various findings in the above section call for an explanation: has the loss of explanatory power of German announcements been compensated by effects of euro area announcements? Why has the general linkage of markets increased and become significant for the US? Is this effect related to EMU? Similarly, why do euro area markets respond to some US news? What is the role of EMU here? We attempt to find answers to these questions in this section by conducting three types of analyses: first, we look at time variations in more detail via rolling-window estimations. Second, we formally test for changes in market interdependence through structural break tests. And third, we investigate whether the increased interdependence over time can be explained by US variables having become better leading indicators for euro area and German variables.

6.1 Euro area news and rolling-window estimations

The lacking effect of German news on the euro area money markets raises the question whether news on the euro area have now taken their place. To test this presumption, we re-estimate our model, replacing the German announcements by a set of euro area news.[14] However, we allow for an initial period where markets had to learn about the ECB's monetary policy strategy, and estimate the model as of January 2000 on only.[15] The

[12] The total effect of these announcements is measured by their effect on the US market multiplied by the US lag in the euro area mean equation, plus their direct effect on the euro area mean equation.

[13] The significance of US news in the US mean equation indicates that the lack of significance of German news in the euro area mean equation is not due to small-sample problems.

[14] 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.

[15] This measure of caution is supported by the rolling window analysis below: figure 4 reveals that the effects have developed considerably over the initial period.

corresponding results are shown in Table 8. As a matter of fact, several of these news change euro area rates in a significant way: CPI, industrial production and unemployment.

Table 8 around here

Hence, while news on Germany are discounted by the market, reflecting their decreased importance for monetary policy setting, euro area news have filled the gap. At the same time, however, US news have become increasingly important. One issue needs to be borne in mind here. As discussed above, US announcements are much more timely, i.e. are released earlier than the corresponding German, and especially the euro area figures. The time delay in announcement can therefore play a role in the importance attached to the news by the market.

To get a first impression of the changes that took place, we repeat the analysis of the preceding section using rolling windows. The first window comprises the sample of January 1993 to December 1996. Subsequently, this window is moved in monthly steps, such that we can estimate the model for 74 windows, with the last one covering a sample from March 1999 to February 2003.[16]

Figures 3a to 3b represent the results of these regressions. Each graph contains the estimated parameters for one news variable or the foreign lag, with their evolution over the 74 windows on the x-axis. The parameters are shown with confidence bands that test the significance of parameters at the 90% level.

Figures 3a and 3b around here

The parameters estimated for the foreign lag increase strongly, immediately after EMU (which is indicated by the vertical line). The increase in importance of US NAPM for euro area rates similarly appears to be coincident with EMU, whereas most other changes occur at different points in time. The relevance of US consumer confidence, industrial production and retail sales becomes apparent only considerably later, for example.

For comparative purposes, we conducted a rolling-window analysis also for the euro area announcements, estimating the models for 24-month windows. Hence, the first window is

[16] 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 place strong weights on the initial periods, which are uninformative if learning processes are present.

estimated for January 1999 to December 2000, the last for March 2001 to February 2003. All in all, 26 windows are estimated in this fashion. Figures 4a and 4b display the results.

Figures 4a and 4b around here

As suggested earlier in this section, the effects of own news in the euro area have evolved somewhat over the estimated sample. This is consistent with the idea that markets first had to learn about the ECB's monetary policy after the formation of EMU. 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, a presumption that seems supported by the evidence in figure 4a.

6.2 Detecting structural breaks around EMU

We interpret the findings of the rolling-window estimations in the previous sub-section that some changes - especially the increased general market linkage - occurred in coincidence with EMU, whereas others - especially the increased importance of US news for euro area markets - occurred somewhat later. For a formal test, we conducted Andrews-Ploberger (1994) tests to identify structural breakpoints. As shown in Table 9, such a breakpoint can indeed be detected for various parameters. The estimated break points for the US lag in the euro area equation (May 31st, 1999) and for the euro area lag in the US equation (June 10th, 1998) are indeed extremely close to the formation of EMU on January 1st, 1999. Whereas some other breaks are detected prior to EMU, the importance of the US NAPM and industrial production for the euro area interest rates have experienced a break in May and November 2000.

Table 9 around here

Hence, we do observe that US markets started reacting to the general developments in European money markets in close coincidence with the formation of EMU. One possible

explanation that comes to mind is related to the fact that through the formation of EMU, a single money market was created in Europe that replaced the national markets. As such, there is only one market rate that needs to be observed by US market participants in order to fully capture the developments in Europe, as opposed to a large number of rates that were giving independent and thus potentially conflicting signals prior to EMU. As a US market participant, observing the European markets has therefore become much less costly, which could explain the closer transmission of interest rate movements.

6.3 Explaining the increased importance of US news

The analysis above has shown that some US news - in particular NAPM, consumer confidence, retail sales, industrial production - have a significant effect on euro area markets in addition to the general market linkage. A key finding is that these US news have an effect on European markets only after the formation of EMU, but not before. The question that we tackle in this final section is therefore to ask *why* US news have become more important for euro area markets in recent years.

One channel, as discussed in section 2, is that the increased importance of US news for the euro area may reflect the higher *real* integration between the US and euro area economies. Higher real integration among the two economies should imply that also macroeconomic announcements are more strongly correlated. Since US news are almost always released before the corresponding news for the euro area and Germany, US news may therefore function now as *leading indicators* for euro area markets. In other words, this higher correlation means that financial market participants do not need to wait any more to the same extent for the release of euro area and German announcements in order to learn about the state of the euro area economy, but they can nowadays learn about the euro area economy ahead of euro area news releases by monitoring US news. This argument is consistent with the finding of the previous sections that in particular German announcements have become less important over time whereas US news have a larger effect on euro area money markets since the advent of EMU.

To test this hypothesis formally, we conduct a test that US announcements (A^{US}) anticipate German/euro area announcements (A^{EA}) or expectations (E^{EA}) by estimating

$$A_t^{EA} = x + l\ A_t^{US} + y\ A_{t-1}^{EA} + m_t \qquad (5)$$

and

$$E_t^{EA} = \zeta + \pi\ A_t^{US} + \upsilon\ E_{t-1}^{EA} + \omega_t \qquad (6)$$

controlling for own past announcements and expectations.

The parameters of interest are λ and π, the results for which are presented in Table 10. The findings are striking and confirm that US macroeconomic variables have become strong leading indicators for euro area and German real economic developments since the advent of EMU in 1999. NAPM, US consumer confidence and US industrial production, all of which have a significant effect on euro area money markets since 1999 are found to be highly and significantly correlated with industrial production and business confidence announcements and expectations in the euro area and in Germany since 1999. Importantly, 3 of the 4 US variables analysed did not exhibit these leading indicator properties *before* 1999, but have adopted these properties only in 1999-2003. Formal testing reveals that the difference in the correlation pre-EMU versus post-EMU is significantly larger in the latter period for many variables (see column "significance" in Table 10).[17] This is consistent with the above findings of the effects of these US variables on euro area and German money markets: the spillover effects of these variables on the German/euro area money markets became significant only since 1999. [18]

Table 10 around here

Analysing the results in more detail shows moreover that the correlations between US and euro area/German announcements and expectations are in some cases large in magnitude. For instance, a 1.0 percentage point change in US industrial production is associated with a 0.908 percentage point change in German industrial production and with a 0.464 percentage point change in euro area industrial production in 1999-2003 (see first row of Table 10). Other point estimates are more difficult to assess in terms of their magnitude because the macroeconomic variables in the US and the euro area/Germany are mostly measured in different units.

[17] The test for a statistically different effect pre-EMU versus post-EMU for the euro area has been conducted by comparing the point estimates of the euro area post-EMU with the estimates of the corresponding German variable pre-EMU. To make this comparison valid, euro area announcements and expectations were standardised by setting their standard deviations equal to the ones of their German counterparts.

[18] Alternative specifications to equations (5) and (6) were also tested to check for the robustness of the results. One of these specifications was to test whether US announcements are correlated with *future* announcements and expectations of German and euro area variables. These correlations were smaller and much less often significant, confirming that the contemporaneous correlation tends to be the strongest.

In addition to industrial production and business confidence, also the US employment and the German and euro area unemployment variables are significantly correlated: higher US non-farm payroll employment is associated with lower unemployment in Germany and the euro area in 1999-2003. This correlation seems to be stronger between US employment and euro area unemployment than between the US and Germany. The increase in the co-movement between the two variables from 1993-98 to 1999-2003 is statistically significant for the euro area unemployment rate at the 5% level.

A word of caution is in order here. The period 1999-2003 comprises the 2001 recession in the US, which has been experienced in a similar fashion in the euro area. As shown by Helbling and Bayoumi (2003), business cycle slowdowns are usually highly synchronised among the G7 countries, and the recent slowdown has followed this pattern, too. The strengthening of the leading indicator properties of US macroeconomic variables therefore might in part be explained by this synchronised slowdown. On the one hand, this caveat finds support in the fact that the importance of US industrial production and NAPM for the euro area money markets shows a structural break in 2000; on the other hand, the recession of 2001 constitutes only a small part of the post-EMU sample for which we find these strong leading indicator properties.

In summary, the findings indicate that US macroeconomic variables have developed into strong leading indicators of euro area real economic developments since the formation of EMU in 1999. This suggests that at least part of the increased interdependence of US and euro area money markets, and in particular the additional effects of some US macroeconomic variables on euro area financial markets, may be explained by the increased *real* interdependence and integration of the US and euro area economies.

7. Conclusions

This paper has investigated the degree and changing nature of economic and monetary policy interdependence between the United States 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 financial 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*. In addition to the general linkage between the US and euro area money markets, there are four US macroeconomic announcements (NAPM, consumer confidence, retail sales, industrial production) to which European markets react significantly. In particular, we find that the effect of these US news on the euro area have become significant only after the formation of EMU in 1999. Conducting formal structural break tests confirms that there was indeed a clear structural break for the spillover across markets of many of the macroeconomic variables around the advent of EMU.

The second aim of the paper was to shed some light on the question *why* the US and euro area money markets have become so much more interdependent over time, and in particular why euro area markets react to some specific US news since EMU. We find strong evidence that US macroeconomic news have become good leading indicators for economic developments in the euro area in recent years as euro area and German macroeconomic announcements and expectations are highly correlated with corresponding US announcements.

Overall, what the results of the paper suggest is that the US and euro area money markets have become significantly more interdependent since EMU, and that this higher *financial* interdependence is at least in part explained by the increased *real* integration of the US and euro area economies in recent years.

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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	86	0.137	0.112	0.203	0.048	0.110	72	14
Bundesbank	144	0.040	0.025	0.066	0.044	0.113	127	17
ECB	86	0.055	0.041	0.090	0.046	0.098	76	10
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	32	0.367	0.280	0.331	0.107	0.175	23	9
Bundesbank	13	0.442	0.120	0.120	0.322	0.114	1	12
ECB	13	0.365	0.166	0.219	0.199	0.240	5	8

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 $\pm$12.5 basis points of the announcement or change.

Source: Federal Reserve, Bundesbank, ECB, Reuters, authors' calculations.

Table 2: Summary statistics for macroeconomic announcements, surveys, and surprises

Announcement	Usual Release	Announcement Mean	Announcement Std. Dev.	Survey Mean	Survey Std. Dev.	Surprise Mean	Surprise Std. Dev.
Euro Area							
Harmonised CPI M/M (%)	12:00	0.002	0.002	0.002	0.002	0.000	0.001
Industrial production M/M SA (%)	12:00	0.002	0.008	0.001	0.006	0.001	0.005
M3 Y/Y (%)	10:00	0.061	0.010	0.060	0.011	0.001	0.004
Unemployment rate (%)	12:00	0.091	0.008	0.091	0.008	0.000	0.001
Germany							
Ifo Business Climate Index	10:00	94.475	5.307	94.513	5.303	-0.038	0.912
M3 Y/Y (%)	09:30	0.063	0.037	0.060	0.031	0.003	0.015
Unemployment rate (%)	10:00	-0.174	34.663	-3.468	18.520	3.294	26.861
CPI M/M (%)	after 11:00	0.002	0.002	0.002	0.002	0.000	0.001
USA							
Real GDP (S.A.A.R.) Advance Y/Y (%)	08:30	0.031	0.017	0.028	0.016	0.003	0.008
Consumer confidence	10:00	108.782	23.251	108.307	22.845	0.475	4.906
CPI M/M (%)	08:30	0.002	0.002	0.002	0.001	0.000	0.001
Industrial production SA M/M (%)	09:15	0.002	0.005	0.002	0.003	0.000	0.003
N.A.P.M.	10:00	51.848	4.556	52.046	4.306	-0.198	1.949
Nonfarm payrolls	08:30	141.213	172.276	151.291	108.944	-10.078	114.689
Retail sales (%)	08:30	0.003	0.009	0.003	0.005	0.000	0.006

Source: MMS, own calculations.

Table 3: Tests of unbiasedness of expectations

Announcement	*a*	*t-stats*	*b*	*t-stats*	R^2	Wald test	p-value	# obs.
Euro Area								
Monetary policy	0.006	*0.560*	1.313	*11.570*	0.615	3.87	[0.025]	86
Harmonised CPI M/M (%)	0.000	*0.660*	1.092	*15.600*	0.838	3.110	[0.054]	49
Industrial production M/M SA (%)	0.001	*1.170*	0.869	*6.890*	0.497	1.020	[0.367]	50
M3 Y/Y (%)	0.002	*1.750*	0.963	*43.010*	0.976	1.590	[0.215]	48
Unemployment rate (%)	0.002	*1.230*	0.980	*71.310*	0.991	3.190	[0.051]	50
Germany								
Monetary policy	-0.015	*-1.470*	0.988	*6.900*	0.251	1.190	[0.306]	144
Ifo Business Climate Index	1.289	*0.860*	0.986	*62.240*	0.971	0.490	[0.611]	119
M3 Y/Y (%)	-0.001	*-0.260*	1.090	*19.800*	0.852	3.280	[0.044]	70
Unemployment rate (%)	2.879	*1.320*	1.014	*9.610*	0.439	0.970	[0.381]	120
CPI M/M (%)	0.000	*-0.620*	1.077	*16.980*	0.713	0.750	[0.473]	118
USA								
Monetary policy	-0.014	*-1.210*	1.055	*17.960*	0.793	1.210	[0.303]	86
Real GDP (S.A.A.R.) Advance Y/Y (%)	0.004	*1.380*	0.988	*12.070*	0.789	3.300	[0.047]	41
Consumer confidence	1.030	*0.470*	0.995	*50.550*	0.956	0.600	[0.552]	121
CPI M/M (%)	0.000	*-1.940*	1.101	*11.500*	0.527	3.160	[0.046]	121
Industrial production SA M/M (%)	0.000	*0.080*	1.220	*18.270*	0.736	6.800	[0.002]	122
N.A.P.M.	2.018	*0.940*	0.957	*23.270*	0.819	1.160	[0.316]	122
Nonfarm payrolls	-39.756	*-2.260*	1.196	*12.670*	0.572	2.640	[0.075]	122
Retail sales (%)	-0.001	*-1.540*	1.294	*12.180*	0.553	3.830	[0.024]	122

Source: MMS, authors calculations.

Note:

Following Gravelle and Moessner (2001), Table 3 shows the results for the test whether the expectations of monetary policy announcements are unbiased, based on the following equation:

$$A_{k,t} = a + b\, E_{k,t} + e_{k,t} \qquad \text{(A.1)}$$

The unbiasedness test is a Wald test of the joint hypothesis H_0: a=0 and ß=1.

Table 4: Tests of efficiency of expectations

Announcement	R^2	Wald test	p-value	# obs.
Euro Area				
Monetary policy	0.032	0.430	[0.856]	80
Harmonised CPI M/M (%)	0.156	1.110	[0.377]	43
Industrial production M/M SA (%)	0.232	1.860	[0.114]	44
M3 Y/Y (%)	0.106	0.690	[0.656]	42
Unemployment rate (%)	0.126	0.890	[0.515]	44
Germany				
Monetary policy	0.02	0.440	[0.851]	138
Ifo Business Climate Index	0.065	1.220	[0.303]	113
M3 Y/Y (%)	0.110	1.170	[0.335]	64
Unemployment rate (%)	0.080	1.540	[0.171]	114
CPI M/M (%)	0.033	0.600	[0.731]	112
USA				
Monetary policy	0.064	0.830	[0.548]	80
Real GDP (S.A.A.R.) Advance Y/Y (%)	0.178	1.730	[0.168]	37
Consumer confidence	0.028	0.510	[0.801]	115
CPI M/M (%)	0.058	1.110	[0.359]	115
Industrial production SA M/M (%)	0.057	1.100	[0.366]	116
N.A.P.M.	0.042	0.800	[0.568]	116
Nonfarm payrolls	0.023	0.420	[0.864]	116
Retail sales (%)	0.216	5.020	[0.001]	116

Source: MMS, authors calculations.

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:

$$A_{k,t} - E_{k,t} = z + \sum_{p=1}^{P} y_p A_{k,t-p} + e_{k,t} \qquad \text{(A.2)}$$

with the lag length usually chosen as P=6. The hypothesis to be tested is $?_1 = ?_2 = ... = ?_P = 0$.

Table 5: Statistical properties of daily interest rate changes

	Germany	Euro Area	United States
Mean	-0.003 ***	-0.001	-0.001
Skewness	0.652 ***	0.268 ***	-0.491 ***
Excess kurtosis	19.654 ***	11.470 ***	8.072 ***
Jarque-Bera	25284.445 ***	5900.368 ***	7267.411 ***
Q(40)	184.882 ***	53.180 *	77.008 ***
$Q^2(40)$	68.984 ***	110.273 ***	132.831 ***

Note:
*/**/*** 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 40^{th} order; $Q^2(40)$ is the Ljung-Box test statistic for the squared interest rate changes.

Table 6: Effects of surprises on Germany/euro area, comparison pre-EMU versus post-EMU

	German/euro area mean equation					German/euro area variance equation				
	Pre-EMU 1993-98		Post-EMU 1999-2003		significance	Pre-EMU 1993-98		Post-EMU 1999-2003		significance
Foreign lag	0.089***	(0.012)	0.305***	(0.023)	+++	0.116***	(0.032)	0.088***	(0.025)	
Ger. Mon. Pol.	0.294***	(0.022)	0.387***	(0.042)	+++	0.176	(0.330)	0.726**	(0.285)	
Ger. CPI	0.007**	(0.003)	0.006	(0.007)		0.240	(0.369)	-0.548*	(0.338)	+
Ger. M3	0.024***	(0.007)	-0.000	(0.011)	+++	0.479	(0.368)	0.097	(0.332)	
Ger. Unemp.	-0.004*	(0.002)	-0.015***	(0.005)		-0.012	(0.422)	-0.206	(0.466)	
Ger. Ifo	0.008	(0.015)	0.025	(0.021)		-0.087	(0.370)	0.052	(0.329)	
US Mon. Pol.	0.021	(0.037)	0.081*	(0.047)		0.044	(0.423)	0.029	(0.378)	
US NAPM	-0.001	(0.007)	0.035**	(0.016)	++	0.713**	(0.361)	0.198	(0.317)	
US Nonf. Payr.	0.003	(0.005)	-0.000	(0.008)		0.728*	(0.406)	1.120***	(0.351)	
US Indus. Prod.	0.001	(0.005)	0.016*	(0.010)		0.244	(0.384)	-0.396	(0.326)	
US GDP	0.005	(0.012)	0.018	(0.014)		-0.542	(0.608)	0.144	(0.540)	
US Cons. Conf.	-0.002	(0.011)	0.041*	(0.024)	+	0.303	(0.373)	-0.097	(0.323)	
US Retail Sales	-0.002	(0.009)	0.017***	(0.006)	++	0.043	(0.367)	0.671**	(0.331)	
US CPI	-0.006	(0.007)	-0.008	(0.012)		0.810**	(0.382)	0.021	(0.335)	

Notes:

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

"significance" shows whether difference across sub-periods is significant.

Table 7: Effects of surprises on United States, comparison pre-EMU versus post-EMU

	US mean equation					US variance equation				
	Pre-EMU 1993-98		Post-EMU 1999-2003		significance	Pre-EMU 1993-98		Post-EMU 1999-2003		significance
Foreign lag	0.020	(0.046)	0.184***	(0.042)	+++	0.007	(0.029)	0.046*	(0.024)	
Ger. Mon. Pol.	-0.031	(0.037)	-0.024	(0.070)		0.759***	(0.278)	0.373	(0.239)	
Ger. CPI	-0.002	(0.010)	-0.006	(0.008)		-0.195	(0.352)	0.212	(0.336)	
Ger. M3	-0.001	(0.015)	-0.018	(0.040)		-0.087	(0.349)	0.135	(0.330)	
Ger. Unemp.	-0.003	(0.004)	0.005	(0.011)		-0.020	(0.405)	-0.520	(0.464)	
Ger. Ifo	0.009	(0.030)	0.007	(0.028)		-0.067	(0.352)	-0.291	(0.326)	
US Mon. Pol.	0.327***	(0.085)	0.169**	(0.085)		0.184	(0.405)	0.413	(0.376)	
US NAPM	0.060***	(0.019)	0.086***	(0.017)		0.164	(0.347)	0.853***	(0.315)	
US Nonf. Payr.	0.079***	(0.016)	0.038**	(0.018)		0.877**	(0.389)	1.439***	(0.348)	
US Indus. Prod.	0.044***	(0.017)	0.011	(0.016)		0.052	(0.369)	0.410	(0.324)	
US GDP	-0.015	(0.038)	0.047	(0.053)		1.440**	(0.585)	0.409	(0.535)	
US Cons. Conf.	0.104***	(0.027)	0.123***	(0.037)		0.294	(0.356)	0.189	(0.324)	
US Retail Sales	0.050**	(0.022)	0.024*	(0.013)		0.680*	(0.353)	0.813**	(0.326)	
US CPI	0.039*	(0.022)	0.002	(0.011)		-0.261	(0.368)	0.839**	(0.332)	

Notes:

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

"significance" shows whether difference across sub-periods is significant.

Table 8: Effects of surprises on Euro area and US, 2000-2003

	Euro area				US			
	Mean equation		Variance equation		Mean equation		Variance equation	
Foreign lag	0.304***	(0.028)	0.131***	(0.036)	0.180***	(0.046)	-0.012	(0.035)
EA Mon. Pol.	0.414***	(0.063)	0.416	(0.391)	-0.100	(0.090)	1.024***	(0.339)
EA CPI	0.023*	(0.012)	0.280	(0.426)	-0.008	(0.015)	-0.158	(0.419)
EA M3	-0.001	(0.016)	0.201	(0.429)	-0.016	(0.022)	0.165	(0.422)
EA Ind. Prod.	0.013**	(0.006)	-0.176	(0.406)	0.013	(0.012)	0.398	(0.415)
EA Unempl.	-0.027***	(0.008)	-0.207	(0.522)	0.007	(0.014)	0.068	(0.516)
US Mon. Pol.	0.094	(0.060)	0.582	(0.486)	0.172*	(0.095)	-0.112	(0.480)
US NAPM	0.014	(0.017)	0.536	(0.423)	0.094***	(0.021)	0.283	(0.419)
US Nonf. Payr.	0.003	(0.012)	0.713	(0.471)	0.047**	(0.019)	0.516	(0.467)
US Indus. Prod.	0.037***	(0.012)	0.380	(0.445)	0.003	(0.017)	0.080	(0.444)
US GDP	0.033	(0.022)	0.028	(0.702)	0.040	(0.053)	1.250*	(0.702)
US Cons. Conf.	0.043*	(0.025)	0.224	(0.434)	0.142***	(0.039)	0.173	(0.427)
US Retail Sales	0.018**	(0.008)	0.373	(0.430)	0.024*	(0.013)	0.640	(0.427)
US CPI	-0.004	(0.012)	0.128	(0.447)	-0.011	(0.012)	-0.378	(0.448)

Notes:

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

Table 9: Andrews-Ploberger (1994) tests for structural breaks in the mean equations

	Euro area			US		
	Estimated break date	Andrews-Ploberger test		Estimated break date	Andrews-Ploberger test	
Foreign Lag	1999:05:31	13.672***	(0.000)	1998:06:10	2.461**	(0.030)
Ger. Mon. Pol.	1994:07:15	3.183**	(0.012)	2001:04:11	0.181	(0.830)
Ger. CPI	1995:06:28	0.883	(0.235)	1996:01:26	0.309	(0.631)
Ger. M3	2001:07:26	0.750	(0.289)	2001:063:29	0.153	(0.890)
Ger. Unemp.	2000:04:05	3.565***	(0.007)	1995:08:08	0.339	(0.595)
Ger. Ifo	2000:11:21	1.228	(0.142)	1997:11:19	0.319	(0.620)
US Mon. Pol.	1997:05:21	2.863**	(0.018)	1994:09:27	0.565	(0.393)
US CPI	1998:03:03	2.810**	(0.019)	1994:07:15	0.157	(0.880)
US Nonf. Payr.	1995:06:05	2.248**	(0.039)	1997:01:10	2.085**	(0.047)
US Indus. Prod.	2000:11:16	2.963**	(0.016)	1999:06:16	1.020	(0.191)
US GDP	2001:02:01	0.703	(0.312)	2000:10:27	0.750	(0.289)
US Retail Sales	2000:03:29	1.289	(0.131)	1995:05:30	0.169	(0.855)
US NAPM	2000:05:12	1.656*	(0.081)	2001:06:13	1.154	(0.157)
US Cons. Conf.	1997:06:18	0.173	(0.846)	1999:06:16	1.708*	(0.076)

Notes:

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

Table 10: Co-movements of US announcements with German/euro area announcements and expectations

Comparison pre-EMU versus post-EMU

	German/euro area *announcements*					German/euro area *expectations*				
	Pre-EMU 1993-98		Post-EMU 1999-2003		significance	Pre-EMU 1993-98		Post-EMU 1999-2003		significance
US industrial production announcement with:										
Ger. industrial production	0.305	(0.506)	0.908*	(0.482)		-0.202	(0.233)	0.812***	(0.223)	+++
EA industrial production			0.464*	(0.235)				0.483**	(0.188)	+++
Ger. Ifo	47.169	(35.79)	159.064***	(38.08)	++	106.631	(62.76)	131.785***	(38.17)	
EA business confidence			170.086***	(40.13)	++			136.162***	(27.41)	
US consumer confidence announcement with:										
Ger. industrial production	0.012	(0.099)	0.248**	(0.119)		0.055	(0.044)	0.166***	(0.057)	+
EA industrial production			0.169***	(0.059)				0.153***	(0.047)	++
Ger. Ifo	-7.022	(8.778)	45.018***	(15.26)	++	18.993	(42.99)	44.567***	(14.11)	
EA business confidence			71.276***	(10.92)	+++			56.866***	(7.924)	++
US NAPM announcement with:										
Ger. industrial production	0.495	(0.542)	0.748	(0.499)		0.728***	(0.244)	0.872***	(0.248)	
EA industrial production			0.744***	(0.218)				0.591***	(0.201)	
Ger. Ifo	170.447***	(37.03)	148.405***	(37.54)		237.012**	(96.88)	159.406***	(34.32)	
EA business confidence			206.877***	(21.24)				157.311***	(17.85)	

Notes:

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

"significance" shows whether difference across sub-periods is significant. For the euro area, the test is vis-à-vis the respective pre-EMU German variable.

Table 10 (cont.): Co-movements of US announcements with German/euro area announcements and expectations

Comparison pre-EMU versus post-EMU

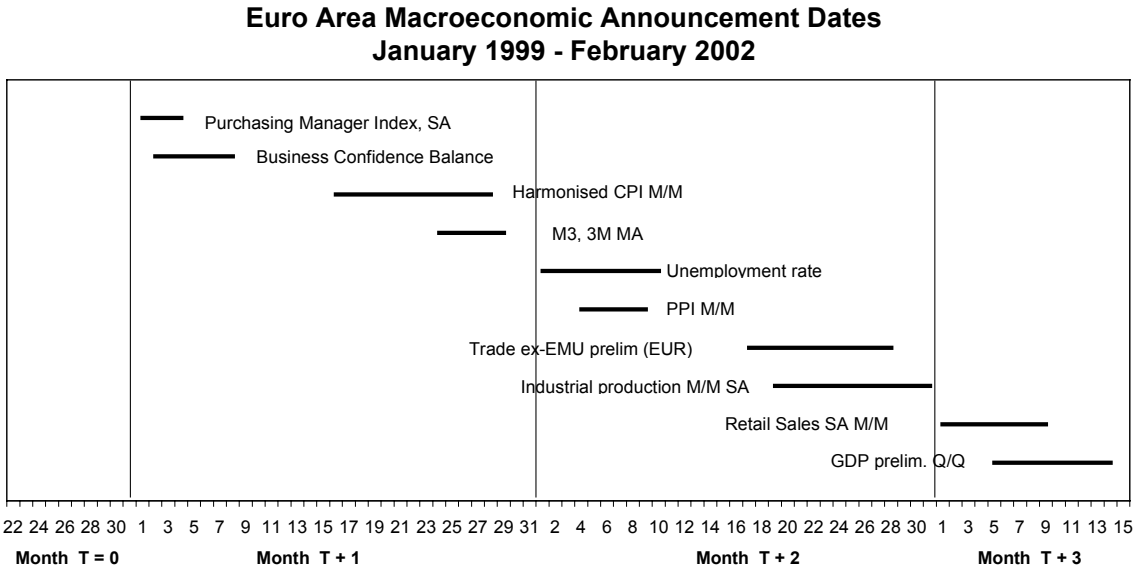
	German/euro area *announcements*					German/euro area *expectations*				
	Pre-EMU 1993-98		Post-EMU 1999-2003		significance	Pre-EMU 1993-98		Post-EMU 1999-2003		significance
US non-farm payroll employment announcement with:										
Ger. Industrial production	0.004	(0.015)	0.030**	(0.013)		0.001	(0.007)	0.016**	(0.006)	+
EA industrial production			0.017**	(0.006)				0.016***	(0.005)	++
Ger. Ifo	0.225	(1.202)	3.783***	(1.224)	++	-0.102	(2.753)	4.259***	(1.064)	+
EA business confidence			4.668***	(1.124)	+++			3.628***	(0.775)	+
Ger. unemployment	7.000	(25.51)	-36.252*	(18.93)		-15.098	(9.253)	-21.116***	(6.201)	
EA unemployment			-87.585***	(18.46)	++			-57.684***	(12.85)	+++

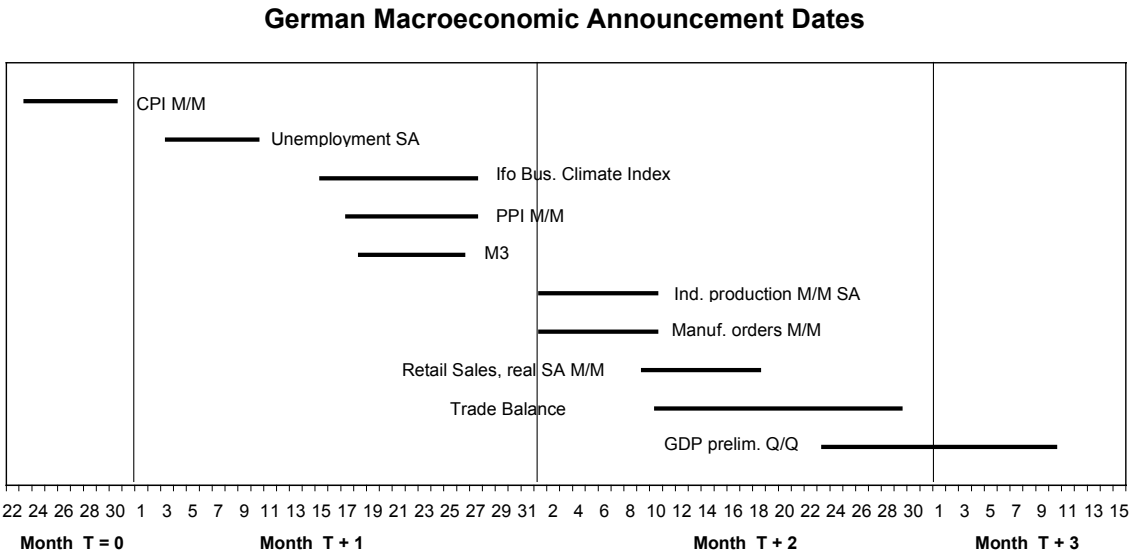
Notes:

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

"significance" shows whether difference across sub-periods is significant. For the euro area, the test is vis-à-vis the respective pre-EMU German variable.

Figure 1: Distribution of release days of macroeconomic announcements





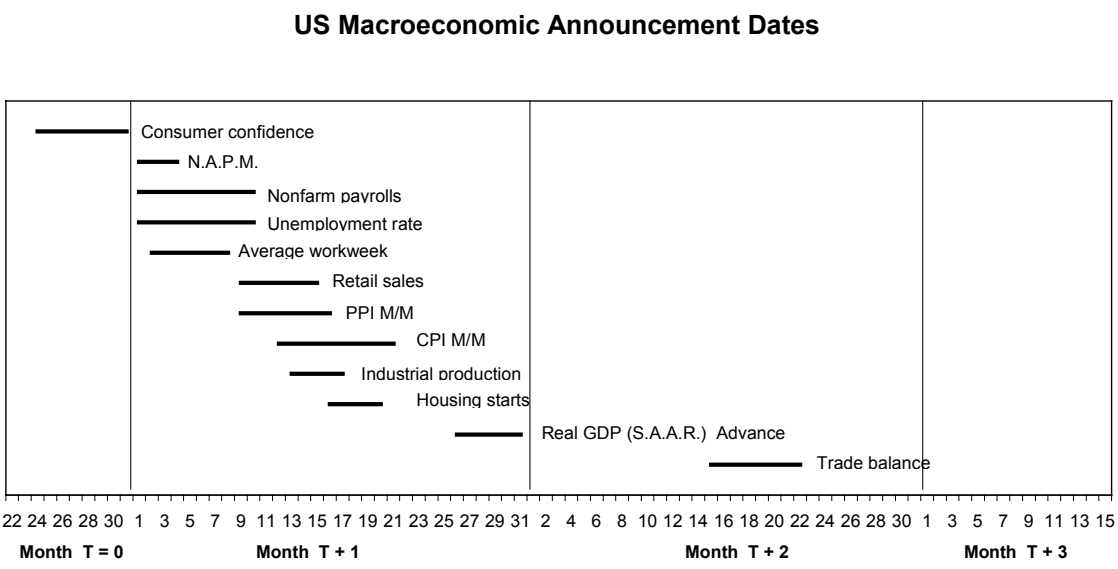
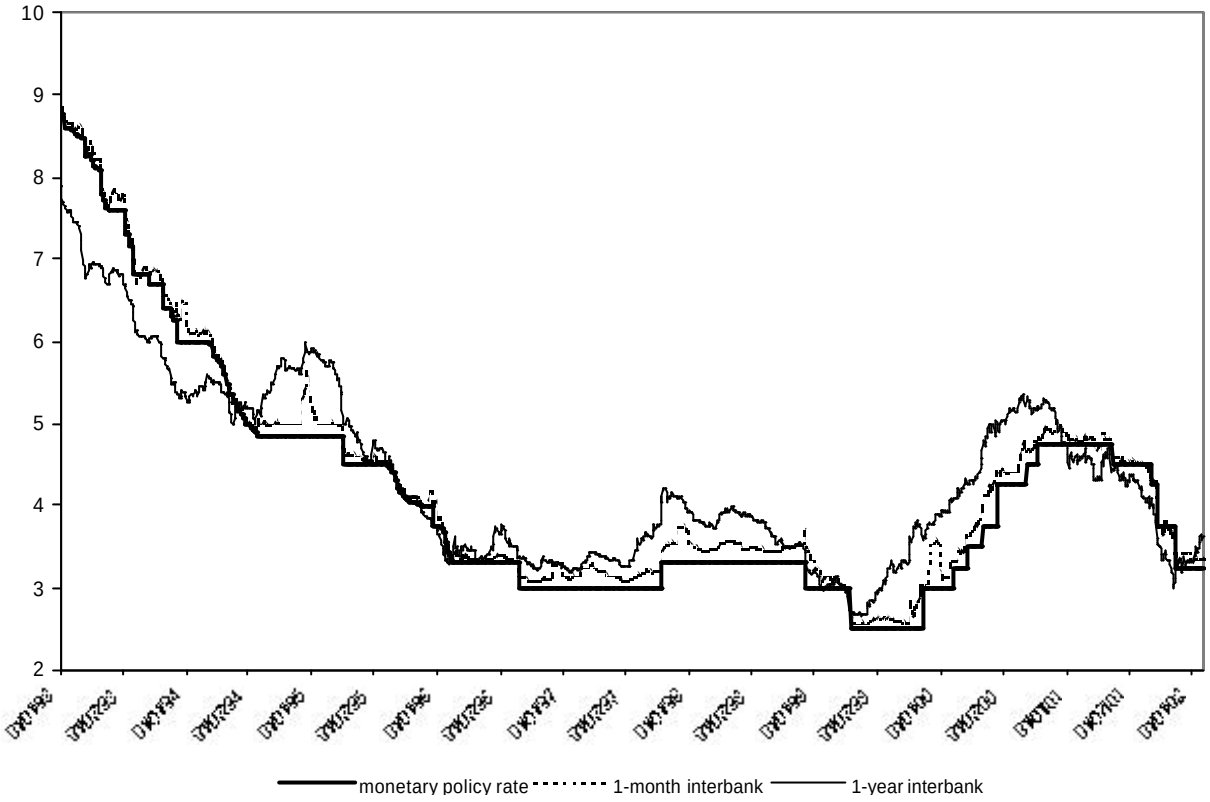


Figure 2: Monetary policy and market interest rates, Germany/euro area and US, 1993-2002 (in %)



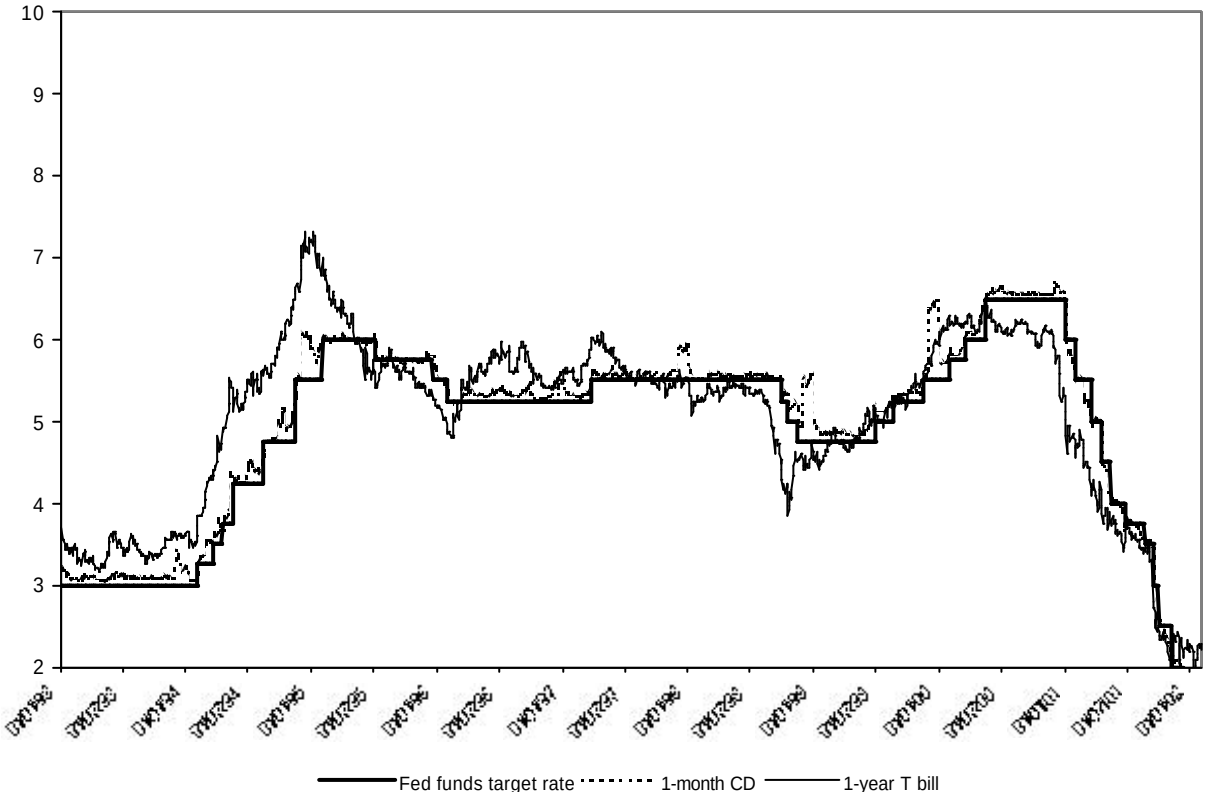
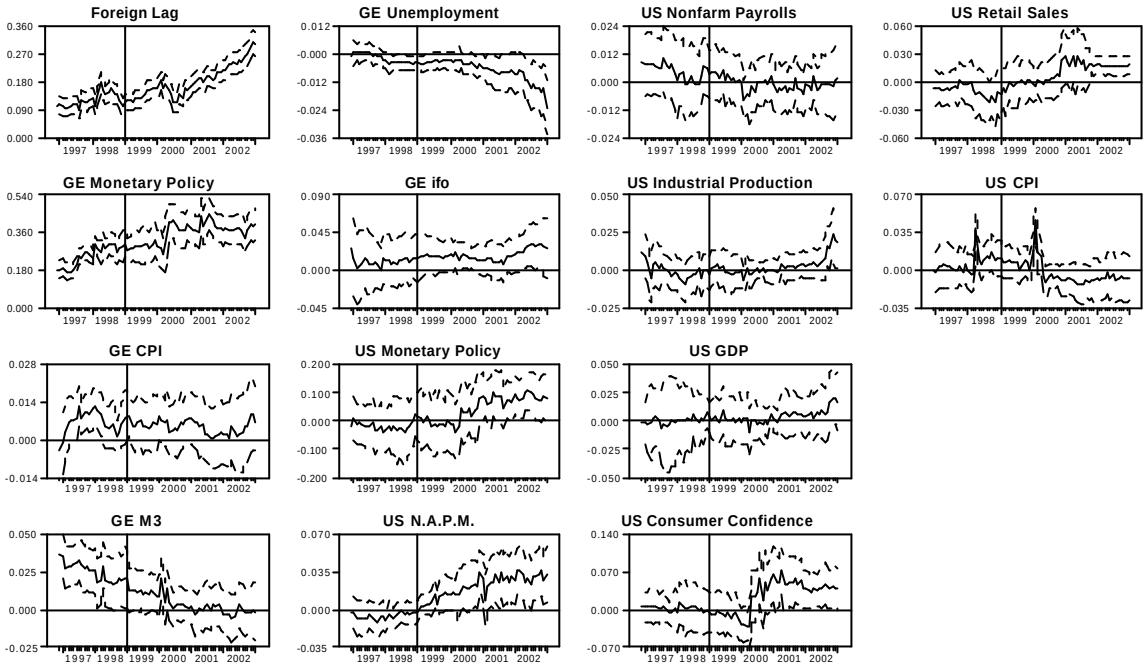
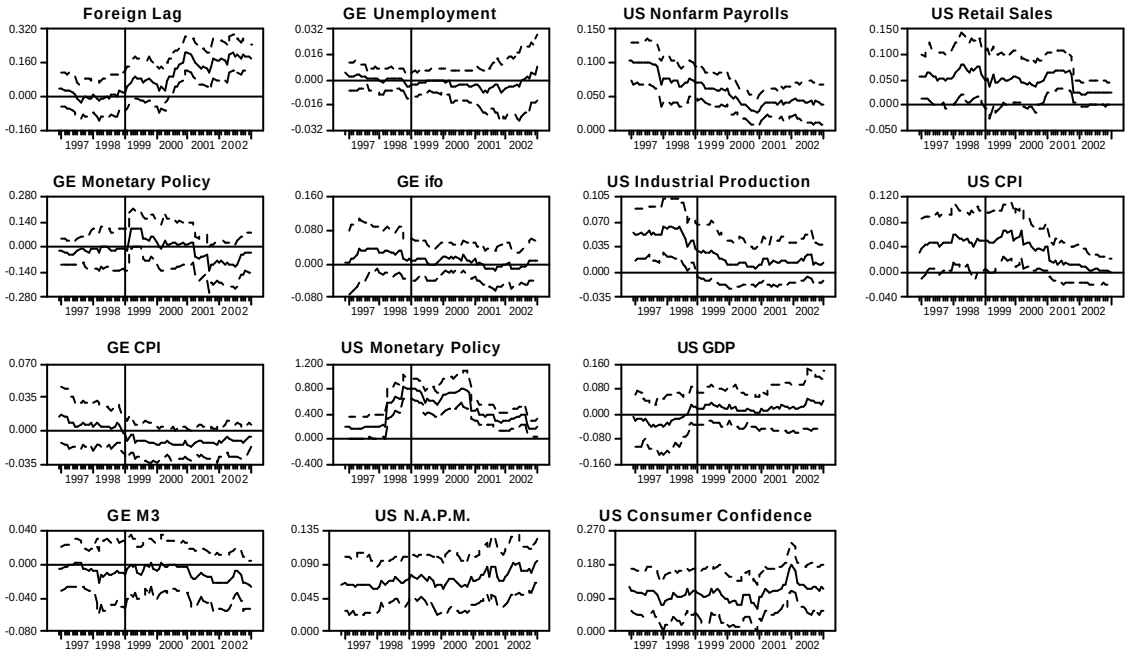


Figure 3: Rolling window parameter estimates of (1)-(2)
Germany and US, January 1993 – February 2003

German mean equation



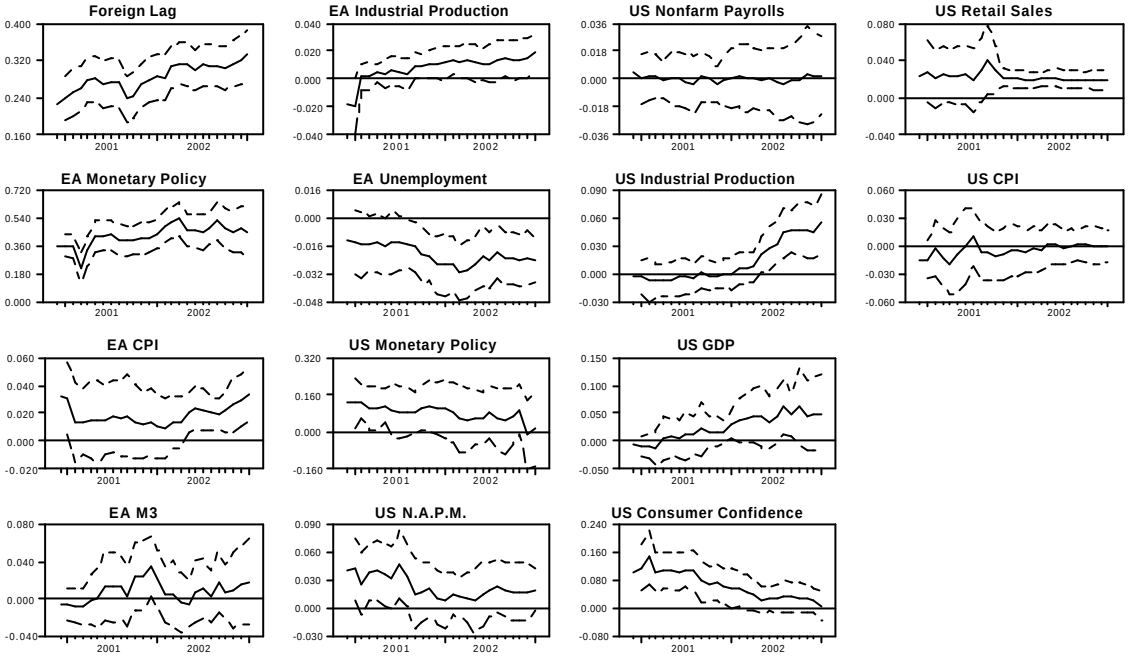
US mean equation



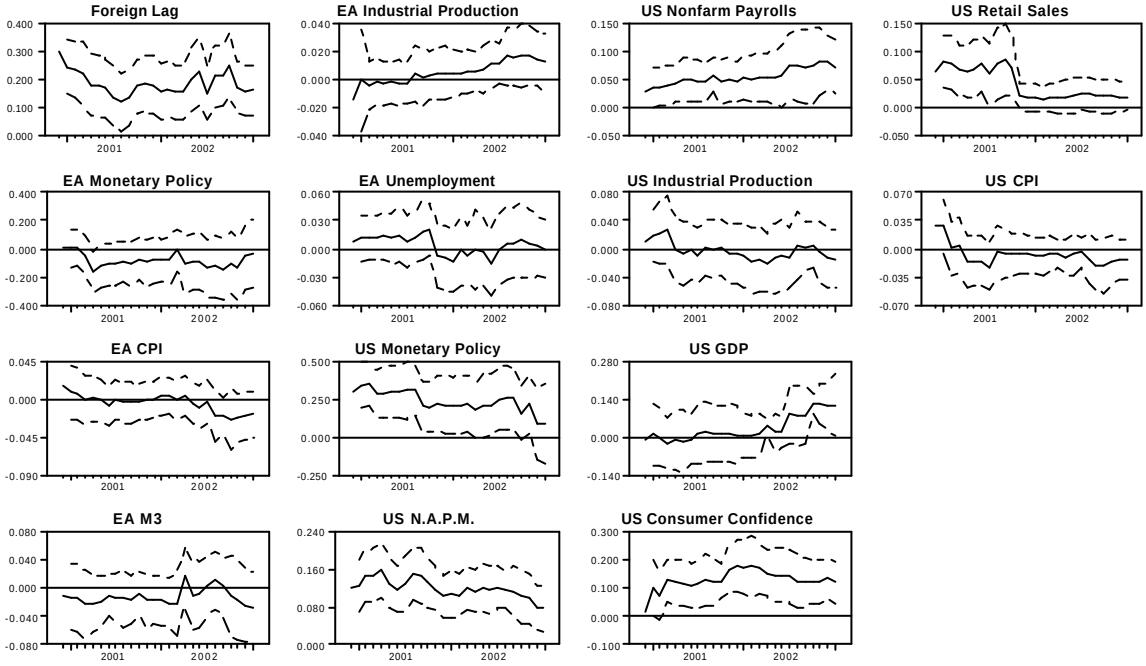
Note: x-axis values correspond to the end point of each rolling window; dotted lines: 90% confidence bands; vertical lines represent the start of EMU on January 1st, 1999

Figure 4: Rolling window parameter estimates of (1)-(2)
Euro Area and US, January 1999 – February 2003

EA mean equation



US mean equation



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

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