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Asymmetric News Effects on Exchange Rate Volatility

N:o 353 / 2008

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ISBN 978-951-39-3367-8
ISSN 1239-3797
Jyväskylä 2008

ABSTRACT[1]

This paper studies asymmetries in the news effects by estimating the impact of different macroeconomic news categories on high frequency EUR/USD volatility with Flexible Fourier Form model. The results show that US news increase volatility more than European news. UK news seems to increase volatility as much as news from the largest euro area countries. News from the smallest euro area countries seem not to affect volatility, nor do news from Japan. A significant difference between the impact of positive and negative news is not found, but the volatility increases more when positive and negative news are announced at the same time compared to when there are only either positive or negative news. Also, macroeconomic news that are positive (or negative) four months in a row increase volatility more than those which are positive and negative in turns.

Key Words: Asymmetry, Macroeconomic News, Exchange Rates, Volatility

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1 Introduction

One of the fundamental questions in financial economics is how new information is incorporated to asset prices. Numerous theoretical and empirical studies have shown, that because of the different motives of the heterogeneous agents (Farmer and Joshi 2002), different trading strategies (Admati and Pfleiderer 1988), psychological choices (Barberis et al. 1998) and different abilities to forecast and analyze the impact of new information on the value of an asset (Damodaran 1985), news not only causes a jump in the prices, but also a significant increase in volatility.

One important part of new information in the markets comprises the scheduled releases of macroeconomic figures. The extensive empirical literature (DeGennaro and Schrieves 1997, Andersen et al. 2003, Bauwens et al. 2005, Dominquez and Panthaki 2006, Laakkonen 2007a among others) has shown that announcements of macro figures cause a jump in the asset prices and significantly increase volatility right after the announcement. More recent literature in the related area of research has been focusing on the following topics: either to study the impact of macro news on different assets simultaneously, or examining the asymmetries between different categories of news. The aim of this paper is to contribute to the latter one.

In this paper we study asymmetric effects of different macroeconomic news categories on high frequency EUR/USD (Euro against United States Dollar) volatility. The paper contributes to the literature by examining two hypotheses relating to the impact of positive and negative news, neither of which to our knowledge have been addressed in the empirical literature earlier.

First, we examine whether 'contradictory' and 'consistent' news affect volatility differently. It is commonly the case that more than one macro figure is announced simultaneously. If some of the surprises are positive and some negative, this might increase volatility more than when either positive or negative news is announced alone (consistent news). This view would be supported by the theories of Damodaran (1985) and Manzan and Westerhoff (2005), who claim that investors are not in the same starting line when it comes to the ability to analyze the correct value of an asset after the arrival of news in the market. They suggest that investors react to news in different ways depending on how they think the information will affect the future payoff of their asset and how big their personal forecast errors are, i.e. how big a surprise the information is to them.

The second new hypothesis examines whether macro indicators which give positive (or negative) signals in row affect volatility more than indicators which give positive and negative signals in turns. Such asymmetries like this might be explained with the theory of 'investor conservatism' proposed by Barberis et al. (1998), who suggest that investors react asymmetrically to news due to their 'conservativeness' (i.e. reluctance) about changing to the correct 'pricing regime', as a result of which they end up overreacting to macro indicators which give the same signal (positive or negative) in succession.

Another contribution of the paper is the used data set. We use a new 5-minute frequency EUR/USD exchange rate data set running from 1 January 1999 to 31 December 2004 and a more comprehensive data set of macro announcements than has been used in the earlier literature. The data set includes all the macroeconomic announcements from the USA, all the euro countries, the UK and Japan. The announcements have been collected from Bloomberg WECO (World economic calendar), and they consist of scheduled releases for macroeconomic fundamentals such as GDP, sales figures, consumer confidence indices etc.

The results suggest that macro announcements increase volatility significantly, US news having the strongest effect. UK news seems to increase volatility as much as news from the largest euro area countries, while news from the smallest euro area, and from Japan, countries does not seem to affect volatility. We do not find a significant difference between the impact of negative and positive news, but the results suggest that 'contradictory' news increase volatility significantly more than 'consistent' news. The results also suggest that macro indicators, which give positive (or negative) signals in succession increase volatility significantly more than the indicators which give positive and negative signals in turns. Although the difference was significant only after four or more news announcements carrying the same sign in a row (+ + + +) or (- - - -). Also, we only find asymmetries in reactions to US news, not to the news from Europe or Japan.

The plan of the paper is as follows. Section 2 reviews the related literature and Section 3 describes the data and methodology. The results of the empirical study are presented in Section 4, and Section 5 concludes.

2 Theoretical backround

The impact of macroeconomic news on exchange rate dynamics has been widely empirically studied in recent decades. The earliest studies in the 1980s used daily return data and simple regressions (e.g. Ito and Roley 1987, Aggarwal and Schirm 1992), but since the 1990s the increasing availability of high-frequency data and improved methods (see e.g. Dacorogna et al. 1993, Andersen and Bollerslev, 1997) have facilitated more detailed study of the effects of news.

The literature can be divided into two strands: the one examines the direct effects of macroeconomic news on exchange rate returns and volatility[2], while the other focuses on the transmission of news through order flow (e.g. Payne 2003, Evans and Lyons 2008). The largest currency pairs (EUR/USD[3], USD/GBP, USD/JPY) have

[2]The literature includes Goodhart et al. (1993), Ederington and Lee (1993), DeGennaro and Schrieves (1997), Almeida et al (1998), Andersen and Bollerslev (1998), Eddelbüttel and McCurdy (1998), Melvin and Yin (2000), Andersen et al. (2003, 2007), Chang and Taylor (2003), Bauwens et al. (2005), Dominquez and Panthaki (2006), Faust et al. (2007), Laakkonen (2007a) among others.

[3]or DEM/USD before euro.

been examined the most, but some smaller currencies have also been used: Fornari et al. (2002), for example, studied the impact of news on Italian lira against the USD. In recent years, however, it has been common to study many currencies or different market instruments simultaneously (e.g. Andersen et al. 2003, 2007, Faust et al. 2007).

Most studies have focused on US news announcements, but some have also examined the impact of European or Asian news. The macro indicators are either examined separately to be able to see which indicators have the largest effects on markets, or in broader categories (e.g. monetary policy news and real economy news).

In general the results have shown that macro indicators affect exchange rates: they cause a jump in the conditional mean and increase the volatility of the exchange rate after the announcement. The impact of news from the US has been found to be stronger than the impact of news from the other countries, and of the US macro indicators, the monthly employment report causes the largest effects on exchange rates.

Many market microstructure theories have suggested that investors might react differently to different kinds of news. One of the stylized facts in the financial market is that investors react more strongly to negative than positive news. We also begin our analysis by studying whether differences exist between the impact of positive vs. negative macroeconomic news. This is not the first time this question has been examined, but the earlier results have been mixed: for example, Andersen et al. (2003) found that negative news have larger impact than positive news, while Pearce and Solakoglu (2007) do not find asymmetries with respect to sign.

One explanation for these mixed findings could be the time span of the data set. Laakkonen and Lanne (2008) found that negative news increases volatility more than positive news, but only when the economy is in expansion. The data used by Andersen and Bollerslev (2003), who found asymmetries between positive and negative news, only covered a period of economic boom. The asymmetric state dependencies found so far might be explained with the theory of Veronesi (1999), which suggests that the reaction to positive and negative news depends on the state of the economy: due to investors' willingness to hedge against the uncertainty about the state of the economy, they overreact to bad news in good times and underreact to good news in bad times.

Another possible explanation could be ambiguity of the news announcements, since commonly the case is that many macroeconomic figures are announced simultaneously. It could be that announcing a whole set of macro figures at the same time would help investors to gain a broader picture of the state of the economy. However, if some of the figures predict better market conditions and some worse, investors could find it difficult to evaluate the overall effect of the news and this would cause excess volatility. The latter outcome would be supported by the theories of Damodaran (1985) and Manzan and Westerhoff (2005), who claim that investors are not in the same starting line when it comes to the ability to analyze the correct value of an asset after the a news announcement arrives in the market. They suggest that investors react to news in different ways depending on how they think the information will affect the future payoff of their asset and how big their personal forecast errors are, i.e. how big a surprise the information is for them. Laakkonen (2007a) studied the hypothesis of 'conflicting' and 'consistent' news, and found that volatility increases significantly more if both positive and negative macro announcements are announced simultaneously than if only positive or negative news is announced. However, since the data set covered only three months, we now wish to confirm the results with a longer data set.

The third possible explanation could be drawn from the theory of 'investor conservatism' by Barberis et al. (1998), who suggest that investors react asymmetrically to news due to their 'conservativeness' about changing to the correct 'pricing regime'. In their model investors value an asset by referring to two 'pricing regimes'. The first is the trend regime and the second is the mean reverting regime. If positive (or negative) news is released one after another, the probability of being in the trend regime increases. Conversely, if there is negative news after positive news (or vice versa), the probability of being in the mean reverting regime increases. Finally, the model predicts that investors overreact to news releases which give the same signal (positive or negative) successively. Therefore, our aim is to study whether macro announcements that are of the same sign (positive or negative) successively have a different effect on volatility compared to macro announcements that are positive and negative in turns. For example, we examine whether positive GDP figure affects volatility more when the GDP announcements from previous months have also been positive compared to when positive GDP figure is released after a negative GDP figure.

3 Data and Methodology

This section describes the data and the methodology used. We also classify the news in different categories to be able to examine asymmetries in the effects of news.

3.1 Exchange Rate Data

The original data set contains 5-minute quotes[4] of the EUR/USD (Euro against United States Dollar) exchange rate from 1st January 1999 to 31st December 2004 and was obtained from Olsen and Associates. The prices are formed by taking the average between the bid and ask quotes, and the returns are computed as the differences of logarithmic prices. The return series is depicted in Figure 1.

[4] According to many studies, 5-minute returns strike the best balance between the disadvantages of microstructure noise (when sampling too frequently) and the loss of important information (when sampling too infrequently). For a discussion see Andersen et al. (2007).

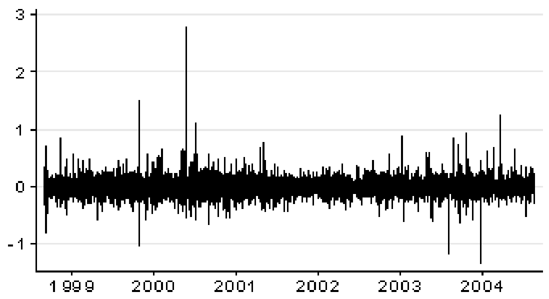

Figure 1 USD/EUR 5-minute logarithmic returns 1st Jan 1999-31st Dec 2004

As the foreign exchange market activity slows down decidedly during weekends and certain holiday non-trading periods, it is standard in the literature to explicitly exclude a number of days from raw 5-minute return series. Following Andersen and Bollerslev (1998), we exclude the weekends and certain holidays by always excluding the returns from 21:05 GMT the night before to 21:00 GMT that evening. Andersen and Bollerslev (1998) state that this definition of a "day" retains intact the intraday periodical volatility structure. The following holidays are excluded from the data: Christmas, New Year, Good Friday and Easter Monday. Besides holidays, three days are excluded from the data because of lack of observations. Daylight savings time was also taken into account as is standard in the literature.

The 5-minute returns exhibit strong intraday periodicity, because of the different trading times in the global 24-hour foreign exchange markets. This has to be taken into account in modeling news effects. Of the alternative models of filtering the periodicity, we chose the Flexible Fourier Form (FFF) model of Andersen and

Bollerslev (1997) that uses different frequencies of sine and cosine functions to capture the periodicity. This choice is motivated by Laakkonen (2007b), who studied the consequences of data filtering on the results obtained by using filtered returns. She concluded that for the purpose of studying the impact of news on volatility, the FFF method performs the best in data filtering among a number of commonly acknowledged filtering methods.

The model takes the following form:

$$R_{t,n} - \bar{R}_{t,n} = \sigma_t \cdot s_{t,n} \cdot Z_{t,n} \tag{1}$$

where $R_{t,n}$ denotes the 5-minute EUR/USD returns, $\bar{R}_{t,n}$ is the expected five-minute returns and $Z_{t,n}$ is an i.i.d (with mean zero and unit variance) innovations, σ_t represents daily volatility and $s_{t,n}$ intraday volatility[5].

To be able separately to identify the intradaily volatility component, both sides must first be squared and then logs taken. Approximating $\bar{R}_{t,n}$ with the sample mean $\bar{R}$ and eliminating the daily volatility component σ_t from the return process we end up with the following expression:

$$2\log\frac{\left|R_{t,n} - \bar{R}\right|}{\hat{\sigma}_t/N^{1/2}} = 2\log(s_{t,n}) + 2\log(Z_{t,n}) \tag{2}$$

[5]In the equations t denotes day and n the 5-minute interval.

where $\hat{\sigma}_t$ is the GARCH(1,1) model estimate for daily volatility and N denotes the number of 5-minute intervals in one day (288 in a 24-hour market). Now, Andersen and Bollerslev (1997) suggest a parametric representation of intraday volatility $s_{t,n}$ and estimate the smooth cyclical volatility pattern by using trigonometric functions. The FFF regression model is the following:

$$\begin{aligned} f_{t,n} &= \alpha + \delta_1 \frac{n}{N_1} + \delta_2 \frac{n^2}{N_2} + \sum_{k=1}^{D} \lambda_k I_k(t,n) \\ &\quad + \sum_{p=1}^{P} \left(\delta_{c,p} \cos\left(\frac{p2\pi}{N} n \right) + \delta_{s,p} \sin\left(\frac{p2\pi}{N} n \right) \right) + \varepsilon_{t,n}, \end{aligned} \tag{3}$$

where $f_{t,n} = 2 \ln \dfrac{|R_{t,n} - \bar{R}|}{\hat{\sigma}_t / N^{1/2}}$. Besides the sinusoids[6], the model contains the intercept α and the normalizing factors $\dfrac{n}{N_1}$ and $\dfrac{n^2}{N_2}$, where $N_1 = (N+1)/2$ and $N_2 = (N+1)(N+2)/6$. The model also contains the indicator variables $I_k(t,n)$. These variables are used to control for holiday effects, weekday effects etc. and $\varepsilon_{t,n}$ is the error term of the model. The estimate for intraday volatility $\hat{s}_{t,n}$ is then obtained as $\hat{s}_{t,n} = \exp(\hat{f}_{t,n}/2)$, where $\hat{f}_{t,n}$ are the fitted values of the model (3). This estimate $\hat{s}_{t,n}$ is normalized so that the mean of the normalized seasonality estimate equals one: $\tilde{s}_{t,n} = \dfrac{T \cdot \hat{s}_{t,n}}{\sum_{t=1}^{[T/N]} \sum_{n=1}^{N} \hat{s}_{t,n}}$ where T is the number of observations in the whole data. The original returns $R_{t,n}$ are then divided by the normalized estimate $\tilde{s}_{t,n}$ to get the filtered returns $\tilde{R}_{t,n} = \dfrac{R_{t,n}}{\tilde{s}_{t,n}}$. See Andersen and Bollerslev (1997, 1998) for further

[6]The value $P =$ 9 was selected by using the Akaike and Schwarz information criteria.

details of the method.

If the intraday periodicity pattern is assumed to remain constant over the data sample, the FFF model is estimated for the entire data set at once. Unfortunately this in not likely to be the case. For example, the trading hours of European markets caused much higher volatility in the early years of euro than they do today (Laakkonen 2007b). Therefore, to be able to filter all the periodicity in volatility, we have to filter the data in subsets, i.e. to model every week in the data separately.

Figure 2 presents the autocorrelation coefficients of absolute returns for 1500 five minute lags, i.e. the autocorrelogram for five days. As can be seen, the FFF method is capable of filtering the intraday periodicity in volatility, although there is still significant autocorrelation left in the absolute returns.

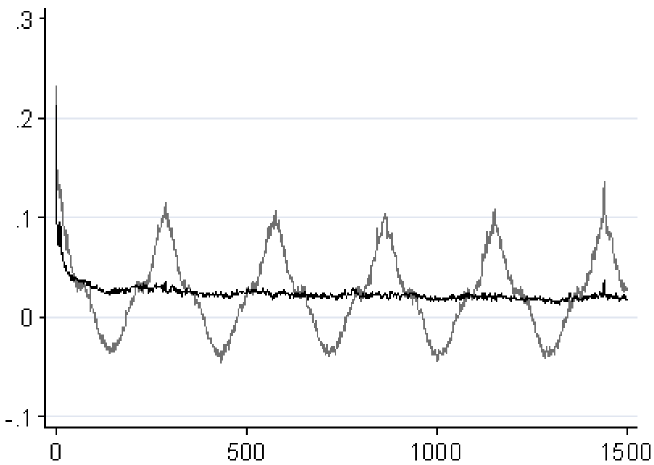

Figure 2 Autocorrelation coefficients of the original and filtered absolute returns
The figure shows the five day correlogram of the filtered five-minute absolute EUR/USD returns (black line) compared to original absolute returns (grey line). The intraday periodicity was filtered by using the Flexible Fourier Form method.

Table 1 Key statistical figures

The table presents the key statistical figures for the original and for the filtered returns. The returns were filtered with the Flexible Fourier Form method.

	Returns	Filtered Returns
Mean	0.00005	0.00008
Standard deviation	0.0431	0.043
Skewness	0.78	0.06
Kurtosis	65.94	28.94
Minimum	-1.35	-1.56
Maximum	2.78	1.40

The key statistical figures of the original and filtered return series are presented in Table 1. The mean and the standard deviation of the return series did not change dramatically when the returns were filtered: the mean return was very close to zero in both of the return series and there were no changes in the standard deviation. However, the filtering did have an effect on skewness and kurtosis. The distribution of financial return series usually shows a lot of extra kurtosis compared to the normal distribution, which indicates the existence of more large returns compared to the tails of the normal distribution. The distribution of the EUR/USD returns was also skewed to the positive side, which indicates that there have been more big positive jumps than big negative jumps. Compared to the original return series, the distribution of the filtered return series was closer to the normal distribution. The distribution of the filtered returns was almost symmetric: the skewness fell from 0.78 to 0.06. Also the extra kurtosis of the distribution fell from 65.94 to 28.94. Although the distribution of the returns is closer to the normal distribution after filtering, because of the excess kurtosis, neither the original nor filtered returns seems not to be normally distributed.

3.2 Macro Announcement Data

The macroeconomic news data set includes all the scheduled macroeconomic figures in the World Economic Calendar (WECO) page published by Bloomberg. The announcements were collected for the USA, the UK, Japan and all the euro countries (except Greece) for the period 1999-2004. The data include the announcement date and time to an accuracy of one minute, the announced figure and the market forecast of the figure. The market forecast is the median of the survey forecasts that Bloomberg collects from the market agents, but it is not available for all of the macro figures: for example, forecasts are not available for smaller euro countries. Table 2 presents the total number of macro announcements and the number of announcements, for which the forecast is or is not available, for each country separately and all combined.

To study asymmetries, the announcements were divided into different categories. The numbers of announcements in the different categories (for all countries combined and separately for the euro area, the UK and the US) are presented in Table 3.

The Bloomberg market forecast is used in classifying news as positive or negative. The news item is defined as positive when the market forecast is smaller than the

Table 2 Number of macro announcements in different categories

News category	All news	Forecast available	Forecast not available
All countries	27410	14670	12740
Austria	463	0	463
Belgium	807	27	780
ECB	2794	1059	1735
Finland	855	0	855
France	1813	1444	369
Germany	3671	1764	1907
Ireland	842	54	788
Italy	2259	1524	735
Japan	3127	1826	1301
Netherlands	992	241	751
Portugal	968	135	833
Spain	1346	626	720
United Kingdom	3317	2412	905
United States	4156	3558	598

announced figure, i.e. the announcement was underestimated. Negative news on the other hand means that market agents had overestimated the announced figure, which was less than the forecast. This classification has been standard in the literature (see e.g. Andersen and Bollerslev, 2003), although, it can be argued that positive news classified in this way might not necessarily be good news (for example if unemployment has increased more than expected[7]). Therefore, we also classified news as positive or negative in an alternative way. News is classified as positive if the next

[7]The estimations were also done with corrected data, where the positive surprise in unemployment was classified as negative news. This did not have a significant effect on the results.

Table 3 Number of macro announcements in different categories

News category	All countries	Euro	UK	USA
Positive news, market forecast	3765	1636	447	1177
Negative news, market forecast	3637	1642	467	1079
Positive news, sign of return	3391	1654	369	954
Negative news, sign of return	3155	1570	346	897
One announcement	2752	1152	130	1064
Consistent news	2684	1658	358	420
Conflicting news	1182	334	246	435
Trend news 2	1732	813	187	531
Trend news 3	1018	470	135	297
Trend news 4	1796	961	263	385
Mean revert news	4122	1868	516	1223

five-minute return following the news announcement is positive (dollar appreciates), and negative if the return is negative (dollar depreciates).

To study whether there are differences between the times when both positive and negative announcements arrive in markets at the same time and the times when news announcements are only either positive or negative, we classify each announcement as either 'contradictory' or 'consistent'. The announcement is 'contradictory', when at the same time (same minute) there are both positive and negative announcements and 'consistent' if there is more than one announcement and they are all only either positive or negative. The times when only one macro announcement arrives in the market are classified as 'one announcement'.

Finally, to study the difference between macro indicators that give the same signal (positive or negative) successively and the indicators which give positive and negative signals in turns, we classify the announcements as 'trend' or 'mean revert', respectively. The announcement is classified as 'trend', when its sign is the same as last month and 'mean revert' if the sign of the announcement is different from last month. The numbers 2, 3 and 4 refer to how many times the sign has been the same in succession.

3.3 The Model

To study the impact of news we estimate the following model:

$$y_{t,n} = c + \sum_{k=1}^{K} \beta_k N_{k;t,n} + \varepsilon_{t,n} \tag{4}$$

where $y_{t,n} = 2 \ln \frac{\left| \tilde{R}_{t,n} - \bar{R} \right|}{\hat{\sigma}_t / N^{1/2}}$. We continue to follow the Flexible Fourier Form framework (see section 3.1 for details), so that the dependent variable is of the same form as in model (3), but now instead of returns $R_{t,n}$ we have filtered returns $\tilde{R}_{t,n}$. Now, on the right-hand side we have a constant, c and the news variables $N_{k;t,n}$ and the error term $\varepsilon_{t,n}$. Since we are interested in different kinds of asymmetries (news announcements from different countries, positive vs. negative news, 'consistent' vs. 'contradictory' news, 'trend' vs. 'mean revert' news), we study them with a total of 12 models. The only difference between these models is that the set of news variable $N_{k;t,n}$ differs between the models. The different news categories are presented in

Tables 2 and 3.

If we were only interested in the impact that the macro figure has immediately after the announcement, the news variables would be dummy variables that are assigned a value of one five minutes after the news announcement and zero otherwise[8]. However, it has been reported that the impact of news lasts from one to two hours (Andersen et al., 2003). Therefore, we follow Andersen and Bollerslev (1998), and first create the average news impact pattern by computing the average absolute returns following the news announcement minus the average absolute returns over the whole data. We then estimate the decay structure of the volatility response pattern of news by fitting a third order polynomial to the average pattern of the impact of a news annnouncement:

$$\lambda\left(i\right) = 0.054\left(1-\left(i/25\right)^3\right) - 0.009\left(1-\left(i/25\right)^2\right)i + 0.0007\left(1-\left(i/25\right)\right)i^2 \qquad (5)$$

where $i = 1, 2, ...25$ denotes the 5-minute interval. The estimated decay structure captures the average news impact pattern quite well and forces the impact to zero after two hours (when $i = 25$), as depicted in Figure 3. Now, when the macro news has been announced at $i = 0$, the news variable obtains the value of $\lambda\left(i\right)$ during the

[8]Most studies that study the impact of news on financial market returns use the actual surprise element (the announced figure minus the forecast) as a news variable rather than a dummy variable that does not take into account the size of the surprise. However, Andersen et al. (2003, 2007) argue that it is the mere presence of an announcement, not so much the size of the corresponding surprise, that tends to boost volatility.

first 25 intervals after the announcement and zero otherwise. The impact of news on volatility $M_k(i)$ can then be calculated for every 25 intervals i separately with the equation

$$M_k\left(i\right) = \exp\left(\frac{\beta_k \cdot \lambda\left(i\right)}{1}\right) - 1 \tag{6}$$

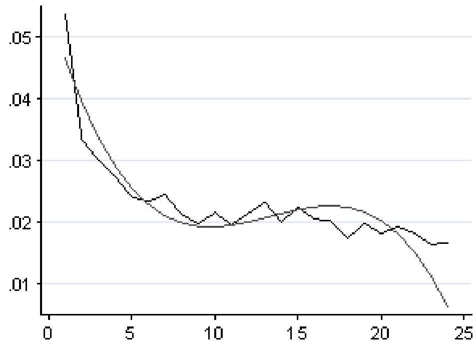

Figure 3 Average news impact pattern and estimated decay structure

The average decay structure of the impact of news announcements was estimated by using the third order polynomial $\gamma(i)$.

The longer dependencies of news could certainly have also been studied for example with lag dummies. However, the benefit of this polynomial method is, as Bollerslev et al. (2000) state, that it fixes the problem of having only a few announcement observations and it is less sensitive to the inherent noise in the return process. One further advantage of this approach is that compared to lag dummies, we now only need one news variable for each news group. To study the impact of news for a period of two hours after the announcement, we would have needed 24 (two hours is 24 five-minute intervals) news variables for all the news categories.

4 Empirical results

Table 4 presents the results of the first two models, which study the impact of news in general without any asymmetries. The coefficient values of the news variables β_k as well as the impact of news on volatility computed for the first 5-minute interval following the news announcement $M_k(1)$ are presented. The t-values in parenthesis are computed by using the Newey-West standard errors (288 lags).

We start by examining the impact of news in general without any asymmetries in Model 1. This news variable includes all the macroeconomic announcements from all the euro countries, Japan, the UK and the USA. As we can see, in general macroeconomic news increase volatility significantly: volatility increases by approximately 34% after the news announcements. Model 2 studies the impact of news from different countries. US news increases volatility clearly more than news from the other countries: volatility increases by 72% immidiately after the US news announcements, while the next largest effect, caused by news from Germany, is only 24%. The magnitude of the impact seem to follow quite closely of the size of the euro countries: news from the ECB and the largest countries, Germany and France, affect volatility the most, while news from the smallest countries like Finland and Austria does not seem to affect volatility significantly. Interestingly, UK news seems to increase volatility as much as the news from the largest euro area countries, while news from Japan does not increase the EUR/USD volatility significantly.

Table 5 presents the results of Models 3 and 4, in which we compare the news effects of announcements which include a forecast to those which do not. The macro figures for which a forecast exists seem to be more important than those without a forecast: news with a forecast increase volatility by 40% while the news without a forecast increase volatility by only 13%. The same phenomenon can be seen in the results of Model 4, in which news from the euro area, the UK and the US are studied separately. In all cases the coefficient of news which has a forecast available is larger than the coefficient of news without a forecast, and for the euro area and US news the difference is also statistically significant.

Table 6 presents the results of Models 5-8, which study the impact of positive and negative news. In Models 5 and 6 news is classified as positive or negative the basis of the market forecast, and in Models 7 and 8 the sign of the return following the news is used in the classification. In Models 5 and 7 the news annoucements from all the countries are combined together, while in Models 6 and 8 positive and negative news from the euro area, the UK and the US are studied separately.

As can be seen, the values of the coefficients for negative news seem to be larger than those for positive news, however, the Wald tests do not reject the equality of the coefficients in any of the cases. Interestingly, when the sign of the return is used in the classification, negative (dollar depreciates) UK and US news increases volatility more than positive UK and US news, while positive (euro depreciates) euro area news

Table 5 Estimation results: forecast vs. no forecast

Table presents the estimation results of Models 3 and 4, which compare the impact of news announcements which include a forecast with those which do not. Model 3 examines the news from all the countries combined, while in Model 4 news from the euro area, the UK and the USA are studied separately. Table presents he coefficient values of the news variables β_k and the t-values (in the parenthesis) computed by using the Newey-West standard errors (288 lags). * and ** denote the 5% and 1% significance levels, respectively. The figures in the last column are the impact of news on volatility computed to the first 5-minute interval following the news announcement: $M_k(1)$.

News variable *k*	**Model 3**	**Model 4**	
forecast available	18.78** (23.04)	-	140 %
forecast not available	6.79** (7.67)	-	113 %
Euro: forecast available		13.41** (13.07)	127 %
Euro: forecast not available		7.50** (7.86)	115 %
UK: forecast available		11.05** (6.10)	122 %
UK: forecast not available		9.48** (3.81)	119 %
USA: forecast available		32.30** (25.10)	179 %
USA: forecast not available		11.83** (4.31)	124 %
Wald-test, p-value			
forecast available = not available	0.000	-	-
Euro: forecast available = not available	-	0.000	-
UK: forecast available = not available	-	0.608	-
USA: forecast available = not available	-	0.000	-

increases volatility more than negative euro area news[9]. Table 7 presents the results of Models 9 and 10, which study the difference between the impact of 'consistent' and 'contradictory' news as well as the times when only one macroeconomic announcement is released. The news is defined as 'contradictory' if both positive and negative

[9] We also studied the impact of the largest and the smallest positive and negative news announcements to see if the magnitude of the surprise matters. Following Vähämaa, Watzka and Äijö (2005) we excluded the low surprise announcements by using the upper and lower quartiles as the sampling boundaries. This did not have an effect to the results.

news is announced at the same time and 'consistent' if there is more than one news announcement and they are all only positive or only negative. In Model 9 news from different countries is not separated, while in Model 10 the impact of 'contradictory' and 'consistent' news from the different markets is examined separately.

The results show that there are differences between the impact of 'one announcement', 'contradictory' news and 'consistent' news, but that the differences are statistically significant only in the case of US news. In general contradictory news increases volatility significantly more than consistent news. While consistent news increases volatility by 27%, contradictory news increases volatility by 49%. Interestingly, the times when there is only one macro announcement seem to increase volatility more than the times when there is more than one announcement and the news gives consistent signal about the state of the economy.

The results of Models 11 and 12, which study the difference between the impact of 'trend news' and 'mean revert news' news are presented in Table 8. If positive macro indicator is followed by negative news of that same indicator (or negative news is followed by positive news), the news is classified as 'mean revert news'. If positive news is followed by positive news (or negative news is followed by negative news), the news is classified as 'trend news'. Since it might matter how many times the sign of

Table 6 Estimation results: positive and negative news

Table presents the estimation results of Models 5-8. All the models study the impact of positive vs. negative news, but the classification of positive and negative news differs between the models. In the Model 5 and 6 the news was classified as positive or negative based on the difference between the announced figure and market forecast and in the Model 7 and 8 by using the sign of the return following the news announcement. Models 5 and 7 examine the news from all the countries combined, while in Models 6 and 8 news from euro area, the UK and the USA are studied separately. Table presents the coefficient values of the news variables β_k and the t-values (in the parenthesis) computed by using the Newey-West standard errors (288 lags). * and ** denote the 5% and 1% significance levels, respectively. The figures in the last column are the impact of news on volatility computed to the first 5-minute interval following the news announcement: $M_k(1)$. The Wald test tests the equality of the positive and negative news coefficient estimates.

	Market forecast			Sign of return		
News variable *k*	**Model 5**	**Model 6**	$M_k(1)$	**Model 7**	**Model 8**	$M_k(1)$
positive news	13.87** (13.56)	-	128 %	20.25** (20.69)	-	44 %
negative news	14.25** (13.46)	-	129 %	21.47** (21.64)	-	47 %
Euro: positive news	-	11.04** (8.12)	122 %	-	16.60** (13.17)	144 %
Euro: negative news	-	10.92** (7.83)	122 %	-	14.27** (11.32)	147 %
UK: positive news	-	5.49* (2.00)	110 %	-	13.15** (5.55)	135 %
UK: negative news	-	10.80* (3.95)	121 %	-	19.22** (7.74)	129 %
USA: positive news	-	21.91** (12.89)	148 %	-	32.70** (19.65)	180 %
USA: negative news	-	25.56** (14.03)	158 %	-	35.54** (20.93)	190 %
Wald-test, p-value						
pos = neg	0.819	-	-	0.379	-	-
Euro: pos = neg	-	0.957	-	-	0.212	-
UK: pos = neg	-	0.264	-	-	0.079	-
USA: pos = neg	-	0.222	-	-	0.246	-

Table 7 Estimation results: consistent and contradictory news

Table presents the estimation results of Models 9 and 10, which examine the impact of one announcement, and of consistent and contradictory news announcements. The news is classified as 'one announcement' if only one macro figure was announced during a five-minute interval, contradictory, if more than one macro figure was released and some of these were positive and some negative and consistent if the surprises were all positive or negative only. Model 9 examines news from all the countries combined, while in Model 10 news from the euro area, the UK and the USA are studied separately. Table presents he coefficient values of the news variables β_k and the t-values (in the parenthesis) computed by using the Newey-West standard errors (288 lags). * and ** denote the 5% and 1% significance levels, respectively. The figures in the last column are the impact of news on volatility computed to the first 5-minute interval following the news announcement: $M_k(1)$.

News variable *k*	**Model 9**	**Model 10**	$M_k(1)$
All countries: one announcement	17.22** (15.31)	-	136 %
All countries: consistent news	13.25** (12.21)	-	127 %
All countries: contradictory news	22.17** (13.79)		149 %
Euro: one announcement		13.78** (8.55)	128 %
Euro: consistent news	-	11.76** (9.02)	124 %
Euro: contradictory news	-	11.51** (4.04)	123 %
UK: one announcement		19.52** (5.39)	142 %
UK: consistent news	-	9.04** (3.44)	118 %
UK: contradictory news	-	14.47 (4.38)	130 %
USA: one announcement		23.94** (13.99)	154 %
USA: consistent news	-	31.88** (13.95)	178 %
USA: contradictory news	-	40.89** (17.46)	209 %
Wald-test, p-value	**one = cons**	**one = cont**	**cons = cont**
Model 9	0.012	0.012	0.000
Model 10, Euro	0.356	0.503	0.938
Model 10, UK	0.020	0.299	0.200
Model 10, USA	0.007	0.000	0.006

the news has been the same in succession, we take this into account by using three different 'trend' news variables: all the news for which the sign of the news has been the same two times in succession are classified as 'trend news 2', while 'trend news 3' and 'trend news 4' mean that the macro indicator has had the same sign three or

Table 8 Estimation results: trendy and mean reverting news

Table presents the estimation results of Models 11 and 12. All the models study the difference between the impact of macro indicators that give either positive or negative signals in succession (trend news) and the macro indicators that give positive and negative signals in turns (mean revert news). The numbers 2, 3 and 4 refer to the number of times the surprises have to be positive (or negative) in a row to be classified as trend news. Model 11 examines the news from all the countries at once, while in Model 12 the news from euro area, the UK and the USA are studied separately. Table presents he coefficient values of the news variables β_k and the t-values (in the parenthesis) computed by using the Newey-West standard errors (288 lags). * and ** denote the 5% and 1% significance levels, respectively. The figures in the last column are the impact of news on volatility computed to the first 5-minute interval following the news announcement: $M_k(1)$. The F-test tests the equality of the "trendy" and "mean reverting" news variable coefficient estimates.

News variable *k*	**Model 11**	**Model 12**	$M_k(1)$
All countries: trend news 2	10.89** (7.98)	-	122 %
All countries: trend news 3	13.59** (7.60)	-	128 %
All countries: trend news 4	12.99** (9.21)	-	126 %
All countries: mean revert news	11.39** (10.83)	-	123 %
Euro: trend news 2	-	6.03** (3.15)	111 %
Euro: trend news 3	-	10.72** (4.47)	121 %
Euro: trend news 4	-	9.87** (5.54)	119 %
Euro: mean revert news	-	8.37** (5.84)	116 %
UK trend news 2	-	14.54** (3.99)	130 %
UK trend news 3	-	13.71** (2.75)	128 %
UK trend news 4	-	8.37* (2.36)	116 %
UK mean revert news	-	3.87 (1.30)	107 %
USA trend news 2	-	20.17** (8.78)	144 %
USA trend news 3	-	24.58** (7.69)	156 %
USA trend news 4	-	29.75** (10.25)	171 %
USA mean revert news	-	21.43** (11.77)	147 %
Wald-test, p-value	**tre2 = mr**	**tre3 = mr**	**tre4 = mr**
Model 11: All countries	0.794	0.332	0.419
Model 12: Euro	0.389	0.447	0.564
Model 12: UK	0.000	0.145	0.418
Model 12, USA	0.713	0.443	0.035

four times in succession, respectively.

Table 8 also presents the results of the Wald tests comparing the coefficients of the 'mean revert news' to those of the different 'trend news' variables. While the coefficients of the 'trend news' variables seem in general to be larger than the coefficients of the 'mean revertin news' variables, we again find the strongest asymmetries in the case of US news: the macro indicators that have had the same sign for four or more months in a row increase volatility significantly more compared to macro indicators that are by turns positive and negative.

5 Conclusions

This paper studies the impact of macroeconomic news on EUR/USD exchange rate volatility, focusing on asymmetries between different news categories. According to our results, macroeconomic announcements increase volatility significantly, US news causing a much larger effect than news from the other countries. UK news increases volatility as much as news from the largest euro area countries while news from the smallest euro area countries and Japan does not increase volatility statistically significantly.

The estimated value of the coefficient for negative news is larger than that of positive news, however, the difference is not statistically significant. Laakkonen and Lanne (2008) find that negative news increases volatility more than positive news, but only when the economy is in expansion. Since the data cover both good and bad economic periods, this might explain why we do not find differences between positive and negative news.

Manzan and Westerhoff (2005) suggest that even professional traders experience difficulties in evaluating the meaning of news. When the signal of news announcements is not so clear it is clearly more difficult to analyze it. We found that news that gives contradictory information on the state of the economy increases volatility more than news that gives consistent information. By contradictory news we mean times when both positive and negative news arrives in the market. News is consistent, on the other hand, when only either positive or negative news arrives. Manzan and Westerhoff (2005) suggest that central authorities should provide more reliable information about fundamentals, and so reduce the degree of misperception.

We also found that macro indicators which give positive (or negative) signals in a succession increase volatility significantly more than the indicators which give positive and negative signals in turns. This result might be explained by the theory of 'investor conservatism' proposed by Barberis et al. (1998), which suggests that investors overreact to macro indicators which successively give positive (or negative) signals of the state of the economy.

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