Information Arrival, Jumps and Cojumps in European Financial Markets: Evidence using tick by tick data

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Abstract

This paper investigates jumps and cojumps in European financial markets employing more than six years of tick by tick data on stock index, currency and interest rate futures. We use a new jump detection measure built upon a methodology proposed by Andersen et al. (2007c) and Lee and Mykland (2008). Our results show that scheduled US macroeconomic announcements cause significant jumps on all asset classes. European equity markets are found to be more responsive to the US fundamentals than currency and interest rate futures. There is a strong correlation between the type of news and orientation of the jumps. The frequency and intensity of jumps have considerably increased in European markets since the global credit crisis started in 2007. We also report strong evidence of cojumps caused by the US macroeconomic surprises across European stock indices futures. The interdependence among European equity markets has increased since the recent worldwide recession.

Keywords: Jumps and cojumps; macroeconomic announcements; tick by tick data; interest rate futures; global credit crisis

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1. Introduction

The idea that macroeconomic news affect financial markets is by now well established. Flannery and Protopapadakis (2002), for example, argue that macroeconomic variables are excellent candidates for extra market risk factors. More recent papers have focused on the information arrival and price discovery process using high frequency intraday data [e.g., Andersen et al. (2003, 2007), Gürkaynak and Wolfers (2006)]. The findings in those papers suggest that macroeconomic news announcements may be responsible for generating jumps and cojumps in financial markets.[1] Jumps are defined as sudden and large discontinuities in pricing process of financial markets. Cojumps arise when jumps occur contemporaneously in multiple markets. Understanding the characterization and causes of jump is central to asset pricing and financial management [see Piazzesi (2005), Lee and Mykland (2008), and Tauchen and Zhou (2005)]. It is also important to consider the extent to which jumps occur simultaneously across different asset classes, such as stock index, interest rate and currency market futures. Beine et al. (2009) argues that investors and speculators who follow real time trading strategies are interested in high-frequency interrelations of asset markets to optimally time their portfolio rebalancing. Therefore, common sources of news and relation of different asset classes to fundamentals help us understand jump characteristics across markets [Lahaye et al. (2011)].

The objective of this paper is to investigate the intraday jumps and cojumps in European financial markets around key US macroeconomic news announcements. We use very high frequency data on stock index futures, i.e., Euro Stoxx50, CAC40 and DAX30 as well as the 3-month Euribor and EUR/USD futures.

We utilize the non-parametric statistic of Lee and Mykland (2008) to detect jumps on high frequency data spanning more than six years. The Lee-Mykland technique to identify intraday jumps allows us to study the role of scheduled macroeconomic announcements in creating jumps. Following Lahaye et al. (2011), we also use this statistic to investigate multivariate issues and test whether macro announcements cause cojumps across multiple financial markets. Even though European equity

[1] Andersen, Bollerslev and Diebold (2007), for example, show that many jumps in DM/$ exchange rate, S&P500 market index, and the 30-year U.S. Treasury bond yield are directly associated with specific macroeconomic news announcements.

markets are found to be the more sensitive to US fundamentals, our results show that scheduled US macroeconomic announcements cause significant jumps on all asset classes. Our findings also indicate a strong correlation between the type of the news and the orientation of the jumps. Moreover, the frequency and intensity of jumps have considerably increased in European markets since the start of the global credit crisis in 2007. We also find a strong evidence of cojumps caused by the US macro surprises across European stock index futures. Our analysis suggests that interdependence among European equity markets has increased since the global recession in 2007.

The recent literature on the relationship between economic fundamentals and financial markets can be divided into two main categories. The first strand of literature has analyzed the impact of macroeconomic news announcements on intraday returns and volatilities in financial markets.[2] The second thread has linked scheduled macro announcements to jumps and cojumps in financial markets. For example, Huang (2007) estimates daily jumps with bi-power variation on 10 years of S&P 500 and U.S. T-bonds data. By analysing conditional distributions of jumps and regressing continuous and jump components on measures of disagreement and uncertainty concerning future macroeconomic states, Huang (2007) finds a major role for payroll news and a relatively more responsive bond market. Dungey et al. (2008) focuses on the US treasury market, and estimates jumps and cojumps across the term structure with bi-power variation. Their results show that macroeconomic announcements are strongly associated with the jumps and cojumps in the term structure. Bollerslev et al. (2008) using a newly developed test statistic find strong evidence for many modest-sized, yet highly significant cojumps that simply pass through standard jump detection statistics when applied on a stock-by-stock basis. Han (2008) analyzes the intraday effects of the US and the EMU macroeconomic shocks on both the conditional means and the conditional variances of the high frequency Dollar–Euro returns. The author finds that macroeconomic shocks may have discernible effects on exchange rates when examined at the high frequency level with the disappearance of the effects at lower frequency levels due to their being drowned in subsequent fluctuations of exchange rates. Jiang et al. (2009) examines

[2] See, for example, Andersen et al. (2003, 2007), Flannery and Protopapadakis (2002), Boyd et al. (2005) and Harju and Hussain (2011).

jumps in the U.S. Treasury bond prices. They show that while jumps occur mostly at pre-scheduled macroeconomic announcement times, announcement surprises have limited power in explaining bond price jumps. They also find that pre-announcement liquidity shocks, such as changes in the bid-ask spread and market depth, have significant predictive power for jumps. Dungey and Hvozdyk (2012) examine cojumping behavior of spot and futures prices in high frequency US Treasury data. They find that cojumping occurs most frequently at shorter maturities and higher sampling frequencies and that the probability of cojumping is particularly affected by news surprises in non-farm payrolls, consumer price index (CPI), gross domestic product (GDP) and retail sales.

Our paper extends the second strand of literature in the following directions. Firstly, we analyze jumps and cojumps around US macroeconomic releases in several European financial markets. Some earlier papers, such as Andersson (2010), Harju and Hussain (2011), and Hussain (2011) have analyzed the impact of US macroeconomic/ monetary policy releases on the intraday returns and volatilities in European financial markets. But to the best of our knowledge, no study links jumps and cojumps in multiple European markets and across different asset classes to the US macroeconomic indicators. Secondly, we estimate jumps at a very high frequency using tick by tick data.[3] These intraday estimates, which are much more precise than daily or even lower frequency intraday jump measures, enable us to describe jumps and cojumps and to carefully link them to macroeconomic indicators. Thirdly, we report the magnitude and the direction of jumps and co-jumps for each relevant US macroeconomic indicator. Finally, contrary to the majority of earlier studies which mainly focused on the US markets, this paper presents new empirical evidence on European financial markets.

The rest of the paper is structured as follows: The data are described in section two. The methodology is presented in section three. Section four describes the empirical findings and a summary and conclusions follow in section five.

[3] Many earlier studies, e.g., Huang (2007), have relied on daily or lower frequency data to investigate the relation between economic fundamentals and jumps and cojumps in financial markets.

2. Data

2.1. Financial markets data

We use tick by tick level 1 quote prices for the three main European equity index futures, i.e. the Euro Stoxx50, CAC40 (French) and DAX30 (German) as well as the 3-month Euribor and EUR/USD futures, covering the period from 26 May 2003 until 31 January 2010.

The description of the acquired dataset is given in Table 1. The Euro Stoxx50 (FESX) index includes the 50 largest companies of the Euro zone. It contains 35% of French stocks, covered by the CAC40 index (FCE) and 33% of German stock, included in the DAX30 index (FDAX). Euro Stoxx50 and DAX30 index futures, traded on the EUREX, are constituted of 4 yearly contracts, which expire the third week of March, June, September and December. CAC40 index futures are operated on EURONEXT with a monthly expiry, while the EUR/USD futures, traded in the Chicago Mercantile Exchange (CME) consist of 4 yearly contracts expiring the third Friday of March, June, September and December. The NYSE EURONEXT 3-month EURIBOR futures are used as a proxy for the interest rate sensitivity on US macroeconomic announcements. For EURIBOR futures, 28 delivery months are available for trading, with the nearest six delivery months being consecutive calendar months. They are quoted as 100 minus the 3-month rate of interest.

Insert Table 1 about here

To limit the detection of spurious jumps due to illiquid market, we filter out mid-quote prices where the bid-ask spread exceeds 4 ticks. We then follow the same procedure as Lee and Mykland (2008) and sample the mid-quote prices at fixed time intervals of 5 minutes in order to limit the market microstructure noise. The descriptive statistics of 5-minute returns are shown in Table 2.

Insert Table 2 about here

2.2. US macroeconomic announcements data

The announcement data consist of scheduled US macroeconomic news releases for the period May 26, 2003 through January 31, 2010. These data contain date, time, actual release and the mean forecast for the indicator. The surprise is calculated as the difference between the actual value of the announced indicator and its mean forecast provided by the Bloomberg World Economic Calendar (WECO). The summary of the announcement data is given in Appendix A. There are total of 23 US macro announcements in our sample.[4] Almost all the indicators are announced either at 14:30 Central European Time (CET) or 16:00 CET with the exception of Industrial production which is released at 15:15 CET.[5]

3. Methodology

Our methodology for detecting the jumps and cojumps in European stock index, currency and interest rates futures around US macro-economic releases is based largely on the model proposed by Lee and Mykland (2008). The idea behind the model is as follows:

Let $p(t)$ be a logarithmic asset price at time t. Consider the continuous time jump diffusion process defined by the following equation:

$$dp(t) = \mu(t)dt + \sigma(t)dW(t) + \kappa(t)dq(t), \qquad 0 \leq t \leq, T \qquad (1)$$

where $\mu(t)$ is a continuous and locally bounded variation process, $\sigma(t)$ is a strictly positive stochastic volatility process with a sample path that is right continuous and has well defined limits, $W(t)$ is a standard Brownian motion, and $q(t)$ is a counting process with intensity $\lambda(t)(P[dq(t) = 1] = \lambda(t)dt$ and $\kappa(t) = p(t) - p(t-)$ is the size of the particular jump. The quadratic variation for the cumulative process $r(t) \equiv p(t) - p(0)$, and $[r, r]_{t,}$ is the integrated volatility of the continuous sample path component plus the sum of the $q(t)$ squared jumps that occurred between time 0 and time t.

[4] The selection of the US macro indicators is based on the availability of data and their occurrence during the European markets' trading hours.
[5] Thereafter, all times are given in Central European Time (CET).

The intuition behind the jump test proposed by Andersen et al. (2007c) and Lee and Mykland (2008) is simple and straightforward. In the absence of jumps, instantaneous returns are increments of Brownian motion. Standardized returns that are too large to plausibly come from a standard Brownian motion must reflect jumps. More formally, let us assume that we have T days of $\lfloor 1/\Delta \rfloor \equiv M$ equally spaced intraday returns and denote the i-th return of day t by $r_{t,i} \equiv p(t + i\Delta) - p(t + (i-1)\Delta)$, where $i = 1, \ldots, M$. Andersen et al. (2007c) and Lee and Mykland (2008) propose the following test statistic for jumps in $r_{t,i}$;

$$J_{t,i} \equiv \frac{r_{t,i}}{\sigma_{t,i}} \qquad (2)$$

One must estimate the unobserved volatility, $\sigma_{t,i}$, with a robust-to-jump estimator. Barnsdorff-Nielsen and Shephard (2004, 2006a) show that under weak conditions, realized bi-power variation (RBV) converges to integrated volatility under the model described by equation (1).

$$\underset{\Delta \to 0}{plim} RBV_t(\Delta) = \int_{t-1}^{t} \sigma^2(s) ds \qquad (3)$$

$$\text{where } RBV_t(\Delta) = \mu_1^{-2} \sum_{i=2}^{M} |r_{t,i}||r_{t,i-1}| \qquad (4)$$

with $\mu_1 \equiv \sqrt{\frac{2}{\pi}} \simeq 0.79788$

Consequently, Andersen et al. (2007) and Lee and Mykland (2008) propose to estimate $\sigma_{t,i}$ as the average of the RBV computed over a local window K observations preceding period t, i. They both explicitly assume that the spot volatility is approximately constant over that window. There is a clear trade off in choosing the window size K: K must be large enough to accurately estimate integrated volatility but small enough for variance to be approximately constant. For returns sampled at frequencies of 60, 30, 15, and 5 minutes, Lee and Mykland (2008) recommend using K: 78, 110, 156 and 270 observations, respectively.

To detect price discontinuities on the 5 price series, we compute the Lee-Mykland test. The statistic detects jumps by taking the ratio of the instantaneous volatility estimated with the realised bi-power variation on a fixed window K to the next realised return.

Let $r(t_i)$ be the log-return of stock S_i, i.e. $r(t_i) = \log \frac{S(t_i)}{S(t_{i-1})}$. The Lee-Mykland statistic, which detects if a jump occurred in the interval $(t_{i-1}; t_i]$, is given by $\mathcal{L}(i) = \frac{r(t_i)}{\widehat{\sigma(t_i)}}$.

The realised bi-power variation on a window K is estimated as

$$\widehat{\sigma(t_i)} = \sqrt{\frac{1}{K-2} \sum_{j=i-K+2}^{i-1} |r_j| \cdot |r_{j-1}|} \qquad (5)$$

Provided that the window size $K \in (\Delta t)^{\alpha}$ where $-1 < \alpha < -0.5$ and that the time between two observations $\Delta t = \max_i\{t_i - t_{i-1}\}$ is small, the null hypothesis of no jump at time t_i is rejected at 1% significant level if

$$\frac{|\mathcal{L}(i)| - C_n}{S_n} > 4.6001$$

n is the number of observations, $c = \sqrt{\frac{2}{\pi}}$, $C_n = \frac{\sqrt{2\log n}}{c} - \frac{\log \pi + \log(\log n)}{2c\sqrt{2\log n}}$ and $S_n = \frac{1}{c\sqrt{2\log n}}$. We rely on Lee-Mykland (2008) test to detect jumps as it is more accurate and precise than the Barnsdorff-Nielsen and Shephard (2004) test. Lee-Mykland (2008) demonstrates that the likelihood of misclassification of jumps becomes negligible using high frequency data.

4. Empirical results

4.1. Descriptive Statistics of Jumps

Table 3 provides an overall view of the identified jumps. The second panel in Table 3 [Jump day frequency] shows that number of days associated with jumps vary across asset classes. In accordance with the results reported by Lahaye et al. (2011), stock index futures exhibit fewer jump days than on Euribor and EUR/USD Futures. European stock index futures jump on 15.72% to 27.67% of the sample days, while currency (EUR/USD) and interest rate (EURIBOR) futures jump on about 36% and 33% of sample days, respectively. However, the number of jumps per day does not vary a great deal across different asset classes. While interest rate (EURIBOR) futures jump on average 3 times per jump day, the European equity and currency futures jump about 2 times on each jump day.

The number of jumps for each instrument is listed in the third panel of Table 3 [All jumps (absolute value)]. The descriptive statistics on jumps show that interest rate and currency futures jump more often than the European equity futures. For example, per observation, the Euribor futures jump more than twice compared to the Euro Stoxx50. One explanation of such phenomena for exchange rate, as suggested by Lahaye et al. (2011) is that they are subject to news from two countries, not just one, and probably because they experience more idiosyncratic liquidity shocks during slow trading in the 24-hour markets. The idiosyncratic liquidity shocks and other news items that are not part of our sample may also explain the relatively more frequent and larger jumps in 3-months Euribor futures.[6] Among the European stock indices, the French market exhibits highest number of jump days indicating higher volatility, confirming the findings of Harju and Hussain (2011).

Table 3 (panel 3) also shows that interest rate and currency futures exhibit relatively larger jumps compared to the stock index futures. The average jump size for Euribor and EUR/USD Futures is 1.08 and 0.94, respectively, while the absolute jumps are similar across European equity indices, ranging from 0.57 for FDAX (DAX30) to 0.76 for FCE (CAC40). The coefficients of variation for absolute jumps also vary across markets, the highest being 0.82 for EURIBOR and EUR/USD Futures, and the lowest, 0.46 for FDAX.

We now turn our attention to asymmetry in jumps frequency. The statistics reported in panel 4 and 5 of Table 3 suggest that there are about equal number of positive and negative jumps in interest rate and currency future markets. However, there are more negative jumps in European stock index futures than positive jumps, indicating asymmetry in stock markets. The last panel in Table 3 shows that 63% of all jumps in FDAX are negative, while the similar figure for the FCE and FESX is 57% and 59%, respectively.[7] Lahaye et al. (2011) show that equity markets tend to show more

[6] For example, Baglioni and Monticini (2010) show that the implicit hourly interest rate in the euro area money market jumped by more than ten times at the outset of sub-prime financial turmoil in August 2010. Authors argue that this evidence may be attributed to an increase of the liquidity premium and of the cost of collateral.

[7] The total numbers of surprises associated with jumps are 254. Out of which, 22 are zero, 125 are negative and 107 are positive surprises. This may also be one of the plausible reasons for observed asymmetry in stock indices futures as the surprises were more often negative than positive during our

negative jumps than the Forex market. However, they find that the disparity between positive and negative jumps on equity markets is not statistically significant.

Insert table 3 about here

4.2. US Macroeconomic announcements and associated Jumps in European markets.

To measure the impacts of scheduled US macroeconomic events on European stock indices, interest rate and currency futures; we perform the Lee-Mykland (2008) test at 1% significance level on the 5-minute mid-quote prices from 26 May 2003 until 31 January 2010.[8] The descriptive results are depicted in Figure 1. Our analysis suggest that as many as 19 out of 23 U.S. macroeconomic indicators have statistically significant effects across all asset classes, including unemployment reports, the housing indicators, the two ISM reports and the consumer confidence. The U.S unemployment reports and house price index cause the highest percentage of jumps across European markets, the former being the most influential of all indicators.

Insert Figure 1 about here

Turning to the specific asset classes, numerous US macro indicators are found to have significant impact on European indices futures (Figure 2). The unemployment reports, net exports numbers, price measures (such as CPI and PPI), initial jobless claims, and import price index are particularly more dominant in causing jumps in stock indices futures. These results support the findings of Harju and Hussain (2011) showing that the U.S unemployment numbers have a significant impact across European equity markets.

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sample period. Therefore, it seems intuitive that European stock indices future experienced more negative jumps.

[8] As noted earlier that almost all US macroeconomic announcements are made either at 14:30 or 16:00 CET, we carry out the test between 13:00 and 22:00 CET.

Figure 3 displays the percentage of jumps in EUR/USD futures linked to the type of US macroeconomic news announcements. As shown in Figure 3, many U.S indicators cause significant jumps in EUR/ USD futures. Particularly forward looking measures, i.e., index of leading indicators and business inventories explain highest number of jumps in currency futures. These results for EUR/USD futures are consistent with those reported by Evans (2011).

Insert Figure 2 & 3 about here

The 3-month EURIBOR futures, however, are relatively less affected by US macroeconomic announcements as illustrated in Figure 4. In case of EURIBOR futures; gross domestic product (GDP), initial jobless claims, factory orders and housing starts numbers exert any influence in causing significant jumps.

Insert Figure 4 about here

We also look at the number of jumps linked to the time of US macroeconomic releases across all asset classes in our sample.[9] Our analysis reveals that 95.43% and 69.67% of all detected jumps in European equity futures are related to the U.S macroeconomic news announcements at 14:30 and 16:00 CET, respectively. For the EURIBOR and EUR/USD future, about 60 and 30 percent jumps occurring at 14:30 and 16:00 CET, respectively, are related to the release of US macroeconomic indicators. These results indicate greater responsiveness of equity markets to the US fundamentals.

Another important observation is that there are differences in markets' response to different types of announcements. These results are not surprising given the earlier results that asset classes respond differently to different announcements. Huang (2007), for example, found that the US fixed income markets are more responsive to the domestic macroeconomic announcements than equity markets. Lahaye et al. (2011) also show that the propensity of macroeconomic surprises to create jumps differs across asset classes, i.e., exchange rates, bonds and stock index.

[9] The results are not shown here to save the space.

4.3. Size and sign of jumps associated with US macroeconomic announcements

In this section, we associate the direction and magnitude of jumps detected in all five markets with the type of macroeconomic announcements. Since we utilize the mean forecast for each macroeconomic announcement to calculate surprises, the magnitude and direction of jumps are related to the value and sign of the given surprise. Appendix B reports the date and time of the jump, the market (product), the return computed as logarithm of the price ratio before and after the jump, the actual announcement along with its mean forecast value, and type of the news announced for each macroeconomic indicator causing a jump in European markets. We look at the direction of the jump based on news type, i.e., whether the surprise is a 'good news' or 'bad news'. An announcement is classified as 'good news' if the event is better than forecasted and as 'bad news' otherwise.

Our results show that most of the U.S macroeconomic events generally cause jumps in all markets in our sample. However, stock index futures clearly dominate the picture. Interestingly, the larger the surprise, the greater impact it has on all three European stock index futures. For example, U.S unemployment rate announcement on 6 June and 5 September 2008, where the employment rate was 0.4 worse than expected, caused a large negative jump in all three equity index futures i.e., Euro Stoxx50, CAC40 and DAX30. There is also a strong correlation between the directions of the surprises and signs of the jumps implying that most of the time, investors only base their trades on the forecasted numbers and take a long position in the index if the indicator is better than expected and short it after a bad news. However, there are sometimes negative reactions to good news. One of the plausible reasons explaining this discrepancy is that there may be some other factors beyond macroeconomic announcements that can have a strong impact on the orientation of the jump. Secondly, as the mean forecast is not always a very good predictor of the market direction, the surprises may not serve as the true sentiment of the market.[10]

[10] Another possible explanation along the same line is that these forecasts are not unanimously adopted among all analysts and big financial institutions typically compile their own forecast. However, it is also important to note that whenever there is an opposite response to the type of announcement, all five index futures analyzed in this study always react uniformly to that particular news event.

Another interesting finding is that all three equity markets repeatedly react to the announced indicator in a similar fashion. For instance, on 4 August 2006, all three equity index futures reacted positively to a better than expected unemployment rate announcement. A unanimous response can also be seen on March 04, 2005 to the unemployment rate announcement and on January 02, 2008 to the ISM Price index, indicating existence of cojumps, particularly on European equity indices futures.

4.4. US macro announcements and Cojumps in European markets

Table 4 reports the number of cojumps and associated probabilities for pairs of markets. As can be seen, the highest probabilities of cojumps are found for the pairs of European equity markets, confirming our earlier assertion. For example, there are about 200 common jumps in DAX30 and Euro stoxx50 futures, 177 between DAX30 and CAC40, and 184 between CAC40 and Euro stoxx50 futures. Moreover, all three European equity indices futures share 155 common jumps in response to the U.S macroeconomic news announcements.

Insert Table 4 about here

The lower panel of Table 4 reports the probability of cojumps conditional on jumps in individual markets (P(coj|jump)). The conditional probability in the first column indicates that 71.92% of all jumps on Euro Stoxx50 (FESX) are also cojumps on DAX30 futures (FDAX). Similarly, 54.96% of all jumps on Euro Stoxx50 are cojumps on DAX30 and CAC futures, signifying a highly dependence structure of European equity markets.

Next, we examine the conditional probability of cojump for every significant US macroeconomic news announcement. Table 5 reports the main findings. First panel shows that 90.47% of the all jumps on Euro Stoxx50 futures are linked with the US unemployment rate surprises at 14:30 CET cause cojumps in DAX30 futures. Likewise, 85.71% of all jumps in Euro Stoxx50 create simultaneous jumps (cojumps) in both German and French stock indices futures.

The second panel of Table 5 shows the probability of a cojump on the considered markets given a jump on the market shown in the corresponding column, in response

to consumer price index announcements (CPI). Our results reveal that 100% of all jumps in Euro Stoxx50 create cojumps in French stock index futures. Moreover, 90.90% of jumps related to US Consumer Price Index in Euro Stoxx50 are cojumps across all three futures markets, i.e., German DAX, French CAC and Euro Stoxx50.

Insert Table 5 about here

Overall, our findings indicate that the number of other US indicators, such as producer price index, Existing home sales, consumer confidence and ISM price index are strongly linked with cojumps in European equity indices futures. These results are supported by significant intraday patterns with sharp peaks in European equity markets at the time of US scheduled macroeconomic news announcements documented by Harju and Hussain (2011), Andersson (2010) and Hussain (2011).

4.5. Time series pattern of Jumps and cojumps

Figure 5 plots the time series of significant jumps in all five asset classes in our sample. As clearly seen, the frequency and the intensity of jumps have increased during our sample period. We are particularly interested in examining whether the recession in global markets started in 2007 has significantly changed the jump dynamics in financial markets. The graphical representation of jumps depicts that both the frequency and size of the jumps have increased after 2007 in all future markets. More frequent and intense jumps represent a majority of volatility during recession years in all five instruments. Appendix C1 and C2 present descriptive statistics on significant jumps before and after 2007 for all asset classes in our sample, respectively. The results show that the percentage of jump days has increased in all markets during the recession period. However, while there is a moderate increase in Equity index, the interest rate (EURIBOR) and currency (EUR/USD) futures have experienced large increases in percentage of jump days after 2007. For example, on 3-months interest rate (EURIBOR) futures, there are 47.57% days associated with jumps during the recession years compared to 19.67% days in the pre-recession period. Similarly, there are 41.62% jump days after 2007 on EUR/USD futures in comparison with 28.83% before that period indicating that currency markets

experienced higher volatility during the global financial crisis. This result for EURIBOR is consistent with that of Baglioni and Monticini (2010) who found huge jumps in European interbank interest rate at the outset of the financial turmoil in August 2007.

The third panel of Appendix C1 and C2 compares the absolute value of all jumps across all markets, during pre and post recession period, respectively. The statistics show that the probability of occurrence of jump (P(jump) and jump size (E(|jumpsize||jump) have increased across all markets during recession. The asymmetry parameters reported in Appendices (the last panel of Appendix C1 and C2) show that there is a slight increase in negative jumps on European stock index and interest rate futures during recession, while more positive jumps are reported for EUR/USD. One of the possible reasons for this phenomenon is that equity markets are more closely related with macroeconomic fundamentals, and have been more adverse economic announcements during recession. Consequently, equity markets have experienced more negative jumps during the global economic downturn.

Insert Figure 5 about here

Figure 6 depicts the time series graph of significant cojumps in three pairs of European stock index futures, revealing more frequent and larger cojumps after 2007. [11] This is an important finding in the context of financial markets interdependence during recession. This suggests that there are more concurrent jumps (cojumps) across equity markets during recession, implying a higher risk caused by the low diversification across European stock index futures.

Insert Figure 6 about here

5. Discussion and Conclusion

[11] We do not report similar graphs for EURIBOR and EUR/USD futures here because there are too little cojumps to draw any conclusion for these instruments.

Price discovery in financial markets is virtually a continuous process. However, pure diffusion processes are sometimes disrupted by sudden and violent price movements, defined as jumps. Cojumps arise when jumps occur contemporaneously across markets. The understanding of jumps and cojumps is important for option pricing, portfolio management, hedging and risk management (VaR) etc.

The objective of this paper is to investigate the intraday jumps and cojumps in European markets around scheduled US macroeconomic news announcements. We use very high frequency data on stock index future (DAX, CAC and Euro Stoxx), interest rate (3-month EURIBOR) and currency (EUR/USD) futures from 26 May 2003 until 31 January 2010. Despite the perceived implications of price discontinuities in financial markets, there are not many papers that have analyzed the cojumps across European markets.

We use a new jump detection measure built upon a methodology proposed by Andersen et al. (2007c) and Lee and Mykland (2008). Our results show that scheduled US macroeconomic announcements cause significant jumps on all asset classes. However, European equity markets are found to be more sensitive to the US fundamentals than other asset classes. Our results also indicate a strong correlation between the type of the news and orientation of the jumps. Moreover, the frequency and intensity of jumps have considerably increased in European markets since the global the start of the global credit crisis in 2007. We also find a strong evidence of cojumps caused by US macro surprises across European stock index futures, suggesting that the interdependence among European equity markets has increased since the global recession in 2007.

These results have important implications for finance practitioners and researchers. Our results suggest that most of the time, investors base their trades only on the forecasted numbers and take a long position in the index if the indicator is better than expected and short it after a bad news. Our results also indicate that there are differences in markets' response to different types of announcements, thus linking the fundamental to different asset classes may allow us to develop hedging strategies suitable to a particular asset class.

Appendix A

Event	Number of events	Time of announcement (CET)
Advance Durable Good	78	14:30
Business Inventories	79	16:00
CPI	77	14:30
Consumer Confidence	80	16:00
Existing Home Sale	59	16:00
Factory Orders	79	16:00
GNP	28	14:30
House Price Index	11	16:00
Housing Start	79	14:30
ISM Manufacturing	80	16:00
ISM Price	68	16:00
Import Price Index	78	14:30
Industrial Production	78	15:15
Initial Jobless Claims	346	14:30
Leading Price Indicator	78	16:00
New Home Sale	79	16:00
Non Farm Productivity	23	14:30
Personal Income	77	14:30
Personal Spending	69	14:30
Producer Price Index	77	14:30
Retail Sales	79	14:30
Trade Balance	79	14:30
Unemployment	80	14:30

Appendix B

Date time	Product	Return	Actual	Forecast	News Type
Unemployment					
2003.09.05 14:30:00	FDAX	-0.0053	6.1	6.2	bad news
2003.10.03 14:30:00	FDAX	0.0092	6.1	6.2	bad news
2003.12.05 14:30:00	FDAX	-0.0056	5.9	6	bad news
2004.01.09 14:30:00	FDAX	-0.0070	5.7	5.9	bad news
2004.03.05 14:30:00	FDAX	-0.0059	5.6	5.6	as forecasted
2004.06.04 14:30:00	FDAX	0.0041	5.6	5.6	as forecasted
2004.08.06 14:30:00	FCE	-0.0052	5.5	5.6	bad news
2004.08.06 14:30:00	FDAX	-0.0067	5.5	5.6	bad news
2004.08.06 14:30:00	FESX	-0.0058	5.5	5.6	bad news
2004.09.03 14:30:00	FCE	0.0029	5.4	5.5	bad news
2004.09.03 14:30:00	FESX	0.0040	5.4	5.5	bad news
2004.10.08 14:30:00	FCE	-0.0044	5.4	5.4	as forecasted
2004.10.08 14:30:00	FDAX	-0.0046	5.4	5.4	as forecasted
2004.10.08 14:30:00	FESX	-0.0046	5.4	5.4	as forecasted
2004.11.05 14:30:00	FCE	0.0047	5.5	5.4	good news
2004.11.05 14:30:00	FESX	0.0049	5.5	5.4	good news
2004.12.03 14:30:00	FCE	-0.0041	5.4	5.4	as forecasted
2004.12.03 14:30:00	FDAX	-0.0046	5.4	5.4	as forecasted
2005.02.04 14:30:00	FCE	-0.0022	5.2	5.4	bad news
2005.02.04 14:30:00	FDAX	-0.0024	5.2	5.4	bad news
2005.03.04 14:30:00	FCE	0.0029	5.4	5.2	good news
2005.03.04 14:30:00	FDAX	0.0037	5.4	5.2	good news
2005.03.04 14:30:00	FESX	0.0038	5.4	5.2	good news
2005.05.06 14:30:00	FDAX	0.0033	5.2	5.2	as forecasted
2006.03.10 14:30:00	FCE	0.0039	4.8	4.7	good news
2006.03.10 14:30:00	FDAX	0.0041	4.8	4.7	good news
2006.08.04 14:30:00	FCE	0.0050	4.8	4.6	good news
2006.08.04 14:30:00	FDAX	0.0048	4.8	4.6	good news
2006.08.04 14:30:00	FESX	0.0051	4.8	4.6	good news
2006.11.03 14:30:00	FCE	0.0031	4.4	4.6	bad news
2006.11.03 14:30:00	FDAX	0.0028	4.4	4.6	bad news
2006.11.03 14:30:00	FESX	0.0033	4.4	4.6	bad news
2006.12.08 14:30:00	FDAX	0.0030	4.5	4.5	as forecasted
2007.02.02 14:30:00	FCE	0.0025	4.6	4.5	good news
2007.02.02 14:30:00	FDAX	0.0025	4.6	4.5	good news
2007.07.06 14:30:00	FDAX	-0.0042	4.5	4.5	as forecasted
2007.09.07 14:30:00	FCE	-0.0059	4.6	4.6	as forecasted
2007.09.07 14:30:00	FDAX	-0.0057	4.6	4.6	as forecasted
2007.09.07 14:30:00	FESX	-0.0052	4.6	4.6	as forecasted
2007.10.05 14:30:00	FCE	0.0037	4.7	4.7	as forecasted
2007.10.05 14:30:00	FDAX	0.0032	4.7	4.7	as forecasted
2007.10.05 14:30:00	FESX	0.0044	4.7	4.7	as forecasted
2008.01.04 14:30:00	FCE	-0.0079	5	4.8	good news

2008.01.04 14:30:00	FDAX	-0.0060	5	4.8	good news
2008.01.04 14:30:00	FESX	-0.0066	5	4.8	good news
2008.03.07 14:30:00	EUR/USD	-0.0062	4.8	5	bad news
2008.03.07 14:30:00	FDAX	-0.0067	4.8	5	bad news
2008.03.07 14:30:00	FESX	-0.0074	4.8	5	bad news
2008.05.02 14:30:00	FCE	0.0104	5	5.2	bad news
2008.05.02 14:30:00	FDAX	0.0085	5	5.2	bad news
2008.05.02 14:30:00	FESX	0.0101	5	5.2	bad news
2008.06.06 14:30:00	FCE	-0.0084	5.5	5.1	good news
2008.06.06 14:30:00	FDAX	-0.0071	5.5	5.1	good news
2008.06.06 14:30:00	FESX	-0.0094	5.5	5.1	good news
2008.08.01 14:30:00	FDAX	0.0058	5.7	5.6	good news
2008.09.05 14:30:00	FCE	-0.0081	6.1	5.7	good news
2008.09.05 14:30:00	FDAX	-0.0079	6.1	5.7	good news
2008.09.05 14:30:00	FESX	-0.0087	6.1	5.7	good news
2009.01.09 14:30:00	FCE	0.0106	7.2	7	good news
2009.01.09 14:30:00	FDAX	0.0093	7.2	7	good news
2009.01.09 14:30:00	FESX	0.0105	7.2	7	good news
2009.06.05 14:30:00	FCE	0.0101	9.4	9.2	good news
2009.06.05 14:30:00	FDAX	0.0114	9.4	9.2	good news
2009.06.05 14:30:00	FESX	0.0113	9.4	9.2	good news
2009.08.07 14:30:00	FCE	0.0097	9.4	9.6	bad news
2009.08.07 14:30:00	FDAX	0.0077	9.4	9.6	bad news
2009.08.07 14:30:00	FESX	0.0096	9.4	9.6	bad news
2009.09.04 14:30:00	EURIBOR	-0.0270	9.7	9.5	good news
2009.10.02 14:30:00	FCE	-0.0055	9.8	9.8	as forecasted
2009.10.02 14:30:00	FDAX	-0.0064	9.8	9.8	as forecasted
2009.10.02 14:30:00	FESX	-0.0067	9.8	9.8	as forecasted
2009.11.06 14:30:00	FCE	-0.0120	10.2	9.9	good news
2009.11.06 14:30:00	FDAX	-0.0124	10.2	9.9	good news
2009.11.06 14:30:00	FESX	-0.0129	10.2	9.9	good news
2009.12.04 14:30:00	FCE	0.0125	10	10.2	bad news
2009.12.04 14:30:00	FDAX	0.0115	10	10.2	bad news
2009.12.04 14:30:00	FESX	0.0135	10	10.2	bad news
2010.01.08 14:30:00	FCE	-0.0036	10	10.1	bad news
2010.01.08 14:30:00	FDAX	-0.0043	10	10.1	bad news
2010.01.08 14:30:00	FESX	-0.0041	10	10.1	bad news

Date time	Product	Return	Actual	Forecast	News type
ISM Manufacturing					
2003.07.01 16:00:00	FDAX	-0.0116	49.8	51	bad news
2004.01.02 16:00:00	FDAX	0.0037	66.2	61	good news
2004.10.01 16:00:00	EURIBOR	0.0171	58.5	58.4	good news
2005.07.01 16:00:00	FCE	0.0029	53.8	51.4	good news
2005.07.01 16:00:00	FDAX	0.0024	53.8	51.4	good news
2005.07.01 16:00:00	FESX	0.0030	53.8	51.4	good news
2006.08.01 16:00:00	FCE	-0.0033	54.7	53.5	good news

2006.08.01 16:00:00	FDAX	-0.0035	54.7	53.5	good news
2006.08.01 16:00:00	FESX	-0.0033	54.7	53.5	good news
2006.09.01 16:00:00	FDAX	-0.0034	54.5	54.5	good news
2006.09.01 16:00:00	FESX	-0.0031	54.5	54.5	good news
2006.10.02 16:00:00	FCE	0.0028	52.9	53.5	bad news
2006.10.02 16:00:00	FDAX	0.0025	52.9	53.5	bad news
2006.10.02 16:00:00	FESX	0.0028	52.9	53.5	bad news
2006.12.01 16:00:00	FDAX	-0.0053	49.5	51.5	bad news
2006.12.01 16:00:00	FESX	-0.0043	49.5	51.5	bad news
2007.01.03 16:00:00	FCE	0.0030	51.4	50	good news
2007.01.03 16:00:00	FDAX	0.0024	51.4	50	good news
2007.01.03 16:00:00	FESX	0.0027	51.4	50	good news
2007.04.02 16:00:00	EUR/USD	0.0077	50.9	51.4	bad news
2007.09.04 16:00:00	EUR/USD	0.0044	52.9	53	bad news
2007.10.01 16:00:00	FESX	0.0034	52	52.6	bad news
2008.01.02 16:00:00	FCE	-0.0055	47.7	50.5	bad news
2008.01.02 16:00:00	FDAX	-0.0050	47.7	50.5	bad news
2008.01.02 16:00:00	FESX	-0.0051	47.7	50.5	bad news
2008.04.01 16:00:00	EUR/USD	0.0024	48.6	47.5	good news
2008.04.01 16:00:00	FESX	0.0053	48.6	47.5	good news
2008.07.01 16:00:00	EUR/USD	0.0039	50.2	48.5	good news
2008.07.01 16:00:00	FCE	0.0073	50.2	48.5	good news
2008.07.01 16:00:00	FDAX	0.0065	50.2	48.5	good news
2008.07.01 16:00:00	FESX	0.0075	50.2	48.5	good news
2008.09.02 16:00:00	EUR/USD	-0.0132	49.9	50	bad news
2008.10.01 16:00:00	EUR/USD	-0.0168	43.5	49.5	bad news
2008.12.01 16:00:00	EUR/USD	-0.0157	36.2	37	bad news

Date time	Product	Return	Actual	Forecast	News type
ISM Price					
2003.07.01 16:00:00	FDAX	-0.0116	56.5	51	bad news
2004.01.02 16:00:00	FDAX	0.0037	66	63.5	bad news
2004.10.01 16:00:00	EURIBOR	0.0171	76	81	good news
2005.07.01 16:00:00	FCE	0.0029	50.5	55.3	good news
2005.07.01 16:00:00	FDAX	0.0024	50.5	55.3	good news
2005.07.01 16:00:00	FESX	0.0030	50.5	55.3	good news
2006.08.01 16:00:00	FCE	-0.0033	78.5	75.3	bad news
2006.08.01 16:00:00	FDAX	-0.0035	78.5	75.3	bad news
2006.08.01 16:00:00	FESX	-0.0033	78.5	75.3	bad news
2006.09.01 16:00:00	FDAX	-0.0034	73	76	good news
2006.09.01 16:00:00	FESX	-0.0031	73	76	good news
2006.10.02 16:00:00	FCE	0.0028	61	67.5	good news
2006.10.02 16:00:00	FDAX	0.0025	61	67.5	good news
2006.10.02 16:00:00	FESX	0.0028	61	67.5	good news
2006.12.01 16:00:00	FDAX	-0.0053	53.5	49.8	bad news
2006.12.01 16:00:00	FESX	-0.0043	53.5	49.8	bad news
2007.01.03 16:00:00	FCE	0.0030	47.5	54	good news

2007.01.03 16:00:00	FDAX	0.0024	47.5	54	good news
2007.01.03 16:00:00	FESX	0.0027	47.5	54	good news
2007.04.02 16:00:00	EUR/USD	0.0077	65.5	58.5	bad news
2007.09.04 16:00:00	EUR/USD	0.0044	63	63	good news
2007.10.01 16:00:00	FESX	0.0034	59	62	good news
2008.01.02 16:00:00	FCE	-0.0055	68	65	bad news
2008.01.02 16:00:00	FDAX	-0.0050	68	65	bad news
2008.01.02 16:00:00	FESX	-0.0051	68	65	bad news
2008.04.01 16:00:00	EUR/USD	0.0024	83.5	75	bad news
2008.04.01 16:00:00	FESX	0.0053	83.5	75	bad news
2008.07.01 16:00:00	EUR/USD	0.0039	91.5	87	bad news
2008.07.01 16:00:00	FCE	0.0073	91.5	87	bad news
2008.07.01 16:00:00	FDAX	0.0065	91.5	87	bad news
2008.07.01 16:00:00	FESX	0.0075	91.5	87	bad news
2008.09.02 16:00:00	EUR/USD	-0.0132	77	82	good news
2008.10.01 16:00:00	EUR/USD	-0.0168	53.5	73	good news
2008.12.01 16:00:00	EUR/USD	-0.0157	25.5	32	good news

Date time	Product	Return	Actual	Forecast	News Type
Factory Orders					
2004.10.04 16:00:00	EUR/USD	0.0024	-0.1	0.1	
2006.03.31 16:00:00	EURIBOR	0.0079	0.2	1.3	
2006.07.05 16:00:00	EURIBOR	-0.0089	0.7	0.1	
2006.07.05 16:00:00	EUR/USD	0.0018	0.7	0.1	
2006.12.05 16:00:00	FCE	0.0058	-4.7	-4.2	
2006.12.05 16:00:00	FDAX	0.0067	-4.7	-4.2	
2006.12.05 16:00:00	FESX	0.0057	-4.7	-4.2	
2007.04.04 16:00:00	EUR/USD	0.0079	1	1.8	
2007.04.04 16:00:00	FCE	-0.0255	1	1.8	
2007.05.02 16:00:00	EUR/USD	-0.0035	3.1	2.2	
2007.06.04 16:00:00	EUR/USD	0.0052	0.3	0.7	
2008.03.05 16:00:00	FCE	0.0067	-2.5	-2.5	
2008.03.05 16:00:00	FDAX	0.0064	-2.5	-2.5	
2008.03.05 16:00:00	FESX	0.0069	-2.5	-2.5	
2008.07.02 16:00:00	EURIBOR	-0.0032	0.6	0.5	
2008.09.03 16:00:00	EUR/USD	-0.0112	1.3	1	
2008.10.02 16:00:00	EUR/USD	-0.0223	-4	-3	
2009.03.05 16:00:00	EUR/USD	0.0056	-1.9	-3.5	
2009.07.02 16:00:00	EUR/USD	-0.0029	1.2	0.8	
2009.08.05 16:00:00	FCE	-0.0046	0.4	-1	
2009.08.05 16:00:00	FESX	-0.0045	0.4	-1	
2010.01.05 16:00:00	EUR/USD	-0.0166	1.1	0.5	

Date time	Product	Return	Actual	Forecast	News Type
Consumer Confidence					

2003.07.29 16:00:00	FDAX	-0.0156	76.6	85	bad news
2003.09.30 16:00:00	FDAX	-0.0093	76.8	80.5	bad news
2004.02.24 16:00:00	FDAX	-0.0041	87.3	92.5	bad news
2004.08.31 16:00:00	FCE	-0.0022	98	103.5	bad news
2004.08.31 16:00:00	FDAX	-0.0034	98	103.5	bad news
2006.10.31 16:00:00	EURIBOR	0.0015	105.4	108	bad news
2008.12.30 16:00:00	EUR/USD	0.0046	38	45.5	bad news
2009.01.27 16:00:00	EUR/USD	0.0051	37.7	39	bad news
2009.02.24 16:00:00	EUR/USD	0.0140	25	35.5	bad news
2009.03.31 16:00:00	EUR/USD	0.0081	26	28	bad news
2009.05.26 16:00:00	FCE	0.0107	54.9	42	good news
2009.05.26 16:00:00	FDAX	0.0119	54.9	42	good news
2009.05.26 16:00:00	FESX	0.0110	54.9	42	good news
2009.06.30 16:00:00	FCE	-0.0059	49.3	55	bad news
2009.07.28 16:00:00	FCE	-0.0066	46.6	49	bad news
2009.07.28 16:00:00	FDAX	-0.0073	46.6	49	bad news
2009.07.28 16:00:00	FESX	-0.0069	46.6	49	bad news
2009.09.29 16:00:00	FCE	-0.0049	53.1	57	bad news
2009.09.29 16:00:00	FDAX	-0.0058	53.1	57	bad news
2009.09.29 16:00:00	FESX	-0.0049	53.1	57	bad news
2009.12.29 16:00:00	EUR/USD	-0.0349	52.9	52.5	good news

Date time	Product	Return	Actual	Forecast	News Type
Initial Jobless Claims					
2003.07.31 14:30:00	FDAX	0.0077	388	400	good news
2005.04.28 14:30:00	FCE	-0.0053	320	320	bad news
2005.04.28 14:30:00	FDAX	-0.0050	320	320	bad news
2005.04.28 14:30:00	FESX	-0.0059	320	320	bad news
2005.07.21 14:30:00	FCE	-0.0040	303	325	good news
2005.07.21 14:30:00	FESX	-0.0049	303	325	good news
2005.11.03 14:30:00	FCE	0.0042	323	330	good news
2005.11.03 14:30:00	FDAX	0.0041	323	330	good news
2005.11.03 14:30:00	FESX	0.0048	323	330	good news
2006.09.21 14:30:00	EURIBOR	-0.0010	318	310	bad news
2006.11.02 14:30:00	FDAX	-0.0027	327	310	bad news
2006.11.02 14:30:00	FESX	-0.0030	327	310	bad news
2007.05.03 14:30:00	FCE	0.0031	305	325	good news
2007.05.03 14:30:00	FDAX	0.0033	305	325	good news
2007.05.03 14:30:00	FESX	0.0039	305	325	good news
2007.11.21 14:30:00	EURIBOR	0.0055	330	330	bad news
2008.07.31 14:30:00	FCE	-0.0096	448	392.5	bad news
2008.07.31 14:30:00	FDAX	-0.0089	448	392.5	bad news
2008.07.31 14:30:00	FESX	-0.0110	448	392.5	bad news
2009.04.02 14:30:00	FCE	0.0629	669	650	bad news

Date time	Product	Return	Actual	Forecast	News Type
New Home Sale					
2005.02.28 16:00:00	EUR/USD	-0.0015	1106	1125	bad news
2006.07.27 16:00:00	EUR/USD	0.0050	1131	1150	bad news
2006.10.26 16:00:00	EUR/USD	0.0061	1075	1040	good news
2006.11.29 16:00:00	EUR/USD	0.0065	1004	1049	bad news
2007.01.26 16:00:00	FDAX	-0.0028	1120	1052	good news
2007.03.26 16:00:00	FCE	-0.0042	848	985	bad news
2007.03.26 16:00:00	FDAX	-0.0044	848	985	bad news
2007.03.26 16:00:00	FESX	-0.0043	848	985	bad news
2007.05.24 16:00:00	EUR/USD	-0.0057	981	860	good news
2007.05.24 16:00:00	FDAX	0.0046	981	860	good news
2007.05.24 16:00:00	FESX	0.0029	981	860	good news
2007.08.24 16:00:00	FCE	0.0041	870	820	good news
2007.10.25 16:00:00	FCE	0.0039	770	770	bad news
2007.12.28 16:00:00	FCE	-0.0031	647	717	bad news
2008.04.24 16:00:00	EUR/USD	-0.0068	526	580	bad news
2008.04.24 16:00:00	FESX	-0.0062	526	580	bad news
2008.09.25 16:00:00	EUR/USD	0.0036	460	510	bad news
2009.08.26 16:00:00	EUR/USD	0.0096	433	390	good news
2009.12.23 16:00:00	EUR/USD	0.0035	355	440	bad news
2009.12.23 16:00:00	FDAX	-0.0037	355	440	bad news

Date time	Product	Return	Actual	Forecast	News type
CPI					
2004.06.15 14:30:00	FDAX	0.0033	0.6	0.5	good news
2005.02.23 14:30:00	EURIBOR	0.0127	0.1	0.2	bad news
2005.04.20 14:30:00	FCE	-0.0025	0.6	0.5	good news
2005.05.18 14:30:00	FCE	0.0020	0.5	0.4	good news
2006.06.14 14:30:00	FCE	-0.0082	0.4	0.4	bad news
2006.06.14 14:30:00	FDAX	-0.0089	0.4	0.4	bad news
2006.06.14 14:30:00	FESX	-0.0074	0.4	0.4	bad news
2006.12.15 14:30:00	FCE	0.0037	0	0.2	bad news
2006.12.15 14:30:00	FDAX	0.0034	0	0.2	bad news
2006.12.15 14:30:00	FESX	0.0034	0	0.2	bad news
2007.02.21 14:30:00	FCE	-0.0026	0.2	0.1	good news
2007.02.21 14:30:00	FDAX	-0.0031	0.2	0.1	good news
2007.02.21 14:30:00	FESX	-0.0029	0.2	0.1	good news
2007.05.15 14:30:00	FCE	0.0072	0.4	0.5	bad news
2007.05.15 14:30:00	FDAX	0.0072	0.4	0.5	bad news
2007.05.15 14:30:00	FESX	0.0082	0.4	0.5	bad news
2007.06.15 14:30:00	FCE	0.0060	0.7	0.6	good news
2007.06.15 14:30:00	FDAX	0.0067	0.7	0.6	good news
2007.06.15 14:30:00	FESX	0.0053	0.7	0.6	good news

Date time	Product	Return	Actual	Forecast	News type
Advance durable goods					
2006.09.27 14:30:00	FCE	-0.0041	-0.5	0.5	bad news

2006.09.27 14:30:00	FDAX	-0.0043	-0.5	0.5	bad news
2006.09.27 14:30:00	FESX	-0.0041	-0.5	0.5	bad news
2007.02.27 14:30:00	FCE	-0.0042	-7.8	-3	bad news
2007.02.27 14:30:00	FDAX	-0.0038	-7.8	-3	bad news
2007.02.27 14:30:00	FESX	-0.0042	-7.8	-3	bad news
2007.03.28 14:30:00	FCE	-0.0038	2.5	3.5	bad news
2007.03.28 14:30:00	FDAX	-0.0044	2.5	3.5	bad news
2007.03.28 14:30:00	FESX	-0.0043	2.5	3.5	bad news
2008.05.28 14:30:00	FDAX	0.0043	-0.5	-1.5	good news
2008.05.28 14:30:00	FESX	0.0049	-0.5	-1.5	good news
2008.07.25 14:30:00	FCE	0.0069	0.8	-0.3	good news
2008.08.27 14:30:00	FDAX	0.0051	1.3	0	good news
2008.08.27 14:30:00	FESX	0.0052	1.3	0	good news
2009.09.25 14:30:00	FCE	-0.0062	-2.4	0.5	bad news
2009.09.25 14:30:00	FDAX	-0.0063	-2.4	0.5	bad news
2009.09.25 14:30:00	FESX	-0.0067	-2.4	0.5	bad news

Date time	Product	Return	Actual	Forecast	News type
Existing Home Sale					
2006.09.25 16:00:00	EUR/USD	-0.0033	6.3	6.2	good news
2006.10.25 16:00:00	EUR/USD	0.0018	6.18	6.23	bad news
2007.01.25 16:00:00	EUR/USD	-0.0023	6.22	6.25	bad news
2007.06.25 16:00:00	EUR/USD	0.0088	5.99	5.97	good news
2008.06.26 16:00:00	EUR/USD	0.0022	4.99	4.95	good news
2008.07.24 16:00:00	EUR/USD	-0.0075	4.86	4.94	bad news
2008.08.25 16:00:00	EUR/USD	-0.0053	5	4.91	good news
2008.11.24 16:00:00	EUR/USD	0.0155	4.98	5	bad news
2009.02.25 16:00:00	EUR/USD	0.0077	4.49	4.79	bad news
2009.06.23 16:00:00	EUR/USD	0.0122	4.77	4.81	bad news
2009.08.21 16:00:00	FCE	0.0071	5.24	5	good news
2009.08.21 16:00:00	FDAX	0.0074	5.24	5	good news
2009.08.21 16:00:00	FESX	0.0084	5.24	5	good news
2009.09.24 16:00:00	FCE	-0.0065	5.1	5.35	bad news
2009.09.24 16:00:00	FDAX	-0.0049	5.1	5.35	bad news
2009.09.24 16:00:00	FESX	-0.0053	5.1	5.35	bad news
2009.12.22 16:00:00	EUR/USD	0.0019	6.54	6.25	good news

Date time	Product	Return	Actual	Forecast	News type
Business Inventories					
2005.11.16 16:00:00	EUR/USD	0.0278		.3	bad news
2007.02.14 16:00:00	FCE	0.0025			bad news
2007.02.14 16:00:00	FESX	0.0026			bad news
2007.06.13 16:00:00	EUR/USD	0.0054		.3	bad news
2008.01.15 16:00:00	EUR/USD	-0.0044		.4	bad news
2008.05.13 16:00:00	EUR/USD	0.0059		.4	good news
2008.07.15 16:00:00	EUR/USD	0.0095		.5	good news
2008.08.13 16:00:00	EUR/USD	-0.0135		.5	bad news

2008.10.15 16:00:00	EUR/USD	-0.0114		.5	good news
2009.01.14 16:00:00	EUR/USD	0.0204	7	).5	good news
2009.12.09 16:00:00	EUR/USD	-0.0253		).5	bad news

Date time	Product	Return	Actual	Forecast	News type
Leading Price Indicator					
2004.07.22 16:00:00	EUR/USD	-0.0078	-0.2	0	bad news
2004.11.18 16:00:00	EUR/USD	-0.0016	-0.3	-0.1	bad news
2005.06.20 16:00:00	EUR/USD	-0.0022	-0.5	-0.3	bad news
2006.04.20 16:00:00	FDAX	0.0032	-0.1	0	bad news
2006.08.17 16:00:00	EUR/USD	-0.0020	-0.1	0.1	bad news
2007.02.21 16:00:00	EUR/USD	0.0028	0.1	0.2	bad news
2007.04.19 16:00:00	EUR/USD	0.0017	0.1	0.1	as forecasted
2007.06.21 16:00:00	EUR/USD	0.0033	0.3	0.2	good news
2007.08.20 16:00:00	EUR/USD	0.0078	0.4	0.4	as forecasted
2008.04.17 16:00:00	EUR/USD	-0.0066	0.1	0.1	as forecasted
2009.06.18 16:00:00	EUR/USD	0.0065	1.2	0.9	good news

Date time	Product	Return	Actual	Forecast	News type
Producer Price Index					
2006.08.15 14:30:00	FCE	0.0054	0.1	0.4	good news
2006.08.15 14:30:00	FDAX	0.0069	0.1	0.4	good news
2006.08.15 14:30:00	FESX	0.0063	0.1	0.4	good news
2007.01.17 14:30:00	FCE	-0.0036	0.9	0.5	bad news
2007.01.17 14:30:00	FDAX	-0.0036	0.9	0.5	bad news
2007.01.17 14:30:00	FESX	-0.0035	0.9	0.5	bad news
2007.07.17 14:30:00	EURIBOR	0.0042	-0.2	0.2	good news
2008.04.15 14:30:00	FCE	0.0045	1.1	0.6	bad news
2009.12.15 14:30:00	FCE	-0.0047	1.8	0.8	bad news
2009.12.15 14:30:00	FDAX	-0.0044	1.8	0.8	bad news
2009.12.15 14:30:00	FESX	-0.0046	1.8	0.8	bad news

Notes: This table reports the date and time of the jump, the market (product), the return computed as logarithm of the price ratio before and after the jump, actual announcement and its mean forecast value, and the type of the news announced for each macroeconomic indicator causing a jump in European markets. We look at the direction of the jump based on whether the surprise is a 'good news' or 'bad news'. An announcement is classified as 'good news' if the event is better than forecasted and as 'bad news' otherwise. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.

Appendix C1

Descriptive statistics on significant jumps before 2007.01.01 from 13:00 until 22:00

	FDAX	FCE	FESX	EURIBOR	EUR/USD
Nb. Obs	169623	170753	123687	169565	134255
Nb. Days	922	641	639	803	770
Jump day frequency					
Nb. Jumpdays	132	156	87	158	222
P(Jumpdays) (in %)	14.3167	24.3370	13.6150	19.6762	28.8312
E(nb. Jumps | jumpday)					
All jumps (absolute value)					
Nb. Jumps	291	391	194	391	392
P(jump) (in %)	0.1716	0.2290	0.1568	0.2306	0.2920
E(|jumpsize||jump)	0.4456	0.5586	0.4363	0.8559	0.6670
Sqrt Var(|jumpsize||jump)	0.3311	0.5744	0.3618	0.5115	0.8747
Positive jumps					
Nb. Jumps>0	112	187	80	199	183
P(jump>0) (in %)	0.0660	0.1095	0.0647	0.1174	0.1363
E(jumpsize|jump>0)	0.4567	0.5980	0.4627	0.8546	0.6885
Sqrt Var(jumpsize|jump>0)	0.4269	0.6291	0.5246	0.5026	0.9282
Negative Jumps					
Nb. Jumps<0	179	204	114	192	209
P(jump<0) (in %)	0.1055	0.1195	0.0922	0.1132	0.1557
E(jumpsize|jump<0)	0.4387	0.5235	0.4178	0.8572	0.6486
Sqrt Var(jumpsize|jump<0)	0.2539	0.5183	0.1696	0.5206	0.8260
Percentage of -ive jumps					
% of neg. jumps	61.5120	52.1739	58.7629	49.1049	53.3163
Standard error	2.8523	2.5262	3.5342	2.5282	2.5198

Notes: The first panel of the table displays, from top to bottom, the number of observations (Nb. obs.) and the number of days in our sample (N. Days). The second panel shows the total number of jump days (Nb. Jumpdays), i.e. days with at least one jump), the probability (in %) of a jump day (P(jumpday)=100(Nb. jumpdays / Nb. Days)), and the number of jumps per jump day (E(nb. jumps|Nb.jumpdays). The third panel gives the total number jumps (Nb.jumps), their proportion (in %) over sample observations (P(jump) = 100(Nb.jumps/Nb.Obs.)), as well as their absolute mean size and standard deviation E(|jumpsize||jump) and Var(|jumpsize||jump)). The panel four and five split the jumps in two categories: positive and negative jumps. Proportions (P(jump > 0) and P(jump < 0)), mean (E(jumpsize|jump > 0) and E(jumpsize|jump < 0)) and std. dev. (Var(jumpsize|jump>0) and Var(jumpsize|jump < 0)) are reported, as for the full set of jumps in absolute value. Finally, the last panel reports the percentage of jumps that are negative (100(Nb. jumps<0/Nb.jumps) and the associated standard error. We use 1% significance level on the 5-minute mid-quote prices from 01 January 2007 until 31 January 2010. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.

Appendix C2

Descriptive statistics on significant jumps after 2007.01.01 from 13:00 until 22:00

	FDAX	FCE	FESX	EURIBOR	EUR/USD
Nb. Obs	185231	218462	175235	233173	192909
Nb. Days	780	776	780	784	949
Jump day frequency					
Nb. Jumpdays	153	236	136	373	395
P(Jumpdays) (in %)	19.6154	30.4124	17.4359	47.5765	41.6228
E(nb. Jumps | jumpday)					
All jumps (absolute value)					
Nb. Jumps	419	568	323	1355	968
P(jump) (in %)	0.2262	0.2600	0.1843	0.5811	0.5018
E(|jumpsize||jump)	0.6638	0.9083	0.7567	1.1520	1.0520
Sqrt Var(|jumpsize||jump)	0.5248	0.8196	0.5600	0.8838	0.7804
Positive Jumps					
Nb. Jumps>0	145	227	131	670	532
P(jump>0) (in %)	0.0783	0.1039	0.0748	0.2873	0.2758
E(jumpsize|jump>0)	0.7666	1.0379	0.8727	1.1472	1.0938
Sqrt Var(jumpsize|jump>0)	0.6597	0.8972	0.7028	0.8913	0.7819
Negative Jumps					
Nb. Jumps<0	274	341	192	685	436
P(jump<0) (in %)	0.1479	0.1561	0.1096	0.2938	0.2260
E(jumpsize|jump<0)	0.6115	0.8230	0.6782	1.1570	1.0011
Sqrt Var(jumpsize|jump<0)	0.4312	0.7522	0.4198	0.8758	0.7755
Percentage of -ive jumps					
% of neg. jumps	65.3938	60.0352	59.4427	50.5535	45.0413
Standard error	2.3240	2.0553	2.7320	1.3582	1.5991

Notes: The first panel of the table displays, from top to bottom, the number of observations (Nb. obs.) and the number of days in our sample (N. Days). The second panel shows the total number of jump days (Nb. Jumpdays), i.e. days with at least one jump), the probability (in %) of a jump day (P(jumpday)=100(Nb. jumpdays / Nb. Days)), and the number of jumps per jump day (E(nb. jumps|Nb.jumpdays). The third panel gives the total number jumps (Nb.jumps), their proportion (in %) over sample observations (P(jump) = 100(Nb.jumps/Nb.Obs.)), as well as their absolute mean size and standard deviation E(|jumpsize||jump) and Var(|jumpsize||jump)). The panel four and five split the jumps in two categories: positive and negative jumps. Proportions (P(jump > 0) and P(jump < 0)), mean (E(jumpsize|jump > 0) and E(jumpsize|jump < 0)) and std. dev. (Var(jumpsize|jump>0) and Var(jumpsize|jump < 0)) are reported, as for the full set of jumps in absolute value. Finally, the last panel reports the percentage of jumps that are negative (100(Nb. jumps<0/Nb.jumps) and the associated standard error. We use 1% significance level on the 5-minute mid-quote prices from 26 May 2003 until 31 December 2006. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.

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Table 1

Description of the raw original series

Asset	Exchange	Trading Months	Trading Unit	Trading Hours	Tick size
FDAX	EUREX	H,M,U,Z	€ 25	07:50 - 22:00	0.5
FCE	NYSE LIFFE Paris	F,G,H,J,K,M,N, Q,U,V,X,Z	€ 5	08:00 - 22:00	0.5
FESX	EUREX	H,M,U,Z	€ 10	07:50 - 22:00	1
EURIBOR	NYSE LIFFE London	F,G,H,J,K,M,N, Q,U,V,X,Z	€ 12.50	01:00 - 06:00	0.005
E-mini EUR/USD futures	CME Globex Electr.	H,M,U,Z	$6.25	07:00 - 21:00	0.0001

Notes: All times are given in Central European Time (CET). FDAX, FCE and FESX, are futures on DAX30 (German), CAC40 (French) and Euro stoxx50 index, respectively. The letters, F,G,H,J,K,M,N,Q,U,V,X,Z denote expiries in January, February, March, April, May, June July, August, September, October, November and December, respectively. FDAX, FESX and EUR/USD have four expiries in March, June, September and December, while French equity index and 3-month Euribor interest rates futures have monthly expiries.

Table 2

Descriptive statistics of log 5-minute returns

	Min	Max	Mean	Volatility	Skewness	Kurtosis
FESX						
H	-7.69E-03	1.85E-02	2.00E-07	8.57E-08	1.39E+00	9.92E+01
M	-7.86E-03	8.83E-03	-3.72E-08	8.75E-08	3.39E-02	7.82E+00
U	-3.41E-03	8.75E-03	-3.03E-07	8.74E-08	2.03E-01	4.92E+00
Z	-7.65E-03	8.81E-03	5.61E-08	8.45E-08	1.93E-01	1.05E+01
FDAX						
H	-9.84E-03	2.26E-02	4.32E-07	1.19E-08	4.66E+01	1.03E+04
M	-7.41E-02	2.07E-02	-1.91E-07	4.68E-08	-2.22E+02	7.67E+04
U	-5.30E-02	5.16E-02	-8.16E-07	9.70E-08	-7.32E+01	1.99E+04
Z	-4.08E-02	3.09E-02	-2.06E-07	7.02E-08	-4.16E+01	9.53E+03
FCE						
F	-5.27E-03	5.43E-03	3.85E-07	2.83E-08	1.02E+00	1.75E+02
G	-3.52E-03	4.53E-03	-4.79E-07	1.34E-08	3.07E+00	1.83E+02
H	-1.81E-02	9.97E-03	-1.01E-06	2.33E-08	-1.02E+01	2.37E+03
J	-4.34E-03	8.71E-03	-5.10E-08	1.37E-08	9.45E+00	8.29E+02
K	-1.49E-02	9.62E-03	6.23E-08	3.21E-08	-3.14E+01	3.06E+03
M	-1.68E-02	2.61E-02	2.66E-06	1.44E-07	2.97E+01	1.99E+03
N	-8.79E-03	8.57E-03	1.65E-07	1.38E-08	-4.05E+00	1.69E+03
Q	-4.34E-02	3.96E-02	-7.16E-06	3.57E-07	-4.35E+01	3.85E+03
U	-2.69E-02	1.02E-02	-3.35E-08	2.74E-08	-6.67E+01	1.08E+04
V	-4.32E-02	6.21E-02	3.65E-07	1.95E-08	4.24E+01	2.42E+03
X	-6.96E-03	5.80E-03	-4.28E-06	5.64E-08	-4.68E+00	1.66E+02
Z	-3.22E-02	2.76E-02	1.59E-06	2.65E-07	-4.84E+00	1.30E+03
EUR/USD						
H	-3.90E-02	3.56E-02	-1.75E-05	6.41E-07	-2.40E+01	1.20E+03
M	-6.77E-02	6.94E-02	4.54E-06	2.26E-06	8.82E+00	1.20E+03
U	-7.86E-02	7.01E-02	-5.19E-06	1.30E-06	8.21E+00	2.74E+03
Z	-4.73E-02	4.37E-02	-1.96E-05	1.25E-06	-2.79E+01	1.32E+03
EURIBOR						
F	-1.30E-03	7.73E-04	-6.28E-07	4.49E-09	-4.20E+00	9.91E+01
G	-4.86E-04	9.46E-04	4.58E-08	3.12E-09	2.24E+00	4.55E+01
H	-2.86E-02	1.19E-02	-3.72E-04	2.62E-06	-5.76E+00	4.69E+01
J	-1.05E-03	1.33E-03	-2.13E-06	3.21E-09	-1.80E+00	1.67E+02
K	-6.04E-04	3.06E-03	3.30E-06	8.69E-09	2.58E+01	7.96E+02
M	-2.82E-02	1.40E-02	-3.81E-04	2.55E-06	-5.64E+00	4.41E+01
N	-4.04E-04	2.53E-03	8.75E-07	5.92E-09	2.61E+01	8.60E+02
Q	-8.41E-03	8.14E-03	-9.93E-06	1.56E-07	-1.31E+00	3.98E+02
U	-3.11E-02	1.18E-02	-3.90E-04	2.60E-06	-5.75E+00	4.79E+01
V	-4.56E-03	6.33E-04	-5.03E-07	2.06E-08	-2.49E+01	7.71E+02
X	-1.27E-03	1.49E-03	-3.21E-06	8.06E-09	1.50E+00	9.88E+01
Z	-3.02E-02	1.31E-02	-3.73E-04	2.63E-06	-5.70E+00	4.72E+01

Notes: This table reports the descriptive statistics of log 5-minute returns for each instrument and for different maturities. FDAX, FCE and FESX, are futures on DAX30 (German), CAC40 (French) and Euro stoxx50 index, respectively. The letters, F,G,H,J,K,M,N,Q,U,V,X,Z denote expiries in January, February, March, April, May, June July, August, September, October, November and December, respectively. FDAX, FESX and EUR/USD have four expiries in March, June, September and December, while French equity index and 3-month Euribor interest rates futures have monthly expiries.

Table 3

Descriptive statistics on significant jumps from 13:00 - 22:00 CET

	FDAX	FCE	FESX	EURIBOR	EUR/USD
Nb. Obs.	354854	389215	298922	402738	327164
Nb. Days	1702	1417	1419	1587	1719
Jump day frequency					
Nb. Jumpdays	285	392	223	531	617
P(jumpday) (%)	16.7450	27.6641	15.7153	33.4594	35.8930
E(nb. Jump| Jumpday)	2.4912	2.4464	2.3184	3.2881	2.2042
All jumps (absolute value)					
Nb. Jumps	710	959	517	1746	1360
P(jump) (%)	0.2001	0.2464	0.1730	0.4335	0.4157
E(|jumpsize||jump)	0.5737	0.7625	0.6362	1.0837	0.9446
√(Var|jumpsize||jump)	0.4674	0.7476	0.5186	0.8227	0.8261
Positive jumps					
Nb. Jumps>0	257	414	211	869	715
P(jump>0) (%)	0.0724	0.1064	0.0706	0.2158	0.2185
E(jumpsize|jump>0)	0.6290	0.8358	0.7165	1.0802	0.9946
√(Var|jumpsize|jump>0)	0.5888	0.8155	0.6710	0.8279	0.8384
Negative jumps					
Nb. Jumps<0	453	545	306	877	645
P(jump<0) (%)	0.1277	0.1400	0.1024	0.2178	0.1971
E(jumpsize|jump<0)	-0.5431	-0.7077	-0.5811	-1.0874	-0.8895
√(Var|jumpsize|jump<0)	0.3808	0.6874	0.3703	0.8172	0.8086
Percentage of -ive jumps					
% of neg. jumps	63.8028	56.8300	59.1876	50.2291	47.4265
Standard error	1.8035	1.5994	2.1616	1.1966	1.3540

Notes: The first panel of the table displays, from top to bottom, the number of observations (Nb. obs.) and the number of days in our sample (N. Days). The second panel shows the total number of jump days (Nb. Jumpdays), i.e. days with at least one jump), the probability (in %) of a jump day (P(jumpday)=100(Nb. jumpdays / Nb. Days)), and the number of jumps per jump day (E(nb. jumps|Nb.jumpdays). The third panel gives the total number of jumps (Nb.jumps), their proportion (in %) over sample observations (P(jump) = 100(Nb.jumps/Nb.Obs.)), as well as their absolute mean size and standard deviation E(|jumpsize||jump) and Var(|jumpsize||jump)). The panel four and five splits the jumps in two categories: positive and negative jumps. Proportions (P(jump > 0) and P(jump < 0)), mean (E(jumpsize|jump > 0) and E(jumpsize|jump < 0)) and std. dev. (Var(jumpsize|jump>0) and Var(jumpsize|jump < 0)) are reported, as for the full set of jumps in absolute value. Finally, the last panel reports the percentage of jumps that are negative (100(Nb. jumps<0/Nb.jumps) and the associated standard error. The sampling frequency is 5 minutes. We use 1% significance level on the 5-minute mid-quote prices from 26 May 2003 until 31 January 2010. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.

Table 4

Cojump probability

Assets	Nb. Obs	Nb. Cojumps	P(cojump) in %
FDAX - FCE	126966	177	0.1394
FDAX - FESX	140800	200	0.1420
FDAX - FCE - FESX	123457	155	0.1255
FDAX - Euribor	110145	1	0.0009
FDAX - EUR/USD	108185	10	0.0092
FCE - FESX	123803	184	0.1486
FCE - Euribor	101285	3	0.0030
FCE - EUR/USD	94561	5	0.0053
FESX - Euribor	99991	1	0.0010
FESX - EUR/USD	105358	9	0.0085
Euribor - EUR/USD	75090	9	0.0120

Probability of a cojump on the considered markets given a jump on the market given in the corresponding column.

P(cojump|jump) in %	FESX	FDAX	FCE
FDAX-FCE	-	48.8950	32.2993
FDAX-FESX	70.9220	55.2486	-
FCE-FESX	65.2482	-	33.5766
FDAX-FCE-FESX	54.9645	42.8177	28.2847

Notes: The first panel of this table depicts the probability of observations, number of cojumps and their respective probabilities for different pairs of asset classes in our sample. The second panel shows the probability of a cojump on the considered markets given a jump on the market given in the corresponding column. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.

Table 5
Conditional probability of cojump for every significant US macro announcement

P(cojump|jump) in %	FESX	FDAX	FCE
Unemployment			
FDAX-FCE	-	66.6667	91.6667
FDAX-FESX	90.4762	57.5758	-
FCE-FESX	95.2381	-	83.3333
FDAX-FCE-FESX	85.7143	54.5455	75.0000
CPI			
FDAX-FCE	-	76.9231	62.5000
FDAX-FESX	90.9091	76.9231	-
FCE-FESX	100.0000	-	68.7500
FDAX-FCE-FESX	90.9091	76.9231	62.5000
ISM PRICE Index			
FDAX-FCE	-	60	100
FDAX-FESX	80	80	-
FCE-FESX	60	-	100
FDAX-FCE-FESX	60	60	100
Factory Orders			
FDAX-FCE	-	100	40
FDAX-FESX	66.66667	100	-
FCE-FESX	100	-	60
FDAX-FCE-FESX	66.66667	100	40
Consumer Confidence			
FDAX-FCE	-	57.1429	66.6667
FDAX-FESX	100	42.8571	-
FCE-FESX	100	-	50
FDAX-FCE-FESX	50	42.8571	50
Initial Jobless Claims			
FDAX-FCE	-	71.4286	62.5000
FDAX-FESX	85.7143	85.7143	-
FCE-FESX	85.7143	-	75
FDAX-FCE-FESX	71.4286	71.4286	62.5000
New Home Sale			
FDAX-FCE	-	33.3333	25
FDAX-FESX	50	33.3333	
FCE-FESX	50	-	25
FDAX-FCE-FESX	50	33.3333	25
Advance Durable Good			
FDAX-FCE	-	57.1429	66.6667
FDAX-FESX	100	100	-
FCE-FESX	57.1429	-	66.6667
FDAX-FCE-FESX	57.1429	57.1429	66.6667
Producer Price Index			
FDAX-FCE	-	88.8889	88.8889

FDAX-FESX		100		88.8889	-
FCE-FESX		100	-		88.8889
FDAX-FCE-FESX		100		88.8889	88.8889
Existing Home Sale					
FDAX-FCE	-			100	100
FDAX-FESX		100		100	-
FCE-FESX		100	-		100
FDAX-FCE-FESX		100		100	100

Notes: This table reports the conditional probability of cojump for every significant US macroeconomic news announcement in our sample. FDAX, FCE and FESX, are futures on DAX30 (German), CAC40 (French) and Euro stoxx50 index, respectively.

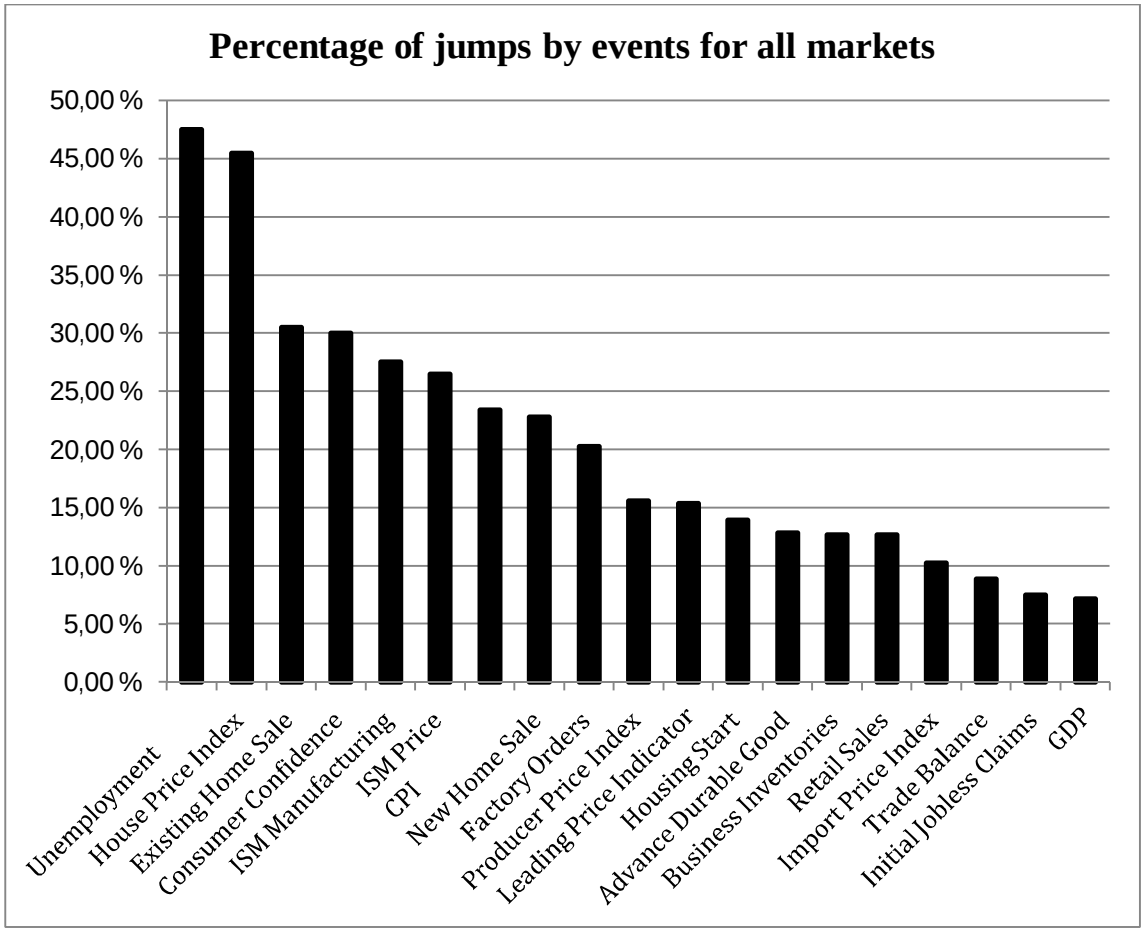

Figure 1. This figure shows the percentage of jumps caused by selected US macroeconomic indicators for all asset classes in our sample, namely FDAX, FCE, FESX, 3-month Euribor interest rate, and EUR/USD futures. FDAX, FCE and FESX are futures on DAX30 (German), CAC40 (French) and Euro stoxx50 index, respectively.

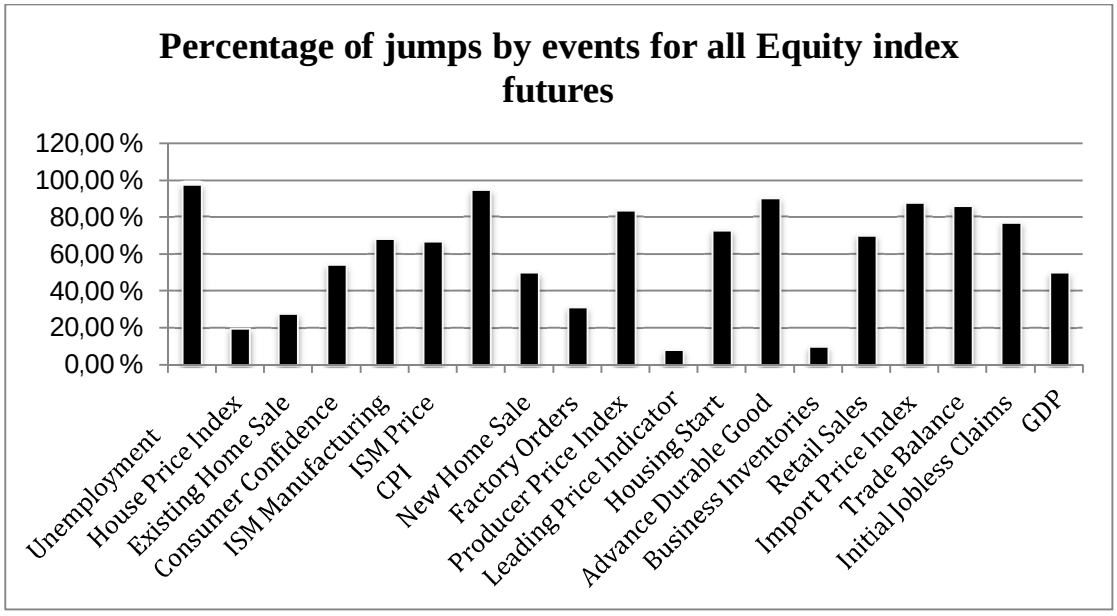

Figure 2. This figure shows the percentage of jumps caused by selected US macroeconomic indicators for all Equity markets futures in our sample, namely FDAX, FCE and FESX. FDAX, FCE and FESX are futures on DAX30 (German), CAC40 (French) and Euro stoxx50 index, respectively.

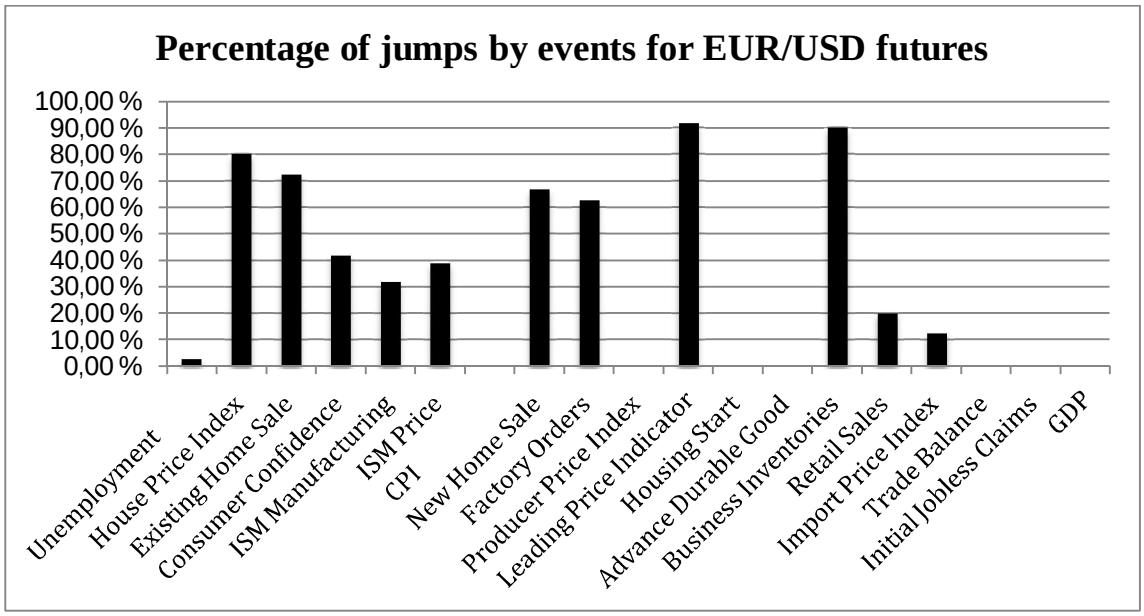

Figure 3. This figure shows the percentage of jumps caused by selected US macroeconomic indicators for EUR/USD futures.

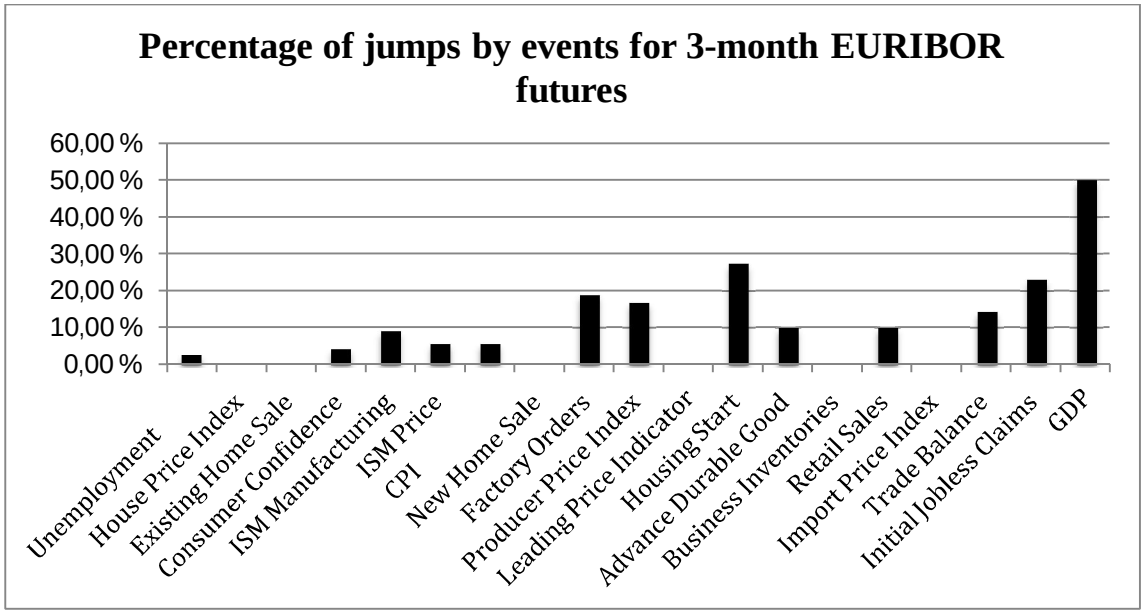

Figure 4. This figure shows the percentage of jumps caused by selected US macroeconomic indicators for 3-month EURIBOR futures.

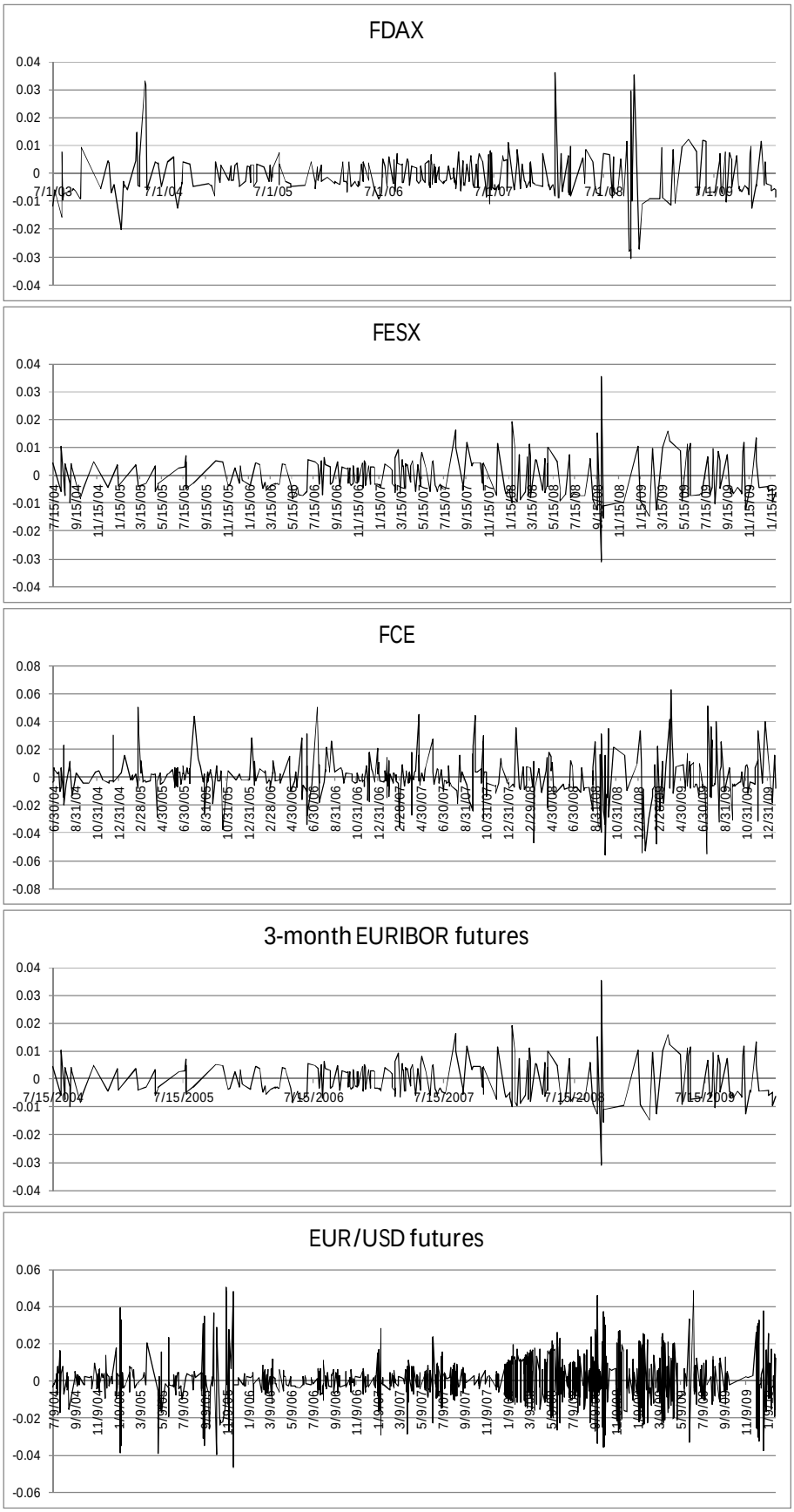

Figure 5. This Figure depicts the time series graph of significant jumps in five European financial markets. FDAX, FESX, FCE, EURIBOR and EUR/USD are futures indices of German DAX, Euro Stoxx 50, French CAC, 3-month Euribor rate, and currency EUR/USD rates, respectively.

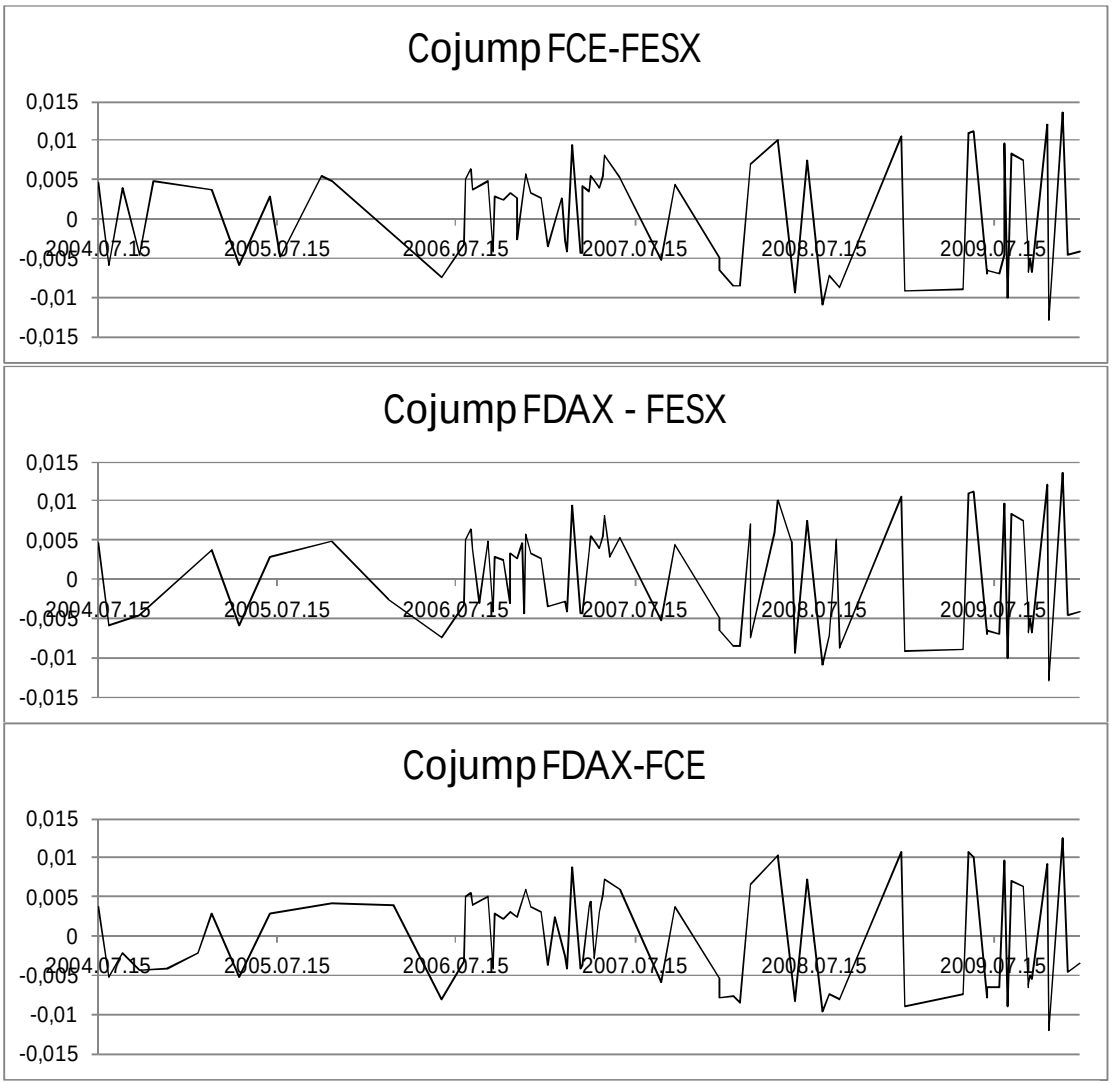

Figure 6. This Figure depicts the time series graph of significant cojumps in three European equity futures markets. FDAX, FESX, FCE are futures indices of German DAX, Euro Stoxx 50, and French CAC, respectively.