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Jumps in Equilibrium Prices and Asymmetric News in Foreign Exchange Markets*

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Abstract

In this paper we examine the intraday effects of surprises from scheduled and unscheduled announcements on six major exchange rate returns (jumps) using an extension of the standard Tobit model with heteroskedastic and asymmetric errors. Since observed volatility at high frequency often contains microstructure noise, we use a recently proposed non parametric test to filter out noise and extract jumps from noise-free FX returns (Lee and Mykland (2012)). We found that the most influential scheduled macroeconomic news are globally related to job markets, output growth indicators and public debt. These surprises impact FX jumps rather in the form of good news, as a result of pessimistic forecasts from traders during the crisis period analyzed. We reconfirmed for most of the currencies the hypothesis that negative volatility shocks have a greater impact on volatility than positive shocks of the same magnitude, reflecting markets' concern about the cost of stabilization policies.

JEL Classification: G14, G12, E44, C22.
Keywords: Forex market, announcements, jump detection test, high frequency data, microstructure noise, asymmetric GARCH.

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1 Introduction

Understanding asset price volatility is a crucial goal for traders and portfolio managers involved in asset pricing, portfolio allocation and hedging strategies against portfolio risk. While standard volatility models such as GARCH or stochastic volatility models have been successful to fit the dynamic features of financial return series up to daily frequencies, they have proven inadequate at higher frequencies because of their inconsistency to represent the market microstructure patterns emerging at the intraday level. With the availability of tick-by-tick data, a wide strand of the literature on volatility modeling has pointed at the role of intraday periodic patterns and of macroeconomic news releases. Intraday volatility results from any regular intraday patterns such as openings and closings of financial markets (Andersen and Bollerslev (1997); Erdemlioglu et al. (2012)). As for announcements effects, Andersen et al. (2003), Laakkonen (2007), Lee and Mykland (2008), and Lahaye et al. (2011) among others, have shown that some of major expected macroeconomic news – such as the consumer price index, ISM (Institute of Supply Management) manufacturing index, consumer confidence index, retail sales, producer price index, non-farm payrolls and news related to the labor market to name a few – tend to be a real catalyst for short-term movements in financial markets, generating large changes in market volatility thereby causing abnormally large returns called 'Jumps' in price dynamics. Jumps are significant large responses of the market surprises to scheduled news on which the community of analysts regularly provides their expectations and to unscheduled news. They occur frequently in the Forex markets, responding not only to U.S. economic news but also to news from around the world because exchange rate is a worldwide sensitive variable.

Identifying jumps in a price process has been explored by a widespread literature. Since the seminal contributions of Barndorff-Nielsen and Shephard (2004), the econometric literature has made tremendous progress on how to detect jumps at high frequency in univariate price process. Lee and Mykland (2008) have provided a major advance in proposing a non parametric test, which Boudt et al. (2011) have improved by introducing a market intraweek seasonality in the instantaneous price volatility. Recently, Lee and Mykland (2012) have proposed a non parametric test controlling for microstructure noise.

The connection between jumps in the exchange rates and the scheduled macroeconomic news has been examined extensively in recent decades, with pioneering studies[1] that have been implemented to investigate the efficient capital market hypothesis. Evans and Lyons (2005) find that arrival of scheduled announcements produce the largest exchange rate changes and that the impact of news remains significant for several days. Barndorff-Nielsen and Shephard (2006) apply their bipower variation procedure to estimate jumps on USD/DEM and USD/JPY exchange rates data by relating the jump days to those of macroeconomic announcements. Andersen and Vega (2007) find evidence of jumps in exchange rates, S&P 500 futures and U.S. Treasury bond futures. The authors also show that these jumps are related to news events and that the jump component has a large magnitude and a lower persistence than the corresponding continuous component

[1] Fama (1965), Ball and Brown (1968), Fama and Schwert (1977)

of the realized volatility. Lahaye et al. (2011) use the non parametric test of Lee and Mykland (2008) that they expand by integrating the market intraweek seasonality in the instantaneous price volatility as in Boudt et al. (2011). The authors detect the presence of jumps in a variety of financial asset prices (exchange rates, equities and bonds) and, using a Tobit-GARCH model, demonstrate that U.S. macro announcements significantly contribute to explaining jumps and cojumps in financial returns.With regard to foreign exchange rates, Lahaye et al. (2011) identify the non farm-payroll, federal funds target releases, GDP, consumer confidence and trade balance shocks as being the most influential macroeconomic news. In short, most papers concerned with the question of the impact of announcement releases on returns report that macroeconomic news exert a significant influence on exchange rate jumps and thereby play a role in the volatility of the Forex market.

Our paper aims to contribute to this literature by examining what types of news surprises influence the movements in six exchange rate returns (EUR, GBP, JPY, AUD, CAD, CHF in terms of USD) from June 2007 to June 2012 using high frequency data. It departs from the previous studies in several respects. Firstly, following Lahaye et al. (2011), we represent the jump process using a Tobit-GARCH class of models (Calzolari and Fiorentini, 1998). This methodology is particularly appropriate for modeling financial jump variables whose values are given by abnormal returns when they are statistically significant and by zero otherwise; such jump variables are therefore measured by censored data (Tobit specification). The GARCH specification for the errors is motivated by the fact that since Mandelbrot (1963), financial returns are known to exhibit volatility clustering patterns at daily or higher frequencies. However, financial asset prices are also characterized by the empirically observed fact that negative shocks have a stronger impact on volatility than positive shocks (this is the so-called leverage effect when stock market are considered). In order to account for this asymmetry, we go further than the previous studies and replace the GARCH process with the more general GJR-GARCH model introduced by Glosten et al. (1993). We qualify the latter as general since for a zero value of the leverage coefficient (no asymmetry) it reduces to a standard GARCH. We thus estimate our exchange rate jump model using a Tobit-GJR-GARCH framework, which to our best knowledge has never been applied to Forex market data. Secondly, we consider two categories of news impacting jumps : scheduled macroeconomic news provided by Bloomberg at specific dates of each month and which are partially expected by traders, and unscheduled news, which consist in unexpected negative real shocks, such as the bankruptcy of some major banks during the subprime crisis, the downgrading of banks' and countries' ratings, the Great East Japan Earthquake of March, 2011 and some other key events.[2] Thirdly, we devote special attention to the question of removing microstructural noise from observed prices.[3] Previous studies, whether they rely on the Lee and Mykland (2008) non parametric statistical procedure, the Barndorff-Nielsen and Shephard test (2004) or the

[2]See Appendix 4 for more details

[3]Microstructural noise represent frictions that can distort trading activity such as transaction costs, liquidity shortages, information asymmetry, bid-ask bounces, errors in the measurement of the observed price.

Jiang-Oomen test (2008) to extract jumps around news events, often ignore the presence of microstructure noise in observed price data. Consequently, instead of identifying jumps in equilibrium (noise-free) prices, they discover them in the observed prices. Thus, very large changes featured by observed prices and due to some sizable market frictions (noise) may be wrongly interpreted as strategic responses from investors (jumps). To avoid this pitfall, we use a recent breakthrough non parametric jump detection test proposed by Lee and Mykland (2012), which allows for asymptotically removing microstructural noise from observed prices by an appropriate frequency re-sampling procedure.[4] Our approach is innovating in that, to our knowledge, no previous empirical study using high frequency data has ever employed this methodology to appropriately detect jumps or simply model asset price volatility.

The use of the new Lee and Mykland (2012) non parametric test reveals that significant jumps represent about 0.41% of all denoised returns and that our scheduled macro news and unscheduled events explain about 34% and 14% of total jumps, respectively. Macroeconomic surprises impact FX jumps rather in the form of good news, reflecting pessimistic forecasts from traders during the crisis period analysed. Significant scheduled macro news concern globally job markets, output growth indicators and public debt. Significant unscheduled events shocks include the Madoff fraud and subprime crisis rescue plans.

The rest of the paper proceeds as follows. Section 2 describes the data used, while Section 3 surveys the main jump detection methods and explains in detail the one we will employ. Section 4 presents our Tobit-GJR-GARCH jump model while estimation results are discussed in Section 5. Section 6 concludes.

[4]Note that some studies have set the noise-eliminating sampling frequency using heuristic approaches. However the choice of the frequency remains arbitrary, leading potentially to a partial elimination of microstructural noise.

2 Data Description

2.1 Exchange Rates

We consider one-minute intraday returns in six currencies against the US Dollar (USD): Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Franc (CHF), Euro (EUR), British Pound (GBP) and Japanese Yen (JPY). All the exchange rate series are provided by Olsen & Associates and Dukascopy. The full sample spans from June 1, 2007 to June 30, 2012. All times are GMT. The FX markets trade 24-hours a day. This implies that each trading day has 1440 one-minute intraday intervals. Due to the lack of observations, the weekends were removed from our data, from Friday midnight to Sunday midnight. After removing from our database weekends and days where there are too many missing values, we end-up with 1527 trading days over the period considered, and a total of 1,908,040 observations for the EUR/USD exchange rate and 1,909,380 for the others.

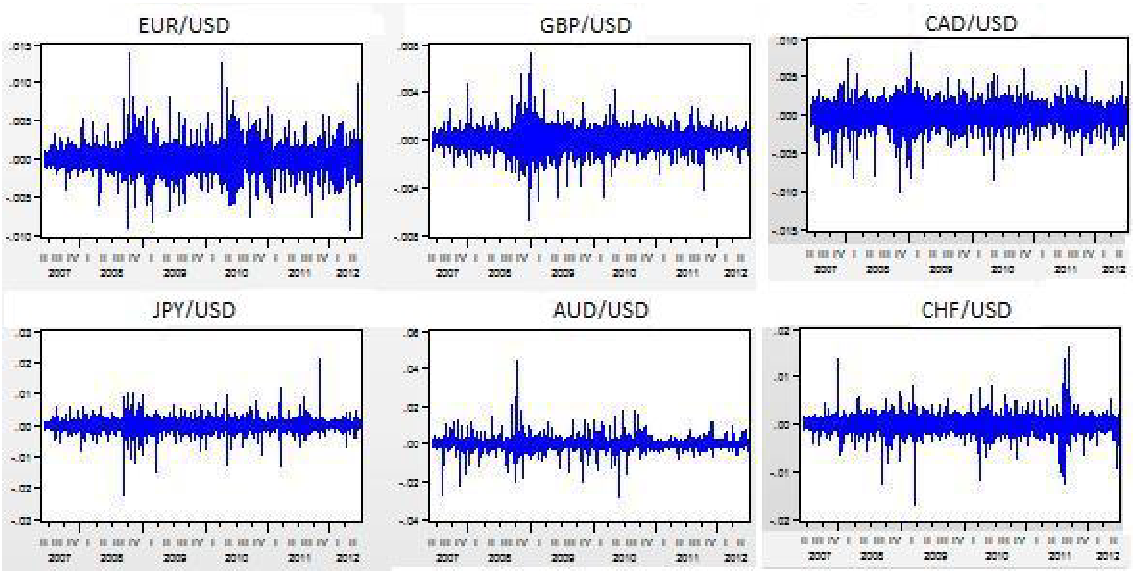

Figure 1: Forex returns

Figure 1 shows the dynamics of our six foreign exchange rate returns. All series exhibit an increase in volatility at the fourth quarter of 2008, which corresponds to the beginning of the financial crisis marked by the collapse of several banks and in particular Lehman Brothers‘ bankruptcy on September 15, 2008. The reaction of the six foreign exchange markets seems to be synchronized around this quarter and the first quarter of 2009 because the financial crisis hit all the markets, with a lesser extent the Swiss franc due to the faster reaction of the Swiss banking system. The EUR/USD returns exhibit also high volatility at the second quarter of 2010, due to the intensification of the Euro zone debt crisis, mostly centered in Greece. Beside the main clusters, many other negative and positive jumps are featured by the exchange rate returns. These jumps may reflect financial traders' behavioral responses to *(i)* surprises from their forecasts on scheduled announcements, *(ii)* unexpected unscheduled events and *(iii)* calendar (intraday or intraweek) periodicity. But they may also include a number of spurious jumps or microstructural noise, due to market frictions, that can spoil the data at the very high frequency. The aim of the following sections is to disentangle the true Forex returns and market microstructure noise by preprocessing the data, so that observed jumps such as the ones in Figure 1 only stem from large spreads of true returns.

2.2 Announcements and economic news

2.2.1 Scheduled macroeconomic news

We define a surprise as a large difference between a released value of a major scheduled macroeconomic news and the market expectation, which we proxy using financial experts' median expectation provided by the Bloomberg 'World Economic Calendar" (WECO) survey.[5] We follow Balduzzi et al. (2001) and standardize the forecast error in each news announcement so that the surprise values for various types of news are comparable. The surprise $S_k(t_i)$ related to the news announcement k is then written as:

$$S_k(t_i) = \frac{A_k(t_i) - F_k(t_i)}{\hat{\sigma_k}} \tag{1}$$

where t_i stands for the intraday time i of day t, $A_k(t_i)$ represents the release of the announcement k at time t_i, $F_k(t_i)$ the median of the survey forecast on the announcement k scheduled at the horizon t_i and $\hat{\sigma_k}$ the standard deviation of the forecast error $A_k(t_i) - F_k(t_i)$. The forecast errors are standardized so that the surprises from releases of different types and reporting conventions are comparable.

We cover an extensive list of announcements comprising the ones used in previous literature and also other announcements. Tables (a) to (e) in Appendix 3 present a summary of all announcements that are likely to trigger sudden price movements, or jumps. These announcements are from the USA, Japan, China, U.K. and the Euro zone, from January 2007 to December 2012 with monthly frequencies. We include announcements from major fields of the economies, called "Market Movers Indicators", and announcements specific to each country. We also include the macroeconomic announcements although they are well anticipated by the market such as Central Banks' target rates. We end up with 47 announcements for the U.S. economy, 12 for China, 6 for the Euro area and 23 for U.K. and Japan. For all these scheduled macro announcements, negative surprises have been separated from positive ones in order to study the asymmetry in producing increased volatility.

Figures (a) to (f) in Appendix 1 display the price dynamics around some scheduled publications. It can be seen that for some news, the market responds almost immediately to the releases by sharp and positive or negative jumps. This confirms that information

[5] Between 80 and 100 financial experts from major companies are asked by Bloomberg to provide their forecasts for each announcement. One week before the announcement is released, Bloomberg computes and publishes the median response as a proxy of the market expectation. Given the size of the panel of respondents and the leading positions of the forecasting agencies and financial institutions represented by the surveyed experts we can consider that the median response represents accurately the market expectation.

is incorporated into the exchange rate very quickly since it lasts no more than a few minutes if not seconds, in line with the findings of Cheung and Chinn (2001). By contrast, Evans and Lyons (2005) show that in currency markets, the impact of U.S. and German announcements effects can persist up to several days. Appendix 1 also plots some anticipated responses to news announcements. In the minutes before a release, movements widen as some market makers pull their orders in anticipation of upcoming volatility.

2.2.2 Unscheduled event news

Jumps can result from unscheduled, therefore totally unexpected news releases. These are, for example, unforeseen official statements, central bank governors‘ or politicians‘ decisions, declarations of bankruptcy from major banks or corporates, announcements from rating agencies or some natural disasters. We account for each of these unanticipated events through a dummy variable. Appendix 4 displays some of the key events that occurred between 2007 and 2012 that we include in our analysis.

To construct unscheduled news data, we first identify major events that happened from January 2007 to December 2012 in the five countries considered in this study. Then, we extract the releases with their exact occurring time from the Reuters and Bloomberg sources of the real-time financial news database Factiva. For each event, we create a dummy variable taking the value 1 at the day of the event and zero elsewhere. We examine forty-five unanticipated events ranging from Lehman brothers bankcruptcy or Bernard Madoff fraud to the Great East Japan Earthquake. These news are fully unexpected because they correspond to isolated events or sometimes events that are unknown to the markets *a priori*. Note that most of them are not related directly to markets.

As an example of unscheduled news, Figure (a) in Appendix 2 illustrates for AUD/USD (left panel) and EUR/USD (right panel) that markets have reacted to President Obama's election on November 6, 2012 at 08:11 p.m. (November 7 at 03:11 a.m. GMT) by selling the safe-haven dollar against most of other currencies. The dollar fell on the view that the Fed will be encouraged to proceed on its quantitative easing path and that this policy will persist after Bernanke's end of term.

Figure (b) in Appendix 2 (left panel) displays the evolution of the JPY/USD exchange rate at 10:57 GMT on March 11, 2011, the day when "the Great East Japan earthquake" occurred. In the immediate aftermath of the earthquake (05:46 GMT), investors were prompted to sell the Japanese currency, which led the Yen to depreciate sharply. Thus, from the economic point of view, this natural disaster can be interpreted as an unexpected negative real shock in the Japanese economy and in particular on its currency. Both panels show that this jump in the currency has rapidly reversed and soared against the major currencies under the effect of the speculation that Japanese investors would repatriate assets to pay for rebuilding.

3 Detecting jumps

As shown, market prices tend to exhibit frequent jumps in their dynamics. To prevent risk, investors need therefore to better understand and forecast this phenomenon. A jump is a sudden price movement where an abnormally large variation in the price process can be observed resulting from a buying and selling pressure. Jumps are therefore remarkable events as they can trigger important losses or gains for investors yielding significant portfolio reallocations. Theoretically, they can be represented by a continuous-time jump-diffusion process. Let the scalar logarithmic asset price $S(t)$ follow an Ito process augmented by a jump component. The dynamic of $S(t)$ is written as :

$$dlogS(t) = \mu(t)dt + \sigma(t)dW(t) + C(t)dJ(t), \tag{2}$$

where $\mu(t)$ denotes the drift term, $\sigma(t)$ the instantaneous volatility process assumed to be càdlàg [6]; $W(t)$ is a standard Brownian motion; $C(t)dJ(t)$ a pure jump component assumed to follow a compound Poisson process since we are interested in large and infrequent price movements. $J(t)$ is the counting process, while $C(t)$ is the jump size. $J(t)$, $C(t)$ and $W(t)$ are assumed to be mutually independent. The asset log-prices $p(t)$ are observed in discrete time t.

We denote the corresponding discrete-time intra-day geometric returns by:

$$r(t_i) \equiv p\left(t + \frac{i}{M}\right) - p\left(t + \frac{(i-1)}{M}\right), \quad i = 1, ..., M \tag{3}$$

where $r(t_i)$ is the ith return of day t and M refers to the number of equally spaced intraday returns observations over the trading day. When a jump occurs at time t_i, the return at this specific time $r(t_i)$ is expected to be much larger than in its regular continuous sample path. The objective of the jump test is to differentiate between jumps and instantaneous volatility that might produce incidentally large fluctuations in asset price returns.

3.1 A review of the usual jump tests

3.1.1 The BNS Test

Barndorff-Nielsen and Shephard (2004), or BNS, proposed an asymptotic non parametric test where they develop a jump robust measure of the daily integrated variance called realized bipower variation. The statistic is then computed as the relative difference between the realized variance and the bipower variation. The BNS statistic, called "relative jump measure", is calculated as follows :

$$RJ(t) = \frac{RV(t) - BV(t)}{RV(t)} \tag{4}$$

where $RV(t)$ is the realized variance which converges uniformly in probability to the integrated volatility augmented by a term of accumulated instantaneous jumps (Andersen and

[6] A càdlàg (in French: "continue à droite, limite à gauche") is a function defined on the real numbers that is right-continuous with left limits everywhere.

Vega, 2007):

$$RV(t) = \sum_{i=1}^{M} r(t_i)^2 \rightarrow \int_0^T \sigma^2(s)ds + \sum_{0<s\leq t} C^2(s), \tag{5}$$

and the other component $BV(t)$ is the realized bipower variation, defined as:

$$BV(t) = (2/\pi)^{-1} \left(\frac{M}{M-1}\right) \sum_{i=2}^{M} |r(t_{i-1})||r(t_i)| \tag{6}$$

An equivalent statistic, $-RV(t)$, called the “ratio statistic”, is proposed and studied in Barndorff-Nielsen and Shephard (2006).

3.1.2 The Jiang-Oomen Test

Jiang and Oomen (2008), or JO, exploited the higher-order sample moments of returns to identify periods that contain jumps and constructed a test based on the hedging error of a swap variance replication strategy :

$$SwV(t) - RV(t) = \frac{1}{3}\sum_{i=1}^{M} r(t_i)^3 + \frac{1}{12}\sum_{i=1}^{M} r(t_i)^4 + ... \tag{7}$$

The swap variance “SwV” is given by:

$$SwV(t) = 2\sum_{i=1}^{M} (R(t_i) - r(t_i)) \tag{8}$$

where $r(t_i)$ is the geometric return defined in the jump-diffusion process, and $R(t_i)$ is the arithmetic return $\frac{P(t_i)-P(t_{i-1})}{P(t_{i-1})}$. JO formulate several z-statistics that test the null hypothesis of no jumps in a sample period.

3.1.3 The Lee and Mykland Test

Lee and Mykland (2008), or LM, compared the magnitude of each change with a sliding-window measure of local volatility and introduced a non parametric test which was assessed by simulation. As discussed by Fan and Fan (2011), the LM test outperforms the BNS and JO tests. LM proposed to standardize the absolute high frequency returns by a robust estimate of its instantaneous volatility, which is the average of realized bipower variation over the window $K = \sqrt{M \times 252}$,[7] thus providing a measure that explains the local variation only from the continuous part.

The statistic $\mathcal{L}(t_i)$, which tests at time t_i whether there was a jump in the asset return from t_{i-1} to t_i is defined as:

$$\mathcal{L}(t_i) \equiv \frac{|r(t_i)|}{\widehat{\sigma(t_{i-1})}} \tag{9}$$

[7] There is a trade-off in choosing the window size K: K must be large enough to accurately estimate integrated volatility but small enough for the variable to be approximately constant over the window.

where

$$\widehat{\sigma(t_{i-1})}^2 \equiv \frac{1}{k-2} \sum_{j=i-k+2}^{i-1} |r(t_j)||r(t_{j-1})|. \tag{10}$$

The idea behind this test is that if the observed value of the Lee & Mykland statistic does not lie in the region of maximum returns, it is unlikely that the realized returns are generated by the diffusion model without jumps. Under the null of no jumps between t_{i-1} to t_i, the statistic $\mathcal{L}(t_i)$ converges in distribution to the absolute value of a standard normal random variable.[8] Besides, as shown by Galambos (1987), the maximum of a standard normal random variable follows a Gumbel distribution. For a given test size, it is then possible to check whether or not a standardized return observation is identifiable with a jump. This test is considered as being among the most important research works on jump detections and applications. However, it presents an important weakness. LM show that their jump test has good power at the 15-minute frequency, and that above this frequency a large number of detected jumps are spurious because of the presence of microstructure noise in price data. Microstructural noise represents frictions that can affect the trading process at very high frequencies, such as transaction costs or liquidity shortages.

To deal with the microstructure noise problem, Lee and Mykland (2012) proposed a new parametric test which allows to asymptotically remove noise from the observed log price in order to determine jumps directly in the equilibrium or noise-free log price. The log price observed at time t_i denoted $\tilde{p}(t_i)$ is determined by the true log price $p(t_i)$ and by market microstructure noise $u(t_i)$:

$$\tilde{p}(t_i) = p(t_i) + u(t_i) \tag{11}$$

where the noise distribution is assumed to be stationary and given by $u(t_i) \sim_{\mathcal{D}} (0, q^2)$ Thus, the noise follows a general process with mean zero and standard deviation q, which the authors call the "market quality parameter" and represents the degree of market imperfection. This is because when $q = 0, u(t_i) = E(u(t_i)) = 0$ and we get a frictionless market where the equilibrium asset price is directly observed. The principle of LM's procedure consists in pre-averaging the observed high frequency price data over appropriately chosen non-overlapping blocks so that asymptotically noise is removed from the observed prices. It focuses on the property that microstructure noise is time-dependent as evidenced by empirical studies (see, among others, Lunde and Hansen (2004)). Since the order of noise dependence is not observable, the authors suggest to infer it from the lag order of the autocorrelation function of the observed returns. Let $k-1$ denote the number of dependence lags resulting from the estimation of this function, the first step is to collect all the k^{th} independent observations $\tilde{p}(t_i), i = 0, k, 2k, ...$ Let now M represent the optimal block size (that is, the number of observations $\tilde{p}(t_i)$ to be pre-averaged) allowing to remove noise in observed log prices. Averaging log prices over non overlapping consecutive sets of M terms yields to denoised log prices:

[8] See Theorem 1 in Lee and Mykland (2008).

$$\hat{p}(t_j) = \frac{1}{M}\left[\tilde{p}(t_j) + \tilde{p}(t_{j+k}) + \tilde{p}(t_{j+2k}) + ... + \tilde{p}(t_{j+k(M-1)})\right] \quad (12)$$

where $j \in \mathcal{J} = \{0, kM, 2kM, ...\}$. This re-sampling process ensures that any abnormal variation between $\hat{p}(t_{j+kM})$ and $\hat{p}(t_j)$ does not result from noise, but signals the presence of a jump in the equilibrium price between the same observation times.

For equation (12) to be of practical use, it remains to determine the optimal block size M. Lee and Mykland (2012) suggest the rule of thumb according to which $M = C(q)[n/k]^{\frac{1}{2}}$ when $n \longrightarrow \infty$, where n is the number of independent observations $\tilde{p}(t_i)$ and $C(q)$ is a constant parameter depending positively on the standard deviation q since, as stated by the authors, the greater the noise standard deviation, the larger must be the block size for pre-averaging. The authors provide a list of values for this parameter that they obtain by simulation for different values of q.[9] They also propose an estimator for the latter that is robust to the presence of jumps,[10] defined as :

$$\hat{q} = \frac{1}{\sqrt{2}}\left[\frac{1}{n-k}\sum_{s=1}^{n-k}\left(\tilde{p}(t_{s+k}) - \tilde{p}(t_s)\right)^2\right]^{1/2} \quad (13)$$

It is now possible to define the statistic $\Psi(t_j) \equiv \hat{p}(t_{j+kM}) - \hat{p}(t_j)$, $j \in \mathcal{J}$, to test for the presence of jumps in the equilibrium prices between t_{j+kM} and t_j. Under the null of no jumps, $\Theta(t_j) = \Psi(t_j)/\sqrt{V\left(\Psi(t_j)\right)}$ is standard normal and $\xi_n = (\underset{t_j, j\in\mathcal{J}}{max}|\Theta(t_j)| - A_n)/B_n$ follows a standard Gumbel distribution as $n \longrightarrow \infty$, where $A_n = \sqrt{C_n} - \frac{log(\pi)+log(log(\frac{n}{kM}))}{2\sqrt{C_n}}$ $B_n = 1/\sqrt{C_n}$ and $C_n = 2\ log(n/kM)$. Hence, the cumulative distribution function of ξ_n is $P(\xi_n \leq (G_n - A_n)/B_n) = exp[-exp(-(G_n - A_n)/B_n)]$, where G_n is a positive real number. The asymptotic critical value $G_{n,\alpha}$ for rejecting the null at the $100\alpha\%$ level of significance is such that $P(\xi_n \leq (G_{n,\alpha} - A_n)/B_n) = 1 - \alpha$, implying $G_{n,\alpha} = -log(-log(1-\alpha))B_n + A_n$. It follows that at the 1%, 5% and 10% levels, we have $G_{n,0.01} = 4.6$, $G_{n,0.05} = 2.97$ and $G_{n,0.10} = 2.25$, respectively.

[9] See Lee and Mykland (2012) Table 5.

[10] See Lee and Mykland (2012), appendices $A4$ and $A5$.

3.2 Separating jumps from microstructural noise

We now apply the Lee and Mykland (2012) test procedure described in subsection 3.1.3 to our FX data. Table 1 displays an overview of some results from the implementation of the denoising method and from the subsequent matching between macroeconomic news surprises and jumps, defined as significant changes in the true or denoised foreign exchange returns.

DESC STAT JUMPS	EUR/USD	GBP/USD	JPY/USD	CHF/USD	AUD/USD	CAD/USD
#obs	1908040	1909320	1909380	1909380	1909380	1909380
#denoised obs	18705	15152	15152	18720	18718	18720
denoising frequency	**102 min**	**126min**	**126min**	**102 min**	**102 min**	**102 min**
q	0.0199	0.0135	0.0266	0.0222	0.0306	0.0222
C	1/19	1/19	1/19	1/19	1/19	1/19
M	51	42	42	51	51	51
#trading days	1325	1327	1327	1327	1327	1327
#jumps	60	65	72	66	99	77
P(#jumps)	0.32	0.43	0.47	0.35	0.53	0.41
#jump days	56	52	52	52	70	63
P(#jump days)	4.22	3.92	3.92	3.92	5.27	4.75
E(#jumps|#jumpday)	1.07	1.25	1.38	1.27	1.41	1.22
Asymmetry in Jumps						
#jumps > 0	32	31	38	32	45	38
P(#jumps > 0)	53.33	47.69	52.77	48.4	45.45	49.35
SD	6.44	6.19	5.88	6.15	5.004	5.69
#jumps < 0	28	34	34	34	54	39
P(#jumps < 0)	46.67	52.30	47.22	51.51	54.54	50.65
SD	6.44	6.19	5.88	5.10	4.99	5.41
MATCHING NEWS						
#surprises	7686	7686	7686	7686	7686	7686
#newsdays	1527	1527	1527	1527	1527	1527
#news	113	113	113	113	113	113
#news | #jumps	29	29	28	35	38	33
#jumps | #news	20	22	27	25	26	27
P(#news | #jumps) (%)	25.66	24.78	25.66	33.63	29.20	30.97
P(#jumps | #news) (%)	33.33	37.50	33.85	26.26	35.06	37.88

Note: The table displays, from top to bottom the number of 1-min observations (#obs),The number of denoised observations (#denoised obs), the quality parameter (q),the q-dependent optimal value (C), the number of sample days (#trading days), the total number of days with jumps (#jump days), days with at least one jump, the probability (in %) of a jump day (P(jump day)=100(#jump days | #trading days)), the number of jumps per jump day (E(#jumps | jump day)=# jumps|#jump days), the total number jumps (#jumps), their proportion (in %) over the sample (P(jump) = 100(#jumps | #obs)). The next panel reports proportions of positive jumps (P(jump > 0) and negative jumps (P(jump < 0)) as well as their standard deviations (SD). Finally, the last panel reports number of suprises (#surprises) calculated with the matching news, number of days with news (#newsdays), number of news that match with at least one jump (#news | jump), number of jumps that match with at least one news (#jump | news). The matching process in based on a time-span window of 102 or 126 minutes depending on the currencies.

Table 1: Preliminary results: denoising and matching

One of the most noteworthy results displayed in the first panel of Table 1 are the denoising frequencies. For the EUR, AUD, CAD and CHF currencies, our initial one-minute frequency data were transformed into 1 hour and 42 minute frequency denoised data and for the GBP and JPY currencies, the initial one-minute data were transformed into 2 hours and 06 minutes frequency denoised data. Using these preprocessed data, we found that significant jumps occur at the frequencies of 0.32% for the Euro, 0.43% for the Pound, 0.47% for the Yen, 0.53 % for the Australian dollar, 0.41% for the Canadian dollar and 0.35% for the Swiss franc.[11] Our results are in line with Lahaye et al. (2011), who found that 0.36% of observed returns can be qualified as jumps. A slight asymmetry is observed for all FX rates (middle panel of Table 1): a negative asymmetry for the EUR and JPY and a positive one for the others.

[11] See more details in the Appendix 5.

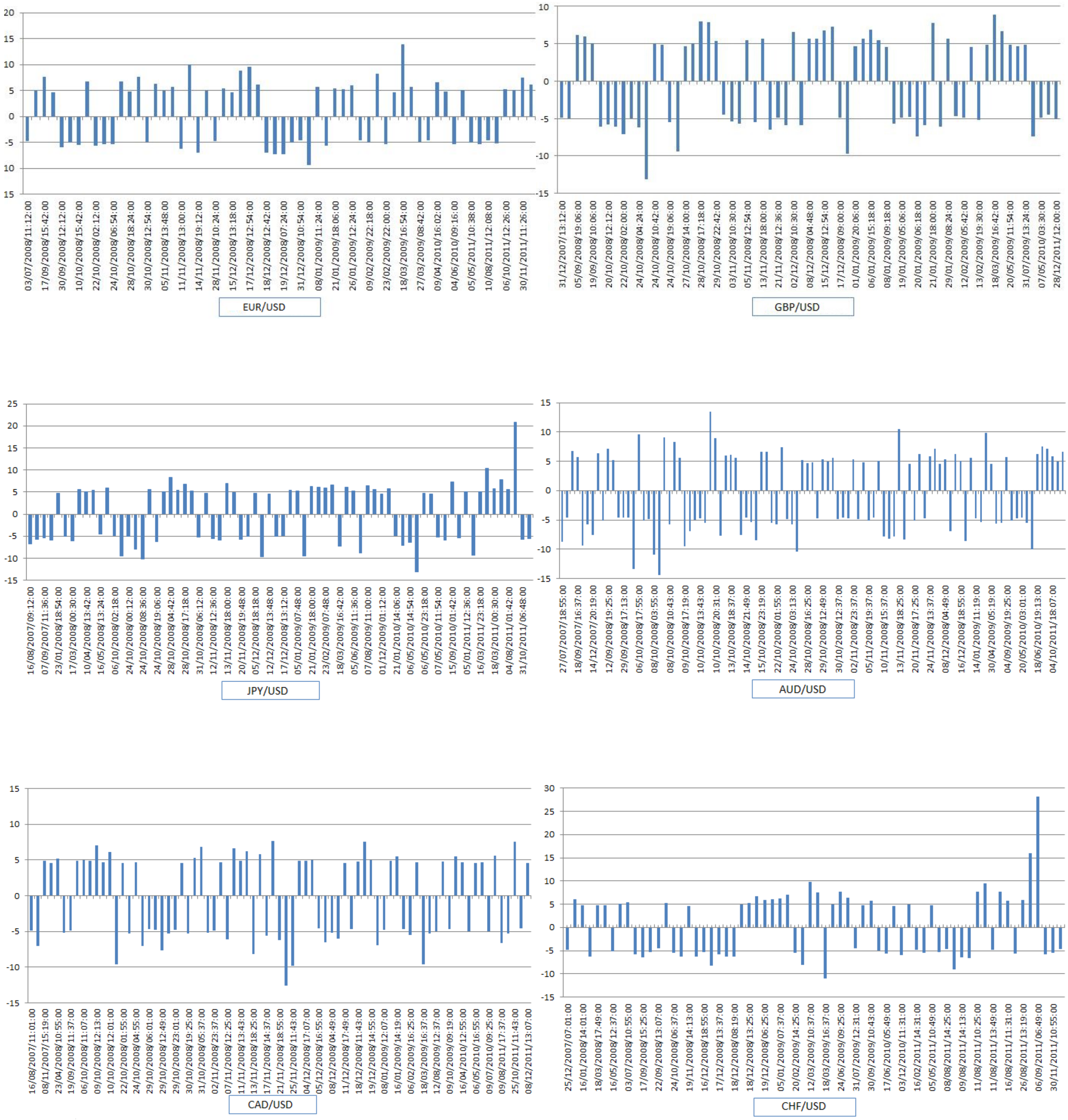

Figure 2: Jumps in major forex returns

Figure 2 presents these jumps for the six currencies considered. It appears that the magnitude of the jumps (the jump size) in absolute value typically varies around a 500% rate of change in all spot rates, with sporadic peaks reaching 1000% to 1500% in the case of EUR, GBP, AUD, CAD and CHF and more than 2000% in the case of JPY and CHF currencies. As expected, jumps are especially concentrated on the financial crisis period, reflecting the uncertainty that characterized the economies from the end of 2008 throughout 2009. The biggest jump in the EUR is positive and located on March 18, 2009, presumably in response to two news about US inflation that were announced before this jump or to traders' expectations on the US Federal Funds Target Rate. For the GBP, the biggest jump is negative and occurred on October 24, 2008, it coincides with a negative surprise on the UK GDP growth expectations. For the CHF currency, a very large positive jump can be noted on September 06, 2011. An obvious event that has at least partially given rise to this jump is the announcement, issued on the same day by the Swiss National Bank, that in order to depreciate the overvalued CHF currency the Bank intended to buy foreign currency in unlimited quantities, thereby leading the currency to loose 9% against the US dollar (according to the Guardian and BBC news). This event has been included in the unscheduled news database. We also tested for the impact of the announcement on the UK Trade Balance in Goods which has increased more than the consensus market has anticipated.

The last panel of Table 1 includes statistics resulting from a matching window between jumps and macroeconomic news. According to this window a matching occurs between a jump and a news if the latter precedes the former by up to 30 minutes or follows it by up to 5 minutes. The time discrepancy between the two events represents investors' response delay to the news release in the first case and their anticipation to upcoming volatility in the last case.[12] Results show that, on average, 33.98% of jumps match our macroeconomic news. Appendix 5 provides further information on which news coincide with how many jumps.

[12]Note that matching news and jumps allows for collecting relevant news before estimation but is not informative about the significance of news nor the sign of their effects.

Table 2 reports more details about the matching process between timestamped jumps and macroeconomic news.

	EUR/USD	GBP/USD	JPY/USD	CHF/USD	AUD/USD	CAD/USD
			#Jumps|Time slot			
00H-08H	2	4	1	3	4	0
08H-10H	1	3	1	2	1	1
10H-12H	4	0	4	4	0	2
12H-14H	**6**	**7**	**10**	**9**	**7**	**15**
14H-16H	2	3	4	4	1	3
16H-18H	2	3	3	2	4	2
18H-22H	3	1	3	1	5	3
22H-00H	3	1	1	0	4	1
			#Jumps |Category of news			
Monetary Policy	**17**	6	4	15	5	6
Production Market	9	**14**	13	14	**9**	12
Job Market	11	5	**25**	**16**	2	**20**
Foreign Trade	2	3	1	3	6	5
Retail market	1	0	6	5	5	3
Inflation	0	0	3	0	7	3
Housing Market	2	7	4	3	8	5
			#Jumps|Origin of news			
EU	3	4	0	2	0	0
UK	8	4	2	8	6	2
CN	0	1	0	6	0	0
JP	8	2	1	0	8	1
US	**23**	**24**	**53**	**40**	**28**	**51**
			#Jumps|Sign of news			
#NS-NJ	8	**9**	4	8	7	4
#PS-NJ	7	6	7	1	7	3
#NS-PJ	**11**	**9**	7	**11**	8	**11**
#PS-PJ	6	8	**13**	7	**10**	6

NS: Negative Surprises; PS: Positive Surprises; NJ: Negative Jumps, PJ: Positive Jumps.

Table 2: Preliminarily results: jumps and news properties

It can be seen that the majority of jumps are detected between noon and two p.m. The Table also shows that over our sample, the JPY, CAD and CHF currencies react more to job market news, the EUR responds more to monetary policy news, the Pound and the Australian dollar are more sensitive to production news. All markets are responsive primarily to the U.S. news, followed by U.K. and Japanese news. Finally, the matching results suggest that positive surprises (PS) cause positive jumps (PJ) for the JPY and the AUD , and negative surprises (NS) cause positive jumps for the other currencies.

4 Modeling Jumps: methodology and results

Defining and computing jumps as statistically significant abnormal returns imply that series involve discontinuities as evidenced by Figure 2. In the following subsections we discuss and estimate the relationship between these jumps and macroeconomic announcements using an appropriate censored data model.

4.1 Modeling Jumps using a Tobit model with asymmetric and heteroskedastic errors

To model jumps in exchange rate returns, we follow Lahaye et al. (2011) approach consisting in using a Tobit-GARCH model which is appropriate to examine in what extent discontinuous jumps are explained by macroeconomic announcement releases and calendar effects (interweekly and intradaily periodic effects), provided that the errors are conditionally heteroskedastic. We go further by taking into account an additional empirical feature commonly evidenced in financial markets, the leverage effect, which says that negative returns increase future volatility by a larger amount than positive returns of the same magnitude. To account for this asymmetry, we rely on a Tobit-GJR-GARCH model where the asymmetric conditional error variance specification is due to Glosten et al. (1993).[13] Calzolari and Fiorentini (1998) have shown how to construct the log-likelihood of a Tobit-GARCH model. We apply their approach to the case of a Tobit-GJR-GARCH model.

We specify the standard Tobit model as follows:

$$y(t_i) = \begin{cases} y^*(t_i) & \text{if } y^*(t_i) > 0 \\ 0 & \text{if } y^*(t_i) \leq 0 \end{cases} \tag{14}$$

where $y^*(t_i) = x'(t_i)\theta + u(t_i), u(t_i) \sim \text{iid N}(0, \sigma)$, $y^*(t_i)$ is an unobservable (latent) random variable, $y(t_i)$ is the observed censored dependent variable, $x(t_i)$ is the vector of exogenous variables and θ is a vector of coefficients. When the dependent variable is the series of jumps, we posit $y(t_i) = |J(t_i)|$. This amounts to simplify the model as (see Lahaye et al. (2011)):

$$|J(t_i)| = \begin{cases} x'(t_i)\theta + u(t_i) & \text{if } x'(t_i)\theta + u(t_i) > 0 \\ 0 & \text{if } x'(t_i)\theta + u(t_i) \leq 0 \end{cases} \tag{15}$$

$$x'(t_i)\theta = \mu + \lambda(t_i) + \delta(t_i) + \gamma(t_i) + \mathcal{F}(t_i)$$

where $|J(t_i)|$ is the absolute value of significant jumps in foreign exchange returns at time t_i, $\lambda(t_i)$ and $\delta(t_i)$ stand for the impacts of surprises from scheduled and unscheduled announcements on significant jumps in foreign exchange returns at period t_i, while $\gamma(t_i)$ and $\mathcal{F}(t_i)$ represent the intraweek and intraday periodicities, respectively. We specify the effect of surprises from scheduled announcements as:

$$\lambda(t_i) = \sum_{j=1}^{N^+} \lambda_j^+ S_j^+(t_i) + \sum_{k=1}^{N^-} \lambda_k^- \mid S_k^-(t_i) \mid \tag{16}$$

where $S_j^+(t_i)$ and $S_k^-(t_i)$ represent positive and negative standardized surprises associated with macroeconomic news announcements, while N^+ and N^- are the number of positive and negative surprises, respectively. The coefficients λ_j^+ and λ_k^- stand for the effect of the positive surprise j and negative surprise k on the forex jump magnitude. The effect of unscheduled news can be written as:

$$\delta(t_i) = \sum_{f=1}^{Q} \delta_f F_f(t_i) \tag{17}$$

where $F_f(t_i)$ is a dummy variable representing an unexpected event and Q the number of such events. The coefficient δ_f identifies the once-for-all impact of the unexpected event on the jump magnitude. Calendar effects are taken into account through an intraweek

[13] Engle and Ng (1993) test different models capturing the asymmetry of the volatility response to news (EGARCH, Asymmetric-GARCH, VGARCH, Nonlinear-Asymmetric-GARCH and GJR-GARCH). In the light of various diagnostic tests, they find that all models show a greater impact of negative return shocks on volatility and that the GJR-GARCH model is the one which performs best.

periodicity:

$$\gamma(t_i) = \sum_{d=1}^{4} \gamma_d D_d(t_i) \tag{18}$$

where $D_d(t_i)$ is a "day of the week" dummy which takes the value 1 when t_i belongs to a business-day d (d = Monday,..., Friday) and 0 otherwise[14], and through an intraday periodicity captured by the Flexible Fourier Form (FFF)(Andersen and Bollerslev, 1997)

$$\mathcal{F}(t_i) = \vartheta_{0,1}\frac{n}{k1} + \vartheta_{0,2}\frac{n^2}{k2} + \sum_{p=1}^{P}[\vartheta_{c,p}cos(\frac{2\pi pn}{N}) + \vartheta_{s,p}sin(\frac{2\pi pn}{N})] \tag{19}$$

where N is the number of intraday observations, $\vartheta_{0,1}$, $\vartheta_{0,2}$, $\vartheta_{c,p}$ and $\vartheta_{s,p}$ are coefficients to be estimated, $k_1 = (N+1)/2$ and $k_2 = (N+1)(N+2)/6$ are normalization constants and P determines the number of phases in the daily cycle. After preliminary tests, we selected a daily cycle of four phases ($P = 4$).

Denoting ϕ and Φ the pdf and the cumulative density function of a standard normal, respectively, the non-linear Probit part of the likelihood (the one concerned by censored observations) is :

$$P\left[|J(t_i)| = 0\right] = P\left[x'(t_i)\theta + u(t_i) \leq 0\right] = P\left[u(t_i) \leq -x'(t_i)\theta\right] = P\left[\frac{u(t_i)}{\sigma} \leq \frac{-x'(t_i)\theta}{\sigma}\right] = \Phi\left(\frac{-x'(t_i)\theta}{\sigma}\right) = 1 - \Phi\left(\frac{x'(t_i)\theta}{\sigma}\right) \tag{20}$$

whereas the linear part concerned by the non-zero observations is:

$$P\left[|J(t_i)| = x'(t_i)\theta + u(t_i)\right] = P\left[u(t_i) = |J(t_i)| - x'(t_i)\theta\right] = P\left[\frac{u(t_i)}{\sigma} = \frac{|J(t_i)| - x'(t_i)\theta}{\sigma}\right] = \frac{1}{\sigma}\phi\left(\frac{|J(t_i)| - x'(t_i)\theta}{\sigma}\right) \tag{21}$$

The log-likelihood function is given by :

$$L\left(|J(t_i)|, \theta, \sigma\right) = \sum_{0} Log\left[1 - \Phi\left(\frac{x'(t_i)\theta}{\sigma}\right)\right] - T_1 Log(\sigma) - \frac{1}{2}T_1 Log(2\pi) - \frac{1}{2}\sum_{1}\left(\frac{|J(t_i)| - x'(t_i)\theta}{\sigma}\right)^2 \tag{22}$$

where:
$\sum_0$ is the summation referring to the censored observations,
$\sum_1$ is the summation referring to the observed observations,
T_1 is the number of non zero observations.

[14] Andersen and Bollerslev (1998) show on the case of the DEM-USD exchange rate that forex volatility is sensitive to the day-of-the-week effects.

We have supposed so far that the $u(t_i)$'s are independently and identically distributed normal errors. To specify a Tobit-GJR-GARCH model we relax the assumption of iid normal errors in (14) and suppose that $u(t_i) \sim \mathrm{N}(0, \sigma(t_i))$ where $\sigma(t_i)^2$ follows a GJR-GARCH(p, m, q) process:

$$\sigma(t_i)^2 = \omega + \sum_{j=1}^{p} \alpha_j u(t_{i-j})^2 + \sum_{k=1}^{m} \gamma_k \mathbb{I}(t_{i-k}) u(t_{i-k})^2 + \sum_{l=1}^{q} \beta_l \sigma(t_{i-l})^2 \tag{23}$$

$$\mathbb{I}(t_{i-k}) = \begin{cases} 1 & \text{if } u(t_{i-k}) < 0 \\ 0 & \text{if } u(t_{i-k}) \geq \ 0 \end{cases}$$

where $\omega > 0, \lambda_j \geq 0, \lambda_k > 0, \beta_l \geq 0$ and $\sum_{j=1}^{p} \alpha_j + \frac{1}{2} \sum_{k=1}^{m} \gamma_k + \sum_{l=1}^{q} \beta_l < 1$. γ_k is the leverage coefficient whose positivity ensures that negative shocks impact volatility by the coefficient $\alpha_j + \gamma_k$, while the effect of positive shocks is α_j. When the dependent variable is observed, then for any lag $s = \{j, k\}$, the squared error in (23) can be written as :

$$u(t_{i-s})^2 = \left[|J(t_{i-s})| - x'(t_{i-s})\theta \right]^2 \tag{24}$$

When it is censored, i.e. $|J(t_{i-s})| = 0$, then $u(t_{i-s})^2$ is proxied by its conditional expectation when $y^*(t_{i-s}) \leq 0$, that is $\tilde{u}(t_{i-s}) = E_{t_{i-s}} \left[u(t_{i-s})^2 / u(t_{i-s}) \leq -x'(t_{i-s})\theta \right]$. Calzolari and Fiorentini (1998) show that this approximation is given by:

$$\tilde{u}(t_{i-s})^2 = \sigma(t_{i-s})^2 + x'(t_{i-s})\theta \ \frac{\sigma(t_{i-s})\phi(t_{i-s})}{1 - \Phi(t_{i-s})} \tag{25}$$

where $\phi(t_i) = \phi\left(\frac{x'(t_i)\theta}{\sigma(t_i)}\right)$ and $\Phi(t_i) = \Phi\left(\frac{x'(t_i)\theta}{\sigma(t_i)}\right)$.

It remains to discuss the sign of $u(t_{i-k})$ in (23) to assess for asymmetry. When the dependent variable is non-zero, the sign is that of $|J(t_{i-k})| - x'(t_{i-k})\theta$. When it is not, it is natural from the preceding approximation to deduce the sign of $u(t_{i-k})$ from that of its approximation $\tilde{u}(t_{i-k}) = E_{t_{i-k}} [u(t_{i-k}) / u(t_{i-k}) \leq -x'(t_{i-k})\theta]$. By simple integration, we can show that (see also Maddala (1983)):

$$\tilde{u}(t_{i-k}) = -\frac{\sigma(t_{i-k})\phi(t_{i-k})}{1 - \Phi(t_{i-k})} \tag{26}$$

The log-likelihood function becomes:

$$L(|J(t_i)|, \Theta) = L(|J(t_i)|, \theta, \omega, \alpha_j, \gamma_k, \beta_l, j = 1, ...p, k = 1, ..., m, l = 1, ..., q) =$$
$$\sum_0 Log \left[1 - \Phi\left(\frac{x'(t_i)\theta}{\sigma(t_i)} \right) \right] - \sum_1 Log(\sigma(t_i)) - \frac{1}{2} T_1 Log(2\pi) - \frac{1}{2} \sum_1 \left(\frac{|J(t_i)| - x'(t_i)\theta}{\sigma(t_i)} \right)^2 . \tag{27}$$

Let Θ_0 be the true vector of parameters and $\hat{\Theta}$ its estimated value. When Newton-like maximization method is employed, the negative of the expected inverse Hessian matrix, $V_H(\Theta)$, evaluated at $\hat{\Theta}$ is:

$$V_H(\Theta) = -E\left[\frac{\partial^2 L(\Theta)}{\partial\Theta\partial\Theta'}\right]^{-1} \quad \text{at} \quad \Theta = \hat{\Theta} \tag{28}$$

Under the null hypothesis, $H_0 : \hat{\Theta} = \Theta_0$, the Wald test statistic $(\hat{\Theta} - \Theta_0)' V_H(\hat{\Theta})(\hat{\Theta} - \Theta_0)$ is asymptotically distributed as a $\mathcal{X}^2(k)$, where k is the number of parameters. $V_H(\hat{\Theta})$ is the covariance matrix of $\hat{\Theta}$ which contains on its diagonal the estimated variances of the parameters.[15] Under the null, the Wald statistic for, say, β, is then:

$$\mathcal{W} = \frac{\hat{\beta}^2}{\widehat{V(\hat{\beta})}} \sim \mathcal{X}^2(1). \tag{29}$$

5 The impact of news announcements on forex returns

The Tobit-GJR-GARCH estimation results are displayed in Table 3 to Table 6. [16]

[15]Alternatively the covariance matrix can be calculated as the outer product of gradients $V_{OPG}(\hat{\Theta}) = \frac{1}{N}\sum_{t_i} G_{t_i}(\hat{\Theta})G_{t_i}(\hat{\Theta})'$, where $G_{t_i}(\hat{\Theta}) = \partial L_{ti}(\Theta)/\partial\Theta$ evaluated at $\Theta = \hat{\Theta}$ and $L_{ti}(\Theta)$ is the log-likelihood at the observation t_i. It can also be calculated using the so-called Sandwich estimator $V_S(\hat{\Theta}) = [V_H(\hat{\Theta})]^{-1} V_{OPG}(\hat{\Theta})[V_H(\hat{\Theta})]^{-1}$. Under regularity conditions $V_H(\hat{\Theta})$, $V_S(\hat{\Theta})$ and $V_{OPG}(\hat{\Theta})$ are asymptotically equivalent.

[16]Results concerning day-of-the-week effects and intraday periodic effects (FFF) are not reported, but are available upon request to the authors.

Macro News	EUR/USD		GBP/USD		JPY/USD		CHF/USD		AUD/USD		CAD/USD	
	λ^+	λ^-	λ^+	λ^-	λ^+	λ^-	λ^+	λ^-	λ^+	λ^-	λ^+	λ^-
Announcements related to the Chinese economy												
Monthly New Loan	-	-	-	-	-	-	-	-20.5***	-	-	-	-
Money Supply M1	-	-	-	-	-	-	-	-13.2***	-	-	-	-
Money Supply M2	-	-	-	11.07	-	-	-	-10.5**	-	-	-	-
Retail Sales	-	-	-	-	-	-	-	-64.9***	-	-	-	-
Value Added of Ind.	-	-	-	-	-	-	-	-69.7***	-	-	-	-
Announcements related to the Euro-Zone economy												
Fixed Assets Inv	-	-	-	-	-	-	-	-3.88	-	-	-	-
M3 Annual Growth	-	-	-	-445.5***	-	-	-	-	-	-	-	-
Money Supply M3	-	-	-	395.1***	-	-	-	-	-	-	-	-
Refinancing Rate	3.49**	-	-	-	-	-	3.0e-07	-	-	-	-	-
Unemp. Rate Euro-Zone	-	-	2.9e-07	-87.6***	-	-	-	-	-	-	-	-
Announcements related to the Japanese economy												
Merchandise TB	-	-	-	-	-	-	-	-	-	2.695	-	-
Balance of Payments CA	2.17e-06	20.3***	-	-	-	-	-	-	-	31.6***	-	-
Economy Watchers Surv.	-	-	-	-	-	-	-	-	27.9***	-	-	-
Housing Starts	-	-	376.3***	-	-	-	-	-	125.4***	-	-	-
Industrial Prodction	45.1*	-	227.3***	-	-	-	-	-	37.8**	-	2.46	-
Loans Discounts Outstand.	2.17e-06	12.4***	-	-	-	-	-	-	-	-	-	-
Machine Orders	-0.88	-	-	-	-	-	-	-	-	18.8*	-	-
Money Stock M2	20.2***	26.3***	-	-	-	-	-	-	-	-	-	-
Money Stock M3	26.1***	15.9***	-	-	-	-	-	-	-	-	-	-
Tertiary Industry	-	-	-	-	59.9***	-	-	-	-	-	-	-
Trade Balance	-	-	-	-	-	-	-	-	-	15.5***	-	-
Announcements related to the U.K. economy												
BoE Official rate PPTA	0.84	-	-	-	-	-	1.4e-07	-	-	-	1.7e-07	-
BoE Official rate	2.1*	-	-	-	-	-	1.4e-07	-	-	-	1.7e-07	-
Claimant Count Rate	-	-	90.9***	-	-	-	-	-	-	-	-	-
CPI Ex Food \ Energy	-	-	-	-	-	-	-	-	23.2***	-	-	-
CPI EU Harmonized	-	-	-	-	-	-	-	-	-18.7***	-	-	-
GDP	0.66	33.2***	-	-126.4***	-	-7.23***	-	-	-	-	-	-
HBOS House Prices 3 Mth	-	-	-	23.8**	-	-	-	-	-	-	-	-
PSNCR Net Borrowing	-2.13	-	-	-	-	-	27.1***	-	-	-	-	-
PSNCR Public Sector Net	-51.5***	-0.36	-	-	-	-	-	-8.41	-	-	-	-
RICS UK Wales Housing	-	-	-	-	-	-	-	-	34.9***	-	-	-
RPI All Items	-	-	-	-	-	-	-	-	21.7***	-	-	-
RPI less Mortgage Int.	-	-	-	-	-	-	-	-	-18.2***	-	-	-
Retail Sales Less Auto	39.9***	-	-	-	-	-	26.2***	-	47.1***	-	-	-
Trade Balance	-	-	-	-	-	-	183.6**	-	-	-	-	-
ILO Unemp. Rate	-	-	75.8***	-	-	-	-	-	-	-	-	-
Announcements related to the U.S. economy												
Retail Sales Less Auto	-	-	-	-	12.4***	-	18.5***	-	-	7.12**	-	-54.2***
Census Bureau	-	-	-	-47.3**	-	-	-	-	-	14.6***	-	-
Conference Board US Ldg.	-0.39**	-	6.15e-07	-	13.3***	-	0.00	-	-	-	-	-
Continuing Jobless	-32.1***	152.2***	-	-	-2.71	-	-11.5***	-34.6**	130.0***	0.36	40.6***	-23.8***
CPI Urban C.Less F E	-	-	-	-	-	-	-	-	-	-1.01	-	-
Consumer Price Index	-	-	-	-	-	-	-	-	-	11.5***	-	-
Capacity Utilisation	0.20	20.1***	-	-82.1***	-	-	0.49	-8.48	-	-	-	-27.1***
Durable Good Orders Ind.	-	-	273.7***	-	-	-	186.5***	-	39.7***	-	9.21	-
DGO ex Transportation	-	-	-7.08	-	-	-	93.9***	-	5.46	-	2.65	-
Existing Home Sales	-	-	44.4***	-	4.91*	-	-	-	80.5***	-	413.6***	-
NonFarm Payrolls	-3.03**	-	-	-	5.52**	-18.7**	1.80*	-	-	-	-	-22.2***
NFP Manufacturing Ind.	-0.06	9.68***	-	-	1.97	15.4**	-	-14.5***	-	-	-	31.4***
Empire State manuf. Surv.	-3.41*	-	54.8***	-	-	-	-	-	-	14.2**	-	51.5***
Federal Funds Target Rate	1.85	1.82	1.14	-	-	-10.8***	0.00	-6.99***	-	6.96*	1.65	-5.93***
Foreign Net Transaction	-32.3***	23.1***	-	-126	-	-	1.30	-	-	-	-	9.85***
FED Consumer Credit	-	-	-	-	-	5.12	-	-	-	34.4***	-	-35.9**
Initial Jobless Claims	9.61*	-72.8***	-	-	7.82***	-7.58***	21.0***	60.97	-	-	-12.9*	10.6***
Import Price Index	-	-	-	-	-	-	-	-	-	67.3***	25.6***	-89.3***
Economic Optimism	-	-	298.4***	-	-	-	-	-	11.9**	-	9.3***	-
Industrial Production	17.1***	-	152.3***	-	-	-	6.84	0.19	-	-	10.5**	-18.1***
ISM Manufacturing	-	-	-	-	-34.2***	-13.3***	-	-	-	-	-	-
MNI Chicago Report	-	-	23.9***	-	-	17.5***	-	-	-	-	-	-10.7***
Manuf. Trade Invent.	-	-	-	-	-	-21.8***	-	-16.9***	-	-	-	-
Merch. Wholesalers Invent.	-	-	-84.8***	-	-	-	-	-	-	11.9***	-	-
NAHBM Index	-3.82**	11.39	0.00	-	-	-25.7***	-	-	-	26.5***	-	-
New One Family Houses	-0.10	24.8***	349.0***	-	-	-	-	-17.75	-	-	-	-
New Privately Owned Hsg.	-	-	-	-	5.65**	-	13.4***	-	-3.18***	-	1.18	-
Personal Consumption	-	-	195.4***	-	33.6***	-	37.4***	-	-	-	-	-
Private Housing Auth.	-	-	-	-	-2.50	-	11.5***	-	-	14.1***	17.8***	-
Pending Home Sales	-	-	-	-65.8***	-	-	-	-	-	-	-	-
Private Housing Start.	-	-	-	-	-	-	-	-	-	-	-	6.43***
Philadelphia Fed Survey	52.5**	-	63.4***	-	27.3***	-36.3***	23.1***	-	-	-	-	-
PPI YoY	-	-	-	-	39.6***	-	-	-	2.66	-	2.1e-07	-
PPI ex Food \ Energy	-	-	-	-	3.18*	-	-	-	1.45	-	2.1e-07	-
PPI Total Goods	-	-	-	-	-	86.9***	-	-	-	-	-	32.0***
PPI Total Goods YoY	-	-	-	-	-	-	-	-	3.88**	-	-	-
Private Total Housing Auth.	-	-	-	-	-	-	-	-	-	-	6.62*	-
Trade Balance	-	-	-	-	-	-5.06	-	-33.8**	-	5.11***	10.02	2.89
Treasury FED Budget Debt	-90.7***	12.7***	-	-33.1*	-	-16.9***	-	-	-	11.2**	-	-9.58***
Univ. Michigan Cons Sentim.	-	-	-	-	-17.7***	-	-	-442.2**	-	-	-3.56**	-
Unemp. Rate	-	4.93***	-	-	-6.04	6.10***	-2.97*	-	-	-	48.1***	-
Unemp. Rate Seas. Adj.	-	5.16***	-	-	-	-	-	-	-	-	-	-

Note : The estimated parameters are those of the component $\lambda(ti)$ given by equation (16). A hyphen (-) indicates that the news does not match with a jump and therefore is not included in the regression. (*), (**) and (***) denote significance at the 10%, 5% and 1% levels of significance, respectively.

Table 3: Estimation of the Tobit-GJR-GARCH model : Scheduled Announcements

Table 3 presents the results related to the impacts of surprises from scheduled macroeconomic announcements on the absolute significant returns of our six currencies.[17] First, it can be seen that among the 78 surprises considered, 18 of them affect three currencies at a time and 6 of them impact four currencies at a time at the 5% level. Because all our exchange rates are denominated against the dollar, most of these 24 significant surprises are related to the U.S. economy. The six most influential surprises (i.e. those that impact four exchange rates at a time) come from continuing jobless claims, initial jobless claims, nonfarm payrolls in manufacturing industries, retail sales (less automobiles), the Philadelphia Fed survey and the Treasury Federal budget debt.

Initial and continuing jobless claims and nonfarm payrolls impact exchange rate volatility because an increase in initial and continuing claims and a decrease in nonfarm payrolls are obvious signs of reduction in employment opportunities and therefore of weakening of the economy. If the US economy enters a recession, one would expect interest rates to fall which, in turn, would make US assets less attractive for foreign investors and depreciate the dollar. These employment situation reports are the most internationally followed U.S. figures because they reflect all major sectors of the economy (production, income, consumption), besides the fact that they are related to U.S. monetary policy: since the last recession, the employment situation drives the "quantitative easing" decisions of the FED. Moreover, as they are the earliest indicators of economic trends published each month, employment announcements can trigger very large movements in FX markets.

Investors focus also on retail sales because these are good predictors of GDP as retail market helps them to spot specific investment opportunities, without having to wait for a company's quarterly or annual report. They monitor the Philadelphia Federal survey because it is viewed as an indicator of the evolution of the manufacturing sector. As for the relationship between news on Federal public debt and the exchange rate of the dollar, a large debt impacts exchange rate if foreign investors believe that the country risks defaulting on its debt and therefore sell the dollar denominated bonds they hold, producing a depreciation of the dollar.

The 18 news which significantly impact only three exchange rates include: the industrial production, personal consumption expenditure capacity utilization, the Empire State Manufacturing survey, the Federal Fund's target rate, housing market news (NAHBM Index), and the new privately owned housing. The latter provides to investors information about new home sales or resales and, through a "ripple effect", all required housing equip-

[17] Note that a number of coefficients are negative whereas the specification in absolute value of the dependent variable and of the negative surprises in Equation 16 suggests that the coefficients λ^+ and λ^- are positive. Such a result may potentially stem from the fact that surprises based on concomitant announcements are measured with errors. Indeed, representing market forecasts by median survey forecasts in calculating surprises may lead to measurement errors on market forecasts or, equivalently, on surprises (Lahaye et al. (2011)). While a measurement error on a single variable is known to imply an attenuation bias (the estimate shrinks towards zero), in the multivariate case the direction of bias is undetermined. Simultaneously, the existence of concurrent announcements at the time of a jump may lead to select several significant surprises with measurement errors, while the estimated model may include one or several negative surprise effect(s) to offset a positive total bias. However, the central issue we are concerned with is not to know the values of the estimated parameters but simply to identify the significant surprises in explaining jumps.

ment. It also reflects the consumer confidence about the future of the economy. The US Federal Funds target rate is announced by the US Federal Open Market Committee (FOMC) and has direct and immediate impact on financial markets since it is considered as a good indicator of monetary policy and a particularly informative nominal interest rate for future real economic variables (Bernanke & Blinder 1992).

We also find that, apart the US variables, GDP and retail sales from UK affect the Euro, the Pound end the Yen. Note that the Swiss Franc is the only currency influenced by all the Chinese announcements. This result is likely related to the historical economic relationship between the two countries. In fact, Swiss firms have been investing in China substantially over the last decade. Swiss banks were among the first Western banks to establish correspondent banking relationships with Chinese banks. Switzerland is also the first country on the European continent that has signed a Free Trade Agreement with China.[18]

Depending on whether its coefficient is reported in the λ^+ or λ^- column under each exchange rate, a news can take the form of a positive or negative surprise. A positive surprise means that the underlying announcement has been underestimated, while a negative surprise reflects an overestimated announcement. Depending on the nature of the announcement, an under- or overestimation of its future value can be viewed either as good news or as bad news. For example, negative (positive) surprises on initial and continuing jobless claims and on public debt are good (bad) news because they imply that reality is better (worse) than expected. This reflects that survey respondents tended to make pessimistic (optimistic) forecasts. Similarly, positive (negative) surprises on retail sales, nonfarm payrolls and Philadelphia Fed survey are good (bad) news. It is noteworthy that both Treasury debt and Philadelphia Fed survey impact exchange rate volatility as good news for most of the currencies. As for nonfarm payrolls, they influence all exchange rates as bad news as a result of optimistic forecasts. Turning to our 24 news that significantly impact at least half of our currency panel, our results show that in 59% of cases financial traders report good news with respect to their forecasts when announcements are released. This can be explained by the fact that during the crisis period analyzed (2007-2012), they were more often delivering pessimistic forecasts. The asymmetry between good and bad news is particularly pronounced for news concerning agents' sentiment on economic health,[19] public debt and housing,[20] for which the proportions of good news are 83%, 80% and 77%, respectively. These findings seem consistent with Andersen et al. (2003) result that "bad news in good times have greater impacts than good news in good times".

[18] *Source* : http://www.swissbanking.org/home/dossiers-link/renminbi.htm

[19] The underlying news are: Economic optimism Index and University of Michigan Consumer Sentiment Index.

[20] The underlying news are: Existing home sales, NAHB Index, New privately owned housing and Private housing authorized.

Date	Unanticipated News	EUR	GBP	JPY	CHF	AUD	CAD
12/12/2007	FOMC Board TAF	-	-	-	-	2.68	-
12/12/2007	20B $ to the ECB and 4B $ to SNB	-	-	-	-	2.68	-
04/01/2008	Bush Paulson meeting with WGFM	-	-	-	-	-	-20.8*
22/01/2008	FED cut interest rate by 75 bpt	-	-	19.0***	-	-	-
14/03/2008	Bear Stearns near collapse	-	-	9.72***	-3.83	-	-
17/03/2008	B.Stearns acquisition for 240M $	-	-	13.6***	14.7***	-	-
22/04/2008	BoE acquire UK bank's mortg-backed	-	-	-	-	-	-10.5***
15/09/2008	Lehman Broth. Bankruptcy	-14.6***	-44.8***	-	-13.5***	9.08*	-9.24***
29/09/2008	700B $ Bailout Plan	-11.8***	-69.8***	-	13.4***	12.3**	4.24
13/10/2008	Dutch Credit 500B $ Bailout Plan	-	-190***	-	-	9.16	-
17/10/2008	The EU 2.7T $ bailout plan	-	7.33	-	-	-0.25	-
20/10/2008	French Gov -10.5B $ Bailout Plan	-15.1***	193***	-	-	-	-19.8***
27/10/2008	Iceland's Kaupthing Bank Defaults	-16.6***	6.74	30.7***	-158***	13.0*	0.82
09/11/2008	AIG 150B $ Bailout Plan	-	-68.4***	-	-	8.95*	7.83
14/11/2008	Freddie Mac- 13.8B $ losses	10.9**	72.1***	-	-	5.98	6.34
09/12/2008	12 Banks Lowered by SP	-	-135***	-	-	-	-158***
11/12/2008	Bernard Madoff fraud	-	61.2***	-7.79***	-	3.15	168***
14/01/2009	SP500 cuts Greece's credit rating on debt	-	-189***	-	-	14.8***	-221***
15/01/2009	US gov. 138B $ bailout to BofA	-	57.2***	-	-	-	-70.6***
19/01/2009	SP 500 slashes Spain's triple A rating	-	205***	-	-	-	-
20/01/2009	1st election of Barack O.	-17.4***	171***	21.9***	-	-	-
27/01/2009	Japan announces a 16.7B $ stimulus	-	-124***	-	-	-	-
12/03/2009	Japan 1.2B $ Bailout Plan	-	-	0.13	18.4***	-	-
20/04/2010	BP Oil Spill spewed into the GoMex.	-	-	-	-	-	12.2***
11/03/2011	Japan earthquake and Tsunami	-	-	-9.40***	-	-	-
06/09/2011	SNB sets min ER at CHF 1.20 per €	-	-	-	18.8***	-	-
27/10/2011	EU. leaders-rescue Greece	-	-	5.16***	-	-	-

Note: A hyphen (-) indicates that the news does not match with a jump and therefore is not included in the regression.
(*), (**) and (***) denote significance at the 10%, 5% and 1% levels of significance, respectively.

Table 4: Estimation of the Tobit-GJR-GARCH model : Unscheduled Announcements

As regards the unscheduled news coefficients, it seems that all our currencies except the Yen are primarily affected by the Lehman Brothers bankruptcy and, in some extent, by the 700B $US bailout plan allowed under the Troubled Asset Relief Program, which both occurred in September 2008. Iceland's Kaupthing bank defaults, the French Government bailout plan, Standard & Poor's decision to downgrade Greece, the first Barack Obama's election and the Madoff fraud are the major other events that impacted many currencies. The EUR/USD was affected by most of the events mentioned above and by Freddie Mac loss releases of 14/11/2008. Jumps in GBP/USD exchange rate were mostly provoked by all events documented above and by many bailout plans (EESA, AIC, Dutch Credit, EU, Us Government) and downgrading announcements (Greece, Spain). The Japanese Yen was not directly hit by the crisis, but was sensitive to Obama's 2009 election, to the Japanese earthquake and Tsunami occurred on March 2011 while the Swiss Franc was subject to the high devaluation plan conducted by the Swiss National Bank. The Australian Dollar was only affected by the US bailout plan and downgrade of Greece's rating.

Coeff	EUR	GBP	JPY	CHF	AUD	CAD
ω	0.15*	1.50**	10.24***	17.09***	0.23**	0.15**
α	0.03***	0.05***	0.26***	0.19***	0.05***	0.04***
γ	0.021*	0.021*	0.56***	0.24**	0.02	0.02
β	0.95***	0.93***	0.11	0.64***	0.93***	0.94***

Note: (*), (**) and (***) denote significance at the 10%, 5% and 1% levels of significance, respectively.

Table 5: Estimation of the Tobit-GJR-GARCH model : the GJR-GARCH

Table 5 displays the estimation results of the GJR-GARCH part of our model. The stationarity condition is satisfied for all currencies. As explained above if the leverage coefficient is non-zero in Equation (23), then positive and negative shocks exert asymmetric effects on volatility. Our results strongly support the presence of asymmetric effects for the Japanese Yen and the Swiss franc at the 5% level of significance and for the Pound and the Euro at the 10% level (note that β is not significant for JPY/USD exchange rate, suggesting that a GJR-ARCH would more adequately fit the volatility for this currency). By contrast, there is no asymmetry for the Australian Dollar and Canadian Dollar, implying that a Tobit-GARCH model would be more appropriate for these two currencies.

It is worth noting that a greater effect of a negative past return in a foreign exchange market cannot be interpreted as straightforwardly as in the stock markets where, following Black (1976), a drop in the stock price of a firm would imply a rise in its leverage and this bad news would in turn lead to an increase in the volatility (leverage effect). Such negative shocks, called "bad news", are then believed to generate larger volatility than positive shocks or "good news". It is hard to define what are "good" and "bad" news in the case of changes in exchange rates (see maya 2008, for an attempt). In fact, the definition is likely to depend upon whether the economy experiences good or bad times (Andersen et al. (2003)). In a boom, appreciation can serve to reduce inflation and can therefore be qualified as good news. In a recession, good news would rather be a depreciation which helps to improve competitiveness and increase exports. Our results do not allow for an interpretation in terms of good or bad news because our jumps are expressed in absolute value and therefore are not informative about the direction of the change in exchange rate. However, the hypothesis that negative volatility shocks have a larger impact on volatility than positive ones is validated by our results and translates as follows. While a foreign exchange jump with a higher-than-expected absolute magnitude (positive residual) reflects capital flows seeking safe haven currencies during the crisis period, a jump with a lower-than-expected absolute magnitude (negative residual) may be viewed as the consequence of an effective intervention policy conducted by the central bank in order to avoid large changes in exchange rates. However, such a stabilizing policy is costly, since it generates transaction costs, international trading costs or risk management costs. Indeed, in the short run central banks bear stabilization policy costs that are all the larger that return volatility is high. Being subject to these costs is interpreted by the market as an undesirable side effect and leads to a volatility response greater than the volatility response due to arbitrage movements in foreign exchange markets.

Overall, our results show that exchange rate jumps residuals exhibit conditional variances that are asymmetric for the most leading world currencies. Ignoring this feature would bias the results and give misleading estimates.

	EUR	**GBP**	**JPY**	**CHF**	**AUD**	**CAD**
AIC	3.7321	6.9088	4.0931	5.7654	4.5324	3.7397
BIC	3.7597	6.9395	4.1218	5.7913	4.5593	3.7673
LLf	1034272	907742	1004892	1138459	1690758	1327704
LLr	1036411	910038	1006191	1138546	1691794	1328660

Note: LLf and LLr are the log-likelihood values for the full Tobit-GJR-GARCH model and for its restricted version without scheduled and uncheduled news.

Table 6: Estimation of the Tobit-GJR-GARCH model: Information Criteria and Log-likelihood values

Table 6 displays the values of the log-likelihood associated with the full Tobit-GJR-GARCH model (LLf) and given by Equation (27) and the values of the log-likelihood associated with the restricted Tobit-GJR-GARCH model (LLr) where the surprises on scheduled announcements (16) and unscheduled events (17) have been removed from the Tobit model which thus only comprises intraweek (18) and intraday (19) periodicities. For each of the currencies, to check that our two categories of news improve significantly the jump model, we compute the likelihood ratio statistic $\mathcal{L} = 2(LLr - LLf)$ which compare to a $\mathcal{X}^2$ with 33, 35, 32, 29, 30 and 32 d.o.f., respectively. We find that news contribute very significantly to explain jumps in each foreign exchange market.

6 Conclusion

This paper studies the effects of two categories of news, scheduled macroeconomic announcements and unscheduled event releases, on jumps in six foreign exchange markets (Euro, Pound, Yen, Australian dollar, Canadian Dollar and Swiss franc, all against the U.S dollar). To this end, we first use an innovative non parametric test procedure suggested by Lee and Mykland (2012) allowing to detect significant jumps in equilibrium prices after removing microstructural noise from observed prices. Test results suggest that the Pound and the Yen have more microstructure noise than the other forex rates, since the denoising frequency is higher for these two exchange rates (126 min vs 102 min). About 0.41% of all denoised returns represent significant jumps, which is a higher proportion of jumps than in previous studies where the denoising frequency is determined by simulations. Using these denoised data we find that our scheduled macro news and unscheduled event releases match with about 34% and 14% of total jumps, respectively. These empirical findings point out the relevance of removing microstructure noise before applying a jump detection test. Turning to model specification, our discontinuous (censored) high-frequency jump data justifies the use of a Tobit model with heteroskedastic structure of residuals. Further, to test for the stylized fact that negative volatility shocks increase volatility by a greater amount than positive shocks, we specify a Tobit-GJR-GARCH model. In line with other results in the literature, we find that news impact volatility significantly. Scheduled macroeconomic surprises affect foreign exchange returns in the form of good news with a proportion of 59 %, reflecting rather pessimistic forecasts from traders during the crisis period analyzed. The macro surprises that exert a common impact to a majority of exchange rate jumps are related to initial and continuing jobless claims, nonfarm payrolls in manufacturing industries, retail sales, the Philadelphia Fed survey and the Treasury Federal budget debt. Concerning the unscheduled event releases, the Lehman Brothers bankruptcy and EESA bailout plan come as the most influential shocks. We also find that jump responses are characterized by a significant asymmetry in negative and positive volatility shocks for most of the major currencies considered, suggesting that markets are sensitive to the costs implied by central banks' stabilization policies.

APPENDIX

APPENDIX 1 : Jumps around some scheduled macroeconomic announcements

Figure (a): EUR/USD around NFP announcement - 2012/12/07 - 13:30

Figure (b): EUR/USD around federal target rate announcement - 2012/12/12 - 18:30

Figure (c): EUR/USD around aggregate european macro announcement - 2012/10/10 - 01:45

Figure (d): JPY/USD around Bank of Japan assets purchase decision announcement - 2012/10/30 - 06:45

Figure (e): AUD/USD around federal target rate announcement - 2012/12/12 - 18:30

Figure (f): AUD/USD around HSBC PMI announcement - 2012/12/12 - 06:00

APPENDIX 2 : Jumps around some unscheduled event news

Figure (a): Jumps around U.S. elections: AUD/USD (left panel) and EUR/USD (right panel)

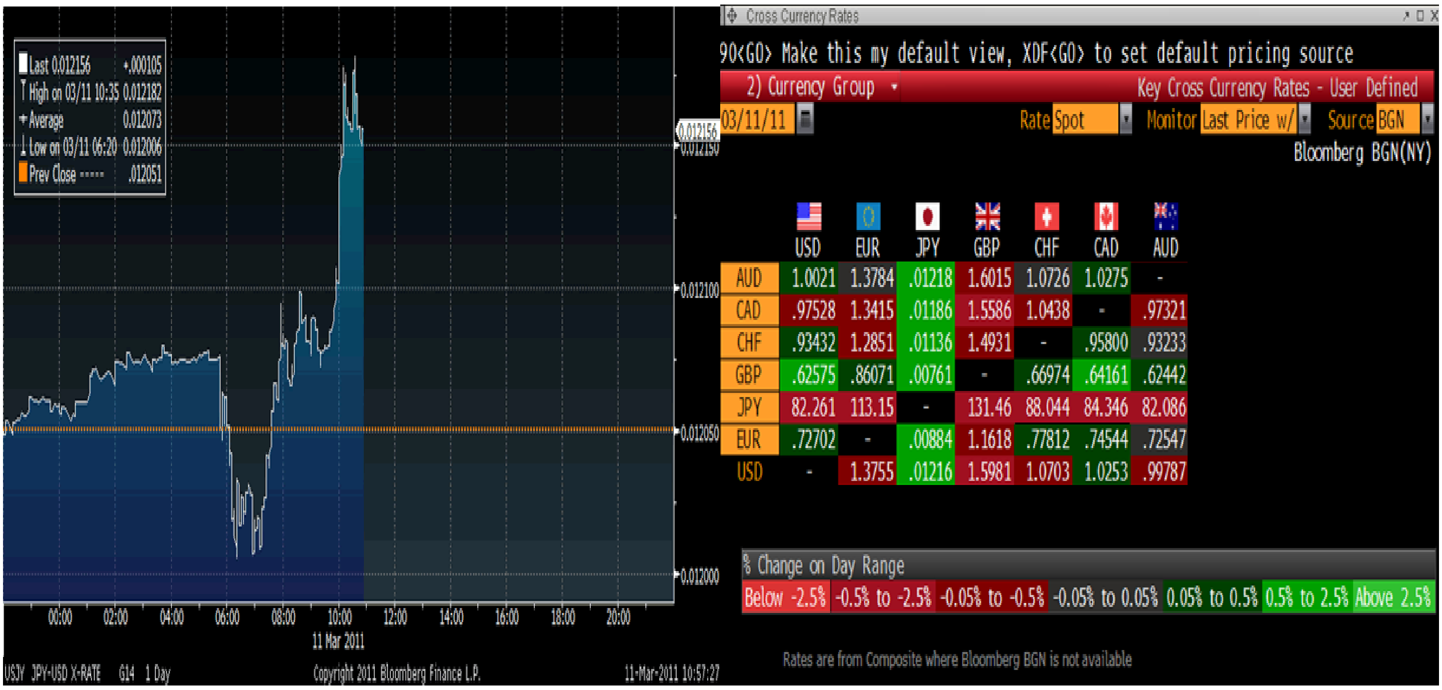

Figure (b): The effect of the Japanese earthquake: the JPY/USD (left panel) and the forex market (right panel)

APPENDIX 3 : Macroeconomic news announcements

Type of announcement	Variable name	Release time	Reporting convention	Source
Activity Indicators				
Philadelphia Federal Index	PHIL	15:00	Value	Philadelphia FDR
Industrial Production	IP	14:15	Rate / %	Federal Reserve
Durable Goods Orders	DGO	13:30	Rate / % Change	U.S. Census Bureau
Factory Orders	FO	15:00	Rate / % Change	U.S. Census Bureau
ISM Manufacturing	ISM	15:00	Value / S.A.	ISM
Empire State Manufacturing Survey	ESMS	13:30	Value / S.A.	FED of New York
MNI Chicago Report	MNCR	14:45	Value / S.A.	MNI DBG
IBD-TIPP Index of Economic Optimism	IEO	15:00	Value / S.A.	IBD and TMI
Consumption and Employment Indicators				
Univ. of Michigan-Consumer Confidence Sentiment	MCCF	15:00	Rate / S.A./ 1985=100	Reuters and Univ. of Michigan
Federal Reserve Consumer Credit	CCD	20:00	Value / Billions	Federal Reserve
Retail Sales less auto	RSLA	13:30	Rate / % Change	U.S. Census Bureau
Non-farm Payrolls Total MoM	NFP	13:30	Value / Thousands	BLS
Non-farm Payrolls Manufacturing Industry	NFP	13:30	Value / Thousands	BLS
Personal Spending Core Price Index	PCE	13:30	Rate / % Change	BEA
Unemployment rates	UP	13:30	Rate / %	BLS
Continuing Jobless and Initial Jobless Claims QoQ	CJC and IJC	13:30	Rate / %	BLS
Property Indicators				
NAHBM Index	NAHBM	15:00	Volume / Thousands	U.S. NAHB
Existing Homes Sales	EHS	15:00	Volume / Thousands	NAR
Pending Home Sales Index	PHS	15:00	Volume / Thousands	NAR
New Home Sales	NHS	15:00	Volume / Thousands	U.S. Census Bureau
Inflation Indicators				
Producer Price Index	PPI	13:30	Rate / % Change	BLS
Consumer Price Index	CPI	13:30	Rate / % Change	BLS
PPI Ex Food and Energy	PPIC	13:30	Rate / % Change	BLS
CPI Ex Food and Energy	CPIC	13:30	Rate / % Change	BLS
Monetary Policy Indicators				
Federal Funds Target Rate	FFRT	19:15	Value / Billions	FED of New York
Treasury Federal Budget Debt	TFBDSD	19:00	Value / Billions	U.S. Treasury
Foreign Trade Indicators				
Trade Balance	TB	13:30	Value / Billions	U.S. Census Bureau
Merchant Wholesalers Inventories Total	MWI	15:00	Value / Billions	U.S. Census Bureau
Foreign Net Transactions	FNT	14:00	Value / Millions	U.S. DoT
Import Price Index	IPI	13:30	Value / Billions	U.S. Census Bureau

BLS : Bureau of Labor Statistics; ISM : Institute for Supply Management; NAR : National Association of Realtors;
NAHB : National Association of Home Builders; IBD : Investors Business Daily and ; TMI:TechnoMetrica Market Intelligence;
BEA : Bureau of Economic Analysis; DBG : Deutsch Börse Group ; DoT : Department of the Treasury.

Table (a): United States (U.S.)

Type of announcement	Variable name	Release time	Reporting convention	Source
Activity Indicators				
Chained GDP at Market Prices QoQ	GDP	08:30	Rate / % Change	ONS
Property Indicators				
HBOS House Prices 3 Mth YoY	HBOS	7:00	Value /	Halifax and BoS
RICS England and Wales housing Market Survey	RICSWHM	23:01	Value /	RICS
Consumption and Employment Indicators				
RPI Less Mortgage Interest Payments	RPIcore	08:30	Value /	ONS
Retail Sales Less Auto	RSLA	08:30	Rate / % Change	ONS
Claimant Count Rate SA	CCR	08:30	Rate / % RATIO	ONS
ILO Unemployment Rates	ILOUP	08:30	Rate / % RATIO	ONS
Inflation Indicators				
Consumer Price Index EU Harmonized	PPI	08:30	Rate / % Change	ONS
CPI Ex Food and Energy	CPIC	08:30	Rate / % Change	ONS
Monetary Policy Indicators				
PSNCR Net Borrowing	PSNCR	08:30	Value / Billions	ONS
PSNCR Public Sector Net Cash Requirement	PSNCRPS	08:30	Value / Billions	ONS
Bank of England Official Bank Rate	BoER	11:00	Value / Billions	BoE
Foreign Trade Indicators				
Visible Trade Balance	TB	08:30	Value / Millions	ONS

ONS : Office for National Statistics; BoS : Bank of Scotland;
RICS : Royal Institution Of Chartered Surveyors; BoE: Bank of England.

Table (b): United Kingdom (U.K.)

Type of announcement	Variable name	Release time	Reporting convention	Source
Activity Indicators				
Value Added of Industry	VAI	01:00 - 02:00	Rate / % Change	NBSC
Consumption Indicators				
Fixed Assets Investment (Excluding Rural Households)	FAI	01:00-03:00	Value / Billions	NBSC
Retail Sales	RS	04:00-07:30	Rate / % Change	NBSC
Inflation Indicators				
Consumer Price Index	CPI	03:30	Rate / % Change	NBSC
Producer Price Index	PPI	03:30	Rate / % Change	NBSC
Monetary Policy Indicators				
Monthly New Loan	MNL	01:00-08:00	Value / Billions	PBoC
Monthly Money Supply M1	M1	01:00-07:00	Rate / % Change	POC
Money Supply 2	M2	01:00-07:00	Rate / % Change	POC
Foreign Trade Indicators				
Trade Balance	TB	-	Value / Billions	NBSC
All announcements are monthly. PBOC: People's Bank of China; NBSC : National Bureau of Statistics of China.				

Table (c): China (CN)

Type of announcement	Variable name	Release time	Reporting convention	Source
Unemployment Indicators				
Unemployment Eurozone SA	UPEUR	09:00	Value	Eurostat
Monetary Policy Indicators				
ECB M3 Annual Growth Rate SA	ECBM3G	08:00	Rate / % Change	ECB
ECB M3 Money Supply 3 Month Moving Avg SA	ECBM3MS	08:00	Rate / % Change	ECB
ECB Main Refinancing Rate	ECBRR	11:45	Rate / % Change	ECB
All announcements are monthly. ECB : European Central Bank, Eurosystem				

Table (d): Euro Zone (EC)

Type of announcement	Variable name	Release time	Reporting convention	Source
Activity Indicators				
Industrial Production	IP	23:50 - 00:50	Rate / % Change	MET&IJ
Tertiary Industry	TI	23:50 - 00:50	Rate / % Change	MET&IJ
Machine Orders	MO	23:50 - 00:50	Rate / % Change	ESRIJ
Economy Watchers Survey Current Conditions	EWSC	22:50 - 23:50	Value /	JMA
Consumption and Employment Indicators				
Loans and Discounts Outstanding Total and Shinkin Banks	LDOSB	22:50	Value /	BoJ
Property Indicators				
Japan Housing Starts	JAS	04:00 / 05:00	Rate / % Change	MLIT
Monetary Policy Indicators				
BoJ Target Rate of Unsecured Overnight Call Rate Expected	BoJTR	-	Rate / % Change	BoJ
Japan Money Stock M2 avg amt outstanding	M2	-	Rate / % Change	BoJ
Japan Money Stock M3 avg amt outstanding	M3	-	Rate / % Change	BoJ
Foreign Trade Indicators				
Japan Balance of Payments Current Account Balance	BPAB	22:50 / 23:50	Value / Billions JPY	MIAC
Japan Merchandise Trade Balance	MTB	22:50 / 23:50	Value / Billions JPY	MIAC
Trade Balance	TB	22:50 / 23:50	Value / Billions JPY	MIAC
All announcements are monthly. MET&IJ: Ministry of Economy Trade & Industry Japan; ESRIJ: Economic and Social Research Institute Japan; MFJ: Ministry of Finance Japan; MIAC: Ministry of Internal Affairs and Communications; MLIT Ministry of Land, Infrastructure, Transport and Tourism; BoJ: Bank of Japan; JMA : Japan Macro Advisors.				

Table (e): Japan (JP)

APPENDIX 4 : Unscheduled event news

Date	Category	Unexpected Events
01/06/2007	RA*	SP500 and Moody's Downgrade over 100 bonds backed by second-lien subprime mortgages.
20/07/2007	Politic	FED - Bernanke warned that the crisis in the subprime lending market could cost up to 100B $.
06/08/2007	Default	American Home Mortgage - Files for chapter 11 bankruptcy protection.
09/08/2007	Market	First incidence of major liquidity squeeze in global money markets.
12/12/2007	Politic	FOMC Board - Announces the creation of a term auction facility (TAF).
12/12/2007	Politic	FOMC - Approved SWAP agreements which will provide 20B $ to the ECB and 4B $ to the Swiss NB.
04/01/2008	Saving	W.Bush meets with the Working Group on Financial Markets (WGFM) chaired by H.Paulson.
22/01/2008	Politic	FED-new panic in the global credit market leads the fed to cut interest rate by 75 basis points.
30/01/2008	Politic	ECB - The leaders of europe's biggest economies meet in London for a credit crunch summit with warning to rating ag.
13/02/2008	Politic	FED - Signs the economic stimulus act 2008 (public law 110-185) into law.
15/02/2008	RA	Moody's Pulled its AAA rating from Financial Guarantee Insurance Company.
17/02/2008	Politic	Britain announces the nationalization of Northern Rock.
14/03/2008	FUSAC	Bear Stearns near collapse - Fed arranges financing with JP Morgan Chase.
17/03/2008	FUSAC	B.Stearns is acquired by JP Morgan for 240M $ a fraction of its share price, in deal backed by 30B $ in FED loans.
22/04/2008	Saving	BoE offers to acquire UK bank's mortgage-backed securities for up to three years in return for Treasury Bills.
09/05/2008	RA	Two major rating agencies downgrade the AIG Co. to AA- after hearing the news of the losses but left the insurance Co. subsidiaries at AA+.
13/07/2008	Saving	U.S. Treasury Department announces increase of credit lines of Fannie Mae and Freddie Mac.
15/09/2008	Default	Lehman Brothers declares bankruptcy, the largest ever in the United States.
29/09/2008	Saving	U.S. House Rejects 700B $ Financial-Rescue Plan.
13/10/2008	Saving	Dutch-Credit - Germany approves a plan to inject 500B € into credit markets.
17/10/2008	Politic	The European Union 27 leaders sign off on a joint 2.7T $ bank bailout plan after a 2-day summit in Brussels.
20/10/2008	Saving	The French government announces it will inject 10.5B € into France's six largest banks.
27/10/2008	Default	Iceland's Kaupthing Bank Defaults on Its Samurai Bonds as Yields Hit 450%.
09/11/2008	Saving	AIG receives a revised 150B $ government bailout plan that will reduce interest payments and give it more time to sell assets.
14/11/2008	Credit losses	Freddie Mac Posts Record Loss, Asks Treasury for 13.8B $.
09/12/2008	RA	Goldman, UBS, Deutsch Bank Among 12 Banks Lowered by S&P.
11/12/2008	Fraud US	Bernard Madoff was arrested and charged with securities fraud.
20/12/2008	RA	Sp500 downgrades the credit rating of eleven of the world's largest banks and says the global crisis could last longer than expected.
14/01/2009	RA	Sp500 cuts Greece's credit rating on debt.
15/01/2009	Saving	The US government has extended a 138B $ bailout to Bank of America (BofA).
19/01/2009	RA	Sp500 slashes Spain's triple A rating (the highest rating available) on debt.
20/01/2009	Politic	First election of Barack Obama.
27/01/2009	Saving	Japan announces a 16.7B $ stimulus package to help businesses that have been decimated by the global financial crisis.
12/03/2009	Saving	Japan will inject $1.2 billion into regional banks Sapporo Hokuyo, Minami-Nippon, and Fukuho bank,
08/04/2009	Saving	US Tresory Gives insurance companies access to the 700B $ TARP funds.
05/04/2010	Media	WikiLeaks an online publisher of anonymous, covert, and classified material, leaks to the public,
20/04/2010	Disasters	BP Oil Spill Up to 260 million gallons of crude oil spewed into the Gulf of Mexico.
19/06/2010	Economy	Bank of China - Announced to further reform the RMB exchange rate regime and to enhance the RMB exchange rate flexibility.
11/03/2011	Disasters	A massive earthquake and tsunami devastates northeastern Japan, leaving 20,000 people dead or missing and unleashing a nuclear crisis.
29/04/2011	Wedding	Britain's Prince William and his bride Kate Middleton marry with huge crowds and a global TV audience.
02/05/2011	War	Al Qaeda chief Osama bin Laden believed responsible for the September 11, 2001 attacks on the U.S. is shot dead by US commandos in Pakistan.
05/08/2011	RA	The United States loses its perfect credit rating as Standard & Poor's credit rating agency reduced the U.S. rating from AAA to AA+.
06/09/2011	Politic	Swiss National bank sets minimum exchange rate at CHF 1,20 per €.
27/10/2011	Politic	European Union leaders reach a ground-breaking deal to save the bloc's single currency, including a new rescue of Greece.
04/03/2012	Politic	Putin was elected to a third term as Russia's president.
12/05/2012	Market	The Facebook IPO Fiasco.

* RA : Rating Agencies

APPENDIX 5 : Matching between macroeconomic news and forex jumps

COUNT.	News FX	Lib	EUR	GBP	JPY/USD	AUD	CAD	CHF	#Jump |News
CN	CNFAI	Fixet Asset Invest	NM	NM	NM	NM	NM	1	1
	CNMNL	Monthly New Loan	NM	NM	NM	NM	NM	1	1
	CNMS1	Money Supply M1	NM	NM	NM	NM	NM	1	1
	CNMS2	Money Supply M2	NM	1	NM	NM	NM	1	2
	CNRS	Retail Sales	NM	NM	NM	NM	NM	1	1
	CNVAI	Value Added of Ind.	NM	NM	NM	NM	NM	1	1
UE	ECBM3G	M3 Annual Growth	NM	1	NM	NM	NM	NM	1
	ECBM3MS	Money Supplu M3	NM	1	NM	NM	NM	NM	1
	ECBRR	Refinancing Rate	3	NM	NM	NM	NM	2	2
	ECBUNEMP	Unemp. Rate UE	NM	2	NM	NM	NM	NM	1
JP	JPBPCA	Balance of Payments CA	1	NM	NM	1	NM	NM	2
	JPEWSC	Economy Watchers Surv.	NM	NM	NM	1	NM	NM	1
	JPHS	Housing Starts	NM	1	NM	2	NM	NM	2
	JPIP	Industrial Prodction	1	1	NM	1	1	NM	4
	JPLDAAO	Loans & Discounts	1	NM	NM	NM	NM	NM	1
	JPMO	Machine Orders	1	NM	NM	1	NM	NM	2
	JPMS2	Money Stock M2	2	NM	NM	NM	NM	NM	1
	JPMS3	Money Stock M3	2	NM	NM	NM	NM	NM	1
	JPMTB	Merchandise Trade Bal.	NM	NM	NM	1	NM	NM	1
	JPTI	Tertiary Industry	NM	NM	1	NM	NM	NM	1
	JPTSB	Trade Balance	NM	NM	NM	1	NM	NM	1
U.K.	UKBoER	BoE Official rate	2	NM	NM	NM	1	1	3
	UKBoEAP	BoE Asset Purchase Prog	1	NM	NM	NM	1	1	3
	UKCCR	Claimant Count Rate	NM	1	NM	NM	NM	NM	1
	UKCPIC	CPI Ex Food & Energy	NM	NM	NM	1	NM	NM	1
	UKCPIEUHM	CPI EU Harmonized	NM	NM	NM	1	NM	NM	1
	UKGDPQoQ	GDP	2	1	2	NM	NM	NM	3
	UKHBOS	House Price 3 Mth	NM	1	NM	NM	NM	NM	1
	UKPSNCR	PSNCR Net Borrowing	1	NM	NM	NM	NM	2	2
	UKPSNCRPS	PSNCR Public Sector	1	NM	NM	NM	NM	2	2
	UKRICSWHM	RICS UK & Wales Housing	NM	NM	NM	1	NM	NM	1
	UKRPIAI	RPI All Items	NM	NM	NM	1	NM	NM	1
	UKRPILMI	RPI less Mortgage Interest	NM	NM	NM	1	NM	NM	1
	UKRSLA	Retail Sales Less Auto	1	NM	NM	1	NM	1	3
	UKTB	Trade Balance	NM	NM	NM	NM	NM	1	1
	UKUPILO	ILO Unemp. Rate	NM	1	NM	NM	NM	NM	1
U.S.	USARSLA	Retail Sales Less Auto	NM	NM	2	1	1	1	4
	USCB	Census Bureau	NM	1	NM	1	NM	NM	2
	USCBLI	Conference Board Leading	1	1	2	NM	NM	3	4
	USCJC	Continuing Jobless	4	NM	3	1	7	6	5
	USCPIC	CPI Ex Food & Energy	NM	NM	NM	1	NM	NM	1
	USCPIM	Consumer Price Index	NM	NM	NM	1	NM	NM	1
	USCU	Capacity Utilization	1	2	NM	NM	2	2	4
	USDGNOIM	Durable Good Orders In.	NM	1	NM	1	2	1	4
	USDGNOTM	DGO ex Transport	NM	1	NM	1	2	1	4
	USECCW	Cost Civilian Workers	NM	1	1	NM	NM	1	3
	USEHS	Existing Home Sales	NM	1	1	1	1	NM	4
	USENFPMI	NFP Manufacturing Ind.	1	NM	6	NM	2	1	4
	USENFP	NonFarm Payrolls	1	NM	6	NM	2	1	4
	USESMS	Empire State manuf. Surv.	1	1	NM	1	1	NM	4
	USFFTR	Federal Funds Rate	3	2	3	4	3	3	6
	USFNT	Foreign Net Trans.	1	2	NM	NM	1	1	4
	USFRCCD	FED Consumer Credit	NM	NM	1	1	1	NM	3
	USIPI	Import Price Idx	NM	NM	NM	1	2	NM	2
	USIOE	Economic Optimism	NM	1	NM	2	1	NM	3
	USIP	Industrial Prodction	1	2	NM	NM	2	2	4
	USISM	ISM Manufacturing	NM	NM	2	NM	NM	NM	1
	USMNCR	MNI Chicago Report	NM	1	1	NM	1	NM	3
	USMTI	Manuf.& Trade Inv.	NM	NM	2	NM	NM	1	2
	USMWI	Merchandise Wholesalers Inv.	NM	1	NM	1	NM	NM	2
	USNAHBMI	NAHBM Index	1	1	1	2	NM	NM	4
	USNOFHSAM	New One Family Houses	1	1	NM	NM	NM	1	3
	USNPOHUSS	NewPrivately Owned Housing	NM	NM	1	1	1	1	4
	USPCE	Personal Consumption Expend.	NM	NM	2	NM	NM	NM	1
	USPPHIL	Philadelphia Fed Survey	1	1	3	NM	NM	3	4
	USPHA	Private Housing	NM	NM	1	1	1	1	4
	USPHS	Pending Home Sales	NM	2	NM	NM	NM	NM	1
	USPHUSS	Private Housing Started	NM	NM	NM	NM	1	NM	1
	USPPIC	Producer Price Index	NM	NM	1	1	1	NM	3
	USPPIC	PPI ex Food \& Energy	NM	NM	1	1	1	NM	3
	USPPIG	PPI Total Goods	NM	NM	1	1	1	NM	3
	USPTHAB	Private Total Housing	NM	NM	NM	NM	1	NM	1
	USTB	Trade Balance	NM	NM	1	1	2	2	4
	USTFBDSD	Treas.Fed Budget Debt	1	1	1	1	1	NM	5
	USIJC	Initial Jobless Claims	4	NM	3	1	7	6	5
	USUMSCFS	U.Michigan Consumer Sentim.	NM	NM	1	NM	1	1	3
	USUP	Unemp. Rate	1	NM	6	NM	2	1	4
	ALL Matching		42	35	56	42	54	56	285

NM : No Matching

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