# Impact of Scheduled U.S. Macroeconomic News on Stock Market Uncertainty: A Multinational Perspecive*

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This study examines how the U.S. macroeconomic news releases affect uncertainty in domestic and foreign stock exchanges. For that purpose, the behavior of the implied volatilities from the U.S. and Finnish markets is investigated around the employment, producer price index (PPI) and consumer price index (CPI) reports. The results confirm the hypothesis that implied volatility increases prior to the macroeconomic news release and drops after the announcement in both markets. This implies that uncertainty associated with the U.S. macroeconomic news releases is reflected in foreign stock markets as well. Of the macroeconomic news releases, the employment report has the largest impact on uncertainty (JEL G14).

**Keywords:** implied volatility, index options, macroeconomic news, uncertainty.

## I. Introduction

This study examines uncertainty in the stock market around scheduled macroeconomic news announcements. Information releases of macroeconomic variables such as gross national product, inflation rate, and unemployment rate have a great impact on the valuation of financial assets. The announcements providing information on these variables are therefore closely followed by the market participants. The dates of these

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news releases are known in advance, but we do not know their information contents. Consequently, market uncertainty is affected by an imminent news release.

The purpose of the paper is to investigate how the U.S. macroeconomic news releases affect uncertainty in domestic and foreign stock exchanges. Because of the central role of the U.S.A in determining the development of the world economy the major indicators about the U.S. economy are important for the valuation of firms not only in the U.S.A. but also in foreign countries. Therefore, uncertainty associated with the release of these indicators is expected to be reflected in both the U.S. and foreign stock exchanges. The paper focuses on the impact of the employment report, the producer price index (PPI) report and the consumer price index (CPI) report releases on uncertainty in stock markets. These reports are considered to be major macroeconomic indicators. Furthermore, previous studies show that the announcements of these variables have the most significant impact on trading and volatility of financial assets (see e.g., Fleming and Remolona [1999], Ederington and Lee [1993], [1996], and Harvey and Huang [1991]). Implied volatilities estimated from stock index options prices are used to investigate stock market uncertainty. Implied volatility can be interpreted to be a market's expectation of the average stock's return volatility over the remaining life of the option contract, as Merton (1973) shows. Thus, the uncertainty around the macroeconomic news release should be reflected in the implied volatility.

This study contributes to the existing literature in three main respects. First, it investigates whether the widely followed macroeconomic news from the world's largest economy has an effect on the uncertainty in a foreign stock exchange. For that purpose, it is examined how the uncertainty around the U.S. macroeconomic news release is reflected in implied volatilities in both the U.S. and foreign stock exchanges. This has important implications for multinational investors since the uncertainty directly affects stock and options valuation. It is important to distinguish the approach of this study from spillover literature (see e.g., Booth, Martikainen and Tse [1997], Niarchos, Tse Wu and Young [1999], Kanas [2000]) in which the realized volatility transmissions across countries are investigated while this paper focuses on the expected volatility around scheduled news releases.

Second, while the studies by Patell and Wolfson (1981) and Donders and Vorst (1996) focus on implied volatilities of stock options around earnings announcements, this paper contributes to the current literature by investigating the impact of scheduled macroeconomic news releases on implied volatilities of stock index options. Patell and Wolfson (1981) and Donders and Vorst (1996) find that there is a significant increase in the implied volatility prior to earnings announcement and a significant decline during the announcement period. These results are in accordance with an argument that information heterogeneity associated with the earnings announcement can be observed in the implied volatility[1].

Third, the study extends the previous literature by investigating the behavior of implied volatility on the announcement day and separate days surrounding it. While the methodologies of Donders and Vorst (1996) and Ederington and Lee (1996) can detect an increase in implied volatility before a news release, they are not able to identify the exact day(s) when it occurs. Our methodology allows us to take into account a possibility that the increase is not a gradual process but instead occurs just prior to the news release. Therefore, our methodology allows us to test directly whether the increase is gradual as hypothesized based on the option theory.

Data from the U.S. and Finnish markets are used in the analysis. Using data from the Finnish market is advantageous for two reasons. First, the Helsinki stock exchange (HSE) is a representative example of a small technology-oriented stock exchange. The U.S.A. is an important trading partner of Finland and the Finnish economy is largely dependent on the economies of its trading partners. Second, the share of foreign

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1. There are several studies investigating the behavior of implied volatility of a stock around unscheduled events such as splits, mergers and acquisitions. French and Dubofsky (1986) and Sheikh (1989) investigate the effect of a stock split on implied volatility. They find that implied volatilities do not anticipate the stock split. On the other hand, implied volatilities are higher after the announcement is made and the increase in implied volatility is correlated with the ex-date increase in return variances. These findings are consistent with the empirical evidence that the variance of stock price increases due to a stock split (see e.g. Ohlson and Penman [1985]). The study by Levy and Yoder (1993) examines the behavior of implied volatility around mergers and acquisitions. They find that the implied volatilities of target firms increase three days prior to the announcement. Furthermore, the target firms' stock price volatilities do not reflect merger or acquisition activity until two days before the announcement, while abnormal returns reflect the activity one day prior to the announcement.

ownership accounts for 71 percent of the total market value of the HSE. Therefore, the behavior of foreign investors is likely to have a major impact on the valuation of Finnish firms. Furthermore, some of the Finnish companies are listed in foreign exchanges.

The rest of the paper is organized as follows. The following section analyses the impact of scheduled news releases on implied volatility. The data is presented in Section Three. Section Four discusses research methodology. Empirical results are provided in Section Five and the final section summarizes the findings of the study.

## II. Implied volatility and scheduled announcements

The Black-Scholes (1973) / Merton (1973) option pricing model is one of the most widely used tools for valuing options. It defines the value of an option as a function of the underlying stock price, the time to expiration of the option, the exercise price of the option, the riskless interest rate and the underlying asset price volatility. As an alternative use of the model, implied volatility can be calculated using the actual market price of an option and the determinants of option value, except for volatility.

There exists empirical evidence that the realized volatilities of financial asset prices are higher around scheduled information releases than during the periods when no significant information is released. For example, Fleming and Remolona (1999) report that the historical volatility of the US treasury market is higher when scheduled macroeconomic reports are released. Similar evidence from the interest rate and foreign exchange rate markets is provided by Ederington and Lee (1993). They show that historical volatility remains significantly higher than normal for fifteen minutes and remains slightly higher for several hours after the release. Regarding stock markets, Donders and Vorst (1996) find that historical stock return volatility is significantly higher on the earnings announcement day than on other days.

The reason for this behavior is that news releases contain relevant information about the values of financial assets and this information is incorporated into prices after the news release. As a consequence of the price adjustment process, it can be expected that volatility is higher than normal on the scheduled announcement day. Assuming the event occurs

during the life of the option, the average implied volatility $\sigma_{average}$ until the expiration day of the option can be expressed as

$$\sigma_{average} = \sqrt{\frac{t-1}{t}\sigma^2_{normal} + \frac{1}{t}\sigma^2_{event}} \tag{1}$$

where $\sigma^2_{normal}$ and $\sigma^2_{event}$ are the stock return variance on a normal trading day and on the announcement day, respectively and t is time-to-expiration. Using this model of the average volatility, the theoretical implied volatility can be described as a function of time as shown by Merton (1973) in the Black-Scholes model context. Figure 1 shows the theoretical implied volatility when investors expect that the volatility will be constant on normal days and twice as much as normal on the event day.


FIGURE 1.— Theoretical implied volatility around scheduled news release. Theoretical ISD assuming that volatility is constant, 22.3 percent, except on the event day 55.8 percent. Expiration day is 20 trading days after the event day. It is assumed that there is a single scheduled announcement day before the maturity of the option.

For the sake of simplicity, the above analysis is based on the assumption of deterministic volatility. The argument presented here,

however, holds approximately for the case where the volatility is stochastic. According to Heynen, Kemna and Vorst (1994), implied volatility is approximately equal to average expected volatility over remaining time to maturity in the cases of the stochastic volatility model by Hull and White (1987) and the GARCH option model by Duan (1995). The latter result is also verified by Donders and Vorst (1996).

## III. Data description

### *A. Macroeconomic Announcements*

The sample consists of monthly employment report, consumer price index (CPI) report, and producer price index (PPI) report releases from the U.S. market covering a period from January 1996 to February 2000. This period has been chosen since the Finnish stock index derivatives trading was moved from Helsinki Stock Exchange to Eurex at the end of February, 2000. Consequently, there are 50 employment report announcements, 50 PPI report announcements and 50 CPI report announcements altogether. The exact publishing days were collected from the actual reports provided by the Bureau of Labor Statistics[2].

The usual release day of the employment report is the first Friday of the month and the 13$^{th}$ of the month for the CPI respectively. The producer price index (PPI) report is usually released one or two days before the CPI report. All news releases are made at 8:30 a.m. Eastern Time (ET) which corresponds to 3:30 p.m. Finnish time (GMT +2 hours). At the time of news releases the NYSE is not open, whereas the trading hours in the HSE range from 10:00 a.m. to 6:00 p.m. Finnish time. Since releases are made during the trading hours of the HSE the impact of the releases is incorporated into the closing prices of stocks and their implied volatilities. This is also supported by Ederington and Lee (1995). They find that prices adjust to macroeconomic news releases within the first minute after the news releases in T-Bond, Eurodollar and Deutschmark futures markets.

### *B. VIX Volatility Index*

2. See, http://stats.bls.gov/bls_news/archives/all_nr.htm

The daily closing values of the CBOE Market Volatility Index[3] (VIX) are used as a proxy for the market's implied volatility. As noted by Blair, Poon and Taylor (2001), using VIX is advantageous since it mitigates most of the problems associated with the measurement of implied volatilities. For example, VIX is likely to minimize the biases caused by the transaction costs. Moreover, since the VIX index represents at-the-money implied volatility, it minimizes the magnitude of bias induced by time-varying stochastic volatilities[4].

VIX is an average of eight S&P 100 put and call option implied volatilities. Since the OEX options are American type options, the volatilities are calculated using the cash-dividend adjusted binomial method. VIX is constructed from the option series that will expire next but has at least eight calendar days to expiry and from the series of the following contract month. Four pairs of put and call options whose strike prices are either just above or below the index price are used according to the following three steps. First, an average implied volatility is calculated from put and call options whose strike prices are just above the index price. Similarly, an average is calculated using put and call options whose strike prices are just below the index price. Second, at-the-money implied volatilities are interpolated using these average implied volatilities. Third, since two sets of options (one set with shorter maturity options and one set with longer maturity options) are used, there are two interpolated at-the-money implied volatilities with different maturities. These volatilities are weighted to obtain a single volatility that always has 30 calendar (22 trading) days to expiry.

VIX behaves according to the theory presented in section two since it has been constructed from the two sets of option series. Before the third step in the calculation, there are two implied volatilities with different maturities estimated from the two sets of options. Both implied volatilities have one more day till maturity at time $t$ than at time $t$–1, i.e. for both series $\sigma_{\text{interpolate}}(t)$ has one more day till maturity than does

3. A more detailed description of VIX is provided by Whaley (1993).

4. As pointed out by an anonymous referee, for S&P 500 options, the movements of the index and the option are not always consistent with theory (see Bakshi, Chao, and Chen [2000]). This can be expected, at least to some extent, to increase variance of our implied volatility estimates and decrease the power of the statistical tests used.

$\sigma_{\text{averaged}}(t-1)$ . In the final step, these volatilities are weighted to obtain a single artificial volatility estimate that always has 30 calendar (22 trading) days to expiry, i.e. the weighted sum of individual maturities equal 30 calendar (22 trading) days. Still, VIX itself behaves according to the theory presented in Section Two since it has been constructed from the two series of implied volatilities with different maturities, which individually behave according to theory. In other words, the properties of the individual implied volatilities are still present in VIX[5].

*C. Finnish Volatility Index*

Helsinki Stock Exchange (HSE), which is the only stock market in Finland, underwent rapid changes in the 1990's. The liberalization of money markets in the late 1980's and the abolition of the foreign ownership restrictions in the stock market in 1993 paved the way for the increase in stock prices and the trading volume of stocks. The success of Nokia and the other listed Finnish high-tech firms in their business operations significantly increased the market values of these firms since the middle of the 1990's. As a consequence, high-tech industry is in a dominant role in the HSE and in the Finnish economy as a whole. To illustrate, the telecommunication and the electronics industry represented 42.3% and 31.1% of the annual turnover and the year-end market value of HSE in 1997 respectively. The proportion of the electromechanic industry of the total foreign exports of Finland was about 42.7% in 1997.

The Finnish stock market is dependent on the U.S. economy and stock market for three main reasons. First, because of the dominant role of the high tech industries in Finland the Finnish economy and stock market is largely dependent on the economies of its trading partners. The U.S.A is the third largest trading partner of Finland. Furthermore, the economic situation in the U.S.A. affects the economies of the other trading partners of Finland. Second, the share of foreign ownership accounts for 71.0% of the total market value of the HSE. Third, some of the Finnish companies are also listed in foreign exchanges.

For these reasons, it can be expected that the U.S. macroeconomic

5. Numerical analysis showing that VIX behaves according to theory presented in Section Two is available on request.

**TABLE 1. Descriptive Statistics of Implied Volatilities from January 1996 to February 2001**

| | Level | | Change: $\ln(ISD_t / ISD_{t-1})$ | |
|---|---|---|---|---|
| Statistics | U.S.A | Finland | U.S.A. | Finland |
| Mean | 23.19 | 25.21 | 0.0007 | 0.0004 |
| Median | 22.61 | 23.73 | –0.0011 | –0.0019 |
| Minimum | 12.74 | 14.74 | –0.1958 | –0.3169 |
| Maximum | 48.57 | 52.73 | 0.2446 | 0.3387 |
| Standard Deviation | 5.58 | 5.28 | 0.0628 | 0.0778 |
| Skewness | 1.27 | 1.22 | 0.20 | 0.23 |
| Kurtosis | 2.98 | 1.77 | 0.87 | 2.38 |

news releases such as the employment report releases, the CPI and PPI report releases have an impact on the valuation of the firms listed in the HSE. It is therefore expected that uncertainty in the U.S stock market is also reflected in the HSE. To investigate this issue, a volatility index from the Finnish market is also needed.

The Finnish volatility index is based on the implied volatilities provided by the Helsinki Stock Exchange (HSE). The implied volatilities are calculated from the daily closing prices of the Finnish stock index options. The underlying index of these options is the Finnish Options Index (FOX) that is a value-weighted index of 25 major stocks quoted on the HSE. The FOX options are European type options. They expire six times a year in February, April, June, August, October and December. The expiration period of each option contract is four months. The last trading day is the fourth Thursday of the month.

The FOX options are thinly traded if compared to the index options traded in the major markets. As a result, there are just a few liquid strike prices available each trading day. For that reason, it is not possible to construct the VIX type of volatility index exactly in the Finnish market. Instead, the HSE uses the weighting method suggested by Latane and Rendleman (1976) to produce a single volatility value. This method weights the individual options on the basis of the partial derivative of the option price with respect to the standard deviation of the stock return. The aggregated value is based on both put and call option prices.

According to Day and Lewis (1992), the weighting method places the greatest weight on the options that are at the money corresponding therefore the construction of VIX in this respect.

It is recognized here that this index is not fully comparable with the VIX. The differences between the volatility indices, however, do not cause a serious problem since the volatility indices are not compared directly with each other; we are only interested in the daily changes in each of the volatility indices separately.

Furthermore, it should be noted that implied volatility is not an unbiased measure of the market's true expectation, since the Black-Scholes model is a nonlinear function (see Butler and Schachter [1996]). The magnitude of the bias is not economically significant (see, e.g., Mayhew 1994). Furthermore, we measure the changes in the volatility, which removes the effect of the bias.

Table 1 gives summary statistics of implied volatilities and their logarithmic changes in the U.S. and Finnish markets. Implied volatilities are slightly higher in the Finnish market than in the U.S. market. Otherwise, all the descriptive statistics seem to be similar in both the markets.

Figure 2 presents the VIX and the Finnish volatility index during the sample period. The indices seem to follow each other closely. This intuition is confirmed by the Pearson correlation coefficient between the volatility series, 0.53, which is statistically significant at the 0.001 level. In addition, the Granger causality test with 5 lags indicates that the VIX Granger causes the Finnish volatility index ($F$-value = 5.31, p-value = 0.001) but the opposite causality is not found. This preliminary result suggests that uncertainty flows from the U.S. market to the Finnish market.

(insert figure 2 about here)

## IV. Research methodology

According to the theory presented in Section Two, implied volatility is hypothesized to gradually increase prior to the employment, the CPI and PPI report releases[6]. On the announcement day implied volatility is

6. It can be assumed that the effect of the unscheduled announcements on the results is minimal because of the random timing of the unscheduled announcements, and because the effects of these announcements can be expected to be zero on average. Furthermore, if the unscheduled

**TABLE 2. Example of the Sample, April 25, 1996 - May 20, 1996.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 04/25/96 | 04/26/96 | 04/29/96 | 04/30/96 | 05/01/96 PreEmp | 05/02/96 PreEmp | 05/03/96 **Emp Report** |
| 05/06/96 PostEmp | 05/0796 PostEmp | 05/08/96 PrePPI | 05/09/96 PrePPI | 05/10/96 **PPI Report** | 05/13/96 MidDay | 05/14/96 **CPI Report** |
| 05/15/96 PostCPI | 05/16/96 PostCPI | 05/17/96 | 05/20/96 | | | |

hypothesized to drop back to its normal level. Since these news releases are widely followed by the U.S. and foreign investors a similar pattern is expected to emerge in both the U.S. and Finnish markets.

To ascertain whether implied volatilities behave as hypothesized, each day of the sample is assigned to one of nine different non-overlapping periods. A pre-announcement period of the employment report (PreEmp) is a two-day period prior to the release day. A post-announcement period of the Employment report (PostEmp) is a two-day period after the release day. A pre-announcement period of the PPI (PrePPI) is a two-day period prior to the release day. The days between the PPI report and CPI report form a period of mid-days (MidDay). A post-announcement period of the CPI report (PostCPI) is a two-day period after the release day. An example of the period formation is presented in table 2.

The following regression model, similar to Ederington and Lee (1996), is estimated to see whether the implied volatility decreases after the macroeconomic news release.

$$\ln\left(ISD_t / ISD_{t-1}\right) = \alpha + \beta D_{0,t}^{Emp} + \delta D_{0,t}^{PPI} + \gamma D_{0,t}^{CPI} + \varepsilon_t, \qquad (2)$$

news announcement affects only the price level, only historical volatility increases due to the price correction process, but implied volatility is not affected since it measures future uncertainty level. Consequently, implied volatility can be considered to be a better measure of market uncertainty than historical volatility.

where $ISD_t$ is implied volatility at day *t*. Dummy variables $D_{0,t}^{Emp}$, $D_{0,t}^{PPI}$, $D_{0,t}^{CPI}$ identify the days on which the employment, PPI and CPI reports are released. Based on the theory presented in section two, it is hypothesized that $\alpha > 0$ since on days with no scheduled news releases implied volatility is expected to increase. In addition, it is hypothesized that $\beta < 0, \delta < 0, \gamma < 0$ because on the scheduled announcement day implied volatility is expected to decrease.

Since we are particularly interested in examining the behavior of implied volatility around the macroeconomic news release day, those days are included in equation 2 using separate dummies. Using this specification it is not only possible to investigate the effects on the actual release days but one can also examine whether there exist any

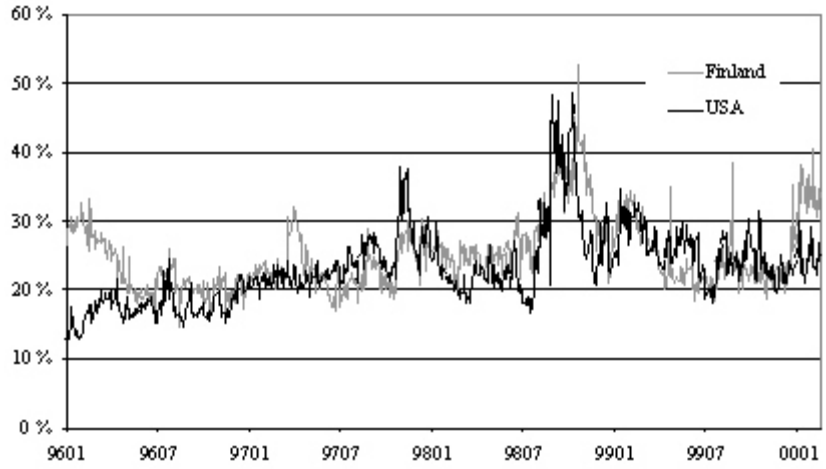


FIGURE 2.—Implied volatilities in the USA and Finland from January 1996 to February 2000.

inferring effects on the days surrounding the macroeconomic news release day. The basic structure of the following regression equation is otherwise similar to equation 2:

$$\ln\left(ISD_t / ISD_{t-1}\right) = \alpha + \sum_{i=-2}^{2} \beta_i D_{i,t}^{Emp} + \sum_{i=-2}^{0} \delta_i D_{i,t}^{PPI} + \phi D_t^{dIID} + \sum_{i=0}^{2} \gamma_i D_{i,t}^{CPI} + \varepsilon_t \quad , \tag{3}$$

where $D_{-2,t}^{Emp}$ is a dummy variable having the value of one two days prior to the employment report release day and zero otherwise. Dummy $D_{-1,t}^{Emp}$ has a value of one a day prior to the employment report release day. Day zero is the report release day and $D_{0,t}^{Emp}$ takes a value of one. Other dummies are defined in a similar manner except for dummy $D_t^{dIID}$, which has a value of one during the days between the PPI and CPI report releases and otherwise zero.

Since Godfrey's test indicates that significant first-order autocorrelation is present, an *AR*(1) term is added to the model. Moreover, the Lagrange Multiplier (*LM*) test for the ARCH effect indicates conditional heteroscedasticity in error terms. Therefore, GARCH(1,1) is fitted. The coefficients of the GARCH equation are statistically significant and the *LM* test shows that the specification is adequate.

Based on the Weisberg (1985) test[7], five outliers are identified in the U.S. data and eight outliers in the Finnish data at the five per cent significance level. These outliers do not occur on the macroeconomic news release days under investigation. These observations are removed and the models are fitted after this. This does not, however, affect the results.

Two non-parametric test procedures are used to gain further

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7. Weisberg's test is calculated as follows (see Weisberg [1985]):

$$t_i = r_i \sqrt{\frac{n-k-1}{n-k-r_1^2}} \quad ,$$

where $r_i$ is the standardized residual, n is the sample size, k is the number of parameters, and $df = n - k - 1$. Critical values of the test statistic are reported in Weisberg (1985).

understanding of the daily behavior of implied volatility around macroeconomic news releases. These tests are the standard sign test and the Wilcoxon sign-rank test. For the sign test, under the null hypothesis the positive and negative changes in implied volatility are equally likely. The Wilcoxon test is used to test the null hypothesis that the sum of positive ranks equals the sum of negative ranks. The changes are measured as logarithmic differences.

## V. Results

The regression results of equation 2 are reported in table 3. The results regarding the U.S. market show that the slope coefficients are all significantly negative. This confirms our hypothesis that implied volatility drops after the macroeconomic news release. In the case of the employment report the effect is the largest. The intercept term is significantly positive indicating that implied volatility increases on average during no news days as hypothesized. These findings are consistent with the results by Ederington and Lee (1996) from the T-bond and Eurodollar markets.

The results from the Finnish market are very similar to those from the U.S. market except that the intercept term is not statistically significant. The numerical values of the slope coefficients regarding the PPI and CPI reports are almost the same as in the case of the U.S. market. However, the impact of the employment report seems to be weaker in the case of the Finnish market. In general, these results suggest that the uncertainty associated with the U.S. macroeconomic news releases is reflected in the Finnish stock market.

To further investigate the behavior of implied volatility around macroeconomic news release day the regression equation 3 is estimated using the U.S. and Finnish data. The results from these estimations are reported in table 4. The results regarding the slope coefficients of announcement days are close to the previous results in table 3. In both the markets implied volatility decreases on the announcement day. Moreover, the dummies after the news releases are not significant. This indicates that the whole effect is absorbed on the announcement day.

Based on the theory in section two, implied volatility is hypothesized

**TABLE 3. Regression Results of equation 2**

| Coefficient | USA Estimate | USA *p*-value | Finland Estimate | Finland *p*-value |
|---|---|---|---|---|
| Intercept | **0.0056** | 0.002 | 0.0018 | 0.350 |
| Employment Report | **–0.0612** | 0.000 | **–0.0349** | 0.003 |
| PPI Report | **–0.0177** | 0.027 | **–0.0212** | 0.033 |
| CPI Report | **–0.0184** | 0.023 | –0.0191 | 0.083 |
| AR(1) | **0.1095** | 0.004 | **0.2932** | 0.000 |
| ARCH(1) | **0.1275** | 0.000 | **0.2373** | 0.000 |
| GARCH(1) | **0.8023** | 0.000 | **0.2436** | 0.002 |
| Adj. *R*-square | 0.047 | | 0.053 | |
| *F*-Statistics | 16.784 | | 26.334 | |
| Prob. of *F*-Stat. | 0.000 | | 0.000 | |

Note: Estimates that are significant at five percent level are given in boldface

to increase gradually at a constant rate as time to news release decreases. Regarding the U.S. market, the results in table 4 show, however, that the intercept term is not statistically significant, whereas the dummies for the one day prior to the employment and PPI news releases $\left(D_{-1,t}^{Emp}, D_{-1,t}^{PPI}\right)$ and the dummy for the days between the PPI and CPI reports $\left(D_t^{BWJD}\right)$ are positive and statistically significant. This implies that implied volatility does not behave according to the hypothesis but instead experiences a sudden jump just a day prior to the release. In the case of the Finnish market these dummies are positive but not statistically significant.

The non-parametric test results are given in table 5. The results are in accordance with the previous results. However, in the case of the PPI report release the effect is not as clear as in the case of regression results. The results confirm that the employment report has the strongest impact on implied volatility in both markets. The number of positive changes is 17.4 per cent on the release day, while this proportion on the day prior the release is 69.5 per cent in the U.S. market. The sign test indicates that both proportions are statistically different from 50 per cent. On the other days surrounding the report release, the proportions are not statistically different from 50 per cent. In the Finnish market the

**TABLE 4. Regression Results of equation 3**

| | USA | | Finland | |
|---|---|---|---|---|
| Coefficient | Estimate | *p*-value | Estimate | *p*-value |
| Intercept | 0.0038 | 0.094 | 0.0013 | 0.576 |
| Emp -2 days | –0.0082 | 0.412 | –0.0013 | 0.919 |
| Emp -1 day | **0.0174** | 0.023 | 0.0021 | 0.879 |
| Emp report | **–0.0615** | 0.000 | **–0.0408** | 0.001 |
| Emp +1 day | –0.0038 | 0.675 | 0.0183 | 0.131 |
| Emp +2 days | –0.0016 | 0.872 | –0.0145 | 0.228 |
| PPI -2 days | 0.0120 | 0.187 | –0.0049 | 0.695 |
| PPI -1 day | **0.0214** | 0.046 | 0.0066 | 0.531 |
| PPI Report | **–0.0187** | 0.022 | **–0.0269** | 0.008 |
| Mid days | 0.0199 | 0.077 | 0.0253 | 0.121 |
| CPI Report | **–0.0165** | 0.038 | **–0.0264** | 0.020 |
| CPI +1 day | –0.0060 | 0.385 | 0.0126 | 0.269 |
| CPI +2days | –0.0073 | 0.394 | –0.0062 | 0.507 |
| AR(1) | **0.1124** | 0.003 | **0.2839** | 0.000 |
| ARCH(0) | **0.0002** | 0.000 | **0.0028** | 0.000 |
| ARCH(1) | **0.1241** | 0.000 | **0.2548** | 0.000 |
| GARCH(1) | **0.8083** | 0.000 | **0.2451** | 0.001 |
| Adj. *R*-square | 0.078 | | 0.102 | |
| *F*-Statistics | 8.920 | | 2.509 | |
| Prob. of *F*-Stat. | 0.000 | | 0.003 | |

Note: Estimates that are significant at five percent level are given in boldface

corresponding figures are 22.5 per cent (*p*-value = 0.001) on the announcement day and 53.6 per cent (*p*-value 0.755) on the day prior the release.

On employment report days implied volatility decreases on average 5.88 per cent in the U.S. market and 3.89 per cent in the Finnish market. The changes are statistically significant according to the Wilcoxon sign-rank test. To illustrate the practical significance of the effect, the mean decrease in implied volatility (5.88 per cent) after the release leads to 5.4 per cent lower at-the-money call option price and 21.4 per cent lower out-of-the money call option price. The call prices are based on the Black-Scholes model assuming that volatility is 23.19 per cent (the U.S. sample average), the time-to-expiration is 22 trading days (property of VIX), the risk-free interest rate is 5 per cent and the strike price of the out-of-the money option is 10 per cent higher than the index price.

**TABLE 5. Change of Implied Volatility around the U.S. Macroeconomic News Release in the USA and Finland**

| Statistics | Country | Number of days relative to report release | | | | |
|---|---|---|---|---|---|---|
| | | –2 | –1 | Release | +1 | +2 |
| Panel A: Emp. Report | | | | | | |
| Mean | USA | –0.0049 | 0.0205 | –0.0588 | 0.0028 | 0.0096 |
| Median | | –0.0056 | 0.0164 | –0.0524 | 0.0067 | –0.0022 |
| #Positive/#Total[a] | | 0.468 | 0.659 | 0.174 | 0.533 | 0.478 |
| Prob. 1[b] | | 0.770 | **0.040** | **0.000** | 0.651 | 0.883 |
| Prob. 2[c] | | 0.497 | **0.028** | **0.000** | 0.565 | 0.391 |
| Mean | Finland | –0.0056 | 0.0032 | –0.0389 | 0.0190 | –0.0069 |
| Median | | –0.0086 | 0.0038 | –0.0288 | 0.0141 | –0.0185 |
| #Positive/#Total[a] | | 0.444 | 0.536 | 0.225 | 0.595 | 0.341 |
| Prob. 1[b] | | 0.551 | 0.755 | **0.001** | 0.280 | 0.066 |
| Prob. 2[c] | | 0.432 | 0.843 | **0.000** | 0.078 | 0.298 |
| Panel B : PPI report | | | | | | |
| Mean | USA | 0.0133 | 0.0303 | –0.0101 | | |
| Median | | 0.0157 | 0.0194 | –0.0063 | | |
| #Positive/#Total[a] | | 0.595 | 0.723 | 0.446 | | |
| Prob. 1[b] | | 0.243 | **0.003** | 0.560 | | |
| Prob. 2[c] | | 0.093 | **0.000** | 0.285 | | |
| Mean | Finland | –0.0019 | 0.0067 | –0.0198 | | |
| Median | | –0.0043 | 0.0082 | –0.0298 | | |
| #Positive/#Total[a] | | 0.428 | 0.511 | 0.377 | | |
| Prob. 1[b] | | 0.440 | 0.880 | 0.135 | | |
| Prob.2[c] | | 0.782 | 0.557 | 0.054 | | |
| Panel C : CPI report | | Days between PPI and CPI reports | | | | |
| Mean | USA | 0.0215 | | –0.0137 | –0.0158 | –0.0058 |
| Median | | 0.0141 | | –0.0214 | –0.0074 | –0.0079 |
| #Positive/#Total[a] | | 0.733 | | 0.333 | 0.466 | 0.466 |
| Prob. 1[b] | | **0.016** | | **0.036** | 0.766 | 0.766 |
| Prob. 2[c] | | 0.074 | | 0.091 | 0.177 | 0.452 |
| Mean | Finland | 0.0303 | | –0.0273 | 0.0120 | –0.0106 |
| Median | | 0.0300 | | –0.0241 | 0.0027 | –0.0045 |
| #Positive/#Total[a] | | 0.678 | | 0.286 | 0.535 | 0.463 |
| Prob. 1[b] | | 0.087 | | **0.008** | 0.761 | 0.755 |
| Prob. 2[c] | | **0.010** | | **0.002** | 0.404 | 0.487 |

[a] Number of positive changes (log difference) divided by the total number of observations.
[b] Probability of sign statistics
[c] Probability of Wilcoxon sign-rank statistics
Note: Test results that are significant at five percent level are in bold

## VI. Summary and conclusions

This study examines how the U.S. macroeconomic news releases affect uncertainty in domestic and foreign stock exchanges. The paper focuses on the impact of the employment report, the producer price index (PPI) report and the consumer price index (CPI) report releases, which are widely followed by U.S. and foreign investors. Therefore, uncertainty associated with the release of these indicators is expected to be reflected in both the U.S. and foreign stock exchanges. The comparative results from these markets are particularly interesting since the U.S.A. is an important trading partner of Finland and the Finnish economy is largely dependent on the economies of its trading partners. In addition, the Helsinki Stock Exchange (HSE) is a representative example of a small technology-oriented stock exchange in which the share of foreign ownership accounts for 71 per cent of its total market value.

The preliminary results confirm that the selection of the Finnish market is particularly interesting since implied volatilities from these markets behave similarly. In addition, the Granger causality test indicates that uncertainty flows from the U.S. market to the Finnish market.

The results of the study confirm the hypotheses that implied volatility increases prior to the macroeconomic news release and drops after the announcement. This indicates that the uncertainty regarding the content of these news reports is an important factor affecting the level of the market uncertainty. Similar behavior is observed in both the markets. This implies that uncertainty associated with the U.S. macroeconomic news releases is reflected in the Finnish stock market. Of the macroeconomic news releases, the employment report has the largest impact on the uncertainty on both markets.

Implied volatility is hypothesized to increase gradually at a constant rate as time to news release decreases. The results indicate that implied volatility does not behave according to this hypothesis but experiences a jump just a day prior to the release. One potential explanation is that investors in options market are shortsighted, adjusting their views about uncertainty just one day before the release. Furthermore, the results reveal that the whole effect is absorbed on the announcement day.

The results of the paper have important implications. The

uncertainty related to the U.S. macroeconomic news releases directly affects stock and options valuation not only in the U.S. market but also in foreign markets. The magnitude of the change in implied volatility around an announcement is big enough to have a significant impact on option prices. For future research, profitability of a trading rule based on the irrational jump in the implied volatility just a day prior to the news release provides an interesting topic. Furthermore, the systematic behavior of implied volatility can be utilized to obtain more accurate forecasts of volatility. This is also left for future research.

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