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How Does Economic News Affect S&P 500 Index Futures?

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〈Abstract〉

Some empirical studies have shown that asset prices respond to announcements of economic news, however, others also have found little evidence. This study assesses how market participants of the S&P 500 Index Futures reacted to the U.S. economic news announcements. For this purpose, using a GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model, we use several U.S. news variables, its each surprise component and interest rates.

We find that some economic news variables affected significantly on the S&P 500 Index Futures. In other words, we find that weekend variable, lagged volatility, and surprise component of trade deficit increased level of volatility. However, interest rate, M1, unemployment announcements caused the variance of the S&P 500 Index Futures to reduce, and each of the surprise component of M1and trade deficit increased it. The result suggests that resolution of uncertainty, through economic news announcement, while, in some cases, causes market participants to reduce their forecast of volatility, a large difference between the market's forecast and the realization of the series causes the volatility to increase.

Ⅰ. Introduction

The impacts of macroeconomic news announcements on the price of assets has increased in interests in the financial and economic literatures. Some researchers have shown that unanticipated announcements of the macroeconomic variables affect asset prices. Researchers have investigated the types of news that make price of asset

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volatile, and have utilized news to test which model of asset pricing is consistent with each condition.

Using unanticipated macroeconomic announcements, we investigate impacts of those variables on the volatility of S&P 500 index futures. For this purpose, we use macroeconomic variables and each surprise component during the Louvre Accord period.[1] Until recently, however, there exist little papers and thus no general consensus regarding the impact of unanticipated macroeconomic announcements on the S&P 500 index futures, and have not even been used comprehensive macroeconomic announcement variables and each surprise component in these contexts. Antonios Antoniou and Phil Holmes(1995) tests how the trading in the FTSE-100 Stock Index Futures affect on the volatility of the underlying spot market. Since the rate of information does not remain constant, volatility must be time varying. To capture the time varying nature of the volatility, in this sense, they use a GARCH process. They find that the futures trading causes to increase volatility. The nature of volatility, however, has not changed post-futures. In other words, the price changes has integrated pre-futures, however, stationary post-futures. Here, the result implies that the introduction of futures caused to improve the speed and quality of information flowing to the spot market. Since the paper does not separate each information, which individual information affect on the spot market. This paper, however, will add to the previous literature and correct those shortcomings. For this purpose, similar to Bonser-Neal and Tanner(1995), we use dummy variables for the announced macroeconomic variables and absolute value of each surprise component. First, we use the GARCH model, which was suggested by Bollerslev(1986), to see how the volatility of S&P 500 Index Futures movement in response to macroeconomic announcement. Many researchers show that ARCH process has shown to provide a good fit for many financial time series. ARCH imposes an autoregressive structure on conditional variance, allowing volatility shocks to persist overtime. Empirically, since the GARCH model dominates ARCH specification, we use it. Second, we control for the effects of macroeconomic announcements in our estimation model. As Bonser-Neal and

1) After the collapse of the Bretton Wood System in the early 1970s, there has been a conspicuous change in the asset markets. The Louvre Accod in 1987, was held to cooperate intervention among G5 countries to stabilize volatility.

Tanner(1995), Dominguez(1993) suggested, controlling such variables is important because the response to economic news occurs within the same time of interval. The rest of this paper is organized as follows: Section I contains a discussion of the empirical evidence of the past literature related to asset price and announcement effects. Section II presents data explanation we used. Section III explains and formulates estimation model, and section IV provides summary and conclusion.

Ⅱ. Empirical Evidence of the Past Literature

Recently, the importance of unanticipated "shocks" or "news" in explaining volatility of asset prices has been investigated in many fields. Recent empirical evidence suggests " macroeconomic announcements" may affect volatility of asset price. Surveys by Cornell(1983), Sheehan(1985), Hakkio and Pearce(1985), Hoffman and Schlagenhauf(1985), Dewyer and Hafer(1989), Cook and Korn(1991), Harvey and Huang(1991) and Savanayana, Schnee weis, and Yau(1992), Jahangir Sultan(1994), and Bonser-Neal and Tanner(1995) have shown various researches regarding the effects between asset prices and macroeconomic variables, such as impacts of money supply announcements, interest rates, trade deficit announcements on asset prices. Among studies, only Dwyer and Hafer(1989) and Hakkio and Pearce(1985) find little evidence that several announcements impact interest rates and exchange rates respectively. Baily and Humpage(1992) and Dominguez(1993) find that interest rate differential affect volatility of asset price. The degree of impacts, however, depends on period. Regarding estimation model, Bollerslev(1986), Hsieh(1991) and Dominguez(1993) use a GARCH(1,1) model to fits stock prices and movements of exchange respectively and finds that it fits the series quite well. Furthermore, regarding the effects among dependant variables, Hardouvelio(1988) shows that adverse news about the trade deficit decreases short-term interest rates. Also, Aggarwal and Shirm(1992) shows that M1 announcement has significant responses to asset prices only some periods. Sultan(1994) shows that the trade deficit announcement, however, has a mixed effect on spot and futures markets.

Examined thus far, while there exists, in part, significant evidence of impacts of macroeconomic announcements on the volatility of asset prices in many cases. The study results of macroeconomic effects, however, are mixed and possibly dependent on the time period examined. Especially, Bonser-Neal and Tanner(1995), aside from central bank intervention variables, investigate whether macroeconomic announcement variables and of its each surprise component stabilized implied volatility of exchange rates in the option market. They find that the weekend variable, trade deficit announcements and CPI announcement variables have significant effects on the implied volatility of exchange rates(DM) at 10% level during the post-Louvre period. Taken together, as news variables, which affect asset price, they use M1, the trade deficit, the industrial production, the producer price index(PPI), the consumer price index(CPI), unemployment rates, and each surprise component of the news variables. In addition Antonious & Holmes(1995) show that the impacts of the futures trading has a positive effects on the volatility of the spot price. Following Bollerslev(1986) and Dominguez(1993), using a GARCH(1,1)(Generalized Autoregressive Conditional Heteroscedasticity) model, we control for the effects of US macroeconomic announcements on percentage changes in volatility of S&P 500 index futures.

Ⅲ. Data

We use macroeconomic variables and each surprise component, the announced weekly change in M1, announced monthly trade deficit, announced industrial production, announced PPI, announced CPI, the announced unemployment rates and each surprise component. The weekend dummy variable(W) is included to allow for the possibility that volatility changes can be different over weekends. Hsieh(1989) and Bonser-Neal(1995) find significant weekend effects in daily changes of exchange rates. Since changes in interest rate also affect asset price(see Dominguez(1993)), we also include it.

Two types of information on U.S. macroeconomic announcements are included in our regression model to control for changes in macroeconomic conditions. First, dummy variables equal to 1 on the day a particular macroeconomic announcement made by government and 0 otherwise are included to capture the impacts of macroeconomic announcements on the volatility of S&P 500. Absolute value of the each surprise component is included to capture the difference between the forecast and realization of the series. Here, we use each absolute surprise value, because it determines magnitude of the each surprise.

A. S&P 500 Index Futures

The data utilized here are based on daily closing prices with maturity date of the March, May, September, December from the MMI. The futures contract which has earliest maturity is called a nearby contract, and the second earliest maturity date is called a first-defer contract. Here, since at the end of the maturity month the price of the futures contract is unavailable, following Taylor(1986), during the month when the nearby contract matures, we use the log-price changes of the first-defer contract.

B. Macroeconomic Data

We use two kinds of U.S. macroeconomic data to control for changes in macroeconomic conditions.[2] We use announcement data and the surprise component for six variables: the weekly change in the money supply M1 in billions of dollars, the monthly merchandise trade balance in billions of dollars, the monthly percent change in industrial production, the monthly percent change in the consumer price index, the monthly percent change in the producer price index, and the monthly unemployment rate. Estimates of the surprise component of the macroeconomic announcements are computed by taking the difference between the announced macroeconomic value and the median forecast of the market participants surveyed by the Money Market Service.

If the degree of resolution of uncertainty regarding the impacts of macroeconomic news causes market participants to reduce their forecast of volatility of S&P 500 Index Futures, we may expect the coefficients of each dummy variable to be negative. Also, a large absolute surprise value may affect in increasing volatility to revise their expectations of current and future macroeconomic conditions and policy. To find

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2) I am grateful to Dr. Bonser-Neal for supplying data and article.

effects of interest rates, we also include the first difference of the log value in the interest rates(LIBOR).

Ⅳ. Estimation Model

The rates of change of spot exchange rates show substantial time-varying variances. A first order AR model can be written as,

$$x_t = \gamma x_{t-1} + \varepsilon_t, \tag{3-1}$$

where

x_t = the variable of interest
x_{t-1} = an independent variable that can be observed at period t-1
ε_t = white noise

From the equation(3-1), the unconditional mean of x_t is zero, however, the conditional mean is γx_{t-1}. The forecast of the time series can be improved by the conditional mean even if the conditional variance remains a constant. Similarly, if we have a model with varying conditional variances, the forecast of the time series can also be improved. Engle(1982) proposes ARCH model, which has a conditional variance,

$$x_t \mid \Psi_{t-1} \sim N(0, h_t), \tag{3-2}$$
$$h_t = h(x_{t-1}, x_{t-2}, \ldots, x_{t-p}, \alpha), \tag{3-3}$$

where Ψ_t is the information set available at time t, α is a vector of unknown parameters and p denotes the order of the ARCH process.

Bollerslev(1986) extends Engle's original ARCH model by developing a technique that allows the conditional variance to be an ARMA process. known as generalized ARCH(GARCH) model. The GARCH model assumes that the current value of the time series conditioned on past information has a normal distribution, where the variance of the distribution is an autoregressive process on both of the past squared values of the time series and of past variances. We can define the GARCH model as:

$$x_t \mid \Psi_{t-1} \sim N(0, h_t), \tag{3-4}$$

$$h_t = \alpha_0 + \Sigma_{i=1,p}\, \alpha_i x_{t-i}^2 + \Sigma_{j=1,q}\, \beta_j h_{t-j}.$$

$$= \alpha_0 + A(L)x_t^2 + B(L)h_t, \tag{3-5}$$

where

$$p \geq 0, q > 0$$

$$\alpha_0 > 0, \alpha_i \geq 0, i = 1, \ldots, q,$$

$$\beta_i \geq 0, i = 1, \ldots, p.$$

For $p = 0$ the process reduces to the ARCH(q) process, and for $p = q = 0$ x_t is simply white noise. A simple GARCH (1,1) can be written as :

$$x_t = \varepsilon_t h_t^{1/2}, \varepsilon_t \sim N(0, 1),$$

$$h_t = \alpha_0 + \alpha x_{t-1}^2 + \beta h_{t-1}, \tag{3-6}$$

where $\alpha_0 > 0, \alpha \geq 0, \beta \geq 0$.

In the ARCH(q) process the conditional variance is specified as a linear function of past sample variances only, whereas the GARCH(p, q) process allows lagged conditional variances to enter as well. So the GARCH process has an adaptive learning mechanism.

As shown in the equation(3-1), in the simple GARCH(1,1) model the conditional mean of x_t is zero, and the conditional variance is ht. The conditional variance is an autoregressive process of the past values of the time series and of the past variances. In a more general GARCH model, we can have non-zero conditional mean. Nonetheless, we can still estimate the model in a manner similar to the simple GARCH model.

Bollerslev(1987) uses a GARCH(1,1) model to fit some daily exchange rates and monthly stock prices. He finds that a GARCH(1,1) model fits better than an ARCH model. Hsieh(1989) also tests five foreign currencies and stock prices and finds the existence of nonlinearity in the data. Hsieh, in this sense, uses a GARCH(1,1) model and finds that it conforms to a GARCH(1,1) model and handles the nonlinearity problem very well. As a test statistic, the Q^2-statistic[3)] is developed for testing serial correlation in non-linear time series context. The Q^2-statistic is defined by the following:

$$Q^2(p) = T(T+2)\,\Sigma_{i=1,p}\, r^2(k)/(T-k),$$

where $r^2(k)$ is the autocorrelation function of the squared values of the time series. The null hypothesis of the Q^2-statistic is that the time series has no autocorrelation in its squared values. Under the null hypothesis, the Q^2-statistic is distributed $\chi^2(p)$. If the time series shows autocorrelation in the squared values, the Q^2-statistic will not have the χ^2 distribution and will fall into the rejection region. The Q^2-statistic is an asymptotic test to detect an ARCH-type non-linear serial correlation in a time series.

A GARCH model will be used to examine the effect of macroeconomic announcements on the volatility of S&P 500 Index Futures. We can examine the time varying volatility as an empirical regularity of S&P 500 Index Futures behavior using the GARCH model, because, the GARCH model describes heteroscedastic behavior successfully.[4)] The GARCH(1,1) model which we estimate has the following form:

$$100\ln(S_t/S_{t-1}) = \beta_0 + \beta_1\ln(I_t/I_{t-1}) + \beta_2 W_t + \Sigma_{i=1}^{6} \gamma_i MACAN_{it} + \Sigma_{i=1}^{6} \delta_k \mid MACSU_{kt} \mid + \beta_3 \ln(S_{t-1}/S_{t-2}) + \beta_4 v_t + e_t \quad (3\text{-}7)$$

$$e_t \mid \Omega_{t-1} \sim N(0, h_t) \quad (3\text{-}8)$$

$$h_t = \alpha_0 + \alpha_1 e^2_{t-1} + \alpha_2 h_{t-1} + \beta_1\ln(I_t/I_{t-1}) + \beta_2 W_t + \Sigma_{i=1}^{6} \gamma_i MACAN_{it} + \Sigma_{i=1}^{6} \delta_k \mid MACSU_{kt} \mid \quad (3\text{-}9)$$

where $100\ln(S_t/S_{t-1})$ shows percentage change of S&P 500 Index Futures, $\ln(I_t/I_{t-1})$

3) See McLeod and Li(1983).

4) See Hsieh(1988a)

Table 4-1 Test of Unit Root in Log-Prices and Log-Price Changes

	Log - Prices	Log-Price Changes
S & P 500	-2.81	-13.48[a]

a Denotes rejection of null hypothesis of an unit root. The MacKinnon critical value at 1% level is -3.99. Thus, significant at 1% level using MacKinnon critical values ADF t-statistic on $\alpha 1$ is the Augmented Dickey Fuller test : $\Delta s_t = \alpha_0 + \alpha_1 s_{t-1} + \Sigma \delta i \Delta s_{t-i} + \varepsilon_t$ where st represents first lag of logarithm of the S&P 500 Index Futures

is the first difference of the logarithm value in interest rates(LIBOR), W_t are weekend dummy variables, $MACAN_{it}$ shows macroeconomic variables, i.e., money supply(M1), the trade deficit, industrial production, the producer price index(PPI), the consumer price index(CPI), and the unemployment rate respectively. Except the weekly M1 announcement data set, others are monthly announcement data. $MACSU_{kt}$ indicates the surprise component of each macroeconomic variable k, for k=1 to 6, as measured by the difference between the announced value and the median value provided data set by the MMS. We use each surprise component as absolute values.

The conditional distribution of the disturbance term has a conditional normal distribution with mean zero and variance h_t. Equation(3-7), the conditional mean model of the log-price changes has AR process. Equation(3-8), the conditional variance model of the log-price changes is an autoregressive process of past residual square and the past variance. Equation(3-8) indicate that the distribution of the error term is conditional on information available at time t-1.The GARCH(1,1) model is estimated by maximum likelihood procedure using the Berndt, Hall and Hausman algorithm (1974).

Ⅴ. Empirical Results

We investigate the effects of macroeconomic announcement effects on the volatility of S&P 500 Index Futures. For this purpose, we include the six macroeconomic announcement variables, its each surprise component, log-change in interest rates and weekend variable in our estimation model.

Table 4-2 Descriptive Statistics of the Log-Price Changes

Maximum	Minimum	Mean	Variance	Skewness	Kurtosis
17.25	-31.53	0.0237	1.528	6.684[a]	203.42[a]

a Denotes rejection of the null hypothesis a normal distribution (see Judge et. al., 1988. p. 891, for the definition and the asymptotic distribution of skewness and kurtosis).

Table 4-3 Test of Serial Dependence

Q(24)	$Q^2(24)$
106[a]	202[a]

a Denotes rejection of null hypothesis. The Ljung-Box Q statistic and Mcleod-Li Q^2 statistic are calculated at lag 24. At 1% level of significance for both tests are 42.98.

Table 4-1 shows results of unit root tests of the log-price changes of the S&P 500 Index Futures. The ADF values indicate rejections of a null hypotheses that the changes of log-price are nonstationary. In other words, the first differences of a logarithm of the S&P 500 Index Futures are stationary. This table also shows that there exist serial dependence and heteroscedastic behavior in the first differences of a logarithm of the S&P 500 Index Futures.

Table 4-2 shows descriptive statistics of the log-price changes of S&P 500 Index Futures. Mean is not significantly different from zero. The variance, however, is very significantly different from zero. The log-price change data are skewed and the kurtosis is significantly different from that of the normal distribution.

Table 4-3 shows serial dependence in log-price changes. The Ljung-Box Q statistic shows that there is a linear dependence in log-price changes. The Q^2 statistic shows that there is a serial dependence in the square of the log-price changes of the S&P 500 Index Futures.

Table 4-4 shows the results from the conditional-mean equation(3-7). The each coefficient of weekend effects, trade deficit announcement and the lagged volatility are statistically significant with positive signs. Our conditional-mean equation shows the effects of macroeconomic announcements and its each component on the trend of S&P

Table 4-4 GARCH Model : Conditional Mean Equation

$$100\ln(S_t/S_{t-1}) = \beta_0 + \beta_1 \ln(I_t/I_{t-1}) + \beta_2 W_t + \Sigma_{i=1}^{6} \gamma_i \, MACAN_{it}$$
$$+ \Sigma_{i=1}^{6} \delta_k \mid MACSU_{kt} \mid + \beta_3 \ln(S_{t-1}/S_{t-2}) + \beta_4 \sqrt{\ } v_t + e_t$$

(February 23, 1987 - December 31, 1989, n=665)

Variables	coefficients
Intercept	0.0005
	(0.0005)
Interest Rate	-2.0379
	(2.9446)
Weekend Dummy	0.2464**
	(0.0954)
M1 Annou. Dummy	0.0149
	(0.0389)
M1 Surprise	-0.0584
	(0.1867)
Trad. Def. Annou. Dummy	-0.0537
	(0.0581)
Trad. Def. Surprise	0.5156**
	(0.2481)
Ind. Prod. Annou. Dummy	-1.5087
	(1.0388)
Ind. Prod. Surprise	0.2754
	(0.4695)
PPI Annou. Dummy	-1.2673
	(1.6722)
PPI Surprise	-0.3045
	(0.9847)
CPI Annou. Dummy	0.4623
	(1.8849)
CPI Surprise	-0.3236
	(0.7836)
Unemp. Annou. Dummy	-0.4001
	(2.7026)
Unemp. Surprise	0.0361
	(0.3063)
Lagged Volatility	0.0487*
	(0.0253)
Variance	0.5136
	(0.7831)

Notes: Standard errors in parentheses, * = significant at 5% level, ** = significant at 1% level. The dependent variables, the changes of S&P 500 Index Futures are from 100 log(s_t /s_{t-1}), st shows S&P 500 Index Futures t. All independent values are used in absolute values. Dummy variables equal one if announcement made, and 0 otherwise. Weekend dummy variable equals one when Friday. For each macroeconomic variable, we use two kinds of variables: one is a dummy variable, the other is an each surprise component. In a dummy variable, we use one if the value is announced, zero otherwise; and a surprise component(announced value - median of the expected value by MMS).

Table 4-5 Daily GARCH Model : Conditional Variance Equation

Sample : February 23, 1987-December 31, 1989, n=665.

$$h_t = \alpha_0 + \alpha_1 e^2_{t-1} + \alpha_2 h_{t-1} + \beta_1 \ln(I_t / I_{t-1}) + \beta_2 W_t + \Sigma_{i=1}^{6} \gamma_i \text{MACAN}_{it} + \Sigma_{i=1}^{6} \delta_k \mid \text{MACSU}_{kt} \alpha$$

Variables	coefficients
α_0	0.7152**
	(0.2558)
α_1	0.4123 **
	(0.1319)
α_2	0.0942**
	(0.0352)
Interest Rate-0.8842 **	
	(0.2148)
M1 Annou. Dummy	- 0.0589 **
	(0.2901)
M1 Annou. Surprise	0.6342**
	(0.3133)
Trad. Def. Annou. Dummy	0.0311
	(0.0923)
Trad. Def. Surprise	0.9808**
	(0.4036)
Ind. Prod. Annou. Dummy	-0.0185
	(1.9854)
Ind. Prod. Surprise-0.3704	
	(0.8455)
PPI Annou. Dummy	-0.5595
	(1.1308)
PPI Surprise	-0.0823
	(0.6475)
CPI Annou. Dummy	-1.9897
	(2.3043)
CPI Surprise	0.0922
	(0.8031)
Unemp. Annou. Dummy	-1.9644*
	(1.2823)
Unemp. Surprise	-0.6685
	(0.4429)
Test of Serial Dependence in Standardized Residuals	
Q(24)	21.3
$Q^2(24)$	6.98

Notes : Standard errors in parentheses, * = significant at 5% level, ** = significant at 1% level. Weekend dummy variable equals one if observation falls on a Friday. For each macroeconomic variable, we use two kinds of variables: one is a dummy variable, the other is a surprise component. In a dummy variable, we use one if the value is announced, zero else; and a surprise component (announced value - median of the expected value by MMS).

500 Index Futures, and the positive and significant estimated coefficients on the above variables indicate that each case raised volatility during our sample period. Here, however, the value of every surprise component is included to capture the difference between the market's forecast and the realization of the series. Thus, a large absolute surprise could increase volatility as trader revise their expectations of current and future macroeconomic conditions and policy. The coefficient value of trade deficit surprise reveals that the magnitude of the surprise, not its direction, affected changes in volatility of S&P500 Index Futures significantly.

Following equation(3-7), we estimate conditional variance equation(3-9). Table 4-5 shows the results of the conditional-variance equation. The first three explanatory variable show GARCH parameters(α_0, α_1, α_2). All three coefficients are highly significant, indicating that the GARCH parameters have explanatory power in our model. This result shows that variance effects are highly persistent. The interest rate, the M1 announcement dummy and surprise, trade deficit surprise and unemployment announcement dummy variables are statistically significant with negative signs. In other words, announcement of interest rate and M1 announcement decreased or raised volatility of S&P 500 Index Futures respectively. Here, each negative and significant sign of coefficient value of announcement - interest rate, M1 and unemployment - shows that the resolution of uncertainty regarding a macroeconomic series' value causes market participants to reduce variance. The significantly positive value of surprise component of M1 announcement, since the absolute value of the surprise component is included to capture the magnitude, not its direction, affects changes in variance. Also, the values of Q^2 statistics for the standardized residuals of the GARCH model imply that the standardized residuals are not autocorrelated in their squared residuals.

Ⅵ. Summary and Conclusion

The intention of this paper was to examine whether the macroeconomic announcement had effects on the volatility of S&P 500 Index Futures during the sample period. we find that some of announcement and surprise components increased volatility of S&P

500 Index Futures during our sample period. From our conditional mean equation, weekend dummy, trade deficit surprise and lagged volatility variables are significantly positive. Our conditional-variance equation shows the capability of "calm" disorderly markets. Since each surprise component captures difference the market's forecast and realization, not its direction, the result of significantly positive signs of the coefficients in M1 and trade deficit surprise on the conditional variance implies that the large difference between the market's forecast and the realization of the series contributed to increase volatility. On the other hand, each negative sign of coefficient in interest rate, M1, and unemployment announcement suggests that release of the information decreased volatility of S&P 500 Index Futures. The results, in several respects, may contain implications for the KOSPI 200 Index Futures. Even though the degree of the market efficiency is different between two countries, we cannot rule out the possibility that the resolution of the information, through economic news, may cause the volatility of the KOSPI 200 to decrease in the futures market. In addition, we can automatically infer that such an effect may, subsequently, affect the volatility of the KOSPI in the spot market.

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