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DEPFID Working Papers - 12 / 2010 - Abstract

Intra-day anomalies in the relationship between U.S. futures and European stock indexes

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The paper presents an empirical investigation of the intraday minute by minute relationship between the U.S. S&P 500 Index Futures and the three major European stock indexes (CAC 40, DAX-100, and FTSE 100). Data analysis shows that the well established positive correlation between futures and stock indexes extends to this specific cross-country case. The correlation is particularly strong in the opening and closing of the European markets, but decreases quickly and remarkably between 13:00 and 13:30 (CET time). This fall is interpreted as derived from the expected release of press communication from U.S. companies. While in U.S. futures traded volumes decrease until the announcements are made, in Europe the expectation of new information coming from U.S. affects indexes price sensitivity providing arbitrage opportunities, due to the imperfect international integration of financial markets.

KEYWORDS: futures market, spot markets, intraday timing, market correlation, information processing

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1. Introduction

The relationship between the price series of stocks and futures is one of the most widely researched topics in finance. The reason is that futures contracts can provide a sentiment indicator to predict and adjust prices of underlying stocks. Price dynamics of futures depends on expectations on stock prices and it is generally assumed that futures markets, characterized by lower transaction costs, react more quickly to the release of new information. Futures prices consequently anticipate price changes in stock markets. The symmetrical relation, that spot prices movements determine futures prices, should also be assumed in order to neutralize the possibility of systematic arbitrage. Otherwise, a speculator could simultaneously buy and sell futures and stocks to profit from the realignment of relative prices.

There is evidence in literature that price behavior makes arbitrage opportunities on futures and stock markets uncommon. However, there is also wide consensus that the realignment of prices in the two markets is not instantaneous and that stock indexes follows the corresponding future indexes with a time lag ranging from five minutes (Stool-Whaley 1990) to forty-five minutes (Kawaller et al. 1987). The growth of online trading and the globalization of financial markets should most probably shorten this lag. The same factors also are supposed to accelerate the integration between U.S. and European financial markets. The continuous release of information and the nonstop trading activity are two factors leading in this direction. In contrast, these markets are differentiated by some features explaining their imperfect financial integration (Chen-Knez 1995, Froot-Dabora 1999, Ayuso-Blanco 2001, Dewachter-Smedts 2007).

This paper aims to provide evidence on the relationship between the price dynamics of the US futures index and of three major European stock indexes to investigate the interdependence between them and the efficiency in ensuring that all the opportunities for profitable arbitrage are removed. Our analysis shows that the widely documented positive correlation between futures and stocks extends to this cross-country case. The correlation is particularly strong in the opening and closing of the European markets but it drops quickly and remarkably between 13:00 and 13:30 (CET time). We claim that this fall, which originates arbitrage opportunities, could be attributed to the flows of news coming from U.S corporate announcements scheduled at 7:00-7:30 (US Eastern time).

The remainder of the paper is organized as follows. Background literature is reviewed in Section 2. Section 3 describes the data set, while results are presented and discussed in Section 4. Section 5 summarizes our findings.

2. Background literature

The efficient market hypothesis (Fama 1970) asserts that whenever a futures index and the underlying spot index are frictionless and rely on the same information to determine prices, any difference between them will be eliminated by trading activity. Formally, the equivalence between the two prices is represented by the following equation, known as the cost of carry model,

$$(1) \qquad FP_t = SP_t \exp[(r-d)(T-t)]$$

where FP_t is the futures index price and SP_t the stock index price at time t, (r-d) is the difference between the rate of interest r and the continuously compounded dividend yield d, and T is the expiration date of the futures contract. Any divergence between the right and the left side of equation (1) provides a riskless arbitrage profit opportunity, which is not consistent with perfectly efficient and continuous markets.

This theoretical relationship has been found not to hold in real markets. The classical reference of Kawaller et al. (1987) sets the stage for this line of research with reference to U.S. markets. They use intraday data for the period 1984-1985 to show that stock index follows the underlying future index with a time lag ranging from twenty to forty-five minutes and that this lead-lag relationship is stable and independent on the distance from futures expiration time. Kawaller et al. (1987) interpret this finding as due to the relative inertia characterizing stock trading, implying that futures can act as information source for the spot market. With reference to longer periods, Herbst et al. (1987) and Stoll-Whaley (1990) provide evidence that the time lag is on average shorter (respectively, eight and five minutes). Chan et al (1993) and Wang-Wang (2001) show that the leading role of futures does not extend to market volatility, which exhibits symmetrical dependence between futures and stock markets.

These findings are confirmed with some qualifications by a long series of papers for a number of countries: Tse (1995) for Japan, Tang et al. (1992), Chung et al (2010) for Honk Kong, Chang-Lee (2008) for Taiwan, Wahab-Lashgari (1993), Abyankar (1995, 1998), Brooks et al. (2001), Brooks-Garrett (2002) for U.K., Nieto et al. (1998) for Spain, Kenourgios (2004), Floros-Vougas (2007), Andreous-Pierides (2008), Kavussanos et al. (2008) for Greece. The European markets are the object of a cross-country investigation by Antoniou et al. (2003), who focus on the three largest European stock indexes (FTSE100 for U.K., DAX-100 for Germany and CAC-40 for France) and their underlying futures contracts during the period 1990-1998. Their analysis substantiates the leading role of futures over spot markets not only within a country but also across countries.

The main implication of the lead-lag relationship between futures and stocks is that it makes arbitrage opportunities available. Thus, the focus of research has been to assess if the future-to-cash price differentials are large enough to cover the transaction costs associated to operate on futures and spot markets.

There may be three main reasons explaining a time-lag differential between the two indexes:

1) While most stocks included in the index are not traded constantly and the corresponding index is adjusted with a lag, futures trade is always executed immediately.

2) Futures trading requires shorter implementation times and lower front-up investments than stock trading, which takes longer times for option selection and order execution.

3) Futures markets are more liquid and characterized by a higher degree of leverage.

Once one of these factors produces an asynchrony between futures and spot prices, arbitrage is possible if the price differential is large enough to cover transaction costs. One of the earlier contribution to sustain this possibility is Figlewski (1984, 1985), who analyze the NYSE futures contract and the NYSE Index from January 1981 to March 1982. However, Figlewski (1984) argues that gains could be due to mispricing bound to disappear in more mature markets. Brennan and Schwarz (1990) propose a trading policy, based on the assumption that stock-futures mispricing follows a Brownian Bridge process, which outperforms the benchmark on U.S. futures markets from 1983 to 1987. This line of research is developed by Cakici-Chatterjee (1991), Chung (1991), Dwyer et al. (1996), Neal (1996) for U.S., Brenner et al (1990), Lim (1992), Tse (1995) for Japan, Stulz et al. (1990), Yadev-Pope (1990), Puttonen (1993), Bühler-Kempf (1995), Brooks et al. (2001), Berglund-Kabir (2003), Bialkowski-Jakubowski (2008) for Europe. Overall, this strand of literature confirms the availability of profitable trading strategies, which exploit the spot-futures lead-lag relation. However, the existence of positive gains from arbitrage depends on a variety of factors. First, the magnitude of price discrepancies is path-dependent and related to the time distance from futures expiration dates. Types and size of transaction costs are decisive in choosing the appropriate trading strategies, which are market-specific. Finally, arbitrage gains should include a risk premium because they are affected by the uncertainty on the magnitude of dividends and interest rates.

Our paper provides evidence on a different source of profitable arbitrage, which depends on the imperfect international integration of financial markets and, specifically, that between the U.S. futures index and the European stock indexes. A significant difference between U.S. and European markets is that they open and close at different times. This feature makes available a time-zone arbitrage in which traders can speculate on the closure of foreign markets (Boudoukh et al. 2002). Once traders become aware of this possibility, efficient markets should react by providing to them up-to-date information to neutralize these opportunities. To test if some exceptions to this prediction are possible, we analyze the intraday relationship between correlation between US futures and European stocks indexes.

3. Data Description

Our database consists of the intraday minute by minute prices observations covering the period from January to June 2010 of the U.S. S&P 500 Index Futures and of three major European stock indexes, the CAC-40 for France, the FTSE100 for U.K., and the DAX-100 for Germany.

The S&P 500 index Futures is one of the most widely traded index futures contracts in the United States. It is a free-float capitalization-weighted index of the prices of five hundreds large-cap common stocks actively traded in the U.S. on the two largest American stock market companies, the NYSE Euronext and the NASDAQ OMX. The S&P 500 Index Futures allows the investor to buy and sell the "market as a whole" rather than a specific security. Investors, anticipating a bull market but unsure which particular stock will rise, might buy stock-index futures. Another investor, seeking to hedge the portfolio against loss of value in a bear market might, on the other hand, might sell a stock-index future. They also enable to benefit from lower costs compared to trading individual stocks or Exchange-Traded Funds (ETFs), to use a financial tool that accommodates a wide range of strategies, different market environments and varied objectives and to effectively replicate all global equity exposure on a single platform.

There are several other reasons making trading S&P 500 futures very attractive. Contracts can be sold as readily as they are bought with the same margin and big liquidity flows. There are no special restrictions at all on being short. Any size order can be handled at any time during the trading session, giving the opportunity to get into or out of a position within seconds. Finally, futures trading typically allows capitalizing on stock market movement for lower commissions and lower tax rates, being profits on futures in U.S. taxed differently from profits on stocks.

The S&P futures contracts are based on the S&P 500 stock index and traded on the Chicago Mercantile Exchange (CME). Trading takes place on the CME Group trading floor during open outcry trading period and, electronically, on the CME Globex platform when the trading floor is closed. CME Clearing matches and settles all trades and guarantees counterparty creditworthiness. The S&P index, on which the future contract is based, is mainly composed by tech stocks that accounts for 17% of the total market capitalization (as of 4th October 2010) followed by financial stocks (16%), health care (12%), industrials (12%) and oil and gas (10%).

A major improvement of the market was to allow traders direct access without going through an order handler. In this way, trading was fully computerized keeping the market open 24 hours a day and enabling traders to respond to news releases in pre-market and after-market session. According to CME Group, now electronically executed trading accounts for almost 90% of the total volume. Regular trading hours for S&P futures contracts are from 8:30 am to 3:15 pm (Central European time). The evening session continues on the Globex until 8:15 am overnight. It starts at 3:30 pm (15 minutes after the close at 3.15).

The CAC-40 is a market value-weighted index, which represents a capitalization-weighted measure of the forty most significant values among the one hundred highest market caps on the Paris Bourse (now Euronext Paris). The index is mainly composed by financial stocks that weight for 19% of total market capitalization followed by consumer goods (15%), industrials (13%) and oil and gas (12%) and its capitalization was 668 billion euro at the 4th of October 2010. The DAX-100, with a market capitalization of 656 billion euro, is a blue chip stock market index consisting of the thirty major German companies trading on the Frankfurt Stock Exchange. The index is mainly composed by basic materials companies that weight for 20% of total market capitalization, followed by financials (18%), consumer goods (17%), industrials (16%) and utility (11%). Finally, the FTSE 100 Index - also called FTSE 100, FTSE, or, informally, the "footsie" - is a share index of the one hundred most highly capitalized UK companies listed on the London Stock Exchange. FTSE 100 companies represent nearly the 80% of the market capitalization of the whole London Stock Exchange. Even though the FTSE All-Share Index is more comprehensive, the FTSE 100 is by far the most widely used UK stock market indicator. Among the three European indexes we analyze, the FTSE 100 is the biggest in terms of market capitalization with a value of 1.5 trillion pounds. Financial stocks represent 22% of total market capitalization followed by oil and gas (18%), materials (14%) and consumer goods for 12%.

4. Results

We investigate the relationship between S&P futures and CAC, DAX, FTSE stock indexes, by analyzing prices changes and volumes. Our main finding is that the intraday price series of US futures and European stock indexes are highly correlated during all the day, but we observe two time-ranges in which the correlation falls off rapidly. The first is from 13:00 and 13:30 (CET time) and the second from 15:00 and 15:30 (CET time). By looking at the intraday volumes of futures, we also find that there is a market slow-down in the period 13:00 - 13:30. Finally, we analyze cross-correlation functions between futures and stock indexes to investigate price time relationship. In contrast with previous literature, our data set does not highlight any time lag between futures and stock indexes. This finding is confirmed by the analysis of the strength of regression coefficients.

To analyze intraday correlation between futures and indexes, we use intraday price data, with one-minute sampling frequency, and split the trading day going from 9:00 to 17:00 (CET time) in periods of 30 minutes, 60 minutes, and 120 minutes. Specifically, we split the day in K time ranges of m minutes. Being the frequency minute by minute, every time-range may be represented by an array of m prices, for each asset. Given the generic split S, we define the matrix G(A,S,k). The matrix is defined by the asset A={SP, CAC, DAX, FTSE}, which is the futures or the stock index, the day-split S and the k-th time range. Given the asset A and the day-split S, we define K matrices like G(A,S,k) with k = 1...K. Each column of G corresponds to one trading day, while each of the m rows of G correspond to one minute in the k-th interval. For example, for the day-split in 16 time ranges of 30 minutes, with 30 days in the data set, we define the following matrix,

$$G(A, S, k) = \begin{pmatrix} p(A,\ t_{k,1},\ day1) & p(A,\ t_{k,1},\ day2) & \dots & p(A,\ t_{k,1},\ day30) \\ p(A,\ t_{k,2},\ day1) & p(A,\ t_{k,2},\ day2) & \dots & p(A,\ t_{k,2},\ day30) \\ \dots & \dots & \dots & \dots \\ p(A,\ t_{k,m},\ day1) & p(A,\ t_{k,m},\ day2) & \dots & p(A,\ t_{k,m},\ day30) \end{pmatrix}$$

where p (A, $t_{k,i}$, d) is the price of asset A at time $t_{k,i}$ (i-th minute of k-th time-range) of the d-th day.

Then, we calculate the correlation between matrices G(A1,S,k) and G(A2,S,k), where A1 is defined by the S&P futures and A2 by the CAC, DAX, FTSE indexes. In this way, we obtain a vector of correlation coefficients R(A1,A2) of K rows. Each row represents the average correlation between A1 and A2 for the k-th time-range and for all the days include in the data set.

Formally,

$$R\ (A1, A2) = (r_1\ r_2\ \dots\ r_K) \quad \text{where:} \quad r_k = E[\rho_k(d)]$$
$$\rho_k(d) = corr(G_d(A1, S, k), G_d(A2, S, k))$$

where E[.] is the expected value operator and G_d is the column of matrix G corresponding to the d-th day.

The correlation between the S&P futures and CAC, DAX, FTSE indexes from January to June 2010 are shown in Tables and Figures 4.1.1, 4.1.2 and 4.1.3, respectively over 30 minutes, 1 hour and 2 hours intervals.

In particular, Table and Figure 4.1.1 point out that correlation is very strong in the opening and closing hours of the market day, while appears weaker in the mid of the day, when two significant correlation gaps emerge. The first is from 13:00 and 13:30 and the second from 15:00 and 15:30. The second correlation fall occurs because futures markets trade 23:45 hours per day, going from 15:30 to 15:15 the next day. In contrast, there are no technical reasons to explain the

13:00-13:30 gap. However, we identify a key element that could help to explain it. Most U.S. companies release press communication on their activity and financial results between 7:00 and 7:30 a.m. (U.S. Eastern Time), which is exactly the temporal window pointed out by correlation analysis for CET time. Being S&P 500 quicker to react to the release of new information than stock indexes, it is possible that European stock markets react more slowly and less sensitively to the news.

To gain insight, we analyze the average trading volumes of future and stock indexes for periods of 30 minutes. Results for S&P futures in September 2010 are shown in Table 4.2.1 and Figure 4.2.1. On average, the highest volumes are traded in the opening phases of the market and gradually decrease to reach the lowest values in the mid of the day. Later, from 13:30-14:00 onward, we observe a strong speed up.

This evidence supports the hypothesis that US futures and European stocks markets react differently to the release of U.S. new information. In US markets, as argued by Admati-Pfleiderer (1988) and Chae (2005), trading volumes decrease prior to the scheduled announcements. Having U.S. traders timing discretion in the opening of the markets, they tend to postpone transactions until the announcements are made. European traders, presumably affected by information overload, weaken price sensitivity on their stock markets, which became less dependent on US futures prices. This asynchrony makes available a time-zone arbitrage which causes a specific source for mispricing, which could be exploited by speculators.

Finally, we analyze the cross correlation sequence between futures and stock indexes. For each asset A in {SP, DAX, CAC, FTSE}, rows of the matrix P_A corresponds to minutes between 9:00 and 17:30 and columns to the market trading days in the data set. We estimate [C,L]=xcorr(P_{SP}, P_A} and obtain a sequence of correlation coefficients C between S&P and A at different lags L. As shown in Figure 4.3.1, the correlation between S&P futures and DAX stock indexes reach its peak at lag=0. Similar results are obtained for CAC and FTSE stock indexes. In all the three European markets, being the last price the most significant for predicting future prices, time-leading behavior and arbitrage opportunities are excluded.

We also estimate linear regression between futures and indexes, using the following model,

$$\hat{I}(t+f) = p_1\, I(t-1) + p_2\, I(t-2) + \ldots + p_k\, I(t-k) + q_1\, F(t-1) + q_2\, F(t-2) + \ldots + q_k\, F(t-k)$$

where $\hat{I}$ is index price estimation at t+f and I(t-k), F(t-k) are the past index and futures prices. We use regress Matlab function to evaluate the regression coefficients $P = [p_1, p_2, \ldots, p_k, q_1, q_2, \ldots, q_k]$.

$$P = \text{regress}(I(t+f), [I(t-k:t-1); I(t-k:t-1)])$$

Tables 4.5.1, 4.5.2 and 4.5.3 show the regression coefficients from DAX index, varying k and f. The coefficients for DAX(t-1), SP(t-1) and SP(t-2) are the only significantly different from zero. Similar values are for CAC and FTSE, omitted here for brevity. These results confirm that the arbitrage opportunities between US futures and European stock indexes are limited to the time period 13:00-13:30.

5. Conclusions

This paper has analyzed the correlation between prices and traded volumes of the U.S. S&P 500 Index Futures and of the major three European stock indexes. We provide evidence that the widely documented positive correlation between futures and stock indexes is not restricted within national markets, but it extends to the relation between U.S. futures and European stocks indexes. The relation is strong enough throughout the day and with no time lag. However, we find that the correlation falls quickly and remarkably between 13:00 and 13:30 (CET). To explain this outcome, we observe that the trading volumes of the S&P 500 futures decrease significantly from 12:00 to 13:30 to increase again after 14:00 to reach the daily pick. In this period, most U.S. companies release press communication on their activity and financial results between 7:00 and 7:30 a.m. (US/Eastern Time). This evidence supports the hypothesis that US futures and European stocks markets react differently to the release of new information. In US future markets traded volumes decrease until the announcements are made. In European markets, information asymmetry influences price sensitivity and stock prices became less dependent on US futures prices by originating arbitrage opportunities due to the imperfect international integration of financial markets.

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Appendix. Tables and Figures

Table 4.1.1 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (30 minutes)

Time Period (CET time)	DAX	CAC	FTSE
09:00-09:30	76.68%	83.66%	70.49%
09:30-10:00	77.67%	85.42%	75.62%
10:00-10:30	73.91%	76.99%	69.76%
10:30-11:00	74.01%	75.94%	67.38%
11:00-11:30	70.69%	77.99%	73.02%
11:30-12:00	67.34%	73.95%	66.38%
12:00-12:30	72.19%	75.39%	71.27%
12:30-13:00	69.17%	72.56%	70.17%
13:00-13:30	**61.88%**	**63.79%**	**57.11%**
13:30-14:00	78%	79.42%	70.52%
14:00-14:30	72.43%	75.98%	67.67%
14:30-15:00	77.69%	81.82%	72.08%
15:00-15:30	**44.41%**	**52.54%**	**45.23%**
15:30-16:00	76.75%	81.07%	84.59%
16:00-16:30	85.25%	90.36%	86.9%
16:30-17:00	77.54%	84.2%	82.06%

Figure 4.1.1 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (30 minutes)

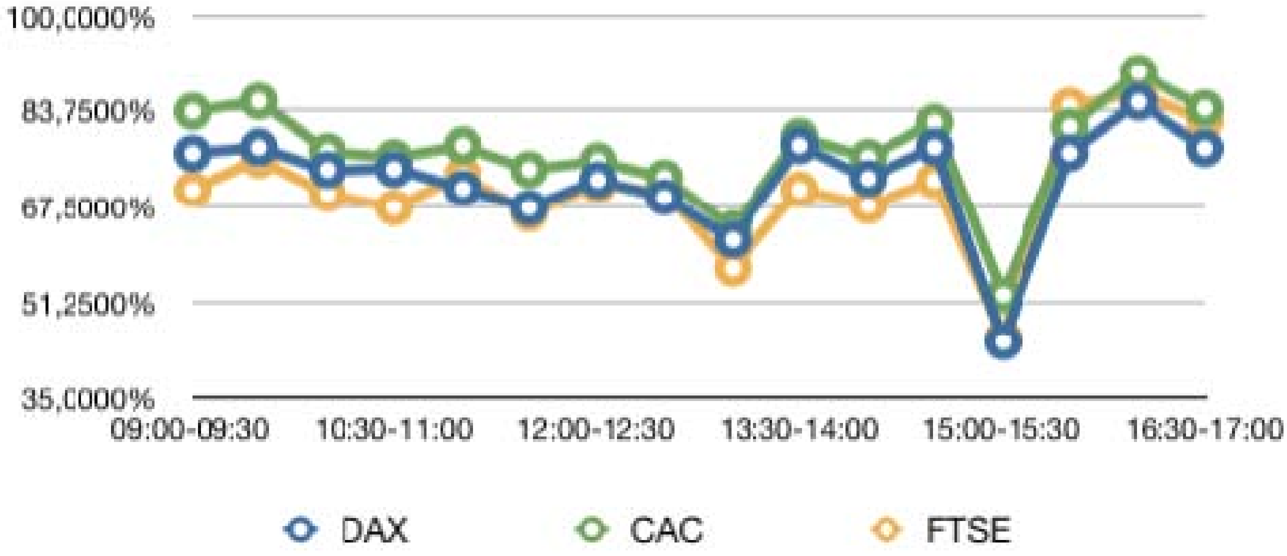


Table 4.1.2 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (1 hour)

Time Period (CET time)	DAX	CAC	FTSE
9:00-10:00	81.58%	85.67%	76.06%
10:00-11:00	81.66%	81.66%	73.49%
11:00-12:00	75.75%	81.05%	75.53%
12:00-13:00	75.64%	77.63%	72.52%
13:00-14:00	**73.9%**	**73.83%**	**66.54%**
14:00-15:00	82.34%	86.89%	81.42%
15:00-16:00	**77.56%**	**80.1%**	**79.29%**
16:00-17:00	87.98%	90.45%	85.94%

Figure 4.1.2 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (1 hour)

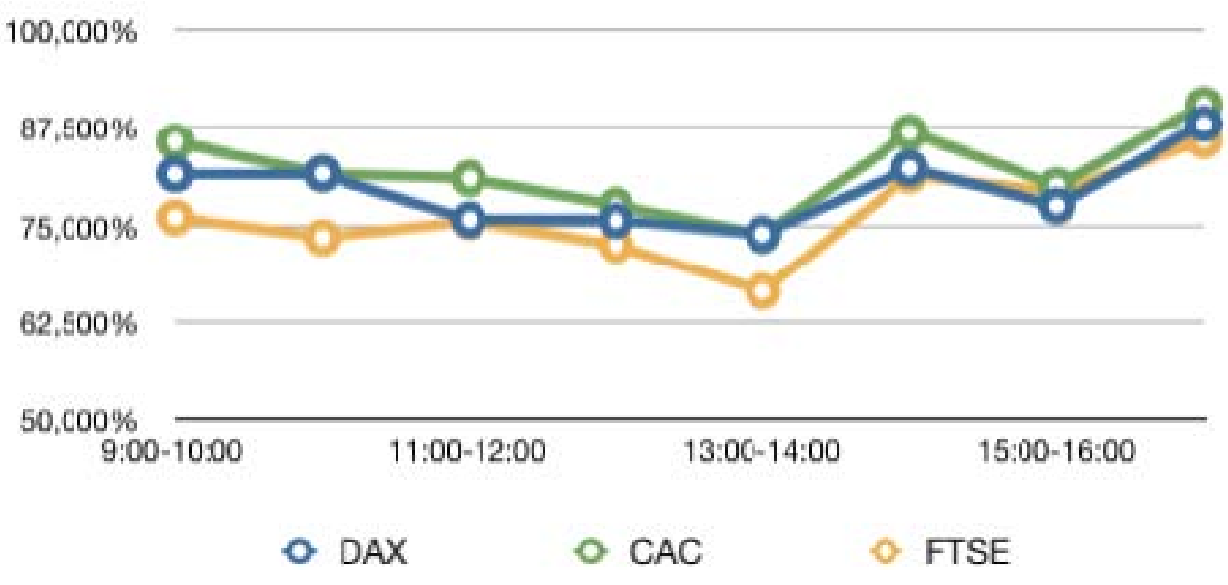


Table 4.1.3 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (2 hours)

Time Period (CET time)	DAX	CAC	FTSE
9:00-11:00	83.82%	87.42%	75.95%
11:00-13:00	81.41%	80.94%	74.47%
13:00-15:00	81.7%	82.48%	77.84%
15:00-17:00	85.94%	85.66%	83.12%

Figure 4.1.3 Correlation between S&P futures and DAX, CAC, FTSE stock indexes from January to June 2010 (2 hours)

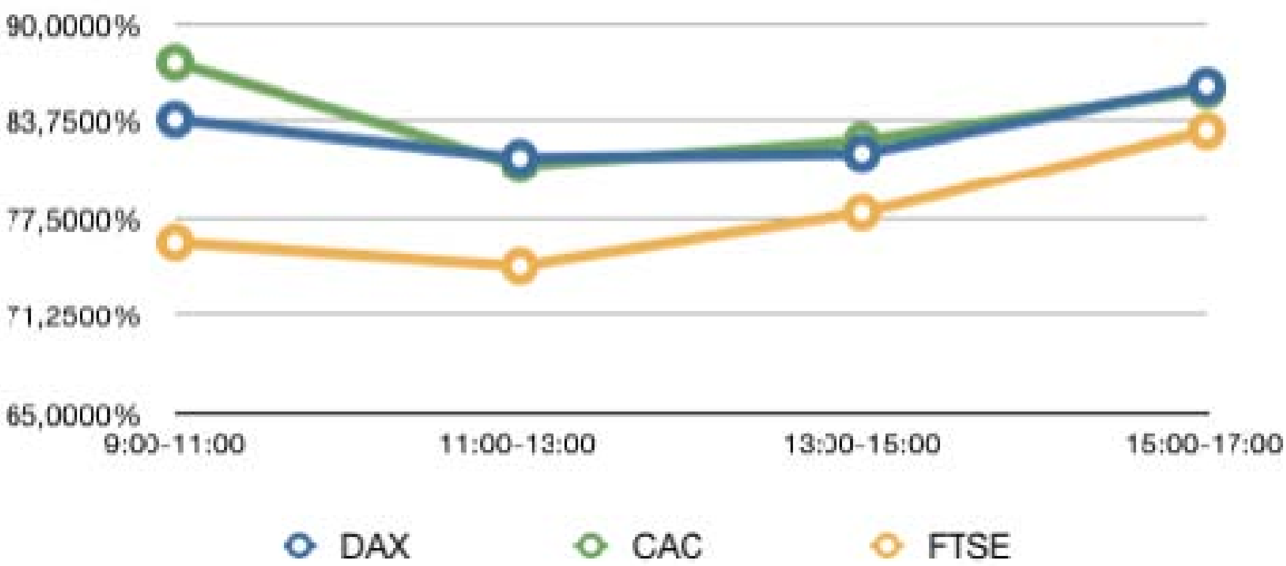


Table 4.2.1 Average Volumes for S&P futures

Time Period (CET time)	Volumes (Average Values)
09:00-09:30	71.43
09:30-10:00	57.23
10:00-10:30	49.27
10:30-11:00	54.30
11:00-11:30	43.43
11:30-12:00	51.73
12:00-12:30	**28.77**
12:30-13:00	**39.80**
13:00-13:30	**38.70**
13:30-14:00	50.97
14:00-14:30	110.00
14:30-15:00	86.43

Figure 4.2.1 Average Trading Volumes for S&P futures

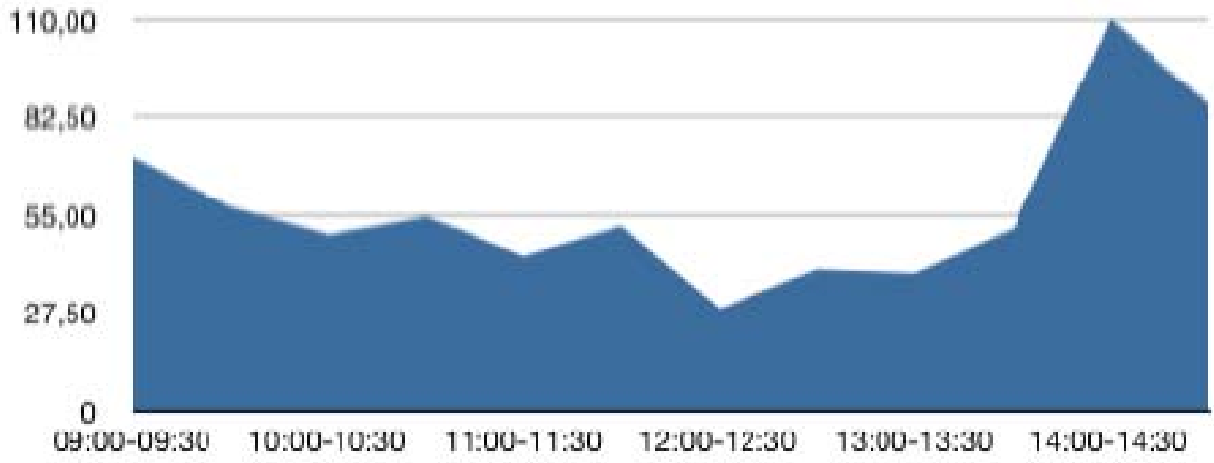
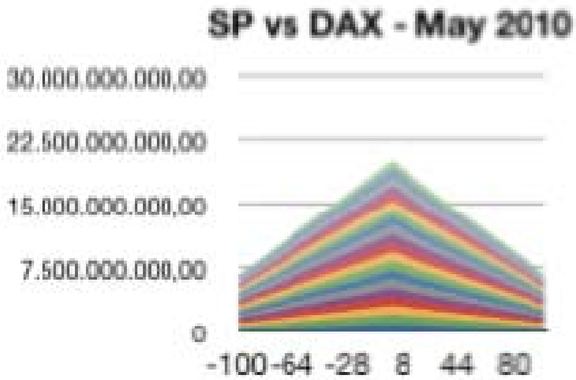
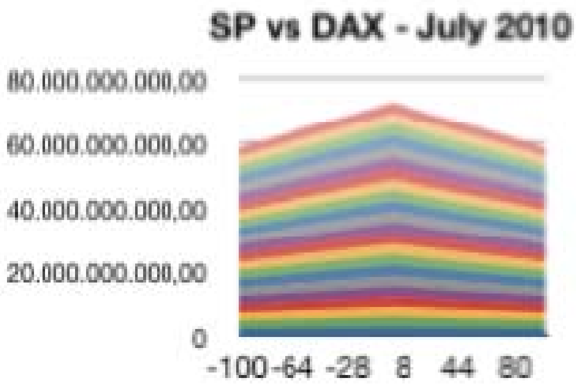


Figure 4.3.1 Correlation between SP futures and DAX index, with lags going from -100 and +100.





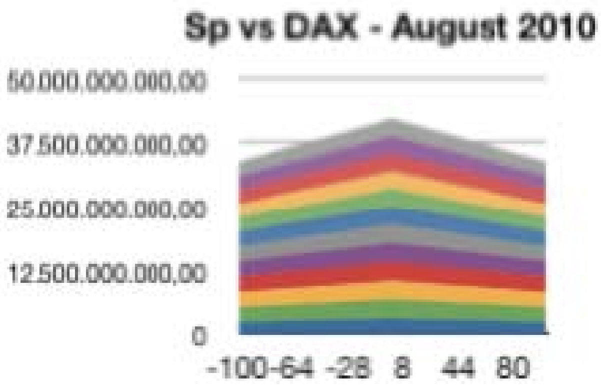


Table 4.5.1 Regression of DAX, using SP and DAX (m = 10 f = 1)

	P min	P	P max
SPU0(t-1)	0.19	0.21	0.23
SPU0(t-2)	-0.18	-0.15	-0.12
SPU0(t-3)	-0.06	-0.03	-0.00
SPU0(t-4)	-0.02	0.00	0.03
SPU0(t-5)	-0.02	0.00	0.03
SPU0(t-6)	-0.05	-0.02	0.00
SPU0(t-7)	-0.01	0.02	0.05
SPU0(t-8)	-0.03	-0.00	0.02
SPU0(t-9)	-0.05	-0.02	0.00
SPU0(t-10)	-0.02	-0.00	0.02
DAX(t-1)	0.80	0.83	0.86
DAX(t-2)	0.05	0.09	0.13
DAX(t-3)	-0.00	0.03	0.07
DAX(t-4)	-0.02	0.02	0.05
DAX(t-5)	-0.02	0.01	0.05
DAX(t-6)	-0.07	-0.04	-0.00
DAX(t-7)	-0.07	-0.03	0.01
DAX(t-8)	-0.01	0.03	0.06
DAX(t-9)	0.02	0.06	0.10
DAX(t-10)	-0.04	-0.01	0.02

Table 4.5.2 Regression of DAX, using SP and DAX (m = 10 f = 5)

	P min	P	P max
SPU0(t-1)	0.20	0.25	0.30
SPU0(t-2)	-0.20	-0.13	-0.06
SPU0(t-3)	-0.09	-0.03	0.04
SPU0(t-4)	-0.09	-0.03	0.04
SPU0(t-5)	-0.06	0.00	0.07
SPU0(t-6)	-0.09	-0.02	0.04
SPU0(t-7)	-0.08	-0.02	0.05
SPU0(t-8)	-0.07	0.00	0.07
SPU0(t-9)	-0.08	-0.02	0.05
SPU0(t-10)	-0.05	-0.00	0.05
DAX(t-1)	0.73	0.80	0.86
DAX(t-2)	-0.02	0.07	0.15
DAX(t-3)	-0.04	0.05	0.13
DAX(t-4)	-0.06	0.03	0.12
DAX(t-5)	-0.07	0.01	0.10
DAX(t-6)	-0.10	-0.02	0.07
DAX(t-7)	-0.06	0.03	0.12
DAX(t-8)	-0.04	0.04	0.13
DAX(t-9)	-0.05	0.04	0.12
DAX(t-10)	-0.13	-0.06	0.01

Table 4.5.3 Regression of DAX, using SP and DAX (m = 20 f = 5)

	P min	P	P max
SPU0(t-1)	0.21	0.25	0.28
SPU0(t-2)	-0.21	-0.16	-0.11
SPU0(t-3)	-0.06	-0.00	0.05
SPU0(t-4)	-0.07	-0.02	0.03
SPU0(t-5)	-0.06	-0.01	0.04
SPU0(t-6)	-0.09	-0.04	0.01
SPU0(t-7)	-0.02	0.03	0.08
SPU0(t-8)	-0.06	-0.01	0.04
SPU0(t-9)	-0.08	-0.03	0.02
SPU0(t-10)	-0.04	0.01	0.06
SPU0(t-11)	-0.04	0.01	0.06
SPU0(t-12)	-0.06	-0.01	0.04
SPU0(t-13)	-0.07	-0.02	0.03
SPU0(t-14)	-0.05	0.00	0.05
SPU0(t-15)	-0.05	-0.00	0.05
SPU0(t-16)	-0.05	-0.00	0.05
SPU0(t-17)	-0.07	-0.03	0.02
SPU0(t-18)	-0.02	0.03	0.08
SPU0(t-19)	-0.04	0.00	0.05
SPU0(t-20)	-0.03	0.00	0.04
DAX(t-1)	0.76	0.81	0.87
DAX(t-2)	-0.01	0.06	0.12
DAX(t-3)	-0.05	0.02	0.08
DAX(t-4)	-0.06	0.00	0.07
DAX(t-5)	-0.02	0.05	0.11
DAX(t-6)	-0.04	0.02	0.09
DAX(t-7)	-0.08	-0.01	0.05
DAX(t-8)	-0.02	0.05	0.11
DAX(t-9)	-0.01	0.06	0.12
DAX(t-10)	-0.07	-0.00	0.07
DAX(t-11)	-0.12	-0.05	0.01
DAX(t-12)	-0.06	0.01	0.07
DAX(t-13)	-0.04	0.02	0.09
DAX(t-14)	-0.07	-0.00	0.06
DAX(t-15)	-0.07	-0.01	0.06
DAX(t-16)	-0.04	0.02	0.09
DAX(t-17)	-0.03	0.04	0.10
DAX(t-18)	-0.10	-0.04	0.03
DAX(t-19)	-0.07	-0.01	0.06
DAX(t-20)	-0.08	-0.03	0.02

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