The effect of US holidays on the European markets: *When the cat's away…*

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Abstract:

This paper presents evidence of the existence of a return effect on European stock markets coinciding with NYSE holidays, which is particularly marked after positive closing returns on the NYSE the previous day. The effect is large enough to be exploited by trading index futures. This anomaly can not be explained by seasonal effects, such as the day of the week effect, the January effect or the pre-holiday effect, nor is it consistent with behavioral finance models that predict positive correlation between trading volume and returns. However, examination of factors such as information volume or investor mix provides a reasonable explanation.

JEL Classification: G14, G10

Keywords: Efficient Market Hypothesis, Seasonal effects, Behavioural Finance

ACKNOWLEDGEMENTS

This paper has received financial support from the Spanish Ministry of Science and Innovation (ECO2009-12819). We would like to thank the editor Robert Faff and anonymous reviewers for their helpful comments. We would also like to thank seminar participants at the 2011 EFMA Annual Meeting (Braga, Portugal) and the 2011 ACEDE Annual Congress, (Barcelona, Spain).

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1.-Introduction

One of the key concepts in the study of stock market behavior is the Efficient Market Hypothesis, which states that prices always fully reflect available information (Fama, 1970). Within such a framework, it is not easy to explain return series patterns, since, once discovered, they will fade with the attempts of arbitrage seekers to make use of the information. The finance literature has nevertheless testified to a large number of such persistent effects in a wide variety of return series, across a broad range of stock markets.

Seasonal effects are one of the more well-known abnormal return patterns, in particular, the day-of-the-week effect (see Lakonishok and Marbely, 1990 and Abraham and Ikenberry, 1994), the January effect (see Keim, 1988), the pre-holiday effect (see Lakonishok and Smidt, 1988 or Meneu and Pardo, 2004) and the summer vacation effect (Hong and Yu, 2009). The Monday effect is usually attributed to a preponderance of bad news over the weekend and to the high proportion of individual traders in the Monday morning investor mix. Fiscal motives and strategic behavior on the part of institutional investors are the usual explanations given for the January Effect. The reasons for the pre-holiday effect are somewhat more complex, however, although there also appears to be some connection with the activity of individual traders, whose risk exposure is greater when trading alongside informed investors and who have difficulties in covering their positions prior to a holiday. Finally, the summer vacation effect appears to be related to a trading lull due to a significant percentage of both large and small scale investors being on holiday, this reduction in trading activity is associated with a significant stock return dip. The above effects may also be accompanied by derivative expiration day effects, a common phenomenon resulting from the effect of market-on-close orders by arbitrageurs to unwind their stock positions, speculative strategies around the expiration date, market manipulation and the kind of option and settlement procedure (see Klemkosky, 1978 or Corredor et al. 2001).

As far as we are aware, however, there is no academic evidence for another familiar stock market pattern, namely, the seasonal effect on European markets during trading sessions coinciding with NYSE closure for one of the 6 US public holidays. These days are neither holidays nor pre-holidays in Europe; they are simply days on which there is no trading on the largest stock market in the world, from which European traders receive most of their market signals[1]. On days such as these, there are two factors that can make EU markets more likely to show some kind of average return or return variance pattern. One is that institutional trading volume decreases due to the absence of US institutional investors. The other is that less macroeconomic information is available. Both these consequences of the US holiday alter the flow of public information and the investor mix on EU markets.

Our results reveal a very significant impact of US holidays on the European markets. In fact, the rate of return on such days is clearly above average and volatility is below, making it difficult to reconcile with explanations based on risk factors. The effect also has a clear economic significance, since it is possible to obtain significant returns after deducting trading costs, by trading index futures.

It is important to note that the profits to be made by trading on this anomaly cannot be explained by other effects, such as the day of the week effect, the January effect or the pre-holiday effect. Nor is it consistent with behavioral finance models that predict a positive correlation between trading volume and returns (see Hong and Stein, 2007), since the trading volume on such days is significantly lower than on other trading days or other Mondays, given that at least four of the six US market holidays are Mondays.

The remainder of this paper is structured as follows. Section 2 presents the database. Section 3 describes the empirical study of the seasonal effect. Section 4 analyses its economic significance by creating strategies using futures contracts in order to test the exploitability of the effect on the markets. Section 5 examines volume-return relationships on these days from the "Behavioral Finance" perspective. Finally, section 6 presents the conclusions, limitations, and potential avenues for future research.

2.- The database

This study uses Datastream data for a period running from 1991 to 2008 on opening and closing prices for European stock market indexes, namely, the CAC40 for the French stock market, the DAX30 for Germany, the EUROSTOXX50 for the

[1] It is important to note that the pre-holiday effect in Europe is not significantly different from this pre-holiday effect when it is also a pre-holiday in US market (the results are available from authors upon request). As a consequence, the effect that we study is not a simply holiday effect in US market. The main difference is due to the fact that European markets are open and the investor mix is different in these markets in these dates. This argument will be explained in more detail in Section 5 of the paper.

euro zone stock market, the FTSE-100 for the United Kingdom stock market and the IBEX35 for the Spanish stock market. The sample length varies with the nature of the data and the index. Opening price data are available from January 1993 for the CAC40 and June 1994 for the FTSE; opening and closing price data are available from December 1993 for the DAX30; and closing price data from January 1992 and opening price data from June 1999 are available for the EUROSTOXX50. The trading volume data on these indexes for the period running from 1994 to 2008 were drawn from the Factset database, starting from April 1994 for the IBEX35 and May 1994 for the DAX30. Finally, we use Bloomberg closing prices for the futures on these indexes for the period 1991 to 2008, except for the IBEX35 for which closing prices are available only from mid-July 1992 and the future on the EUROSTOXX50 which is available only from mid-June 1998. The futures data will be used to construct trading strategies designed to exploit potential return patterns associated with the New York stock exchange holiday effect.

Every year there are six holidays in the United States that are not holidays in Europe. These are: Labor Day (the first Monday in September), President's Day (the third Monday in February), Memorial Day (last Monday in May), Independence Day (the fourth of July), Thanksgiving day (the fourth Thursday in November), and Martin Luther King Day (the third Monday in January), although it should be noted that the last of these has only been a holiday since 1998.

Using opening and closing prices, we have obtained three return measures: the off-market return (R_t^{co} close-to-open return), the intraday return (R_t^{oc} open-to-close return) and the ordinary return (R_t^{cc} close-to-close return). More specifically:

$$R_t^{co} = \ln \frac{(I_t^o)}{(I_{t-1}^c)} \qquad R_t^{oc} = \ln \frac{(I_t^c)}{(I_t^o)} \qquad R_t^{cc} = \ln \frac{(I_t^c)}{(I_{t-1}^c)}$$

Table 1 gives the descriptive statistics for the stock market indexes analyzed. As already stated, the closing price data are available for the whole sample period for the majority of the markets considered, but the opening price data for some cover a more limited period. Furthermore, to ensure time homogeneity in the return estimates, returns were not calculated for no-trading periods of 3 days or more (excluding Saturdays and Sundays). This leaves us with different numbers of observations for close-to-close, close-to-open and open-to-close returns.

As the table shows, the daily returns appear to be slightly positive, but not significantly different from zero. The success rate of positive returns is approximately 50%. The only positive return rates clearly below 50% are found in the off-market (close-to-open) returns for the US, UK, German and French stock markets.

3.-The NYSE holiday effect on European stock markets

As an initial approximation, Table 2 presents the close-to-close return estimates for the whole sample of stock markets for days on which the NYSE is closed. Also shown are the standard deviations and the percentage of positive returns. Finally, given that most of these holidays fall on weekdays, specifically 4 Mondays and 1 Thursday, the table also contains the data for those days of the week.

The results shown in Table 2 are very revealing. The daily returns of the European stock markets when US market is closed range between 0.22% for the Paris stock exchange CAC40 and 0.42% for the German DAX30. The close-to-close returns of the European stock markets considered show an average of 0.32%, versus 0.02% for the study period as a whole. In other words, when the US market is closed, returns on the European stock markets are 15.53 times higher than the usual average. They are 20.26 times higher than the average for Mondays and 17.34 higher than the average for Thursdays across the set of European stock markets considered.

As can be seen, all the indexes considered, except for the French CAC40, whose returns on those days are different from zero at only just above the 10% level, show significantly positive close-to-close returns, unlike either the average returns or the usual Monday or Thursday returns.

The percentage of days showing positive returns is also higher when the NYSE is closed for trading due to a holiday. In fact, the average percentage of positive returns is 68.70%, practically twice the usual Monday or Thursday percentage and 37% higher than the returns for the sample period as a whole.

Finally, the average return deviation for the European stock markets when the NYSE is closed for a holiday is 1.26%, and accounts for 93% of the average deviation over the whole sample period. This deviation is approximately twice that of a normal Monday and practically two and a half times that of a normal Thursday. In any event, the risk premium is clearly high on US public holidays: 16.63 times higher than for overall returns, 10.78 higher than the Monday average and 7.94 higher than the Thursday average.

These results suggest that the European stock markets perform very favorably on NYSE holidays, and that the situation is clearly potentially exploitable.

It is also worth noting that the magnitude of the effect is such that the profits cannot easily be eroded by transaction costs. This is an issue that we will return to later, however.

We continue this initial descriptive analysis with a regression analysis that will allow us to control for additional variables, such as past market data for the European markets or the NYSE. The variance is modeled using a GARCH(1,1) specification, since the Engle's test results reveal the presence of significant ARCH effects in all the markets considered. As a first approximation, we consider the following regression equation:

$$R_t^E = \beta_0 + \beta_1 . D_H^{NY} + \beta_2 R_{t-1}^E + \beta_3 R_{t-1}^{NY} + u_t$$

where u_t follows a $N(0, h_t)$; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

R_t^E is the return estimate for the European market considered, and R_{t-1}^{NY} is the ordinary rate of return for the NYSE, after deducting the effect of the ordinary return rate of the domestic market in question[2] and D_H^{NY} is a dummy variable that is equal to 1 on NYSE holidays that coincide with trading days in the European market under consideration and 0 otherwise. We use the GARCH(1,1) model because it is a parsimonious approximation of conditional volatility models that appears to provide a good fit with finance series volatility patterns (see Lamoreaux and Lastrapes, 1990).

Table 3 gives the results of the above regression analysis of the various markets considered. As can be seen, the β_1 coefficient, obtained using the GARCH(1,1) model, is positive in all cases and significant at the 10% level[3]. In other words, NYSE holidays have an observable effect on the European stock markets that does not appear to be due to the impact of the previous day's trading either on the European market considered in each case or on the NYSE.

The observed effect can obviously be attributed to other seasonal effects, such as the day of the week effect, the January effect or the pre-holiday effect. These

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[2] Due to correlation between the European stock markets and the NYSE, which appear as dependent variables, in order to avoid problems with collinearity, we ran an auxiliary regression between the US market and the European market and introduced the residuals of this regression instead of the original variable. This solution removes the risk of problems with collinearity, and, although it may cause some problems with the interpretation of the transformed variable, this has no importance in the case in hand.

[3] Panel A in table 3 shows the results from the estimation of the GARCH (1,1), while panel B shows the Newey-West robust covariance matrix for OLS estimates. Henceforth, we will provide only the GARCH (1,1) results. The results using both estimation procedures are similar. These results are available upon request.

possibilities are discarded by including dummies for the above-mentioned effects, which leaves the following equation:

$$R_t^E = \beta_0 + \beta_1.D_H^{NY} + \beta_2.D_M + \beta_3.D_T + \beta_4.D_{Th} + \beta_5.D_F + \beta_6.D_D + \beta_7.D_J + \beta_8.D_{PH}^E + \\ + \beta_9 R_{t-1}^E + \beta_{10} R_{t-1}^{NY} + u_t$$

where u_t follows a N(0, h_t) ; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

D_M, D_T, D_{Th} and D_F are the Monday, Tuesday, Thursday and Friday dummies, respectively, and D_D and D_J are the December and January dummies, respectively. Finally, D_{PH} is the pre-holiday dummy for the European market in each case.

The results obtained (see Table 4) show that the incorporation of seasonal effects in no way alters the previous findings. This is hardly surprising in the case of the daily seasonal effects, since, although 4 out of the 6 holidays are Mondays, the preliminary findings had already revealed the US holiday returns to be different from Monday returns and Thursday returns.

The results also prove to be robust to the use of December and January dummies to capture the turn-of-the-year effect. This was foreseeable given that the only holiday to fall in either of those months is Martin Luther King Day, which actually falls in the second fortnight of January when the turn-of-the-year effect has lost some of its impact. Finally, even after including the pre-holiday effect of the market under analysis, although it is statistically significant for all market indexes, the results still remain unaltered.

It is assumed in the above analyses that European stock market performance on NYSE holidays is independent of the sign of closing returns on the NYSE the previous day. However, there are reasons to believe that the sign of the news may have an impact on price movements and thereby on subsequent market performance (see Hong, Lin and Stein, 2000 or Blasco et al., 2005). In order to investigate this issue we estimate the following regression:

$$R_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_M + \beta_{4.}D_T + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \\ + \beta_9.D_{PH}^E + \beta_{10} R_{t-1}^E + \beta_{11} R_{t-1}^{NY} + u_t$$

where u_t follows a N(0, h_t) ; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

The dummy variable $D_H^{NY,P}$ ($D_H^{NY,N}$) is equal to 1 on NYSE holidays that are trading days for the European stock markets, after positive (negative) closure on the NYSE the day prior to the holiday and 0 otherwise.

The results, which are given in Table 5, prove to be quite revealing, because the effect is statistically significant only after positive closure on the NYSE, with the exception of the French stock exchange, where there is no significant effect at all, and the Spanish stock exchange where it is significant after both positive and negative NYSE closure[4]. The remaining markets show a significant effect only after positive closing returns on the NYSE the previous day. It does not therefore appear to be a mere question of return persistence, since there is no return persistence after negative closure on the NYSE. This seems to be a more complex phenomenon.

To explore the issue further, we propose the decomposition of the European stock market returns into off-market returns and intraday returns. It appears reasonable to assume that if the observed effect is the result of some of the NYSE information not being fully reflected in prices on European stock markets before they close, we should see a considerable effect on the off-market returns of the European stock indexes and a less marked or even inexistent effect on intraday returns. However, if the effect is not directly related to the incorporation of US market news pending, the effect on intraday returns should be equal to or greater than on off-market returns. In this respect, as argued by French and Roll (1986), the NYSE previous day's closing return is public information that emerges outside EU market trading hours and should therefore become incorporated at start of trading on EU markets the following day. Finally, the results may be due to positive EU market opening returns generated by a higher concentration of retail investors, as reported by Berkman et al. (2011) for the US market. We will examine this possibility in section 5.

[4] We performed several tests to evaluate the effect of Lindley's paradox on our results. First, we computed a standardized measure of the effect size (Cohen's d), which range between 0.14 and 0.27, and show a small effect for 3 of the markets (CAC40, Eurostoxx50 and Ibex35) and a medium one for 2 of them (Dax30 and FTSE100). The Cohen's d following a positive NYSE closing return are always medium, ranging between 0.33 and 0.55, that is, 2.28 times higher than the value associated with the US holiday effect without taking into account the sign of the previous day's NYSE closing return. Using Chebyshev's inequality, the lowest probability of an US holiday effect greater than zero under any distribution is 0.74 for the CAC40, 0.95 for the DAX30, 0.90 for the EUROSTOXX 50, 0.95 for the FTSE100 and 0.92 for the IBEX35. If we calculate the probability of a US holiday effect after a positive previous day's NYSE closing return, we find that the lowest probabilities are slightly higher. We also computed the Mann-Whitney test for any US Holiday and compared against the rest of the trading sessions. We found significant differences with p-values below 0.01, except for the CAC40, which showed a p-value of 0.033. We also computed this test for a US Holiday following a positive NYSE closing return and compared against the rest of the trading sessions. In this case, all the differences were significant with p-values below 0.001, except for the CAC40, which showed a p-value of 0.0048. Thus, all these results appear to suggest that the effect is not due to Lindley's paradox.

The results, which are given in Tables 6 and 7, respectively, are enlightening, since we find that European off-market returns on the NYSE holiday are not significantly different from zero at the standard levels of significance, regardless of the sign (positive or negative) of the NYSE's previous day's closing return. Turning to intraday returns, however, we find a significant holiday effect, but only after positive closing returns on the NYSE the previous day. The exceptions are the CAC40, which shows very small but statistically significant positive returns in both cases and the Eurostoxx50 which shows statistically significant negative returns after negative closing returns on the NYSE the day before the holiday. Thus, neither positive opening returns, nor the incorporation of public information about the NYSE previous day's closing return can explain our results.

This enables us to confirm that the effect appears after the NYSE information has been fully reflected in European stock market prices at market opening, which means that the effect is basically related to that day's trading on the European stock markets and is not triggered by an incorporation of news from the previous day's trading on the NYSE. However, there is no reason to assume that this is due exclusively to the effect of off-market news on EU market prices, since the interpretation of good and bad news by noisy traders in the information-scarce context typical of market holidays might also play a role, which is another possibility that we will discuss in section 5.

4. The economic significance of the NYSE holiday effect: Strategies-trading with future contracts.

In an initial approximation, we present a graph with the return from buying at opening of trade on the European markets if the NYSE closed with positive returns on the day before the holiday and selling at close of trade (see Figure 1). This graph also enables us to compare of the returns to this strategy with each market's reference index return. It should be noted that not only does the strategy show a good return performance but also that the returns are not related with the market cycle, that is, positive returns are obtained in both bullish and bearish periods[5]. This apparent lack of correlation between this type of strategy and the European index returns could prove very interesting for professional portfolio managers intent on reducing risks and diversifying their strategies.

[5] We have in fact used the past 24 months' cumulative return as a proxy for the market state, under the premise that a positive cumulative return is indicative of an up-market period and a negative cumulative return is indicative of a down-market period (in line with Cooper et al, 2004 or Muga and Santamaria, 2009 research on the momentum effect) and the t-test reveals no significant differences in returns to the strategy between up-market and down-market states for any of the European stock markets considered. The results are available upon request.

To gain a better understanding of the economic significance of the effect, we implement strategies by trading index futures using closing price data. As Jensen (1978) notes, it is quite possible that "inefficiency" exists to the point where the benefits of exploiting it do not offset the costs incurred in doing so. The first strategy is to take a buying position on European futures the day before a Holiday and take a selling position the day after. This strategy is implemented only on NYSE holidays. Given that the closing prices of the index futures in question are available from Bloomberg, we will assume implementation of the strategy at those prices. Furthermore, since we have shown the effect to be greater after positive closing returns on the NYSE the day before the holiday, we calculate the strategy return for that case only. Finally, for the sake of comparison, we calculate the return on the same strategy when the previous day's NYSE closing return was negative[6]. We use strategies on index futures because they allow us to trade on the indexes directly, with a relatively small investment and very low trading fees[7].

The results show the economic importance of the strategy that consists of buying the day prior to the US holiday and selling at the close of the day's trading, after positive closing returns on the NYSE the previous. The return ranges from 0.47% for the CAC40 to 0.74% for the Eurostoxx50, all returns being positive and significant at the standard levels. These gross returns are considerably higher than the trading fees, which barely amount to 0.01%. It is important to note that the average returns from strategies based on daily futures trading are not significantly different from zero. They are in fact significantly different from those obtained from trading only on NYSE holidays, particularly when the previous day's closing price on the NYSE was positive. There is also no significant difference from zero in the returns from strategies based on trading on European trading days that are holidays for the NYSE after negative closing returns on the NYSE the day before. This could be why daily trading on NYSE holidays produces positive returns that are sometimes statistically significant.

5.- Volume-return relationships and investor behavior.

As mentioned in the introduction to this paper, it is not easy to explain the presence of seasonal effects within the framework of the Efficient Market

[6] Although other strategies involving earlier buys and later sells were theoretically possible, given that the NYSE does not open until 15:30, central European time, the following day, or at least until the opening of the US futures market (one hour earlier), lack of data prevented us from creating other strategies.

[7] Total fees for an institutional investor applying the buy-sell strategy amount to around €1.55 for a Eurostoxx50 future to £2.45 for a FTSE100 future.

Hypothesis (EMH). However, the "behavioral finance" literature has given rise to a series of theoretical models, which, without forming a single corpus, provide explanations for some reported phenomena that the EMH approach has failed to explain.

One of the earliest theoretical models in this line of research is that proposed by DeLong el al. (1990) which describes a market in which there are irrational noise traders with erroneous stochastic beliefs. The presence of this type of investor generates in the market an asset pricing risk that prevents the arbitrage predicted by the EMH, and leads to a persistent shift in the prices of these assets. According to the cited authors, their model helped to explain some of the anomalies documented up to that date such as the mean reversion of stock returns, De Bondt and Thaler (1985).

The predictions of this model may vary with changes in the proportions of rational arbitrageurs and noise traders in the investor mix. Therefore a reduction in the proportion of noise traders in the market would reduce the risk of major equilibrium price deviations and thereby lower expected returns. Hong and Yu (2009) use the same model to explain the summer vacation effect mentioned in the introduction, which they call "Gone fishin' " using observations in 51 stock markets around the world. This seasonal effect consists of a significant reduction in trading activity over holiday periods, accompanied by a return dip in the various markets considered. The authors' proposed explanation for this is variation in the ratio of investor types at different points of time.

The model developed by DeLong et al. (1990) is not the only one that uses the presence of heterogeneous agents to explain stock market price movements. Hong and Stein (2007) offer a review of the literature describing a set of behavioral finance models, known generically as Disagreement Models, which share a basic common feature in that they ascribe a key role to heterogeneous beliefs on the part of investors. According to their review, the main characteristic of these models is that they predict a positive correlation between stock returns and trading volume.

There is a diversity of mechanisms that can generate investor disagreement, depending on the model being analyzed. Thus, Hong and Stein (1999) present a model with gradual information flow in which certain relevant news reaches some investors sooner than others, causing asset-pricing variation that leads to increased trading activity, this effect is more pronounced in the event of bad news, as shown by Hong, Lim and Stein (2000). Another mechanism, reported in works such as Hirshleifer and Teoh (2003) or Pen and Xiong (2006), is known as "limited attention", by which investors pay attention only to a limited range of the available data. One last investor behavior mechanism that can generate disagreement is the presence of heterogeneous priors (Kandel and Pearson, 1995).

The combination of these mechanisms with the arrival of market news produces an effect between stock returns and trading volume that predicts a positive relationship between the two. Evidence of this relationship can be found in the literature, for example in the already cited Hong and Yu (2007) which reports a reduction in trading volume associated with lower stock returns during holiday periods, or in Mei, Scheinkman and Xiong (2009) which describes higher returns associated with higher trading volumes for similar shares in a dual trading market such as the Chinese stock market. They specifically report lower trading volume and returns in the portion of the market available to foreign investors in China.

This interpretation of trading volume contains the underlying idea that it could be a sort of proxy for investor sentiment. However, it appears that certain premises must be satisfied before this positive relationship between volume and returns can exist. Firstly, there must be no change in the investor mix in the market, since this plays a decisive role in overall investor disagreement. Secondly, the only change must be in the volume of information reaching the market, such that this is the only variable that can trigger the investor disagreement mechanisms. At this point, various questions arise. What happens if there is a change in the investor mix as well as in the volume of information? What happens if the investor mix changes but the volume of information remains the same? We believe that there is no direct answer to these questions, since the two forces that are involved can produce opposing effects. In concrete terms, assuming no change in priors or investor mix, higher (lower) trading volume will be linked to higher (lower) investor disagreement, which, according to the arguments put forward by Hong and Stein (2007) will result in higher (lower) stock returns. However, changes in the investor mix, defined as the ratio of noise traders to sophisticated traders, will alter the level of noise trader risk and, according to De Long et al (1990), will trigger rising or falling returns.

In the case of the NYSE holiday effect, one can expect a foreseeable change in the investor mix due to an increase in the ratio of noise traders to sophisticated traders. We assume that US investors who trade in European stock markets are mostly institutional investors and, therefore sophisticated traders[8] The absence in

[8] In 2008, US equity funds managed the 60% of the total net assets managed by equity funds in the World. The total net assets managed by equity funds were 5,844 billions of dollars. The 22% of the US equity funds are international equity funds. The market value of US holdings of foreign securities is also very important. In 2008 this value was 2,748 billions of dollars (5,253 in 2007). Europe attracts

the European stock markets of these investors would lead us to predict higher returns on those days because of the increase in the ratio of noise traders.

At the same time, the flow of information is significantly lower since the European stock markets will not feel the impact of the opening of the NYSE nor will they need to react to macro news from the US. Considering this issue alone, that is, the reduction in news output, and assuming no change in priors, there should be a reduction in investor disagreement, trading activity and returns. Thus, the final outcome of this effect and the change in the investor mix will depend on their intensity.

In this situation, the sign of the previous day's closure on the NYSE may play a key role in predicting the final outcome. In fact, the findings for returns might be consistent with this line of reasoning. In particular, it appears reasonable to believe that after positive closing returns on the NYSE the previous day, the weight of bullish noise traders will have a strong impact, generating buying pressure that will drive asset prices upwards on the European stock markets. However, after negative closing returns on the NYSE, their weight will be much less; the impact will be further reduced by short selling constraints; and European stock market returns might remain unaltered as the change in investor mix and the lower level of information flow cancel each other out.

We test these arguments by examining trading volume patterns on the European stock markets on the 6 NYSE holidays. The study variable is abnormal trading volume[9], which is written as follows:

$$V_t^E = V_t^{E,O} - \frac{\sum_{s=1}^{200} V_{t-s}^{E,O}}{200}$$

where $V_t^{E,O}$ is the log of the ordinary trading volume of the European market index E on day t.

The model specification used to test for abnormal trading volume on US market holidays is in line with that used to test for abnormal returns, but has some differences. The constant is assigned to Mondays, since the Monday trading volume is lower than that of other days of the week and, at least 4 of the 6 holidays are Mondays. This makes for clearer interpretation of the holiday dummy[10]. Year

more than 40% of the US equity investment (see www.ici.org and Department of the Treasury, Federal Reserve Bank of New York for further details)

[9] The selected measure in analogous with that used in works such as Llorente et al (2002), Dennis and Strickland (2002), Covrig and Ng (2004) or Del Rio and Santamaría (2010).

[10] Note that, as far as the return data are concerned, there is no day of the week that shows significantly higher values than any other for the sample period considered.

dummies are also included to capture the fact that volume can vary greatly from one period to another and may not be fully captured by the moving average used to correct for ordinary volume. Furthermore, since trading volume shows considerably higher autocorrelation, one week lagged trading volume is included. In addition, since the Engle's test results reveal the presence of ARCH effects, the variance is modeled by means of a GARCH (1,1) specification, which takes the following form:

$$V_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_T + \beta_4.D_W + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \beta_9.D_{PH}^E + \\ + \sum_{j=1}^{4} \beta_{9+j} V_{t-j}^E + \sum_{k=1}^{13} \beta_{11} D_k + u_t$$

where u_t follows a $N(0, h_t)$; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

As already stated, expected trading volume in the European stock markets is lower on US market holidays, due to the absence of US investors and a reduction in investor disagreement produced by lower information volume. The withdrawal of US institutional investors alters the investor mix by increasing the proportion of noise traders. In fact, according to the model used by DeLong et al (1990), the increase in the proportion of unsophisticated traders might be the reason for the European stock market return increases observed on US market holidays. Indirect evidence of this can be seen from a comparison of the volatility levels on NYSE holidays, which shows holiday Monday volatility to be twice that of any other Monday and holiday Thursday volatility to be two and half times that of any other Thursday.[11].

The absence of macroeconomic and stock market data, such as the NYSE opening price, means that the volume of information reaching the market is low compared with other days. This should also reduce the level of investor disagreement. The lack of any other market information makes the previous day's closure of the NYSE the main news item. Thus, assuming the hypotheses of the disagreement models, we should find higher trading volume in the European stock markets after positive NYSE closures than after negative ones, in association with the higher returns observed on European stock markets when the NYSE is closed for a holiday. However, analysis of the two variables mentioned above (less disagreement and a higher ratio of noise traders to sophisticated traders) shows that this relationship is no longer as direct. There is, in fact, no clear evidence to support the existence of higher trading volume in either case, beyond the fact that

[11] The available data for the Spanish market, which are more complete, show the average trade size on those days to be smaller, suggesting also a lower average investor size, which would be a sign of the withdrawal of a large proportion of institutional sophisticated traders.

a negative closure of the NYSE the previous day would trigger a rush of sell orders. It is not clear, however, whether the resulting increase in trading activity would be statistically significant.

Table 9 shows the results for the various European stock markets analyzed[12]. As stated earlier, the trading volume for Mondays is significantly lower than for other days of the week. Pre-holidays on the European stock markets are also associated with lower trading volume, though not significantly lower in the majority of cases than the average for Mondays. However, NYSE holidays produce volumes significantly below the Monday average and thus also below the Thursday average, which is significantly higher. As expected, therefore, there is substantially less trading activity on NYSE holidays than on any other day, after controlling for effects such as the day-of-the-week effect, the January effect or the pre-holiday effect.

The results show that trading activity drops significantly after positive and negative previous day's closures on the NYSE in all the observed indexes except the DAX30, where, although trading on these days is below the average for other days when the US market closure was positive (χ^2=4.79, p=0.028) but not when it was negative (χ^2=0.04, p=0.847), it is still higher than the Monday average. Nevertheless, a certain pattern does emerge, in that the trading volume on the European stock markets when the NYSE is closed does not vary significantly as a function of positive or negative closure of the US stock exchange.

This result does not support the direct conclusions from the disagreement models, which do not capture the effect on trading volume of a relevant change in the market investor mix, but it does support our hypothesis relating to the effect of lower information volume in conjunction with a higher ratio of noise traders to sophisticated traders.

Overall, the results presented show higher returns in association with lower trading activity in the European stock indexes on days when the NYSE is closed. The relationship is not as predicted by the aforementioned investor behavior models, where there is a positive volume-return relationship. In the context of disagreement theories, volume could be a market sentiment proxy, Hong and Stein (2007).

In the context of this study, however, lower trading volume is not due to less investor disagreement; it is rather a consequence of the absence of a particular type of trader in the market, namely, US traders, whose absence increases the ratio of

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[12] We also computed theNewey-West robust covariance matrix for OLS estimates with similar results. The results are available upon request.

noise traders to sophisticated traders. The absence of the latter is reflected in the drop in trading volume observed on Mondays[13] and the further drop that can be observed in the European stock markets when it is a holiday in the US.

Changes in the investor mix may affect return patterns. Berkman et al. (2011), who find positive returns generated during the off-market period that revert during the trading day, attribute the phenomenon to the higher concentration of retail investors at start of trade on the markets. In our case, the higher concentration of retail investors in the investor mix may be due to the absence of US institutional investors during the trading session, which is one of the potential sources of the higher intraday returns found earlier[14].

We have already stressed the fact that the absence of US institutional investors should not, in itself, cause any variation in market returns. Indeed, as can be seen from the data displayed in Table 9, the average abnormal trading volume for Mondays is lower than for any other day of the week, with no observed effect on returns, which are not significantly different from other days of the week. The phenomenon therefore appears to require the interaction of some additional factor, which could be the difference in the flow of information to the European stock markets that takes place on such days, since no significant news will be expected from the US market during these trading sessions[15].

In particular, taking the key news to be the previous day's closure of the NYSE, when it has been positive, bullish European noise traders can take a buying position without worrying about having to close it before the end of the session, since they will not be expecting bad news at the start of trading in New York, and

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[13] Note that institutional money from the US would enter the European market from 2 pm European time (8 am NY time) at the earliest, possibly even later, following early morning meetings to plan the week's decisions.

[14] These returns, due to changes in the investor mix, as reported by Berkman et al (2011), should revert with the return of sophisticated traders to the market. To test this assumption, we repeated the analysis reported in table 5, this time including a dummy variable to capture the post-NYSE holiday effect. The results, which were statistically significant at the 5% level for the FTSE and at the 10% level for the DAX, and non-significant for the remaining indexes, are partially consistent with findings reported by Berkman et al. (2011) and with the effect of changes in the investor mix explained earlier. It should be noted, however, that the alteration in the investor mix that takes place on NYSE holidays persists for a few hours of the following day's trading session, that is, until institutional investors begin trading in the US. This could result in weaker return reversal than would occur if they were already in action at start of trading on European markets. The results of this analysis are available from the authors upon request.

[15] Obviously, the absence of macro news from the US market, together with the fact that it is closed for trading, result in a marked decrease in information flow on those days. One indirect factor that can be cited is that the bid-ask spread, which could be taken as a proxy for disagreement or information asymmetries resulting from the arrival of information, is significantly lower for the Spanish market, after controlling for daily, monthly and pre-holiday seasonal effects. In fact, Monday's spread is somewhat, though not significantly, higher than the average for all other days. However, the spread on NYSE holidays is significantly lower than all other days and, importantly, it is significantly lower than for other Mondays (approximately 7% lower than for an average session and 9% lower than for any other Monday)

no relevant macro data will have emerged. This state of affairs will generate buying pressure in the market leading to positive returns associated with the low trading volume observed in this study.

If, on the other hand, closing returns on the NYSE are negative, traders taking up a buying position to make the most of the lack of news due to the NYSE holiday will be joined by traders wishing to sell as a result of the NYSE negative closure. This is likely to prevent very intense buying pressure and thereby significant abnormal returns.

Both effects can be assumed to be driven by the absence of a large proportion of US institutional investors. It should be stressed that their absence changes the investor mix by increasing the ratio of noise traders to sophisticated traders, thus generating noise trader risk, which might explain the existence of abnormally positive returns on such days.

6.-Conclusions

This paper has revealed the existence of a new share price anomaly for which there is no evidence in the academic literature as far as we are aware. The said effect consists of the presence of significant positive returns in European stock markets on days when the NYSE takes a holiday. This anomaly is not due to seasonal effects, such as the day-of-the-week, January or pre-holiday effects, although most of the NYSE holidays in fact fall on Mondays. Since the previous day's inertia both on the European market being considered and the US market also fail to provide the explanation, we rule out explanations citing previously-documented capital market anomalies. It should be noted that the effect, which is of considerable magnitude and can be economically exploited, cannot easily be explained in terms of issues relating to transaction costs or traditional risk factors. In fact, the returns are about 15 times higher than on an average day during the sample period and are also associated with below-average total risk.

More detailed analysis has shown that this effect is not indifferent from the previous day's return on the NYSE. In fact, it only reaches significance after positive closing returns on the NYSE. Analysis of open-to-close and close-to-open returns shows that the effect is observed almost exclusively in intraday returns, and therefore cannot be due to NYSE information because it has been fully reflected in European stock market prices at market opening.

On US market holidays, the European stock markets present two characteristics that can explain the results obtained. Firstly, these trading sessions are devoid of economic news announcements from the world's main economic news generator. Therefore the absence of US markets also has an effect on the total amount of relevant news being conveyed to the European stock markets. All other conditions being equal, this situation will reduce the level of investor disagreement, which, according to the arguments put forward by Hong and Stein (2007), should result in lower trading volume and lower returns. In addition, the withdrawal of US investors results in an increase of the ratio of noise traders to sophisticated traders, which in turn generates noise trader risk; this, according to De long et al. (1990), will result in positive returns. The conjunction of both effects predicts lower volume, but not necessarily the lower returns predicted by the disagreement models, where the volume-return relationship is assumed to be positive, since the final impact on returns will depend on the joint impact of both effects.

Finally, the magnitude of the effect depends on the sign of the previous day's closure of the NYSE, in the sense that, if it is positive, the weight of bullish noise traders will cause buying pressure, driving prices upwards, and arbitrageurs will refrain from trading for fear of prices shifting even further from equilibrium. If, however, the NYSE is negative, short selling constraints in conjunction with less upward price pressure could offset both effects.

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	Return	SD	Max	Min	N	N+	%N+
USCO	0.00%	0.13%	1.65%	-2.27%	4513	1596	35.36%
USOC	0.02%	1.09%	9.46%	-9.13%	4514	2373	52.57%
USCC	0.02%	1.12%	10.96%	-9.47%	4513	2375	52.63%
CCCO	0.02%	0.71%	6.81%	-7.57%	4507	1673	37.12%
CCOC	-0.01%	1.15%	7.32%	-7.68%	4027	2040	50.66%
CCCC	0.01%	1.39%	10.59%	-9.47%	4507	2315	51.36%
DXCO	0.01%	0.40%	3.75%	-7.83%	3772	1351	35.82%
DXOC	0.01%	1.39%	11.14%	-8.87%	3779	2017	53.37%
DXCC	0.02%	1.52%	10.80%	-8.87%	3772	2014	53.39%
EXCO	0.04%	0.73%	6.22%	-5.65%	4332	2284	52.72%
EXOC	-0.03%	1.46%	9.60%	-7.90%	2401	1208	50.31%
EXCC	0.02%	1.34%	10.44%	-8.18%	4332	2293	52.93%
FTCO	0.01%	0.41%	5.43%	-4.14%	4424	1159	26.20%
FTOC	0.00%	1.14%	8.42%	-9.20%	3593	1858	51.71%
FTCC	0.01%	1.15%	9.38%	-9.27%	4424	2255	50.97%
SPCO	0.00%	0.81%	6.05%	-15.57%	4456	2290	51.39%
SPOC	0.03%	1.13%	11.35%	-6.52%	4464	2380	53.32%
SPCC	0.03%	1.36%	10.12%	-9.59%	4456	2367	53.12%

Table 1.-Summary statistics for the data sample. The US market is measured by the NYSE S&P500 index (US); the Spanish market by the Stock Exchange Association's IBEX35 index (SP); the Eurostoxx platform by the EUROSTOXX50 index (EX); the German market by the DAX30 (DX); the British market by the FTSE100 (FT); and the French market by the CAC40 (CC). CC, CO, and OC denote close-to-close, close-to-open and open-to-close returns, respectively. Daily returns (Return), Standard deviation of daily returns (SD). Max (Min) is the maximum (minimum) of daily return. N is the number of observations. N+ is the number of observations with positive return. %N+ is the percentage of observations with positive return.

	CAC40	DAX30	EUROSTOXX50	FTSE-100	IBEX35
Holiday in NY (Return)	0.22%	0.42%**	0.28%*	0.35%*	0.32%*
Holiday in NY (SD)	1.30%	1.30%	1.24%	1.15%	1.32%
Holiday in NY (% Ret +)	63.64%	73.81%	66.32%	67.47%	72.28%
Sample (Return)	0.01%	0.02%	0.02%	0.01%	0.03%
Sample (SD)	1.39%	1.52%	1.34%	1.15%	1.36%
Sample (% Ret +)	51.36%	44.69%	50.88%	50.03%	52.52%
Monday (Return)	-0.03%	0.10%	0.03%	0.00%	-0.03%
Monday (SD)	0.80%	0.43%	0.83%	0.45%	0.85%
Monday (%Ret +)	33.73%	29.76%	48.18%	23.34%	45.82%
Thursday (Return)	0.03%	-0.03%	0.01%	0.04%	0.04%
Thursday (SD)	0.72%	0.33%	0.69%	0.41%	0.75%
Thursday (% Ret +)	36.19%	28.05%	49.89%	24.09%	50.75%

Table 2. Close-to-close data for the various European share indexes considered. Daily returns (R), Standard deviation of daily returns (SD) and percentage of positive returns (% Ret +). * and ** denote significance at the 5% and 1% levels, respectively.

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
Panel A: Estimation using GARCH(1,1)										
β_0	0.0267	0.11	0.0584	0.00	0.0452	0.00	0.0350	0.00	0.0564	0.00
β_1	0.1848	0.09	0.2579	0.03	0.1600	0.07	0.2104	0.01	0.2579	0.01
β_2	1.6320	0.29	-0.1813	0.91	2.9236	0.05	-2.7262	0.13	5.3415	0.00
β_3	39.8701	0.00	37.1683	0.00	43.7313	0.00	31.7774	0.00	30.6179	0.00
α_0	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
α_1	0.0702	0.00	0.0804	0.00	0.0778	0.00	0.0824	0.00	0.0983	0.00
α_2	0.9183	0.00	0.9090	0.00	0.9181	0.00	0.9113	0.00	0.8872	0.00
AdjR^2	0.108		0.068		0.129		0.120		0.078	
Panel B: OLS Estimates. Newey-West standard errors										
β_0	0.0014	0.94	0.0046	0.85	0.0136	0.45	0.0124	0.42	0.0250	0.21
β_1	0.1758	0.17	0.4171	0.00	0.2660	0.03	0.3195	0.00	0.3043	0.02
β_2	-0.6591	0.77	-1.6836	0.40	-1.2948	0.59	-1.7355	0.46	1.8878	0.43
β_3	48.6354	0.00	40.7430	0.00	51.2846	0.00	42.0491	0.00	38.4400	0.00
AdjR^2	0.1255		0.0777		0.1468		0.1387		0.0881	

Table 3: Results of the test of the NYSE holiday effect on European stock markets. The β coefficients are multiplied by 100. R_t^E is the return of the European market under consideration and R_{t-1}^{NY} is the NYSE ordinary return, after controlling for domestic market ordinary returns and D_H^{NY} is a dummy variable that is equal to 1 for NYSE holidays that are Trading days in the European market under consideration in each case and 0 otherwise.

Panel A shows the results using GARCH (1,1)
$R_t^E = \beta_0 + \beta_1 . D_H^{NY} + \beta_2 R_{t-1}^E + \beta_3 R_{t-1}^{NY} + u_t$; where u_t follows a N(0, h_t); $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

Panel B shows the Newey-West robust covariance matrix for OLS estimates. $R_t^E = \beta_0 + \beta_1 . D_H^{NY} + \beta_2 R_{t-1}^E + \beta_3 R_{t-1}^{NY} + u_t$

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
β_0	0.0087	0.80	0.0193	0.60	0.0420	0.14	0.0210	0.42	0.0232	0.49
β_1	0.2130	0.05	0.2579	0.03	0.1688	0.06	0.2319	0.00	0.2884	0.00
β_2	-0.0294	0.54	0.0479	0.37	-0.0085	0.84	-0.0176	0.64	-0.0243	0.61
β_3	-0.0117	0.81	0.0283	0.58	-0.0254	0.53	-0.0064	0.86	-0.0084	0.86
β_4	0.0019	0.97	-0.0213	0.68	-0.0367	0.37	0.0155	0.68	0.0426	0.36
β_5	0.0367	0.46	0.0507	0.33	0.0026	0.95	0.0383	0.31	0.0841	0.08
β_6	0.0615	0.27	0.0884	0.14	0.0825	0.12	0.0924	0.02	0.0496	0.39
β_7	0.0987	0.07	0.0678	0.29	0.0948	0.04	-0.0077	0.86	0.0797	0.18
β_8	0.1627	0.09	0.2163	0.03	0.2839	0.05	0.0164	0.79	0.1184	0.13
β_9	1.5987	0.30	-0.2862	0.86	2.8587	0.05	-2.8238	0.11	5.2301	0.00
β_{10}	39.8207	0.00	37.0764	0.00	43.7751	0.00	31.7627	0.00	30.4713	0.00
α_0	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
α_1	0.0698	0.00	0.0819	0.00	0.0099	0.00	0.0815	0.00	0.0981	0.00
α_2	0.9188	0.00	0.9085	0.00	0.0093	0.00	0.9123	0.00	0.8874	0.00
$AdjR^2$	0.107		0.069		0.129		0.119		0.078	

Table 4: Results of the test of the NYSE holiday effect on European stock markets controlling for seasonal effects (day-of-the-week effect and January effect). The β coefficients are multiplied by 100. R_t^E is the return of the European market under consideration and R_{t-1}^{NY} is the NYSE ordinary return, after controlling for domestic market ordinary returns and D_H^{NY} is a dummy variable that is equal to 1 for NYSE holidays that are Trading days in the European market under consideration in each case and 0 otherwise. D_M, D_T, D_{th} and D_F are the Monday, Tuesday, Thursday and Friday dummies, respectively. D_D and D_J are the December and January dummies, respectively. D_{PH}^E is equal to 1 for the preholiday day in each European market.

$$R_t^E = \beta_0 + \beta_1.D_H^{NY} + \beta_2.D_M + \beta_3.D_T + \beta_4.D_{Th} + \beta_5.D_F + \beta_6.D_D + \beta_7.D_J + \beta_8.D_{PH}^E + \beta_9 R_{t-1}^E + \beta_{10} R_{t-1}^{NY} + u_t$$

where u_t follows a $N(0, h_t)$; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
β_0	0.0087	0.80	0.0202	0.58	0.0423	0.13	0.0209	0.42	0.0232	0.49
β_1	0.1884	0.20	0.3921	0.00	0.2327	0.03	0.2849	0.00	0.2737	0.01
β_2	0.2409	0.12	0.1231	0.53	0.1009	0.46	0.1828	0.11	0.3072	0.04
β_3	-0.0296	0.54	0.0478	0.37	-0.0084	0.84	-0.0182	0.63	-0.0244	0.61
β_4	-0.0116	0.81	0.0271	0.60	-0.0258	0.52	-0.0071	0.85	-0.0083	0.86
β_5	0.0020	0.97	-0.0214	0.68	-0.0369	0.37	0.0156	0.67	0.0425	0.36
β_6	0.0367	0.46	0.0501	0.33	0.0025	0.95	0.0374	0.32	0.0841	0.08
β_7	0.0615	0.27	0.0881	0.14	0.0828	0.12	0.0904	0.03	0.0497	0.39
β_8	0.0992	0.07	0.0640	0.31	0.0935	0.04	-0.0061	0.89	0.0796	0.17
β_9	0.1628	0.09	0.2166	0.03	0.2840	0.05	0.0149	0.81	0.1183	0.13
β_{10}	1.6254	0.29	-0.4218	0.79	2.7840	0.06	0.3322	0.83	5.2429	0.00
β_{11}	39.8645	0.00	36.8539	0.00	43.6503	0.00	31.6752	0.00	30.5039	0.00
α_0	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
α_1	0.0698	0.00	0.0860	0.00	0.0769	0.00	0.0789	0.00	0.0979	0.00
α_2	0.9188	0.00	0.9083	0.00	0.9193	0.00	0.9121	0.00	0.8877	0.00
$AdjR^2$	0.107		0.069		0.129		0.118		0.077	

Table 5: Results of the test of the NYSE holiday effect on European stock markets (close-to-close data) sorted by the sign of the NYSE close-to-close returns. All the β coefficients are multiplied by 100. R_t^E is the return of the European market under consideration and R_{t-1}^{NY} is the NYSE ordinary return, after controlling for domestic market ordinary returns and the dummy variable $D_H^{NY,P}$ ($D_H^{NY,N}$) is equal to 1 for NYSE holidays that are European market trading days, when the NYSE closed on a positive (negative) note and 0 otherwise. D_M, D_T, D_{th} and D_F are the Monday, Tuesday, Thursday and Friday dummies, respectively. D_D and D_J are the December and January dummies, respectively. D_{PH}^E is equal to 1 for the preholiday day in each European market.

$$R_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_M + \beta_4.D_T + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \beta_9.D_{PH}^E + \beta_{10}R_{t-1}^E + \beta_{11}R_{t-1}^{NY} + u_t$$

where u_t follows a $N(0, h_t)$; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
β_0	0.0089	0.59	0.0024	0.83	-0.0012	0.85	-0.0048	0.22	0.0029	0.83
β_1	-0.1285	0.14	0.0553	0.16	-0.0118	0.38	-0.0055	0.71	0.0082	0.89
β_2	0.0155	0.80	0.0506	0.26	-0.0297	0.37	-0.0010	0.96	0.0947	0.16
β_3	-0.0006	0.98	0.0016	0.93	0.0132	0.09	0.0072	0.09	-0.0273	0.16
β_4	0.0021	0.92	-0.0032	0.82	0.0117	0.20	-0.0065	0.13	0.0065	0.74
β_5	0.0139	0.48	0.0081	0.67	0.0173	0.07	0.0097	0.03	0.0182	0.36
β_6	-0.0046	0.84	0.0094	0.60	0.0028	0.72	0.0083	0.09	0.0073	0.71
β_7	-0.0009	0.97	0.0203	0.21	-0.0021	0.79	-0.0001	0.99	0.0068	0.79
β_8	0.0390	0.05	-0.0278	0.22	-0.0045	0.55	0.0023	0.73	0.0047	0.85
β_9	-0.0454	0.36	0.0055	0.82	-0.0210	0.37	-0.0128	0.13	-0.0176	0.64
β_{10}	1.8069	0.00	0.3933	0.42	-0.2946	0.18	0.0690	0.62	1.7973	0.00
β_{11}	23.4251	0.00	10.8923	0.00	9.1674	0.00	0.1903	0.27	35.6331	0.00
α_0	0.0000	0.00	0.0000	0.08	0.0000	0.00	0.0000	0.00	0.0000	0.00
α_1	0.1324	0.00	0.0681	0.00	0.1335	0.00	0.0828	0.00	0.1045	0.00
α_2	0.8558	0.00	0.9286	0.00	0.8585	0.00	0.8598	0.00	0.8839	0.00
AdjR^2	0.182		0.136		0.058		0.01		0.254	

Table 6: Results of the test of the NYSE holiday effect on European stock markets (close-to-open data) sorted by the sign of the NYSE close-to-close returns. All the β coefficients are multiplied by 100. R_t^E is the return of the European market under consideration and R_{t-1}^{NY} is the NYSE ordinary return, after controlling for domestic market ordinary returns and the dummy variable $D_H^{NY,P}$ ($D_H^{NY,N}$) is equal to 1 for NYSE holidays that are European market trading days, when the NYSE closed on a positive (negative) note and 0 otherwise.. D_M, D_T, D_{th} and D_F are the Monday, Tuesday, Thursday and Friday dummies, respectively. D_D and D_J are the December and January dummies, respectively. D_{PH}^E is equal to 1 for the preholiday day in each European market.

$$R_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_M + \beta_4.D_T + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \beta_9.D_{PH}^E + \beta_{10}R_{t-1}^E + \beta_{11}R_{t-1}^{NY} + u_t$$

where u_t follows a N(0, h_t) ; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
β_0	0.0001	0.00	0.0200	0.54	-0.0006	0.66	0.0066	0.03	0.0452	0.10
β_1	0.0015	0.05	0.3240	0.00	0.0193	0.00	0.0019	0.04	0.3004	0.00
β_2	0.0013	0.03	0.1517	0.33	-0.0280	0.00	0.0012	0.19	0.1672	0.14
β_3	-0.0003	0.00	0.0442	0.36	-0.0009	0.58	-0.0078	0.02	0.0399	0.31
β_4	-0.0001	0.01	0.0348	0.45	-0.0038	0.03	-0.0095	0.01	-0.0058	0.88
β_5	0.0002	0.00	-0.0283	0.55	0.0060	0.00	-0.0086	0.02	0.0327	0.39
β_6	-0.0001	0.00	0.0271	0.56	0.0015	0.41	-0.0078	0.04	0.0867	0.03
β_7	0.0060	0.02	0.0603	0.26	0.0007	0.56	-0.0054	0.09	0.0245	0.62
β_8	0.0000	0.96	0.0794	0.19	-0.0001	0.96	-0.0002	0.83	0.0734	0.13
β_9	0.0001	0.14	0.2016	0.02	-0.0602	0.00	0.0541	0.01	0.1864	0.00
β_{10}	0.0017	0.20	-1.5478	0.29	0.1909	0.02	0.0091	0.88	-1.8495	0.19
β_{11}	-0.0007	0.71	18.0895	0.00	1.3620	0.00	0.3659	0.00	-7.7144	0.00
α_0	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
α_1	0.1764	0.00	0.0898	0.00	0.1246	0.08	13.1308	0.00	0.1180	0.00
α_2	0.8023	0.00	0.9060	0.00	0.8363	0.00	81.8517	0.00	0.8704	0.00
AdjR^2	0.01		0.03		0.01		0.01		0.01	

Table 7: Results of the test of the NYSE holiday effect on European stock markets (open-to-close data) sorted by the sign of the NYSE close-to-close returns. All the β coefficients are multiplied by 100. R_t^E is the return of the European market under consideration and R_{t-1}^{NY} is the NYSE ordinary return, after controlling for domestic market ordinary returns and the dummy variable $D_H^{NY,P}$ ($D_H^{NY,N}$) is equal to 1 for NYSE holidays that are European market trading days, when the NYSE closed on a positive (negative) note and 0 otherwise. D_D and D_J are the December and January dummies, respectively. D_{PH}^E is equal to 1 for the preholiday day in each European market.

$$R_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_M + \beta_4.D_T + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \beta_9.D_{PH}^E + \beta_{10}R_{t-1}^E + \beta_{11}R_{t-1}^{NY} + u_t$$

where u_t follows a N(0, h_t) ; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

	CAC40	DAX30	ESTX50	FTSE100	IBEX35
Holiday in NY	0.00198	0.00364	0.00334	0.00278	0.00331
pvalue1	0.13	0.00	0.07	0.01	0.05
pvalue2	0.17	0.01	0.07	0.01	0.08
Holiday in NY & NY closes +	0.00471	0.00737	0.00743	0.00511	0.00674
pvalue1	0.01	0.00	0.00	0.00	0.00
pvalue2	0.01	0.00	0.00	0.00	0.00
Holiday in NY & NY closes -	-0.00069	-0.00002	-0.00177	0.00050	-0.00019
pvalue1	0.72	0.99	0.57	0.76	0.94
pvalue2	0.66	0.89	0.60	0.83	0.85
Total Sample	0.00016	0.00026	-0.00011	0.00015	0.00032
pvalue1	0.40	0.21	0.73	0.39	0.15
pvalue2	-	-	-	-	-

Table 8: Results of the futures strategies consisting of buying at close of trading the day prior to an NYSE holiday and selling at close of trading on the day of the NYSE holiday. pvalue1 is the significance level of the null hypothesis of zero returns. pvalue2 is the significance level of the hypothesis of zero mean difference between the strategy and the sample as a whole.

	CAC40		DAX30		ESTX50		FTSE100		IBEX35	
	Coef	pv	Coef	pv	Coef	pv	Coef	pv	Coef	pv
β_0	-0.0807	0.00	-0.0506	0.00	-0.0567	0.00	-0.0698	0.00	-0.0447	0.00
β_1	-0.1225	0.00	0.0274	0.06	-0.1450	0.00	-0.0831	0.00	-0.1338	0.00
β_2	-0.1462	0.00	0.0556	0.00	-0.1394	0.00	-0.1014	0.00	-0.1234	0.00
β_3	0.1128	0.00	0.0849	0.00	0.0914	0.00	0.0986	0.00	0.0686	0.00
β_4	0.1141	0.00	0.1003	0.00	0.0944	0.00	0.1073	0.00	0.0661	0.00
β_5	0.1188	0.00	0.0884	0.00	0.0923	0.00	0.1014	0.00	0.0684	0.00
β_6	0.0977	0.00	0.0769	0.00	0.0874	0.00	0.0681	0.00	0.0893	0.00
β_7	0.0047	0.63	0.0109	0.37	-0.1325	0.00	-0.0134	0.03	-0.0137	0.23
β_8	-0.0392	0.00	-0.0118	0.05	-0.0980	0.00	-0.0147	0.00	0.0180	0.02
β_9	0.0326	0.00	0.0291	0.00	0.0318	0.00	0.0316	0.00	0.0554	0.00
β_{10}	0.0173	0.04	-0.0023	0.73	0.0067	0.44	0.0201	0.00	0.0087	0.36
β_{11}	0.0202	0.02	-0.0151	0.03	-0.0005	0.95	0.0149	0.03	0.0018	0.86
β_{12}	-0.0061	0.44	-0.0303	0.00	-0.0222	0.00	0.0000	1.00	-0.0116	0.29
β_{13}	0.0023	0.78	-0.0232	0.00	0.0040	0.62	0.0039	0.53	-0.0041	0.68
β_{14}	-0.0008	0.92	-0.0227	0.00	-0.0016	0.84	-0.0027	0.70	0.0026	0.80
β_{15}	0.0085	0.32	-0.0185	0.01	-0.0084	0.12	-0.0070	0.26	0.0026	0.80
β_{16}	0.0090	0.32	-0.0257	0.00	-0.0096	0.26	-0.0049	0.49	-0.0082	0.47
β_{17}	0.0113	0.44	-0.0429	0.01	0.0067	0.71	0.0161	0.14	-0.0519	0.03
β_{18}	0.0032	0.67	-0.0430	0.00	-0.0049	0.46	0.0106	0.05	-0.0705	0.00
β_{19}	0.0058	0.44	-0.0113	0.12	-0.0036	0.66	-0.0009	0.88	0.0149	0.06
β_{20}	0.0270	0.00	-0.0153	0.03	-0.0001	0.99	0.0134	0.02	0.0303	0.00
β_{21}	0.0088	0.29	-0.0332	0.00	-0.0004	0.95	0.0068	0.33	0.0006	0.96
β_{22}	0.0048	0.57	-0.0449	0.00	0.0007	0.93	0.0129	0.04	-0.0176	0.07
β_{23}	0.3739	0.00	0.4831	0.00	0.3895	0.00	0.3141	0.00	0.3307	0.00
β_{24}	0.0965	0.00	0.1480	0.00	0.1192	0.00	0.1414	0.00	0.1171	0.00
β_{25}	0.0848	0.00	0.0952	0.00	0.0947	0.00	0.0992	0.00	0.0541	0.01
β_{26}	0.0812	0.00	0.0985	0.00	0.0713	0.00	0.1014	0.00	0.0876	0.00
α_0	0.0047	0.00	0.0084	0.00	0.0014	0.00	0.0031	0.00	0.0026	0.00
α_1	0.1228	0.00	0.3024	0.00	0.1663	0.00	0.3273	0.00	0.2353	0.00
α_2	0.4642	0.00	0.2751	0.00	0.7508	0.00	0.3976	0.00	0.6847	0.00
$AdjR^2$	0.3939		0.4414		0.3215		0.3986		0.2314	
χ^2	2.2169	0.13	1.7016	0.19	0.0739	0.78	1.7573	0.18	0.1677	0.68

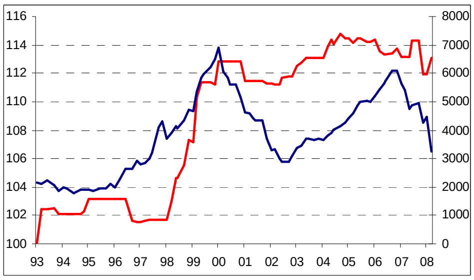
Table 9: Results of the analysis of volume traded on the various European stock markets considered. V_t^E is the abnormal trading volume of the European market under consideration in each case, which is defined as $V_t^E = V_t^{E,O} - \sum_{s=1}^{200} V_{t-s}^{E,O}$ where $V_t^{E,O}$ is the log of the ordinary volume of European market index E on day t. The dummy variable $D_H^{NY,P}$ ($D_H^{NY,N}$) is equal to 1 for NYSE holidays that are European market trading days, when the NYSE closed on a positive (negative) note and 0 otherwise. D_M, D_T, D_{th} and D_F are the Monday, Tuesday, Thursday and Friday dummies, respectively. D_D and D_J are the December and January dummies, respectively. D_k are the corresponding year dummies. Finally, the $\chi 2$ statistic is for the null hypothesis that trading volume will be the same after a positive closure (β_2) as after a negative closure (β_3) of the NYSE on the day prior to a holiday.

$$V_t^E = \beta_0 + \beta_1.D_H^{NY,P} + \beta_2.D_H^{NY,N} + \beta_3.D_T + \beta_4.D_W + \beta_5.D_{Th} + \beta_6.D_F + \beta_7.D_D + \beta_8.D_J + \beta_9.D_{PH}^E + \sum_{j=1}^{4}\beta_{9+j}V_{t-j}^E + \sum_{k=1}^{13}\beta_{11}D_k + u_t$$

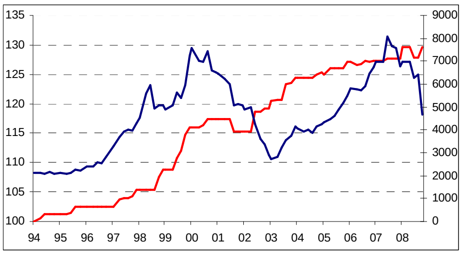
where u_t follows a N(0, h_t) ; $h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1}$

Figure 1: Comparative analysis of futures strategy return patterns

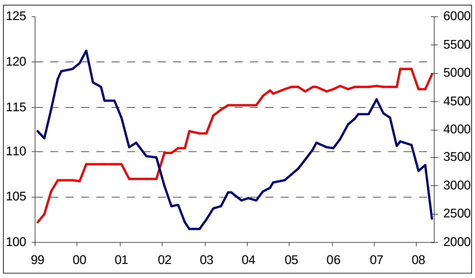
CAC40



DAX30



EUROSTOXX50



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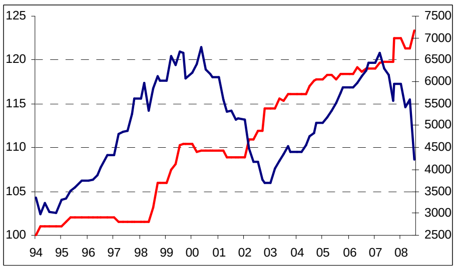
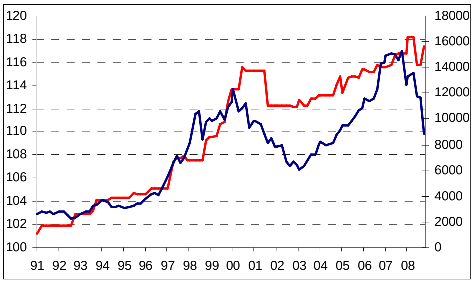


IBEX35



The red line shows the returns on the strategy consisting of buying European index shares at opening of trading and selling at close of trading (when positive) on days that are NYSE holidays and trading days in Europe. The blue line shows the return patterns for each European market, respectively.