New findings regarding return autocorrelation anomalies and the importance of non-trading periods

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Abstract

In this paper, differences in return autocorrelation across weekdays have been investigated. Our research provides strong evidence of the importance on non-trading periods, not only weekends and holidays but also overnight closings, to explain return autocorrelation anomalies. While stock returns are highly autocorrelated, specially on Mondays, when daily returns are computed on a open-to-close basis, they do not exhibit any significant level of autocorrelation. Our results are compatible with the information processing hypotheses as an explanation of the weekend effect.

Key-words: return autocorrelation, stock market anomalies, non trading periods.
JEL: G10.

1. Introduction

In the last twenty years, an increasing number of papers have investigated stock market anomalies, reporting strong evidence that daily stock returns show empirical regularities that are difficult to explain from asset pricing theories. The day-of-the-week and the turn of the year effects are two of the best-documented regularities. In the first case, it consists in a negative equity return on Monday and an abnormally high return on the last trading day of the week (usually Friday). The January effect refers to the regular tendency showed, specially by prices of small capitalization stocks, to increase on January. In addition, some papers have found that daily stock returns show a significantly positive first order autocorrelation, and thus, tomorrow expected return is not independent of the computed return today. These findings suggest that the use of historical data could be of some help to predict future returns[1], with obvious implications for the efficiency of equity markets. The reported positive return autocorrelation has been usually justified through non-synchronous trading explanations. Accordingly, since daily return are usually computed through a stock market index, the inclusion in the index of securities that are subjected to infrequent trading could cause positive stock return autocorrelation. However, since a significant level of first-order serial correlation has been found on common stock portfolios of large and actively traded firms (eg. Perry, 1985), non-synchronous trading seems to be not the only cause of correlation in daily market indexes.

More strikingly, several authors have found that return autocorrelation varies significantly across days, being especially strong on Mondays. Thus, the reported differences in mean returns across weekdays (the weekend effect) seem to be due, at least to a certain extent, to a strong level of autocorrelation on Monday stock return. In a pioneer paper, Cross (1973) finds that an increase in the S&P 500 index on Monday was twice as likely if the index increased rather than decreased the previous Friday. Later, Keim and Stambaugh (1984), and Jaffe and Westerfield (1985) show that return autocorrelation between Friday and Monday was the highest of any pair of successive days. In the first case the authors investigate the US case while in the second they investigate return autocorrelation in the US, Australia, Japan, Canada and the United

Kingdom. More recently, Beseembinder and Hertzel (1993) documents a similar pattern in the serial dependence of security returns not only around weekends but also around holidays. The authors find that the tendency for Monday returns to reinforce Friday returns is a part of a wider process that applies to holidays as well as Friday closings.

Nevertheless, in spite of the attention devoted, a well accepted explanation to justify the existing differences in return autocorrelation across the day of the week does not exist yet. As Keim and Stambaugh (1984) points, if the low Monday returns were due to measurement errors in prices on Friday, and if these errors vary over time, the higher than average errors on Fridays would tend to produce lower than average errors on Mondays. Thus, this behavior would imply a positive but lower or even a negative correlation between Friday and Monday returns.

The abnormal strong autocorrelation on Mondays seem to be due to the existence of the weekend non-trading period. Lakonishok and Maberly (1990), reports some evidence supporting a day-of-the-week effect in the trading pattern of individual investors, in the same way as Ritter (1988) proposes "the parking of the process hypothesis" to explain the January effect[2]. While the observed tendency by individual investors to increase the trading activity on Mondays can be explained in terms of the unique costs individuals face in evaluating their portfolios comparing to institutional investors, it is more difficult to explain the documented evidence of an asymmetric activity between buying and selling operations. The reason is that, as some studies show, financial analysts produce much more buying than selling recommendations. (see Groth, Lewellen, Schlarbaum and Lease, 1979, and Dimson and Marsh, 1986). Following this line or research, Abraham and Ikemberry (1994) discusses that because individual investors typically work during the weekdays, they will tend to use the weekends to analyze financial information and to decide about financial operations (the information processing hypothesis). They argue that while investors with liquidity needs, will place sell orders independently of the previous market conditions, positive feedback traders will show a more aggressive selling pressure following the receipt of negative market information on Fridays. The result of such a behavior would be that not only the selling pressure made by individual investors is stronger on Mondays than in any other day of the week, but also is substantially heavier on Monday following a decline in the market the previous Friday. The examination of conditional versus unconditional mean returns across weekdays, supports individual investors being, at least partially, the responsible of the weekend effect.

Other explanations of the day-of-the week anomalies has been based on models of strategic behavior (see Admati and Pfleiderer, 1989 and Foster and Viswanathan, 1990), considering heterogeneous investors. In the firs case, the authors develop a model in which the interaction among potentially informed traders, discretionary liquidity traders and market makers are the responsible of the patterns in expected prices changes. On the other hand, Foster and Viswanathan suggest that information asymmetries, that are higher when the market first open after a period of non-trading, can caused the abnormal behavior in stock returns around weekends. Following this approach, Campbell, Grossman and Wang (1993) observes that for stock indexes as well as for individual large stocks, the first order daily return autocorrelation declines with trading volume. The authors explain this fact with a model where the interaction among different groups of investors is the responsible that price changes followed by high trading volume will tend to be reversed.

In this paper, we investigate daily stock autocorrelation in the Spanish equity market following Bessembinder and Hertzel approach. In fact, our investigation constitutes a natural extension of their research. They showed the importance of non-trading periods (weekends and holidays) to explain differences in daily stock autocorrelation. However, non-trading periods also include overnight closings. Therefore, if non-trading was the cause of the reported differences in returns autocorrelation across weekdays, we should expect that these differences will disappear if only daily trading returns are computed. Accordingly, two models have been estimated. In model one, daily stock returns have been computed in the usual close-to-close basis, while in model two, open-to-close returns have been used. The use of close-to-close returns as well as open-to-close returns will allow a better understanding of the nature of stock market anomalies.

On the other hand, the fact that the research on stock market anomalies is strongly concentrated in the US case, jointly with the reasons argued by Lakonishok and Smidt (1988) for being skeptical about documented return anomalies obtained from a database that has been widely examined by other researchers, provide additional interest to our research, that constitutes the first investigation of the issue in the Spanish equity market.

The remainder of the paper is organized as follows. Section 2 provides a brief description of the IBEX-35 index, used in the analysis. In section 3, we present the methodology and data employed in the analysis. Empirical results are shown in section 4. Finally, section 5 contains the summary of the paper and the main conclusions.

2. The IBEX-35 index

The Spanish stock market has changed dramatically in the last two decades, in the framework of the deep process of modernization experienced by the Spanish financial system. Either the number of companies listed in the stock market, as the number of operations performed has increased dramatically. The IBEX-35 is the index most widely used to measure the behavior of the Spanish stock market. It is formed by the 35 most liquid companies that are simultaneously listed in the four Spanish stock exchanges, through the SIBE (Sistema de Interconexión Bursátil Español). The composition of the index is revised ordinarily twice a year (on December and June) accordingly with the criteria of liquidity.
The IBEX 35 is calculated since the 29 of December of 1989, when a value of 3.000 was assumed at the closing time. The index is not adjusted by dividends, and thus it underestimates the return obtained by the equivalent portfolio. The importance of the IBEX-35 in the Spanish capital markets is also due to its role as a subjacent asset in the Financial Futures and Options Spanish Market (MEFF).

3. Methodology and data

3.1. Methodology

We have followed the approach by Bessembinder and Hertzel investigating the effect of weekends and holidays in the level of stock return autocorrelation. In a similar way, a regression model has been proposed where daily return autocorrelation has been allowed to vary across weekdays. Thus, daily stock returns have been regressed on prior day return, employing indicator variables to allow coefficient estimates to vary according with the day of the week. To evaluate if the potential differences in return autocorrelation are produced during the trading time or during the non-trading period, two models have been estimated. In model one, daily returns have been computed in the usual way as close-to-close returns, while in model two, open-to-close returns have been used.

To provide a basis for comparison, we first estimate the first order autocorrelation coefficient (B), using all days in the sample, from the equation (1)

$$R_t = \sum_{i=1}^{n} a_i d_{it} + BR_{t-1} + \varepsilon_t \qquad (1)$$

Where R_t is the daily index return computed from the closing of day t-1 to the closing of day t in the model of close-to-close return and computed from the opening of day t to the closing of day t in the model of open-to-close returns. Variables d_1, d_2, d_3, d_4 and d_5 are the indicator variables that represent every trading day of the week, from Monday to Friday. Therefore, intercepts are allowed to vary across days in equation (1) in order to control for differences in mean returns. Evidence reported by García (2001) supports the inclusion of these indicator variables.

To evaluate the existence of differences in return autocorrelation regarding the day of the week, equation (2) has been estimated.

$$R_t = \sum_{i=1}^{n} a_i d_{it} + \sum_{i=1}^{n} B_i R_{t-1} + \mu_t \qquad (2)$$

As it can be seen, intercepts as well as slopes are allowed to vary across the day of the week. Estimates of B_i measure the autocorrelation of day i return with previous day return, for each day to the week. Thus B_1 measures the autocorrelation of Monday returns with Friday returns, B_2 the autocorrelation of Tuesday returns with Monday returns and so on.

3.2. Data

The investigation carried in this paper uses daily price data from the IBEX-35 index during the period comprised from the second of January of 1992 to the first of December of 2000. Although, as it has been pointed in section 2, the IBEX-35 index is calculated since December of 1989, information publicly available at the Sociedad de Bolsas web-site, does not included the period December 1989-December 1991. Therefore, a period of 9 years has been covered by our analysis, representing 2.259 observations. Daily returns have been calculating in the usual way as: R_t = log (P_t/P_{t-1}), where P_t represents the closing price of the index on day t, in the analysis of close-to-close return and as R_t = log(P_c/P_a), where P_c represents the closing price of the index and P_o the opening price, in the analysis of open-to-close returns.

4. Results

Table 1 reports the estimate coefficients of equation (1) as well as their associated t values and significance levels for the model using close-to-close returns and for the model using open-to-close returns respectively. For each model, the F value jointly with the significance level is reported.

Table 1. Estimation of equation 1

Close-to-close returns

Variable	Coefficient	(t-Student)	Significant level
a_1	-5.010E-04	-0.832	0.406
a_2	1.951E-03	2.303	0.021
a_3	-1.050E-08	0.000	1.000
a_4	9.723E-04	1.141	0.254
a_5	2.474E-03	2.899	0.004
B	0.102	4.865	0.000
F Value	7.203		
Sig. Level	0.000		

Open-to-close returns

Variable	Coefficient	(t-Student)	Significant level
a_1	2.101E-04	0.420	0.675
a_2	6.840E-04	0.973	0.330
a_3	-7.320E-04	-1.040	0.298
a_4	3.331E-04	0.471	0.638
a_5	2.013E-03	2.845	0.004
B	-1.14E-02	-0.543	0.587
F value	3.390		
Sig. Level	0.005		

The results reported by table 1 show important differences regarding the use of close-to-close or open-to-close returns. In the first case, a day-of-the-week effect in average daily returns is clearly observed, since two of the indicator variables introduced in the model to compute for differences in mean returns, d_2 and d_5, reveal statistically significant at the conventional levels. In both cases, the associated coefficients, a_2 and a_5, have a positive sign, indicating that average return on Tuesday and Friday are above the other days of the week. The indicator variable, d_1, introduced to compute for differences in Monday average return, although with a negative associated coefficient, it is not significant. In the model using open-to-close returns, only the variable d_5 is statistically significant, with a positive associated coefficient, showing that Friday average open-to-close return is above the average daily return. However, the most interesting point is the examination of daily return autocorrelation. Using close-to-close return, the B estimate coefficient is statistically significant at any of the conventional levels, with a positive sign, supporting most of the existence evidence about a positive and strong daily portfolio return autocorrelation in most equity markets worldwide. Nevertheless, when returns are computed on an open-to-close basis, the B estimate coefficient shows a negative sign, although not statistically significant at any convenient level, indicating that portfolio daily open-to-close return does not exhibit any degree of autocorrelation. In both cases, the model is globally significant, at the usual levels, although the F value of the model of close-to-close returns is more than twice the F value in the model of open-to-close returns, indicating that day-of-the-week anomalies are much more important when return are computed on a close-to-close basis.

Table 2. Estimation of equation 2

Close-to-close returns

Variable	Coefficient	(t-Student)	Significant level
a_1	-7.656E-04	-1.262	0.207
a_2	2.205E-03	2.598	0.009
a_3	3.203E-04	0.376	0.707
a_4	1.237E-03	1.448	0.148
a_5	2.782E-03	3.225	0.001
B_1	0.249	5.057	0.000
B_2	-2.289E-02	-0.503	0.615
B_3	5.679E-02	1.184	0.236
B_4	0.102	2.221	0.026
B_5	0.140	3.107	0.002

F Value	6.072
Sig. Level	0.000

Open-to-close returns

Variable	Coefficient	(t-Student)	Significant level
a_1	1.030E-04	0.202	0.840
a_2	7.880E-04	1.111	0.267
a_3	-5.892E-04	-0.828	0.408
a_4	4.561E-04	0.640	0.523
a_5	2.138E-03	2.995	0.003
B_1	4.015E-02	0.824	0.410
B_2	-1.963E-03	-0.042	0.966
B_3	-5.509E-02	-1.131	0.258
B_4	4.154E-02	0.843	0.399
B_5	-6.600E-02	-1.534	0.125

F Value	2.410
Sig. Level	0.010

Table 2 reports the results of the estimation of equation 2. As in the previous case, the results have been provided for the model using close-to-close return and for the model using open-to-close returns.

The results showed by table 2 show important differences in the estimate coefficients depending on how returns are computed. For the model using close-to-close returns, daily return autocorrelation strongly depends on the day of the week. Thus, return autocorrelation between Monday and Friday (B_1) and between Friday and Thursday (B_5) are statistically significant at a 1% level, while autocorrelation between Thursday and Wednesday (B_4) is significant at a 5% level. On the other hand, return autocorrelation between Tuesday and Monday (B_2) and between Wednesday and Tuesday (B_3) is not statistically significant. All the significant coefficients show a positive sign, indicating that the reported first order autocorrelation, although different in size across days, is always positive. The only estimate coefficient with a negative sign, although non-significant is B_2, showing a negative correlation between Monday and Tuesday returns.

As it could be expected after the results showed by table 1, none of the estimate coefficients B_1, B_2, B_3, B_4 and B_5 are statistically significant at any conventional level in the model using open-to-close returns. This result supports Rogalsky (1984) findings, showing the importance of non-trading periods to explain stock return anomalies. While the author find that differences in mean returns across weekdays are due to returns generated by differences between the opening and the previous closing price, our results indicate that the anomalies in return autocorrelation disappear when daily returns are computed on a open-to-close basis.

The abnormally high and positive reported return autocorrelation between Mondays and Fridays indicates that a high return on Friday favors a high return on Monday (on a close-to-close basis) much more than, for instance, a high return on Wednesday, favors a high return on Thursday. This results is consistent with Lakonishok and Maberly findings that the weekend effect could be explained, at least partially, by the buying-selling behavior by individual investors, what is called the information processing hypotheses. Accordingly, if individual investors decide buying and selling transaction during the weekend, Monday returns should show clearly signs of a delayed reaction to information, stronger than in any other day of the week. However, since we do not know the hourly distribution of stock orders in the Spanish market by size, a cautious interpretation of this support must be done

On the other hand, our results strongly support Bessembinder and Hertzel findings. As table 2 shows, the mean autocorrelation between Friday and Monday is not only the highest of any pair of successive days, but is almost twice the autocorrelation using all days in the sample (the estimate of B in equation 1). Considering only the significant autocorrelation estimates in equation 1, it is almost twice the autocorrelation between Friday and Wednesday (B_5) and almost 2.5 times the autocorrelation between Thursday and Wednesday (B_4). In addition, as in Bessembinder and Hertzel, our results show that the autocorrelation behavior of stock returns increases as we approach to the weekend. The authors also find that the correlation of returns of the second day after the weekend (Tuesday) was negative, indicating that stock prices tend to reverse the second day after the weekend. As showed by table 2, the only estimate autocorrelation coefficient with a negative sign, although non-statistically significant is B_2, measuring autocorrelation between Tuesday and Monday returns.

Nevertheless, our findings are difficult to reconcile with the non-synchronous trading hypothesis as an explanation of stock return autocorrelation. First, because the different level of autocorrelation across weekdays will imply that, for any reason, non-synchronous trading will be systematically more important in some days than in others. In addition, if non-synchronous trading was the cause of the positive first order return autocorrelation, it would be expected that it would persist independently on how returns are computed. Our results clearly show that return autocorrelation disappears once returns are computed on an open-to-close basis.

4. Conclusions

Despite the important attention devoted during the last twenty years, the behavior of daily stock returns across days is still a puzzling issue. Researchers have reported wide evidence supporting the so-called weekend effect, consisting of positive and abnormally high returns on Fridays followed by negative returns on Mondays, across national equity markets. A question that immediately arises is how such an abnormal behavior has remained over the years in spite of being widely known. However, the weekend effect is more complex than the reported differences in average daily returns across weekdays. In this paper, we have reported evidence of an abnormally high autocorrelation between Fridays and Mondays returns, that is 2.5 times the average return autocorrelation using all days in the sample. On the contrary, returns autocorrelation in the central days of the week (between Tuesday and Monday and between Wednesday and Tuesday) is non-significant. This result support empirical evidence available mostly in the US stock market, especially Bessembinder and Hertzel investigation of return autocorrelation during non-trading periods. They found that the existence of weekends and holidays was the cause of the observed abnormal return behavior during trading intervals. Our results reveal that non-trading periods, not only weekends and holidays, but also including overnights closings, are the cause of the abnormal pattern of return autocorrelation across weekdays. Therefore, a strong support is provided to market closings as the cause of the abnormal autocorrelation behavior

The absence of autocorrelation on stock return when they are computed on an open-to-close basis would support Rogalsky findings regarding the importance of distinguishing between trading and non-trading daily return. Although the author limit the attention to the existing differences in mean stock returns across weekdays, our results reveal that non-trading is also the cause of the different levels of return autocorrelation across weekdays.

Our results indicate that the Monday opening play a major role in explaining the weekend effect. Such a situation is fully compatible with the information processing hypotheses suggested by Abraham, and Ikenberry, as an explanation of the weekend effect. However, in order to provide a stronger support to this hypothesis, additional research regarding the daily and hourly distribution or stock orders by size is required.

Finally, strong evidence has been provided against the non-synchronous trading as the cause of stock return autocorrelation.

NOTES

1. An increasing number of papers have discussed about the profitability of the use of technical trading rules and price momentum strategies.

2. In a survey, the authors find evidence of a "parking the process" behavior by individual investors. Only in seventeen per cent of cases the process of a selling operation was reinvested the same day and only in twenty-two per cent of cases, was reinvested within the same week.

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