Intraday linkages between the Spanish and the US stock markets: evidence of an overreaction effect

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I. Introduction

The existence and modeling of linkages among equity markets has received great attention from different studies in order to analyze its influence on market behavior. Studies have concentrated on analyzing how news from one stock market influences, the performance of other markets, see Hamao, Masulis and Ng (1990) or Koutmos and Booth (1995) and the integrating of emerging markets, see Masih and Masih (1999) or Bekaert and Harvey (2000). Other studies analyze the price and volatility spillovers between advanced markets, see Conolly and Wang (2000) or Bae, Karolyi and Stulz (2000), which find that the US market acts as a leader over other markets.

With the availability of intraday trading data, study of intraday price reversals becomes feasible. Stoll and Whaley (1990) find a negative correlation between overnight and following daytime returns in NYSE common stocks from 1982 to 1986, implying the existence of price reversals in the morning trading session. Fabozzi, Ma, Chittenden and Pace (1995) find intraday price reversals for stocks on the NYSE and the AMEX during 1989. Finally, Gosnell (1995) also documents that the proportion of reversals is low near the opening of the market, but rapidly increases in the first hour of trading.

This paper improves the previous literature in various ways. Firstly, we differ from previous methodologies (basically two-step procedure or multivariate GARCH models) by focusing on short-term information transmission following the approaches of Lin, Engle and Ito (1994), Susmel and Engle (1994) and Baur and Jung (2005). Secondly, recent papers referenced to the Spanish market have focused their analysis on the response of the market to bad news from the Dow Jones index, see Blasco, Corredor and

Santamaría (2002) or Blasco, Corredor, Del Rio and Santamaría (2005). However, there are no previous studies which analyze the behavior of the main Spanish stock index, IBEX-35, hereafter IBEX, in its early and final hours of trading and the influence of the main US index, Dow Jones Industrial Average, hereafter DOW, on that trading and on investor behavior. Finally, we shed some light on the behavior of the Spanish stock market by providing some clues in order to better understand how the US market affects it.

The Spanish stock market has combined from the earlier nineties, when its main stock index IBEX-35 was created, sharp rises with periods of losses. Additionally, the improvement on the technical, operational and organizational systems supporting the market has enabled it to channel large volumes of investment and have made it more transparent, liquid and effective.

The pooling of interests has enabled Spain to reach a significant size in the European context and a diversified structure that covers the whole chain of activities in the markets, from trading to settlement. That enables it to make better use of resources, reduced costs and streamline services.

The results corroborate the influence of the US market over the IBEX but they also suggest that the IBEX have usually a low price movement till DOW opening. Additionally, they suggest that the main Spanish stock index reacts quickly to the news, basically in the first four minutes following the opening of the US market, and furthermore, the existence of an overreaction effect during the two following hours which precede to the closing of the Spanish market.

The remainder of the paper is organized as follows. Section 2 describes the methodology and presents the data, Section 3 shows the principal results and Section 4 provides the main conclusions.

II. Data and Methodology

Data

This paper analyzes the influence of the NYSE on the Spanish stock market in its early hours of trading (9:00 am CET) and at 3:30 pm CET, which is the opening hour of the NYSE. Starting on January 2, 2003 we have compiled intraday data of the IBEX, the main Spanish stock index, through December 31, 2004. Starting from the first quote at 9:00 am the data are available on the basis of a minute by minute interval until the first quote plus 10 minutes, repeating the same procedure at 3:30 pm. Additionally, opening and closing prices of both IBEX and DOW indexes are also computed in order to calculate daytime and overnight returns[1].

We divide daily (close-to-close) returns into overnight (previous close-to-open) returns, NR, and daytime (open-to-close) returns, DR for both markets. Additionally, we calculate three different returns for the IBEX. Firstly, overnight returns are calculated starting on the previous closing price of the IBEX and ending on the opening of the day after increasing the length in 1 min intervals until open plus 10 min is reached (reporting ten different overnight returns). Secondly, in order to analyze the influence of the opening of the DOW, we calculate the daytime returns as the difference between the opening price and the price at 3:30 pm plus 10 min (increasing again the length in 1 min intervals until 3:40 pm and reporting also ten different daytime returns). Finally, we calculate other daytime returns as the difference between the closing price of the IBEX and the price at 3:30 pm plus 10 min (calculating once again ten different daytime returns).

[1] Considering that there is not a substantial overlapping period of trading between the NYSE and the Spanish stock market, just two hours from 3:30 pm to 5:30 pm (CET time), it is not necessary to use intraday data from the DOW. For that reason we just use opening and closing prices for the DOW which reflect all the relevant information we need to analyze the relationship between these two markets.

Based on the common procedure, all returns are computed as logarithm differences of the stock price indexes and if one market is closed while the other market is open we set the latter's returns as missing.

Methodology

There are different options to analyze the information transmission between two or more markets. Wei, Liu, Yang and Chaung (1995) test the volatility spillover effect from the US and Japanese markets to the emerging Asian markets by using an univariate GARCH estimator. They find no significant volatility spillover effects using open-to-close returns. Liu and Pan (1997) employ a similar univariate GARCH model and do not find significant volatility spillover from both the US and Japanese markets**.** Wang, Rui and Firth (2002), Wang and Firth (2004) and Lee, Rui and Wang (2004), among others, use a standard two-stage procedure. In the first stage, they use alternative GARCH models to estimate the unexpected returns for each index and each market that cannot be predicted based on public information. In the second stage, they use those unexpected returns to analyze the interdependence of returns and volatilities between the markets.

Blasco, Corredor, Del Rio and Santamaría (2005) perform the two stage adjustment process proposed by Gallant, Rossi and Tauchen (1992) by using a set of dummy and time-trend variables to capture some systematic effects and then analyze the influence of basic news on returns, volatility and volume.

French, Schwert and Stambaug (1987), Akgiray (1989), Conolly (1989), Baillie and DeGennaro (1990), Bollerslev, Chou and Kroner (1992), Kyriacou and Sarno (1999), Gonzalez, Spencer and Walz (2003) and Franses, Van Dijk and Lucas (2004) applied the GARCH models to stock indexes showing that they are useful in modeling the dynamic behavior of stock returns. They also provided evidence that GARCH methodology is capable of capturing leptokurtosis, skewness and volatility clustering, common characteristics of the distribution of daily stock prices, as is pointed out by Rahman, Lee and Ang (2002).

The latter show that the intraday return volatility is best described by a GARCH (1,1) specification. Those results were consistent with Akgiray (1989) who estimated volatility using different ARCH and GARCH specifications and found the GARCH (1,1) performed the best.

King and Wadhwani (1990) hypothesized that international participants simply focus on price movements in other countries, specifically the United States. Ling, Engle and Ito (1994) improve the approach of King and Wadhwani (1990) by decomposing close to close returns into daytime and overnight returns and by employing an aggregate shock model which is related to the GARCH in mean model employed by Hamao, Masulis and Ng (1990).

Baur and Jung (2005) adapted the aggregate-shock model proposed by Lin, Engle and Ito (1994) by assuming that the returns follow a simple GARCH (1,1) process. This may include additional variables which capture possible effects on the returns (e.g., day of the week or holiday dummy) in both mean and volatility equations.

In order to analyze the intraday return and volatility spillovers between the IBEX and the DOW we adapt the methodology used by Baur and Jung (2005) by assuming that the returns in a market follow a GARCH model such as:

$$r_{1,t} = \mu_1 + \beta_1 r_{1,t-1} + \beta_2 r_{2,t-1} + \varepsilon_{1,t}$$

$$h_{1,t} = a_{11} + b_{11}\varepsilon^2_{1,t-1} + c_{11}h_{1,t-1} + d_{11}r^2_{2,t-1}$$

where $r_{1,t}$ are the IBEX returns and $r_{2,t}$ the DOW returns.

We investigate three hypotheses using this methodology. The first one analyzes the impact of the previous Open-to-Close returns of the DOW and IBEX ($DOWDR_{t-1}$ and $IBEXDR_{t-1}$ respectively) on the overnight returns of the Spanish stock index ($IBEXNR_t$). Additionally, we analyze the influence of the DOW daytime volatility by including its squared return lagged one period in the variance equation:

$$IBEXNR_t = \mu_1 + \beta_1 IBEXDR_{t-1} + \beta_2 DOWDR_{t-1} + \varepsilon_{1,t}$$
$$h_{1,t} = a_{11} + b_{11}\varepsilon^2_{1,t-1} + c_{11}h_{1,t-1} + d_{11}DOWDR^2_{t-1}$$

In the mean equation of the second model we measure the return spillovers from DOW overnight ($DOWNR_t$) returns into the IBEX daytime returns from Open-to-3:30 pm ($IBEXDR_t$). Additionally, we try to identify possible spillovers from the IBEX overnight returns into the IBEX daytime returns. We also analyze if DOW overnight volatility, characterized by the squared overnight returns, contain any relevant information for the daytime returns from Open-to-3:30 pm by including it into the volatility equation.

$$IBEXDR_t = \mu_1 + \beta_1 IBEXNR_t + \beta_2 DOWNR_t + \varepsilon_{1,t}$$
$$h_{1,t} = a_{11} + b_{11}\varepsilon^2_{1,t-1} + c_{11}h_{1,t-1} + d_{11}DOWNR^2_t$$

Finally, we investigate the contemporaneous correlation between the DOW overnight ($DOWNR_t$) returns and the IBEX daytime returns from 3:30 pm-to-Close ($IBEXDBR_t$). In this case, the daytime returns of the Spanish index ($IBEXDR_t$) from Open-to-3:30 pm is added as an exogenous variable in the mean equation. Furthermore, the DOW overnight squared returns lagged one period are included in the volatility equation in order to capture the volatility spillover from the American market into the Spanish market.

$$IBEXDBR_t = \mu_1 + \beta_1 IBEXDR_t + \beta_2 DOWNR_t + \varepsilon_{1,t}$$
$$h_{1,t} = a_{11} + b_{11}\varepsilon^2_{1,t-1} + c_{11}h_{1,t-1} + d_{11}DOWNR^2_t$$

In all cases we run several regressions using different proxies of the IBEX overnight and daytime returns by starting from the reference quote (Opening or 3:30 pm price) and extending the time span on a minute by minute basis until the reference quote plus 10 min. The main objective of these procedures is to analyze the behavior of the Spanish market as more and more real-time information is available. In all the regressions maximum likelihood estimation are obtained from the Berndt-Hall-Hall-Hausman algorithm.

III. Empirical Results

Table 1 reports basic statistics for daily daytime and overnight returns for the IBEX and DOW indexes. Tables 2 to 4 report intraday overnight returns (Previous Close-to-Open plus 10 min) and intraday daytime returns (Open-to-3:30 pm plus 10 min and 3:30 pm plus 10 min-to-Close) for the IBEX. All tables cover the sample period from January, 2003 to December, 2004.

The first notable findings are the differences between daytime and overnight returns and volatilities reported on Table 1. Daytime returns are higher than overnight returns (0.000419 versus 0.000396 for the IBEX and 0.000481 versus $3.49 \cdot 10^{-5}$ for the DOW). Similar results are obtained for the volatilities. The daytime volatility for the IBEX and

DOW indexes are 0.009444 and 0.008801 respectively, while the overnight volatilities are 0.005381 and 0.001798 respectively. These values reveal another important finding: daytime trading is similar in both markets while overnight trading is more intense on the Spanish market due to the higher values on its returns and volatility. This is due to the arrival of information and noise from the DOW which takes place overnight. Furthermore, these four series have significant skewness and kurtosis, which indicate that their empirical distributions have heavy tails relative to the normal distribution.

Relative to the results shown in Table 2, the most interesting fact is the difference between volatility and returns behavior. Volatility increases slowly but constantly during the first ten minutes of trading because it adjust better to news than do returns values which have a more heterogeneous behavior.

Tables 3 and 4 report the basic statistics of the two different intraday daytime returns. The analysis of the means of both daytime returns and their comparison with the mean of the whole period (open-to-close), reported on the first column of Table 1, lead us to suggest that the price movements in the Spanish stock market is concentrated in the last two hours just after the opening of the US markets.

Although, the mean of the daytime returns (Open-to-Close) for the whole sample is $4.19\cdot10^{-4}$, the mean of the day returns from Open-to-3:30 pm is only $5.76\cdot10^{-5}$. Whereas, the mean for the period from 3:30 pm-to-Close, $3.61\cdot10^{-4}$, is significantly bigger and closer to the mean of the whole trading day. This fact leads us to think that the difference is caused by reduced price movements while the Spanish market waits for the arrival of new information (e.g., DOW overnight returns).

Table 5 reports the regression results for the first hypothesis. The first three rows show the coefficients relative to the mean equation which measure the impact of DOW's and IBEX's previous open-to-close returns ($DOWDR_{t-1}$ and $IBEXDR_{t-1}$ respectively) on the overnight returns of the Spanish stock index ($IBEXNR_t$). In this case, if IBEX overnight returns contain any information from DOW or IBEX and their previous daytime returns, these coefficients should be significant.

These coefficients show that there are significant transmissions of information from DOW and IBEX previous daytime returns. All the coefficients in the mean equation are significant, which means that the overnight returns of the Spanish main stock index are influenced by both previous daytime returns. These results are consistent with the previous empirical evidence that shows significant transmissions of information between the US markets and different developed and emerging markets (a few examples are Becker, Finnerty and Gupta, 1990; Peiró, Quesada and Uriel, 1998; and Lee, Rui and Wang, 2004). Additionally, we find significant and negative values for the previous IBEX daytime returns which show evidence of an overreaction effect into the IBEX overnight returns.

The most important findings with respect to the volatility equation are the existence of significant spillover effects from the DOW previous daytime returns into the Spanish overnight returns and the increasing of persistence values when the time span is extended. In all cases, the results of the Ljung-Box statistics show, for the standardized and squared residuals with 10 lagged values, the inexistence of serial correlation in the mean equations or remaining ARCH effects in the variance equations. Additionally, the ARCH LM test results which provide no evidence of additional ARCH effects in the standardized residuals.

Table 6 reports the results of the second hypothesis, which investigates the contemporaneous correlation between the DOW and the IBEX overnight returns and IBEX daytime returns from Open-to-3:30 pm ($IBEXDR_t$).

We find no significant contemporaneous spillovers from the IBEX overnight returns to the IBEX daytime returns until 3:30 pm. However, all the estimated coefficients in the mean equation relative to the DOWNR variable are positive and significant. These results suggest that the events that take place from close to open in New York significantly affect the daytime returns of the Spanish index.

However, this "Opening Dow" effect has no apparent influence on the volatility equation. Coefficients relative to the overnight volatility spillovers from the DOW are not significant, as shown in columns 2 to 12 of Table 6, although persistence values are higher than on the first hypothesis which might be due to the great influence of US news on Spanish investors. Finally, there is no evidence of ARCH effects in the standardized residuals as shown in the ARCH LM test neither is there any for the Ljung-Box statistics which show no evidence of serial correlations or remaining ARCH effects.

We obtain some additional clues which enables us to understand the influence of the DOW on the IBEX from the results of the regressions relative to the third hypothesis, which are shown in Table 7. There is no information overlap between the DOW overnight returns and the IBEX daytime returns from 3:30 pm-to-Close. Therefore, if the Spanish market is efficiently processing the information contained in the overnight returns there should be no significant spillover effects in either mean or variance equations, as Baur and Jung (2005) pointed out.

None of the coefficients relative to the daytime returns of the IBEX are statistically significant. This means that the price movements of the first part of the trading day in the Spanish market have no influence from 3:30 pm to 5:30 pm. However, the DOW overnight returns coefficients are statistically significant. These values support the previous findings, which make it clear that the Spanish stock market waits for the opening of the US market before reacting. Additionally, the negative values suggest the existence of an overreaction effect where the previous losers outperforms the previous winners.

That overreaction behavior is consistent with the findings of Fung, Mok and Lam (2000), who suggest the existence of intraday price reversals following large price changes at the opening of the S&P 500 Futures market and the HIS (Hong Kong) Futures market; and Lo and MacKinlay (1990) who argue that when some stocks react more quickly to information than others they lead the investors to use a contrarian strategy that may produce profits.

Volatility coefficients relative to the DOW overnight corroborate the overreaction effect because all the coefficients are negative. However, the results reveal that the most important transmission of information is produced between 3:30 pm and 3:34 pm (reported in columns 2 to 6) as both the mean and volatility coefficients relative to the DOW are significant[2]. While in the following regressions (Columns 7 to 12) only the variable in the mean equation is statistically significant. This fact determines the reaction of the IBEX in the following two hours (until the closing of the market).

IV. Conclusions

This paper differs from the previous methodologies by focusing on short-term information transmission following the approaches of Lin, Engle and Ito (1994), Susmel and Engle (1994) and Baur and Jung (2005). It analyzes the behavior of the main Spanish stock index, IBEX, in its early and final hours of trading and the influence of the main US index, DOW, on the stock index prices.

We have contrasted in this paper three hypotheses concerning the transmission of information from the US market to the Spanish market. The results of the first hypothesis show that the previous daytime returns of the DOW index have a great influence on the overnight returns of the IBEX.

However, the most important findings are relative to the second and third hypotheses which firstly suggest that the Spanish stock market usually has a low price movement till DOW opening and, secondly, that the Spanish market reacts quickly to DOW news,

[2] With the exception of the volatility coefficient in the fifth column where the endogenous variable is the IBEX daytime return from 3:30 pm plus 3 min-to-Close.

basically in the first four minutes following the opening of the US market. Finally, we find the existence of an overreaction effect during the two hours before the closing of the Spanish stock market.

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Table 1. Descriptive Statistics

	IBEXDR	IBEXNR	DOWDR	DOWNR
Mean	0.000419	0.000396	0.000481	$3.49 \cdot 10^{-5}$
Median	0.000407	0.000806	0.000593	$-2.06 \cdot 10^{-5}$
Maximum	0.054157	0.023751	0.035499	0.020044
Minimum	-0.033971	-0.027487	-0.035885	-0.020167
Std. Dev.	0.009444	0.005381	0.008801	0.001798
Skewness	0.324171	-0.700756	0.166136	2.105963
Kurtosis	6.129889	6.481102	4.470254	77.54050
Jarque-Bera	213.2706	293.9681	47.42906	116357.8
Probability	0.000000	0.000000	0.000000	0.000000
Sum	0.209873	0.198399	0.240822	0.017493
Sum Sq. Dev.	0.044590	0.014479	0.038724	0.001616
Observations	501	501	501	501

Table 2. Descriptive Statistics Overnight Returns (Previous Close-to-Open plus 10 min)

	IBEXNR	IBEXNR1	IBEXNR2	IBEXNR3	IBEXNR4	IBEXNR5	IBEXNR6	IBEXNR7	IBEXNR8	IBEXNR9	IBEXNR10
Mean	0.000396	0.000256	0.000275	0.000299	0.000309	0.000293	0.000310	0.000327	0.000351	0.000333	0.000343
Median	0.000806	0.000869	0.000764	0.000804	0.000766	0.000727	0.000757	0.000794	0.000880	0.000836	0.000662
Maximum	0.023751	0.023703	0.023238	0.024472	0.025483	0.027145	0.025809	0.027790	0.027954	0.028577	0.029426
Minimum	-0.027487	-0.026565	-0.026261	-0.027202	-0.025771	-0.025675	-0.024736	-0.024784	-0.025423	-0.027028	-0.028271
Std. Dev.	0.005381	0.005485	0.005746	0.005864	0.005974	0.006017	0.006047	0.006103	0.006175	0.006163	0.006186
Skewness	-0.700756	-0.697061	-0.602100	-0.519654	-0.470275	-0.377262	-0.393491	-0.357962	-0.359583	-0.384927	-0.393635
Kurtosis	6.481102	5.916518	5.399824	5.470381	5.314850	5.148016	4.918544	5.035500	5.104222	5.276363	5.410024
Jarque-Bera	293.9681	218.1366	150.4931	149.9439	130.3261	108.2009	89.76570	97.19001	103.2258	120.5427	134.1847
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	0.198399	0.128279	0.137562	0.149637	0.155029	0.146714	0.155330	0.163912	0.175969	0.166855	0.171967
Sum Sq. Dev.	0.014479	0.015043	0.016510	0.017195	0.017843	0.018103	0.018284	0.018622	0.019068	0.018994	0.019135
Observations	501	501	501	501	501	501	501	501	501	501	501

Table 3. Descriptive Statistics Daytime Returns (Open-to-3:30 pm plus 10 min)

	IBEXDR30	IBEXDR31	IBEXDR32	IBEXDR33	IBEXDR34	IBEXDR35	IBEXDR36	IBEXDR37	IBEXDR38	IBEXDR39	IBEXDR40
Mean	$5.76\cdot10^{-5}$	$5.34\cdot10^{-5}$	$4.36\cdot10^{-5}$	$7.15\cdot10^{-5}$	$9.60\cdot10^{-5}$	$5.98\cdot10^{-5}$	$6.71\cdot10^{-5}$	$7.64\cdot10^{-5}$	$6.53\cdot10^{-5}$	$4.34\cdot10^{-5}$	$1.69\cdot10^{-5}$
Median	0.000306	0.000305	0.000246	0.000220	0.000347	0.000348	0.000268	0.000185	0.000309	0.000260	0.000294
Maximum	0.022553	0.022901	0.022577	0.022287	0.022663	0.022959	0.023023	0.023583	0.022592	0.022824	0.022585
Minimum	-0.021651	-0.021647	-0.021845	-0.021269	-0.021517	-0.021697	-0.022699	-0.021583	-0.021847	-0.020996	-0.020328
Std. Dev.	0.007013	0.007041	0.007068	0.007090	0.007160	0.007187	0.007196	0.007181	0.007181	0.007159	0.007128
Skewness	-0.126022	-0.133227	-0.141078	-0.139476	-0.120285	-0.139934	-0.141887	-0.145246	-0.127240	-0.127445	-0.131107
Kurtosis	3.518160	3.459085	3.434486	3.358452	3.406715	3.395566	3.456821	3.433453	3.429987	3.391500	3.366807
Jarque-Bera	6.930827	5.881667	5.602641	4.306563	4.661197	4.901419	6.037329	5.683579	5.211428	4.555792	4.243976
Probability	0.031260	0.052822	0.060730	0.116103	0.097238	0.086232	0.048866	0.058321	0.073850	0.102500	0.119793
Sum	0.028871	0.026761	0.021867	0.035832	0.048092	0.029947	0.033633	0.038298	0.032735	0.021741	0.008453
Sum Sq. Dev.	0.024588	0.024785	0.024980	0.025131	0.025629	0.025830	0.025894	0.025787	0.025785	0.025624	0.025405
Observations	501	501	501	501	501	501	501	501	501	501	501

Table 4. Descriptive Statistics Daytime Returns (3:30 pm plus 10 min-to-Close)

	IBEXDRB30	IBEXDRB31	IBEXDRB32	IBEXDRB33	IBEXDRB34	IBEXDRB35	IBEXDRB36	IBEXDRB37	IBEXDRB38	IBEXDRB39	IBEXDRB40
Mean	0.000361	0.000365	0.000375	0.000347	0.000323	0.000359	0.000352	0.000342	0.000354	0.000376	0.000402
Median	0.000360	0.000384	0.000413	0.000504	0.000459	0.000458	0.000497	0.000443	0.000499	0.000458	0.000562
Maximum	0.043577	0.044572	0.045122	0.044877	0.045134	0.045619	0.045973	0.044441	0.043767	0.043428	0.043435
Minimum	-0.017323	-0.017970	-0.017996	-0.017970	-0.017961	-0.018032	-0.018555	-0.018644	-0.018770	-0.018511	-0.018234
Std. Dev.	0.005690	0.005657	0.005640	0.005596	0.005578	0.005559	0.005562	0.005534	0.005526	0.005519	0.005513
Skewness	1.046544	1.093814	1.152943	1.137797	1.155958	1.207630	1.234903	1.147517	1.143184	1.148471	1.149078
Kurtosis	10.53984	11.27672	11.79973	11.94369	12.20207	12.70301	13.05367	12.13326	11.79935	11.67387	11.59007
Jarque-Bera	1278.181	1529.924	1727.454	1777.881	1879.232	2087.122	2237.302	1851.269	1725.445	1680.686	1650.603
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	0.181001	0.183112	0.188005	0.174041	0.161780	0.179926	0.176240	0.171574	0.177138	0.188131	0.201420
Sum Sq. Dev.	0.016190	0.016004	0.015906	0.015660	0.015558	0.015451	0.015469	0.015313	0.015266	0.015228	0.015197
Observations	501	501	501	501	501	501	501	501	501	501	501

Table 5. Hypothesis 1. IBEX Overnight Returns (Close to Open plus 10 min)

Regressor	0 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min
Mean Constant	$4.01 \cdot 10^{-4}$	$2.90 \cdot 10^{-4}$	$3.52 \cdot 10^{-4}$	$3.82 \cdot 10^{-4}$	$3.98 \cdot 10^{-4}$	$3.91 \cdot 10^{-4}$	$3.72 \cdot 10^{-4}$	$3.82 \cdot 10^{-4}$	$4.10 \cdot 10^{-4}$	$3.93 \cdot 10^{-4}$	$4.06 \cdot 10^{-4}$
	(2.833)	(1.955)	(2.228)	(2.357)	(2.453)	(2.381)	(2.201)	(2.229)	(2.393)	(2.279)	(2.328)
IBEXDR(-1)	-0.210	-0.222	-0.217	-0.218	-0.214	-0.217	-0.222	-0.221	-0.222	-0.216	-0.216
	(-8.277)	(-8.583)	(16.350)	(-7.759)	(-7.428)	(-7.365)	(-7.416)	(-7.308)	(-7.251)	(6.937)	(-6.989)
DOWDR(-1)	0.407	0.418	0.428	0.435	0.438	0.442	0.443	0.441	0.439	0.434	0.431
	(17.075)	(17.298)	(16.350)	(16.008)	(16.156)	(16.158)	(15.748)	(15.542)	(15.249)	(15.087)	(15.159)
Variance Constant	$3.31 \cdot 10^{-8}$	$2.46 \cdot 10^{-7}$	$4.11 \cdot 10^{-7}$	$3.35 \cdot 10^{-7}$	$3.29 \cdot 10^{-7}$	$1.36 \cdot 10^{-7}$	$3.21 \cdot 10^{-7}$	$2.76 \cdot 10^{-7}$	$2.16 \cdot 10^{-7}$	$2.98 \cdot 10^{-7}$	$2.35 \cdot 10^{-7}$
	(0.171)	(0.906)	(0.865)	(0.776)	(0.773)	(0.387)	(0.738)	(0.613)	(0.477)	(0.574)	(0.532)
ARCH	0.101	0.106	0.105	0.093	0.099	0.088	0.080	0.074	0.081	0.081	0.077
	(1.656)	(1.754)	(1.698)	(1.619)	(1.835)	(1.940)	(1.937)	(1.935)	(1.941)	(1.892)	(1.898)
GARCH	0.721	0.743	0.756	0.763	0.759	0.783	0.777	0.787	0.781	0.781	0.788
	(8.252)	(8.180)	(7.717)	(7.730)	(8.153)	(9.615)	(9.415)	(10.502)	(10.318)	(10.086)	(10.569)
$DOWNR^2$ (-1)	0.040	0.033	0.033	0.037	0.040	0.039	0.041	0.041	0.043	0.041	0.041
	(2.643)	(2.076)	(1.827)	(1.845)	(1.849)	(1.968)	(1.931)	(1.936)	(1.872)	(1.847)	(1.887)
Skewness	-0.238	-0.364	-0.386	-0.403	-0.473	-0.420	-0.434	-0.431	-0.437	-0.439	-0.412
Kurtosis	4.066	4.116	4.286	4.485	4.943	4.732	4.662	4.757	4.931	4.833	4.520
LB(10)	15.472	7.2832	5.6287	8.1719	7.4107	7.2993	8.1776	7.9398	8.7496	8.6892	8.3109
LBS(10)	25.399	18.977	13.696	9.7710	5.8705	6.7754	7.7173	8.9851	7.5621	8.8397	8.0951
ARCH-LM Test	0.014	0.066	0.170	0.336	0.461	0.525	0.709	0.698	0.736	0.707	0.629

Notes: Robust t-statistics in parentheses.
Skewness and Kurtosis coefficients for standardized residuals
LB(10) and LBS(10) are the Ljung-Box statistics for the standardized residuals and squared residuals, respectively, with 10 lagged values included.
ARCH-LM test is the test statistic for the presence of ARCH effects in the standardized residuals with one lagged value included. P-values are reported.

Table 6. Hypothesis 2. IBEX Daytime Returns (Open-to-3:30 pm plus 10 min)

Regressor	0 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min
Mean Constant	$1.93\cdot10^{-4}$	$2.02\cdot10^{-4}$	$1.88\cdot10^{-4}$	$2.20\cdot10^{-4}$	$2.35\cdot10^{-4}$	$2.27\cdot10^{-4}$	$2.19\cdot10^{-4}$	$2.37\cdot10^{-4}$	$2.19\cdot10^{-4}$	$2.10\cdot10^{-4}$	$1.75\cdot10^{-4}$
	(0.702)	(0.734)	(0.682)	(0.798)	(0.841)	(0.806)	(0.771)	(0.842)	(0.778)	(0.745)	(0.623)
IBEXNR	0.014	0.011	0.008	0.002	-0.004	-0.006	-0.004	-0.006	-0.008	-0.010	-0.006
	(0.242)	(0.190)	(0.135)	(0.036)	(-0.073)	(-0.107)	(-0.067)	(-0.103)	(-0.128)	(-0.163)	(-0.095)
DOWNR	0.335	0.337	0.338	0.352	0.362	0.367	0.358	0.367	0.378	0.386	0.391
	(2.223)	(2.179)	(2.203)	(2.245)	(2.367)	(2.411)	(2.347)	(2.326)	(2.380)	(2.418)	(2.415)
Variance Constant	$6.72\cdot10^{-7}$	$7.77\cdot10^{-7}$	$7.57\cdot10^{-7}$	$8.99\cdot10^{-7}$	$8\cdot10^{-7}$	$7.65\cdot10^{-7}$	$6.65\cdot10^{-7}$	$8.04\cdot10^{-7}$	$7.54\cdot10^{-7}$	$7.79\cdot10^{-7}$	$8.17\cdot10^{-7}$
	(1.495)	(1.489)	(1.441)	(1.456)	(1.419)	(1.365)	(1.405)	(1.433)	(1.434)	(1.420)	(1.424)
ARCH	0.072	0.077	0.077	0.085	0.076	0.074	0.065	0.075	0.072	0.075	0.073
	(2.825)	(2.897)	(2.844)	(2.879)	(2.777)	(2.753)	(2.674)	(2.714)	(2.807)	(2.839)	(2.736)
GARCH	0.910	0.903	0.903	0.892	0.903	0.905	0.916	0.904	0.908	0.904	0.905
	(29.753)	(27.634)	(26.917)	(23.944)	(26.177)	(26.761)	(30.431)	(26.221)	(28.363)	(27.146)	(26.303)
$DOWNR^2$	0.007	$6.13\cdot10^{-4}$	0.002	0.010	0.013	0.016	0.022	0.017	0.015	0.018	0.021
	(0.156)	(0.012)	(0.049)	(0.199)	(0.261)	(0.325)	(0.448)	(0.324)	(0.297)	(0.355)	(0.403)
Skewness	-0.041	-0.060	-0.067	-0.064	-0.057	-0.047	-0.054	-0.064	-0.068	-0.067	-0.086
Kurtosis	3.076	3.076	3.033	2.991	3.056	3.094	3.114	3.111	3.100	3.105	3.127
LB(10)	10.456	10.968	10.447	11.210	11.165	10.441	11.300	11.521	12.368	13.211	12.488
LBS(10)	12.367	10.843	10.970	12.382	12.125	12.294	13.797	13.560	13.067	12.546	13.885
ARCH-LM Test	0.980	0.920	0.941	0.888	0.993	0.978	0.962	0.932	0.986	0.986	0.853

Notes: Robust t-statistics in parentheses.
Skewness and Kurtosis coefficients for standardized residuals
LB(10) and LBS(10) are the Ljung-Box statistics for the standardized residuals and squared residuals, respectively, with 10 lagged values included.
ARCH-LM test is the test statistic for the presence of ARCH effects in the standardized residuals with one lagged value included. P-values are reported.

Table 7. Hypothesis 3. IBEX Daytime Returns (3:30 pm plus 10 min-to-Close)

Regressor	0 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min
Mean Constant	$3.62\cdot10^{-4}$	$4.01\cdot10^{-4}$	$3.83\cdot10^{-4}$	$3.82\cdot10^{-4}$	$3.54\cdot10^{-4}$	$3.66\cdot10^{-4}$	$3.26\cdot10^{-4}$	$3.60\cdot10^{-4}$	$3.91\cdot10^{-4}$	$3.79\cdot10^{-4}$	$4.16\cdot10^{-4}$
	(2.020)	(2.319)	(2.251)	(2.237)	(2.088)	(2.207)	(1.896)	(2.140)	(2.337)	(2.276)	(2.512)
IBEXDR	0.012	0.021	0.012	0.005	$2.51\cdot10^{-4}$	$4.22\cdot10^{-4}$	$-2.44\cdot10^{-4}$	0.002	0.005	0.006	0.006
	(0.383)	(0.670)	(0.378)	(0.163	(0.007)	(0.131)	(-0.007)	(0.074)	(0.190)	(0.221)	(0.208)
DOWNR	-0.133	-0.223	-0.122	-0.122	-0.180	-0.251	-0.148	-0.180	-0.154	-0.218	-0.188
	(-2.583)	(-4.086)	(-2.374)	(-1.973)	(-3.388)	(-3.760)	(-2.164)	(-2.839)	(-2.154)	(-3.323)	(-2.846)
Variance Constant	$2.90\cdot10^{-7}$	$2.46\cdot10^{-7}$	$2.70\cdot10^{-7}$	$2.60\cdot10^{-7}$	$2.67\cdot10^{-7}$	$2.48\cdot10^{-7}$	$1.73\cdot10^{-7}$	$2.00\cdot10^{-7}$	$2.05\cdot10^{-7}$	$1.95\cdot10^{-7}$	$1.93\cdot10^{-7}$
	(5.536)	(4.628)	(4.990)	(3.590)	(3.532)	(3.508)	(1.713)	(2.187)	(2.188)	(2.244)	(2.215)
ARCH	-0.019	-0.020	-0.018	-0.015	-0.018	-0.015	-0.001	-0.005	-0.007	-0.005	-0.006
	(-2.034)	(-1.481)	(-1.673)	(-1.620)	(-1.801)	(-1.539)	(-0.082)	(-0.453)	(-0.745)	(-0.461)	(-0.565)
GARCH	1.000	1.003	1.000	0.997	0.999	0.996	0.981	0.985	0.988	0.986	0.987
	(133.709)	(94.997)	(114.163)	(118.408)	(116.547)	(115.315)	(72.637)	(80.918)	(96.491)	(88.651)	(85.297)
$DOWNR^2$	-0.052	-0.051	-0.048	-0.033	-0.036	-0.026	$-8.98\cdot10^{-4}$	-0.012	-0.014	-0.014	-0.014
	(-3.139)	(-2.662)	(2.762)	(-1.500)	(-1.801)	(-1.360)	(-0.051)	(-0.707)	(-0.794)	(-0.813)	(-0.809)
Skewness	0.208	0.111	0.112	0.059	0.006	-0.050	-0.032	-0.021	-0.015	-0.025	-0.023
Kurtosis	3.816	3.374	5.106	3.475	3.442	3.511	3.693	3.555	3.468	3.499	3.487
LB(10)	4.5275	5.3931	5.7589	5.6995	6.4060	7.1688	7.3648	8.3238	8.2583	9.6198	10.434
LBS(10)	15.401	12.351	11.298	11.024	10.365	8.4601	7.6098	9.0080	9.8248	10.449	10.078
ARCH-LM Test	0.067	0.169	0.261	0.251	0.280	0.244	0.195	0.083	0.067	0.128	0.124

Notes: Robust t-statistics in parentheses.
Skewness and Kurtosis coefficients for standardized residuals
LB(10) and LBS(10) are the Ljung-Box statistics for the standardized residuals and squared residuals, respectively, with 10 lagged values included.
ARCH-LM test is the test statistic for the presence of ARCH effects in the standardized residuals with one lagged value included. P-values are reported.