Arbitrage opportunities and event impacts on Spanish rights issues

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Abstract

In equity offerings in which pre-emptive subscription rights are issued, there are two ways of acquiring the company's shares: either by buying them directly on the market, or by subscribing to the new shares using the subscription rights. This could lead to the existence of arbitrage opportunities. In addition, the announcement of these processes incorporates very relevant information to the market, which could generate abnormal returns for the shares. This paper analyses both hypotheses simultaneously on the same sample and concludes that there are indeed arbitrage opportunities and also abnormal returns can be detected. Furthermore, it is also concluded that these effects are especially significant in companies with low liquidity or for which short positions in the market are not available.

Keywords: rights offering, abnormal returns, arbitrage, Spanish stock market

JEL Classifications: G140, G280

I. Introduction

Equity issues, specifically those in which Preferential Subscription Rights (PSRs) are issued, have been analysed both in terms of the possible existence of arbitrage opportunities, as in **Marzal and Montes (2000)**, as well as the effects on the company's subsequent performance, as in **Guirao (2001)**, **Pastor-Llorca and Martín-Ugedo (2004)**, **Riaño, Ruiz and Santamaría (2006)**, **Riaño, Ruiz and Santamaría (2007)**. Also noteworthy is the study by **Ramírez and Cabestre (2010)**, dedicated to analysing the consequences of the listing of the new shares. However, the literature, neither carry out both analyses jointly nor assess specific characteristics of these processes (size, dilutive or not, monetary or released, and insured or not) in its analysis in order to demonstrate in which types of processes arbitrage is more likely to occur. This is the objective of the present study, with the addition of being the first to include companies listed on an alternative stock exchange.

To carry out this study, focused on Spanish companies, a strategy will be applied to exploit possible arbitrage opportunities arising from differences in the price formation between the company's shares and subscription rights. This strategy will have two versions, considering whether it is possible to take short positions in the company concerned or not. On the other hand, the event study methodology will be used to analyse whether these processes generated significant short- and long-term effects. Our results suggest that arbitrage opportunities do exist and that they do not disappear over time, being clearer in small and illiquid companies.

II. Materials and Methods[1]

II.1) Data

The period analysed extends from 2000 to 2020, including 395 rights issues carried out by 111 Spanish companies. From these processes, different characteristics have been identified, both specific to the company (whether it is listed on the Continuous Market (MC), on the Alternative Stock Market (MAB) or it is a constituent of the IBEX35) and specific to the process,[2] such as whether it is *Dilutive* (new shares represent at least 50% of the old ones), *Monetary* (payment required for subscribing new shares) and *Insured* (in the monetary, if the company can ensure its success). On the other hand, a total of 1,963 events have been analysed (as it is shown in Table 1). All price series are from *Thomson Reuters Refinitiv* database. Time series contains adjusted prices, and events have been obtained from the websites of the Spanish stock market regulator *Comisión Nacional del Mercado de Valores* (CNMV) for IBEX and MC companies, and from the *BME Growth* for MAB companies. Finally, the data used for the SMB and HML factors are from *Kenneth French's Data Library*,[3] while the risk-free interest rate corresponds to that of the one-year treasury bill of Spain from the website of the *Bank of Spain*.

II.2) Methodology

II.2.A) Arbitrage Opportunities.

The strategy consists of acquiring a share through pre-emptive subscription rights and taking a short position in a *Contract for Differences* (CFDs) on the same share to cover the position

[1] All the methodology described here is detailed in greater depth in the Appendix V.2 from the Supplementary Document, together with the Figures and Tables cited throughout the article, in the Appendix V.1.

[2] In October 2020, the MAB was renamed BME MTF Equity. Spanish small companies have been listed since then in the so-called BME Growth segment of BME MTF Equity. Nevertheless, we have kept the original name as it was the one in force during the period under analysis

[3] Since data for these factors are not available for Spain, we employ series of European companies considering the integration of Spanish and European regulation and markets, and because Spanish companies are included in these factors.

(Strategy I). If it is not possible to take such a short position, the result is obtained as the difference between the theoretical price of the share and its actual price (Strategy II).

In both cases, this return (see equation [2] and [3] in the Supplementary Document) must be reduced by the commissions (net return), which have been estimated by simulating investments in the strategies with positive results and using the information on commissions provided by two brokers. Furthermore, outliers have been detected and eliminated using the Median Absolute Deviation methodology proposed by **Leys et al. (2013)**. Finally, Student's *t*-test for the mean and a Wilcoxon test for the median were employed.

II.2.B) Short-Term Event Study.

We computed the abnormal return for each of the events identified in (t) as the difference between the firm's daily return in *t* and its expected return estimated by the market model.[4] Then, we grouped these abnormal returns according to which event they correspond to and the characteristics of the process. On the different series obtained, a *t*-Student test and bootstrapping are used to test their mean, and a Wilcoxon test for their median.

II.2.C) Long-Term Event Study.

To analyse the existence of long-term abnormal returns, monthly equally weighted portfolios were constructed containing all the companies that have undergone a rights issue in the previous year. The CAPM model of **Sharpe (1964)** and **Lintner (1965)** [A], the 3-factor model of **Fama and French (1993)** [B], and an extension of the latter including the illiquidity factor of **Amihud (2002)** [C] were applied to this portfolio. The constant of the regression measures the long-term abnormal performance.

[4] Being the IBEX-35, or the IBEX SmallCap for MAB companies. The estimation period starts at $(t - 210)$ and ends at $(t - 30)$.

III. Results

III.1) Arbitrage Opportunities

Table 2 explains the acronyms used in the following tables and figures. Figures 1 and 2 show, on an aggregate and daily basis respectively, the distribution of the results obtained. Figures 3 and 4 show the mean and median of the daily net results, while Figures 5 to 24 show the histogram of net returns for strategies I and II. Finally, Tables 3, 4, 5 and 6 show the mean and median returns obtained and the results of the tests.

Considering an arbitrage opportunity as a positive net return, we can see from the tables and histograms of returns that such anomalies can be detected, and that they appear to occur in virtually all of the groups constructed. Moreover, when analysing day by day, we can see that these anomalies usually persist over time. Also noteworthy is the presence of such high net returns that they should be considered as outliers.

In aggregate terms, however, all the averages and medians calculated are negative and, in many cases, significant. Nonetheless, the case of dilutive rights issues stands out, in which the mean remains positive for many days and when aggregating results.

Finally, no significant differences appear to be found between the results of Strategy I and Strategy II. However, this also indicates that these arbitrages could be exploited without the need to have short positions in the issuing company's shares.

The results obtained can be summarized as follows:

i. As in **Marzal and Montes (2000)**, the strategy leads sometimes to positive net returns over the entire rights trading period. Theoretically, one would expect that, upon detection of arbitrage, investors would push prices until the arbitrage is eliminated.

ii. High costs estimated lead to median returns always negative. When applying the tests, these median returns are usually significant. On the contrary, in some cases the benefits of arbitration outweigh these costs.

III.2) Event Study

Tables 7 and 8 summarise the results of the short-term abnormal returns, Figures 25 to 30 show the distribution of the abnormal returns, and Table 9 shows the results for the long-term event study. The results obtained in these analyses do not allow us to draw particularly relevant conclusions.

IV. Conclusions

This is the first joint search for arbitrage opportunities between shares and rights and the event study of anomalous returns for the rights issues events in the Spanish market. It also adds two novelties: it includes the Alternative Stock Market and assess four specific characteristics of these processes to demonstrate in which arbitrage is more likely to appear.

The results obtained suggest that, in certain cases, there are arbitrage opportunities that do not disappear during the whole rights trading period, leading a continuous market inefficiency. This result is surprising because two reasons: opportunity remains after it has been detected and overcomes the high costs estimated.

Moreover, these discrepancies are not explained by the usual market factors, so these abnormal returns are free from the typical risk factors.

We found that it is more likely to find arbitrage opportunities in small companies, diluted, monetary and non-insured, although none of the average positive returns are statistically significant. These results are more evident in illiquid companies or companies where it is not possible to take short positions.

Disclosure statement

The Authors declare that there is no conflict of interest.

Acknowledgement

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References

Amihud, Y. (2002). "Illiquidity and stock returns: cross-section and time-series effects". Journal of financial markets, 5(1), 31-56.

Bellera, C. A., Julien, M., & Hanley, J. A. (2010). Normal approximations to the distributions of the Wilcoxon statistics: accurate to what N? Graphical insights. Journal of Statistics Education, 18(2).

Fama, E. F., & French, K. R. (1993). "Common risk factors in the returns on stocks and bonds". Journal of financial economics, 33(1), 3-56.

Guirao, J. Y. (2001). "El efecto de las ampliaciones liberadas en el valor de las acciones", en Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad, 30(107), 11-38.

Leys, C., Ley, C., Klein, O., Bernard, P., & Licata, L. (2013). Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median. Journal of experimental social psychology, 49(4), 764-766.

Lintner, J. (1965). "Security prices, risk, and maximal gains from diversification". The journal of finance, 20(4), 587-615.

Martinez, M. A.; Nieto, B.; Rubio, G. y Tapia, M. (2005), "Asset pricing and systematic liquidity risk: An empirical investigation of the Spanish stock market", International Review of Economics and Finance, 14, 81-103.

Marzal, J. L. S., & Montes, R. M. (2000). "El arbitraje entre acciones y derechos de suscripción en la bolsa española", en Bolsa de Madrid, (93), 39-43.

Mitchell, M. L., & Stafford, E. (2000). "Managerial decisions and long-term stock price performance". The Journal of Business, 73(3), 287-329.

Pastor-Llorca, M. J., & Martín-Ugedo, J. F. (2004). "Long-run performance of Spanish seasoned equity issues with rights". International Review of Financial Analysis, 13(2), 191-215.

Ramírez, M. Á. A., & Cabestre, F. J. R. (2010). Incidencia de la admisión a cotización de las nuevas acciones con diferencias económicas sobre la liquidez y actividad negociadora de las acciones en circulación. Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad, 39(145), 13-40.

Riaño, C., Ruiz, F. J., & Santamaría, R. (2006). Rights offerings in Spain: Effects on ex-rights stocks during the subscription period. Journal of Asset Management, 7(3), 255-272.

Riaño, C., Ruiz, F. J., & Santamaria, R. (2007). Determinants of the underpricing of new shares during the subscription period: empirical evidence from the Spanish stock exchange. Applied Financial Economics, 17(7), 521-540.

Sharpe, W. F. (1964). "Capital asset prices: A theory of market equilibrium under conditions of risk". The journal of finance, 19(3), 425-442.

Wilcoxon, F. (1945). "Individual comparisons by ranking methods". Biometrics bulletin, 1(6), 80-83.

V. Annex

V.1) Tables and Figures

Table 1: Total of relevant dates analysed by event and group of rights issue.

	Announcement	Meeting	Start	End	Result	Quotation	Total
Total	364	222	394	394	309	280	1.963
IBEX	135	71	139	139	133	126	743
MC	192	105	207	207	132	114	957
MAB	37	46	48	48	44	40	263
Dilutives	40	39	45	45	41	38	248
Not Dilutives	324	183	349	349	268	242	1.715
Monetary	107	92	123	123	116	94	655
Released	257	130	271	271	193	186	1.308
Insured	27	19	29	29	29	22	155
Not Insured	337	203	365	365	280	258	1.808

NOTES: Table 1 shows the total number of dates analysed in the short-term Event Study, by event and for each group of rights issues. It should be noted that the only events for which data are available for all the processes analysed are the start and end of the listing of pre-emptive subscription rights. For the rest, it was not always possible to identify the date on which some of the events occurred.

Table 2: Explanation of acronyms.

Category	Name	Code	Explanation
By Group	**Total**	**Total**	Includes all rights issues analysed.
	IBEX	**IBEX**	Includes only rights issues by companies listed on the IBEX-35 index.
	MC	**MC**	Includes only rights issues carried out by companies listed on the Spanish Continuous Market (and not listed on the IBEX-35 index).
	MAB	**MAB**	Includes only rights issues by companies listed on BME MTF EQUITY (previously known as *Mercado Alternativo Bursátil* (MAB)).
	Dilutives	**DIL**	Includes only rights issues in which the ratio of new shares to old shares is equal to or higher than 50%.
	Not Dilutives	**nDIL**	Includes only rights issues in which the ratio of new shares to old shares is lower than 50%.
	Monetary	**MON**	Includes only rights issues in which payment is required for the subscription of new shares.
	Released	**REL**	Includes only rights issues in which payment is not required for the subscription of new shares.
	Insured	**INS**	Includes only monetary rights issues where the issuing company is able to guarantee the success of the process.
	Not Insured	**nINS**	Includes only not monetary rights issues, or the monetary ones where the issuing company is not able to guarantee the success of the process.
By Strategy	**Strategy I**	**I**	The net returns have been obtained by applying Strategy I (assumes that it is always possible to take short positions in the shares of the issuing company).
	Strategy II	**II**	The net returns have been obtained by applying Strategy II (assumes that it is not possible to take short positions in the shares of the issuing company).

Figure 1: Number of net average returns by strategy, group and sign.

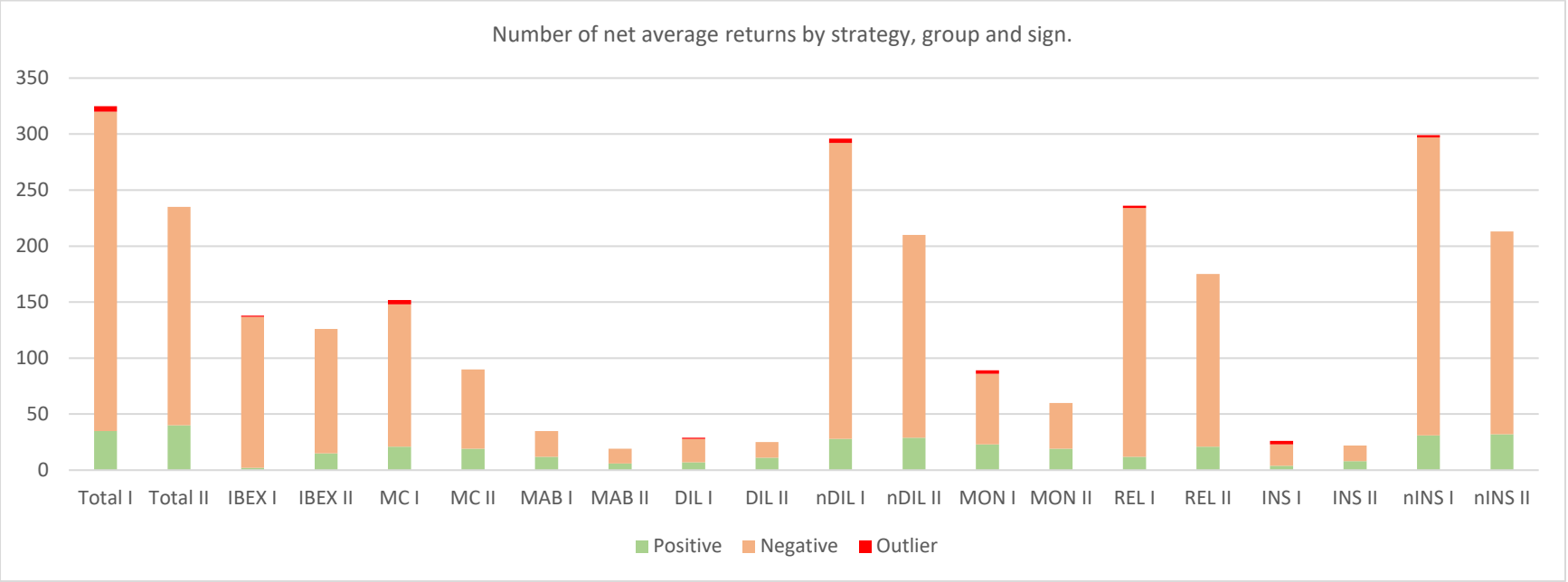
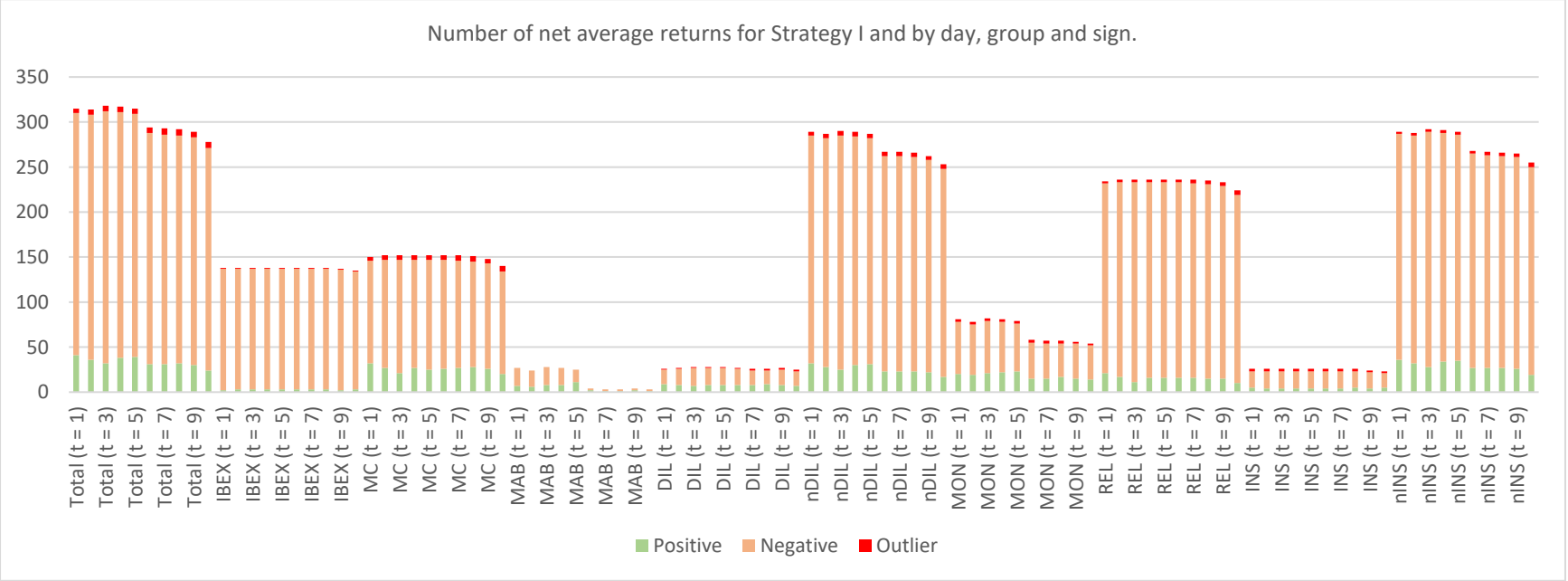


Figure 2: Number of net average returns for Strategy I and by day, group and sign.



NOTES: Figure 1 shows, for each strategy and group of rights issue, the total number of processes for which the average outcome is positive, negative, or those whose profitability has been considered as an outlier. Figure 2 shows the same, although it focuses on strategy I and shows the average outcome on each of the days analysed.

In summary, it can be seen that there are not many differences between strategies I and II (taking into account that the number of results available for strategy II is lower), and that on average the positive results, although small in number, are persistent over time.

Figure 3: Distribution of Average Net Results by day and in average (for both strategies).

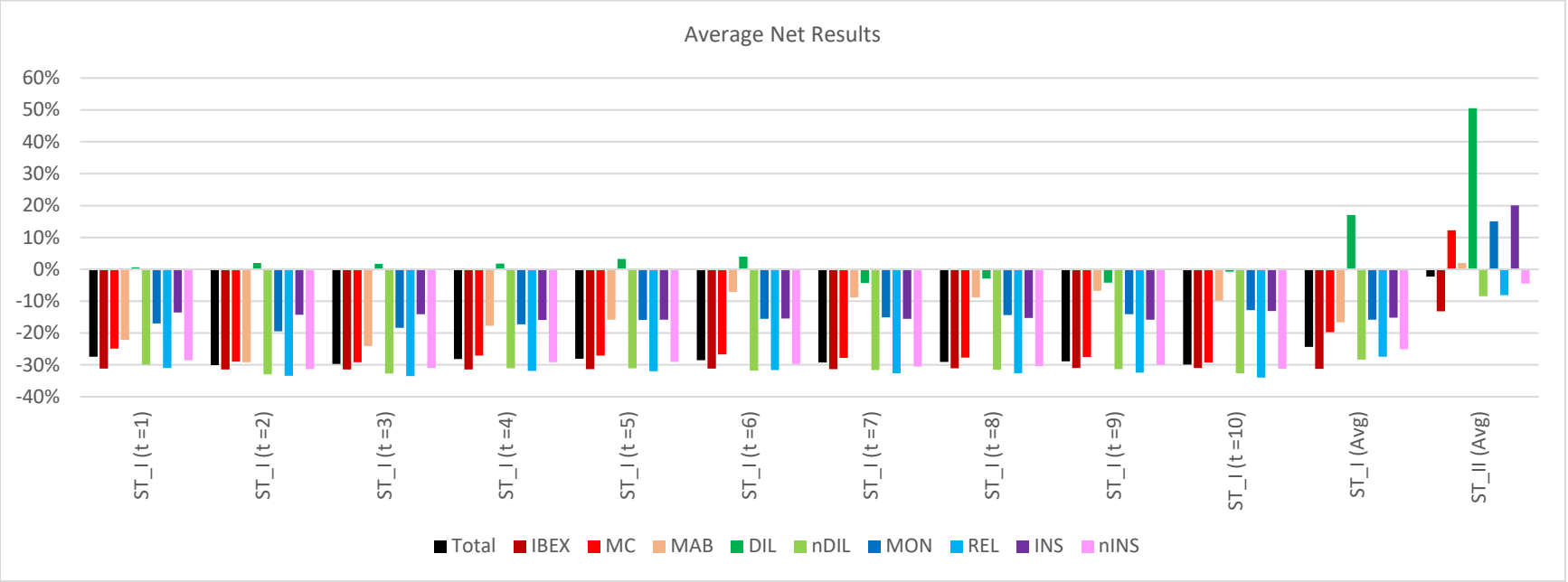
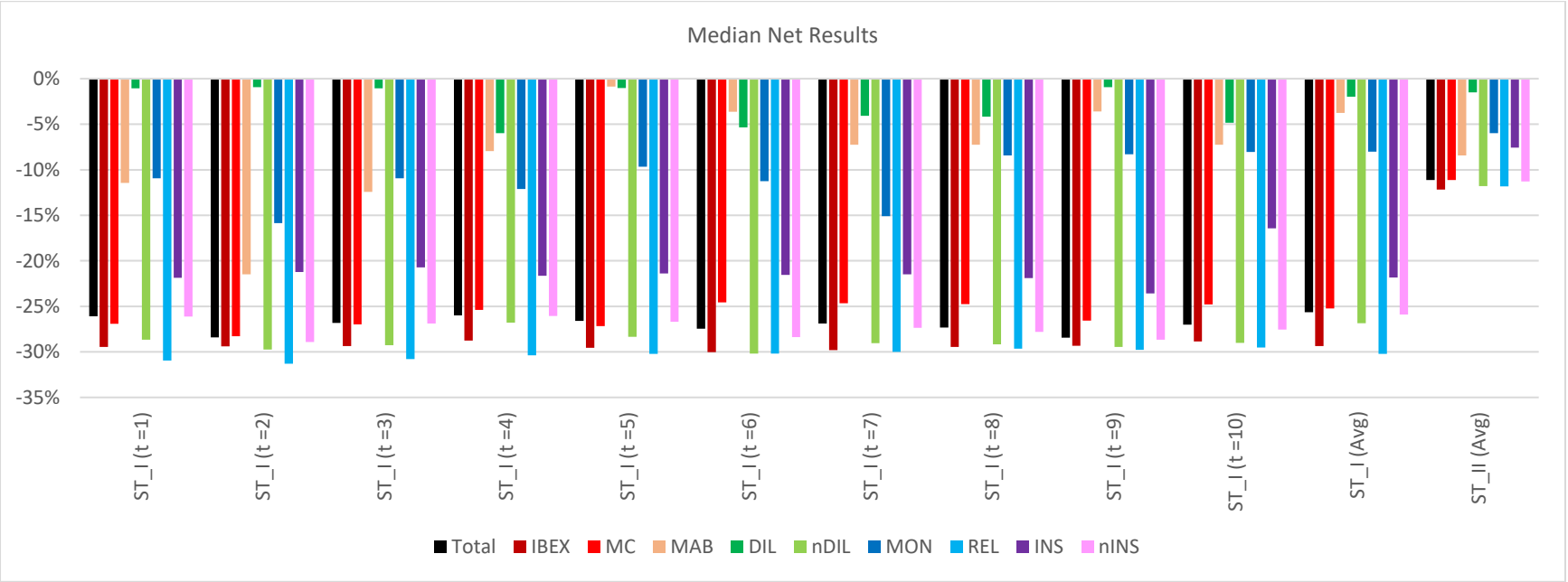


Figure 4: Distribution of Median Net Results by day and in average (for both strategies).



NOTES: Figure 3 shows the daily average results obtained in each of the groups on each of the days analysed (for strategy I only), as well as the aggregated result for strategies I and II. Figure 4 replicates this analysis but showing the Median of the results instead of the average.

In summary, both the means and medians are, in almost all cases, negative. However, the positive means observed in the group of outliers do point to the possible existence of arbitrage opportunities in some of these processes.

Figure 5: Histogram of Net Returns (Total - I).

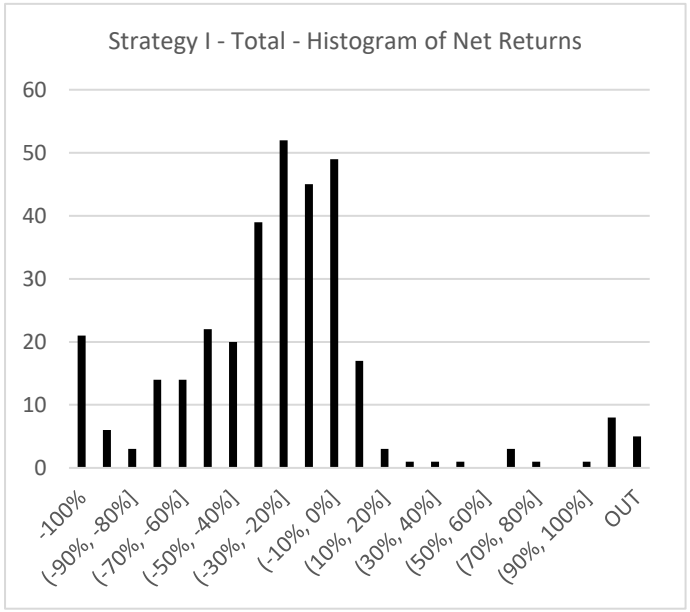


Figure 6: Histogram of Net Returns (IBEX - I).

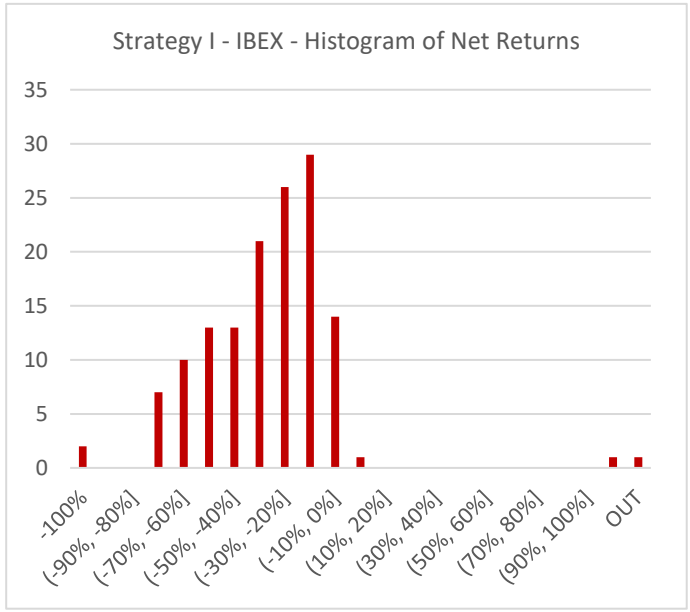


Figure 7: Histogram of Net Returns (MC - I).

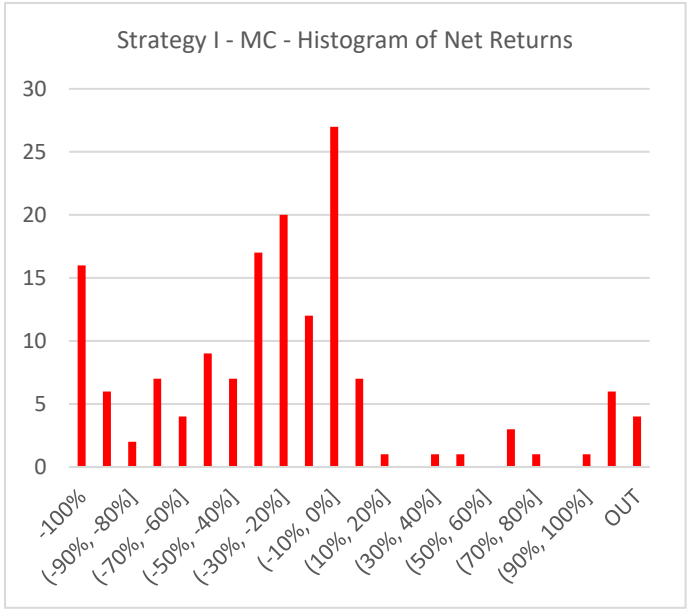
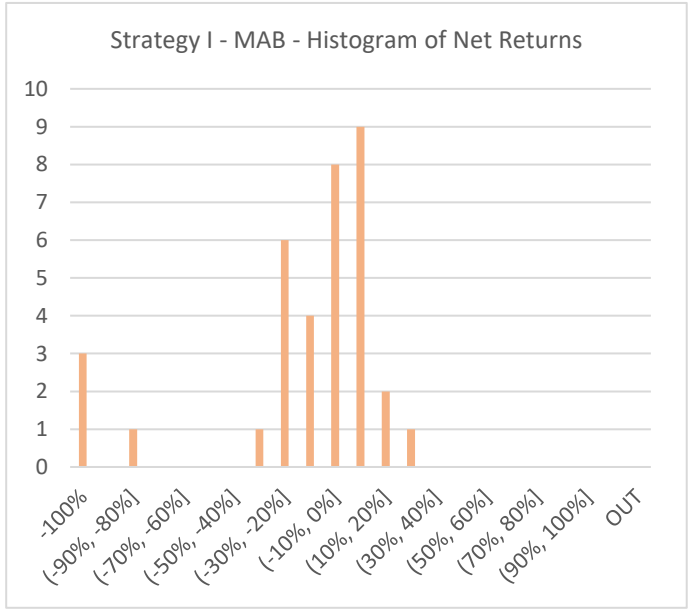


Figure 8: Histogram of Net Returns (MAB - I).



NOTE: Figures 5 to 14 show the Histogram of average net return for the set of rights issues, as well as for each of the subgroups constructed (calculated on the basis of Strategy I). The net returns considered as outliers are also included as a separate value.

We can observe how, in practically all groups, the majority of net returns obtained are negative. However, positive net returns can be found in all groups, which indicates that there have been arbitrage opportunities in these processes.

Although the behaviour of the return is very similar among the groups, some particularities can be observed. Specifically, it can be seen that in the IBEX and MAB groups of companies there have been practically no positive returns, while in the dilutive ones more opportunities can be observed.

Many of the outliers seem to be found in monetary and especially dilutive processes, while there are none when the issuers are IBEX or MAB companies.

Figure 9: Histogram of Net Returns (DIL - I).

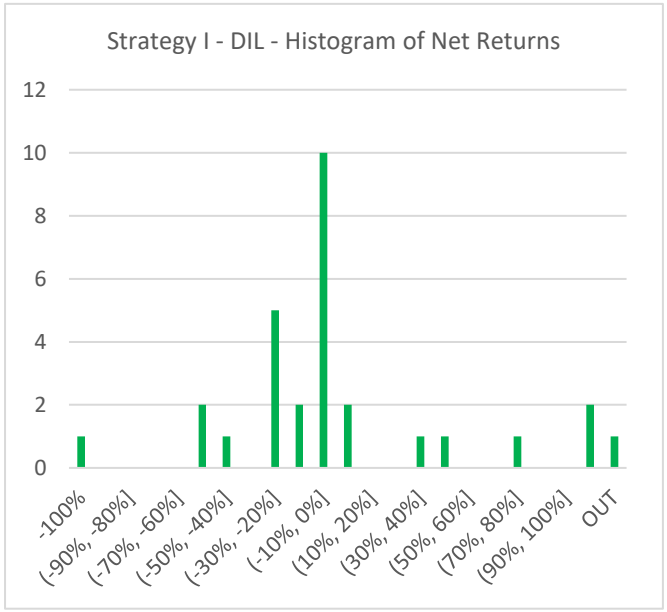


Figure 10: Histogram of Net Returns (nDIL - I).

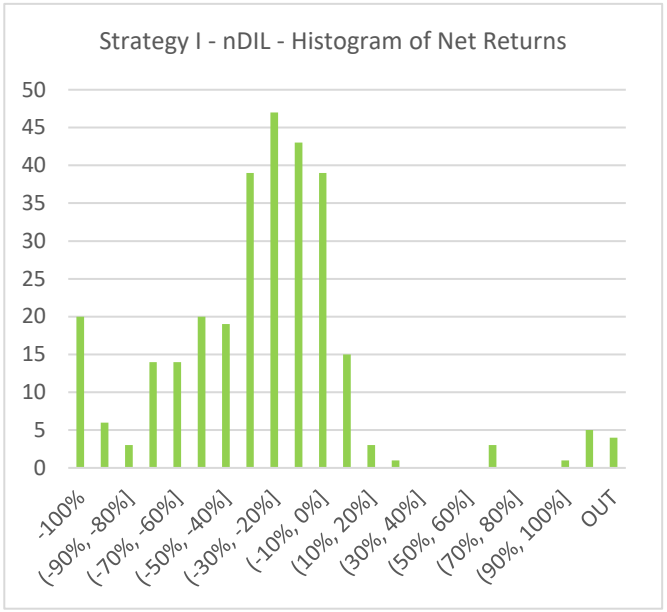


Figure 11: Histogram of Net Returns (MON - I).

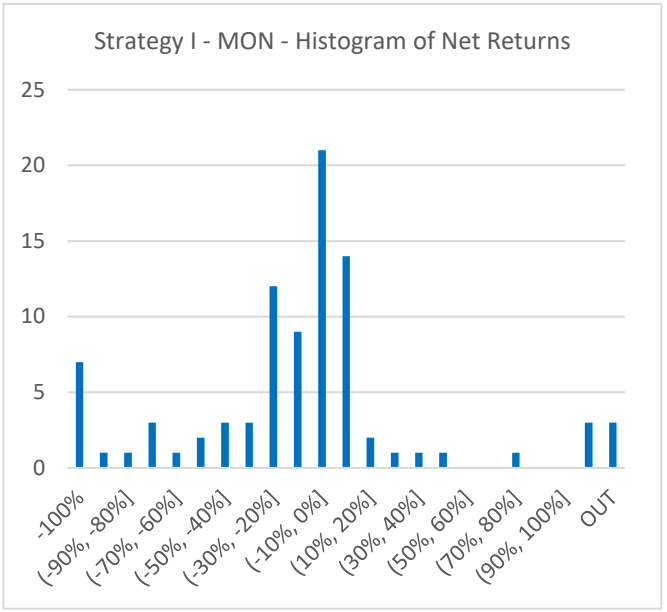


Figure 12: Histogram of Net Returns (REL - I).

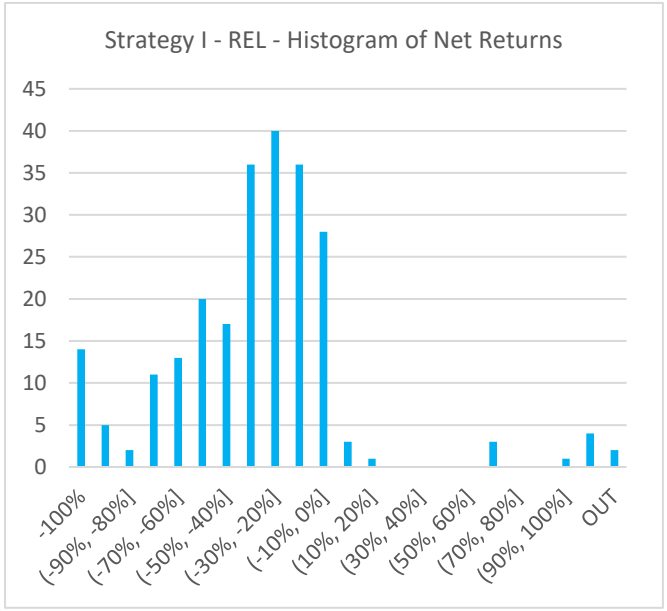


Figure 13: Histogram of Net Returns (INS - I).

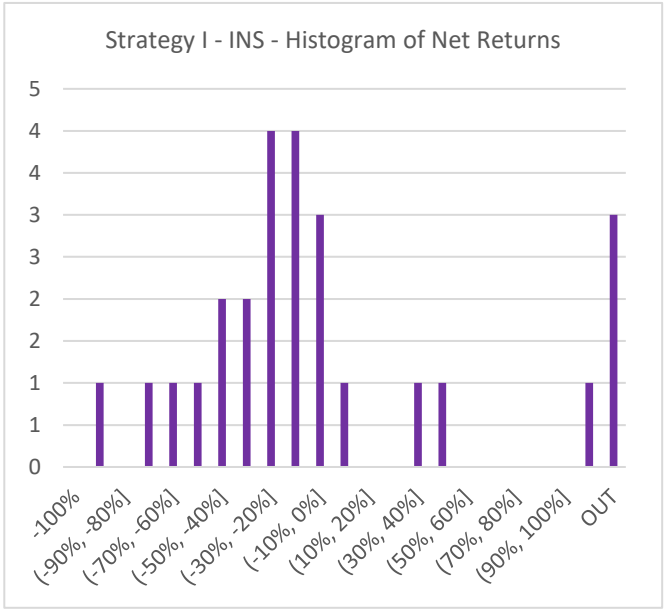


Figure 14: Histogram of Net Returns (nINS - I).

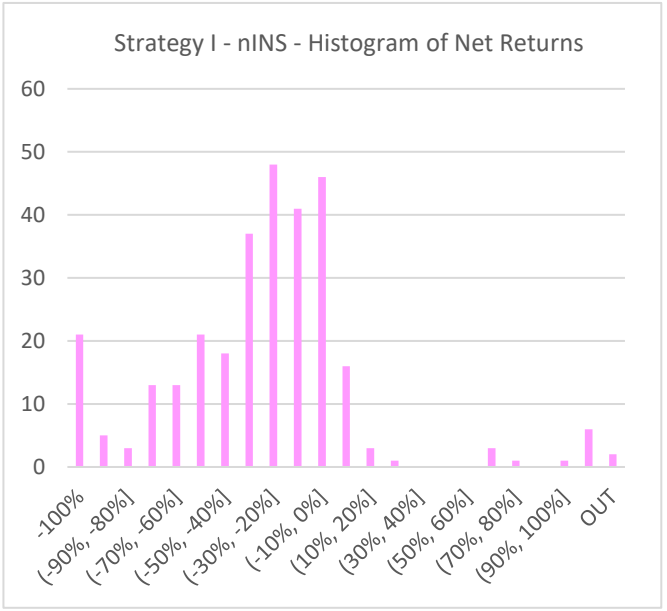


Figure 15: Histogram of Net Returns (Total - II).

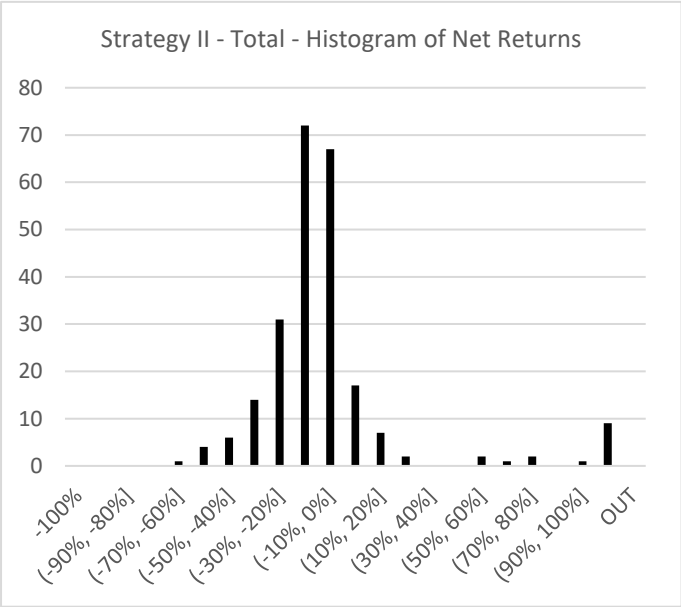


Figure 16: Histogram of Net Returns (IBEX - II).

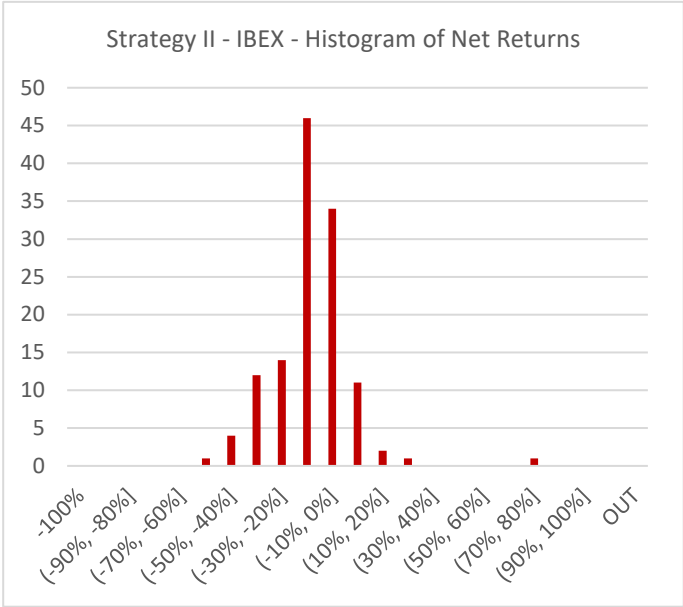


Figure 17: Histogram of Net Returns (MC - II).

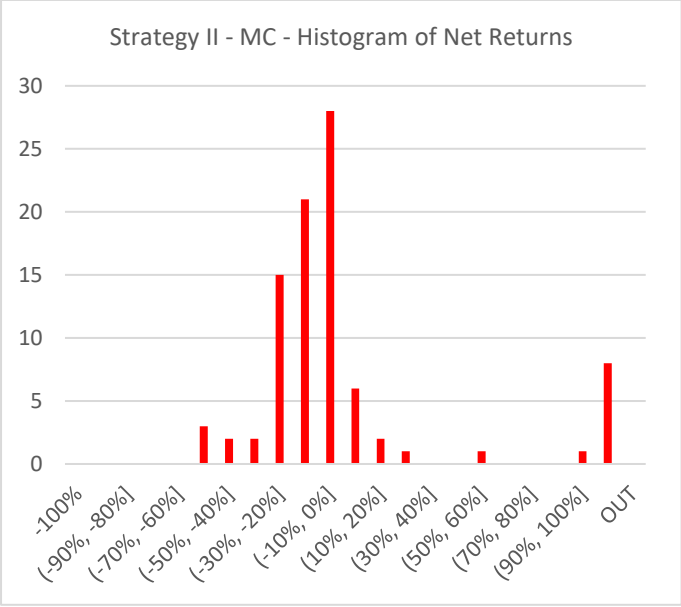
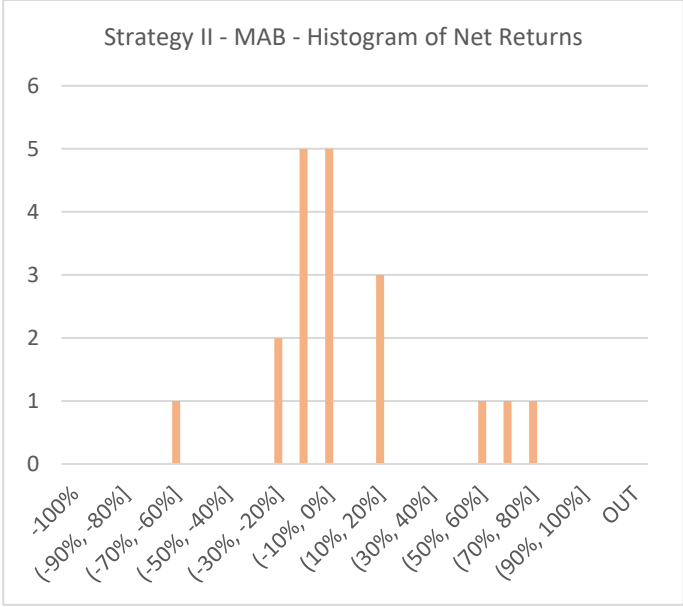


Figure 18: Histogram of Net Returns (MAB - II).



NOTE: Figures 15 to 24 show the Histogram of average net return for the set of rights issues, as well as for each of the subgroups constructed (calculated on the basis of Strategy II). The net returns considered as Outliers are also included as a separate value.

We can observe that the results for strategy II are not particularly different from those obtained for strategy I. Again, most of the net returns obtained are negative in all the groups analysed.

As in the previous case, it is again the case that more arbitrage opportunities are detected in the group of the dilutive processes.

In the Strategy II results, it was not possible to determine any return as an Outlier.

Figure 19: Histogram of Net Returns (DIL - II).

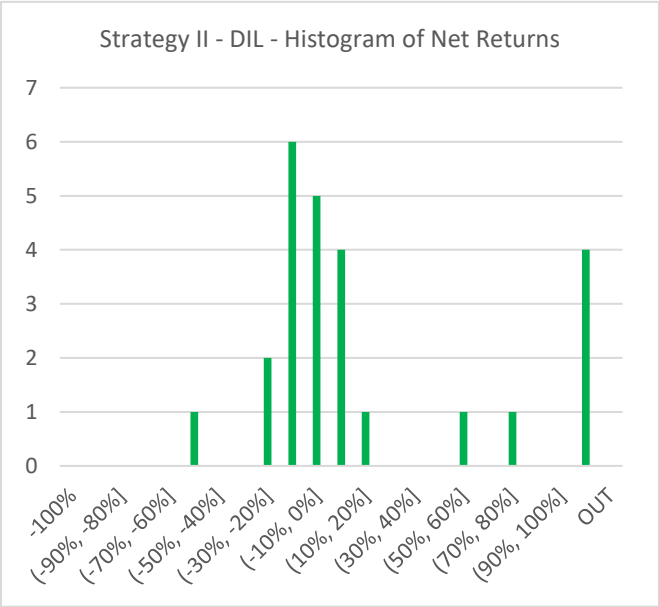


Figure 20: Histogram of Net Returns (nDIL - II).

Figure 21: Histogram of Net Returns (MON - II).

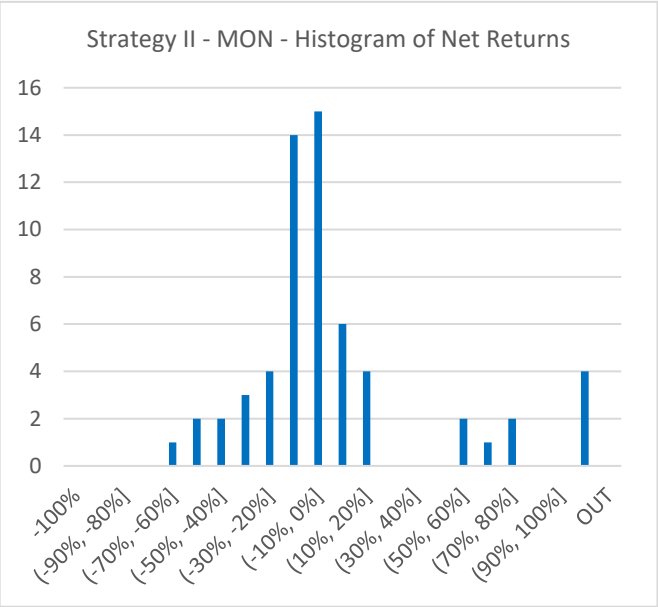


Figure 22: Histogram of Net Returns (REL - II).

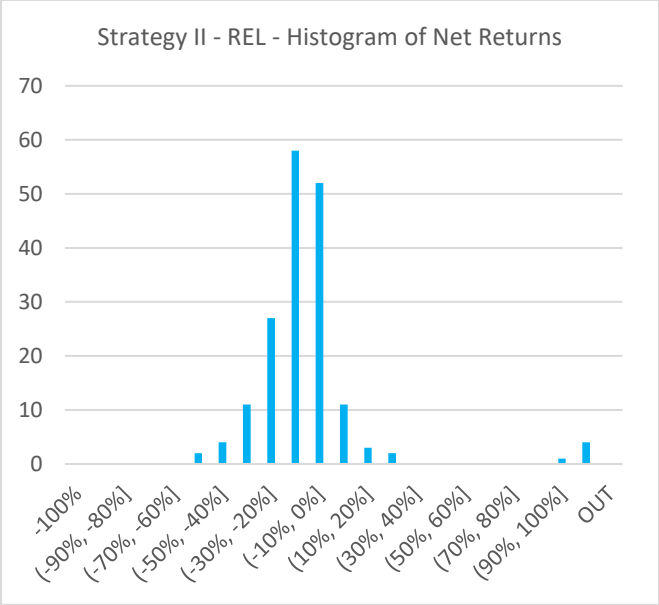


Figure 23: Histogram of Net Returns (INS - II).

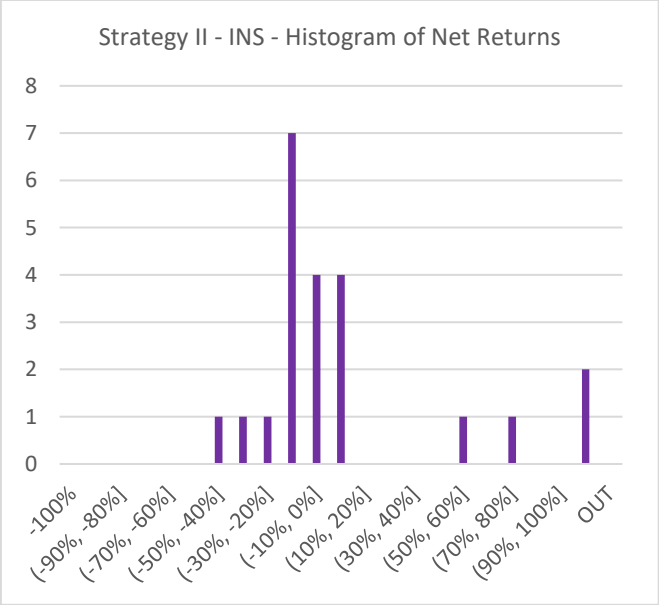


Figure 24: Histogram of Net Returns (nINS - II).

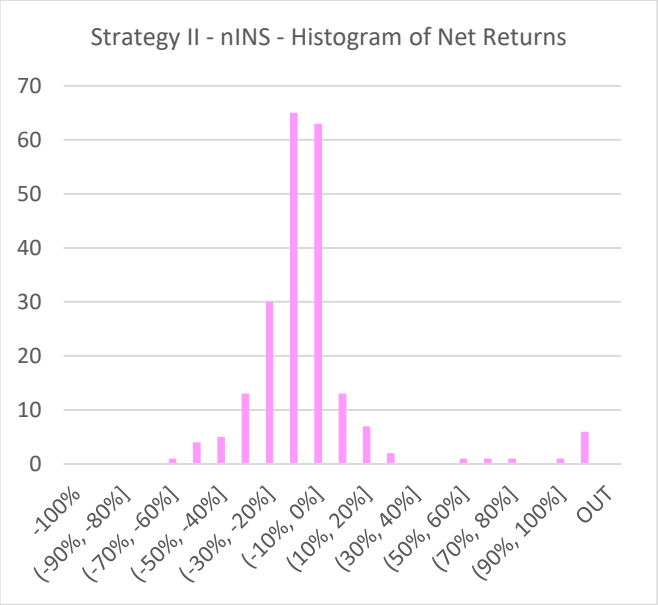


Table 3: Main statistics and results for t-Student and Wilcoxon test for IBEX, MC and MAB rights issues (daily and aggregate results).

Group	Results		Strategy I											Strategy II
			Avg.	t =1	t =2	t =3	t =4	t =5	t =6	t =7	t =8	t =9	t =10	Avg.
IBEX	Average (%)		-31,26%	-31,18%	-31,40%	-31,43%	-31,45%	-31,34%	-31,17%	-31,35%	-31,04%	-30,99%	-30,94%	-13,17%
	Median (%)		-29,35%	-29,46%	-29,39%	-29,35%	-28,77%	-29,54%	-30,03%	-29,79%	-29,47%	-29,34%	-28,86%	-12,16%
	Std. Dev. (%)		75,01%	34,69%	34,51%	34,46%	34,39%	34,61%	34,81%	34,57%	34,61%	35,06%	34,50%	15,14%
	t-Student test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***	***	***	***	***	***	***
	Wilcoxon test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***	***	***	***	***	***	***
MC	Average (%)		-19,75%	-24,91%	-28,94%	-29,15%	-27,09%	-27,05%	-26,70%	-27,82%	-27,72%	-27,53%	-29,25%	12,26%
	Median (%)		-25,22%	-26,91%	-28,27%	-26,98%	-25,40%	-27,18%	-24,58%	-24,66%	-24,76%	-26,56%	-24,79%	-11,13%
	Std. Dev. (%)		164,02%	63,87%	48,51%	49,91%	54,44%	54,83%	55,18%	52,03%	52,54%	55,52%	48,55%	86,86%
	t-Student test	P-Value	0,1451	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,1838
				***	***	***	***	***	***	***	***	***	***	
	Wilcoxon test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***	***	***	***	***	***	***
MAB	Average (%)		-16,66%	-22,18%	-29,15%	-24,08%	-17,68%	-15,80%	-7,06%	-8,84%	-8,82%	-6,74%	-9,79%	1,97%
	Median (%)		-3,75%	-11,44%	-21,49%	-12,43%	-7,94%	-0,85%	-3,62%	-7,26%	-7,26%	-3,59%	-7,26%	-8,44%
	Std. Dev. (%)		31,80%	33,40%	34,89%	35,12%	35,81%	42,44%	9,95%	9,75%	9,73%	9,71%	11,35%	34,46%
	t-Student test	P-Value	0,0039	0,0019	0,0004	0,0012	0,0164	0,0750	0,2507	0,0019	0,0004	0,0012	0,0164	0,8061
			***	***	***	***	**	*		***	***	***	**	
	Wilcoxon test	P-Value	0,0016	0,0003	0,0004	0,0009	0,0116	0,0532	0,2326	0,1425	0,1425	0,2326	0,1425	0,0001
			***	***	***	***	**	*						***

Table 4: Main statistics and results for t-Student and Wilcoxon test for dilutive and not dilutive rights issues (daily and aggregate results).

Group	Results		Strategy I											Strategy II
			Avg.	t =1	t =2	t =3	t =4	t =5	t =6	t =7	t =8	t =9	t =10	Avg.
Dilutives	Average (%)		17,05%	0,58%	1,95%	1,68%	1,77%	3,30%	3,94%	-4,24%	-2,94%	-4,16%	-0,78%	50,51%
	Median (%)		-1,98%	-1,05%	-0,94%	-1,04%	-5,97%	-1,02%	-5,36%	-4,09%	-4,17%	-0,94%	-4,83%	-1,50%
	Std. Dev. (%)		119,68%	52,41%	56,11%	58,79%	60,13%	64,01%	67,50%	51,95%	52,34%	52,49%	56,89%	137,89%
	t-Student test	P-Value	0,4573	0,9563	0,8609	0,8830	0,8795	0,7912	0,7682	0,9563	0,8609	0,8830	0,8795	0,0794
														*
	Wilcoxon test	P-Value	0,0608	0,1983	0,1346	0,0854	0,0714	0,0682	0,0793	0,0766	0,0944	0,0713	0,0764	0,3146
			*			*	*	*	*	*	*	*	*	
Not Dilutives	Average (%)		-28,31%	-29,90%	-33,00%	-32,67%	-31,04%	-31,04%	-31,78%	-31,61%	-31,53%	-31,30%	-32,57%	-8,48%
	Median (%)		-26,86%	-28,68%	-29,75%	-29,26%	-26,78%	-28,34%	-30,19%	-29,05%	-29,18%	-29,46%	-29,02%	-11,80%
	Std. Dev. (%)		57,41%	49,66%	38,95%	39,40%	42,49%	42,80%	42,39%	42,83%	43,04%	45,15%	39,27%	32,58%
	t-Student test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0002
			***	***	***	***	***	***	***	***	***	***	***	***
	Wilcoxon test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6009
			***	***	***	***	***	***	***	***	***	***	***	

NOTES: Tables 3 and 4 show the main results on the arbitrage analysis performed on the sample of rights issues (i.e. the mean and median returns and their standard deviation, and the tests on the mean (t-Student) and on the median (Wilcoxon)), for IBEX, MC and MAB processes (Table 3) and the dilutive and non-dilutive ones (Table 4).

In summary, it can be observed that the statistically significant returns are always negative (with the exception of the dilutive group, where they are positive and high), while the medians are significant in many cases, and in most of them they are negative. On the other hand, no significant differences can be observed between the results of strategies I and II.

Table 5: Main statistics and results for t-Student and Wilcoxon test for monetary and released capital increases (daily and aggregate results).

Group	Results		Strategy I											Strategy II
			Avg.	**t =1**	**t =2**	**t =3**	**t =4**	**t =5**	**t =6**	**t =7**	**t =8**	**t =9**	**t =10**	**Avg.**
Monetary	**Average (%)**		-15,83%	-17,03%	-19,44%	-18,38%	-17,24%	-15,93%	-15,55%	-15,10%	-14,37%	-14,09%	-12,80%	15,01%
	Median (%)		-8,01%	-10,94%	-15,85%	-10,94%	-12,12%	-9,67%	-11,25%	-15,11%	-8,41%	-8,29%	-8,03%	-5,96%
	Std. Dev. (%)		45,87%	47,60%	48,23%	47,68%	47,81%	50,04%	51,68%	52,82%	53,01%	53,21%	54,76%	90,67%
	t-Student test	**P-Value**	0,0019	0,0023	0,0008	0,0010	0,0021	0,0070	0,0298	0,0023	0,0008	0,0010	0,0021	0,2047
			***	***	***	***	***	***	**	***	***	***	***	
	Wilcoxon test	**P-Value**	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0003	0,0005	0,0007	0,0012	0,0008	0,0000
			***	***	***	***	***	***	***	***	***	***	***	***
Released	**Average (%)**		-27,47%	-30,95%	-33,46%	-33,53%	-31,86%	-31,99%	-31,63%	-32,62%	-32,57%	-32,39%	-33,93%	-8,11%
	Median (%)		-30,21%	-30,94%	-31,29%	-30,81%	-30,39%	-30,23%	-30,20%	-29,99%	-29,63%	-29,77%	-29,53%	-11,82%
	Std. Dev. (%)		72,10%	51,05%	38,88%	39,88%	43,70%	43,94%	44,40%	41,41%	41,66%	44,03%	37,20%	37,67%
	t-Student test	**P-Value**	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0049
			***	***	***	***	***	***	***	***	***	***	***	***
	Wilcoxon test	**P-Value**	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0620
			***	***	***	***	***	***	***	***	***	***	***	*

NOTES: Tables 5 and 6 show the main results of the arbitrage analysis performed on the sample of rights issues (i.e. the mean and median results and their standard deviation, and the tests on the mean (t-Student) and on the median (Wilcoxon), for monetary and released processes (Table 5) the insured and not insured ones, and the aggregation of them (Table 6).

In summary, the conclusions drawn from the analysis in Tables 3 and 4 are replicated here. In this case, there are no relevant differences between strategies I and II either.

Table 6: Main statistics and results for t-Student and Wilcoxon test for insured. not insured. and total rights issues (daily and aggregate results).

Group	Results		Strategy I											Strategy II
			Avg.	t =1	t =2	t =3	t =4	t =5	t =6	t =7	t =8	t =9	t =10	Avg.
Insured	Average (%)		-15,14%	-13,55%	-14,27%	-14,12%	-15,91%	-15,84%	-15,41%	-15,54%	-15,24%	-15,79%	-13,06%	20,02%
	Median (%)		-21,82%	-21,88%	-21,22%	-20,72%	-21,65%	-21,38%	-21,55%	-21,47%	-21,91%	-23,59%	-16,43%	-7,57%
	Std. Dev. (%)		52,54%	52,64%	51,91%	54,28%	54,01%	53,32%	52,98%	52,79%	52,29%	52,74%	52,73%	93,59%
	t-Student test	P-Value	0,1808	0,2301	0,2010	0,2254	0,1718	0,1683	0,1768	0,2301	0,2010	0,2254	0,1718	0,3272
	Wilcoxon test	P-Value	0,0069	0,0132	0,0088	0,0081	0,0058	0,0053	0,0069	0,0069	0,0069	0,0093	0,0177	0,0000
			***	**	***	***	***	***	***	***	***	***	**	***
Not Insured	Average (%)		-25,05%	-28,56%	-31,32%	-30,94%	-29,17%	-29,02%	-29,70%	-30,51%	-30,34%	-30,00%	-31,28%	-4,50%
	Median (%)		-25,91%	-26,13%	-28,91%	-26,88%	-26,06%	-26,68%	-28,36%	-27,37%	-27,82%	-28,68%	-27,55%	-11,29%
	Std. Dev. (%)		67,17%	50,24%	40,62%	41,21%	44,31%	45,27%	45,52%	43,30%	43,67%	45,75%	40,65%	51,39%
	t-Student test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,2027
			***	***	***	***	***	***	***	***	***	***	***	
	Wilcoxon test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,2132
			***	***	***	***	***	***	***	***	***	***	***	
Total	Average (%)		-24,34%	-27,43%	-30,03%	-29,68%	-28,17%	-28,02%	-28,54%	-29,29%	-29,10%	-28,89%	-29,85%	-2,28%
	Median (%)		-25,64%	-26,08%	-28,41%	-26,83%	-25,99%	-26,59%	-27,45%	-26,88%	-27,32%	-28,46%	-27,01%	-11,13%
	Std. Dev. (%)		85,00%	66,35%	55,07%	56,37%	60,64%	65,36%	59,31%	59,01%	61,99%	58,96%	63,01%	201,18%
	t-Student test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,8622
			***	***	***	***	***	***	***	***	***	***	***	
	Wilcoxon test	P-Value	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
			***	***	***	***	***	***	***	***	***	***	***	***

Table 7: AAR and test results for each event for IBEX, MC MAB, dilutive and not dilutive rights issues.

Group	Relevant Date	AAR	Median	Std. Dev.	t-Student Test		Wilcoxon Test		Bootstrapping		
					P-Value		P-Value		Low	Up	
IBEX	Announcement	-0,1386%	4,3914%	0,0248%	0,5473		0,6450		-0,0061	0,0035	
	Meeting	-0,0430%	2,0442%	-0,0389%	0,7544		0,3545		-0,0035	0,0032	
	Start	1,7741%	20,3554%	-0,1239%	0,0844	*	0,2935		-0,0099	0,0152	
	End	0,3662%	3,7576%	0,0614%	0,0538	*	0,9559		-0,0037	0,0038	
	Result	-0,1290%	4,3901%	-0,0759%	0,6060		0,3259		-0,0060	0,0043	
	Quotation	-0,3612%	5,3577%	-0,0657%	0,2602		0,1576		-0,0079	0,0042	
MC	Announcement	0,0324%	1,2854%	0,0021%	0,7698		0,7282		-0,0030	0,0025	
	Meeting	0,2925%	1,4263%	0,1152%	0,0884	*	0,9428		-0,0034	0,0036	
	Start	0,9229%	16,3284%	-0,3162%	0,5063		0,0002	***	-0,0138	0,0838	
	End	0,0339%	2,3124%	0,0631%	0,8632		0,7811		-0,0049	0,0041	
	Result	-0,3073%	4,2292%	0,0079%	0,4035		0,5228		-0,0111	0,0042	
	Quotation	-0,1538%	1,2916%	-0,0936%	0,1838		0,1030		-0,0029	0,0022	
MAB	Announcement	-0,2889%	5,8326%	0,0242%	0,4933		0,5513		-0,0120	0,0060	
	Meeting	-0,0290%	2,2424%	-0,0657%	0,8947		0,3371		-0,0045	0,0055	
	Start	2,7092%	24,6650%	0,1872%	0,1156		0,9567		-0,0176	0,0225	
	End	0,6068%	4,6487%	0,1143%	0,0618	*	0,9296		-0,0050	0,0058	
	Result	0,3839%	3,5527%	-0,0716%	0,2166		0,5925		-0,0052	0,0078	
	Quotation	-0,4683%	7,9956%	0,0652%	0,5330		0,6194		-0,0220	0,0091	
Dilutives	Announcement	0,0171%	2,7492%	0,1112%	0,9700		0,5150		-0,0089	0,0105	
	Meeting	-0,5926%	2,2915%	-0,2019%	0,0861	*	0,0384	**	-0,0067	0,0069	
	Start	0,2066%	2,6165%	-0,1353%	0,5869		0,4510		-0,0072	0,0084	
	End	0,2912%	2,6563%	0,0210%	0,4512		0,7442		-0,0078	0,0080	
	Result	-1,1285%	6,5393%	-0,2871%	0,2585		0,0825	*	-0,0219	0,0146	
	Quotation	-0,7092%	3,8048%	-0,0169%	0,2454		0,1381		-0,0120	0,0147	
Not Dilutives	Announcement	-0,5413%	4,1318%	-0,4707%	0,4123		0,1184		-0,0123	0,0160	
	Meeting	0,4731%	2,7535%	0,0319%	0,2898		0,7395		-0,0080	0,0099	
	Start	16,7178%	58,3534%	0,4445%	0,0610	*	0,9762		-0,0815	0,0765	
	End	2,0049%	8,7021%	0,0371%	0,1292		0,8152		-0,0171	0,0274	
	Result	-1,2379%	8,5939%	-0,4548%	0,3618		0,1396		-0,0280	0,0210	
	Quotation	-1,7882%	13,6556%	0,1570%	0,4246		0,5605		-0,0609	0,0241	

NOTES: Table 7 shows the Aggregate Abnormal Returns (AAR) for each event analysed, and the tests performed on the abnormal returns (t-Student and Bootstrapping on the mean and Wilcoxon on the median) for IBEX, MC, MAB, dilutive and non-dilutive rights issues. We can observe that, in general terms, abnormal returns are not significant, with the exception (on some occasions) of those generated by the start and end of the trading period of pre-emptive subscription rights. It is also noteworthy that, when abnormal returns are significant, they are also positive.

Table 8: AAR and test results for each event for monetary, released, insured, not insured and total rights issues.

Group	Relevant Date	AAR	Median	Std. Dev.	t-Student Test		Wilcoxon Test		Bootstrapping		
					P-Value		P-Value		Low	Up	
Monetary	Announcement	-0,0889%	4,4259%	0,0406%	0,7178		0,8138		-0,0076	0,0035	
	Meeting	-0,1530%	1,8499%	-0,0474%	0,2647		0,2451		-0,0033	0,0029	
	Start	-0,1527%	2,1886%	-0,1566%	0,1932		0,0783	*	-0,0026	0,0025	
	End	0,1549%	2,4451%	0,0631%	0,2373		0,9413		-0,0032	0,0029	
	Result	0,0407%	3,3092%	-0,0377%	0,8406		0,4940		-0,0056	0,0037	
	Quotation	-0,1371%	2,0569%	-0,0729%	0,3007		0,1014		-0,0033	0,0030	
Released	Announcement	-0,9311%	7,5331%	-0,1311%	0,2038		0,0469	**	-0,0164	0,0102	
	Meeting	-0,1798%	2,4907%	-0,2204%	0,4905		0,1171		-0,0057	0,0061	
	Start	6,3014%	35,9585%	0,2570%	0,0542	*	0,9854		-0,0316	0,0234	
	End	0,7394%	5,8787%	-0,0172%	0,1656		0,5402		-0,0076	0,0117	
	Result	-0,3037%	6,9443%	-0,1923%	0,6385		0,3071		-0,0151	0,0107	
	Quotation	-1,2775%	8,9392%	-0,1188%	0,1691		0,0735	*	-0,0176	0,0127	
Insured	Announcement	0,1913%	1,8644%	0,0445%	0,1012		0,9566		-0,0030	0,0028	
	Meeting	0,0538%	1,6614%	0,1088%	0,7125		0,7476		-0,0034	0,0030	
	Start	-0,2807%	2,2969%	-0,2369%	0,0452	**	0,0113	**	-0,0032	0,0028	
	End	0,1969%	2,2009%	0,1097%	0,1421		0,9879		-0,0039	0,0034	
	Result	-0,0239%	1,4157%	0,0079%	0,8145		0,5269		-0,0027	0,0027	
	Quotation	0,1019%	1,5739%	-0,0630%	0,3785		0,4046		-0,0023	0,0031	
Not Insured	Announcement	-0,1204%	2,8105%	-0,4974%	0,8255		0,2070		-0,0102	0,0152	
	Meeting	0,5579%	2,4803%	-0,2319%	0,3392		0,7134		-0,0130	0,0117	
	Start	8,1243%	35,4366%	1,0732%	0,2269		0,9974		-0,1686	0,0237	
	End	0,0762%	5,0517%	-0,1476%	0,9358		0,4356		-0,0207	0,0189	
	Result	-1,5196%	8,8544%	-0,3237%	0,3630		0,2907		-0,0436	0,0201	
	Quotation	-0,4921%	2,5549%	-0,4174%	0,3761		0,2740		-0,0121	0,0103	
Total	Announcement	-0,1401%	4,4970%	0,0367%	0,5678		0,7504		-0,0072	0,0036	
	Meeting	-0,0992%	1,9967%	-0,0380%	0,4797		0,3014		-0,0033	0,0035	
	Start	1,2696%	18,6357%	-0,1752%	0,1939		0,0529	*	-0,0091	0,0288	
	End	0,3893%	3,6434%	0,0631%	0,0419	**	0,9694		-0,0032	0,0041	
	Result	0,0151%	3,6314%	-0,0508%	0,9447		0,3891		-0,0049	0,0044	
	Quotation	-0,3500%	5,5342%	-0,0630%	0,3106		0,1973		-0,0082	0,0047	

NOTES: Table 8 shows the Aggregate Abnormal Returns (AAR) for each event analysed, and the tests performed on the abnormal returns (t-Student and Bootstrapping on the mean and Wilcoxon on the median) for the monetary, released, insured, not insured and total rights issue.

In summary, the conclusions obtained from the analysis in Table 7 seem to be replicated also for these groups of processes, both in the significance and in the sign of the significant abnormal returns.

Table 9: Results for the long-term event study by model of reference for each group of rights issues.

	Total	**IBEX**	**MC**	**MAB**	**Dilutes**	**Non-Dilutives**	**Monetary**	**Released**	**Insured**	**Not Insured**
Panel A: CAPM										
Constant (%)	0,1200%	-0,3537%	-0,0200%	0,9100%	-0,9100%	0,2500%	0,0600%	0,1600%	-0,4800%	0,1600%
p-value	0,612	0,990	0,944	0,057	0,041	0,279	0,873	0,475	0,263	0,499
				*	**					
Adjusted R^2 (%)	52,7%	55,4%	35,0%	2,5%	8,1%	53,5%	26,9%	54,9%	25,9%	49,4%
Panel B: Fama and French										
Constant (%)	-0,0400%	0,0200%	-0,3000%	0,8800%	-1,0900%	0,1000%	-0,2100%	0,0400%	-0,6600%	0,0200%
p-value	0,855	0,949	0,322	0,080	0,020	0,626	0,562	0,852	0,128	0,927
				*	**					
Adjusted R^2 (%)	56,6%	57,7%	43,9%	2,7%	10,6%	56,9%	33,3%	57,3%	30,0%	52,6%
Panel C: Fama and French + Amihud										
Constant (%)	-0,0600%	0,0014%	-0,3300%	0,8900%	-1,0800%	0,0800%	-0,2300%	0,0200%	-0,6400%	-0,0056%
p-value	0,780	0,996	0,274	0,080	0,022	0,722	0,514	0,917	0,145	0,980
				*	**					
Adjusted R^2 (%)	56,7%	57,7%	44,2%	2,7%	10,6%	57,1%	33,4%	57,4%	30,1%	52,9%

NOTES: Table 9 shows the result of the long-term Event Study conducted according to the three benchmark models and for each group of rights issues. In summary, a relevant change in the results can be observed when adding the illiquidity factor, which highlights the importance of the model specification and its effects on the results.

Figure 25: Histogram of AR (Announcement).

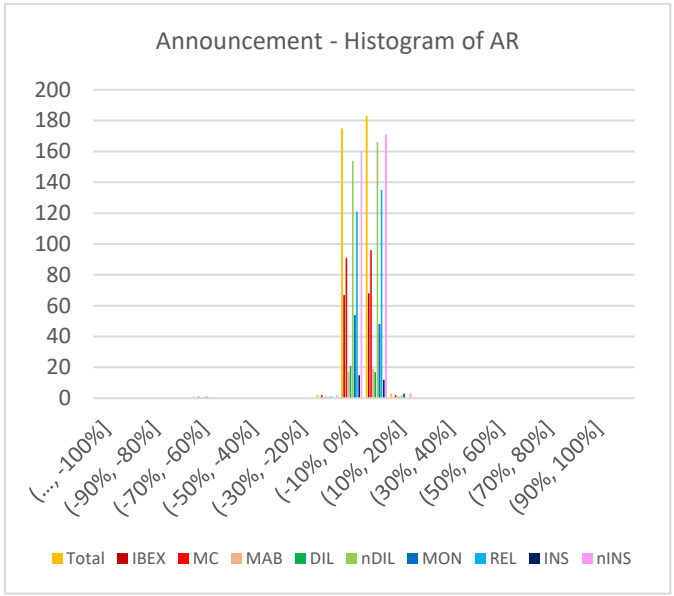


Figure 26: Histogram of AR (Meeting).

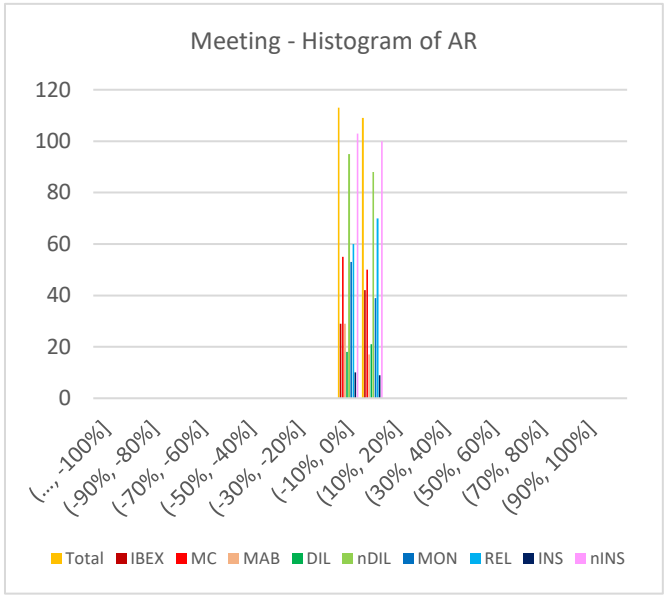


Figure 27: Histogram of AR (Start).

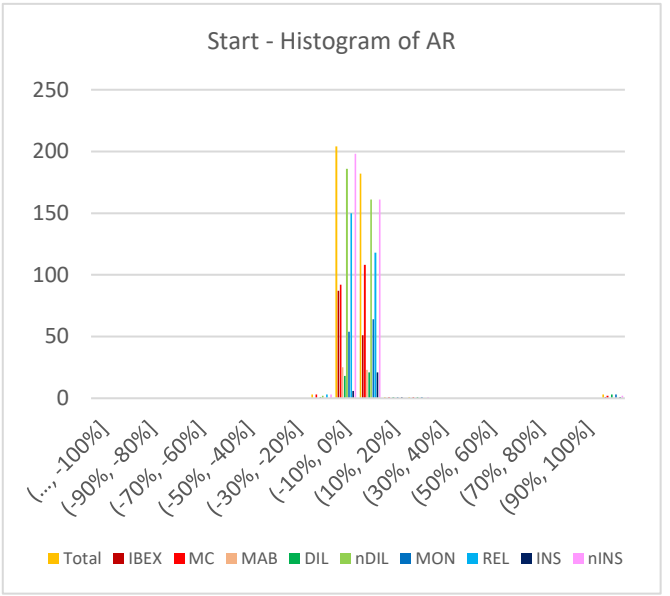


Figure 28: Histogram of AR (End).

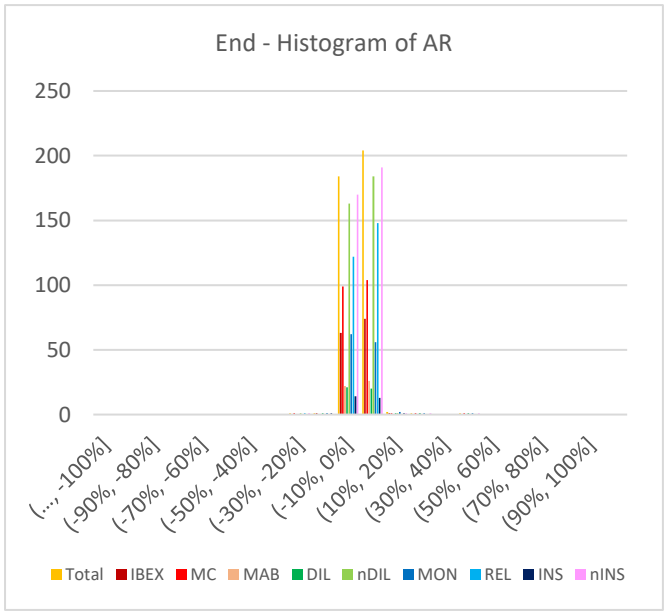


Figure 29: Histogram of AR (Result).

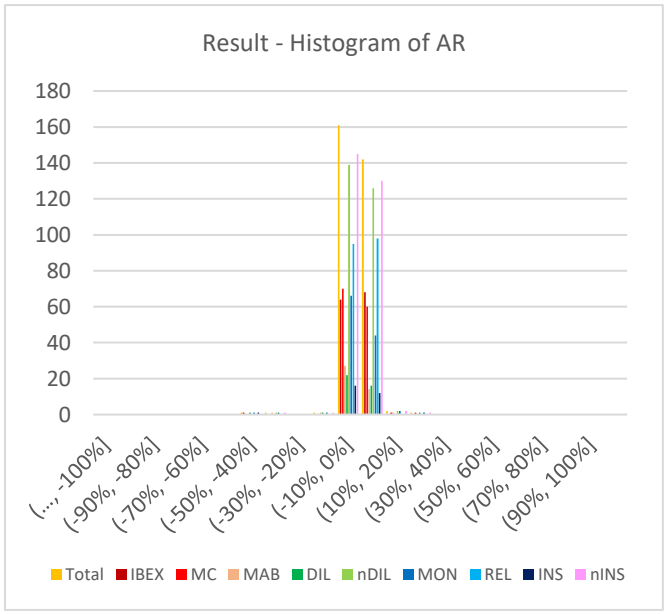
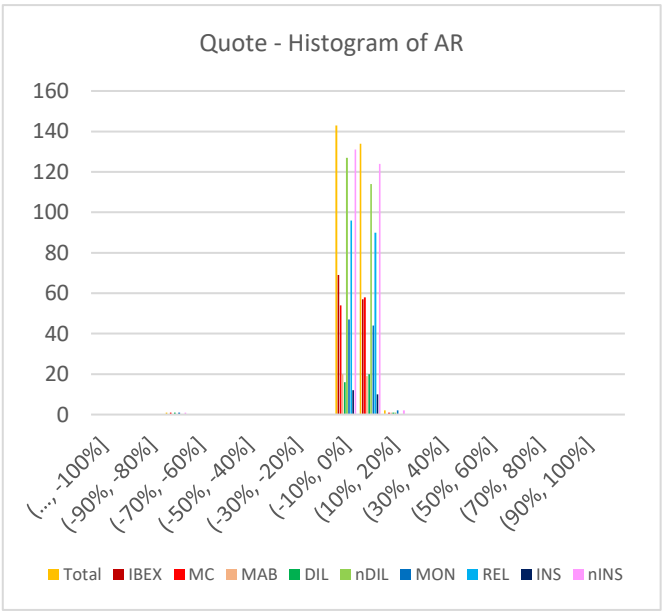


Figure 30: Histogram of AR (Quote).



NOTES: Figures 25 to 30 show the RA histogram for each of the events and groups analysed. In general terms, they cluster around 0%.

V.2) Methodology

V.2.A). Opportunities of Arbitrage

The strategy to be exploited consists of acquiring a new share through subscription rights and selling one of the already listed shares (a strategy that could be called "Direct Arbitrage"). This would consist of selling one share and acquiring the necessary subscription rights to, through these, acquire a new share. To carry out these operations, it is necessary to know the share and the right prices on the dates when both assets are traded simultaneously. It is also necessary to know the issue rate, which is the sum of the nominal value and the issue premium (if any) of the subscription rights, and the number of rights required to acquire a new share.

The price at which a new share can be bought with the rights in a rights issue can be computed as follows:

$$P_{Stock\_Right,i,t} = \frac{(P_{Right,i,t} \cdot n_{Old,i} + (Nominal_i + Premium_i) \cdot n_{New,i} * 1_{Monetary})}{n_{New,i}} \quad [1]$$

V.2.A.i). Existence of short positions for all companies – Strategy I.

The strategy described below assumes that it is possible to take short positions in the share. The percentage difference between buying the shares of the company i at time t through the rights, with respect to the price at which they are quoted on the market, has been calculated according to the following expression:

$$Differential_{i,t} = \frac{P_{Stock,i,t} - P_{Stock\_Right,i,t}}{P_{Stock\_Right,i,t}} \quad [2]$$

where $P_{Stock,i,t}$ and $P_{Stock\_Right,i,t}$ are respectively the quoted price of the share and the PSD, and $n_{Old,i}$ indicates the number of rights to acquire $n_{New,i}$ new shares. In order to obtain the net spread, the costs arising from the transactions that have to be carried out to implement such a strategy should be applied.

V.2.A.ii) No short positions for all companies – Strategy II.

If there is no possibility of taking short positions on the assets side, the arbitrage strategy detailed above could not be carried out. The alternative strategy would be to buy the shares through the PSRs and sell the new shares at the closing price of the day they start trading. In order to check whether this operation is profitable on average, the price of

the shares on the day on which the new shares began to be quoted are compared with the average of the theoretical prices of the new shares calculated for each day on which the PSRs were quoted, obtaining the gross spread as follows:

$$Differential = \frac{P_{Stock,i,t\_6} - \sum_{t=1}^{\tau} \frac{P_{Stock\_Right,i,t}}{\tau}}{\sum_{t=1}^{\tau} \frac{P_{Stock\_Right,i,t}}{\tau}} \quad [3]$$

where τ is the total number of days the PSRs were listed, and t_6 is the day the company's new shares began trading. It has not always been possible to clearly identify the start date of trading of the new shares, so less results will be shown for this strategy.

V.2.A.iii) Estimation of the effect of commissions.

Without a correct estimation of the effect of the expenses and commissions that may be incurred when executing an arbitrage strategy, its result cannot be considered valid, since the result of the former could eliminate the potential benefit of the latter. However, this exercise is not simple, and can be done in different ways and approaches. In this paper, as a basis, it has been decided to make a conservative estimate of these costs.

In order to make this estimate, we simulated the execution of this arbitrage strategy in those rights issues in which a positive result was identified. Each of the legs of the strategy has been carried out through a different broker, with the purchase of rights and subsequent sale of shares through *Renta 4 Banco*, and CFD trading through *IG*. The investment made, adding the purchase price of rights, the share subscription price and the margins required for short positions, would be a maximum of €100,000. Once the positions to be taken in each of these strategies have been defined, all the movements to be made and the commissions that would be charged are simulated, using the tables and information provided by both entities.

The estimated effect of the commissions that will be used for the calculations will be the percentage that all these commissions represent on the simulated result of the strategy. For Strategy I, the estimated result is 2.16%. With respect to Strategy II, without the commissions corresponding to CFD trading, the estimated result is 0.96%. In both strategies, the net spread will be obtained as the gross spread (calculated following the procedure in the two previous sections, as appropriate) minus the estimated effect of the corresponding commissions. Using the price series obtained for both the share and the rights, these expressions will be applied to the first ten days of trading of the subscription rights (in Spain, rights usually trade for eleven days), and we will consider that an arbitrage opportunity has existed when the net return (after applying commissions and expenses) is positive.

V.2.A.iv) Detection and filtering of outliers.

In calculating the net returns, a set of excessively high results were obtained which, although not too many, their magnitude could affect some of the tests performed, especially those related to the mean. Because of this, it has been decided to eliminate these results from the sample.

To detect and filter outliers, we used the "Median Absolute Deviation" (MAD) methodology, described in **Leys et. al. (2013)**. To carry out this procedure, the median of the returns is obtained, and a new series is obtained as the absolute value of the difference between these values and the median obtained. The MAD parameter is obtained by multiplying the median of the new series by the b parameter. This is:

$$MAD = b \cdot M(|NR_i - M(NR)|) \quad [4]$$

where M represents the median of the containing series, while the parameter b is equal to the inverse of the 0.75 quartile of the original return series.

Once the MAD parameter has been obtained, an outlier is defined as any return that exceeds, in absolute value, the median of the original series plus 2.5 times the MAD. In other words, net returns that meet the following equation will not be considered outliers:

$$M(NR) - 2{,}5 \cdot MAD < NR_I < M(NR) + 2{,}5 \cdot MAD \quad [5]$$

V.2.A.v) Statistical tests applied:

Once the series of returns were obtained, and having eliminated those considered as Outliers, a series of tests were carried out. These tests consist of a parametric test on the mean (t-Student) and a non-parametric test on the median (Wilcoxon). In both cases, the final result will be a P-Value. We will consider the factor of interest to be significant if the P-Value is less than 0.1, and not significant otherwise.

With respect to the **t-Student test**, the null hypothesis that the mean of the series is equal to 0 is tested against its alternative hypothesis. This is:

$$H_0: \mu = 0$$
$$H_1: \mu \neq 0$$

where μ is the mean of the series. To do this, the t-statistic is obtained, which is calculated as follows:

$$t = \frac{\mu}{\sigma}\sqrt{n}$$

where σ is its standard deviation, and n is its size. The P-value is obtained by comparing the absolute value of the t-statistic with a t-Student distribution, with $(n - 1)$ degrees of freedom.

Regarding to the **Wilcoxon (1945) test**, the null hypothesis that the median of the series is equal to 0 is tested against its alternative hypothesis. This is:

$$H_0: M = 0$$
$$H_1: M \neq 0$$

where M is the median of the series. To carry out this test, first the absolute values of the returns are calculated and ordered from lowest to highest, assigning each number a rank according to the position they occupy. After this, the T^+ and T^- parameters are obtained as the sum of the ranks corresponding to positive and negative returns, respectively, and the T parameter is calculated as the difference between positive and negative (this is, $T = T^+ - T^-$).

Using the normal approximation defined in **Bellera et. al. (2010)**, the W statistic, whose distribution under H_0 is that of a normal standard, can be obtained as follows:

$$T \sim^a N\left(0, \sqrt{\frac{n(n+1)(2n+1)}{6}}\right) \quad W = \frac{T}{\sqrt{\frac{n(n+1)(2n+1)}{6}}} \sim^a N(0,1)$$

Finally, the P-Value will be obtained by comparing the W-statistic obtained with the normal standard distribution.

V.2.B). Short-Term Event Study

V.2.B.i). Events

The Event Study technique is going to be used to test if certain relevant event produced abnormal returns (both positive and negative). For this study six events related to rights issues are selected, summarised in the following list:

1. *Announcement of the rights issues.*
2. *Approval of the process by the General Shareholders' Meeting.*
3. *First day of trading of the Subscription Rights.*
4. *Last day of trading of the Subscription Rights.*
5. *Publication of the results of the offering.*
6. *Day when new shares start trading*

V.2.B.ii). Calculation of Abnormal Returns.

Once these events have been detected, it will be analysed whether they caused abnormal returns. To estimate the CAPM model, data corresponding to the 250 days prior to the last day of analysis (30 days away from the day of the first event) is used. The data corresponding to the 30 days prior to the event are not used to avoid contamination of the estimation. The IBEX-35 will be the market portfolio. Abnormal returns $AR_{n,t}$ of the company i at time t will be obtained as follows:

$$\widehat{AR_{\iota,t}} = R_{i,t} - \widehat{R_{\iota,t}} \quad [6]$$

where $\widehat{R_{\iota,t}}$ is the expected return according to the model taken into consideration. Then we will use the CAPM model of **Sharpe (1964)** and **Lintner (1965)**, whose econometric expression is defined below:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{m,t} - R_{f,t}) + \varepsilon_{i,t} \quad [7]$$

where $R_{i,t}$ and $R_{m,t}$ are, respectively, the daily return of firm i and the daily return of a market index at time t, respectively, and α_i and β_i are the coefficients estimated by the model for each company, and $R_{f,t}$ is the daily return of the Spanish Treasury Bills.[1] After estimating the parameters of model [7] in the estimation period (not contaminated period), we estimate de expected return as in [8]:

$$\widehat{R_{\iota,t}} = R_{f,t} + \widehat{\alpha_\iota} + \widehat{\beta_\iota}(R_{m,t} - R_{f,t}) \quad [8]$$

V.2.B.iii) Hypothesis to test.

The aim is to analyse the significance of these returns according to which event they correspond. Therefore, they are going to be classified according to this criterion, until six sets of returns are formed, to which the contrasts defined below will be applied. Then, we will test the Null Hypothesis (H_0) that these events do not generate abnormal returns. To do so, firstly we will apply the **Student t-statistical**. Secondly, the non-parametric rank test (**Wilcoxon (1945)**), will also be applied, because by making a contrast on the median, this test reduces the effect of outliers. Both tests are explained at section *V.2.a.v)*. Finally, a bootstrapping will be performed to obtain a confidence interval for the average abnormal return. To construct this interval, a new sample is constructed by random sampling with replacement. With the new simulated sample, we obtain value of its corresponding t-statistic. From the sample obtained by repeating

[1] This series is formed from data obtained from the Bank of Spain.

this process 999 times, the values corresponding to its 2.5%($t_{2.5}$) and 97.5% ($t_{97.5}$) percentiles are extracted to form the lower (L) and upper (U) limits of the confidence interval as follows:

$$L = \mu - t_{97.5} \cdot \frac{\sigma}{\sqrt{n}}; \quad U = \mu - t_{2.5} \cdot \frac{\sigma}{\sqrt{n}} \quad [9]$$

where μ, σ and n are, respectively, the mean, standard deviation, and size of the original series.. The abnormal return will be considered as not significant when the lower band is negative, and the upper band is positive, significant and negative when the value of both bands is negative, and significant and positive when the value of both bands is positive.

V.2.C). Long-Term Event Study

Abnormal long-run performance is estimated using a formal assessment model. Since, unlike studies of short-term events, a crucial aspect is to control adequately for risk in the estimation of expected returns, we use both the CAPM model of **Sharpe (1964)** and **Lintner (1965)** (expression [1]), and the three-factor model of **Fama and French (1993)** (expression [2]). However, it is also used an extended model which includes an illiquidity risk factor based on the illiquidity measure proposed by **Amihud (2002)** (expression [3]). We will use these models to analyse the performance of a portfolio, constructed each calendar month including companies that in previous 12 months made a rights issues.

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p\left(R_{m,t} - R_{f,t}\right) + \varepsilon_{p,t} \qquad [10]$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p\left(R_{m,t} - R_{f,t}\right) + s_p SMB_t + h_p HML_t + \varepsilon_{p,t} \qquad [11]$$

$$R_{p,t} - R_{f,t} = \alpha_p + \beta_p\left(R_{m,t} - R_{f,t}\right) + s_p SMB_t + h_p HML_t + i_p ILIQ_t + \varepsilon_{p,t} \qquad [12]$$

where $R_{p,t}$ is the weighted return in calendar month *t* of the portfolio, $R_{f,t}$ is the return in month *t* of the treasury bills, $R_{m,t}$ is the monthly return of the IBEX 35. SMB_t and HML_t are the **Fama and French (1993)** factors, and $ILIQ_t$ is the illiquid factor, built as detailed in **Martínez et al. (2005)**. The estimation of the constant (α_P) allows us to contrast the null hypothesis that the average abnormal monthly return of the portfolio formed by companies in the sample is zero, thus indicating the absence of bad behaviour. To do so, we will use a Student-t statistical test over this parameter.

V.3.C). Calculus using Python

The Python programming language was used for downloading and organizing data prior to performing the calculations and methodologies explained. In this process, the following libraries have been used:

NumPy: Harris, C. R., Millman, K. J., Van Der Walt, S. J., Gommers, R., Virtanen, P., Cournapeau, D., ... & Oliphant, T. E. (2020). Array programming with NumPy. Nature, 585(7825), 357-362.

Pandas: McKinney, W. (2010, June). Data structures for statistical computing in python. In Proceedings of the 9th Python in Science Conference (Vol. 445, No. 1, pp. 51-56).

Statsmodels: Seabold, S., & Perktold, J. (2010, June). Econometric and statistical modeling with Python skipper seabold 1 1. In Proc 9th Python Sci Conf (Vol. 57, p. 61).