The Intra-Month Effect in TOPIX Stock Returns

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1. Introduction

Many studies have reported anomalous calendar dependencies in stock returns in the United States, Japan and in other countries. Calendar dependencies are considered anomalous because there is no compelling reason for stock prices to fluctuate to the pattern of the calendar. And also, and this is more important, because there are reasons for them not to fluctuate thus. Calendar anomalies defy then the current understanding of how assets are valued, and this makes them a meaningful and an interesting field of investigation.

One of these calendar anomalies is the monthly pattern, or intra-month effect first reported by Ariel (1987). During the nineteen year period (1963-1981) that he investigated, Ariel found that the mean daily return is positive only during the first half of each trading month, being insignificantly different from zero during the second half. Trading month was defined by Ariel as spanning from the last trading day of a calendar month to the trading day before the last trading day in the following calendar month. A similar pattern was found in Japanese stock returns by Kato (1990a, 1990b). Studying stock returns on the Tokyo Stock Exchange (TSE) for a period extending for 13 and a half years from January 1974 to June 1987 he found that the last seven trading days of the calendar month exhibit higher average returns than the rest of the trading days of the month.

In this study we take a new look at the monthly pattern in the stock returns of the TSE. The underlying rationale pursued here was to try to uncover the conditions under which it might be said that a monthly pattern exists in the TSE stock returns that was as much constant as possible for the several subperiods into which the past half century was divided. The contributions made here to the study of the intra-month effect are the following. First, by using the longest sample of data ever used in the study of this anomaly for TSE stock returns, we are able to come as near as possible to the ideal of taking the long view in the study of calendar anomalies. Second, the long time series data used here allows us also to divide the sample data into several nonoverlapping subperiods of meaningful length to see whether the anomaly under study is stable across time, or might not just affect a small portion of the data, albeit so strongly as to affect the results of tests on the entire sample. Thus, following Lakonishok and Smidt (1988),

we give special importance to the evidence that a particular monthly pattern persists through most of the several nonoverlapping subperiods considered. Third, we consider how outliers might influence the monthly pattern. Fourth, we investigate the possible presence of seasonalities in the intra-month effect. Fifth, we look to alternative definitions of trading month to see whether there might not be other patterns in the monthly cycle that yield stronger patterns.

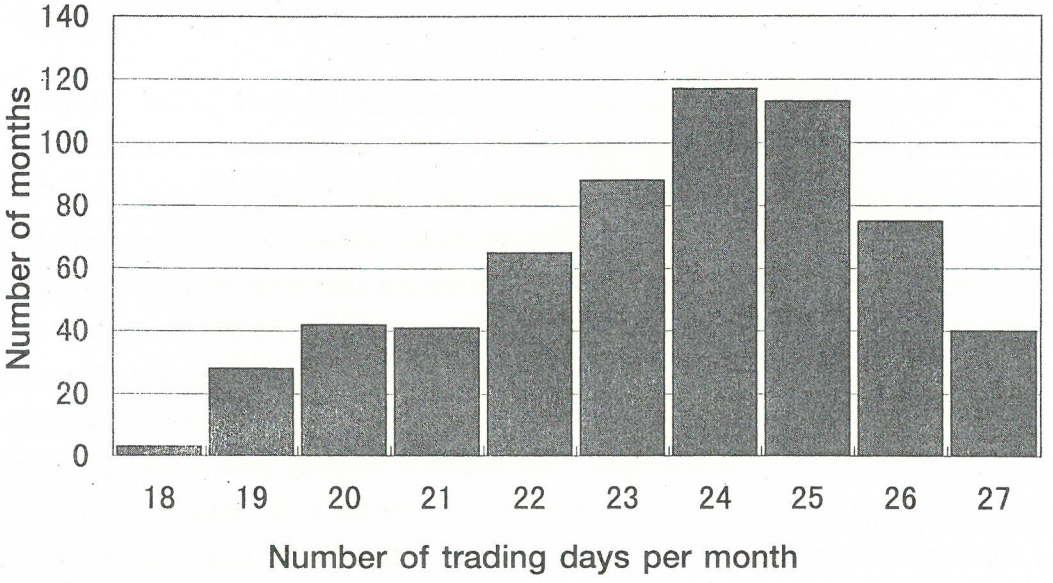
This work is proceeds as follows. In the next section we describe the data used in this study. In Section 3 we test whether stock returns are higher for one particular half of the month. We use standard difference of the means tests that we apply both to daily returns and to cumulative returns. Because a calendar pattern needs to be detectable in different time periods before it can be properly classified as an anomaly, we apply the same tests to ten five-year periods to be able to judge the stability of the monthly pattern. In Section 4 we try to evaluate the role played by outliers on the structure of the intra-month effect, whether they exacerbate it or lessen it. In Section 5 we turn our attention to the possible existence of seasonalities in the monthly pattern. In Section 6 we perform the same tests on other groupings of trading days searching for the strongest alternative monthly pattern. This work concludes with Section 7.

2. Data Description

This study investigates the existence of monthly patterns in the TSE using the TOPIX stock price index. This is a capitalization weighted index that includes all stocks quoted in the First Section of the TSE. This index is available for the period from the beginning of 1950 to the end of 2000, corresponding to 612 months and 14,404 daily observations.

One aspect that should be borne in mind when analyzing the intra-month effect is that not every calendar month has the same number of trading days. This is evident from inspection of Figure 1 where the number of months with a given number of trading days is depicted. It can be noted that while there are months with as many as 27 trading days there are also months with as few as 18. The overall average number of trading days per month is 23.5 days. It should also be noticed that the there has been a decrease of the number of trading days per month during the past five decades. This is apparent from Table 1 where the number of months with a given number of trading days is shown for each ten year period. It can be noticed that the average number of trading days per month has steadily decreased from decade to decade, from a high of 25.1 days in the 1950s to

Figure 1 -Number of trading days per month



20.6 in the 1990s. The main factor of this decrease is the gradual abolition of trading on Saturdays that took place during the 1980s. While there were on average 4.2 trading Saturdays per month during the 1950s and 1960s, in the 1990s there were none. Another factor that explains the decrease in the number of trading days per month is the slow increase in the number of national holidays during the past decades.

3. The monthly pattern in the overall market and its stability

We begin by studying the monthly pattern of stock index returns in the TSE by analyzing in this section the behavior of TOPIX stock returns for the period from 1950 to 2000 and for several of its subperiods. In this section we will investigate the strength and longitudinal stability of the monthly pattern using mainly two different ways to partition the days of a month. These two ways are adopted with slight modifications from the previous literature (Ariel, 1988, Kato, 1993, Lakonishok and Smidt, 1988).

Figure 2 allows a first glimpse at the intra-month effect of stock returns in the TSE. It presents a histogram of the arithmetic mean returns for the nine trading days before and after the start of each calendar month. The period under consideration is all available data, what results in each daily mean being estimated from 612 daily observations. Each bar in the histogram starts from the global mean of stock returns,

which for this period was 3.59×10^{-4}. It is apparent that days with above average mean returns are concentrated before the end of the calendar month. Moreover, the last trading day of the month stands out as having, by a large difference, the largest mean returns from among all days.

These results are somewhat similar to those reported by Kato (1990b, 1993) for the Japanese market. Nevertheless, because the sample periods under consideration are different, they differ in some details even though the same TOPIX index is used. This fact by itself says a lot about the sensibility of results concerning this anomaly to the sample period used. The most salient difference is that the daily mean returns change sign less frequently in the results reported here. But it can also be noted that the signs of the mean daily returns in Kato (1993)[1] are the opposite of those reported here for all except two of the first seven trading days of the month, and that the ranking of the days with highest mean returns differs considerably. The profile of the daily mean returns in Figure 2 differs also, in a curious way, from those of Ariel for the U.S. market. While the day with largest mean returns is the last trading day of the calendar month in both Japan and the U.S., the other days with largest mean returns are found to be the trading days immediately preceding the last trading day of the calendar month in Japan, while in the U.S. they are the trading days immediately following the last trading day of the calendar month. It may also be noticed that while the daily mean returns seem to fall after the last trading day of the month, the days with lowest daily mean returns are to be found just before the five last trading days of the month.

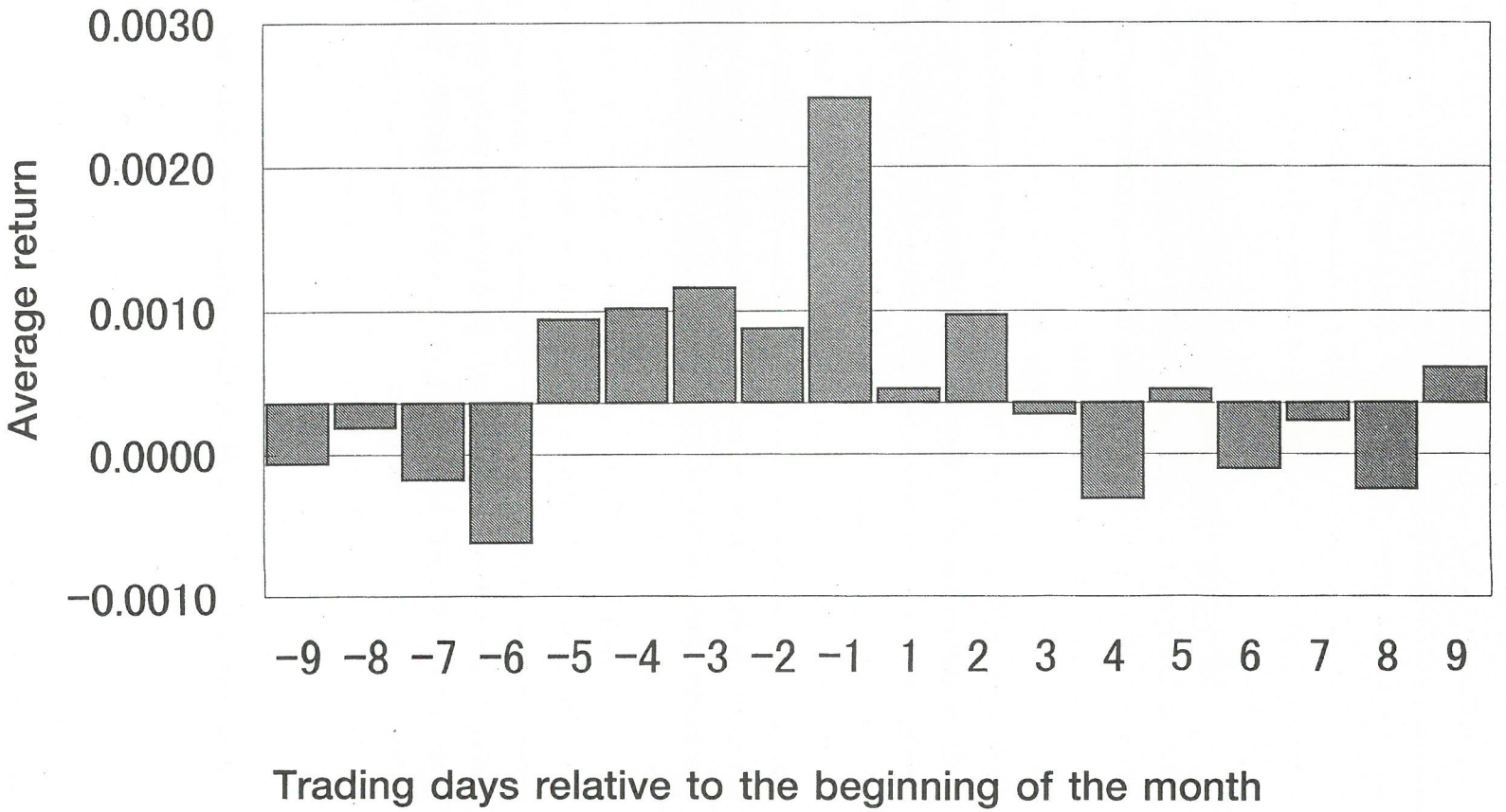
Table 1 – Evolution of the number of trading days per month

	Number of months					
Number of Trading Days	1950s	1960s	1970s	1980s	1990s(1)	Total
18	0	0	0	0	3	3
19	0	0	0	1	27	28
20	0	0	0	5	37	42
21	0	0	0	9	32	41
22	0	0	14	26	25	65
23	12	11	33	24	8	88
24	31	33	26	27	0	117
25	35	33	25	20	0	113
26	23	26	18	8	0	75
27	19	17	4	0	0	40
Total Number of Months	120	120	120	120	132	612
Average number of trading days	25.1	25.0	24.1	23.2	20.6	23.5

(1) Includes the year 2000

[1] In Figure 10.2(p.351).

Figure 2 - Histogram of the daily arithmetic mean returns for trading days around the start of each calendar month



Given that in Japan the trading days with above average mean returns seem to be concentrated just before the end of the calendar month, in this section trading month will be defined as roughly coinciding with calendar month: the first trading day of each calendar month starts the trading month, and the trading month closes with the last trading day of the calendar month[2]. Our interest is thus to verify if there exists an appreciable difference between mean daily returns of trading days belonging to different parts of the trading month.

We start by investigating the possibility that the mean daily returns might be higher for either the first or the second half of a trading month. By dividing each trading month in half, with any middle trading day discarded whenever the number of trading days in a given month is an odd number, we can check whether the mean daily return from the second half of trading months significantly exceeds the mean daily return from the first half of trading months. In Table 2 we present the mean daily return, the standard deviation and the number of observations for the trading days in the first half of a trading month, for those in the second half of a trading month, and also the difference of the above mentioned two means and the corresponding t-statistics. The difference of the means is calculated by subtracting the mean return of the first half of the trading month from the mean return of the second half. Thus negative values indicate that the mean returns of the first half of the trading month are higher than those of the second half. Besides the results for the entire period we present also those for ten sub-periods of five years.

Two points should be noticed before we delve on the results obtained. First, as the trading months have from 18 to 27 trading days, different months have different number of trading days in each half, even though every month has the same number of trading days in its two halves. Second, the middle of a trading month can fall anywhere between the twelfth and the twentieth day of a calendar month. Thus the first half of a trading month can end as late as near the close of the third week of a calendar month, and the second half of a trading month can begin as early as before the end of the second week of a calendar month.

Returning to the results of Table 2 we notice that the mean daily returns of the trading days in the first half of a trading month are not significantly different from the

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[2] It should be noticed, however, that in this definition the coincidence between calendar month and trading month is not complete. As is apparent from the discussion bellow, some portions of a calendar month can include more trading days than others.

mean daily returns of the trading days in the second half of the trading month for the 1950-2000 period. Moreover, in four of the ten subperiods considered, the mean daily returns of the trading days of the first half of a calendar month is larger than the mean daily returns of the trading days of the second half of the calendar month, and of these four one is statistically significant at the 5% level. Of the remaining six periods, when the mean daily returns of the trading days of the second half of a calendar month exceeds the mean daily returns of the trading days of the first half of the calendar month, only two are statistically significant at the 5% level. These results throw in doubt the hypothesis that the trading days in one half of a trading month have as a group a higher mean daily return than the trading days in the other half of a trading month in a stable and consistent way. In particular, there is no strong evidence supporting the view that mean daily returns are higher in the second half of the trading month rather than in the first half. But it can be said that, during the two five-year periods of the 1970s, trading days in the second half of a month seem to outperform by a large margin trading days in the first half.

As the above results may have been influenced by inclusion of many trading days far away from the beginning and from the end of the trading month, we divide the trading month into three different groups of days to get a sharper focus at what may be happening to stock returns around the turn of a month[3]. The first includes the first nine trading days

Table 2 - Difference of daily mean returns between first and second half of trading month

	1950-2000 (612 months)	1950-1954 (60 months)	1955-1959 (60 months)	1960-1964 (60 months)	1965-1969 (60 months)	1970-74 (60 months)	1975-1979 (60 months)	1980-1984 (60 months)	1985-1989 (60 months)	1990-94 (60 months)	1995-99 (60 months)
First half of trading days in each month											
Mean daily return	0.000322	0.001209	0.000889	0.000510	0.000258	-0.000272	0.000010	0.000255	0.000856	-0.000236	-0.000221
Standard Deviation	0.008653	0.010778	0.005776	0.007855	0.006438	0.007853	0.004625	0.005565	0.008063	0.013493	0.011799
Number of observations	7047	734	736	738	734	718	697	697	670	599	602
Second half of trading days in each month											
Mean daily return	0.000402	0.000045	0.000440	-0.000226	0.000687	0.000952	0.000724	0.000750	0.000981	-0.000620	0.000411
Standard Deviation	0.009112	0.010214	0.006095	0.007986	0.006191	0.009085	0.004494	0.005477	0.011345	0.013521	0.012287
Number of observations	7047	734	736	738	734	718	697	697	670	599	602
Difference of the means	0.000080	-0.001164	-0.000449	-0.000736	0.000429	0.001224	0.000714	0.000495	0.000125	-0.000384	0.000632
t-statistic	0.534438	-2.123943 *	-1.450628	-1.784940	1.301273	2.731182 *	2.921831 *	1.673690	0.232466	-0.492006	0.910283

* Significant at the 5% level

of the month, the second the last nine trading days, and the third any trading days not included in the first two groups. Thus the third group may include a minimum of zero and a maximum of nine trading days for any trading month.

In Table 3 we present the mean daily return, the standard deviation and the number of observations for the trading days in each of the above mentioned three groups, the difference of the mean daily returns from the first two groups and also the corresponding t-statistics for each difference. By restricting the number of trading days that belong either to the group of days that follow immediately the start of a trading month or to the group of days that immediately precede the end of a trading month we get somewhat different results from those obtained previously. It can be noticed that for the period from 1950 to 2000 the mean daily return is lower for the nine-trading-days group at the beginning of the month than for the all-trading-days group in the first half of the trading month, and that it is higher for the nine-trading-days group at the end of the month than for the all-trading-days group in the second half of the trading month. As a result, the difference between the mean returns of the nine-trading-days group at the beginning of the month and the nine-trading-days group at the end of the month is statistically significant at the 5% level. However, the story told by the ten five-year subperiods in Table 3 is still somewhat similar to that of Table 2: in seven of the ten subperiods the mean daily returns are higher for the group at the end of the month than for the group at the beginning, but in only three out of these seven is the difference statistically significant at the 5% level. Two of these three subperiods fall as before in the 1970s, and the third period is adjacent to them, falling in the first half of the 1980s. For three five-year subperiods the mean daily returns at the beginning of the month are higher than for those at the end. From these results we may conclude that the statistically significant difference obtained for the overall period from 1950 to 2000 seems to be under the strong influence of the behavior of stock returns during the 1970s. It can be said, further, that the monthly pattern considered here, if it can be considered to exist, it is nevertheless not longitudinally stable.

To help visualize the difference between the two classes of returns, in Figure 3 a polygon of the daily frequencies of the first nine trading days and the last nine trading days of a trading month is depicted for the 1950-2000 period. Intervals are 0.5% wide

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[3] As inspection of Figure 2 shows, our focus may not be sharp enough as trading days (-9) through (-6), relative to the end of a month, have below average returns. We return to this question in Section 6.

Table 3 - Difference of daily mean returns between first and last nine trading days of a month

	1950–2000 (612 months)	1950–1954 (60 months)	1955–1959 (60 months)	1960–1964 (60 months)	1965–1969 (60 months)	1970–74 (60 months)	1975–1979 (60 months)	1980–1984 (60 months)	1985–1989 (60 months)	1990–94 (60 months)	1995–99 (60 months)
First nine trading days											
Mean	0.000258	0.001112	0.000905	0.000630	0.000215	−0.000200	−0.000078	0.000216	0.000816	−0.000424	−0.000374
Standard Deviation	0.008915	0.010926	0.005971	0.008078	0.006390	0.007807	0.004725	0.005528	0.007879	0.013721	0.011997
Number of Observations	5508	540	540	540	540	540	540	540	540	540	540
Last nine trading days											
Mean	0.000645	−0.000066	0.000546	0.000249	0.000939	0.001426	0.000978	0.000941	0.001461	−0.000275	0.000451
Standard Deviation	0.008924	0.009651	0.005858	0.007622	0.006221	0.008995	0.004604	0.005332	0.009153	0.013506	0.012505
Number of Observations	5508	540	540	540	540	540	540	540	540	540	540
All other trading days											
Mean	0.000058	0.000894	0.000506	−0.000706	0.000213	−0.000440	0.000088	0.000241	−0.000050	−0.000831	0.000958
Standard Deviation	0.008703	0.011222	0.005974	0.008001	0.006371	0.008447	0.004124	0.005752	0.013566	0.012025	0.010447
Number of Observations	3388	421	425	428	417	385	347	348	280	152	153
Difference of the means	0.000387	−0.001178	−0.000359	−0.000381	0.000724	0.001626	0.001056	0.000725	0.000645	0.000149	0.000825
t-statistic	2.276944 *	−1.877773	−0.997329	−0.797176	1.886522	3.172404 *	3.720372 *	2.193559 *	1.241065	0.179839	1.106295

* Significant at the 5% level

and each point represents the number of daily observations with returns falling in that interval. There are a total of 5508 daily observations for each nine trading day group, corresponding to nine days for every month in the fifty one years under consideration. The following remarks can be made concerning this figure. First, the shapes of the two curves have a remarkable resemblance. Second, the group of the last nine trading days has higher number of observations in the classes to the right of zero, except for the largest two classes, those with returns higher than 2.5%. In a similar way, the group of the first nine trading days has a higher number of observations in the classes to the left of zero, except for the three classes with the largest negative absolute values, i.e., those to the left of -2%. Third, both groups exhibit fat tails, which raises the possibility that the results obtained above may be unduly influenced by the presence of outliers. This possibility will be addressed in the next section. Fourth, the left tail is fatter for the nine-trading-days at the end of the month than for the nine-trading-days at the beginning, and the opposite happens in the right tail.

Another way to assess the possible existence of a monthly effect in stock returns in different groups of trading days is to test the difference of the mean cumulative return between two groups of trading days. The cumulative return is the serial product of one plus the realized return of each of the nine consecutive trading days. Arguably, the

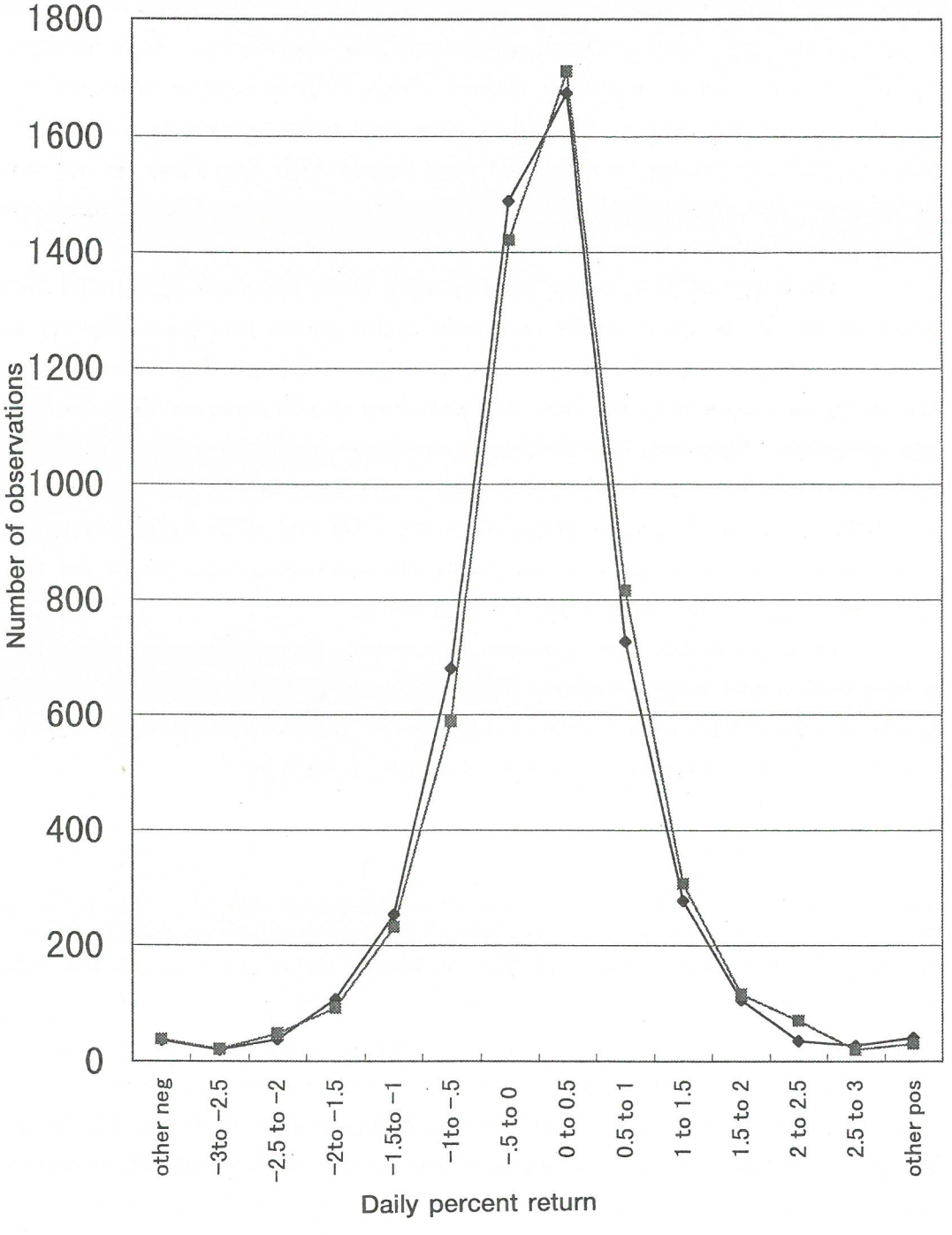
cumulative return of several consecutive trading days is an economically more relevant measure of possible monthly patterns of stock returns. This is because an investor seeking to profit from any such regularity in stock returns would hold stocks for the group of days when mean returns are higher than average instead of holding stocks for a single day. Table 4 presents the results obtained for a standard difference of the means test comparing the mean cumulative return over the first nine trading days of trading months with the mean cumulative return over the last nine trading days of trading months, both for the entire 1950-2000 period and for the ten five year subperiods. It can be observed that for the entire 1950-2000 period the difference between the two means is positive and the corresponding t-statistic is not statistically significant at the 5% level (but it is at the 10%). For three of the ten subperiods the mean cumulative return of the first nine trading days is higher that that of the last nine trading days, and only for two of the remaining seven periods (again 1970-74 and 1975-79) is the t-statistic significant. These results seem to show that if there was any monthly pattern defined by low mean stock returns in the first nine trading days of the month and low mean stock returns in the last nine trading days of the month, then that pattern existed only during the 1970s. For the twenty year periods that preceded and that followed the 1970s the evidence concerning the existence of such an effect is very weak or no-existent.

4. Excluding outliers

We mentioned above the possibility that the results presented in Section 3 might be unduly influenced by the presence of outliers. The results in Table 5 replicate those in Table 3 except that daily returns with absolute value higher than 3.0% were excluded from the computations[4]. Thus, the first group includes each of the first nine trading days

[4] The replication of Table 4 excluding outlier observations presents several problems that would render their results without much meaning. The problems arise from the need to replace the 181 daily returns that exceed 3.0% in absolute value. This is because the test of the difference of the mean between the cumulative return from the first nine trading days and the cumulative return of the last nine trading days requires that the number of days that contribute to the cumulative return to be fixed and equal to nine days for every period at the beginning and at the end of the month. A possible solution to this problem would to be use the returns of the tenth, eleventh, etc., trading days if one, two or more outliers fell during the first nine trading days of a month and had to be discarded from

Figure 3 - Polygon of daily return frequencies



of the month, provided its return was less that 3.0% in absolute value. Likewise, the second group includes all the last nine trading days of the month whose absolute value was less than 3.0%. There is no special reason to have chosen 3.0% instead of any other number for the cutoff value dividing outliers from other observations. With the above definition 181 observations classify as outliers. Most of these occurred during the first subperiod (1950-55) and after 1985 (there were eight outliers during the year 2000). Also, the first nine trading days included more outliers (76) than either the last nine trading days (68) or the other trading days that did not belong to either of those two groups (37).

The results of Table 5 give more credence to the hypothesis that trading days before the end of the month exhibit on average higher returns than those following its beginning. The mean return of the last nine trading days is larger than that of the first nine trading days not only for the 1950-2000 period but also for seven out of the ten five-year subperiods. Moreover, the difference is statistically significant at 5% for the 1950-2000 period and for five of the subperiods, and for six subperiods if 10% was chosen as the significance level. For three subperiods in the 1950s and 1960s the mean return is higher for the first nine trading days than for the last nine trading days, but for just only one subperiod is this difference statistically significant.

These results show that, if outliers are removed, the monthly pattern can be said to have been around since the middle 1960s with some longitudinal stability. Thus it may be said that outliers seem to wither out the monthly pattern in the TSE stock returns. Why this may be so deserves the attention of further investigation.

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the sample. Similarly, if some outliers fell during the last nine trading days of a month they could be substituted for by one or more of the trading days immediately preceding the last nine trading days. However, this method besides sometimes causing overlapping between the two groups of trading days for the months with smaller number of trading days (see Section 2 above), generally would be using returns from a group of days that we already know would not be a good proxy (the "all other trading days" of Table 3). This group of days would not act as a good proxy because the "all other trading days"group has a mean daily return that is different from the mean of daily returns of both the first nine trading days' group and the last nine trading days' group.

Table 4 - Difference of cumulative returns between first and last nine trading days

	1950-2000 (612 months)	1950-1954 (60 months)	1955-1959 (60 months)	1960-1964 (60 months)	1965-1969 (60 months)	1970-74 (60 months)	1975-1979 (60 months)	1980-1984 (60 months)	1985-1989 (60 months)	1990-94 (60 months)	1995-99 (60 months)
First nine trading days cumulative returns											
Mean	0.002459	0.010466	0.008263	0.005917	0.001979	-0.001665	-0.000620	0.001987	0.007460	-0.003583	-0.003393
Standard deviation	0.031420	0.044121	0.022648	0.033238	0.021340	0.028462	0.019457	0.019329	0.027548	0.046586	0.035285
Number of observations	612	60	60	60	60	60	60	60	60	60	60
Last nine trading days cumulative returns											
Mean	0.005961	-0.000202	0.004957	0.002453	0.008579	0.013022	0.008861	0.008523	0.013340	-0.001940	0.003818
Standard deviation	0.031694	0.040329	0.019610	0.031144	0.023606	0.031203	0.015810	0.017391	0.031886	0.053128	0.030473
Number of observations	612	60	60	60	60	60	60	60	60	60	60
Difference of the means	0.003502	-0.010668	-0.003306	-0.003464	0.006600	0.014687	0.009481	0.006536	0.005880	0.001643	0.007211
t-statistic	1.941230	-1.382409	-0.854801	-0.589080	1.606543	2.693682*	2.929317*	1.947135	1.080884	0.180111	1.198058

*Significant at the 5% level

Table 5 - Difference of daily mean returns between first and last nine trading days of a month when outliers are excluded

	1950-2000 (612 months)	1950-1954 (60 months)	1955-1959 (60 months)	1960-1964 (60 months)	1965-1969 (60 months)	1970-74 (60 months)	1975-1979 (60 months)	1980-1984 (60 months)	1985-1989 (60 months)	1990-94 (60 months)	1995-99 (60 months)
First nine trading days (excluding outliers)											
Mean return	0.000212	0.001181	0.001031	0.000442	0.000215	-0.000034	-0.000078	0.000160	0.000764	-0.000738	-0.000777
Standard Deviation	0.007519	0.008853	0.005612	0.007693	0.006390	0.006864	0.004725	0.005378	0.006994	0.009785	0.009883
Number of observations	5432	528	538	537	540	534	540	539	536	513	523
Last nine trading days (exoluding outliers)											
Mean return	0.000716	0.000105	0.000558	0.000250	0.001014	0.001598	0.000978	0.000950	0.001587	-0.000287	0.000529
Standard Deviation	0.007684	0.009044	0.005503	0.007342	0.005979	0.007203	0.004604	0.004878	0.007742	0.010472	0.010366
Number of observations	5440	536	538	538	539	533	540	538	531	519	523
All other trading days (excluding outliers)											
Mean return	0.000146	0.000368	0.000596	-0.000365	0.000310	0.000044	0.000088	0.000241	0.000088	-0.000757	0.000933
Standard Deviation	0.007048	0.008486	0.005691	0.007215	0.006057	0.006963	0.004124	0.005752	0.007521	0.010290	0.009659
Number of observations	3351	407	424	424	416	381	347	348	274	148	151
Difference of the means	0.000504	-0.001075	-0.000472	-0.000192	0.000799	0.001632	0.001056	0.000790	0.000822	0.000451	0.001306
t-statistic	3.458177*	-1.959617*	-1.394364	-0.418072	2.119733*	3.789127*	3.719997*	2.525458*	1.820487	0.714884	2.084758*
Number of outliers	181	30	5	9	2	17	0	3	19	52	36

*Significant at the 5% level

5. Seasonalities in the intra-month effect

We turn now to the issue of whether there are seasonal patterns in the intra month effect. That is to say, whether, the intra month effect is stronger during certain periods of the year rather than in others, or during a particular month in comparison to the remaining.

In Table 6 we present for each month from January to December the mean daily return, the standard deviation and the number of observations for the first nine trading days, the last nine trading days, and the remaining trading days of a trading month. At the bottom of the table we present the difference of the means between the first nine and the last nine trading days as well as the respective t-statistic. It should be noted that the differences are taken within each month, not between the last nine trading days of a month and the first nine trading days of the following month. The period under consideration is, as before, 1950-2000. These results show that for eight of the twelve months the mean daily returns of the last nine trading days of a month exceed those of the first nine trading days. The difference between these means is small for the generality of the months, with the exception of December. Further, of the eight months, only one, December, presents a difference between the means of the two groups of trading days that is statistically significant at the usual 5% level. For none of the months when the mean daily returns of the first nine trading days exceed the mean daily returns of the last nine trading days of a month is the difference of the means statistically significant.

These results seem to suggest the presence of a seasonal pattern in the monthly effect. The monthly effect occurs mainly during December, being at best very weak during the other months. This is confirmed by testing for the monthly effect for all months except December. The difference between the mean daily returns of the first nine trading days and the last trading days of a trading month for all months from January to November is just 3×10^{-4}, and the t-statistic for this difference is equal to 1.6767, thus not significantly different from zero at the 5% level.

The seasonality in the monthly effect seems to be due more to exceptionally high mean returns in the last nine trading days of December compared to the mean returns of the last trading days of the other months, rather than to a fall in mean returns during the first nine trading days of December relative to the mean returns in the first nine trading days of the other months. Table 7 presents the difference between the mean returns in the first nine trading days of all months from January to November and the mean returns in the first nine trading days of December. The difference is very small and not statistically significant. In contrast, the difference between the mean returns of the last

Table 6 - Montly difference of daily mean returns between first and last nine trading days (1950-2000)

	January	February	March	April	May	June	July	August	September	October	November	December
First nine trading days												
Mean	0.0013725	0.0006989	−0.0004057	0.0000546	0.0008260	0.0007506	0.0005801	−0.0003710	−0.0003186	−0.0003244	0.0000135	0.0002215
Standard deviation	0.0109345	0.0077795	0.0091388	0.0109020	0.0081737	0.0070235	0.0079128	0.0081705	0.0079552	0.0105329	0.0086513	0.0086470
Number of observations	459	459	459	459	459	459	459	459	459	459	459	459
Last nine trading days												
Mean	0.0015085	0.0002330	0.0007163	0.0009362	0.0002480	0.0004852	0.0002327	0.0005808	0.0000441	0.0003118	0.0008522	0.0015945
Standard deviation	0.0087774	0.0077334	0.0101771	0.0086192	0.0069499	0.0083089	0.0081922	0.0098510	0.0093087	0.0089505	0.0102968	0.0092597
Number of observations	459	459	459	459	459	459	459	459	459	459	459	459
All other trading days												
Mean	0.0014440	−0.0003270	0.0007431	0.0008162	−0.0012791	0.0002450	−0.0001747	0.0009011	−0.0007368	−0.0004407	0.0001399	−0.0007830
Standard deviation	0.0068837	0.0072809	0.0074775	0.0100804	0.0077022	0.0082378	0.0095723	0.0091038	0.0070152	0.0125463	0.0073865	0.0064131
Number of observations	197	219	325	277	265	324	361	365	247	333	228	247
Difference of the means	0.00013600	−0.00046596	0.00112208	0.00088159	−0.00057805	−0.00026541	−0.00034738	0.00095176	0.00036270	0.00063618	0.00083870	0.00137299
t-statistic	0.20779930	−0.91006151	1.75753974	1.35903699	−1.15429529	−0.52263646	−0.65342423	1.59322697	0.63460387	0.98607241	1.33607611	2.32176851*

*Significant at the 5% level

nine trading days in the months from January to November and the mean returns of the last nine trading days in December, also presented in Table 7, is about 0.1% and statistically significant at 5%.

Another possible way to analyze seasonality in the monthly pattern is to look at the differences between the last nine trading days of a month and the first nine trading days of the following month for the twelve possible pairings of consecutive months. To save space the results of these differences and the corresponding *t*-statistics are not reported here, but it can be said that they are not statistically significant.

A somewhat different result is obtained if the monthly pattern is analyzed through the use of cumulative returns. Although we know already, from Section 3 above, that the monthly pattern is not statistically significant in cumulative returns, it is of interest to investigate whether this is might not be due to a possible seasonal reversal of the pattern. It is possible to imagine a situation where some months exhibit a large difference between cumulative returns at the end of the month and cumulative returns at the beginning of the month, and where this pattern reverses itself for some other months[5]. Table 8 presents the mean of the cumulative returns of the first nine trading days of a month and its standard deviation, the mean of the cumulative returns of the last trading days and its standard deviation, and the difference of the two means and the *t*-statistic from a standard

Table 7 – Difference of daily mean returns between first and last nine trading days of a month (1950–2000)

	Jan–Nov	December	Difference (t-statistic)
First nine trading days			
Mean	0.0002615	0.0002215	–0.0000400
Standard deviation	0.0089393	0.0086470	(0.0919625)
Number of observations	5049	459	
Last nine trading days			
Mean	0.0005590	0.0015945	0.0010355
Standard deviation	0.0088885	0.0092597	(-2.38131158*)
Number of observations	5049	459	

*Significant at the 5% level

difference of the means test. The period under analysis is still that from 1950 to 2000. Thus each mean in Table 8 is calculated using 51 sample observations. Cumulative returns are especially high for the first and last nine trading days of Januarys and for the last nine trading days of Decembers. From this it results that the difference between the mean cumulative returns of the first nine trading days and the last nine trading days of a month is quite small for all months with the exception of December. Still, not even for December is the difference statistically significant at 5% (but only at the 10% level). The monthly pattern is found to be reversed for three months, February, June and July, but the difference between mean returns is not statistically significant in any of these cases. It can be concluded then that the absence of the monthly pattern in cumulative returns is not due to a possible seasonal reversal of the monthly pattern[6].

6. Alternative definitions of trading month

It has already been mentioned that the trading days with lowest returns are not only the first trading days of the calendar month but also the trading days immediately

[5] It will be remembered that there is a reversing of the monthly effect in cumulative returns between the 1950-1964 period and the 1965-1999 period (see Table 4 above).

[6] Also, no statistically significant seasonal reversal could be found for the differences between the last nine trading days of a month and the first nine trading days of the following month.

Table 8 - Monthly difference of cumulative returns between first and last nine trading days

	January	February	March	April	May	June	July	August	September	October	November	December
First nine trading days												
Mean	0.0126787	0.0065128	-0.003588	0.0005706	0.0074435	0.0068758	0.0052752	-0.003055	-0.002844	-0.002912	0.0004801	0.0020716
Standard deviation	0.0401998	0.0315681	0.0296837	0.0354549	0.0243381	0.0257628	0.0260495	0.0339823	0.0248899	0.0316378	0.0380104	0.0291119
Last nine trading days												
Mean	0.0136273	0.00221	0.0066913	0.0085678	0.0085678	0.0043358	0.0021904	0.0056307	0.0007069	0.0026614	0.0077944	0.0146861
Standard deviation	0.0256223	0.0278036	0.0371783	0.0298654	0.0298654	0.0234912	0.0283729	0.0432315	0.036797	0.0209004	0.0342415	0.0362644
Difference of the means	0.0009486	-0.004303	0.0102792	0.0079972	0.0011243	-0.00254	-0.003085	0.0086855	0.0035505	0.0055733	0.0073143	0.0126145
t-statistic	0.1421044	-0.730459	1.5430114	1.231991	0.2084079	-0.52026	-0.571947	1.127996	0.5707642	1.049671	1.0210185	1.9371592

* Significant at the 5% level

preceding the last five trading days of the calendar month. This raises the possibility that the definition of trading month used until now (that the trading month corresponds to the calendar month) might not be the most appropriate to evaluate the strength of the monthly pattern of stock returns. In other words, the monthly pattern or intra-month effect in the TSE stock prices might not be best thought of as being a turn of the month effect.

We approach the problem of alternative possible definitions of the trading month in an empirical way. Inspection of Figure 2 shows that there are seven trading days with above average daily returns around the turn of the calendar month, including the last five and the first two trading days of the calendar month. At the beginning of the month, the third and following trading days have, in general, bellow average mean returns. The same happens to the trading days just before the last five trading days of the calendar month. This suggests that a trading month can be defined as starting in the third trading day of a calendar month and extending to the second trading day of the following calendar month. It should be remembered that in his study Ariel (1987) defined trading month as starting in the last trading day of a calendar month and ending in trading day preceding the last trading day of the following calendar month.

With this definition of calendar month, and given the information provided in Figure 2 and by the several tests performed in

the previous sections, it should be expected that the group of last seven trading days of a trading month should have cumulative returns that are higher than either the cumulative returns of the group of the first seven trading days of the newly defined trading month or than those of the group of seven trading days preceding the group of last seven trading days of the new trading month. In what follows, we will designate these three groups of days as, respectively, the last seven trading days, the first seven trading days and middle seven trading days. It should be remembered that as the number of trading days in a given month can be as low as 18 days, there is overlapping between the first seven trading days and the middle seven trading days for about 12% of the months in the sample period under study. This should not worry us excessively as our primary interest is to know if there might not be a significant difference between the cumulative returns of last seven trading days and the cumulative returns of either of the other two groups of trading days, not between the cumulative returns of these last two groups. Finally, it should be noticed that this grouping of trading days differs in two fundamental aspects from the grouping of days used by Kato (1990b). First it is based on the trading month as defined above, not on the calendar month. Second, here each group of days is defined so as to have a fixed number of trading days, not a fixed number of calendar days.

The results of difference of the means tests between the cumulative returns of the last seven trading days and the middle seven trading days as well as those between the last seven trading days and the first seven trading days, performed for the period from 1950 to 2000, and for the usual ten five-year periods are presented in Table 9. It can be noticed that the mean of the cumulative returns of the last seven trading days exceeds that of the middle seven trading days for the longer period as well as for all the ten subperiods. The difference is statistically significant at the usual 5% level for the longer period as well for six of the subperiods. If a 10% significance level was used instead, the difference would be significant for seven of the subperiods. In a general way, the monthly pattern defined as the difference between the mean cumulative returns of the last seven trading days and the cumulative returns of the middle seven trading days can be said to be stronger than the monthly pattern defined as the difference between the mean returns of the last nine trading days and the first nine trading days that was used in the previous sections. The reasons that can be drawn in support of this statement are the following. First, the difference between the means of the two groups of days under consideration in each case is in general higher for the last seven versus middle seven trading days definition. Second, the number of subperiods for which the difference is statistically significant is larger, and in general the t-statistics are also higher for the last seven versus middle seven trading days definition. The disparity between the t-statistics for the 1950-

2000 period is especially eye caching: not statistically significant at the 5% level for the previous definition of trading month and statistically significant at all reasonable significance levels for the actual definition of trading month. Third, the subperiods for which a monthly pattern can be detected are more evenly found in the fifty years period for the present definition of trading month. While for the definition of trading month used in the previous sections the monthly pattern is to be found mainly in the 1970s, for the present definition of trading month the monthly pattern can be found in all the five decades under consideration in statistically significant magnitudes. Curiously, it seems that when the trading month is defined as starting in the third trading day of a calendar month, the t-statistics corresponding to the difference of cumulative returns of the last seven trading days and cumulative returns of the middle seven trading days have smaller values in the first and larger values in the second five-year period of each decade under consideration (except for the 1990s). The 1990s not conforming to this pattern does not allow us to claim uncovering yet another statistical regularity in stock returns.

The results of the test, for the same time intervals as above, of the difference between the mean of the cumulative returns of the last seven trading days and that of the first seven trading days are also presented in Table 9. They are quite similar to those obtained for the tests of the difference of the mean between the cumulative returns of the last seven trading days and the middle seven trading days, but in general the values of the differences of the means are lower as also are the values of the respective t-statistics. Thus only in four of the ten subperiods is the difference of mean returns statistically significant at the 5% level, and in one subperiod the pattern appears reversed.

The possible existence of seasonalities in the difference of the mean cumulative returns of the last seven trading days and the middle seven trading days was also investigated. Table 10 presents the difference of the mean cumulative returns of these two groups of days as well as the respective t-statistics. The difference is always positive and the t-statistics are statistically significant at the 5% level for seven months. This constitutes evidence in favor of the seasonal stability of the monthly effect. Table 10 also presents the difference of the mean cumulative returns of the last seven trading days of a month and the first seven trading days of the following trading month. Although the mean cumulative returns of the last seven trading days exceeds that of the first seven trading days for all months except May, the difference is statistically significant only for two months.

Thus it seems safe to conclude that the evidence in favor of the existence of a monthly pattern is strongest when the trading month is defined to start in the third trading day of a calendar month and to end in the second trading day of the following calendar

Table 9 - Difference of cumulative returns between last seven and middle seven trading days and between last seven and first seven trading days

	1950–2000 (612 months)	1950–1954 (60 months)	1955–1959 (60 months)	1960–1964 (60 months)	1965–1969 (60 months)	1970–74 (60 months)	1975–1979 (60 months)	1980–1984 (60 months)	1985–1989 (60 months)	1990–94 (60 months)	1995–99 (60 months)
(A) Middle seven trading days											
Mean cumulative returns	−0.0019791	−0.0019611	−0.0008099	−0.0034062	0.0006081	0.0004078	−0.0013427	0.0024820	0.0001647	−0.0111573	0.0003270
Standard deviation	0.0261666	0.0295127	0.0180365	0.0213100	0.0147303	0.0264014	0.0144439	0.0141867	0.0298044	0.0388703	0.0342080
Number of observations	612	60	60	60	60	60	60	60	60	60	60
(B) Last seven trading days											
Mean cumulative returns	0.0079872	0.0053263	0.0115829	0.0042424	0.0110353	0.0109650	0.0086348	0.0059989	0.0101365	0.0041522	0.0048497
Standard deviation	0.0266632	0.0396847	0.0211662	0.0268683	0.0205328	0.0309641	0.0175664	0.0163628	0.0233444	0.0335814	0.0278074
Number of observations	612	60	60	6.00E+01	6.00E+01	6.00E+01	6.00E+01	60	60	60	60
(C) First seven trading days											
Mean cumulative returns	0.0009902	0.0067121	0.0036194	0.0040416	−0.0015073	−0.0012000	0.0000403	0.0022282	0.0079312	−0.0038710	−0.0043174
Standard deviation	0.0266806	0.0374254	0.0187796	0.0269741	0.0182025	0.0237967	0.0158293	0.0181731	0.0233679	0.0380272	0.0317678
Number of observations	612	60	60	60	60	60	60	60	60	60	60
Difference of the means (B)–(A)	0.0099663	0.0072874	0.0123927	0.0076485	0.0104271	0.0105572	0.0099775	0.0035169	0.0099718	0.0153096	0.0045227
t-statistic	6.5997465*	1.1413790	3.4519302*	1.7276117	3.1962048*	2.0096347*	3.3983400*	1.2578939	2.0402611*	2.3086075*	0.7946659
Difference of the means (B)–(C)	0.0069970	−0.0013858	0.0079635	0.0002007	0.0125425	0.0121650	0.0085945	0.0037708	0.0022053	0.0080232	0.0091670
t-statistic	4.5889870*	−0.1967797	2.1799713*	0.0408360	3.5406667*	2.4129248*	2.8153527*	1.1944086	0.5171722	1.2250049	1.6818887

*Significant at the 5% level

Table 10 - Monthly difference of cumulative returns between last seven and middle seven trading days and between last seven and first seven trading days

	January	February	March	April	May	June	July	August	September	October	November	December
(A) Middle seven trading days of the trading month												
Mean cumulative returns	0.0056995	−0.0023938	0.0007248	0.0003077	−0.0047367	−0.0016638	−0.0082752	−0.0007499	−0.0082993	−0.0032672	0.0020106	−0.0031065
Standard deviation	0.0276180	0.0242821	0.0252202	0.0255351	0.0192583	0.0218040	0.0228272	0.0365633	0.0190177	0.0321754	0.0271758	0.0265293
Number of observations	51	51	51	51	51	51	51	51	51	51	51	51
(B) Last seven trading days of the trading month												
Mean cumulative returns	0.0136029	0.0027520	0.0061287	0.0165555	0.0042669	0.0087981	0.0059529	0.0055400	0.0012097	0.0077164	0.0070736	0.0162493
Standard deviation	0.0255097	0.0246639	0.0379760	0.0248592	0.0226274	0.0269140	0.0252461	0.0218416	0.0253078	0.0219243	0.0238852	0.0323236
Number of observations	51	51	51	51	51	51	51	51	51	51	51	51
(C) First seven trading days of the trading month												
Mean cumulative returns	0.0112220	0.0045608	−0.0033242	0.0031296	−0.0008455	0.0056909	0.0017108	−0.0033704	−0.0021322	−0.0001633	−0.0041776	−0.0004185
Standard deviation	0.0336151	0.0262063	0.0294346	0.0240185	0.0235808	0.0236603	0.0228968	0.0287832	0.0213407	0.0263745	0.0278873	0.0284887
Number of observations	51	51	51	51	51	51	51	51	51	51	51	51
Difference of the means (B)–(A)	0.0079033	0.0051458	0.0054039	0.0162478	0.0090036	0.0104619	0.0142280	0.0062899	0.0095089	0.0109836	0.0050630	0.0193558
t-statistic	1.5012344	1.0617590	0.846538715	3.2559112*	2.1639680*	2.1569843*	2.9853225*	1.0546807	2.1451070*	2.0146023*	0.9993553	3.3055903*
Difference of the means (B)–(C)	0.0090421	0.0060762	0.0029991	0.0174010	−0.0014240	0.0070873	0.0093232	0.0076722	0.0013730	0.0118940	0.0074921	0.0050274
t-statistic	1.7656494	1.1299667	0.4766576	3.6267639*	−0.3106272	1.4323500	1.7390380	1.7942706	0.2682510	2.3944642*	1.4391944	0.7698672

*Significant at the 5% level

month. A monthly pattern that is statistically significant can then be found in the TSE stock returns for roughly half of the five-year periods of the half century since 1950. This pattern consists in cumulative stock returns in the last seven days of a trading month being higher than cumulative stock returns in periods of similar length either preceding or following it. The difference seems to be more important when the cumulative returns of the last seven trading days are compared with the cumulative returns of the middle seven trading days.

7. Conclusion

This study tried to find the conditions under which a monthly pattern is strongest and statistically more significant. To this end several possible patterns were investigated. Patterns associated to a trading month defined to start in the first trading day of a calendar month were found to be mainly phenomena confined to the 1970s, and which affected exclusively Decembers. It was found the removal of outliers and the redefinition of the trading month to start in the third trading day of a calendar month yield monthly patterns that are stronger and statistically more significant. It was also found that cumulative returns are especially low during the middle seven trading days and especially high during the last seven trading days, and that the difference between the means of the cumulative returns of these two groups of days is quite stable across the several subperiods into which the past half century was divided and that it was not much affected by seasonality. It may thus be concluded that the monthly pattern in the TSE can be better understood as consisting in stock returns having low mean during the middle seven trading days and high mean during the last seven trading days of the (above defined) trading month.

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