

# Trades Reshuffling: A Possible Explanation For the Day-of-the-Week Effect

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## 1. Introduction

The objective of this paper is to present and test a new possible explanation for the Day-of-the-Week effect. The presence of this effect in many stock markets, including Japan and the U. S. is empirically well demonstrated. Although small and not exploitable economically in the presence of even very low transaction costs (much lower than those actually found), the Day-of-the-Week effect is regarded by some as one of the many anomalies that provides the best example of the invalidity of the Efficient Market Hypothesis. Whether one agrees with this view or not it must be accepted that all attempts to explain the weekly patterns in stock prices with the use of economic theory have been rejected by empirical evidence.

To try to explain this effect, the hypothesis, tentatively denominated as trades reshuffling, that investors have preferred days of the week for selling stocks and other preferred days for buying them is advanced here. This hypothesis is based on one hand in the existence of regulations requiring the stock market to be closed during certain days of the

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week and that the settlement of a transaction takes place up to a certain number of business days after the transaction (3 in the case of Japan). On the other hand it is based on the assumption that most investors, when considering a stock to buy or to sell, will evaluate its prospects over the medium and long run (here, a period somewhat longer than a week, for example one month, will be long enough), and will be unconcerned with price movements over the short periods. In other words, this assumption means that, if an investor thinks the future prospects of a certain stock are good, he will buy (or hold to it) even if he expects its price to fluctuate around today's price for some days to come. In this case, when the investor is not concerned with the short run movement of stock prices, he will pay attention to the transaction costs of a possible trade and will try to minimize them. As the two cited regulations give rise to different transaction costs depending the 3 days following a transaction are business days or not (for sellers the costs will be lower if the 3 days following a transaction are business days and higher in the other days; for buyers the opposite happens) we can expect that investors will prefer to trade in certain days in preference to others, that is, when possible to reshuffle their trades from certain days of the week to others. This will imply that the supply curve of stocks will be more to the right during certain days of the week and more to the left during the others, while the opposite happens to the demand curve, what will result in lower returns in the former and higher in the later. This prediction concerning stock returns differs from the predictions made by other hypothesis, namely by the settlement hypothesis, and seems to be better supported by the empirical evidence.

This paper is organized as follows. In Section 2, the Day-of-the-week effect is presented together with some hypotheses advanced in

the past to explain it. In Section 3, the trades reshuffling hypothesis is explained. Section 4 presents the empirical evidence and Section 5 concludes.

## 2. The Day-of-the-Week effect

One of the many anomalies presented against the efficient Markets Hypothesis is the Day-of-the-Week Effect. In textbooks it is variously presented as “*unusual behavior*” (Radcliffe, 1994), “*without economic rationale*” (Francis, 1991) “*in several ways odder [than other recurrent patterns]*” (Bodie, Kane and Marcus, 1993) that “*provides an interesting counterexample to the efficient market hypothesis*” (Fuller and Farrell, 1987) and is already “*extensively examined*” (Elton and Gruber, 1995).

This anomaly consists in the returns of an asset (a stock or an index) not being equal across all days of the week; or, to be more specific, in returns having been found to be lower on Mondays than on the other days of the week for no apparent reason (French 1980, Gibbons and Hess, 1981, Jaffe and Westerfield, 1985a). Ignoring holidays and assuming for simplicity that settlement occurs on the same business day, returns for any day of the week other than Monday represent a 1 day period investment and thus their expected returns should be the same, and in historical data they should not be very different on average. Concerning the returns on Mondays we can think of two hypothesis: either the process generating returns operates in terms of calendar time or in terms of trading days. In the first case the returns on Monday should be expected to be the triple of the expected return for the other days of the week. In the second case, the returns on Monday should be expected to be similar to those of the other days. However, in the U. S. stock markets, where settlement occurs on the

fifth business day after the day of transaction (thus falling in the same week day one week later, if there are no holidays during that week) returns for each day of the week have been found to differ and returns for Mondays have been found not only to be less than those for the other days of the week but even to be negative.

From the results reported by French (1980) for the U. S. stock market it has been calculated that, ignoring transaction costs, the trading rule of buying the S&P 500 index at the closing price of Monday and selling it at the closing price of Friday, would have generated an average annual return of 13.4% from 1953 to 1977, while a simple buy and hold strategy would have yielded a 5.5% annual return in the same period (Fuller and Farrell, 1987). But, if transaction costs of a mere 0.25% per transaction were included, the buy and hold strategy would have yielded a higher return.

Nevertheless the day of the week effect poses a problem to the Efficient Market Hypothesis. In an efficient market, knowledge of this effect would make it to be arbitrated away, if not by straightforward arbitrage (that would not compensate because of transaction costs) at least by “indirect” or “opportunistic” arbitrage, because some of the purchases planned for Friday might be delayed until next Monday, while some of the sales planned for Monday might be brought forward to Friday or delayed until Tuesday or other day later in the week. The decreased buying and increased selling on Friday would tend to reduce the average returns on these days, while the increased buying and decreased selling on Monday would tend increase its average returns. This reshuffling of buying and selling would thus tend to equalize the rates of return across the days of the week.

Several hypotheses have been advanced to attempt to explain this effect within the framework of the Efficient Markets Hypothesis. One

of the first was French's (1980) hypothesis that the day-of-the-week effect might reflect a "closed-market" effect. To examine this hypothesis, he compared for each day of the week the returns when the previous day was a holiday with the returns when the previous day was not an holiday. As he found that in general returns following an holiday are higher than when the previous day was not an holiday he concluded against this hypothesis and did not explore the issue further.

Then there was the settlement hypothesis proposed by Gibbons and Hess (1981) and the check clearing process hypothesis proposed by Lakonishok and Levi (1982) which were not supported by the evidence gathered by the authors and was also rejected by Dyl and Martin (1985). These hypothesis take account of the fact that the settlement of a transaction (the exchange of stock for cash) occurs several days after the transaction takes place: *"most transactions are settled several business days after the quote or transaction date. The observed quotations then are not spot prices but forward prices. These forward prices equal the spot prices grossed up by the riskless rate of interest for the length of the settlement period. Since settlement days are calculated in terms of business days, any settlement period that is not a multiple of five will introduce a day of the week effect; currently, the settlement period for stocks is 5 business days. Before February 10, 1968, however, the settlement period was 4 business days. Prior to this date, Monday's price should be grossed up 4 days of interest, whereas Tuesday's through Friday's prices should be grossed up by 6. This asymmetry in settlement periods creates a day of the week effect (...) a low and perhaps, negative return on Monday"* (Gibbons and Hess, 1981, p.588-590).

Then, Kleim and Stambaugh (1984) proposed and rejected the hypothesis that this effect was due to a specialist related bias. The possibility of measurement error due to infrequent trades was also ex-

amined by Gibbons and Hess (1981) and Kleim and Stambaugh (1984) and likewise rejected. The Day-of-the-Week effect seems thus to be quite robust even if not exploitable in the presence of transaction costs.

The Day-of-the-Week effect is also documented for Japan, but instead of a negative return on Mondays as in the U.S., the salient finding is that returns are lowest on Tuesdays and highest on Wednesdays (Pettway and Tapley, 1984, Jaffe and Westerfield, 1985a, 1985b, Kato, 1991). Some of the possible explanations presented for the U. S. were also examined by these studies and their ability to explain the existence of this effect in Japanese stock prices was rejected. Of special interest here is the rejection by Jaffe and Westerfield (1985b) of the settlement hypothesis: for the period examined by these authors (1970~1983), this hypothesis predicted that *“Japanese common stocks should have high expected returns on Thursday.”* This is because in Japan settlement takes place, as we will see in more detail in the next section, on the third business day after the transaction. Thus, *“an individual earns the Thursday return when he buys at the Wednesday close and sells at the Thursday close. Here, he pays cash on Saturday and receives cash on Monday, i. e., cash payment occurs two days before the receipt. Conversely, cash payment occurs only one day before cash receipt for one-day holding periods beginning elsewhere during the week”* (Jaffe and Westerfield, 1985b, p.267). In other words, we should expect the returns of every week day to be the same, with the exception of Thursday when they should be somewhat higher than on the other days. Empirical tests show that *“however, the average return for Japanese stocks on Thursday is low (...), a result inconsistent with the above”* (Jaffe and Westerfield, 1985b, p. 267).

### **3. Trades reshuffling: a new look at the settlement hypothesis**

There are two regulations in the Tokyo Stock Exchange (TSE) that may help understand why the Day of the Week Effect Occurs. These are the regulations concerning the settlement procedures, more specifically the settlement period, and the regulations concerning trading periods.

The Tokyo Stock Exchange Procedure Rule 9 establishes that there are four types of trades according to the agreed settlement period: ordinary transactions, where cash and stocks are exchanged up the third business day after the transaction is agreed; same day settlement transactions, where the exchange of cash for stock takes place in the same day if the transaction occurred in the morning session or, if there is agreement between the parties, in the following morning if the transaction occurs in the afternoon session; special contract transactions, where the exchange of cash for stock takes place up to fifteen days after the transaction was entered upon; and transactions of not yet issued stocks, where the exchange of stocks for cash takes place up to the fourth day after the new stock is issued (New Japan Securities, 1990, p.88). By far the most common type of trade are ordinary transactions, representing more than 99% of all trades (Nihon Keizai Shimbun-sha, 1986).

Another regulation makes a constraint in the time the market is allowed to be opened. The Tokyo Stock Exchange Procedure Rule 3 requires the Exchange to close on Sundays, Saturdays, National Holidays, Mondays following a Sunday that coincides with a National Holiday and the first three days of January and the last day of December (New Japan Securities, 1990, p. 85). These regulations are

institutional and can be changed. For example up to February 1989 the market was also open in some Saturdays. With technical progress and increased deregulation we can also think of the possibility of the stock market being opened 24 hours a day, 7 days a week: for example, computer trading may allow the trading time to be extended at very low cost; already in the TSE, except for the most traded 150 stocks which still go to the floor, all stocks are traded using a computerized trading system. Although the TSE has actually some latitude in deciding when it can be opened, the main constraints are social and political. Thus this constraint can be considered to be exterior or exogenous to the market.

These two Regulations are the basis where the settlement hypothesis, as presented in the previous section, is based. The settlement hypothesis as it has been formulated until now<sup>2)</sup>, tries to explain the weekly patterns in stock prices as arising due to the existence of a “capital cost” or “implicit interest” that ought to be present in a forward price that is what stock prices really are. This view is especially suitable when it is assumed that there are at least some investors who buy at the close of one day to sell at the close of the next<sup>3)</sup>. However it does not tell us nothing about how it might affect the behavior of the other investors, those, presumably the great majority, who hold their stocks for periods longer than one business day.

The above two Regulations can be used in a somewhat different way to explain the Day-of-the-Week effect. It will be easily accepted that medium and long term investors, who do not try to predict the short term movement of stock prices, when decide to buy or sell a particular

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2) See, for example Gibbons and Hess (1981) or Jaffe and Westerfield (1985b).

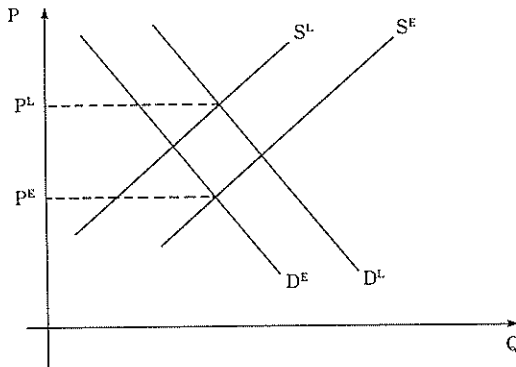
3) We are tempted to say that this hypothesis takes the likeness of stock investment with over-night deposits a bit too far.



stock will do so based on their medium and long term expectations concerning the future price and dividends of that stock. It can be argued that these investors, who for the most part will not hold strong views on the short run behavior of stock prices, might be more concerned with the certain “capital cost” (or “capital profit”) that is present in every stock transaction, than with the possible (but uncertain in relation to sign and magnitude) capital gain or loss (either potential, when buying, or real, when selling) arising from a short term price movement. It can furthermore be argued that if this is so, they may reshuffle their trades in a way to minimize their “capital costs” (when selling) or maximize their “capital profits” (when buying). A consequence of this reshuffling, where buyers avoid certain days of the week when their “capital costs” are high and prefer to buy in those days when they are low, and likewise sellers prefer to sell in certain days of the week in preference to the others, is that the demand and supply curves for stocks will shift in relation to the hypothetical case where (for example) the settlement takes place in the same day as the transaction. Thus we arrive to the conclusion that this shift in the demand and supply curves for stocks might cause the Day-of-the-Week effect. As will be seen later, the implications of this trade reshuffling hypothesis are different from the traditional settlement hypothesis.

Let’s examine in more detail how the combination of the Regulations 3 and 9 can originate differences in the behavior of investors who want to sell from those who want to buy, and in this way might explain the Day-of-the-Week effect. Let’s consider first the case of an investor who wants to sell: if he sells just before a holiday or a weekend he will face an higher opportunity cost than if he sells in any other day. If he sells a stock on, let’s say, a Thursday, he will be paid only on the Tuesday in following week (assuming there is no trading on Saturdays and

there was no holiday during this interval). This is a five day interval, in which he forfeits the possession of the stock but has not received payment yet. If he had sold on a Tuesday, he would have been paid Friday, only a three day interval. Thus there is a difference of two days, during which he is not earning the market rate of interest on the value of the sale. This fact may lead rational investors who do not have strong views on whether the price of their stock is going to increase or decrease in the next few days to reshuffle their selling from Wednesdays, Thursdays and Fridays to Mondays and Tuesdays (provided there is no holiday in the next three days) when there is no trading on Saturdays; or, when there was trading on Saturdays, it might lead them to avoid selling on Thursdays, Fridays and Saturdays and induce them to do it on Mondays, Tuesdays and Wednesdays. In Figure 1, this reshuffling of selling from late in the week to the early days of that or next week is represented by two different offer curves:  $S^E$  represents the selling schedule in the early days of a week and  $S^L$  that of the later days: to minimize the “capital costs” involved in the



**Figure 1** Supply and Demand Curves Early in the Week ( $S^E$  and  $S^L$ ), And Late in the Week ( $S^L$  and  $S^L$ )

transaction, sellers will do their selling early in the week whenever they can, and thus  $S^E$  is to the right of  $S^L$ .

The investor who wants to buy a stock has a symmetric position: if for example, he buys a stock on a Thursday, he will have to pay only on the Tuesday of the following week (assuming also there is no trading on Saturdays and there was no holiday during this interval). This is a five day interval, in which he has already earned the right to the possession of the stock but has not paid yet. If he had bought on a Tuesday, he would have to pay until Friday, only a three day interval. Thus there is again a difference of two days, during which he can be earning the market rate of interest on the value he must pay. This may again lead rational investors, who do not have strong views on whether the price of stock is going to increase or decrease in the next few days, to move their buying from Mondays and Tuesdays to Wednesdays, Thursdays and Fridays, when there is no trading on Saturdays. In Figure 1 this reshuffling of buying from early in the week to later in the week is also represented by two demand curves,  $D^E$  and  $D^L$ , which represent respectively the demand curve for stocks in the early and late days of the week. To maximize the number of days that they can have the right to a stock without having to pay for it, buyers will do their buying late in the week whenever they can, what results that  $D^L$  is to the right of  $D^E$ .

Thus we have the following situation: when there is no trading on Saturdays, there will be an incentive for selling trades to be shifted from Monday and Tuesday to Wednesday, Thursday and Friday and for buying trades to be shifted from Wednesday, Thursday and Fridays to Monday and Tuesdays. The increased selling pressure resulting from the shift of the supply curve of stocks to the right, and decreased buying pressure resulting from the shift of the demand curve for

stocks to the left in the early days of the week will tend to depress stock prices on Mondays and Tuesdays. Likewise, the decreased selling pressure and increased buying pressure in the later days of the week will tend to increase stock prices on Wednesday, Thursday and Fridays. When there is trading on Saturdays, the increased selling pressure and decreased buying pressure and the consequent depression on stock prices will be felt on Mondays, Tuesdays and Wednesdays and the decreased selling pressure and increased buying pressure, that will tend to increase stock prices, will be felt on Thursday, Friday and Saturdays.

As can be clearly seen from Figure 1, the reshuffling described above will result in lower prices in the early days of the week and in higher prices in the late days. This is in contrast with the prediction of the traditional settlement hypothesis that is based on how many days mediate between a cash out-flow and the following cash-inflow when buying and selling take place on two consecutive business days: this hypothesis implies equal returns for all days except for Thursdays (when there is trading in the following Saturday) or Wednesdays (when there is no trading in the following Saturday), days when returns should be somewhat higher.

It can also be pointed out that concerning trading volume no conclusion can be drawn from the above analysis.

Finally we can also speculate that the Day-of-the-Week effect would disappear if either, or both:

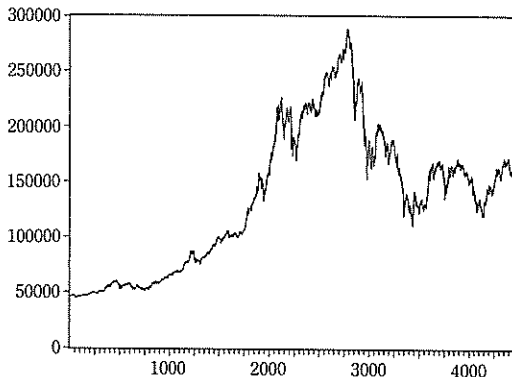
- (a) Rule 9 was changed to allow only same day settlement transactions; or
- (b) Rule 3 was changed to allow trading in all days, including holidays and weekends.

## 4. Empirical tests

### 4.1 Data

The tests that follow were performed on the daily closing prices of the Topix price index, for the period starting in December 28, 1979, and finishing in October 31, 1996, with a total of 4477 observations. Figure 2 presents a plot of this data. It should be noticed that the closing price from Mondays to Fridays is the afternoon closing price but that for Saturdays it is the morning closing price: in doing this we are following usual practice. The daily returns were computed by taking logarithms to the first differences of prices: Figure 3 presents their plot.

If not otherwise stated, in what follows we present the results for three different time periods: (1) December 28, 1979, to October 31, 1996, using all available data; (2) December 28, 1979 to January 31, 1989, with a total of 2560 observations; and (3) January 31, 1989 to October 31, 1996, with a total of 1918 observations. The choice of the



**Figure 2** Closing Values of the Topix Price Index (1980-1996)

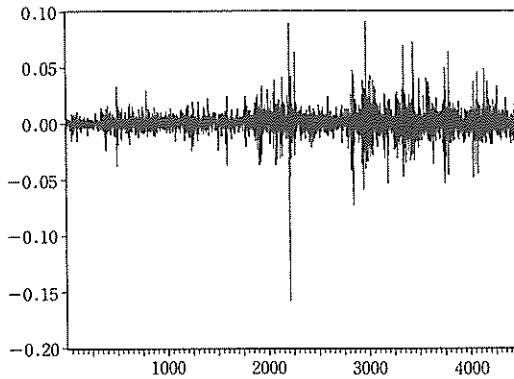


Figure 3 Daily Returns of the Topix Price Index (1980–1996)

end of January of 1989 as the breakpoint of two sub-periods was made taking in attention the fact that the trading on Saturdays was discontinued at that time. Another possible breakpoint would have been December 18, 1989, when the Topix attained its maximum closing price. However, this criteria seemed less relevant to the point under investigation and anyway the results for all the following tests are very similar whatever the division chosen.

#### 4.2 The day of the week effect

To test for Day-of-the-Week effect, we start by considering the standard model used in most of the literature:

$$R_t = \sum_{i=1}^7 \alpha_i D_i + \epsilon_t \quad (1)$$

where  $R_t$  is the return of the index in period  $t$ ,  $D_i$  is a dummy variable for the  $i$ th day of the week (i. e.,  $D_2=1$  if observation  $t$  falls on a Monday and 0 otherwise; and likewise for all values of  $i$  from 2 to 7), and  $\epsilon_t$  is a iid normal disturbance.

**Table 1** Tests for the Day-of-the-Week hypothesis

Period	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Statistics
Dec 28, 1979	-0.001007	-0.000444	0.000825	0.000851	0.000617	0.001517	R <sup>2</sup> =0.00540
Oct 31, 1996	(-2.888079)	(-1.29321)	(2.40642)	(2.47821)	(1.79887)	(2.72849)	DW=1.733
Dec 28, 1979	-0.000112	-0.000956	0.001923	0.000793	0.000991	0.001517	R <sup>2</sup> =0.01249
Jan 31, 1989	(-0.289057)	(-2.50395)	(5.05234)	(2.07367)	(2.60929)	(3.34865)	DW=1.788
Jan 31, 1989	-0.002057	0.000147	-0.000460	0.000919	0.000175		R <sup>2</sup> =0.00486
Oct 31, 1996	(-3.336563)	(0.24278)	(-0.75875)	(1.51940)	(0.28793)		DW=1.690

First, in Table 1, we present the results for the entire period and the two sub-periods. Figures in parentheses are *t* ratios. Looking first to the results for the entire period, it can be noticed that the explanatory power of the daily returns by the day of the week effect is quite low, about 0.5% for the entire period. Then, we can notice that indeed there seems to be a statistically significant day of the week effect: returns are lowest on Mondays and highest on Saturdays (a departure from the results found in the literature cited above, due undoubtedly to the sample periods in consideration being different).

Looking now at the results for the two sub-periods we notice a first puzzling result: whereas we would expect, according the settlement hypothesis, that “*Japanese common stocks should have high expected returns on Thursday*” (Jaffe and Westerfield, 1985b, p. 267) during the first sub-period (because there was trading on Saturdays) and on Wednesday during the second (because there was not trading on Saturdays) we find that the opposite happens: the highest returns are found on Wednesday during the first period and on Thursday during the second.

To take a closer look at what is happening we regressed again equation (1) for every year between 1980 and 1996, and present the estimated average daily returns in Table 2. A curious pattern

Table 2 More tests for the Day-of-the-Week hypothesis

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Highest	Lowest
1980	-0.000606	-0.000823*	0.00122***	-0.000144	0.000919**	0.000968***	Wednesday	Tuesday
1981	0.001106	-0.000807	0.001995**	-0.000544	0.000888	0.00042	Wednesday	Tuesday
1982	0.001117	-0.001609*	0.001368	-0.000731	0.000057	0.000872	Wednesday	Tuesday
1983	0.001017	-0.001076*	0.001579**	0.001134***	0.000635	0.001249***	Wednesday	Tuesday
1984	0.00051	-0.00119	0.002109**	0.000127	0.001472	0.001879**	Wednesday	Tuesday
1985	-0.000378	-0.000887	0.00217*	0.000794	-0.000485	0.001933**	Wednesday	Tuesday
1986	0.001563	-0.00137	0.000667	0.002698**	0.002381***	0.002907***	Saturday	Tuesday
1987	-0.005006**	-0.00266	0.002601	0.002879	0.002884	0.002431	Friday	Monday
1988	-0.000558	0.001408	0.003455*	0.001137	0.00011	0.001346	Wednesday	Monday
1989	0.000474	0.00177**	0.001572**	-0.000268	0.0005266	0.003505	Saturday	Thursday
1990	-0.001156	-0.001658	-0.001794	-0.0014317	-0.002089		Tuesday	Friday
1991	-0.003759**	0.000677	-0.000515	0.001467	0.001539		Friday	Monday
1992	-0.004035***	-0.003243	-0.002578	0.004652**	-0.000942		Thursday	Monday
1993	-0.003022***	-0.000236	-0.000152	0.003834**	0.001641		Thursday	Monday
1994	-0.000672	0.000749	0.000271	0.000652	0.000504		Tuesday	Monday
1995	-0.001574	0.001922	-0.000218	0.000314	-0.000166		Tuesday	Monday
1996	-0.002531**	0.001186	0.000019	0.000412	0.000161		Tuesday	Monday

\* 10% significance level

\*\* 5% significance level

\*\*\*1% significance level



emerges: in the nine years between 1980 and 1988 (when there was trading on Saturdays) the highest return falls 7 out of 9 times on a Wednesday and the lowest falls also 7 out of 9 times on a Tuesday; in the remaining years (when the trading on Saturdays was discontinued), the highest return falls 4 out of 8 times on a Tuesday and the lowest 6 out of 8 times on a Monday. This shift of the most frequent days with lowest and highest returns from Tuesday–Wednesday to Monday–Tuesday and especially the change of Tuesday from being the most frequent day with the lowest return to its becoming the most frequent day with the highest return when Saturday trading was discontinued is very interesting. The market seems to be behaving as if the settlement of trades takes place in the fourth day after the transaction! If the settlement took place four days after the transaction, when the market was opened on Saturdays, investors would avoid selling on Wednesdays and would prefer to sell on the previous Tuesday (this strategy would allow them to receive their payment in 4 instead of in 5 days) and buyers would avoid buying on Tuesdays and would try to buy instead on Wednesdays (thus allowing them to pay in 5 instead of in 4 days). The same argument *mutatis mutandis* would explain low returns on Monday and high returns on Tuesday for the periods when the market was closed on Saturdays. However, settlement occurs up to the third day after the trade, not up to the fourth, and thus the settlement hypothesis is clearly at odds with the evidence.

This result can be seen in a more intuitive way with the help of Figure 4 where the data in Table 2 is plotted. In this Figure is depicted what we might call a longitudinal representation of the Day-of-the-Week effect through the 17 years under consideration. We can see that the days with the highest and lowest returns remain the same for a considerable period although there is quite a lot of change in the

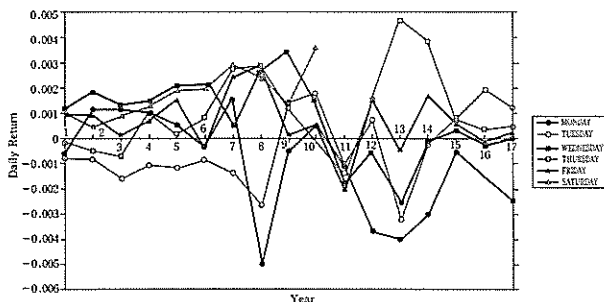


Figure 4 The Day-of-the-Week Effect Through the Years

relative position of the other days.

Finally, the Durbin-Watson statistic in Table 1 for the three periods leads us to suspect that the daily returns might be autocorrelated. Inspection of the correlograms of residuals for the three periods shows that in fact there is significant autocorrelation and that the process seems to be of order 2 in all three cases.

### 4.3 The day of the week effect in the presence of autocorrelation

The suspicion of the presence of autocorrelation leads us to fit the following autoregressive model:

$$R_t = \sum_{j=1}^J \beta_{t-j} R_{t-j} + \sum_{i=1}^7 \alpha_i D_i + \varepsilon_t \quad (2)$$

where the variables are as defined above. Inspection for several values of  $J$  confirms our suspicion that the daily returns are AR(2). The results of estimation of equation (2) when  $J=2$  for the three periods is presented in Table 3. Overall, the consideration of autocorrelation does not change much the estimated magnitude of the Day-of-the-Week effect for the periods considered.

**Table 3** Tests for the Day-of-the-Week hypothesis in the presence of autocorrelation

Period	R <sub>1</sub>	R <sub>2</sub>	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Statistics
Dec 28, 1979	0.144986	-0.076051	-0.001121	-0.000216	0.000625	0.000665	0.000598	0.001412	R <sup>2</sup> =0.2899
Oct 31, 1996	(9.71897)	(-5.23146)	(-3.24739)	(-0.63547)	(2.43171)	(2.01473)	(1.76278)	(2.620578)	DW=1.999
Dec 28, 1979	0.113354	-0.068203	-0.00245	-0.000829	0.002029	0.003513	0.001044	0.001460	R <sup>2</sup> =0.0274
Jan 31, 1989	(5.73631)	(-3.46977)	(-0.61191)	(-2.17933)	(5.36525)	(1.34244)	(2.75198)	(3.24026)	DW=1.995
Jan 31, 1989	0.168785	-0.000690	-0.002098	0.000525	-0.000645	0.000971	0.000064		R <sup>2</sup> =0.0357
Oct 31, 1996	(7.41333)	(-3.93230)	(-3.45679)	(0.879267)	(-1.07764)	(1.62985)	(0.10631)		DW=1.997

#### 4.4 The “Closed Market” effect

We test then the hypothesis that returns are lower in those days that follow a day when the market was closed. To do this we regress the following equation:

$$R_t = c + \sum_{j=1}^2 \beta_{t-j} R_{t-j} + \alpha_8 D_8 + \epsilon_t \quad (3)$$

where the dummy variable  $D_8=1$  when the market was closed the previous day and 0 otherwise. The average returns when the market was opened in the previous day are given by the estimated intercept; the estimated value of  $\alpha_8$  gives the difference between these returns and the returns for the days that followed a day when the market was closed. The results are presented in Table 4 and show that for the three periods under consideration the average returns of days following a closed market are negative in contrast to days following an opened market.

Because Monday might dominate the results, the above equation was regressed again for all observations excluding Mondays. The results are presented in Table 5. We can notice that the results are no longer as supportive of the “Closed Market” effect when the definition of clos-

**Table 4** Tests of the "Closed Market" (All Observations)

Period	Intercept	R <sub>-1</sub>	R <sub>-2</sub>	D <sub>8</sub>	Statistics
Dec 28, 1979	0.000606	0.147231	-0.080515	-0.001644	R <sup>2</sup> =0.0283
Oct 31, 1996	(3.6606)	(9.89132)	(-5.41281)	(-4.59477)	D.W.=2.001
Dec 28, 1979	0.00081	0.111403	-0.072557	-0.000877	R <sup>2</sup> =0.0162
Jan 31, 1989	(4.51259)	(5.63726)	(-3.67913)	(-2.21015)	D.W.=2.002
Jan 31, 1989	0.000342	0.166439	-0.088679	-0.002489	R <sup>2</sup> =0.0369
Oct 31, 1996	(1.12218)	(7.33855)	(-3.90996)	(-3.89192)	D.W.=1.997

**Table 5** Tests of the "Closed Market" Effect (Excluding Mondays)

Period	Intercept	R <sub>-1</sub>	R <sub>-2</sub>	D <sub>8</sub>	Statistics
Dec 28, 1979	0.000612	0.105114	-0.096486	-0.00172	R <sup>2</sup> =0.0194
Oct 31, 1996	(3.79103)	(6.65968)	(-6.12111)	(-1.46944)	D.W.=1.864
Dec 28, 1979	0.000843	0.087395	-0.111384	0.000089	R <sup>2</sup> =0.0178
Jan 31, 1989	(4.62180)	(4.11981)	(-5.16104)	(0.000899)	D.W.=1.994
Jan 31, 1989	0.000320	0.113230	-0.091557	-0.002828	R <sup>2</sup> =0.0213
Oct 31, 1996	(1.10338)	(4.72109)	(-3.86678)	(-1.96942)	D.W.=1.776

ed is restricted only to days other than Sunday: the estimated coefficients of D<sub>8</sub> become smaller and it even becomes positive for the first sub-period, and in general the values of the t-statistic for the estimated α<sub>8</sub> are lower.

#### 4.5 The trades reshuffling hypothesis

To test the hypothesis that investors when possible prefer buying and try to avoid selling before holidays and weekends we regress the following equation:

$$R_t = c + \sum_{j=1}^2 \beta_{t-j} R_{t-j} + \alpha_9 D_9 + \varepsilon_t \quad (4)$$

where D<sub>9</sub> is a dummy variable with D<sub>9</sub>=1 if the market is opened in

**Table 6** Tests of the Trades Reshuffling Hypothesis

Period	Intercept	$R_{-1}$	$R_{-2}$	$D_9$	Statistics
Dec 28, 1979	0.000598	0.142735	-0.079331	-0.000870	$R^2=0.0255$
Oct 31, 1996	(3.16175)	(9.57452)	(-5.32082)	(-2.88843)	D.W.=1.995
Dec 28, 1979	0.001091	0.105244	-0.071292	-0.000958	$R^2=0.0177$
Jan 31, 1989	(4.92169)	(5.33248)	(-3.61656)	(-2.96258)	D.W.=1.999
Jan 31, 1989	0.000105	0.163352	-0.088137	-0.000923	$R^2=0.0306$
Oct 31, 1996	(0.31368)	(7.17583)	(-3.86800)	(-1.64440)	D.W.=1.995

all the following three days and  $D_9=0$  otherwise, and the other variables are as defined before. Thus the average return of those days that are followed by an holiday or weekend within the following three days is estimated as the intercept. If there is a concentration of buying and an avoidance of selling in these days as the trade reshuffling hypothesis predicts, the estimated intercept will be positive. The estimated coefficient of  $D_9$  shows the average difference of the returns of those days followed by an holiday or weekend within the following three days and the returns of those days that are not followed by such a day. If there is in fact a concentration of selling and an avoidance of buying during these days the estimated value of this coefficient should be negative.

In Table 6 we present the results for the three periods under consideration. As can be noticed the values of the t-statistic for the estimates of the different parameters are significantly different from zero at the usual significance levels, except for the last sub-period where the estimated intercept is not significantly different from zero (this is a period when stock prices fell) and the estimated parameter of  $D_9$  is different from zero only at the 10% significance level. The  $R^2$  adjusted for the number of degrees of freedom for the three different estimates of equation 4 are somewhat (but not much) lower than those

of equation 2, but this should be expected as the reshuffling of trades hypothesis should explain part of the Day-of-the-Week effect (and not more). We may thus conclude that in general the empirical evidence here gathered does not reject the trades reshuffling hypothesis proposed in Section 3.

## 5. Conclusions

The Day-of-the-Week effect has been known to defy any rational explanation. This paper presented another possible explanatory hypothesis based on economic theory and institutional constraints. This trades reshuffling hypothesis leads to the prediction of low stock returns in the early days of the week and high stock returns in the later days of the week and in the days before holidays. This hypothesis has not been rejected for the Topix stock price index for the period 1980–1996 in Japan. However, further tests on individual stocks and other indexes, on other sample periods and for other countries is warranted.

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