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The Distribution of Daily Stock Returns and Settlement Procedures: The Paris Bourse

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ABSTRACT

In many countries settlements take place a fixed number of business days after the transaction (U.S., Japan). In other countries settlements take place periodically on a fixed date when all transactions performed before this date are settled (U.K., France, Italy). In both cases settlement procedures should cause returns not to be identically distributed over all days. The effect is likely to be the largest on markets where all trades are settled only once a month. An empirical investigation of the largest of those markets, the Paris Bourse, demonstrates the importance of the settlement procedure on the distribution of daily returns.

SETTLEMENT PROCEDURES VARY CONSIDERABLY across national stock markets. In many countries settlements take place a fixed number of business days after the transaction. These countries are referred to in this paper as countries with a *fixed settlement lag.* In other countries settlements take place periodically on a fixed date and all transactions performed before this date are settled then. These countries are referred to as countries with a *fixed settlement date.* In both cases settlement procedures should cause returns not to be identically distributed over all days.

Fixed Settlement Lag

The U.S. is an example of a country with a fixed settlement lag. Stock transactions are settled five business days after the trade. In case of payment by check, an additional business day is required to clear the check. In weeks without holidays, transactions are settled eight calendars days after the trade except when this transaction takes place on a Friday;[1] then the transaction is settled ten calendar days after the trade. This two-calendar-day difference in settlement should push up the prices on Fridays and lead to higher daily returns on Fridays and lower returns on Mondays when returns are measured from close to close. The difference in return should be of an order of magnitude of two days of interest. Other stock markets such as Japan, Canada, or Australia have different settlement delays ranging from two to ten days. In all cases the weekend should introduce differences in the distribution of daily stock returns depending on the day of the week. For example, one should expect daily Japanese stock returns to

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[1] This is detailed in Lakonishok and Levi (1982). They discuss the influence of holidays on the settlement lag.

be high on Thursdays and low on Fridays.[2] In all cases the order of magnitude of the difference in return should typically be two days of interest due to the weekend.

A large number of empirical studies[3] have found that the distribution of U.S. stock returns is not identical for all days of the week. It is often found that the returns on Mondays tend to be significantly lower than on the other days. Studies[4] of other national markets have also found that daily stock returns were not identically distributed. A significant negative return is generally found on Mondays in Canada and the U.K. and on Tuesdays in France, Japan, Australia, and Singapore. This day-of-the-week effect is usually much larger than the expected effect of the settlement procedure and often does not take place on the expected day.[5] This implies that the observed day-of-the-week effect is explained by other phenomena and that the influence of the settlement procedure on the distribution of daily returns is too small to be detectable without a precise model of these other phenomena.

Fixed Settlement Date

While the expected influence of the settlement procedure on the distribution of daily returns is quite small for countries with a fixed settlement lag, it is usually much larger for countries with fixed settlement dates such as the U.K., France, or Italy. In the U.K. the trading year is divided into *account settlement periods* of two weeks.[6] This is a forward market with a new account period starting every other Monday. The financing advantage brought by a new account period should imply a positive return on these Mondays; the extra return should be on the order of two weeks of interest. In theory, the forward stock price should converge to the implicit[7] spot price on the last day of the account period and move up from the spot price on the first day of the account period by an amount equal to the basis (cost of carry). In the absence of dividend payments and transaction costs, arbitrage requires that the forward price be equal to the spot price plus the financing cost of the position to maturity of the forward contract. If the underlying daily spot returns are identically distributed, so should be the observed (forward) returns on every day except the first day of the account period.[8] This should create a day-of-the-fortnight effect. Jaffe and Westerfield (1985) and Condoyanni, O'Hanlon, and Ward (1987) found evidence of this

[2] See Jaffe and Westerfield (1985).

[3] See, for example, French (1980), Gibbons and Hess (1981), and Rogalski (1984).

[4] See Jaffe and Westerfield (1985), Theobald and Price (1984), and Condoyanni, O'Hanlon, and Ward (1987).

[5] See, for example, Lakonishok and Levi (1982) and Jaffe and Westerfield (1985).

[6] There are only 24 or 25 account periods in a year because of vacations, so the length of this account settlement period is sometimes greater than two weeks. All the trades during an account period are settled on the second Monday following the last Friday of the period.

[7] We call this spot price implicit because there is no organized cash market where spot prices could be observed. The same comment applies to the Paris Bourse from 1983. Prior to 1983, a small cash market existed in Paris, but the volume of transaction was extremely low compared to that of the forward market and transaction costs were very high.

[8] If the underlying daily spot returns were identically distributed with a mean m and if i is the constant daily interest rate, the mean return of observed (forward) daily returns should be approxi-

positive return on a Monday starting an account period. However, this leaves unexplained the strongly negative return found on the other Mondays.

In France, Italy, and, to some extent, Switzerland and Belgium, as well as some developing countries, the settlement of all transactions takes place once a month on a fixed date. This system was instituted by Napoleon, the French emperor.

In this paper we provide empirical evidence of the settlement effect on daily stock returns for the largest of these markets with a monthly settlement: the Paris Bourse. Paris now ranks fourth in the world, just ahead of Frankfurt, in terms of market capitalization. All major companies listed in Paris are traded on a forward market[9] called the *Marché à Terme* until 1983 and the *Marché à Règlement Mensuel* thereafter. This forward market provides a single monthly settlement of all transactions at the end of the month when ownership is transferred. The last day of trading on which all trades are settled is called the *liquidation*. This is fairly similar to the British system except for the fact that the liquidation can take place on any day of the week. The liquidation takes place on the seventh business day preceding the end of the calendar month. The cash transfers take place on the last business day of the month. For example, in January 1989 the last business day is January 31 (a Tuesday) and the liquidation is set on January 23 (a Monday). Any trade on January 23 or before will be settled at the end of January. Any trade on January 24 or after will be settled at the end of February. So the February settlement month starts on January 24 for transaction purposes. This settlement procedure is likely to affect the distribution of daily stock returns. The magnitude of the effect ought to be one month of interest and hence much larger than in London, where the account period lasts two weeks, and in New York, where the difference in settlement delays is at most two days. The French market provides a good opportunity to test the importance of settlement procedures on the distribution of daily stock returns. Section I presents an empirical analysis of the liquidation effect on the daily distribution of stock returns. The effect of dividend payments, which tend to be concentrated in June and July, is detailed. Next we investigate whether the liquidation effect could explain the day-of-the-week effect observed in France as in other countries. Section II summarizes the results.

I. Empirical Results

A. The Data

The tests are conducted using the daily CAC 240 index from January 2, 1978 to November 3, 1989. The Paris Bourse is open from Monday to Friday, and we

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mately $m - i$ for each day, except the first Monday of a two-week account period, when it should be approximately $m + 13i$. This simple reasoning assumes a week of seven business days without vacations, no dividend payments, and no transaction costs in building an arbitrage. It still gives an order of magnitude for the theoretical effect. The influence of dividend payments is studied in the French case.

[9] Until 1983, all major companies were listed both on the spot and forward markets. However, most of the transactions (over 95%) took place on the forward market ("Marché à Terme"). Since 1983, they are only listed on a forward market; investors insisting on a cash settlement receive the forward price minus a fixed discount. The counterpart is a broker who performs the cash/forward arbitrage. A futures market on the stock index has only recently been introduced (early 1989).

can calculate 3087 daily returns. The CAC index is calculated by the Paris Bourse and is the most widely used index. It is a market-capitalization-weighted index of all the major French companies listed on the *Marché à Règlement Mensuel.*[10] Dividends are not included in the index and are therefore excluded from the daily return calculations. During the period studied, all shares listed on the forward market were traded in an open outcry call auction. This competitive call auction system, sometimes called *fixing*, has been described in Cohen, Maier, Schwartz, and Whitcomb (1986) and Solnik (1988). The stock exchange calls in order all shares. Once a share is called, the exchange clerk tries to find the price that equilibrates demand and supply, through an open outcry procedure. This fixing price will be the *Premier cours* or opening price, and all transactions will be done at this price once it becomes the official equilibrium price. In other words, brokers must execute all market and limit orders received prior to the opening of the exchange at this fixing price. Because of the sequential quotation process, some shares are only called at the end of the trading session (the exchange floor was usually open for less than two hours from 12:30 to 14:00 before lunch); the fixing price is their single quotation for the day. For some other shares a few further transactions take place after the initial auction. However, they must still be conducted on the floor under a competitive outcry auction, and there are no market makers.[11] Over the period under study, most of the transactions (typically over 90%) take place at the *Premier cours.* This is why the CAC index was only calculated once a day based on the fixing price. In a continuous market maintained during the day by specialists or market makers, the difference between opening and closing prices can be significant and affect the result of empirical studies on the behavior of daily returns. In a fixing market where shares are only traded for a few minutes during the day, there exists basically a single price for the day. If we were to conduct an international comparison of daily stock return behavior, we would have to decide whether to compare the French stock returns calculated on opening or on closing prices of foreign continuous markets. However, our current objective is not a test of the international synchronization of a day-of-the-week effect but simply a test of the influence of the monthly settlement procedure on the Paris Bourse.

B. Test of the Liquidation Effect

On the Paris Bourse, we cannot test the hypothesis that daily returns on spot prices are identically distributed since most shares are not traded independently on a cash market and we can only observe forward prices. But if they were, arbitrage can tell us what the distribution of daily *forward* returns would look like in the absence of dividend payments and transaction costs and with the assumption of a constant interest rate. As discussed above in the British case,

[10] The data were provided by Lombard Odier and carefully checked. The index is adjusted for splits and stock dividends but not for cash dividends. Over the period, the index covered around 200 issues. This index is now called the CAC 240 or SBF 240 index since it includes 240 issues.

[11] A major reform of the Paris Bourse takes place from 1988 to 1991. In late 1988 major shares started to be traded on a computer assisted market. The computer system is an adapted version of the Canadian CATS. Market making is progressively introduced.

all daily forward returns should be identically distributed (with a mean daily return slightly below that of the spot mean return), except for the first day of the monthly settlement period (liquidation), when forward prices should go up by an amount equal to one month of interest.

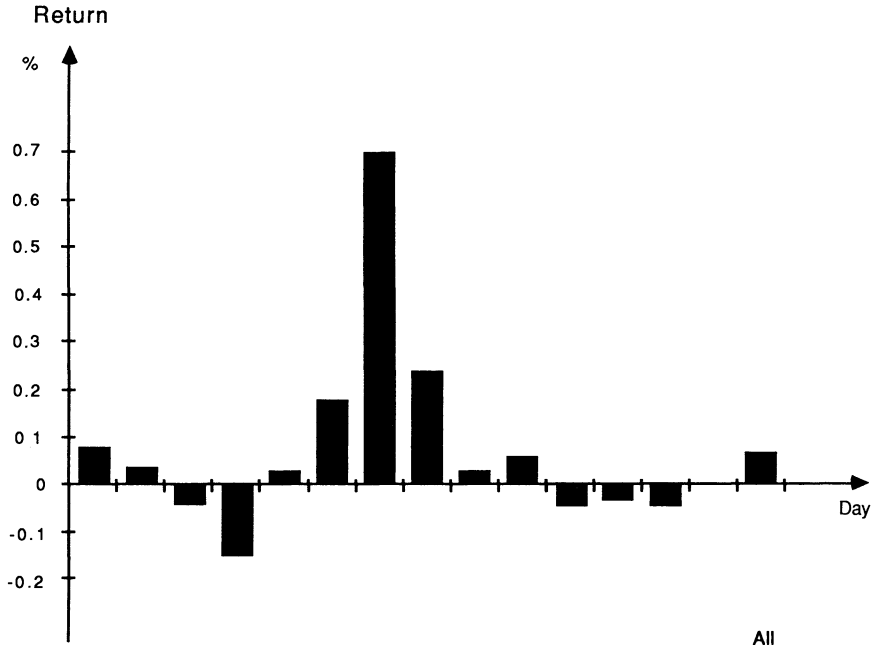
The equality of mean (forward) returns and the monthly settlement effect is tested by running the regression:

$$R_t = \alpha_0 d_{0,t} + \sum_k \alpha_{T+k} d_{T+k,t} + u_t, \tag{1}$$

where R_t is the return for day t (from day $t-1$ to day t) and $d_{T+k,t}$ is a dummy variable taking the value of one if day t falls on a day $T+k$ surrounding the liquidation date T and zero otherwise. k ranges from five days prior to liquidation to seven days after the liquidation; hence, the last day ($k=7$) is the first business day of the new calendar month. $d_{0,t}$ is a dummy variable that takes the value of one if day t falls on any day not included in the interval $T-5$ to $T+7$ and zero otherwise. The regression coefficients can be regarded as the mean return on the respective days.

The mean daily return over the period January 1978–November 1989 has been 0.074%, and the estimation of equation (1) is reported in Figure 1. The mean daily return on the opening day of a new settlement month (0.698%) is large and significantly different from the mean daily return at the 99% confidence level. The difference (0.624%) is in the order of magnitude of one month of interest rate but is somewhat smaller than the average one-month risk-free rate over the period (around 0.9%).

More surprising are the large daily returns on the days surrounding the first day of a new settlement month. The large return on the second day of the settlement month can be partly explained by the positive serial correlation in the index (0.024) due to non-trading. Some of the 200+ shares that make up the index trade infrequently, and it takes a couple of days for a full adjustment by all shares. However, the serial correlation on this value weighted index is quite low to account for such a large daily return; it could be that the market simply does not adjust immediately. The rather large return on the liquidation day (0.18% with a t-statistic of 1.9) is more puzzling. Until October 1983, transactions on the last day of the settlement month could be done "ici" (here) or "là bas" (there), meaning with delivery this month or next month. One could engage simultaneously in two different types of transactions with, of course, two different market prices, the price for a là bas transaction being higher than that of an ici transaction. This procedure was apparently adopted to clearly outline the impact of the new liquidation to the novice investor. Unfortunately, the index calculation did not differentiate between the two types of prices so that the index value on the day of liquidation partly anticipated the financing advantage of the new settlement month. The dual trading procedure was dropped in October 1983, and a test conducted on the period October 1983–November 1989 gives an insignificant mean return of 0.032% for the liquidation day compared to a mean return of 1.036% for the next day. The second day of the new settlement month still has a mean return of 0.253%.



Day	T-5	T-4	T-3	T-2	T-1	T	T+1	T+2	T+3	T+4	T+5	T+6	T+7	All Other
Mean Return	.08	.04	-.04	-.16	.03	.18	.70	.24	.03	.06	-.04	-.08	-.04	.07
t-statistic	.87	.42	-.37	-1.7	.33	1.9	7.3	2.5	.32	.68	-.42	-.84	-.40	2.09

F (13,3072) = 4.7

Mean daily return = 0.074 %

Figure 1. Mean daily returns around the liquidation day *T*. January 1978 to November 1989. All returns are expressed in %. The *t*-statistic tests for the difference from 0, and the *F*-statistic tests for the equality of all mean daily returns.

The global impact of the new settlement month can be estimated from Figure 1 by adding the mean daily return of days T to $T + 2$ (1.12%) and comparing it with a normal three-day return of 3 times 0.074%. The difference (0.90%) is close to the average risk-free rate over the period.

C. Dividend Payments

French companies pay their dividends only once a year, and payments are mostly made in the months of June and July. In 1988, 38% of the firms making up the CAC index paid their annual dividend in June and 42% paid it in July; the dividend yield on the CAC index was 1.4% in June and 1.5% in July. The average dividend yield over the total period 1978–1989 has been slightly less than 2%, both in June and in July; this is about 1.7% above the average yield for the

other ten settlement months. If a stock pays a dividend during a given settlement month, any purchaser of the stock during that month will receive the shares ex-dividend at the settlement taking place at the end of the month. Hence, the forward price should drop, ceteris paribus, on the first day of the monthly settlement period by an amount related to the scheduled dividend payment during the month. All other daily forward prices should not be affected by a dividend payment. If the impact on the firm's value is exactly equal to the dividend paid out, then the forward price on the first day of the settlement period should drop by an amount equal to that discounted dividend. Given the higher dividend payments in June and July, the return on the first day of the June and July settlement months should be roughly 1.7% below that of other months since index return calculations do not include dividend paid. An effect with such a magnitude would not show up for countries where firms pay quarterly dividends spread out through the year.

To test this effect, mean daily returns are estimated separately for June–July and for the other ten months of the year. We report in Table I the daily return for the days surrounding the *first day* of a settlement month. The liquidation date is again denoted T. The first day of a new settlement month (day $T + 1$) is like the ex-dividend date in studies on ex-day behavior, and the index value should drop on that day by an amount related to the dividend to be paid during the settlement month. The price appreciation due to the new settlement month is indeed smaller in the first day of June and July, when most dividends are paid (0.571%), than in non-dividend months (1.216%). While this difference (0.645%) is statistically significant, it is less than the average difference in monthly dividend yield between June–July and the other months (1.7%). This result is consistent with a drop in the stock price on the ex-day being less than the dividend.

D. Day-of-the-Week

Our final question is whether this settlement procedure could explain the pattern of daily returns observed in previous studies of the Paris Bourse. Condoyanni, O'Hanlon, and Ward (1987) found a significant and stable negative return on Tuesdays for the period 1969–1984. Solnik and Bousquet (1990) found a similar result for the period 1978–1987. An obvious question is whether this day-of-the-week phenomenon could be explained by the settlement procedure.

Table I

Influence of Dividend Payments on Mean Daily Returns

Daily returns around liquidation day T, 1978–1989, in % per day. Day T is the liquidation day; the liquidation effect should be fully discounted in days T to $T + 2$ and should be smaller for the dividend months (June and July) than for the other months.

Settlement	Day T	Day $T + 1$	Day $T + 2$	Total 3 days
June–July	0.014	0.473	0.084	0.571
All other months	0.222	0.724	0.270	1.216

Table II

Estimation of $R_t = \alpha_1 d_{1,t} + \alpha_2 d_{2,t} + \cdots + \alpha_5 d_{5,t} + u_t$, with a Test of the Null Hypothesis $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5$

Returns in %, 1978–1989; each coefficient represents the mean daily return for a day of the week. The test is conducted with and without the days affected by the liquidation effect.

Period	Monday	Tuesday	Wednesday	Thursday	Friday	F-stat.	Degrees of Freedom
Jan. 2, 1978–Nov. 3, 1989	0.095	−0.088	0.127	0.093	0.142	4.06	(4,3086)
	(2.06)	(−1.90)	(2.76)	(2.01)	(3.09)		
Same excluding liquidation	0.076	−0.109	0.109	0.057	0.092	3.71	(4,2939)
	(1.64)	(−2.42)	(2.31)	(1.22)	(1.92)		

The standard methodology to test the day-of-the-week effect is replicated by running the following regression:

$$R_t = \alpha_1 d_{1,t} + \alpha_2 d_{2,t} + \cdots + \alpha_5 d_{5,t} + u_t, \tag{2}$$

where R_t is the rate of return on day t (from day $t-1$ to day t) and $d_{i,t}$ is a dummy variable taking the value of one on the respective day of the week and zero otherwise. The coefficients of (2) are the mean returns for Monday to Friday. If the daily returns were drawn from an identical distribution, we would expect the regression coefficients to be equal. Tests of this equation for the total period are reported in Table II. The hypothesis of equality of the regression coefficients is rejected at the five percent confidence level (F-test of 4.06). This rejection is mostly explained by the negative coefficient for Tuesdays and to some extent by a somewhat higher return on Fridays.

During the 1978–1989 period, the distribution of the liquidation dates was as follows: 20 Mondays, 26 Tuesdays, 27 Wednesdays, 51 Thursday, and 18 Fridays. The frequent occurrence of Thursdays is natural. As mentioned in the introduction, the liquidation takes place on the seventh business day preceding the end of the calendar month. If the month ends on a Friday, Saturday, or Sunday, the liquidation will take place on a Thursday if there are no vacations in-between. Because the major impact of the liquidation on the daily return takes place on the *next day*, this phenomenon will tend to increase the mean return observed for Fridays. To adjust for this, days following a liquidation were excluded. Results for the total period are also reported in Table II. The major difference is that the mean return on Fridays is no longer the highest, but the return on Tuesday stays significantly negative. The hypothesis that all mean returns are equal for each day of the week is still rejected at the 5% confidence level (F-statistic of 3.71).

II. Summary

Settlement procedures vary considerably across national stock markets. In many countries, settlements take place a fixed number of business days after the transaction. In other countries, settlements take place periodically on a fixed date when all transactions performed before this date are settled. In both cases, settlement procedures should cause returns not to be identically distributed over

all days. Of all the settlement procedures used in the major stock markets, the end-of-the-month settlement on the Paris Bourse is the most likely to introduce irregularities in the distribution of observed daily stock returns because it creates the largest potential differences in settlement lags. Indeed, a large and significant effect is found on the start of a new settlement month. Its observed magnitude is consistent with the theory which states that the extra return should be equal to one month of interest. Indeed, the return is around 1% on the first two days of a new settlement month. Even if the distribution of daily returns on the underlying, and unobservable, spot price is stationary with a constant mean and variance, the distribution of the observed (forward) returns should be the superposition of two distributions with different means. Furthermore, the concentration of the annual dividend payments on two months of the year, June and July, should be discounted in two single days (the first days of these settlement months). Since the index calculation does not include dividends, the mean return on those two days is significantly smaller than for the other months of the year. The daily returns on the start of the months of June and July, when most dividends are paid, are significantly smaller than in non-dividend months; the difference of 0.65% is less than the dividends paid on the index (around 1.7%).

As in the countries with other types of settlement procedures, the monthly settlement cannot explain the day-of-the-week effect observed on the Paris Bourse because there is no concentration of liquidation dates on Tuesdays.

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