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DAILY ANOMALIES IN THE BRUSSELS EQUITY MARKETS

The aim of this paper is to study daily seasonalities in the equity returns of the Brussels Stock Exchange and to test some explanations for these anomalous empirical regularities. Generally, security return distributions are not independent of the day of the week. Persistent daily seasonalities have indeed been observed in the distributions of index and security returns of a number of stock exchanges. Using the Standard and Poor's Composite Index, Cross (1973) and French (1980) documented a Monday effect or Weekend effect, that is the average return on Friday is abnormally high while it is abnormally low, even negative, on Monday. The existence of this anomaly has been confirmed by subsequent research by Gibbons and Hess (1981), Lakonishok and Levi (1982) and Keim and Stambaugh (1984) on various American stock market indexes and for longer periods of time. This effect has also been observed at different degrees in market indexes of other countries: in Finland by Berglund, Liljeblom and Wahlroos (1984) and in the U.K., Japan, Canada and Australia, France and Singapore by Jaffe and Westerfield (1985) and Condoyanni, O'Hanlon and Ward (1987 and 1988). Besides, Jaffe and Westerfield and Condoyanni et al. also identified in countries like France, Japan, Australia and Singapore, a Tuesday effect that dominates the Monday effect, the returns being at their lowest level on Tuesday.

The presence of such a "day of the week" effect in equity pricing has received considerable interest from the academic community. Several explanations have been examined in the literature: the measurement errors due, for example, to non-synchronous trading, holidays, bid-ask spread or specialist activity by Gibbons and Hess (1981) and Keim and Stambaugh (1984); the settlement procedure by Gibbons and Hess (1981), Lakonishok and Levi (1982) and Theobald and Price(1984); the firm size by Rogalski (1984) and Keim and Stambaugh (1984); the January effect by Rogalski (1984) and the international integration by Jaffe and Westerfield (1985) and Condoyanni, O'Hanlon and Ward (1987 and 1988). But despite the effort and time devoted to their study, the suggested explanations were never unanimous, nor did any of them completely account for the existence of these anomalies.

This paper shows that the stock returns on the Brussels Stock Exchange markets exhibit a Tuesday effect. Because of the friction on the trading process, it also appears that this "day of the week" effect mainly concerns frequently traded stocks. None of the adjustments related to measurement errors, i.e. adjustment for heteroscedasticity, autocorrelation, holiday and dividend distribution, does appear to explain the daily seasonality. This study does not either reveal any strong relationship between the Tuesday effect and other seasonal anomalies like the January effect and the settlement effect in the Belgian returns. Similarly, tests will not entirely support the hypothesis of an international integration, which means that the Tuesday effect is not merely a reflection of the U.S. Monday effect due to the difference in the zone time.

I. The Markets and the Data.

The sample consists of all domestic equities traded on the spot and the forward markets of the Brussels Stock Exchange (BSE) from 1st January 1977 to 31st December 1985. The number of securities for each market and for each year is reported in table I. Various statistics on the two markets are also given in table I.

The forward market includes only a few securities which are also quoted on the spot market. They are generally among the largest and the most traded ones, and their turnover on the forward market represents more than sixty per cent of the total turnover of the two markets together. As to the spot market, it is partitioned into two markets, the *Corbeille* and the *Parquet* which are both auction markets. On the *Corbeille* several auctions can take place per day, while there is only one auction per day on the *Parquet* . Transactions on the spot market are paid cash the following day. For the forward market, there are also several auctions per day and trading must be made by multiple of a minimum quantity. The account period on the forward market is roughly ten trading days and it does not always systematically end on the same day of the week. The payment of purchased shares takes place two trading days after the end of the account period but the proceeds of a sale are cashed two more trading days later.

The returns in this study are calculated as rates of return, they include dividends and are adjusted for changes in capital. To simplify the calculation and the presentation of the results, the analysis will be conducted only on market indexes and on portfolios. The major index returns this study uses for each market are returns of an equally weighted and a value weighted market portfolio consisting of all common stocks listed on these markets respectively. The spot market portfolios will also at times be partitioned into securities exclusively quoted on the spot market and securities simultaneously quoted on the spot and the forward markets. Occasionally, portfolios constructed on the basis of the level of trading of the securities will also be used in the tests.

II. Daily Seasonalities in the Returns: the Evidence

The weak form of the efficient market hypothesis assumes that current prices fully and instantaneously reflect all information from historical sequences of prices. According to this hypothesis the distribution of the returns should not exhibit a seasonal pattern. Concerning daily returns more specifically, the average daily returns should not vary across the days of the week. With respect to this, French (1980) pointed out that two attitudes can be considered according to whether the process that generates the returns is continuous on the whole calendar week or on the trading period of the week only. Under the calendar time hypothesis, the average Monday return should be three times the average return of the other days of the week if the trading period is five days. And under the trading time hypothesis, no difference should be observed between the daily average returns.

Table I

Characteristics of the Markets of the Brussels Stock Exchange

	1977	1978	1979	1980	1981	1982	1983	1984	1985
Number of Trading Days	246	246	246	245	245	245	246	248	246
Market Capitalization [a]	364.799	371.974	408.922	368.098	299.775	376.702	512.488	710.309	856.143
Turnover [b]	17.294	17.886	27.283	23.892	23.713	47.052	67.772	88.969	107.520
Turnover/Capitalization [c]	4.74	4.81	6.67	6.49	7.91	12.49	13.22	12.52	12.56
	Securities quoted on the spot market only								
Listed Domestic Securities	260	252	243	238	231	225	236	271	271
Average Market Capitalization [a]	1.407	1.475	1.683	1.544	1.298	1.676	2.170	2.617	3.173
Volume of transaction [d]	3671	3726	4132	4228	4775	8287	11856	11504	11769
Value of the volume of transaction [b]	6.215	6.646	8.049	6.918	6.867	14.675	24.805	28.080	37.282
Value of the volume/Capitalization [c]	1.70	1.79	1.97	1.88	2.29	3.89	4.84	3.95	4.35
Dividends [b]	17.186	12.713	14.860	14.074	11.383	13.060	21.475	19.974	24.297
Dividends/Capitalization [c]	4.71	3.42	3.63	3.82	3.80	3.47	4.19	2.81	2.84
	Securities quoted on the spot and forward markets								
Listed Domestic Securities	36	36	36	36	36	36	36	44	46
Average Market Capitalization [a]	5.977	6.270	7.015	6.516	5.294	6.582	7.719	10.017	11.797
Total Market Capitalization [a]	227.122	232.033	259.533	241.110	195.876	249.497	331.092	462.296	551.540
Volume on the spot market [d]	1309	1283	1449	1690	2043	3803	5675	4631	4559
Value of the volume(spot market) [b]	2.168	2.147	2.730	2.727	2.620	5.568	10.921	10.090	12.145
Value of the volume/Capitalization [c]	0.95	0.93	1.05	1.13	1.34	2.23	3.30	2.18	2.20
Volume on the forward market [d]	5272	6218	8103	8309	10232	18930	23397	27418	25185
Value of the volume(forward market) [b]	11.079	11.240	19.23	16.974	16.846	32.377	42.967	60.889	70.238
Value of the volume/Capitalization [c]	4.88	4.85	7.41	7.04	8.60	12.98	12.98	13.17	12.73
Total Turnover/Capitalization [c]	5.83	5.78	8.46	8.17	9.94	15.31	16.28	15.35	14.93
Dividends [b]	7.983	4.494	7.106	6.118	4.652	5.815	8.391	8.703	10.038
Dividends/Capitalization [c]	3.51	1.94	2.74	2.54	2.37	2.33	2.53	1.88	1.82

[a] average on the year in billions of Belgian francs

[b] in billions of Belgian francs

[c] in per cent

[d] in thousands of shares

These two hypotheses have been tested by French on the returns of the Standard and Poor's composite portfolio and both were not supported by the data. French's results show indeed not only that the average Monday return is not equal to or greater than the average return of the other days, but also that it is significantly negative while it is generally positive for the other days. Friday average return is, on the other hand, very large.

Daily statistics for the indexes of the two markets of the Brussels stock exchange are presented in table II. The table displays the average percentage return per day of each index, their standard deviation and the value of their t-test statistic. To test the joint hypothesis that all average daily returns are equal to zero, the dummy variable regression (1) is also run. In this regression $\tilde{R}_{kt}$ is the daily return for index k in period t, D_{it} is the dummy variable for day i, that is, $D_{it}=1$ for day i and $D_{it}=0$ otherwise, and $\tilde{\varepsilon}_{kt}$ is the error term. The value of the F-test statistic of this regression is also presented in table II.

$$\tilde{R}_{kt} = \sum_{i=1}^{5} \hat{\beta}_{ki} D_{it} + \tilde{\varepsilon}_{kt} \qquad (1)$$

Interestingly, there is no Monday or Weekend effect as such in the Belgian market index returns. The average Monday return is positive and it is never the smallest return of the week. It is even significantly positive at the five per cent level and above the average daily return for the spot market indexes. As to the forward market indexes, the hypothesis of a zero value of the average Monday return is not rejected. With regard to the average return on Friday, it is, just as in the studies on the American indexes, generally the highest return of the week, especially for the forward market indexes.

The most important feature of table II is that it reveals a seasonal pattern which is concentrated on Tuesday. The Tuesday return is indeed very low compared to the returns of the other days of the week. The t-test statistics indicate that the hypothesis of a zero average Tuesday return is not rejected at a five per cent significance level in three cases out of four. And even if the hypothesis is rejected for the equally weighted index of the spot market, the average Tuesday return of this index is by far the smallest return of the week.

As to the other days of the week, table II shows that the pattern depends on the market. As far as the spot market is concerned, the seasonal pattern appears to be concentrated on Tuesday although the average Wednesday return of the value weighted index is also low compared to the daily returns of the rest of the week. Concerning the forward market indexes, the seasonal pattern contrasts more the returns of the beginning of the week with those of the end of the week. Almost all t-test statistics for the first three days of the week are not significant at the five per cent level, while they are always positive and statistically significant for Thursday and Friday.

Another interesting result in table II concerns the standard deviation of the daily returns. Their daily pattern does not necessarily fit that of the returns. One can indeed observe that the

Table II

Average Percentage Returns on Stock Indexes by Day of the Week

	Mon.	Tues.	Wed.	Thurs.	Fri.	All Days	F-test
	Equally Weighted Spot Index						
Observations	424	456	460	446	427	2213	
Mean (a)	.0795	.0262	.0464	.0437	.0623	.0511	
Std Deviation (a)	.4918	.3047	.2720	.2478	.3216	.3366	
t-test (b)	3.33	1.84	3.66	3.73	4.00	7.14	11.48
	Value Weighted Spot Index						
Observations	424	456	460	446	427	2213	
Mean (a)	.0984	-.0319	.0406	.1110	.1301	.0682	
Std Deviation (a)	.5919	.5945	.5301	.4891	.5182	.5490	
t-test (b)	3.42	-1.14	1.65	4.79	5.19	5.84	12.10
	Equally Weighted Forward Index						
Observations	424	456	460	446	427	2213	
Mean (a)	.0452	.0138	.0388	.0665	.1232	.0557	
Std Deviation (a)	.7680	.6516	.6710	.6100	.6034	.6633	
t-test (b)	1.21	.45	1.08	2.30	4.22	3.95	4.52
	Value Weighted Forward Index						
Observations	424	456	460	446	427	2213	
Mean (a)	.0377	-.0087	.0598	.0741	.1192	.0558	
Std Deviation (a)	.7951	.8075	.7311	6733	.7093	.7455	
t-test (b)	.98	-.23	1.76	2.32	3.47	3.52	3.89

(a) in per cent.

(b) t-test and F-test coefficients significant at the 5% level are underlined (two tails test).

standard deviation of Monday returns for the equally weighted index of the spot and the forward markets is respectively about fifty per cent and fifteen per cent greater than the largest standard deviation of the other days. A similar observation has been done by Fama (1965) for American stock returns. As for the two value weighted indexes, Tuesday has the largest standard deviation of the week, but only to a slight extent from that of Monday. In these two cases, the contrast is again between the beginning and the end of the week.

The comparison of the different indexes is to some extent surprising since one might have expected a stronger seasonal behaviour in the returns of the forward market index than in those of the spot market index, as predicted by the Theobald and Price hypothesis. Theobald and Price (1984) developed an analytic relationship between non-trading and daily seasonality. They argued that any test of seasonality necessitates independently and identically return distributions through time. If this condition is not satisfied, a diffusion of the daily seasonalities across the days of the week will occur. According to their hypothesis, the daily

returns of the market indexes composed of a small number of frequently traded securities should then exhibit a stronger daily seasonality than larger indexes, or indexes which include smaller and less traded securities. Because of friction in the trading process, infrequently and thinly traded securities have longer adjustment delays of their price to a change in information than have frequently traded securities. Therefore any daily seasonality in their returns is diffused among the days of the week. One would then expect that large indexes, that is, indexes which are composed of a large number of small firm securities, as well as equally weighted indexes, which give more weight to the returns of small firm securities, present weaker evidence of a seasonal pattern in their returns than do value weighted indexes or indexes composed of a small number of large and frequently traded securities.

Comparing the equally weighted and value weighted indexes of the spot market, one can observe that the results are consistent with the Theobald and Price hypothesis, the seasonal behaviour appears to be more pronounced for the value weighted index than for the equally weighted index. This seems to be also the case for the forward market indexes even if the value of the F-test statistic is greater for the equally weighted index.

Things are less apparent, however, if one compares indexes of the two markets. A look at the results shows that the indexes of the forward market exhibit a weaker seasonality than do the indexes of the spot market. This observation is obviously inconsistent with the Theobald and Price hypothesis unless the two markets present a different seasonal pattern.

The importance of the Tuesday effect in the index returns can be tested with the following dummy variable regression

$$\tilde{R}_{kt} = \hat{\beta}_{k2} + \hat{\beta}_{k1}D_{1t} + \hat{\beta}_{k3}D_{3t} + \hat{\beta}_{k4}D_{4t} + \hat{\beta}_{k5}D_{5t} + \tilde{\varepsilon}_{kt} \qquad (2)$$

where $\tilde{R}_{kt}$ is the return of the market index k in period t, D_{it} is the dummy variable for day i (D_{it}=1 if observation t falls on day i and 0 otherwise), and $\tilde{\varepsilon}_{kt}$ is the error term. The regression intercept measures the average Tuesday return, and the slopes $\hat{\beta}_{k1}$, $\hat{\beta}_{k3}$, $\hat{\beta}_{k4}$ and $\hat{\beta}_{k5}$ measure the difference between the average return of the other days of the week and that of Tuesday. If the F-test of the regression is statistically significant, the joint hypothesis of equality between the average Tuesday return and those of the other days of the week, i.e. $\hat{\beta}_{k1}=\hat{\beta}_{k3}=\hat{\beta}_{k4}=\hat{\beta}_{k5}=0$, is rejected. The results are presented in table III.

At the five per cent significance level, the F-test statistic rejects the hypothesis of equality of the returns for the value weighted index of the spot market only. Furthermore all t-test coefficients of the slopes are statistically significant for this index. When the equally weighted index of the spot market is the dependent variable, the hypothesis of equality of the average daily returns is not rejected, the average Tuesday return is positive and none of the slopes, but Monday's, is statistically significant. As for the two indexes of the forward market, the results confirm the existence of a contrast between the daily returns of the beginning of the week and

those of the end of the week, even if Friday is the only day which presents a statistically significant difference in return from Tuesday.

Table III

Test of Hypothesis of Equal Day-to-Day Mean Returns[a][b]

$$\tilde{R}_{kt} = \hat{\beta}_{k2} + \hat{\beta}_{k1}D_{1t} + \hat{\beta}_{k3}D_{3t} + \hat{\beta}_{k4}D_{4t} + \hat{\beta}_{k5}D_{5t} + \tilde{\varepsilon}_{kt}$$

	$\hat{\beta}_{k2}$ Tues.	$\hat{\beta}_{k1}$ Mon.	$\hat{\beta}_{k3}$ Wed.	$\hat{\beta}_{k4}$ Thurs.	$\hat{\beta}_{k5}$ Fri.	F-test
Spot Market						
Equally W. Index	.0262	.0533	.0202	.0175	.0361	1.58
		1.66	2.35	.91	.78	1.59
Value W. Index	-.0319	.1304	.0725	.1429	.1620	6.50
		-1.25	3.54	2.01	3.93	4.40
Forward Market						
Equally W. Index	.0138	.0313	.0200	.0527	.1094	1.74
		.45	70	.46	1.19	2.45
Value W. Index	-.0087	.0465	.0686	.0828	.1279	1.76
		-.25	.92	1.39	1.67	2.55

(a) the estimated coefficients are multiplied by 100. The t-test statistics are given below the coefficients.
(b) F-test and t-test coefficients which are significant at the 5% level are underlined (two tails test)

Since a number of securities on the spot market of the BSE are very infrequently traded, one could expect, as predicted by the Theobald and Price hypothesis, some diffusion of the daily seasonal pattern across the days of the week. Therefore the analysis of the daily fluctuations in the returns on the spot market has been replicated on various portfolio index returns. In order to avoid a possible effect of any seasonality in the forward market returns on the spot market, the securities which are traded simultaneously on both markets were first separated from those which are exclusively traded on the spot market. Let us remember that the former securities have generally a large market value. They are traded every day and their volume of transaction approximately represents one third of the total volume of transaction on the spot market. As to the securities which are exclusively traded on the spot market, five portfolios are constructed on the basis of the frequency of trading of the security. The first portfolio includes stocks which, on average, are traded less than 4 days a month, the second one stocks which are traded 4 to 7 days, the third one 8 to 11 days, the fourth one 12 to 15 days and the fifth one stocks which are traded more than 15 days a month.[1] They will be denoted afterwards by LTP1 to LTP5. The number of securities included in these portfolios, as well as the results of the dummy variable regression (2) for these portfolios, are shown in table IV.

Table IV

Test of Hypothesis of Equal Day-to-Day Mean Returns on the Spot Market [a][b]

$$\tilde{R}_{kt} = \hat{\beta}_{k2} + \hat{\beta}_{k1}D_{1t} + \hat{\beta}_{k3}D_{3t} + \hat{\beta}_{k4}D_{4t} + \hat{\beta}_{k5}D_{5t} + \tilde{\varepsilon}_{kt}$$

	$\hat{\beta}_{k2}$ Tues.	$\hat{\beta}_{k1}$ Mon.	$\hat{\beta}_{k3}$ Wed.	$\hat{\beta}_{k4}$ Thurs.	$\hat{\beta}_{k5}$ Fri.	F-test	Sec.[c]
	Securities Exclusively Quoted on the Spot Market - Equal. W. Index						
All securities	.0405	.0296	.0109	-.0095	.0062	.73	
	2.44	1.24	.46	-.40	.26		
LTP1	-.0318	-.0857	.1078	.0157	-.0020	1.74	31
	-.62	-1.16	1.49	.22	-.03		
LTP2	.0746	.0093	-.0567	-.0570	-.0778	1.37	66
	2.31	.20	-1.25	-1.24	-1.68		
LTP3	.0684	-.0434	.0249	-.0215	-.0587	.85	58
	1.92	-.85	.49	-.43	-1.14		
LTP4	.0185	.0495	.0065	.0098	.0604	1.32	44
	.79	1.46	.20	.29	1.78		
LTP5	.0264	.0945	.0197	.0149	.0705	3.86	30
	1.31	3.26	.69	.52	2.44		
	Securities Exclusively Quoted on the Spot Market - Value W. Index						
All securities	.0440	.0758	.0102	.0271	.0924	4.76	
	2.40	2.86	.39	1.04	3.50		
LTP1	.0480	.0539	.0724	-.0263	-.0048	2.94	31
	1.98	1.54	2.12	-.76	-.14		
LTP2	.1777	-.0173	-.0596	-.1008	-.0803	.71	66
	3.58	-.24	-.85	-1.43	-1.12		
LTP3	.1052	.0578	-.0077	-.0568	.0179	1.78	58
	3.45	1.32	-.18	-1.31	.41		
LTP4	.0319	.0664	.0080	.0214	.0610	1.09	44
	1.11	1.61	.20	.53	1.48		
LTP5	.0369	.0825	.0136	.0384	.1071	4.33	30
	1.72	2.67	.45	1.26	3.48		
	Securities Quoted on Both the Spot and the Forward Markets						
Equally W. Index	-.0585	.1670	.0748	.1629	.1958	7.07	50
	-1.94	3.85	1.76	3.80	4.52	.0126	
Value W. Index	-.0748	.1597	.1062	.2077	.1998	6.12	50
	-2.18	3.24	2.20	4.27	4.06	.0110	

(a) The estimated coefficients are multiplied by 100. Their t-test statistics are given below.
(b) F-statistics and t-statistics significant at the 5% level are underlined (two tails test)
(c) The number of securities in a portfolio corresponds to the number of securities which were quoted at least once during the period 1977-1985.

A test of the Theobald and Price hypothesis has also been conducted between some of these portfolio indexes. It consists in running a dummy variable regression with the difference between the returns of two portfolios as dependent variable.

$$\tilde{R}_{kt} - \tilde{R}_{lt} = \sum_{i=1}^{5} \hat{\beta}_{li} D_{it} + \tilde{\varepsilon}_{kt} \qquad (3)$$

If there is no diffusion of the daily seasonality across the days of the week, all differences, measured by the $\hat{\beta}_{li}$, between the daily returns of the portfolios should be equal to zero, i.e. $\hat{\beta}_{li} = 0$ (i=1,...,5). The F-statistic of the regression can be used to test the Theobald and Price hypothesis. Its values are presented in table V.

The results of the regression (2) in table IV show that when the securities exclusively quoted on the spot market are separately analysed, the Tuesday effect is weaker than it is in table III for the index of the whole spot market. Tuesday returns are indeed mostly positive, sometimes even significantly so, and when there is a positive difference between the return of a particular day of the week and Tuesday's, it is, in most cases, not statistically significant, whether the portfolio index is the equally weighted one or the value weighted one. Looking more particularly at the portfolios which are composed of the most tradedsecurities, LTP4 and LTP5, one can observe that Tuesday has always the smallest return of the week. The return of these portfolios is high on Monday, then it falls on Tuesday and starts to recover slowly on Wednesday and Thursday, to finally jump again to a high level on Friday. The differences in daily returns are, however, only significant on Monday and Friday for the portfolio LTP5. The F-statistic of the regression is also positive for this portfolio only.

The seasonal behaviour of the daily return on the spot market is more pronounced if one considers the portfolio of the securities quoted simultaneously on the spot and the forward markets. The Tuesday returns of both indexes are significantly negative, and most of the differences in return between the other days and Tuesday are significantly positive. The two F-tests of the regression also reject the joint hypothesis of no differences between the return on Tuesday and the return of the other days of the week.

Table V

Test of Theobald and Price Hypothesis (a)

$$\tilde{R}_{kt} - \tilde{R}_{lt} = \sum_{i=1}^{5} \hat{\beta}_{li} D_{it} + \tilde{\varepsilon}_{kt}$$

	(5)-(1)	(5)-(2)	(5)-(3)	(5)-(4)	SF-(5)	F-SF
Equal. Weighted Indexes	5.28	2.05	2.79	1.04	3.68	5.87
Value Weighted Indexes	3.40	1.98	1.57	.67	3.55	6.89

(1) = LTP1 (2) = LTP2 (3) = LTP3 (4) = LTP4 (5) = LTP5
SF = spot index of the securities quoted on the spot and the forward markets
F = forward index
(a) F-statistics significant at the 5 % level are underlined.

As expected, in table V the F-statistics of the regression (3), testing the Theobald and Price hypothesis, show that the hypothesis of no diffusion of the daily seasonality in the returns across the days of the week is rejected between portfolios LTP5 and LTP1. The similarity of the seasonal pattern is also rejected between the returns on the spot market of portfolio LTP5 and the portfolio composed of securities quoted on both markets (SF), and interestingly, between the returns of the latter portfolio on the spot market (SF) and the forward market (F). This last result tends to support the hypothesis of another seasonal behaviour in the returns on the forward market.

The first conclusion at this stage is that there is a Tuesday effect in the returns on the spot market of the BSE. The return on Tuesday is lower, or even negative, compared to the returns of the other days of the week. But because of the infrequent trading which diffuses the seasonal pattern across the days, the effect mainly concerns the large and frequently traded securities. When one considers smaller and less traded securities, the effect spreads to Wednesday and Thursday and becomes more a middle of the week effect, or even disappears. As to the forward market, the Tuesday effect is less prominent, even if the average return on Tuesday is always the lowest return of the week. The pattern that comes out suggests more a beginning of the week effect than a mere Tuesday effect.

III. Some Possible Explanations

The objective of this section is to ensure that the seasonal pattern observed in the returns is not caused by some statistical properties in the distribution of the returns or some characteristics of the markets. To this end some plausible explanations related to measurement errors are tested.

A. Adjustment for Heteroscedasticity

As Gibbons and Hess (1981) remarked, equation (1) assumes that the covariance matrix is constant across the days of the week. Therefore, since the value of the standard deviation of the daily returns of stock indexes depends on the day of the week, they suggested to avoid heteroscedasticity by standardizing the variables of equation (1) by the estimated standard deviation of the returns of each day respectively.

$$\frac{\tilde{R}_{kt}}{\sigma_i} = \sum_{i=1}^{5} \hat{\beta}_{1t} \frac{D_{it}}{\sigma_i} + \tilde{\varepsilon}_{kt} \qquad (4)$$

This test has been conducted on the Belgian market indexes, and it can be concluded that the adjustment for heteroscedasticity cannot explain the fluctuations in the daily returns. Table VI shows indeed that the seasonal pattern in the parameters of the dummy regression is not changed.

Table VI

Test of Hypothesis of Equal Day-to-Day Average Return with an Adjustment for Heteroscedasticity (a) (b)

	β_1 Mon.	β_2 Tues.	β_3 Wed.	β_4 Thurs.	β_5 Fri.	F-test
Spot market						
Equally W. Index	.1618	.0860	.1706	.1765	.1938	11.56
	3.33	1.84	3.66	3.73	4.00	
Value W. Index	.1664	-.0537	.0766	.2269	.2510	13.12
	3.42	-1.14	1.65	4.79	5.19	
Forward market						
Equally W. Index	.0588	.0213	.0504	.1090	.2043	5.19
	1.21	.45	1.08	2.30	4.22	
Value W. Index	.0474	-.0108	.0819	.1101	.1681	4.31
	.98	-.23	1.76	2.32	3.47	

(a) The coefficients are multiplied by 100. Their t-statistics are given below.
(b) F-statistics and t-statistics significant at the 5% level are underlined (two tails test)

B. Adjustment for Autocorrelation

Another inappropriate statistical assumption concerns the presence of autocorrelations in the distribution of the daily returns. Number of studies revealed that most daily stock returns are negatively autocorrelated and that market index returns, especially when they include a number of infrequently traded stocks, are positively autocorrelated.[2] Corhay (1989) showed that the Belgian market index returns act according to that rule, and furthermore that the first order autocorrelation in the daily Belgian index returns, especially the equally weighted one of the spot market, exhibits a seasonal pattern. In order to eliminate the effect of the autocorrelation and its seasonal pattern, a modified dummy variable regression is run:

$$\tilde{R}_{kt} = \hat{\beta}_{k2} + \hat{\beta}_{k1}D_{1t} + \hat{\beta}_{k3}D_{3t} + \hat{\beta}_{k4}D_{4t} + \hat{\beta}_{k5}D_{5t} + \sum_{i=1}^{5} \hat{\gamma}_{1t}\, D_{it} + \tilde{\varepsilon}_{kt} \qquad (5)$$

where D_{it} is the dummy variable representing day i of the week, β_i (i=1,3,4,5) is the difference, corrected for the first order autocorrelation, between the average return of day i and the average return of Tuesday (intercept), and γ_i is the first autoregressive parameter corresponding to day i. In addition to the regression F-test, the F-statistics of the two following joint hypotheses are also computed,

$$H(\beta): \quad \hat{\beta}_{k1} = \hat{\beta}_{k3} = \hat{\beta}_{k4} = \hat{\beta}_{k5} = 0$$

$$H(\gamma): \quad \hat{\gamma}_{k1} = \hat{\gamma}_{k2} = \hat{\gamma}_{k3} = \hat{\gamma}_{k4} = \hat{\gamma}_{k5} = 0.$$

Table VII

Test of Hypothesis of Equal Day-to-Day Return with an Adjustment for the first Autocorrelation [a] [b] [c]

$$\tilde{R}_{kt} = \hat{\beta}_{k2} + \hat{\beta}_{k1}D_{1t} + \hat{\beta}_{k3}D_{3t} + \hat{\beta}_{k4}D_{4t} + \hat{\beta}_{k5}D_{5t} + \sum_{i=1}^{5} \hat{\gamma}_{ki}\tilde{R}_{kt-1}D_{it} + \varepsilon_{kt}$$

	Mon. $\hat{\beta}_{k2}$	Tues. $\hat{\beta}_{k1}$	Wed. $\hat{\beta}_{k3}$	Thurs. $\hat{\beta}_{k4}$	Fri. $\hat{\beta}_{k5}$	$\hat{\gamma}_{k1}$	$\hat{\gamma}_{k2}$	$\hat{\gamma}_{k3}$	$\hat{\gamma}_{k4}$	$\hat{\gamma}_{k5}$	F-test	F (β)	F (γ)
Spot Market													
Equally W. Index	-.0061	.0281	.0415	.0323	.0437	1.013	.3324	.3238	.3879	.6539	101.18	1.62	180.35
	-.44	1.43	2.16	1.66	2.24	23.57	8.89	7.16	7.87	12.41			
Value W. Index	-.0643	.1142	.1134	.1631	.1377	.3876	.3078	.2755	.3405	.5195	40.33	6.59	66.68
	-2.64	3.24	3.33	4.76	3.93	8.18	7.53	6.86	7.39	10.40			
Forward Market													
Equally W. Index	.0027	.0024	.0268	.0595	.1001	.3423	.1828	.2810	.1665	.3126	17.88	1.86	30.70
	.09	.06	.63	1.39	2.31	6.56	4.59	6.09	3.70	6.21			
Value W. Index	-.0166	.0284	.0773	.0839	.1105	.2192	.1782	.1452	.1341	.3518	12.10	1.65	20.32
	-.49	.57	1.60	1.72	2.24	4.36	4.08	3.43	2.85	6.78			

(a) Printed estimated parameters of the betas are multiplied by 100.

(b) t-statistics of the estimated coefficients are given below the coefficients.

(c) Values of the t and F statistics which are significant at the five percent level are underlined (two tails test).

If there is a seasonality in the first order autocorrelation, H(γ) will be rejected, and similarly, if there is still a seasonality in the returns after they are corrected for the first order autocorrelation, H(β) will be rejected.

The results of the regression and the tests are reported in table VII. All tests of H(γ) are rejected. This supports the hypothesis of a seasonal pattern in the autocorrelation function; the autocorrelation is higher between Monday and Friday and between Thursday and Friday than it is between any other adjacent days. This also suggests that the correction for the first order autocorrelation can have an impact on the seasonality in the returns. But as one can observe in table VII, the adjustment intensifies the Tuesday effect in the spot market returns. Tuesday average return is negative for both indexes, even significantly for the value weighted one, and the differences in return between the last three days of the week and Tuesday become larger. The F-test statistic of the hypothesis H(β) is, however, still not significant for the equally weighted index. As for the forward market indexes, the hypothesis of no difference between the daily returns is still not rejected. The adjustment for autocorrelation tends to strengthen the contrast between the early beginning of the week and the end of it by decreasing Monday and Tuesday mean returns.

C. Adjustment for Holiday Returns

Disregarding the weekend's returns, the series of returns of the market indexes still includes holiday returns. This means that if the process generating the returns is continuous on the first five days of the week, some returns are returns on more than one day. Furthermore, most of the holidays take place at the end or at the beginning of the week. Out of 86 holiday returns, 31 are Monday returns and 35 Tuesday returns. This suggests that the average daily returns for these two days can be influenced by the holiday returns.

In order to avoid such impact in the tests, the average daily returns of table II have been recalculated after eliminating the holiday returns. The resulting average daily returns figure in table VIII, as well as the average value of the returns after a one day and a two days' holiday.

The comparison between table II and table VIII reveals that when the holiday returns are taken into consideration, the magnitude of the seasonal pattern in the daily returns is to some extent strengthened. Excluding holiday returns from the series substantially tends to increase the average Monday return and to decrease the average Tuesday return.

D. Adjustment for Dividend Distribution.

As one can observe in table IX, the distribution of dividends, expressed as an average dividend per day and per security, often takes place on Tuesday. On the spot market, more than 40 per cent of the dividends are distributed on Tuesday. This percentage goes beyond 65 per cent when the forward market is considered. It is however important to notice that in these figures, the dividends distributed by the securities quoted simultaneously on both markets are

counted twice. If one excludes these stocks, the average Tuesday dividend on the spot market will be reduced by more than seventy per cent.[3]

Table VIII

Daily Average Percentage Returns after Eliminating the Holiday Returns (a) (b)

	Mon..	Tues.	Wed..	Thurs.	Fri.	Holiday Returns One day	Two days
Observations	393	421	449	438	426	40	46
Spot Market							
Equally W. Index	.0864	.0168	.0492	.0449	.0711	.0700	-.0602
	3.43	1.14	3.61	3.79	5.51	1.16	-.66
Value W. Index	.1212	-.0426	.0486	.1134	.1300	.019	-.1395
	4.08	-1.48	1.95	4.84	5.17	.19	-1.79
Forward Market							
Equally W. Index	.0624	.0080	.0305	.0666	.1243	.0273	-.0327
	1.60	.25	.98	2.30	4.25	.24	-.27
Value W. Index	.0623	-.0092	.0636	.0776	.1204	-.0081	-.2307
	1.54	-.23	1.84	2.41	3.50	-.06	-2.34

(a) t-test statistics are given below the mean returns
(b) t-statistics significant at the 5% level are underlined (two tails test)

Table IX

Average Returns by Day of the Week when the Ex-Div Days are Excluded (a) (b)

	Observ.	Mon.	Tues.	Wed.	Thurs.	Fri.
Spot Market						
Div. Distribution(c)		180.7	562.9	185.2	208.6	215.8
Equally W. Index	1491	.0467	.0034	.0318	.0233	.0669
		2.14	.16	1.69	1.24	3.57
Value W. Index	1491	.1631	-.0166	-.0006	.1021	.1310
		4.82	-.50	-.02	3.49	4.50
Forward Market						
Div. Distribution(c)		103.0	2579.5	0.9	760.4	297.9
Equally Weighted	2094	.0390	-.0096	.0348	.0450	.1145
		1.20	-.28	1.12	1.40	3.54
Value W. Index	2094	.0362	.0019	.0602	.0732	.1110
		1.03	.05	1.80	2.10	3.17

(a) The mean returns are multiplied by 100. Their t-test statistics are given below.
(b) t-statistics significant at the 5% level are underlined (two tails test)
(c) Average dividends distributed per day and per security in thousands of Belgian francs.

The fact that a number of securities go ex-div on Tuesday can contribute to giving a lower value to the Tuesday return. In order to avoid the impact of the ex-div days on the daily mean returns, these were again computed after excluding the ex-div days. The results, which are displayed in table IX, show that the seasonal pattern is more or less the same. The distribution of dividends does not seem to boost or impede significantly the day of the week effect.[4]

IV. Daily Seasonalities and Other Anomalous Seasonal Regularities

A. The Month of the Year Effect

The most common seasonal anomaly in the returns is certainly the January or month of the year effect. It refers to the observation that the average monthly returns are larger in January in relation to the rest of the year. A monthly effect was first noticed by Officer (1975) on the Australian equity market. The January effect itself was revealed by Rozeff and Kinney in 1976 on the U.S. equity market. Subsequently, Gultekin and Gultekin (1983) reported evidence of the January effect in most of the indices of 18 countries, among which Belgium.

Among the potential explanations of the January effect, the most tested one is the tax-loss selling hypothesis (Keim (1983) and Reinganum (1983)). According to that hypothesis, as the end of the fiscal year approaches, investors can reduce their taxes by selling the securities on which they lost money during the year. In doing so they realize capital losses that are deductible from their taxable income. The sale of the securities depresses prices which recover at the beginning of the next fiscal year as securities move back toward their equilibrium value.

The Belgian case was first partly investigated in the international comparison of Gultekin and Gultekin (1983) who found significant differences between the returns of January and those of the other months. The Belgian index Gultekin and Gultekin used in their test is a value weighted index computed from a price index on the largest Belgian stocks, without adjustment for dividends. Later, Corhay, Hawawini and Michel (1987), and Hawawini, Michel and Corhay (1989) reported the same seasonality in the returns of an equally weighted and a value weighted index on 170 securities of the spot market, and they observed that three quarters of the annualized average monthly return is earned in January and April.

Although the objective of this paper does not specifically concern the analysis of the annual pattern of the returns, it is interesting to disaggregate the daily returns according to the months. Rogalski (1984) revealed indeed a relationship between the Monday effect and the January effect in American index returns. Monday returns are positive during January, whereas they are negative for the rest of the year. The findings of Rogalski were, however, not supported by the results of Jaffe and Westerfield (1985) for Japan.

In table X the average daily returns of the four Belgian market indexes are calculated for each month. Their values confirm the results of the previous studies on Belgian monthly returns. As expected, the average daily returns are very large in January and April, with a small advantage to the latter. It can furthermore be observed that the high return in April is followed by an average negative return in May for the spot value weighted index and the two forward indexes. This pattern is due to the behaviour of the investors who anticipate the distribution of dividends. A look at table X shows that almost fifty per cent of the dividends of the stocks

Table X

Average Percentage Returns per Month and per Day.(a)

Month	% Div.	Mon.	Tues.	Wed.	Thurs.	Fri.	All Days	F-test
		Spot Equally Weighted Index						
Jan.	2	.1137	.0721	.0658	.0999	.1343	.0966	.25
Feb.	3	.2267	.0496	.0963	.0724	.1006	.1090	2.07
Mar.	7	.0385	.0174	.0346	.0099	.0302	.0259	.08
Apr.	14	.1882	.0821	.0520	.0851	.1939	.1138	2.20
May	28	.0762	.0692	.0071	.0700	.0440	.0519	.45
June	26	.1308	.0377	.0384	.0645	.0266	.0584	1.03
July	3	.1212	.0336	.0442	.0282	.1183	.0681	1.58
Aug.	1	.1441	.0305	.0841	.0611	.1155	.0857	1.08
Sept.	1	.0656	.0114	.0418	.0399	.1240	.0568	1.41
Oct.	3	.0522	-.0490	.0136	-.0762	-.0150	-.0149	1.07
Nov.	5	.0610	-.0032	-.0101	.0161	-.0073	.0109	.57
Dec.	7	-.2590	-.0406	.0935	.0641	-.1110	-.0475	1.23
F-test		2.12	.71	.58	1.38	2.40	4.04	
		Spot Value Weighted Index						
Jan.	2	.1007	.0605	.0339	.2112	.3095	.1404	1.32
Feb.	3	.2654	-.1481	.0115	.1074	.1230	.0718	2.48
Mar.	7	.1619	.0192	-.0023	-.0136	.0049	.0326	.71
Apr.	14	.2115	.1293	.0579	.1702	.2954	.1656	.95
May	28	-.0554	-.3635	.0952	.0532	.0311	-.0576	3.35
June	26	.0304	.0640	.0401	.1320	-.0010	.0538	.37
July	3	.1085	-.0515	.0258	.1157	.1452	.0660	1.41
Aug.	1	.0819	-.0382	.0300	.1348	.2127	.0836	1.67
Sept.	1	.0391	.0224	-.0361	.1228	.1621	.0629	1.33
Oct.	3	-.0062	-.0347	.0638	.0393	-.0354	.0054	.21
Nov.	5	.0239	-.0172	-.0148	.0666	.0583	.0225	.23
Dec.	7	.2261	-.0263	.1883	.1913	.2914	.1734	1.05
F-test		.97	1.75	.44	.68	2.07	2.65	

(a) Mean returns significant at the 5% level are underlined (two tails test).

quoted on the forward market are distributed in May. Consequently, investors who intend to take advantage of the distribution of dividends buy shares in April, which tends to put prices up. Then, when dividends have been distributed, stock prices begin to decrease to their normal level.

Some differences can be observed between the indexes. In December, the two forward indexes as well as the spot value weighted index have a large and significant average daily return, while the spot equally weighted index has a negative one. The latter index has also lower average returns in January and April than the three former indexes. This leads one to believe that because of the infrequent trading of the small securities, there is some diffusion of the seasonality from the end of one month to the beginning of the next one. The high average returns in December can plausibly be accounted for by a Belgian law, called De Clercq law,

Table X

Average Percentage Returns per Month and per Day (continued)

Month	% Div.	Mon.	Tues.	Wed.	Thurs.	Fri.	All Days	F-test
		Forward Equally Weighted Index						
January	3	.0559	.1574	.0039	.2250	.2229	.1311	.70
Feb.	1	.2571	.0755	-.0494	.1000	.1239	.1007	.80
Mar.	8	.0497	-.0359	.0274	-.0153	.0393.	0124	.12
Apr.	6	.3359	.0017	.1434	.1107	.2759	.1614	.93
May	47	-.0960	-.2085	.0098	.1772	.1019	-.0146	2.91
June	16	-.0805	.0776	.0238	.0542	-.0296	.0108	.45
July	3	.0333	-.0276	.0076	.0680	.2405	.0619	1.61
Aug.	0	.0225	.0500	.1994	.0387	.1920	.1017	.70
Sept.	1	-.0726	.0310	-.0033	-.0562	.2494	.0303	2.18
Oct.	1	-.0114	-.0655	-.0429	.0097	-.1032	-.0428	.12
Nov.	3	-.0256	.0685	-.1085	.0057	.0375	-.0055	.50
Dec.	11	.1078	.0596	.1991	.1173	.1684	.1307	.54
F-test		.97	.79	.78	.65	1.47	1.88	
		Forward Value Weighted Index						
Jan.	3	-.0456	.1378	.1193	.1857	.3399	.1442	1.09
Feb.	1	.2437	-.1324	.0036	.1405	.0790	.0666	1.15
Mar.	8	.0624	.1076	.0080	-.0646	.0223	.0264	.34
April	6	.3942	.1116	.1779	.0975	.2149	.1895	.61
May	47	-.1584	-.5322	.1047	.0187	-.0300	-.1303	3.40
June	16	-.0952	.0132	.0356	.0827	-.0307	.0032	.39
July	3	.0484	-.0545	.0708	.0464	.1537	.0515	.54
Aug.	0	.0096	-.0368	.1416	.1915	.1818	.0990	1.03
Sept.	1	-.0483	.0783	.0128	-.0305	.2823	.0596	1.87
Oct.	1	-.0523	.0165	-.0013	.0957	-.0925	-.0066	.26
Nov.	3	.0005	.1421	-.1106	.0704	.0174	.0236	.76
Dec.	11	.1433	.0535	.1567	.0534	.3000	.1401	.19
F-test		1.23	2.08	.49	.51	1.54	2.25	

(a) Mean returns significant at the 5% level are underlined (two tails test).

whose objective was to incite small investors to invest in Belgian equities. Since 1982, this law allows taxpayers to deduct from their taxable income a specified amount of money they have to invest in Belgian stocks before the end of the fiscal year, that is, by the end of December. Most of the individual investors generally invest in investment funds. Therefore, as these funds mainly include stocks with large market values, there is an additional demand for these stocks in December and their prices rise.

The disaggregation of the average daily returns by month and day (table X) provides some interesting information, although it does not reveal any strong and persistent relationship between the monthly and weekly seasonalities which is common to all four indexes. An analysis of the variance has also been done in order to test the difference, for each month, between the mean returns of the five days, and to test the difference, for each day, between the

mean returns of the twelve months. The spot equally weighted index excepted, the month of May is the month which presents the largest differences between the average return of the days of the week, and it is practically the only month of which computed F-test statistic exceeds the critical value at the five per cent level. It appears that the low or negative return on Tuesday in table II for the two forward indexes and the spot value weighted index is mainly due to the negative Tuesday return in May. This phenomenon is explained by both the dividend distribution and the settlement process on the forward market. It has already been observed that almost half of the dividends on the forward market are distributed in May, which generates a negative average daily return in that month. It must be also mentioned that the settlement process constrains the securities togo ex-div on the first day of an account period.[5] Therefore, since during the period of study ten out of eighteen account periods that started in May have Tuesday as their first day, Tuesday is the day of the week in May of which average return is the most influenced by the negative ex-div effect. The month of May also experiences the worst average Monday return for these three indexes. Monday returns, on the other hand, are always large in February and April. Finally, Friday is the day which has systematically the largest differences in returns between the months; its computed F ratio is always the largest one of the series.

C. The Settlement Effect

One of the most attractive and testable explanations of the day of the week effect relates to the settlement procedure of the stock market. As Gibbons and Hess (1981) pointed out, transactions on a stock exchange do not necessarily coincide with payment and delivery. There is generally a settlement period at the end of which transactions are settled. Gibbons and Hess argued then that the settlement procedure will introduce a day of the week effect in the returns if its length is not a multiple of five business days. The reason is that the stock price will be raised by the interest between the transaction date and the transfer of funds.

This settlement effect on the daily returns has been tested on market indexes of various countries. Gibbons and Hess (1981) and Lakonishok and Levi (1982) examined U.S. market indexes and concluded that the settlement period, which is of six days, does not explain the Monday effect in the U.S. returns. Jaffe and Westerfield (1985) reached the same conclusion for Japan, Australia, Canada and the U.K., even if for this latest country they observed, like Theobald and Price (1984) and Condoyanni, O'Hanlon and Ward (1987), a significant settlement effect. According to these two studies, on the U.K., prices of the first Monday of the account period[6] incorporate a 21 days interest against a 10 days interest for the preceding Friday, and the second Monday a 14 days interest against a 17 days interest for its preceding Friday. It follows that the returns of the first Monday of the period are larger than those of the other days, while the returns of the second Monday are lower.

With regard to the settlement procedure, the trading year on the forward market of the BSE is also divided into 24 or 25 account periods of roughly two weeks, but a period does not necessarily begin on every other Monday. Out of the 216 account periods of the sample, 9 start on Monday, 134 on Tuesday, 2 on Wednesday, 49 on Thursday and 22 on Friday. The last trading day of an account period is an important one since it plays a prominent part in the trading process. On that day, the investors who had, for example, bought shares during the account period that just came to an end, can either clear their position by selling the shares or keep their position by paying an interest. These two transactions take place without having to pay the full costs of transactions. At the end of the account period begins a settlement period of four trading days. The first day of the procedure is the settlement day. For stocks traded on the forward market, this day also corresponds to the ex-div day. The payment of the purchased shares is made one day later, and the proceeds of a sale, as well as the transfer of the shares, are made two more days later. With respect to the spot market, all of these operations generally take place on the trading day following the transaction.

According to the settlement procedure on the forward market, the stock prices will incorporate an adjustment interest, which unfortunately depends on which days of the week the account period starts and ends. Considering the case of an account period starting on a Tuesday and ending on a Monday, the stock prices will incorporate on the first Tuesday of the period a 17 days interest against a 4 days interest on the preceding Monday. This difference in interest implies that, in this simple example, the return of the first Tuesday of the period should be larger than the returns of the other days of the account period. More generally, if there is a settlement effect in the prices, the returns should be larger for the first day of the account period than for any other day of the account period.

To investigate the settlement effect on the Belgian stocks, the average returns were calculated for the last five trading days and for the first four trading days of the account periods, the number of days before and after the last day of the account period being chosen in order to avoid overlapping in the series of returns. The mean returns figure in table XI, the position of the days being identified by the numbers -4 to +4, with 0 denoting the last day of the account period. The mean returns of the days that are not included in the range -4 to +4, have also been computed.

Even if the mean return of the first day of the account period does not appear at first sight as the largest return of the period for all indexes, table XI puts in evidence a pattern in the returns that is obviously related to the settlement process. Looking at the two forward indexes, one can observe that the mean returns at the beginning of the period are positive and often very large while the mean returns of the last days of the period are negative or at least not statistically different from zero. Such a pattern is caused by investors who speculate on a rising market, buying shares at the beginning of the account period and selling them back at the end of it. The low mean return on the first day of the account period should, however, not be accepted as

Table XI

The Settlement Pattern in the Returns (a) (b)

Day	Obs.	Spot Indexes Equ. W. I	Val. W.	Spot Indexes(c) Equ. W.	Val. W.	Forward Indexes Equ. W.	Val.. W.
-4	199	.0220	-.0390	-.0891	-.0950	-.1149	-.0560
		1.09	-1.05	-2.11	-1.92	-2.62	-1.15
-3	216	.0460	.0606	.0147	.0506	-.0115	.0234
		1.86	1.75	.37	1.12	-.29	.53
-2	216	-.0094	.0503	-.0432	.0430	-.0294	.0268
		-.25	1.38	-.94	.89	-.60	.55
-1	216	.0242	.0109	-.0310	-.0352	-.0877	-.0588
		1.15	.31	-.70	-.77	-2.11	-1.25
0	216	.0560	.0304	-.0174	-.0069	-.0309	.0261
		2.58	.87	-.39	-.15	-.68	.58
1	216	.0667	.0683	.1360	.0754	.3227	.1749
		3.26	1.39	2.81	1.09	6.78	2.51
2	216	.0782	.1551	.2185	.1864	.1955	.1861
		4.22	4.12	4.92	3.59	4.17	3.62
3	216	.0807	.1293	.1943	.1561	.1250	.0586
		4.42	3.78	4.71	3.31	3.08	1.24
4	213	.0691	.0863	.1015	.0747	.1195	.1114
		4.21	2.80	2.77	1.78	3.27	2.57
Other Days	289	.0695	.1082	.0906	.1058	.0563	.0572
		3.42	3.13	2.20	2.41	1.29	1.20
First Day Ex-div Periods Excluded	106			.1964	.1937	.3838	.3174
				2.57	2.60	5.45	4.09

(a) All mean returns are multiplied by 100.

(b) t-statistics are given below the mean returns, those which are significant at the 5% level are underlined (two tails test)

(c) Portfolio composed of stocks quoted on the spot and the forward markets.

such since it also comes under the influence of the negative ex-div effect. Therefore the first day mean returns of the stocks quoted on the forward market has also been calculated for the account periods when there were no dividend distribution. These mean returns, which appear on the last line of table XI, are larger than those computed when all accounts periods are included in the data. At the sight of these results, it appears that there is also a strong settlement effect on the first day of the account period, but that the positive impact of this effect is partially counterbalanced by a negative ex-div effect. In this regard, Tuesday has a particular situation since on the one hand it is the first day of an account period in roughly one case out of two, and on the other hand, it is the day of the week during which most dividends are distributed.

Another interesting feature of table XI is that it reveals the presence of the settlement effect in the returns on the spot market. The effect appears, however, to be stronger in the spot returns of the securities quoted on both markets than for the whole spot index. This suggests that the settlement effect is mainly restricted to the securities quoted on both markets[7].

The objective now is to examine to which extent the settlement pattern influences the seasonality in the daily returns. Since the account periods do not always start and end on the same days, it is impossible to test the impact of the settlement pattern for each day of the week and for each position (-4 to +4) in the account period simultaneously. Therefore the returns have been simply partitioned into those which precede the settlement date (day -4 to day 0) and those which follow the settlement date (day 1 to day 4). The mean of the returns of these two subperiods, as well as of the returns of the days that do not belong to these subperiods, were then calculated on a day by day basis. The t-test statistics on the difference between the mean returns of the two subperiods and the F-test statistics on the differences between the mean returns conditional upon the day were also computed.

The results, presented in table XII, show that for the end of the account period (day -4 to day 0), most of the daily mean returns are not statistically significant. Furthermore, the Tuesday mean return is always the smallest one of the week and is negative, twice significantly, for the securities quoted on both markets. None of the F-test statistic on the differences between the five days is however statistically significant. In contrast, the mean returns at the beginning of the account period (day 1 to day 4) are generally positive and often statistically significant, and the values of the F-test statistics indicate that the returns exhibit, at least for the spot market, a seasonal pattern. Tuesday mean returns for this part of the account period, as well as for the days that are in the middle of the period, are still the lowest of the week. One can also observe that when the daily returns of the middle of the account period are considered separately, a seasonal pattern which is consistent for all indexes emerges. Friday mean returns are exceptionally large, while Tuesday's and Wednesday's are almost zero or negative.

The values of the t-statistic on the difference between the mean returns at the beginning and the end of the account periods reveal a significant impact of the settlement pattern on Thursday and Friday, whatever the index may be. As to the first three days of the week, the results are mixed. Considering Tuesday returns more particularly, the equally weighted index of the forward market is the only index which presents on that day a significant difference between the returns of the halves of the account periods.

It can be concluded that the impact of the settlement pattern in the returns does not explain the low return on Tuesday. Its average return is still the lowest of the week, whatever its position in the account period. It also appeared that the differences between the mean return of the days are larger during the first half of the account period than at any other moment, this increase in the differences being mainly due to the impact of the settlement pattern on Thursday and Friday returns.

Table XII

Settlement Pattern and Mean Return by Day [a]

Period Relative to the Settlement Date	Mon.	Tues.	Wed.	Thurs.	Fri.	All Days	F-test
	Spot Market			Equally Weighted Index			
Before (-4 to 0)	.0469	.0090	.0518	.0145	.0136	.0279	.63
After (1 to 4)	.1625	.0428	.0447	.0751	.0952	.0737	3.65
Other days	.0837	.0287	.0309	.0442	.1707	.0695	.98
t-test (Before/After)	-1.69	-1.12	.26	-2.45	-2.56	-2.99	
	Spot Market			Value Weighted Index			
Before	.0413	-.0361	.0174	.0457	.0523	.0236	1.01
After	.1828	-.0309	.0872	.1837	.1789	.1098	5.42
Other days	.1421	-.0084	-.0020	.0994	.3310	.1082	1.92
t-test (Before/After)	-1.90	-.09	-1.28	-2.85	-2.57	-3.47	
	Spot Market [b]			Equally Weighted Index			
Before	-.0090	-.1014	-.0463	-.0274	.0276	-.0323	1.18
After	.3647	-.0056	.1260	.2408	.2194	.1628	7.35
Other days	.1487	-.1372	-.0546	.1305	.3212	.0906	2.46
t-test (Before/After)	-3.91	-1.47	-2.69	-4.82	-3.46	-6.73	
	Spot Market [b]			Value Weighted Index			
Before	.0041	-.0884	-.0067	.0389	.0176	-.0073	1.08
After	.2052	-.0635	.1029	.2342	.2004	.1233	4.80
Other days	.1459	-.0593	-.0247	.1327	.3423	.1058	1.62
t-test (Before/After)	-2.05	-.31	-1.48	-2.98	-2.79	-3.90	
	Forward Market			Equally Weighted Index			
Before	-.0346	-.1015	-.0363	-.0871	-.0089	-.0539	.77
After	.2261	.1418	.1497	.2198	.2362	.1909	.91
Other Days	.0683	-.0913	-.0258	.1246	.2381	.0563	.97
t-test (Before/After)	-2.70	-3.85	-2.81	-5.17	-4.23	-8.35	
	Forward Market			Value Weighted Index			
Before	.0045	-.0446	.0187	.0040	-.0205	-.0070	.29
After	.1052	.0255	.1347	.1575	.2319	.1328	1.86
Other Days	.0521	-.0007	.0058	.0366	.2914	.0572	.67
t-test (Before/After)	-1.03	-.88	-1.59	-2.32	-3.62	-4.16	

(a) All mean returns are multiplied by 100, those which are significant at the 5% level are underlined (two tails test).

(b) Portfolio composed of stocks quoted simultaneously on the spot and the forward market.

V. Day of the Week Effect and International Integration

The issue examined here is whether the Tuesday effect observed in the Belgian stock returns is a reflection of the Monday effect that has been put in evidence in the U.S. index returns. Because of the difference in the time zone, it turns out that the BSE markets are closed when the NYSE opens.[8] Returns on the BSE markets cannot therefore be influenced by the behaviour of the NYSE on the same day, but by those of the preceding trading day.

This kind of international relationship with the U.S. has been investigated by Jaffe and Westerfield (1985) for Japan and Australia, and by Condoyanni, O'Hanlon and Ward (1987) for France, Japan, Singapore and Australia. Both studies examined the cross-correlations

conditional upon the day of the week between the returns of these countries, which exhibit a Tuesday effect, and those of the NYSE leaded by one day, and they found no significant differences in the cross-correlations across the days of the week. From these cross-correlations, Condoyanni, O'Hanlon and Ward deduced that the seasonal pattern in the stock returns of these countries could be partially attributed to the American Monday effect. As for Jaffe and Westerfield, they went further in the tests and they concluded that the difference in the time zone can partially explain the Australian Tuesday effect, but not the Japanese.

Three American indexes from the tape of the Center for Research in Security Prices (CRSP) are used in this study. They are respectively the Standard and Poor's 500 Composite Index (S&P) and the equally weighted (USEW) and value weighted (USVW) market portfolio of all stocks quoted on the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX).[9] The mean returns by day of the week for the three American indexes are displayed in table XIII, and as expected, they exhibit a Monday effect, the effect being particularly large for the USEW index.

Table XIII

Average Percentage Returns on U.S. Indexes by Day of the Week.(a)

	Mon.	Tues.	Wed.	Thurs.	Fri.	F-test
S&P	-.0916	.0248	.0773	.0284	.0843	2.65
USEW	-.1184	.0154	.1464	.1494	.2571	15.19
USVW	-.0825	.0343	.1012	.0587	.1278	3.86

(a) All mean returns are multiplied by 100. Those which are significant at the 5% level are underlined (two tails test).

The cross-correlations, conditional upon the day of the week, between the returns of the spot and the forward market indexes of the BSE and those, leaded by one day, of the three U.S. indexes have been calculated. Their values, which are reported in table XIV, show that the cross-correlation varies across the days of the week, the pattern being more or less consistent for all pairs of Belgian and American indexes. The value of the cross-correlation is at its lowest level on Monday and tends to increase continuously across the days of the week. This suggests that the Tuesday effect on the BSE is not a reflection of the Monday effect. Some autocorrelations are larger on Tuesday for the spot equally weighted index. But since the spot equally weighted index is the Belgian index which exhibits the weakest Tuesday effect, nothing can be inferred from this observation.

The hypothesis of a reflection of the Monday effect can also be tested by running a dummy variable regression with the difference between the Belgian returns and those of the U.S. leaded by one day as dependent variable.

$$\tilde{R}(B)_{kt} - \tilde{R}(US)_{mt-1} = \sum_{i=1}^{5} \hat{\beta}_{ki} D_{it} + \tilde{\varepsilon}_{kt} \qquad (7)$$

for k=1 to 4 and m=1 to 3.

Table XI

Cross-Correlations Between Belgian and Leaded American Index Returns.

Belgian Index	U.S. Index	Mon.	Tues.	Wed.	Thurs.	Fri.	All Days
Spot Market							
Equally W.	S&P	.077	.169	.135	.120	.303	.158
	USEW	.068	.214	.183	.140	.351	.196
	USVW	.084	.181	.142	.127	.320	.169
Value W.	S&P	.157	.258	.329	.308	.356	.285
	USEW	.111	.265	.293	.253	.352	.265
	USVW	.151	.262	.327	.306	.366	.287
Forward Market							
Equally W.	S&P	.223	.257	.245	.344	.339	.278
	USEW	.197	.257	.202	.313	.353	.263
	USVW	.223	.264	.235	.344	.351	.281
Value W.	S&P	.218	.266	.318	.356	.335	.299
	USEW	.173	.236	.256	.284	.313	.253
	USVW	.214	.265	.312	.353	.341	.298

Table XV

Difference Between Belgian and U.S. Returns by Day of the Week (a)

$$\tilde{R}(B)_{kt} - \tilde{R}(US)_{mt-1} = \sum_{i=1}^{5} \hat{\beta}_{ki} D_{it} + \tilde{\varepsilon}_{kt}$$

Belgian Index	U.S. Index	$\hat{\beta}_{k1}$ Mon.	$\hat{\beta}_{k2}$ Tues.	$\hat{\beta}_{k3}$ Wed.	$\hat{\beta}_{k4}$ Thurs.	$\hat{\beta}_{k5}$ Fri.	F-test(b)
Spot Market							
Equally W.	S&P	.0403	.1219	.0105	-.0389	.0597	1.85
	USEW	-.1425	.1417	.0218	-.0980	-.0488	8.88
	USVW	-.0048	.1116	.0018	-.0610	.0326	2.25
Value W.	S&P	.0185	.0496	-.0017	.0181	.1018	.81
	USEW	-.1643	.0754	.0096	-.0410	-.0067	4.62
	USVW	-.0267	.0393	-.0103	-.0040	.0747	.046
Forward Market							
Equally W.	S&P	-.0283	.0834	-.0064	-.0224	.1071	1.80
	USEW	-.2111	.1092	.0049	-.0816	-.0014	7.40
	USVW	-.0735	.0731	-.0015	-.0445	.0800	2.26
Value W.	S&P	-.0326	.0726	.0174	-.0197	.0913	1.26
	USEW	-.2154	.0984	.0288	-.0788	-.0173	6.61
	USVW	-.0778	.0623	.0088	-.0418	.0641	1.74

(a) All estimated coefficients are multiplied by 100. Those which are significant at the 5% level are underlined (two tails test).

(b) The F-statistics of the regressions which are significant at the 5% level are underlined.

If the pattern in the Belgian returns is merely a reflection of the U.S. one, the estimated slopes, which express the differences conditional upon the day between the Belgian and the American returns, should not be statistically different from zero. The results of the regression, which are reported in table XV, can be interpreted in different ways. The null hypothesis, measured by the F-test of the regression, that the seasonal pattern in the Belgian returns is a reflection of the U.S. seasonality is rejected for the four Belgian indexes when the American index is the USEW index, while it is never rejected when the S&P and the USVW are used. Such a contrast in the result can be explained by the fact that the Monday effect in the American index returns is stronger than the Tuesday effect in Belgium. Therefore, as, out of the three American indexes, the USEW index is the index whose returns exhibit the largest Monday effect, it is not surprising that the differences in returns from the Belgian indexes and this index still exhibit a seasonal pattern. Besides, one can also notice that the regressions with the spot value weighted index, the Belgian index whose returns exhibit the strongest Tuesday effect, have a lower F-test statistic. In conclusion, the results of this test tend to partially support the hypothesis that the Tuesday effect on the BSE returns is a reflection of the Monday effect in the U.S..

A last test of the reflection of the American Monday effect on Tuesday consists in running a dummy variable regression which accounts for the cross-autocorrelation with the American returns.

$$\tilde{R}(B)_{kt}=\hat{\beta}_{k2}+\hat{\beta}_{k1}D_{1t}+\hat{\beta}_{k3}D_{3t}+\hat{\beta}_{k4}D_{4t}+\hat{\beta}_{k5}D_{5t}+\sum_{i=1}^{5}\hat{\gamma}_{mi}\tilde{R}(US)_{mt-1}D_{it}+\tilde{\varepsilon}_{kt} \qquad (8)$$

for k=1 to 4 and m=1 to 3.

The regression coefficients $\hat{\beta}_{ki}$, that is, the mean return on Tuesday and the differences in mean return between the other days of the week and Tuesday, after they are adjusted for the cross-correlation with the U.S. returns, are presented in table XVI. A F-test statistic of the hypothesis that $\hat{\beta}_{k1}$, $\hat{\beta}_{k3}$, $\hat{\beta}_{k4}$ and $\hat{\beta}_{k5}$ are jointly equal to zero also appears in this table.

The results show that after adjusting for the cross-correlation with the U.S., the Tuesday effect is still present in the returns. The comparison with table III reveals that the seasonal pattern in the spot indexes is more or less similar. Furthermore, the value of their F-statistic rejects the hypothesis that all differences in returns from the other days are jointly equal to zero. As for the forward indexes, Friday is still the only day which presents, after adjustment, a statistically significant difference in return from Tuesday's, and the F-test statistics are still not statistically significant.

Table XVI

Mean Returns when Cross-Correlations with U.S. Indexes are Taken into Account.[a]

$$\tilde{R}(B)_{kt}=\hat{\beta}_{k2}+\hat{\beta}_{k1}D_{1t}+\hat{\beta}_{k3}D_{3t}+\hat{\beta}_{k4}D_{4t}+\hat{\beta}_{k5}D_{5t}+\sum_{i=1}^{5}\hat{\gamma}_{mi}\tilde{R}(US)_{mt-1}D_{it}+\tilde{\varepsilon}_{kt}$$

Belgian Index	U.S. Index	$\hat{\beta}_{k1}$ Mon.	$\hat{\beta}_{k2}$ Tues.	$\hat{\beta}_{k3}$ Wed.	$\hat{\beta}_{k4}$ Thurs.	$\hat{\beta}_{k5}$ Fri.	F-test[b]
Spot Market							
Equally W.	S&P	.0709	.0344	.0070	.0047	.0467	5.18
	USEW	.0614	.0386	.0026	-.0031	.0287	3.72
	USVW	.0691	.0343	.0065	.0037	.0438	4.88
Value W.	S&P	.1063	-.0283	.0526	.1128	.1480	4.76
	USEW	.0847	-.0206	.0466	.0961	.1107	2.75
	USVW	.1022	-.0292	.0514	.1092	.1417	4.40
Forward Market							
Equally W.	S&P	.0180	.0070	.0129	.0316	.1174	2.11
	USEW	-.0243	.0149	.0070	.0078	.0751	1.23
	USVW	.0091	.0063	.0119	.0260	.1101	1.93
Value W.	S&P	.0203	.0006	.0407	.0376	.1070	.61
	USEW	-.0158	.0074	.0369	.0176	.0650	.71
	USVW	.0126	-.009	.0396	.0321	.0995	1.12

(a) The estimated coefficients of the regressions are multiplied by 100. Those which are significant at the 5% level are underlined (two tails test).

(b) The F-statistics which are significant at the 5% level are underlined.

It can therefore be concluded that the daily seasonal pattern in the Belgian returns can at the very most be partially explained by the U.S. Monday effect, the Tuesday effect on the BSE appearing to be mainly an indigenous effect.

VI. Conclusions

The evidence presented in this study tends to support the existence of a persistent and indigenous Tuesday effect in the Belgian stock returns. Tuesday average return appears to be systematically lower than the return of the other days of the week. Neither the various adjustments for the measurement errors, nor the analysis of the relationship between this effect and other seasonal anomalies in the Belgian or in the U.S. returns did strongly support a plausible explanation of the lower return on Tuesday.

Besides, this study also documented a seasonal pattern related to the settlement process on the forward market of the BSE. The average daily returns appear to be statistically very large during the first four days of the account periods, while they are not statistically different from zero during the last days of the periods. This settlement effect seems to be explained by the behaviour of the investors who speculate for a rise, buying shares at the beginning of a period and selling them at the end of it.

These seasonal patterns in the distribution of the returns contradict the hypothesis of the efficiency of the market insofar as they would permit investors to obtain abnormal returns from trading strategies based on these anomalous behaviours of the security prices. But can these daily anomalies be really considered as inefficiencies? On the one hand, it can indeed be argued that, because of the importance of the costs of transaction, a daily seasonality cannot easily be used in order to generate profit, and therefore cannot be considered as an inefficiency. But on the other hand, a daily seasonality can be considered as an indirect inefficiency insofar as the investors can plan their orders so as to obtain a better price, postponing, for example, their selling to Friday and their buying to Tuesday.

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Footnotes

1) There are approximately 20 trading days per month.
2) Cohen, Hawawini, Maier, Schwartz and Whitcomb (1980) demonstrated that even if individual stock return distributions present a small negative first order autocorrelation, the friction in the trading process causes a positive and often very large autocorrelation in the market index returns. Because of the friction in the trading process, there are some delays in the adjustment of the stock prices to changes in information. These delays induce some positive intertemporal cross-covariances between stock prices which, in turn, generate a positive autocorrelation in the market index returns. Consequently, the larger an index is and the larger its proportion of small firms is, the larger its autocorrelation coefficients are.
3) This can be easily proved by multiplying the average dividends on Tuesday of table IX by the number of stocks listed on each market, and then by calculating the ratio of the total of the dividends distributed on the forward market by the total of the dividends distributed on the spot market.
4) This test presents a weakness for the spot market insofar as each time there is a dividend distribution for one security, the corresponding index return is deleted. This means that for this market, 722 out of 2213 returns are suppressed. This bias is minor for the forward market since securities on this market may go ex-div only on the first day of an account period.
5) The problem of the settlement process and of its impact on the stock returns is dealt with in the next subsection.
6) The trading year on the London Stock Exchange is divided into 24 to 25 account periods of two weeks. An account period starts every other Monday, and settlement takes place on the second Monday following the end of the account period.
7) In fact, the same test conducted on the portfolio composed of stocks exclusively quoted on the spot market did not reveal a settlement effect in the returns.
8) The forward market of the BSE opens at 12:30 local time, the Corbeille at 12:50, and the *Parquet* at 13:00. The closing time of these markets is not determined in advance. These markets are auction markets and they close when there is no new orders issued. On the *Parquet*, there is only one auction per day, while on the forward and on the *Corbeille* markets successive auctions are possible. Trading on these markets is nevertheless always ended by 13:30 local time, that is, two hours before the NYSE opens.
9) For reason of availability of the American index returns, all tests in this section are carried out on the period 1977 to 1984.