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STOCK RETURNS AND THE WEEKEND EFFECT

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This paper examines two alternative models of the process generating stock returns Under the calendar time hypothesis, the process operates continuously and the expected return for Monday is three times the expected return for other days of the week Under the trading time hypothesis, returns are generated only during active trading and the expected return is the same for each day of the week During most of the period studied, from 1953 through 1977, the daily returns to the Standard and Poor's composite portfolio are inconsistent with both models Although the average return for the other four days of the week was positive, the average for Monday was significantly negative during each of five five-year subperiods

1. Introduction

The process generating stock returns has been one of the most popular topics of research in finance since Bachelier's pioneering article, published in 1900 [1] Although many authors have addressed this issue,[2] several questions have not been resolved One of these is whether the process operates continuously or only during active trading Since most stocks are traded only from Monday through Friday, if returns are generated continuously in calendar time, the distribution of returns for Monday will be different from the distribution of returns for other days of the week On the other hand, if stock returns are generated in trading time, the distribution of returns will be the same for all five days of the week

Several researchers have examined this issue by studying the variance of price changes For example, Fama (1965) tests the hypothesis that returns

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[1] Bachelier (1900)

[2] See, for example, Castanias (1979), Clark (1973), Oldfield, Rogalski and Jarrow (1977), Fama (1965, 1970, 1976), and Officer (1972)

are generated in calendar time by comparing the variance of stock returns for Monday with the variance for other days of the week On the other hand, Clark (1973) develops a model in which returns are generated in trading time and tests the implication that the variance of the returns should be linearly related to the volume of trading [3]

This paper examines the process generating stock returns by comparing the returns for different days of the week Ignoring holidays, the returns reported for Monday represent a three-calendar-day investment, from the close of trading Friday to the close of trading Monday, while the returns for other days reflect a one-day investment Therefore, if the expected return is a linear function of the period of investment, measured in calendar time, the mean return for Monday will be three times the mean for the other days of the week However, if the generating process operates in trading time, the returns for all five days represent one-day investments and the mean return will be the same for each day

The results of tests using the daily returns to the Standard and Poor's composite portfolio from 1953 to 1977 are surprising Inconsistent with both the calendar and trading time models, the mean return for Monday was significantly *negative* in each of five five-year subperiods, as well as over the full period [4]

Section 2 develops a model of daily stock prices which is used in the third section to test the hypotheses about daily return behavior and to examine the anomalous returns for Monday Section 4 explores the implications of these negative returns for market efficiency, and section 5 discusses the value of knowledge about them for any individual investor Some implications of the results for empirical tests using daily stock prices are analyzed in the final section

2. Model of daily stock returns

Previous studies have shown that the behavior of stock prices can be described by a multiplicative random walk,[5]

$$P_t = P_{t-1}\{\exp[E(R_t) + \varepsilon_t]\} - D_t,$$

where P_t is the price at the end of period t, D_t is the dividend paid during

[3]Other studies include Godfrey, Granger and Morgenstern (1964), and Granger and Morgenstern (1970)

[4]After writing this paper, I became aware of a paper by Gibbons and Hess (1979) documenting the negative returns for Monday from 1962 through 1978 and discussing their implications Cross (1973) also presents evidence of the negative returns Although Cross does not discuss the result, his table 1 shows that the mean return for Monday from 1953 through 1970 was −0 18 percent

[5]See Cootner (1964) and Fama (1965)

period t, $E(R_t)$ is the expected return in period t, and ε_t is a serially independent random variable whose expected value is zero This model is equivalent to

$$R_t = \ln((P_t + D_t)/P_{t-1}) = E(R_t) + \varepsilon_t,$$

where R_t is the continuously compounded return observed in period t

To test the hypotheses about daily return behavior, it is assumed that, for any particular day of the week, the expected return is constant and the error term is drawn from a stationary normal distribution This assumption implies, for example, that the expected return for every Tuesday is the same and that every Tuesday's error term is drawn from the same distribution This is summarized by

$$R_t = E(R_d) + \varepsilon_{dt},$$

where the subscript d indicates the day of the week on which the return is observed

3. Empirical tests

3 1 Summary of the data

The daily returns to the Standard and Poor's composite portfolio are used to examine whether returns are generated in calendar time or trading time This portfolio consists of 500 of the largest firms on the New York Stock Exchange [6] Under the trading time hypothesis, the expected return to this portfolio is the same for each trading day However, if the calendar time model is correct, the expected return is higher not only for Mondays, but also for days following holidays To insure that, under the calendar time hypothesis, the expected return for Monday is always three times the expected return for the other days of the week, any return for a period which includes a holiday is omitted For example, if Tuesday is a holiday, the return for the succeeding Wednesday is not included in the sample

The summary statistics for the remaining 6024 observations, from 1953 to 1977, are presented in table 1 Inspection of the means for each of the five subperiods (1953–1957, 1958–1962, 1963–1967, 1968–1972, and 1973–1977)

[6]Before March 1, 1957, the Standard and Poor's portfolio was comprised of 90 stocks Standard and Poor's calculation of the return to this portfolio does not include dividends, suggesting that the results presented simply reflect a systematic pattern in the 'ex-dividend' dates To control for this, the returns to the value weighted market portfolio provided by the Center for Research in Security Prices, University of Chicago, including dividends, were examined from 1963 through 1977 with no significant differences in the results

Table 1

Means, standard deviations, and t-statistics of the percent return from the close of the previous trading day to the close of the day indicated[a]

		Monday	Tuesday	Wednesday	Thursday	Friday
1953–1977	Mean	−0 1681	0 0157	0 0967	0 0448	0 0873
	Standard deviation	0 8427	0 7267	0 7483	0 6857	0 6600
	t-statistic	−6 823[c]	0 746	4 534[c]	2 283[b]	4 599[c]
	observations	1170	1193	1231	1221	1209
1953–1957	Mean	−0 2256	−0 0096	0 1592	0 0553	0 1413
	Standard deviation	0 8998	0 7498	0 7141	0 6751	0 6222
	t-statistic	−3 851[c]	−0 197	3 497[c]	1 287	3 533[c]
	observations	236	238	246	247	242
1958–1962	Mean	−0 1691	0 0537	0 0777	0 0652	0 1131
	Standard deviation	0 8512	0 7223	0 6503	0 6347	0 6097
	t-statistic	−3 045[c]	1 149	1 885[b]	1 624	2 892[c]
	Observations	235	239	249	250	243
1963–1967	Mean	−0 1389	0 0385	0 1008	0 0517	0 1015
	Standard deviation	0 5820	0 4991	0 5515	0 4933	0 4386
	t-statistic	−3 650[c]	1 193	2 884[c]	1 660[b]	3 600[c]
	Observations	234	238	249	251	242
1968–1972	Mean	−0 1673	−0 0058	0 1465	0 0003	0 1034
	Standard deviation	0 7769	0 6233	0 7425	0 6516	0 5898
	t-statistic	−3 266[c]	−0 144	3 005[c]	0 007	2 705[c]
	Observations	230	239	232	225	238
1973–1977	Mean	−0 1393	0 0016	0 0057	0 0470	−0 0219
	Standard deviation	1 0379	0 9609	0 9968	0 9102	0 9304
	t-statistic	−2 058[b]	0 026	0 091	0 813	−0 368
	Observations	235	239	255	248	244

[a]Returns for periods including a holiday are omitted These returns are defined as $R_t = \ln(P_t/P_{t-1})$ 100

[b]5 % significance level

[c]0 5 % significance level

and for the full 25 years indicates that the expected return was not constant through the week nor was the return for Monday three times the return for the other days of the week Rather, the return for Monday was negative and lower than the average return for any other day for each of the five subperiods In addition, the t-statistics shown in table 1 indicate that the hypothesis that Monday's expected return was positive can be rejected during any five-year period at a 5 percent significance level The returns for the full 25 years, with a mean of $-0\ 17$ percent, allow rejection of this hypothesis at the 0 5 percent level

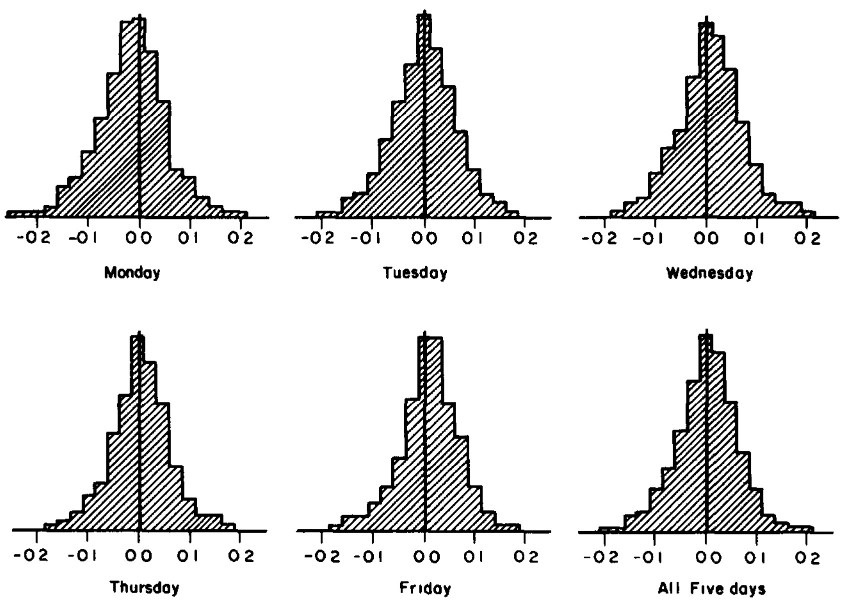

Fig 1 Histograms of daily returns, in percent, from 1953 through 1977

The difference between the returns for Monday and the returns for the other days of the week is illustrated by the histograms of these returns shown in fig 1 While the mass of the first histogram, comprised of the returns for Monday over the full period, is mostly in the negative region, the mass for the other histograms is centered in the positive region

The annual mean returns, shown in table 2, further enrich this picture In 20 of the 25 years studied, the mean return for Monday was negative, while Tuesday, with the next largest number, had only nine average returns which were negative In addition, Monday's mean was lower than the mean for any other day of the week during 20 of the 25 years

Table 2

Average percent return from the close of the previous trading day to the close of the day indicated[a]

	Monday	Tuesday	Wednesday	Thursday	Friday
1953	−0 2488	−0 0570	0 1181	0 0641	0 0110
1954	0 0362	0 0260	0 1746	0 1959	0 2524
1955	−0 2351	0 0857	0 2497	0 0020	0 3135
1956	−0 1445	−0 0393	−0 0649	0 0327	0 2069
1957	−0 5102	−0 0560	0 3083	−0 0237	−0 0949
1958	0 0301	0 0830	0 1166	0 1246	0 2043
1959	−0 1403	0 0865	0 0066	0 0485	0 1819
1960	−0 3487	0 0121	0 0286	0 0560	0 1604
1961	−0 0620	0 0440	0 2011	0 0631	0 1311
1962	−0 3263	0 0388	0 0404	0 0343	−0 1070
1963	−0 0836	0 1248	0 0525	0 0588	0 0969
1964	−0 0400	−0 0463	0 1023	0 0585	0 1692
1965	−0 1286	0 0505	0 0740	0 0354	0 1512
1966	−0 2645	−0 0414	0 1416	−0 1049	−0 0064
1967	−0 1755	0 1062	0 1343	0 2142	0 1026
1968	0 0007	0 0623	0 2410	−0 0664	0 0086
1969	−0 3503	−0 0691	0 0754	0 0404	0 0842
1970	−0 2790	−0 1230	0 2677	−0 0361	0 1370
1971	−0 0621	0 0872	0 0489	−0 0193	0 0899
1972	−0 1529	0 0206	0 1469	0 0501	0 1935
1973	−0 4738	0 0338	−0 0578	0 1293	−0 0877
1974	−0 3784	0 1677	−0 1015	−0 0956	−0 2676
1975	0 1918	−0 2279	0 1450	0 2250	0 2383
1976	0 1089	0 1496	0 1483	−0 0433	−0 0275
1977	−0 1274	−0 1126	−0 1091	0 0237	0 0403

[a]Returns for periods including a holiday are omitted These returns are defined as $R_t = \ln(P_t/P_{t-1})$ 100

3 2 *Tests of the trading time and the calendar time hypotheses*

The low returns for Monday, relative to the other days of the week, suggest that neither the trading time nor the calendar time model is an accurate description of the return generating process If the trading time model were correct, the expected return would be the same for each day of the week The regression,

$$R_t = \alpha + \gamma_2 d_{2t} + \gamma_3 d_{3t} + \gamma_4 d_{4t} + \gamma_5 d_{5t} + \varepsilon_t, \qquad (1)$$

is used to formally test this proposition In this regression, R_t is the return to the Standard and Poor's portfolio and the dummy variables indicate the day of the week on which the return is observed (d_{2t} = Tuesday, d_{3t} = Wednesday, etc) The expected return for Monday is measured by α, while γ_2 through γ_5 represent the difference between the expected return for Monday and the expected return for each of the other days of the week If the expected return is the same for each day of the week, the estimates of γ_2 through γ_5 will be close to zero and an F-statistic measuring the joint significance of the dummy variables should be insignificant

The estimates of eq (1), presented in part A of table 3, indicate that the observed returns are inconsistent with the trading time model during most of the period examined, from 1953 through 1977 In fact, the F-statistic, testing the hypothesis that γ_2 through γ_5 are zero, is significant at the 0 5 percent level during the first four subperiods and over the full 25 years The period from 1973 through 1977, with an F-statistic of 1 265, is the only period in which the trading time model is not rejected

If the calendar time hypothesis is correct, the expected return for Monday is three times the expected return for the other days of the week The test of this hypothesis is very similar to the test of the trading time model The regression used is,

$$R_t = \alpha(1 + 2d_{1t}) + \gamma_2 d_{2t} + \gamma_3 d_{3t} + \gamma_4 d_{4t} + \gamma_5 d_{5t} + \varepsilon_t, \tag{2}$$

where the dummy variable, d_{1t}, equals 1 if the return is for a Monday and the other variables are the same as above In this regression, α measures one-third of the expected return for Monday and γ_2 through γ_5 estimate the difference between this fraction of Monday's return and the expected return for each of the other days of the week If the expected return for Monday is three times the expected return for each of the other days, an F-statistic testing the hypothesis that γ_2 through γ_5 equal zero should not be significant

The estimates of eq (2) are presented in part B of table 3 Again, the F-statistics indicate that the calendar time hypothesis can be rejected during the first four subperiods and over the full period While neither the trading time nor the calendar time hypothesis can be rejected during the last subperiod, the returns observed from 1953 through 1972 are inconsistent with both the trading time and the calendar time models

3 3 *An examination of the returns following holidays*

While the tests described above allow rejection of both the calendar time and the trading time models of the return generating process, they provide very little information about the nature of the negative expected returns For example, do the systematically negative returns occur only on Mondays or do they arise after any day that the market is closed? If the negative returns reflect some 'closed-market' effect, the expected return will be lower following holidays as well as weekends

Table 3

F-tests of the trading time and calendar time hypotheses[a]

	α	γ_2	γ_3	γ_4	γ_5	$\bar{R}^2$	F-statistic	Degrees of freedom
	Part A Trading time — $R_t=\alpha+\gamma_2 d_{2t}+\gamma_3 d_{3t}+\gamma_4 d_{4t}+\gamma_5 d_{5t}+\varepsilon_t$							
1953–1977	−0 168	0 184	0 265	0 213	0 255	0 016	25 400	(4,6019)
	(0 022)	(0 030)	(0 030)	(0 030)	(0 030)			
1953–1957	−0 226	0 216	0 385	0 281	0 367	0 034	10 603	(4,1204)
	(0 048)	(0 067)	(0 067)	(0 067)	(0 067)			
1958–1962	−0 169	0 223	0 247	0 234	0 282	0 017	6 171	(4,1211)
	(0 045)	(0 064)	(0 064)	(0 064)	(0 064)			
1963–1967	−0 139	0 177	0 240	0 191	0 282	0 025	8 754	(4,1209)
	(0 045)	(0 047)	(0 047)	(0 047)	(0 047)			
1968–1972	−0 167	0 161	0 314	0 168	0 271	0 022	7 394	(4,1159)
	(0 045)	(0 063)	(0 063)	(0 063)	(0 063)			
1973–1977	−0 139	0 141	0 145	0 186	0 117	0 001	1 265	(4,1216)
	(0 063)	(0 089)	(0 089)	(0 089)	(0 089)			
	Part B Calendar time — $R_t=\alpha(1+2d_{1t})+\gamma_2 d_{2t}+\gamma_3 d_{3t}+\gamma_4 d_{4t}+\gamma_5 d_{5t}+\varepsilon_t$							
1953–1977	−0 056	0 072	0 153	0 101	0 143	0 016	25 396	(4,6019)
	(0 007)	(0 022)	(0 022)	(0 022)	(0 022)			
1953–1957	−0 075	0 066	0 234	0 131	0 216	0 031	8 476	(4,1204)
	(0 016)	(0 050)	(0 050)	(0 050)	(0 050)			
1958–1962	−0 056	0 110	0 134	0 122	0 170	0 017	4 933	(4,1211)
	(0 015)	(0 047)	(0 047)	(0 047)	(0 047)			
1963–1967	−0 046	0 085	0 147	0 098	0 148	0 025	6 998	(4,1209)
	(0 011)	(0 035)	(0 035)	(0 035)	(0 035)			
1968–1972	−0 056	0 050	0 202	0 056	0 159	0 022	5 910	(4,1159)
	(0 015)	(0 047)	(0 047)	(0 047)	(0 047)			
1973–1977	−0 045	0 048	0 052	0 093	0 025	0 009	1 011	(4,1216)
	(0 021)	(0 066)	(0 066)	(0 066)	(0 066)			

[a]The dependent variable, R_t, is measured in percent Observations for Monday represent three-calendar-day returns, while the observations for other days represent daily rates of return Returns for periods including holidays are omitted The dummy variables indicate on which day of the week each return is observed (d_{1t}=Monday, d_{2t}=Tuesday, etc), and the standard errors of the coefficients are in parentheses The F-statistic tests the hypothesis that γ_2 through γ_5 are zero Fractiles of the F-distribution $F_{4\ 1000}(95\%)=2\ 37$, $F_{4\ 1000}(99\ 5\%)=3\ 72$

To examine this closed-market hypothesis, the returns to the Standard and Poor's portfolio for days following holidays are compared with the 'non-holiday' returns used in the tests above If the closed-market hypothesis is correct, the average holiday return should be lower than the average non-holiday return for each day of the week On the other hand, if the negative returns for Monday are only evidence of a 'weekend' effect, this will not be the case Instead, one could expect the return for Monday, Wednesday, Thursday, or Friday to be higher than normal because it includes an

Table 4

Means and standard deviations of the percent return from the close of the previous trading day to the close of the day indicated, for periods which include holidays and for periods which do not include holidays, 1953–1977[a]

		Holiday returns	Non-holiday returns
Monday	Mean	−0 0740	−0 1681
	Standard deviation	0 6967	0 8427
	Observations	54	1170
Tuesday	Mean	−0 0581	0 0157
	Standard deviation	0 7780	0 7267
	Observations	78	1193
Wednesday	Mean	0 1465	0 0967
	Standard deviation	0 9258	0 7483
	Observations	33	1231
Thursday	Mean	0 2192	0 0448
	Standard deviation	0 7232	0 6875
	Observations	40	1221
Friday	Mean	0 5014	0 0873
	Standard deviation	0 5289	0 6600
	Observations	42	1209

[a]These returns are defined as $R_t = \ln(P_t/P_{t-1})$ 100

additional positive expected return for the holiday itself Only the return for Tuesday should be lower because, after a holiday on Monday, it includes the negative expected return for the weekend The average daily returns, presented in table 4, are completely consistent with the implications of the weekend hypothesis The average return is higher for Mondays, Wednesdays, Thursdays, and Fridays following holidays, while the average return for Tuesdays is lower This indicates that the persistently negative returns for Monday are caused by some weekend effect, rather than by a general closed-market effect [7]

[7]One set of returns suggests that a third explanation might be slightly more accurate The New York Stock Exchange was closed each Wednesday during the second half of 1968 Interestingly, the average return to Thursday for this period was −0 1443 percent, which is significantly negative at the 5 percent level This suggests that the negative expected returns may arise whenever the market is closed on a regular basis

3 4 A Bayesian analysis of the negative returns for Monday

The t-tests presented in table 1 indicate that it is very unlikely that the persistently negative returns for Monday would have occurred if the mean of the underlying distribution were positive At the same time, however, it seems reasonable that most people's expectations of the return for Monday were positive How are these expectations affected by the evidence from 1953 through 1977?

One formal approach to this problem is based on Bayes' rule Suppose that, before examining the data, an individual's opinion about the expected return to Monday can be described by a probability density function, $P_0(\mu)$ Further, suppose that, given the expected return for Monday, μ, the probability of observing an average return of $\bar{X}$ is $P_x(\bar{X}\mid\mu)$ Then, by Bayes' rule, one's beliefs about the expected return for Monday, after examining the data, can be described by a distribution whose density function is proportional to the product of these two density functions That is,

$$P_1(\mu\mid\bar{X}) \propto P_0(\mu) \; P_x(\bar{X}\mid\mu)$$

Since the process generating the returns for Monday is assumed to be normal, the density function of the average return given the mean of the process (the 'likelihood function'), $P_x(\bar{X}\mid\mu)$, is also normal If one's prior beliefs, $P_0(\mu)$, are summarized by a normal distribution, then the posterior distribution, $P_1(\mu\mid\bar{X})$, will also be normal [8]

In describing the parameters of the posterior distribution, it is convenient to define the precision of an estimate or distribution, h, as the inverse of its variance Using this definition, the mean of the posterior distribution is an average of the prior mean and the mean of the observed returns, weighted by their precisions That is,

$$\mu_1 = (\mu_0 h_0 + \bar{X} h_x)/(h_0 + h_x),$$

where μ_1 is the mean of the posterior distribution, μ_0 is the mean of the prior distribution, and $\bar{X}$ is the mean of the observed returns The weights, h_0 and h_x are the precision of the prior distribution and the precision of the mean of the observed returns, respectively The precision of the posterior distribution, h_1, is given by

$$h_1 = h_0 + h_x,$$

the sum of the prior and likelihood precisions

[8]Since the variance of the sample returns is used to estimate the variance of the return generating process, the posterior distribution is actually Student-t However, with 1169 degrees of freedom, the normal approximation is quite reasonable

For example, suppose an individual's prior beliefs about the mean of the process generating the returns for Monday can be summarized by a normal distribution with a mean of 0 02 percent and a standard deviation of 0 01 percent This implies a 97 5 percent prior probability that the expected return for Monday is positive The average return to Monday from 1953 through 1977 is −0 17 percent and the standard deviation of this estimate is 0 025 percent Using Bayes' rule to update the prior distribution, the posterior distribution is normal with a mean of −0 006 percent and a standard deviation of 0 009 percent For this individual, the evidence observed over

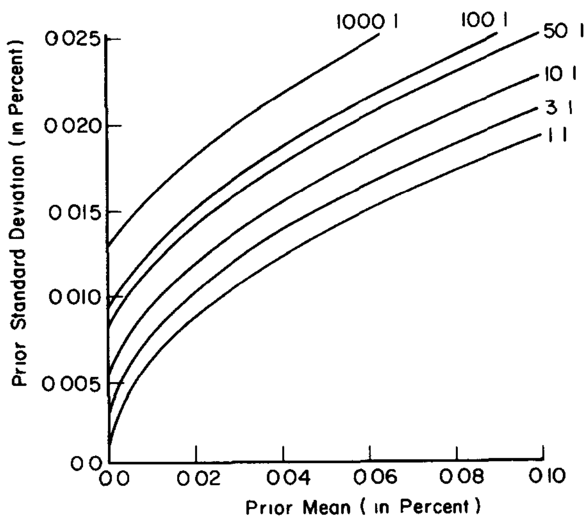

Fig 2 Posterior odds ratios comparing the hypothesis that Monday's mean is negative to the hypothesis that Monday's mean is positive, for normal prior distributions Each curve indicates the ratio of the probability that the posterior mean is negative to the probability that it is positive for different normal prior distributions, under the assumption that the return generating process is normal

the 25-year period reduces the probability that the expected return for Monday is positive from 97 5 percent to approximately 25 percent

One useful measure of an individual's beliefs after examining the data is his posterior odds ratio, the ratio of the posterior probability that the expected return is negative to the posterior probability that it is positive Under the assumption that the prior distribution is normal, fig 2 presents the posterior odds ratio for different initial parameters For example, if the prior mean is 0 02 percent and the standard deviation about this mean is 0 01 percent, the posterior odds ratio is approximately 3 to 1

Although each individual must form his own prior distribution about the expected return for Monday, it seems reasonable that most people's opinion will be based, at least in part, on either monthly or annual stock returns Suppose that an individual has already examined the monthly returns from 1953 through 1977 and that he forms his prior distribution using this information Further, suppose that, before studying the daily returns, he believes that returns are generated in trading time Then each trading day has the same expected return and the mean of this person's prior distribution about the expected return for Monday will be equal to the average monthly return divided by 20 9, the average number of trading days per month The prior variance is equal to the variance of the estimated monthly expected return dividend by 20 9

Since the average monthly return from 1953 through 1977 is 0 741 percent and the standard deviation about this estimate is 0 227 percent, this individual's prior mean and standard deviation are 0 035 percent and 0 059 percent, respectively [9] Using the procedure described above for updating the prior distribution, the mean and standard deviation of the posterior distribution are −0 128 percent and 0 022 percent, respectively This posterior distribution implies an odds ratio which is greater than 1000 to 1 In other words, starting with a prior distribution that is based on the trading time model and the monthly returns from 1953 through 1977, one would conclude that it is 1000 times more likely that the expected return for Monday is negative than that it is positive Similar conclusions would be reached using the calendar time model or using the monthly returns from 1926 through 1952

4. Implications for market efficiency

The empirical tests discussed above indicate that, for a large class of prior distributions, the expected stock market return from Friday to Monday was probably negative over the period from 1953 to 1977 Perhaps the most obvious explanation for this result is that the information released over the weekend tends to be unfavorable For example, if firms fear 'panic selling' when bad news is announced, they may delay announcement until the weekend, allowing more time for the information to be digested While this behavior is certainly possible, it would not cause systematically negative stock returns in an efficient market [10] Instead, investors would come to

[9]The monthly returns to the value weighted market portfolio provided by the Center for Research in Security Prices, University of Chicago, are used to form the prior distributions in this section

[10]For a summary of the efficient markets hypothesis and much of the related empirical work, see Fama (1970) Fama's (1970, p 383) definition of an efficient market as one 'in which prices "fully reflect" available information' is the definition used in this paper

expect the release of unfavorable information on weekends and they would discount stock prices appropriately throughout the week

If one concludes that the expected return for Monday is negative, it is tempting to also conclude that the market is inefficient However, any test of the efficient markets hypothesis is simultaneously a test of efficiency and of assumptions about the nature of market equilibrium Because of this, one can never unambiguously reject market efficiency Nevertheless, it is difficult to imagine any reasonable model of equilibrium consistent with both market efficiency and negative expected returns to a portfolio as large as the Standard and Poor's composite [11]

5. Potential profit from the negative returns for Monday

Even if one were to conclude that the negative returns for Monday are evidence of market inefficiency, the profit to any individual from knowledge of the negative returns is more limited than it may appear One simple trading strategy based on this information would be for an individual to purchase the Standard and Poor's composite portfolio every Monday afternoon and to sell these investments on Friday afternoon, holding cash over the weekend Ignoring transactions costs, this trading rule would have generated an average annual return of 13 4 percent from 1953 to 1977, while a buy and hold policy would have yielded a 5 5 percent annual return However, no investor can ignore transactions costs If these costs are only 0 25 percent per transaction, the buy and hold policy would have yielded a higher return in each of the 25 years studied

This does not mean that knowledge of the market inefficiency would be of no value If the expected return from Friday to Monday is negative, an individual could increase the expected return to his investments by altering the timing of trades which would have been made anyway — delaying purchases planned for Thursday or Friday until Monday and executing sales scheduled for Monday on the preceding Friday

6. Conclusions

This paper examines two alternative models of the process generating stock returns Under the calendar time hypothesis, the process operates continuously, and, since the return for Monday represents a three-calendar-day investment, the expected return for Monday will be three times the

[11]The Sharpe–Lintner model does admit the possibility that the expected return to the portfolio of New York Stock Exchange stocks is negative It is possible that the stock market has a sufficiently negative correlation with the larger portfolio of all marketable assets (a low enough β) that investors are willing to accept a negative expected return in exchange for the stock market's diversifying value However, this explanation seems unreasonable

expected return for other days of the week Under the trading time hypothesis, returns are generated only during active trading Since any of the returns represents only one trading day, if this model is correct the expected return will be the same for each day of the week

During most of the period studied, from 1953 through 1977, the daily returns to the Standard and Poor's composite portfolio are inconsistent with both the trading time and the calendar time models Surprisingly, although the average return for the other four days of the week was positive, the average return for Monday was significantly *negative* during each of five five-year subperiods

To test whether the systematically negative returns occur only on Monday or after any day that the market is closed, the returns for days following holidays are compared with the returns for periods which do not include holidays Only Tuesday's average 'holiday' return was lower than its average 'non-holiday' return, indicating that the negative expected returns are caused by a weekend effect and not by a general 'closed-market' effect

The weekly pattern in the expected returns could lead to biases in empirical tests using daily stock data Implicit in many of these tests is the assumption that the unconditional expected return is constant throughout the week The potential for bias is illustrated by Waud's (1970) study of Federal Reserve discount rate changes from 1953 to 1967 Waud finds that, for a sample of 16 rate increases, the average return to the Standard and Poor's composite portfolio on the day of the announcement was −0 245 percent while, for a sample of 9 decreases, the average return was 0 520 percent To determine the significance of these results, Waud compares them with 0 034 percent, the average daily return for the period studied [12] However, only one of the 25 rate changes occurred on Monday Since the expected return to Monday was significantly lower than the expected return to other days of the week, the unconditional expected return for an announcement day was actually higher than the average daily return A comparison of the announcement day returns with this higher unconditional expected return would be a more accurate test of the effect of discount rate changes in stock returns [13]

The persistently negative returns for Monday appear to be evidence of market inefficiency Although an active trading strategy based on the negative expected returns would not have been profitable because of transactions costs, investors could have increased their expected returns by altering the timing of trades which would have been made anyway —

[12] Actually, Waud's test is slightly more complicated After removing both the mean and an autoregressive factor (but not effecting the weekly variation in the returns) he determines whether the announcement days returns are significantly positive or negative

[13] In fact, this difference in the unconditional expected returns does not significantly effect Waud's conclusions

delaying purchases planned for Thursday or Friday until Monday and executing sales scheduled for Monday on the preceding Friday

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