Arbitrage, Institutional Investors, and the Monday Effect

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In this paper we examine the hypothesis that the Monday effect disappeared as a result of arbitrage activity by institutional investor trading empowered by a reduction in transaction costs. Our empirical results argue against this conclusion because of the following: 1) We find that changes in Monday returns are too large to be consistent with arbitrage activity; 2) the shift in the Monday effect occurs primarily in the bull market of the 1990s, much later than the timing of shifts in transaction costs identified in previous research; and 3) when returns are segmented based on magnitude, we find that the patterns in the shifts of weekday returns are inconsistent with profitable arbitrage activity.

Introduction

The survey article for this issue reports a long-term shift in mean Monday returns for large-cap stocks from significantly negative and lower than all other weekdays to significantly positive and higher than other weekdays. Other articles in this issue indicate that this shift: applies to a large number of securities (Sullivan and Liano, 2003); does not result from changes in the return correlation between Friday and Monday (Tori, 2003); and is compatible with the hypothesis that small and large-cap stocks differ in their susceptibility to macro and microeconomic trends (Singleton and Wingender, 2003). Although the shift is dramatic for large-cap stocks, small-firm securities still experience negative returns. The strength of this persistence is such that, as shown by Miller, Prather, and Mazumder (2003), switching between funds within a fund family to avoid Monday's negative return beats a buy-and-hold strategy.

All of the above findings are consistent with order flow causing the Monday effect and with a reversal of this effect resulting from shifts in market flows. Gond-

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halekar and Mehdian (2003) provide evidence supporting the hypothesis that order flow from pessimistic individual investors on Monday creates negative returns and posit that shifts in market behavior by individual investors during the bull market of the 1990s may have reduced the Monday effect. Chan, Leung, and Wang (forthcoming) and earlier Kamara (1997) provide an alternative explanation. These authors argue that the Monday effect disappeared because of the increasing dominance of institutional investors. Kamara further argues that a reduction in transaction costs that would allow institutional investors to conduct arbitrage was a necessary condition to eliminate the Monday effect.

In this paper we investigate the role of transaction costs and institutional investors during the time period of the change in the Monday effect to see if the evidence holds that the change in the Monday effect is a result of the increasing dominance of institutional investor trading. In the second section we present previous arguments and evidence concerning the association of institutional investors and the Monday effect and then suggest further tests to clarify this question. In the third section e present empirical evidence indicating that arbitrage activity by institutional investors did not eliminate the Monday effect as concluded by Kamara and Chan, Leung, and Wang. The changes in Monday returns are too large to be consistent with arbitrage activity. The shift in the Monday effect occurs primarily in the bull market of the 1990s, much later than the timing of shifts in transaction costs associated with institutional trading. When returns are segmented based on magnitude, we find that the patterns in the shifts of weekday returns are inconsistent with profitable arbitrage activity. The final section provides summary comments.

Behavior of Individual and Institutional Investors and the Monday Effect

Kamara and Chan, Leung, and Wang argue that the rise of institutional investors directly created the decline in the Monday effect. They provide evidence that as institutional ownership grew, the Monday effect disappeared. These authors and other researchers identify three considerations that could account for a linkage between the growth of institutional investors and a relative increase in average returns for Monday: weekday order flow, irrational investor behavior and reductions in transaction costs. We provide a brief consideration of these arguments and draw three testable implications based on them.

Previous Hypotheses and Findings Weekday Order Flow Patterns

As described more fully in the survey of this issue, an extensive literature has examined the association of various weekday order flow patterns and Monday returns. Among others, Kelly (1930), Miller (1988), and Lakonishok and Maberly (1990) posit that individuals make weekend investment decisions that result in a pre-

ponderance of sell orders coming to the market on Mondays and that this activity leads to the Monday effect. Lakonishok and Maberly (1990), Abraham and Ikenberry (1994), Brooks and Kim (1997) for the U.S. market, and Draper and Paudyal (2002) for the U.K. market present empirical results supporting this hypothesis. On the other hand, Wang and Walker (2000) and Brooks and Kim (1997) make arguments that suggest that institutional investors also tend to predominately initiate sell orders on Mondays. Further, Sias and Starks (1995), Brooks and Kim (1997), and Wang and Walker (2000) provide empirical evidence in support of the hypothesis that institutional investors generate low returns on Monday. Thus, the increasing dominance of institutional investor trading is unlikely to be the only reason for the reversal of the Monday effect in large-cap stocks.

Irrational Investment Behavior

Rystrom and Benson (1989) and Gondhalekar and Mehdian (2003) link negative Monday returns to a pervasive societal propensity for individuals to be depressed on Monday. Both Kamara and Chan, Leung, and Wang imply that this irrational behavior, consistent with beliefs long held by technicians, does not associate with institutional investors. Thus, as institutional investors become more dominant in the marketplace, anomalies such as the Monday effect that are linked to irrational behavior will tend to dissipate. Goetzmann and Zhu (2002), however, provide empirical evidence that irrational investor behavior associated with the rainy day effect emanates from institutional investors. Thus, as with considerations of shifts in order flow, to the extent that irrational investor behavior creates the Monday effect, the growth of institutional investors would not automatically dissipate the Monday effect.

Goetzmann and Zhu (2002) provide evidence that patterns in equilibrium prices associated with the weather cannot be linked to trading by individual investors; instead they can be associated with the positions taken by specialists on the floor of the exchange. Clearly their study suggests caution in assuming that systematic patterns in stock returns such as the Monday effect arise from trading by individual (irrational) investors. Thus, the assumption made by Kamara and Chan, Leung, and Wang that the increasing dominance of institutional investors and the contemporaneous decline in the Monday effect is indicative of the Monday effect being dissipated by the arbitrage activity of institutional investors at the expense of individual (irrational) investors may be premature. As with considerations of shifts in order flow, the assumption about the impact of arbitrage activity by institutional investors on the Monday effect therefore needs additional research attention.

Arbitrage Activity and the Reduction in Transaction Costs

Kamara relies on the presumed rationality of institutional investors to recognize the temporal nature of negative Monday returns and argues that institutional inves-

tors would eliminate the Monday effect if transaction costs were low enough to allow profitable arbitrage activity. Kamara identifies two events associated with reductions in transaction costs that would encourage arbitrage activity relative to the Monday effect:

a. A general lowering of commission charges following the 1975 abolition of fixed commission rates by the NYSE; and
b. The introduction of futures contracts on equity indexes.

Because these shifts affected primarily large-cap stocks, Kamara posits the continuation of a Monday effect for small-firm securities. Kamara does not, however, provide details of the arbitrage activity that eliminated the Monday effect but instead infers arbitrage activity from empirical evidence. Kamara observes the following:

a. After the introduction of negotiable commissions in 1975 by the NYSE, average Monday returns are no longer significantly negative for a large-firm index, but continue to be significantly negative for a small-firm index; and
b. After the introduction of trading in the futures contract on the S&P 500 index in 1982, average Monday returns are no longer significantly less than the average returns of other weekdays for the S&P 500 index.

In contrast, the average Monday returns for a small-firm index continue to be significantly lower than the average returns for other weekdays.

Kamara cites two empirical findings to support the contention that traders carry out arbitrage activity with the S&P 500 futures to profit from temporary negative Monday returns. First, open interest for the S&P 500 futures contract declines significantly on Friday and increases significantly on Monday. Second, on Friday the average return for the S&P 500 futures is negative, lower than any other weekday and significantly lower than the average of other weekdays.[1] These findings suggest

[1]Kamara argues that the pattern in open interest reflects a tendency for traders to sell on Friday and to repurchase at a profit on Monday. The action of an arbitrageur selling could, however, involve either an increase, a decrease, or no change in open interest. Open interest would only decline if a closing sales transaction were combined with a closing purchase transaction. Even if the arbitrageur did have a long position, open interest would only be reduced if the other side of the trade willingly gave up a chance for arbitrage profit. Hence, this empirical finding seems to require some more detailed explanation of a trading pattern that would suggest a reduction in open interest and arbitrage activity.

The observed return pattern in the futures contract for the S&P 500 index argues more directly against the use of the futures contract in arbitrage activity. Kamara asserts that futures prices decline on Friday in anticipation of the Monday seasonal (p. 80). Kamara notes that on Monday the average return to the S&P 500 futures is positive, however, higher than on any other weekday and significantly greater than the average of other weekdays. Because returns to the S&P 500 futures are positive on Monday, a trader would be absorbing a loss by selling on Friday close and buying on Monday close. The timing of an arbitrage does not have to involve close-to-close transactions. Conceivably, the futures contract could opened enough lower on Monday morning to allow the arbitrageur to profit from a Friday close sell. If returns

correlation over time between the availability of futures contracts and the decline in the Monday effect for large stocks. They do not rule out the possibility that the two variables could be influenced by a third factor (e.g., fluctuations in stock prices arising from swings in the sentiment of investors as suggested by the Blue Monday hypothesis) or that the correlation may be spurious. In the next section we formulate three testable implications for investigating this issue further.

Testable Implications

In this section we describe three hypotheses that we argue are consistent with arbitrage activity eliminating the Monday effect. In the next section we report empirical tests of these hypotheses.

a. Arbitrageurs will lay off their open positions as soon as possible. Thus, one should see a shift in returns from Friday to Monday with little impact on returns for the rest of the week. Unless there is a fundamental change in the underlying factors that create the Monday effect, arbitrage activity ought to modify, not eliminate, the effect. Hence, without the elimination of the factors creating the Monday effect, given some risk in the arbitrage, one might expect Monday returns to remain negative, on average, and possibly significantly less than the returns for other weekdays. Certainly, without some fundamental change other than cheaper arbitrage, one would not expect Monday returns to become positive and relatively large.
b. Shifts in the Monday effect should be timed to correspond to the shifts in transaction costs such as the introduction of the S&P 500 futures contract. These shifts should continue in the face of any trend pattern that may exist in the data before the occurrence of these events.
c. One would expect arbitrageurs to have the ability to forecast average Monday returns based on historical observations, but not to be able to forecast returns for individual Mondays. Hence, arbitrage activity occurring on Friday should not vary with eventual Monday return. If the Monday effect occurs in part because some Monday returns are extremely low relative to other days of the week (as demonstrated by Singleton and Wingender), then this pattern should not be affected by arbitrage activity.

In the following section we discuss the data and methodology used to test these additional questions and report the empirical results of these tests. In general, we find reason to question the role of transaction costs and arbitrage activity in the elimination of the Monday effect.

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fell enough from Friday's close to allow for arbitrage profit, the return from Monday open to Monday close would have to be extraordinarily high.

Empirical Evidence

Strength of the Reversal of the Monday Effect

Kamara postulates that the increase in institutional investor trading and the reduction in transaction costs engendered arbitrage activity seeking to profit from historic negative returns on Monday. Because transaction costs are higher for small-firm securities, this activity should primarily influence the returns of large-cap stocks. Thus, we examine the return pattern of a large-firm index and a small-firm index. For the large-firm index we select the S&P 500 index, given the role of the introduction of the S&P 500 futures in the arguments examined above. For the small-firm index we study the returns of the smallest decile of securities from the NYSE. Both sets of returns are collected from the CRSP database for the 40-year period 1963 through 2002.

The weekday returns for both indexes are reported in Panel A of Table 1. We report average returns for the entire 40-year period and for two 20-year subperiods, 1963 through 1982 and 1983 through 2002. For the full sample period both indexes display a highly significant weekday effect that is characterized by a significantly negative Monday return. For both indexes the average Monday return is significantly lower than for the returns of three of the four other weekdays. The average Friday return is significantly higher than each of the other weekday returns for the small-firm index. Wednesday has the highest average return for the large-firm index, but this return is only significantly greater than the average return for Monday.

An examination of the weekday pattern with the data divided into 20-year subperiods reveals a stark contrast between the S&P 500 index and the index for the smallest size decile of the NYSE. The small-firm index shows a consistent weekday pattern between the two subperiods. In the two subperiods the rank of each of the daily returns is the same and all of the significant contrasts are the same. The S&P 500 index displays a strikingly different weekday pattern across the 20-year subperiods. In the first 20-year subperiod the average return for Monday is significantly negative. There is a significant difference in returns across the week characterized by a significant contrast between average Monday returns and the average return for each of the other weekdays. In the second 20-year subperiod average daily returns are much more uniform. The average returns for Monday and Tuesday, where returns had been lowest, increase, and the average return for each of the other weekdays decreases. Monday returns are no longer negative, and there is no weekday effect and no significant contrast between any weekday.

The contrast between the small-firm index and the large-firm index is consistent with arbitrage occurring on large-cap stocks where transaction costs are lowest. But the shift in return for large-cap stocks is not consistent with arbitrage activity. The weekday effect did not disappear only because Monday returns increased, but because of a general leveling of returns. Further, Monday's returns have become on average positive. Some change other than arbitrage is necessary to cause Monday

Table 1 Panel A—S&P 500 Index, Small-Firm Decile of NYSE Securities Index

Index	Period	Mon	Tue	Wed	Thu	Fri	F-stat
Small Firm Decile	1963-2002	-.0892	-.0570	.0985	.1131	.2783	
		[-4.47]	[-2.94]	[5.07]	[5.79]	[14.20]	
		(.0000)	(.0032)	(.0000)	(.0000)	(.0000)	
		Rank=5	Rank=4	Rank=3	Rank=2	Rank=1	57.898
		LT	LT	GT	GT	GT	(.000)
		W,H,F	W,H,F	M,T	M,T	M,T,W,H	
				LT	LT		
				F	F		
	1963-1982	-.0844	-.0493	.1181	.1293	.3025	
		[-2.90]	[-1.74]	[4.14]	[4.53]	[10.55]	
		(.0037)	(.0820)	(.0000)	(.0000)	(.0000)	
		Rank=5	Rank=4	Rank=3	Rank=2	Rank=1	32.102
		LT	LT	GT	GT	GT	(.000)
		W,H,F	W,H,F	M,T	M,T	M,T,W,H	
				LT	LT		
				F	F		
	1983-2002	-.0941	-.0647	.0793	.0971	.2542	
		[-3.43]	[-2.45]	[3.00]	[3.64]	[9.50]	
		(.0006)	(.0144)	(.0027)	(.0003)	(.0000)	
		Rank=5	Rank=4	Rank=3	Rank=2	Rank=1	26.061
		LT	LT	GT	GT	GT	(.000)
		W,H,F	W,H,F	M,T	M,T	M,T,W,H	
				LT	LT		
				F	F		
S&P 500 Index	1963-2002	-.0570	.0373	.0869	.0242	.0576	
		[-2.662]	[1.795]	[4.170]	[1.155]	[2.741]	
		(.0078)	(.0727)	(.0000)	(.2483)	(.0061)	6.471
		Rank=5	Rank=3	Rank=1	Rank=4	Rank=2	(.000)
		LT	GT	GT		GT	
		T,W,F	M	M		M	
	1963-1982	-.1349	.0229	.0936	.0259	.0828	
		[-5.317]	[.925]	[3.761]	[1.040]	[3.313]	13.098
		(.0000)	(.3552)	(.0002)	(.2983)	(.0009)	(.000)
		Rank=5	Rank=4	Rank=1	Rank=3	Rank=2	
		LT	GT	GT	GT	GT	
		T,W,H,F	M	M	M	M	
	1983-2002	.0218	.0516	.0804	.0225	.0325	
		[.631]	[1.549]	[2.411]	[.668]	[.964]	.542
		(.5284)	(.1215)	(.0159)	(.5040)	(.3349)	(.705)
		Rank=5	Rank=2	Rank=1	Rank=4	Rank=3	

Average daily returns are reported as percentages. The t-statistic reported in brackets and the corresponding p-value reported in parentheses result from a two-tail test of the null hypothesis that average returns are zero. Ranks are reported for average returns, with 1 indicating the highest average return and 5 indicating the lowest average return. Results from Scheffe's multiple comparison test are shown below the weekday's rank with LT indicating less than and GT indicating greater than at the 5 percent level of significance where appropriate. The F-statistic and corresponding p-value represent a test of the hypothesis that returns are equal across weekdays

returns to become positive. Profitable arbitrage activity requires that the Monday returns arising from non-arbitrageur trading be negative on average. For arbitrage

based on a known trading pattern to be profitable, the net effect on returns should be zero at best, but not a complete reversal of the existing pattern. Lower cost arbitrage could therefore plausibly make a permanent change in the Monday effect, but causing a reversal of average Monday returns is not possible.

Table 1 Panel B—Average Weekday Returns, S&P 500 Index

Index	Period	Mon	Tue	Wed	Thu	Fri	F-stat
S&P 500 Index	1983-1986	-.0310	.0419	.0839	.1045	.0823	
		[-.533]	[.745]	[1.489]	[1.837]	[1.446]	.873
		(.5939)	(.4565)	(.1368)	(.0665)	(.1485)	(.480)
		Rank=5	Rank=4	Rank=2	Rank=1	Rank=3	
	1987-1990	-.0938	.1349	.1429	-.0654	.0698	
		[-.988]	[1.472]	[1.563]	[-.710]	[.754]	1.435
		(.3232)	(.1413)	(.1184)	(.4781)	(.4511)	(.220)
		Rank=5	Rank=2	Rank=1	Rank=4	Rank-3	
	1991-1994	.1243	-.0073	.0787	.0451	-.0624	
		[2.537]	[-.155]	[1.660]	[.947]	[-1.30]	2.285
		(.0113)	(.8772)	(.0972)	(.3441)	(.1939)	(.058)
		Rank=1	Rank=4	Rank=2	Rank=3	Rank=5	
	1995-1998	.1068	.2592	.0698	-.0703	.1414	
		[1.546]	[3.893]	[1.046]	[-1.041]	[2.088]	
		(.1225)	(.0001)	(.2956)	(.2983)	(.0370)	3.164
		Rank=3	Rank=1	Rank=4	Rank=5	Rank=2	(.013)
			GT		LT		
			H		T		
	1999-2002	.0019	-.1734	.0260	.0990	-.0684	
		[.018]	[-1.781]	[.267]	[1.009]	[-.697]	.115
		(.9854)	(.0753)	(.7897)	(.3131)	(.4857)	(.348)
		Rank=3	Rank=5	Rank=2	Rank=1	Rank=4	

Average daily returns are reported as percentages. The t-statistic reported in brackets and the corresponding p-value reported in parentheses result from a two-tail test of the null hypothesis that average returns are zero. Ranks are reported for average returns, with 1 indicating the highest average return and 5 indicating the lowest average return. Results from Scheffe's multiple comparison test are shown below the weekday's rank with LT indicating less than and GT indicating greater than at the 5 percent level of significance where appropriate. The F-statistic and corresponding p-value represent a test of the hypothesis that returns are equal across weekdays

To provide a closer look at returns for the S&P 500 index in this 20-year period we further divide the data into four-year periods. The average weekday return for these periods is reported in Panel B of Table 1. In the first two four-year subperiods average Monday returns remain negative and lower than other weekday returns, but there is no significant difference across weekdays. In the next two subperiods, during the bull market of the 1990s, there is a significant difference in average weekday returns. The significant weekday effect does not occur because of a strong negative Monday average return. Rather, in both of these four-year periods, average Monday returns are positive. In the period 1991 through 1994 average Monday returns are greater than the returns of any other weekdays. The weekday effect occurs because of a large positive Monday return rather than because of a negative Monday return.

This period would be very unprofitable for the typical Monday effect arbitrageur. In the last subperiod, which includes a substantial bear market, the weekday effect is no longer evident, and Monday average returns are more modest relative to other weekdays.[2]

Timing of the Reversal of the Monday Effect

In addition to investigating the strength of the Monday reversal, we seek to examine the timing of the shift in Monday returns. Is the timing of changes in the weekday return pattern for large-cap stocks consistent with the timing of changes in transaction costs? To examine the return changes over time we calculate the Friday minus Monday return for each week for the S&P 500 index over the period beginning January 1963 and ending December 2002. (If Monday is a holiday we discard the weekly return, if Friday is a holiday we calculate the difference in the return for Monday and the previous Thursday.) Previous research shows that this difference has diminished over time; we investigate whether this difference appears to have shifted smoothly over time or if this difference appears to jump at particular intervals associated with shifts in the level of transaction costs.

We begin by estimating equation (1):

$$\delta R_t = \gamma_0 + \gamma_1 T_t + \varepsilon_t \quad (1)$$

where:

δR_t = The difference between Friday's return and the following Monday's return for each week;

T_t = Trend measure with a value of 1 for the year 1963 and increases by 1 for each additional year;

γ_0 and γ_1 = Ordinary least squares estimates of the intercept and trend, respectively; and

ε_t = Error term.

The results from estimating this equation are reported in Table 2 as model 1. The results indicate a significant difference between the daily Friday and Monday return estimated as .31 percent at the start of the data period. As estimated by γ_1 there is an annual decrease of .01 percent in this difference over the forty-year sample period. The trend is large enough to cause the estimated Friday-Monday differential to be negative in the later years of the sample period. This trend is significant at the .0005 level.

The annual trend in the Friday-Monday differential may not result from a steady trend over the years, but may instead result from shifts occurring at various points in time. We investigate this possibility by using three jump variables. The first two

[2]These results raise the possibility of an association between the relative strength of Monday returns and general market returns.

jump variables associate with changes in transaction costs identified by Kamara as allowing arbitrageurs to eliminate the Friday-Monday differential. J_1 is a jump variable that measures the impact of the abolition of fixed commission charges on the trend in the Friday-Monday differential. J_2 is a jump variable that measures the impact of the introduction of the S&P 500 futures contract on the trend in the Friday-Monday differential. J_1 assumes a value of 1 after the abolition of fixed commission charges May 1, 1975 and assumes a value of zero otherwise. J_2 assumes a value of 1 after the introduction of the S&P 500 futures contract on March 31, 1982 and assumes a value of zero otherwise.

Table 2–Trend in the Decline of the Monday Effect for the S&P 500 Index

$\delta R_t = \gamma_0 + \gamma_1 T_t + \gamma_2 J_1 + \gamma_3 J_2 + \gamma_4 J_3 + \varepsilon_t$

Model	γ_0	γ_1	γ_2	γ_3	γ_4
	.0031	-.0001			
1	[4.540]	[-3.317]			
	(.0000)	(.0005)			
	.0036	-.0001	-.0005		
2	[2.549]	[-1.650]	[-0.425]		
	(.0109)	(.0496)	(.3356)		
	.0034	-.0001		-.0042	
3	[2.814]	[-1.388]		[-0.316]	
	(.0049)	(.0826)		(.3761)	
	.0045	-.0000			-.0021
4	[4.270]	[-0.544]			[-1.723]
	(.0000)	(.2933)			(.0426)
	.0083	.0001	-.0023	-.0008	-.0034
5	[3.271]	[1.152]	[-1.605]	[-0.623]	[-2.354]
	(.0011)	(.1248)	(.0543)	(.2668)	(.0093)

Notes: The GLM is run for the period 1963 through 2002. As defined above δR_t represents the Friday minus Monday return for each paired observation. T_t is a dummy variable for trend; 1 for 1963, 2 for 1964, etc. J_1 is a dummy variable for the Mayday end of fixed commissions; 0 before and 1 after 5/1/75. J_2 is a dummy variable for the introduction of S&P 500 futures trading; 0 before and 1 after 3/31/82. And J_3 is a dummy variable to guard against spurious correlation; 0 before and 1 after 1/1/1990. Regression coefficients are reported along with t-statistics in brackets and p-values in parentheses. The p-values for the regression coefficients (with exception of the intercept) are for one-tail tests because the hypothesis argues for a negative regression coefficient

If the reduction in the Friday-Monday differential depends on these transaction costs altering events, regressing the return differentials on trend and these jump variables should result in a significant negative coefficient for the jump variables and the elimination of a significant impact from the trend variable. To guard against the possibility that the trend variable spuriously correlates with the jump variables associated with the dates for changes in transaction costs, we include a third jump variable. On a somewhat *ex cathedra* basis we place this jump variable to correspond with the bull market of the 1990s. Thus, J_3 assumes a value of 1 after January 1, 1990 and assumes a value of zero otherwise. We introduce each of the jump variables

separately with the trend and then combine all three jump variables with trend in a final regression.

The complete model (model 5 in Table 2) is shown as equation (2):

$$\delta R_t = \gamma_0 + \gamma_1 T_t + \gamma_2 J_1 + \gamma_3 J_2 + \gamma_4 J_3 + \varepsilon_t \quad (2)$$

The dependent and independent variables are defined above and all of the regression coefficients are estimated using the GLM.

We begin estimation of the influence of the jump variables with regression model 2 that includes trend and a jump variable for the impact on trend from the abolition of fixed commission charges. The results of this regression are shown in Table 2. The sign of the coefficient for the J_1 is negative as expected, but not significantly different from zero. Further, the trend variable remains significant at the .05 level. Similar results are found by estimating model 3 that includes trend and a jump variable for the introduction of the S&P 500 futures. Trend remains significant at the .10 level, and the coefficient for the variable for the S&P 500 futures is not significant, although of the expected sign.

Model 4, as reported in Table 2, examines the possibility that trend in the Friday-Monday differential accelerated in the 1990s. The jump variable for the 1990s is significant at the .05 level, indicating that a significant shift in the reduction of the Monday effect occurred in the 1990s. Further, with the inclusion of the 1990s jump variable, trend is no longer significant, suggesting that there is no statistically reliable shift in the Friday-Monday differential until the 1990s. The results from model 4 suggest that some factor occurring in the 1990s unrelated to arbitrage engendered by lower transaction costs was primarily responsible for the reversal in average Monday returns.

Model 5 as reported in Table 2 includes all three jump variables along with trend. In this model trend is no longer significant. The impact of the 1990s is now stronger and is significant at the .01 level. In addition, a marginally significant jump is indicated at the time of the abolition of fixed commissions in May of 1975. Taken together, this evidence suggests a weak trend beginning in the mid 1970s that becomes highly significant in the 1990s. The introduction of the S&P 500 futures appears to have little impact on the Friday-Monday differential.

Evidence from Extreme Observations

If the Monday effect disappears as a result of arbitrage activity, the resulting shift in returns should be evidenced by small consistent decreases in the return for Friday and consistent small increases in the return for Monday. If extreme observations had created the Monday effect in periods prior to the onset of arbitrage activity, one would expect these extreme observations to continue in the face of arbitrage activity. We examine the changes in the return pattern of the S&P 500 index to see if they are consistent with the impact of arbitrage activity. We apply GLM analysis to

the forty-year sample period with the data divided into five eight-year subperiods. The data are further divided by magnitude of return. One sample is formed by identifying those trading days across weekdays that encompass the lowest 5 percent of all observations. In addition, we examine a set of data with extreme observations eliminated by extracting those daily returns with the highest or lowest 5 percent of all observations. This procedure allows for tests on the relevant extreme observations and for tests on data for which all extreme observations have been eliminated.

Panel A of Table 3 shows results of the application of a GLM across weekdays for the S&P 500 index when only extremely low observations are considered. The results from our sample suggest that extreme values do not appear to play a crucial role in creating the Monday effect. Extreme returns for Monday do not appear to be significantly less than the extreme returns for other weekdays (but they may occur more frequently). On the other hand, we reject the hypothesis of equal returns across weekdays in two of the five subperiods and the average returns for Monday are always the lowest or the next to the lowest for each of the five subperiods. Thus, arbitrageurs benefit from extremely low Monday returns and consistent with an impact from arbitrage activity the relative value of extremely low Monday returns compared to extremely low returns for other weekdays does not change. This finding may explain why there are more open positions in S&P 500 futures on Friday. The condition may result from traders hedging against an unpredictable large negative Monday return.

Table 3 Panel A—S&P 500 Index Average Weekday Returns 5% Lowest Returns

Index	Period	Mon	Tue	Wed	Thu	Fri	F-stat
S & P 500	1963-1970	-1.8980	-1.8420	-1.8763	-1.6442	-2.1523	.789
		Rank=4	Rank=2	Rank=3	Rank=1	Rank=5	(.543)
	1971-1978	-2.2051	-1.7847	-1.9036	-1.7654	-1.6976	
		Rank=5	Rank=3	Rank=4	Rank=2	Rank=1	4.323
		LT F				GT M	(.003)
	1979-1986	-2.0792	-1.8344	-1.7880	-1.9295	-1.7083	1.456
		Rank=5	Rank=3	Rank=2	Rank=4	Rank=1	(.223)
	1987-1994	-3.3195	-1.8929	-1.8478	-2.2997	-2.6161	1.448
		Rank=5	Rank=2	Rank=1	Rank=3	Rank=4	(.225)
	1995-2002	-2.4644	-2.1060	-1.9875	-2.0380	-2.2969	2.373
		Rank=5	Rank=3	Rank=1	Rank=2	Rank=4	(.054)

Average daily returns are reported as percentages. T-statistics and p-values testing whether average returns are zero are not reported because the data have been culled to include the lowest 5 percent of observations, providing the expectation that the average returns will be negative. Ranks are reported for average returns with 1 indicating the highest average return and 5 indicating the lowest average return. Results from Scheffe's multiple comparison test are shown below the weekday's rank, with LT indicating less than and GT indicating greater than at the 5 percent level of significance where appropriate. The F-statistic and corresponding p-value represent a test of the hypothesis that returns are equal across weekdays

Further, evidence on whether the shift in the Monday effect results from arbitrage activity may be inferred from an examination of shifts in the weekday patterns

for return data with extreme observations eliminated. Arbitrage activity should cause a small increase in Monday returns and a small decrease in Friday returns. Panel B of Table 3 shows the application of the GLM to weekday observations for the S&P 500 index for the forty-year sample period with the 5 percent of the observations with the highest returns and the 5 percent of the observations with the lowest returns excluded. The forty-year sample is again divided into five eight-year sample periods. The first two subperiods show a strong weekday effect characterized by Monday returns that are negative and significantly less than other weekdays. Consistent with an impact from arbitrage activity, in the last two subperiods (periods after the introduction of the S&P 500 futures) Monday returns increase relative to other weekdays, and there is no significant weekday effect among this data. Arbitrage activity should moderate a significant negative pattern. Arbitrage activity should not cause average Monday returns to be positive or large relative to other weekdays. This shift, however, is exactly what occurred. Average Monday returns in the last two subperiods are positive and larger than the returns for any other weekday. If traders are arbitraging negative Monday returns, they are taking a loss most days.[3] Any other weekday would appear to be a better candidate for arbitrage activity. Monday returns are not statistically significantly higher than other weekdays, but are more than twice as high as the return for most other all weekdays in the last two subperiods. These comparisons do not suggest arbitrage activity.

[3]We recognize that consistent losses on arbitrage activity would not forestall profitable arbitrage if consistent small losses were offset by occasional large gains. This possibility does not seem likely because average Monday returns are higher than any other weekdays. Although extreme returns for Monday are lower than other weekdays, the difference is not significant. Nonetheless, we explore this possibility by conducting some back of the envelope calculations for each of the last two subperiods. The subperiod including the years 1987 through 1994 for Monday is described by the following: there were 342 observations in the moderate return data set with an average return value of .08049 percent; there were 21 observations in the extremely low return data set with an average return value of -3.3195 percent; and there were 22 observations in the extremely high return data set with an average return of 2.18746 percent. With arbitrageurs shorting Monday, their average return would have been -.02 percent. This is the period that included Black Monday 1987. The subperiod including the years 1995 through 2002 for Monday is described by the following: there were 315 observations in the moderate return data set with an average return value of .12148 percent; there were 36 observations in the extremely low return data set with an average return value of -2.4644 percent; and there were 32 observations in the extremely high return data set with an average value of 2.23159 percent. The average return for shorting Monday in this sample period would have been -.05 percent. We recognize that individual arbitrageurs may not immediately know when profitable trading opportunities have disappeared, but the length of the period over which Monday returns are on average positive argues against this possibility.

Table 3 Panel B—Average Weekday Returns S&P 500 Index Lowest 5% and Highest 5% of All Observations Excluded

Index	Period	Mon	Tue	Wed	Thu	Fri	F-stat
	1963-1970	-.1399	-.0036	.0818	.0371	.0985	
		Rank=5	Rank=4	Rank=2	Rank=3	Rank=1	13.691
		LT	GT	GT	GT	GT	(.000)
		T,W,H,F	M	M	M	M	
	1971-1978	-.1005	.0230	.0404	-.0381	.0609	
		Rank=5	Rank=3	Rank=2	Rank=4	Rank=1	3.827
S & P		LT				GT	(.004)
500		F				M	
	1979-1986	.0020	.0197	.0389	.0007	.0690	.741
		Rank=4	Rank=3	Rank=2	Rank=5	Rank=1	(.564)
	1987-1994	.0805	.0420	.0781	.0147	.0278	.880
		Rank=1	Rank=3	Rank=2	Rank=5	Rank=4	(.475)
	1995-2002	.1215	.0425	.0543	.0378	.0870	.885
		Rank=1	Rank=4	Rank=3	Rank=5	Rank=2	(.472)

Average daily returns are reported as percentages. T-statistics and p-values testing whether average returns are zero are not reported because the data have been culled to exclude extreme observations reducing the chance that returns will be significantly different from zero. Ranks are reported for average returns with 1 indicating the highest average return and 5 indicating the lowest average return. Results from Scheffe's multiple comparison test are shown below the weekday's rank, with LT indicating less than and GT indicating greater than at the 5% level of significance where appropriate. The F-statistic and corresponding p-value represent a test of the hypothesis that returns are equal across weekdays

Conclusion

In this paper we examine the hypothesis that the Monday effect disappeared as a result of arbitrage activity by institutional investor trading empowered by a reduction in transaction costs. We report theoretical arguments and empirical evidence from previous research that relate to this argument. The additional evidence that comes from the new tests run in this research leads us to dispute the hypothesis that the Monday effect disappeared due to changes in transaction costs. The changes in Monday returns are too large to be consistent with arbitrage activity, but require some additional explanation. The results indicate that the timing of the shift in the Monday effect does not appear to be consistent with shifts in transaction costs, especially with the introduction of the S&P 500 futures. Finally, the patterns in the shifts of weekday returns when returns are segmented based on magnitude are found to be inconsistent with profitable arbitrage activity.

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