How Widespread Was Late Trading in Mutual Funds?

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A major component of the mutual fund scandals of 2003 was the allegation that certain investors were allowed to engage in late trading of mutual fund shares. Under the forward pricing rule (22c-1), trades in U.S.-based, open-ended mutual funds are required to be priced at the next net asset value per share (NAV) calculated after an order is placed. For funds that calculate NAVs once per day at 4 p.m. Eastern time (the vast majority), orders must be placed before 4 p.m. to be priced at the current-day NAV. Late traders who violate this rule can use information revealed after 4 p.m. to guide their trades, buying fund shares when their current value is greater than NAV and selling when the reverse is true. Doing so allows them to earn expected abnormal returns at the expense of the fund's long-term shareholders.

This paper estimates the extent of late trading by testing whether trades purported to have been placed before 4 p.m. are correlated with market movements after 4 p.m. that make the trade turn out to have been advantageous. In my sample, this correlation exists with market movements between 4 p.m. and 9 p.m., but not with post-9 p.m. movements. Clearly, one of the leading explanations for this correlation is that some of the trading decisions in question were made as late as 9 p.m.

Using this methodology and daily flow data from a sample of funds, I estimate that long-term shareholders' average annualized losses from late trading between 1998 and 2003 were 3.8 and 0.9 basis points in international and domestic equity funds, respectively. If similar dilution rates prevailed outside the sample, annual losses to late trading would be approximately $400 million per year. Fund family-level tests reveal statistically significant evidence of late trading in 39 out of 66 fund families. That late trading was this widespread may no longer seem surprising, given the ongoing corroboration of this result in evidence gathered by regulators, but when the first draft of this study was circulated in early September 2003, it surprised some industry participants to the point of disbelief.[1]

Profiting from late trading involves trading mutual fund shares at relatively high frequency. Late trading is usually practiced in combination with a legal practice known as stale price arbitrage, or "market timing." Stale price arbitrage exploits the fact that for many asset classes, such as international equities that trade in different time zones, the asset prices used to calculate NAVs at 4 p.m. do not fully reflect recent market movements. Whereas stale price arbitrageurs condition trades on market movements as of 4 p.m., late traders postpone trading decisions until later in the day. Unlike late trading, stale price arbitrage had been documented in the academic literature and discussed in the popular press before September 2003.[2]

Fund companies were usually aware of any high-frequency trading in their funds. In some cases, fund companies had received payments for allowing it, either directly or via so-called sticky asset deals, in which arbitrageurs place additional monies in high-fee investments. The degree to which fund companies were aware of illegal late trading in their funds varies, however. In some cases, fund management companies had direct knowledge of the late trading (U.S. Congress, Steven Cutler, 2003). In others, the late trading was executed through intermediaries, such as brokerage firms. Mutual funds

[1] See, for example, industry participants quoted in Jonathan Burton (2003), John Hechinger (2003), and Scott B. Nelson (2003).

[2] Academic papers include Rahul Bhargava et al. (1998); John Chalmers et al. (2001); William N. Goetzmann et al. (2001); Jason Greene and Charles Hodges (2002); Jacob Boudoukh et al. (2002); and Zitzewitz (2003).

have traditionally allowed intermediaries time after 4 p.m. to total the day's orders before reporting them to the fund. Some intermediaries allegedly used that extra time to add or delete trades after 4 p.m. One limitation of my analysis is that I cannot determine whether a fund company knowingly allowed illegal trading or whether it allowed trading it thought to be legal (albeit harmful to shareholders).

Academic interest in understanding the extent of late trading springs from interest in agency conflicts in mutual fund investing more generally (Paul G. Mahoney, 2004). While the dilution of shareholder assets due to late trading was fairly modest in percentage terms, its revelation has helped prompt renewed interest in addressing these conflicts. The study contributes to the literature on these conflicts and can also be viewed as adding to a broader set of studies that use statistical techniques to detect illegal activity.

I. Data

In order to test whether funds flows are correlated with post-4 p.m. market movements, I use daily data on fund assets, returns, and distributions from TrimTabs and Lipper. The data are available from February 1998 to December 2003 and from March 2000 to December 2003, respectively. Since post-4 p.m. market indicators are more readily available for equity than for fixed income, I restrict the study to U.S. and international equity funds and include only sector funds for which returns are well predicted by general equity indices (communication and technology funds). Of the funds in these categories contained in the June 2001 Morningstar universe that have tickers, 15 percent (28 percent of assets) appear in TrimTabs at some point during the sample period, 71 percent (43 percent of assets) appear in Lipper, and 75 percent (48 percent of assets) appear in the combined sample. For funds appearing in both sources for a given time period, I use TrimTabs data.[3] I

eliminate a small number of observations from Lipper as outliers.[4]

An issue with both the TrimTabs and Lipper data is that inflows are reported with a one-day lag for almost all funds (see Zitzewitz, 2003, sect. 4; Greene and Hodges, 2002).[5] I correct for this lag by treating each day's asset figures as pre-flow rather than post-flow, but perform checks to ensure that this correction is appropriate.

For simplicity, I use the near-month S&P 500 future contracts from the Chicago Mercantile Exchange Time and Sales data as a single indicator of market movements. The S&P 500 futures contract trades from 4:45 p.m. through to the following trading day, every day except Friday (and other days preceding a market closure). Other post-4 p.m. indicators, such as the Nasdaq 100 future for technology funds or the Singapore Nikkei future opening price for Japan funds, are slightly better predictors of next-day returns, but are not statistically significantly better predictors of inflows. At the risk of understating late trading in these asset classes, I used the S&P 500 as a single indicator for all asset classes.

II. Testing for Late Trading

Table 1 provides an example of a regression that tests for late trading by measuring the correlation between daily mutual fund flows and market movements after 4 p.m. The dependent variable is net inflows to the fund, normalized by prior-day assets, where inflows are defined as the difference between a fund's current-day assets and its prior-day assets adjusted for current-day fund returns and distributions. The independent variables are log changes in the near-month S&P 500 futures contract price. The first two terms control for market timing using information before 4 p.m. Subsequent terms capture late trading using information after 4 p.m. Controlling for market movements before 4 p.m.

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[3] Where TrimTabs and Lipper overlap, daily flow-to-asset ratios are highly, but not perfectly, correlated ($r = 0.93$). No measures of flows are constructed by mixing data from the two sources.

[4] I treat as outliers observations in which the log of shares outstanding changes by more than 3 or with log returns greater than 30 percent in absolute value. This eliminates about 24,000 out of 3.6 million fund-day combinations, mostly due to the first restriction.

[5] Funds that cater to high-frequency traders (e.g., Rydex, Profunds, Potomac) are an exception. I drop these funds from the sample.

TABLE 1—CORRELATION OF FUND FLOWS WITH
POST-4 P.M. MARKET MOVEMENTS
(Dependent variable: Flow(t)/Assets(t − 1))

	International	U.S. equity
Observations	1103	1103
R^2	0.44	0.07
3 a.m. to 11:30 a.m.	0.368***	0.056***
	(0.026)	(0.008)
11:30 a.m. to 4 p.m.	0.473***	0.064***
	(0.023)	(0.009)
4 p.m. to 4:15 p.m.	0.418***	0.096***
	(0.113)	(0.035)
4:15 p.m. to 5 p.m.	0.365***	0.085***
	(0.103)	(0.024)
5 p.m. to 6 p.m.	0.269**	0.050*
	(0.118)	(0.028)
6 p.m. to 7 p.m.	0.067	0.028
	(0.186)	(0.040)
7 p.m. to 8 p.m.	0.313	0.103*
	(0.210)	(0.058)
8 p.m. to 9 p.m.	0.274	−0.041
	(0.221)	(0.054)
9 p.m. to 3 a.m. (t + 1)	−0.036	0.024
	(0.098)	(0.030)
3 a.m. to 11:30 a.m. (t + 1)	−0.018	−0.008
	(0.024)	(0.009)
11:30 a.m. to 4 p.m. (t + 1)	0.025	−0.013
	(0.025)	(0.007)

Notes: Each column is a regression of the equal-weighted average inflow-to-asset ratio for funds in a category on S&P 500 futures changes in three different time windows. Heteroskedasticity-robust standard errors in parentheses.

 * Significant at 10-percent level.
 ** Significant at 5-percent level.
 *** Significant at 1-percent level.

does not significantly affect the coefficient estimates after 4 p.m., but does improve their precision.[6]

The coefficients in Table 1 provide strong evidence of a correlation with market movements between 4 p.m. and 6 p.m., and weak evidence for 6 p.m. to 9 p.m. The absence of a correlation with movements after 9 p.m. is consistent with 9 p.m. being the latest late trading time mentioned in the complaint against Canary Capital Partners, LLC.[7] The correlations are

strongest in technology, international, and small-cap equity funds, suggesting that late traders understandably focus on asset classes with more volatility and in which 4 p.m. NAVs are stale (Zitzewitz, 2006, Table 1).

Comparing the coefficients for international funds before and after 4 p.m. yields one measure of the extent of late trading. Suppose that arbitrageurs trade based on either changes in the S&P 500 futures as of 4 p.m. (stale price arbitrage) or as of 6 p.m. (late trading). In this case, the (dollar-weighted) shares of arbitrageurs who also late trade will be given by the ratio of the coefficients before and after 4 p.m. This ratio suggests that 57 percent of arbitrageur dollars were also being late traded. If, instead, one assumes that arbitrageurs take into account the higher beta of international markets with respect to S&P 500 future movements after 4 p.m., one would conclude that 30 percent of arbitrageur dollars were late traded (Zitzewitz, 2006, p. 12).

This is perhaps surprising, given the modest contribution of late trading to the profitability of arbitrage trading international funds. An arbitrageur trading in and out of the average international equity mutual fund would have earned annualized abnormal returns of 37 percent by making trading decisions at 4 p.m.; making trading decisions at 9 p.m. increases these returns only to 40 percent (calculated in Zitzewitz, 2006).[8]

It is puzzling that international fund arbitrageurs engaged in illegal activity to raise their returns by such a modest amount. A possible explanation is that late trading was available only to arbitrageurs who were so large that they were compelled to trade in multiple asset classes, including large-cap equity that was profitable to trade only using information after 4 p.m. Given that they were already late trading domestic funds, even a small amount of incremental profit made late trading international funds attractive. Unfortunately, with only fund-level data, I cannot test this hypothesis.

To further examine how widespread late trading was, I repeat the analysis in Table 1 for individual fund families. If I replicate Table 1 for individual fund families and test the

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[6] Including other determinants of flows that are known as of 4 p.m., such as distributions or seasonals, does not affect the results, as one would expect given that they are essentially uncorrelated with 4:15 p.m.-to-9 p.m. market movements.

[7] *State of New York v. Canary Capital Partners, LLC* (2003), *Complaint,* p. 7.

[8] For the average domestic equity fund, on the other hand, prices are not very stale as of 4 p.m., and postponing decisions until 9 p.m. raises abnormal returns from 3 percent to 14 percent (Zitzewitz, 2006, Table 3).

statistical significance of market movements between 4:15 p.m. and 9 p.m., I find evidence (at a one-tailed, 95-percent confidence level) of late trading in the international funds of 40 out of 71 fund companies and the domestic equity funds of 13 of 77 families.[9] Among families with sufficient data available from both asset classes, for 39 of 66 the joint hypothesis of no late trading in either asset class can be rejected; 11 of these families test positive for late trading in both classes.

This does not necessarily imply that all 39 fund families were colluding with late traders. First, given a 95-percent confidence level, one would expect a false positive rate of 5 percent. In addition, late traders often placed trades through intermediaries; in these cases fund companies may have been aware of the frequent trading, but not of the fact that trading decisions were being made after 4 p.m. The Securities and Exchange Commission (SEC) reported in November 2003 that just over 10 percent of 88 large fund families admitted to knowledge of late trading in their funds (Cutler, 2003, p. 16). Combined with my results, they suggest that some funds were aware of the late trading, and some were not.

My agreements with TrimTabs and Lipper prevent me from reporting results for individual fund companies, but a sufficient number of fund families have been named by regulators as having knowingly allowed late trading, so that I can report results for these families as a group.[10] If I replicate the results in Table 1 for named and unnamed fund families, I find that the coefficient for named firms is approximately three times higher than for unnamed firms. This factor of 3 difference exists for both international and U.S. equity funds and is significant at the 1-percent level. Given that these firms represent about 11 percent of assets in my sample, this implies that about 30 percent of the late trading in my sample was conducted in fund families that were cited for knowingly allowing it.

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[9] Fund families with fewer than 5,000 observations (fund ∗ day combinations) were excluded from this analysis.

[10] According to the "Scandal Scorecard" on www.wsj.com, the following firms have been accused of knowingly allowing late trading as of December 2004: Alger, Alliance, Bank of America, Federated, and MFS. Not all of these firms are necessarily included in my combined sample.

TABLE 2—DILUTION DUE TO LATE TRADING BY YEAR
(Basis points per year)

Year	U.S. equity	International equity
1998	1.17**	5.66**
	(0.73)	(2.23)
1999	1.23***	4.24***
	(0.61)	(2.03)
2000	0.04	1.82
	(1.67)	(1.96)
2001	1.41***	7.88***
	(0.63)	(2.45)
2002	0.92*	0.61
	(0.53)	(2.66)
2003 (Jan.–Aug.)	1.09***	3.23***
	(0.30)	(1.69)
2003 (Sept.–Dec.)	−0.05	0.61
	(0.22)	(0.79)
1998 to 2003	0.88***	3.77***
	(0.36)	(0.90)

Notes: Dilution is calculated as specified in Section III. The heteroskedasticity-robust standard error is from an asset-weighted regression of daily dilution figures on time period dummies.
* Significant at 10-percent level.
** Significant at 5-percent level.
*** Significant at 1-percent level.

III. Measuring Dilution

Dilution of long-term shareholders due to late trading can be calculated as the reduction in fund assets from apparent late trades being priced at today's, rather than tomorrow's, NAV:

$$(1) \quad dil_t = (NAV_{t+1}^{4PM} - NAV_t^{4PM})$$

$$\cdot \frac{E(flow_t|I_t^{9PM}) - E(flow_t|I_t^{4PM})}{NAV_t^{4PM}},$$

where I^{9PM} is market information available as of 9 p.m. The second term captures the presumed late trades, measured as the change in the expectation of $flow_t$ due to market movements after 4 p.m.

Table 2 reports estimates of the losses due to late trading. These are calculated using equation (1) above, where $E(flow_t|I_t^{9PM})$ is calculated using the linear model in Table 2 (excluding the right-hand-side variables after 9 p.m.). Unsurprisingly, estimated late trading drops after September 2003, when the regulators' investigation

was announced.[11] Late trading dilution was largest in fund categories that reacted most to market movements: Asian, European, and domestic technology funds (Zitzewitz, 2006, Table 4).

IV. Alternative Explanations

What, other than late trading, could produce a correlation between mutual fund orders before and after 4 p.m. market movements? As mentioned above, one possibility is that some funds in the TrimTabs and Lipper samples report daily asset data post-flow rather than pre-flow, and inappropriately treating them as pre-flow creates an apparent correlation with next-day market movements. The fact that flows are uncorrelated with market movements after 9 p.m. (and that regression coefficients are precisely estimated) suggests that this is not the source of the relatively strong correlation with 4:15 p.m.-to-9 p.m. market movements.[12]

A second possibility is insider trading, e.g., a technology CFO buying a tech fund prior to a positive earnings surprise rather than buying his own company's stock. As a test of whether this was an important source of the correlation, I reestimated Table 1 excluding the period 10 to 45 days after the end of the calendar quarter when over 75 percent of COMPUTSTAT firms announce quarterly earnings. The coefficient excluding this period was not significantly different.

A third possibility is that the causality runs in the other direction: mutual fund inflows lead to an increase in the stock market. The timing of the correlations does not fit well with this explanation, as it would require that flows are front run by people who learn about them between 4 p.m. and 9 p.m. This explanation also does not fit well with the strongest correlation being between S&P 500 futures movements and *international* fund inflows. If reverse causality were the source of the correlation, regressing 4:15 p.m.-to-9 p.m. S&P 500 returns on the estimated dollar value of inflows into international and domestic equity funds would capture this relationship. The resulting coefficient on international fund inflows suggests that a $1 billion inflow "causes" a 32-basis-point appreciation in the S&P 500, which is an implausibly large effect by several orders of magnitude.

V. Discussion

This paper presents evidence that mutual fund trades purportedly placed before 4 p.m. are correlated with market movements from 4 p.m. to 9 p.m. and argues that illegal late trading is the likely source of the correlation. Trading mutual funds using information after 4 p.m. earns profits for the arbitrageurs but costs long-term shareholders an annual average of 3.8 and 0.9 basis points from 1998 to 2003 in international and domestic equity funds, respectively, or about $400 million per year. While dilution due to late trading may have been small as a percentage of assets, the fact that illegal trading was so widespread has helped prompt increased regulatory scrutiny of manager-investor conflicts more generally.

The extent of late trading appears to have dropped sharply since September 2003. In addition, policy proposals are now being considered that will likely make late trading more difficult to execute. Among these is the so-called "hard close," which would require orders to be received by the fund or its transfer agent by 4 p.m., eliminating the possibility for intermediaries to add or cancel orders after 4 p.m. Even if this rule were put in place, however, it is unlikely that any system will be completely immune to abuse. It is hoped that the fairly simple empirical techniques used in this paper will provide a method for fund managers, trustees, and regulators to monitor for late trading in the future.

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[11] The apparent *decline* in late trading from 1999 to 2000 is not related to the addition of the Lipper funds to the sample; a similar decline is observed if the sample is restricted to the TrimTabs data.

[12] In addition, I replicate the family-level tests for correlations with post-9 p.m. next-day market returns conducted in Zitzewitz (2003) and again find that the null hypothesis of no correlation is rejected only at rates that approximate the significance level of the test.

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