How Widespread is Late Trading in Mutual Funds?

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Abstract. This paper uses daily fund flow data to examine the extent of late trading in the U.S. mutual fund industry. Trading decisions that are required by law to have been made before 4 PM Eastern Time are correlated with market movements from 4 to 9 PM that evening. The cross-sectional variation in this correlation is consistent with late trading being its primary cause and inconsistent with alternative explanations. For example, apparent late trading ceases in September 2003 after the announcement of the investigation into mutual fund trading practices, it is three times greater in fund families that have been cited by regulators for allowing late trading, and it is greater in funds and asset classes that are also receiving heavy stale price arbitrage flows. In my sample, which includes 75 percent of non-specialized equity mutual funds and 48 percent of assets, late trading led to average annual shareholder dilution from 1998 to 2003 of 3.8 and 0.9 basis points in international and U.S. equity funds, respectively. If these dilution rates prevailed industry wide, they would imply shareholder losses of about $400 million per year. Furthermore, there is statistically significant evidence of late trading in the funds of 39 of 66 fund families.

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Introduction

One of the major components of the so-called Mutual Fund Scandals of 2003 is the allegation that certain investors were allowed to engage in the late trading of mutual fund shares. Under the forward pricing rule, trades in U.S.-based open-ended mutual funds are to be priced at the next net asset value (NAV) calculated after an order is received.[1] The vast majority of U.S.-based mutual funds calculate NAVs once per day at 4 PM Eastern Time, and so, for these funds, orders received before 4 PM should be priced at the NAV calculated on the day of the trade while trades received after 4 PM should instead be priced at the next-day net asset value.[2]

Late trading occurs when investors place trades after 4 PM but still receive the 4 PM price. These late traders can use the information revealed after 4 PM to guide their trades: buying funds when their current value is greater than their 4 PM value and selling the funds 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 presents a methodology for using daily mutual fund flow data to test for whether late trading has occurred in a particular fund. Using this methodology and daily flow data from approximately 75 percent of U.S.-based equity mutual funds (representing 48 percent of assets), it estimates that average losses to long-term

[1] See rule 22c-1 enacted in 1968 under the Investment Company Act of 1940. Investors in open-ended mutual funds buy and sell shares from the fund itself, contributing or receiving the fund's net asset value per share on the day of the trade.

[2] One of the legal defenses that will apparently be used by some of those accused of late trading is to claim that the "time of NAV calculation" refers to the time that the calculation is actually performed, usually 30-90 minutes after 4 PM, as opposed to the time the NAV is calculated as of. Regulators do not agree that this is a reasonable interpretation of the law, but it remains to be seen if this defense will prevail in court. See, e.g., Stewart (2004) and Wells and Wighton (2004).

shareholders from late trading were 3.8 and 0.9 basis points in international and domestic equity funds from 1998-2003, 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 by 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.[3]

The basic approach of this paper is to test whether trades that are supposed to have been placed before 4 PM are correlated with market movements after 4 PM that make the trade turn out to have been advantageous. In my sample, this correlation exists with market movements between 4 and 9 PM, but not with post-9 PM movements. Clearly, if such a correlation exists, one of the leading candidate explanations is that some of the trading decisions in question were made as late as 9 PM. Alternative explanations are considered, but none fit the facts well. As additional pieces of evidence that these correlations are indeed indicative of late trading, I note: 1) that my estimate of late trading is roughly three times higher for mutual fund companies that have been cited for allowing late trading in enforcement actions as of April 2004 and 2) that estimated late trading fell fairly sharply in mid-to-late 2003, when investigations by federal and state regulators began.[4]

[3] See, for example, industry participants quoted in Burton (2003), Hechinger (2003) and Nelson (2003).
[4] A caveat: my understanding is that methods similar to those outlined in this paper have been used by regulators to test for or corroborate evidence of late trading, so the fact that named funds have higher measured late trading may be partly related to this similarity of measurement techniques.

Why should economists, as opposed to regulators and prosecutors, care about late trading or any of the other issues raised in the recent investigations? One reason is that mutual funds have become a or even the primary investing and retirement savings vehicle in the U.S., especially for middle and upper-middle class investors. While the drain from these savings due to late trading was fairly modest in percentage terms, the discovery of late trading has helped prompt a reassessment of agency problems in and hidden costs of mutual fund investing. This study thus contributes to a literature that includes work documenting the extent of stale price arbitrage (Greene and Hodges, 2002; Zitzewitz, 2003), soft dollars and 12b1 fees (Siggelkow, 2003), favoritism within fund families (Gaspar, Massa, and Matos, 2003), the high level of expenses and commissions (Hortascu and Svensson, 2004), and risk taking in response to incentives (Chevalier and Ellison, 1997). It also can be viewed as adding to a broader set of studies that use statistical techniques to detect illegal activity.

The remaining sections in this paper provide background on late trading, describe the data and methodology, present the results, and examine alternative explanations. A discussion follows.

I. Background

Mutual funds were widely abused by insiders in the 1920s.[5] For example, during certain hours of the day, insiders could simultaneously trade at today and yesterday's prices, extracting money from the fund at the expense of long-term shareholders. The Investment Company Act of 1940 aimed to restore investor confidence by preventing

[5] See Baumol, et. al. (1990) and Ciccotello, Edelen, Greene, and Hodges (2002) for details.

these and related abuses, and contains numerous provisions designed to ensure that NAVs used for transactions accurately reflect the current value of the fund.

Prior to 1968, however, most mutual funds practiced backward pricing, pricing trades using the most recent *prior* NAV. This created an analogous opportunity for investors, particularly those who were able to avoid sales loads, to dilute long-term shareholders by buying shares in a fund on days in which the market value of its assets had risen. On such days, the NAV used to price the transaction was less than the current value of the assets at the time the trade was placed.[6] The forward pricing rule was adopted to protect average shareholders from this dilution. The rule is extremely well known throughout the industry, since it determines the dating and thus the pricing of mutual fund trades.

State and federal regulators have alleged that certain investors were allowed to place trades after 4 PM, in some cases as late as 9 PM, that received the 4 PM price. This lowered the returns of the funds involved, but favored investors often paid for the privilege, either directly or via so-called sticky asset deals, in which they placed additional monies in high-expense ratio investments.

The degree to which funds were aware of illegal late trading in their funds varies. In some cases, fund management companies had direct knowledge of the late trading. In others, the late trading was executed through intermediaries, such as brokerage firms. Mutual funds have traditionally allowed intermediaries extra time after 4 PM to total the day's orders before reporting them to the fund; some intermediaries allegedly used that

[6] The difference between a fund's current value and its last NAV was also used by brokers as an inducement to encourage clients to buy a fund. At the time the forward pricing rule was proposed, an official of a "large Eastern no-load mutual fund" bemoaned "the loss of a good sales tool." (*Wall Street Journal*, 6/26/1968, 2).

extra time to add or delete trades after 4 PM. In these cases, the fund management company was usually aware of high-frequency trading in their funds and in some cases had obtained compensation for allowing the trading, but was not necessarily aware that the trading decisions were being made after 4 PM.

Late trading is related to a practice commonly called market timing. A market timer trades mutual funds at high frequency but makes trading decisions before 4 PM. Often, the motivation for market timing is to exploit the fact that in many asset classes, the most recent price as of 4 PM is stale, i.e. does not fully reflect recent market movements.[7] Examples include international equities (due to the earlier closure of foreign markets) and less-liquid assets such as small-cap equities and high-yield and municipal bonds. As is the case with late trading, the market timer buys (sells) funds following positive (negative) market movements, when the current fund value is above (below) the NAV, diluting long-term shareholders in the process. Unlike late trading, market timing has been documented in the academic literature and discussed in the popular press.[8]

Market timing is legal, whereas late trading is not. But the SEC has been encouraging funds to restrict market timing opportunities through a combination of fair-value pricing (i.e., updating stale prices to reflect recent market movements) and other deterrents such as monitoring and short-term trading fees. At least until mid-2003, most fund companies showed a strong preference for addressing the problem solely through

[7] Market timing is a misnomer, since a "market timer" in an international fund is usually not investing to time the market, but to exploit the stale pricing of mutual fund shares. But since market timing is the term that is widely used by industry, I will use it as well in this paper.

[8] Academic papers on the subject include Bhargava, Bose, and Dubofsky (1998), Chalmers, Edelen, and Kadlec (2001), Goetzmann, Ivkovic, and Rouwenhorst (2001), Greene and Hodges (2002), Boudoukh, Richardson, Subrahmanyam, and Whitelaw (2002), and Zitzewitz (2003). Press coverage from before September 2003 includes Hulbert (2000), Lucchetti (2000), Bullard (2000), Stone (2002), and Carnahan (2003).

fees and monitoring, despite the shortcomings of these solutions. The most notable shortcoming is that whereas proper fair-value pricing removes dilution opportunities from all investors equally, it is difficult to ensure that fees and monitoring are applied to all investors. I remarked on this puzzling preference for fees and monitoring in Zitzewitz (2003), and postulated that one possible explanation was that fund managers wanted to preserve the right to selectively allow dilution opportunities to specific investors. The current investigations have revealed multiple instances in which fund management companies exempted specific investors from fees and monitoring in exchange for compensation.

Late trading is often practiced in combination with market timing. Both practices are based on the underlying principle of trading using information not yet reflected in fund NAVs, both involve the frequent buying and selling of funds, and both are easier to implement in large scale with the complicity of the fund manager. In several cases, arbitrageurs were willing to pay mutual fund companies for the right to frequently trade funds in asset classes in which the prices use to calculate NAVs are not stale as of 4 pm (e.g., large-cap equity). Late trading provides an explanation for why they might have been willing to do so.

II. Data and Methodology

The basic approach of the paper is to determine the extent of late trading by measuring the correlation between daily mutual fund flows and post-4 PM market movements. Post-4 PM movements in liquid, efficient markets should be difficult to anticipate as of 4

PM, so if trading decisions are correlated with these market movements, it may be evidence that the trading decisions were made after 4 PM.

A simple example of a regression testing for late trading would be the following:

$$\frac{flow_t}{assets_{t-1}} = \beta_0 + \beta_1 \cdot \Delta SP_t^{3:00-11:30} + \beta_2 \cdot \Delta SP_t^{11:30-16:00} + \beta_3 \cdot \Delta SP_t^{16:15-21:00} + \varepsilon_t . \qquad (1)$$

The dependent variable is net inflows to the fund, normalized by prior-day assets, where inflows are defined as the difference between the assets of the fund(s) in question and the prior-day assets adjusted for current-day fund returns. The independent variables are changes in the Chicago Mercantile Exchange near-month S&P 500 futures price. The first two terms control for market timing using pre-4 PM information; the third term captures late trading using post-4 PM information. Controlling for pre-4 PM market movements serves two purposes: 1) it controls for any correlation between pre and post-4 PM market movements which, given the liquidity of the S&P 500 future, is minor, and 2) by reducing the variance of the error term, it improves the efficiency of estimation.[9]

A starting time of 4:15 is used for the third term to prevent any staleness in the 4 PM S&P futures price from improperly leading to an inference of late trading. The S&P future is extremely liquid, with bid-ask spreads that are 1-2 basis points at 4 PM, so any staleness should be minor. Nine PM is taken as the stopping time since that was the latest late trading time mentioned in the complaint against Canary Capital Partners, LLC.[10]

[9] One might include other determinants of flows that are known as of 4 PM on the right-hand-side as controls; examples include distributions and fixed effects for seasonals (e.g., day of week, day of month, month). Doing so does not affect the results, as one would expect given that their effect on flows is smaller and that they are essentially uncorrelated with 4:15 to 9 PM market movements.

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

Dilution of long-term shareholders due to late trading can be calculated in two ways that are conceptually different, but turn out to be quantitatively equivalent in expectation. The first approach is to measure the reduction in fund assets from the apparent late trades being priced at today's rather than tomorrow's NAV:

$$dil_t = (NAV_{t+1}^{4PM} - NAV_t^{4PM}) \cdot \frac{E(flow_t \mid I_t^{9PM}) - E(flow_t \mid I_t^{4PM})}{NAV_t^{4PM}}, \qquad (2)$$

where I^{9PM} is market information available as of 9 PM. The second term captures the presumed late trades, measured as the change in the expectation of $flow_t$ due to post-4 PM market movements. The second approach is to measure the reduction in fund assets relative to what they would have been had trades placed by 9 PM been priced at a 9 PM NAV:

$$dil_t = (NAV_t^{9PM} - NAV_t^{4PM}) \cdot \frac{E(flow_t \mid I_t^{9PM}) - E(flow_t \mid I_t^{4PM})}{NAV_t^{4PM}} \qquad (3)$$
$$NAV_t^{9PM} = E(NAV_{t+1}^{4PM} \mid I_t^{9PM})$$

The difference between (2) and (3) is the product of unanticipated NAV returns and anticipated flows (as of 9 PM); in expectation, this product must be zero.[11] Equation (3) can be viewed as a less noisy version of (2), since it eliminates the component of late trading dilution related to post-9PM market movements. Assuming that trading decisions used only pre-9 PM market information, then this post-9 PM component might be regarded as attributable to luck rather than to the improper trading.

[11] If the expectations are estimated in-sample using the same linear regression model for flows and returns, then (2) and (3) will be identical, even in a finite sample.

The daily fund flow data come from TrimTabs and Lipper, which collect daily assets, returns, and distributions from subsets of U.S.-based open-ended mutual funds. TrimTabs data is available from February 1998 to December 2003; Lipper data from March 2000 to December 2003. Since post-4 PM 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 those sector funds whose returns are well predicted by general equity indices (communication and technology funds). Of the funds in the June 2001 Morningstar universe for these categories 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, TrimTabs data is used.[12] A small number of observations from Lipper are eliminated as outliers.[13]

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, Section 4 and Greene and Hodges, 2002, for a discussion of this issue).[14] I correct for this lag by calculating flows assuming each day's asset figures are pre-flow rather than post-flow, but perform checks below to ensure that this correction is appropriate.

For simplicity, I use changes in the price of the near-month S&P 500 future from the CME/Globex Time and Sales data as a single indicator of recent market movements.

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[12] 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.

[13] Specifically, observations in which the log of shares outstanding changes by more than 3 (i.e., the number of shares grows or shrinks by a factor of more than roughly 10 in a day) or with log returns greater than 30 percent in absolute value are eliminated as outliers. This eliminates about 24,000 out of 3.6 million fund-day combinations; mostly due to the first restriction.

[14] An exception to this are funds that cater to high-frequency traders (e.g., Rydex, Profunds, Potomac), which do not report with a lag to TrimTabs (but do report with a lag to Lipper). I drop these funds from the sample.

The S&P future trades from 4:45 PM through to the following trading day every day except Friday (and other days preceding a market closure). I experimented with alternative post-4 PM indicators (the Nasdaq 100 future for technology funds; the Singapore Nikkei future opening price for Japan funds); these indicators were slightly better predictors of next-day returns but were 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.

III. Results

Table I presents estimates of equation (1) for international and U.S. equity funds, and for subcategories thereof. Results are reported for both equal-weighted and asset-weighted average inflows. The results suggest clear evidence of a correlation between post-4 PM market movements and mutual fund inflows, consistent with late trading. The correlations suggest that late trading is most prevalent in technology, international and small-cap equity funds, suggesting that late traders focus on asset classes with more volatility and in which 4 PM NAVs are stale.

Table II repeats the analysis with a finer decomposition of time periods on the right-hand side. The relationship between current-day flows and market movements is statistically significant in every time period until 6 PM. The sum of the coefficients from 6 PM to 9 PM is significant for international equity and all funds, although coefficients for individual hourly figures are mostly not. After 9 PM, estimated coefficients are close to zero (and fairly precisely estimated). The absence of a correlation between today's inflows and post-9 PM market movements suggests that the correlation with 4 to 9 PM

market movements is not due to an inappropriate correction for timing lags in the Lipper and TrimTabs data.

Comparing the pre and post-4PM coefficients for international funds yields one measure of how widespread late trading is. Suppose that arbitrageurs in international funds trade either only on pre-4 PM market movements or on market movements through to 6 PM -- they either do stale price arbitrage only or combine it with late trading, but never practice late trading as a stand-alone strategy. Assume also that their investment rule is linear in expected next-day fund returns. In this case, the (dollar-weighted) share of stale price arbitrageurs who also late trade is given by:

$$\frac{\beta_{flow}^{post-4PM} \div \beta_{return}^{post-4PM}}{\beta_{flow}^{pre-4PM} \div \beta_{return}^{pre-4PM}}. \qquad (5)$$

This ratio is roughly 30% using 11:30 AM to 4 PM and 5 to 6 PM as the two periods, suggesting that about 30% of stale price arbitrageur dollars were also traded until 5 to 6 PM. The point estimate for the 8 to 9 PM period is less precisely estimated, but its magnitude also suggests that about 30% of arbitrageur dollars were traded until this time.

This is perhaps surprising given the modest contribution of late trading to the profitability of arbitrage trading international funds. Table III presents estimates of the abnormal returns earned by a stale price arbitrageur, a late trader, and a trader employing both strategies together. For domestic equity funds, prices are not very stale as of 4 PM, and so late trading contributes the bulk of the abnormal returns. For international funds the contribution of late trading is modest, however.

It is therefore a puzzle why so many international fund arbitrageurs engaged in illegal activity to raise their returns by such a modest amount. One possibility is that late trading was only available to arbitrageurs who were so large that they were compelled to trade in multiple asset classes, including asset classes like large-cap equity that were only profitable to trade using post-4 PM information. 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.

Tables IV and V report estimates of the losses due to late trading. These are calculated using equation (3) above, where NAV_t^{9PM} and $E(flow_t|I_t^{9PM})$ are calculated using the linear model in Table 2 (excluding the post-9 PM right-hand-side variables). Estimating dilution using (2) yields quantitatively similar, but less precise, estimates. Late trading losses are largest in technology and international equity funds. Losses are large in 1998 and 1999, in 2001, and again in the first eight months of 2003.[15] Unsurprisingly, estimated late trading drops after September 2003, when the investigation by state and federal regulators began.

Equations (2) and (3) can also be constructed using a non-linear model to estimate expected flows and NAV returns. Figure 1 plots kernel regressions of inflows on post-4PM market movements for international, domestic, and technology funds. The relationship appears to be slightly convex, with large positive market movements being accompanied by greater inflows; this is what one would expect if some arbitrageurs followed an asymmetric trading strategy of owning the fund only on days with large

[15] The apparent decline 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.

positive expected returns. Tests for these relationships using a quadratic or a spline functional form allowing for a slope change at zero do not reject the linear model at standard statistical confidence levels, however.

One can also test the appropriateness of the linear expectational model by testing whether $NAV_{t+1}^{4PM} - NAV_t^{9PM}$ is correlated with $flow_{t+1} - E(flow_{t+1}|I_t^{9PM})$. If today's "unexpected" flows are correlated with post-9PM "unexpected" returns, it may indicate that the expectational model used by the econometrician is less sophisticated than the model used by arbitrageurs. Tests for this correlation do not reject at the 5 percent significance level for any of the seven asset classes listed in Table I.

Another way in which to examine how widespread late trading was is to repeat the analysis in Table I for individual fund families. 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 in SEC and state investigations as of April 2004 that I can report results for these families as a group.[16] If I replicate the asset-weighted results Table I for named and unnamed fund families, I find that coefficients are neither statistically nor economically significantly different for either international or U.S. equity funds. If I limit the named firms to firms that have been specifically cited for allowing late trading, however, 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

[16] According to the "Scandal Scorecard" on WSJ.com, the following firms have been accused of allowing improper trading as of April 2004: Alliance, Alger, Amvescap, Bank of America, Bank One, Deutsche, Federated, Fleet, Franklin-Templeton, Fremont, Janus, MFS, PEA/Pimco, Pilgrim, Putnam, RS, Strong. Of these, Alger, Alliance, Bank of America, Federated, and MFS have been specifically cited for allowing late trading. Not all of these firms are necessarily included in my combined sample.

about 30 percent of the late trading in my sample was conducted in fund families that have already been cited for it.

If I replicate Table I for individual fund families, I find statistically significant evidence (at a one-tailed, 95 percent confidence level) of late trading in the international funds of 40 out of 71 fund companies in the combined sample.[17] In domestic equity funds there is evidence of late trading for 13 out of 77 families. 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 40 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, sources such as the NYAG's complaint against Canary Capital Partners alleged that late traders often placed trades through intermediaries such as Bank of America or Security Trust Company; in these cases funds may have been aware of the frequent trading, but not of the fact that trading decisions were being made after 4 PM. The 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, 16). These survey results are self-reported, and may thus be downwardly biased, but combined with my results they suggest that some funds were aware of the late trading, and some were not.

[17] In other words, the coefficient on the 4:15 to 9 PM market movements is positive and significant for 40 out of 71 fund families. The coefficient is negative and significant for 2 of 71 and 4 of 77 families for international and domestic equity funds, respectively. Regressions for fund families are run by constructing a time series of total inflows-to-total assets ratios for a family's funds in a given asset class. Fund families with fewer than 5,000 observations (fund*day combinations) were excluded from this analysis.

IV. Alternative Explanations

What, other than late trading, could produce a correlation between supposedly pre-4 PM mutual fund orders and post-4 PM 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 post-9 PM market movements (and the regression coefficients are precisely estimated) suggests that this is not the source of the relatively strong correlation with 4:15 to 9 PM market movements.[18]

A second possibility is insider trading, e.g. a technology CFO buying a tech fund prior to a positive earnings surprise rather than buying company stock. As a test of whether this was an important source of the correlation, I reestimated Table I excluding the period 10 to 45 days after the end of the calendar quarter when over 75 percent of COMPUSTAT 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; the story would have to be that flows through intermediaries that get invested the following day are front run by people who learn about them between 4 and 9 PM. This explanation also does not fit well with the fact that the strongest correlation is between international fund inflows and post-4 PM movements in the S&P

[18] In addition, I replicate the family-level tests for correlations with post-9 PM 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. Especially for international funds, where it is now acknowledged that stale price arbitrage was commonplace, this suggests that the flow data is not inappropriately lagged.

500. If reverse causality were the source of the correlation, regressing 4:15 to 9 PM S&P 500 returns on the estimated dollar value of inflows into international and domestic equity funds would capture this relationship. When I do this, I get a negative and statistically insignificant coefficient on domestic fund inflows. The 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 supposedly placed before 4 PM are correlated with market movements from 4 to 9 PM, and argues that illegal late trading is the likely source of the correlation. Trading mutual funds using post-4 PM information earns profits for the arbitrageurs, but costs long-term shareholders an annual average of 3.8 and 0.9 basis points from 1998-2003 in international and domestic equity funds, respectively. Assuming this dilution rate prevails throughout the industry, this would imply annual losses of about $400 million. While the amount of long-term shareholder wealth lost due to late trading is large in absolute dollar terms, it is small relative to that lost to market timing. It is also probably smaller than the impact of other issues that are now receiving scrutiny, such as excess trading due to incentives created by soft dollars and investors of choosing high-expense-ratio funds.

But charging a high expense ratio for an index fund, overtrading to earn soft dollars, and even allowing market timing are not illegal, whereas allowing late trading is. Late trading is thus suggestive of a different kind of oversight and agency problem within

mutual funds than these other practices. Understanding the extent to which the mutual fund industry engaged in illegal activity that harmed shareholders is of first-order importance in understanding the degree of agency problems in the industry.

On the positive side, 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 PM, eliminating the possibility for intermediaries to add or cancel orders after 4 PM. Even if this rule is put in place, however, it is unlikely that any system will be completely immune to abuse. Hopefully, 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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Table I. Correlation of fund inflows with post-4PM market movements
Dependent variable: flow(t)/assets(t-1)

				S&P 500 futures changes					
	Weighting	**Obs.**	**R^2**	**3 AM to 11:30 AM**		**11:30 AM to 4 PM**		**4:15 PM to 9 PM**	
International equity	Equal	1101	0.43	0.361***	(0.026)	0.459***	(0.024)	0.309***	(0.074)
	Asset	1101	0.49	0.200***	(0.014)	0.301***	(0.015)	0.173***	(0.043)
Foreign stock	Equal	1101	0.29	0.323***	(0.029)	0.531***	(0.032)	0.423***	(0.090)
	Asset	1101	0.46	0.240***	(0.019)	0.403***	(0.021)	0.254***	(0.058)
Asia/Japan/Europe stock	Equal	1101	0.40	0.844***	(0.066)	0.830***	(0.056)	0.593***	(0.172)
	Asset	1101	0.44	0.810***	(0.063)	1.033***	(0.059)	0.434**	(0.178)
Global/Latin/EM stock	Equal	1101	0.34	0.219***	(0.025)	0.254***	(0.017)	0.102**	(0.049)
	Asset	1101	0.38	0.114***	(0.008)	0.136***	(0.008)	0.072***	(0.024)
U.S. equity	Equal	1101	0.07	0.053***	(0.007)	0.060***	(0.008)	0.061***	(0.017)
	Asset	1101	0.14	0.033***	(0.005)	0.050***	(0.004)	0.039*	(0.020)
Large cap	Equal	1101	0.02	0.040***	(0.008)	0.044***	(0.010)	0.051***	(0.018)
	Asset	1101	0.06	0.022***	(0.006)	0.035***	(0.004)	0.025	(0.022)
Mid cap	Equal	1101	0.10	0.067***	(0.009)	0.094***	(0.009)	0.044*	(0.027)
	Asset	1101	0.21	0.060***	(0.009)	0.104***	(0.008)	0.049**	(0.021)
Small cap	Equal	1101	0.08	0.065***	(0.011)	0.072***	(0.010)	0.107**	(0.042)
	Asset	1101	0.05	0.063***	(0.010)	0.069***	(0.008)	0.071***	(0.026)
Technology funds	Equal	1101	0.03	0.239***	(0.099)	0.240***	(0.049)	0.184***	(0.058)
	Asset	1101	0.13	0.147***	(0.035)	0.253***	(0.026)	0.355***	(0.080)

Notes:
1. Each row is a regression of flows on S&P futures changes for different asset classes and weighting methods.
2. Heteroskedasticity-robust standard errors in parenthesis.
3. Significance at 10, 5, and 1 percent level indicated by 1, 2, and 3 asterisks, respectively.

Table II. Until when does late trading occur?

Dependent variable	Flow(t)/Assets(t-1)			Returns(t+1)		Standard deviation of S&P changes
Asset class	International	U.S. equity	All	International	U.S. equity	(in basis points)
Observations	1103	1103	1103	1103	1103	
R^2	0.44	0.07	0.25	0.68	0.92	
3 to 11:30 AM	0.368***	0.056***	0.212***	0.217***	0.000	82.2
	(0.026)	(0.008)	(0.015)	(0.020)	(0.015)	
11:30 AM to 4 PM	0.473***	0.064***	0.268***	0.348***	0.083***	93.8
	(0.023)	(0.009)	(0.014)	(0.020)	(0.016)	
4 to 4:15 PM	0.418***	0.096***	0.114*	0.516***	0.695***	23.0
	(0.113)	(0.035)	(0.065)	(0.067)	(0.111)	
4:15 to 5 PM	0.365***	0.085***	0.225***	0.683***	0.934***	21.7
	(0.103)	(0.024)	(0.056)	(0.064)	(0.054)	
5 to 6 PM	0.269**	0.050*	0.160**	0.908***	0.981***	16.8
	(0.118)	(0.028)	(0.064)	(0.092)	(0.071)	
6 to 7 PM	0.067	0.028	0.047	0.571***	1.044***	10.6
	(0.186)	(0.040)	(0.103)	(0.156)	(0.102)	
7 to 8 PM	0.313	0.103*	0.209*	0.955***	0.783***	9.1
	(0.210)	(0.058)	(0.122)	(0.179)	(0.122)	
8 to 9 PM	0.274	-0.041	0.116	1.082***	0.823***	9.7
	(0.221)	(0.054)	(0.122)	(0.242)	(0.165)	
9 PM to 3 AM (t+1)	-0.036	0.024	-0.006	1.206***	1.059***	24.8
	(0.098)	(0.030)	(0.052)	(0.118)	(0.050)	
3 to 11:30 AM (t+1)	-0.018	-0.008	-0.012	0.575***	0.980***	
	(0.024)	(0.009)	(0.014)	(0.022)	(0.014)	
11:30 AM to 4 PM (t+1)	0.025	-0.013	0.006	0.212***	0.908***	
	(0.025)	(0.007)	(0.014)	(0.019)	(0.016)	

Notes:
1. Each column is a regression of flows or returns on S&P futures changes for different time periods.
2. Heteroskedasticity-robust standard errors in parenthesis.
3. Significance at 10, 5, and 1 percent level indicated by 1, 2, and 3 asterisks, respectively.

Table III. Theoretical profitability of stale price arbitrage, late trading, and the two strategies in tandem
Annualized excess returns versus buy-and-hold strategy with comparable exposure to same funds

	Strategy pursued		
Asset class	Stale price arbitrage	Late trading	Both
All international equity	37.1***	8.5**	40.3***
	(4.2)	(3.6)	(4.4)
All domestic equity	3.2	10.7*	13.6**
	(5.7)	(5.6)	(5.8)
Domestic technology funds	2.4	18.7**	20.9***
	(7.8)	(7.7)	(7.9)

Notes:

Annualized excess returns are measured as in Zitzewitz (2003): a maximum frequency trading strategy is assumed in which the trader holds the equal-weighted average fund if expected next-day returns are positive and cash otherwise. Expected returns are estimated using the model in Table I for the two prior years (for domestic equity funds, S&P changes from 2 to 3 PM and 3 to 4 PM are substituted as the pre-4PM predictive variables). Returns are compared with a strategy of buying and holding the fund and cash in proportions that yields the same average exposure to the fund. Heteroskedasticity-robust standard errors are in parenthesis.

Table IV. Dilution due to late trading by asset class
Basis points per year, 1998-2003

	Equal	Value
U.S. equity	1.30***	0.88**
	(0.34)	(0.36)
Large cap	0.95***	0.51
	(0.30)	(0.35)
Mid cap	0.94**	1.02***
	(0.44)	(0.38)
Small cap	1.55***	1.06***
	(0.55)	(0.37)
Technology funds	6.74***	13.45***
	(1.95)	(2.73)
International equity	6.27***	3.77***
	(1.57)	(0.90)
Foreign stock	6.05***	3.80***
	(1.25)	(0.83)
Asia/Japan/Europe stock	11.30***	10.23***
	(3.54)	(3.83)
Global/Latin/EM stock	2.36**	1.62***
	(1.05)	(0.52)

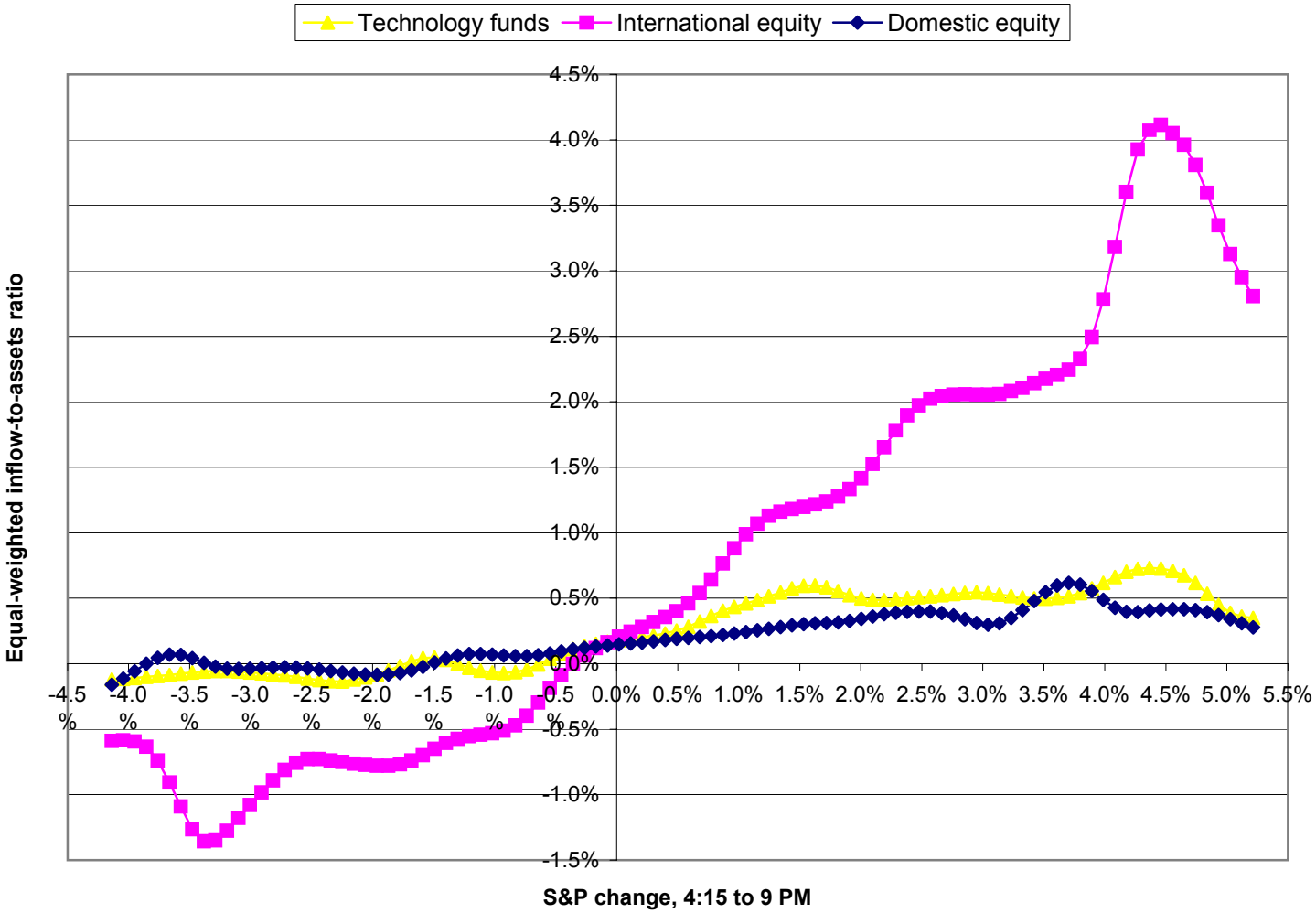
Dilution is calculated for each day using the formula in Equation (3) in the text and the model in Table II (including variables through 9 PM). The heteroskedasticity-robust standard error is from a regression of these 1,076 daily dilution figures on a constant.

Table V. Dilution due to late trading by year
Basis points per year

	U.S. Equity		International equity	
Year	Equal	Value	Equal	Value
1998	2.21**	1.17**	11.68**	5.66**
	(1.00)	(0.73)	(4.32)	(2.23)
1999	2.84***	1.23***	7.35***	4.24***
	(1.03)	(0.61)	(3.30)	(2.03)
2000	1.11*	0.04	4.25	1.82
	(0.66)	(1.67)	(4.65)	(1.96)
2001	1.12***	1.41***	12.68***	7.88***
	(0.69)	(0.63)	(3.91)	(2.45)
2002	-0.01	0.92*	-1.16	0.61
	(0.82)	(0.53)	(3.67)	(2.66)
2003 (Jan-Aug)	0.87***	1.09***	4.12***	3.23***
	(0.33)	(0.30)	(3.01)	(1.69)
2003 (Sept-Dec)	1.96	-0.05	-0.03	0.61
	(3.17)	(0.22)	(0.81)	(0.79)
1998 to 2003	1.30***	0.88***	6.27***	3.77***
	(0.34)	(0.36)	(1.57)	(0.90)

Dilution is calculated for each day using the formula in Equation (3) in the text and the model in Table II (including variables through 9 PM). The heteroskedasticity-robust standard error is from a regression of these 1,076 daily dilution figures on time period dummies.

Figure 1. Non-parametric estimate of late trading



Univariate kernel regression using daily equal-weighted inflow-to-assets ratio for each asset class as a dependent variable. Regressions use a Gaussian kernel with a bandwidth of 25 basis points.