Who Cares About Shareholders? Arbitrage-Proofing Mutual Funds

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As is becoming increasingly widely known, mutual funds often calculate their net asset values (NAVs) using stale prices, which causes their daily returns to be predictable. By trading on this predictability, investors can earn 35–70% per year in international funds and 10–25% in asset classes such as small-cap equity and high-yield and convertible bonds. These abnormal returns come at the expense of long-term shareholders, dilution of whom has grown in international funds from 56 basis points in 1998–99 to 114 basis points in 2001. Despite these losses and pressure from the Securities and Exchange Commission (SEC), the vast majority of funds are not market-updating their prices to eliminate NAV predictability and dilution, but are instead pursuing solutions that are only partly effective. The speed and efficacy of a fund's actions to protect shareholders from dilution is negatively correlated with its expense ratios and the share of insiders on its board, suggesting that agency problems may be the root cause of the arbitrage problem.

1. Introduction

Financial markets may be efficient enough to prevent widely known arbitrages, but are financial institutions? Mutual funds currently use pricing policies that allow market timers to earn large trading profits at the expense of long-term shareholders. Despite the fact that this arbitrage opportunity has been understood by the industry for 20 years and heavily exploited since at least 1998, the fund industry was still taking only limited

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action to protect its long-term shareholders as of late 2002. This article contributes to the documentation of the arbitrage opportunity and resulting losses to long-term shareholders, discusses the shortcomings of the industry's response to date, and examines the relationship between funds' governance and their actions to protect their long-term shareholders.

The source of the arbitrage opportunity is the way in which open-end mutual funds price their shares. Whereas investors in closed-end or exchange-traded funds trade with each other on the equity exchanges, investors in open-end mutual funds trade directly with the fund itself. Transactions in open-end funds are priced using the net asset value (NAV) per share calculated by funds at the end of the business day. Funds have traditionally calculated their NAVs by valuing their assets using their most recent transaction prices as of the close of U.S. equity markets at 4:00 P.M. eastern time (ET) and allowed investors to place trades up until that time.

For many asset classes, the most recent transaction price at 4:00 P.M. ET does not fully reflect all available market information. The most obvious example is international equities that trade on exchanges that are located in different time zones and close 2–15 hours before U.S. markets. In addition, domestic small-cap equities and high-yield and convertible bonds often trade infrequently and have wide bid-ask spreads. This can cause the most recent transaction price to be systematically different from the price that would prevail in a liquid market at 4:00 P.M., even for assets that trade on exchanges that are open at that time.

Investors can take advantage of mutual funds that calculate their NAVs using stale closing prices by trading based on recent market movements. For example, if the U.S. market has risen since the close of overseas equity markets, investors can expect that overseas markets will open higher the following morning. Investors can buy a fund with a stale-price NAV for less than its current value, and they can likewise sell a fund for more than its current value on a day that the U.S. market has fallen. Analogous opportunities exist when the values of infrequently or illiquidly traded domestic assets have recently changed.

A series of recent studies have shown that the potential returns to even a very simple trading strategy are quite high. Arbitrageurs who buy international funds on days the S&P 500 has risen and sell them on days it has declined can earn uncompounded excess returns of 35% per year; refinements to the trading strategy can double these returns. The arbitrage returns available in domestic small-cap and convertible and high-yield and convertible bond funds are smaller but still substantial, at 20–25% and 10–25%, respectively. These excess returns come at the expense of long-term shareholders, who are diluted by advantageously timed inflows and outflows. This article presents evidence from a sample of funds that suggests long-term shareholders are losing about $5 billion per year across all asset classes. Dilution is concentrated in international equity funds, where the arbitrage opportunities are largest; in 2001 it averaged 1.1% and

2.3% of assets per year in general and regionally focused international funds, respectively.

Dilution of long-term shareholders has grown rapidly in the last four years, and the mutual fund industry is beginning to respond. But given the size of the problem, the industry response has been surprisingly slow, and it has almost exclusively consisted of countermeasures that have significant shortcomings. The Securities and Exchange Commission (SEC) is not only permitting, but actively encouraging international funds to use systematic methods to substitute market-updated (or "fair-value") prices for stale prices when calculating their NAVs. But the fund industry, as represented by the Investment Company Institute, is lobbying the SEC to back down from requiring fair-value pricing and to allow funds to address the problem solely by adding transaction fees and by monitoring trades for arbitrage activity. These solutions are only partially effective, as evidenced by the fact that dilution is still large even in funds that employ them. In addition, they can be and usually are selectively applied, potentially giving fund companies the discretion to allow certain investors the opportunity to arbitrage their funds. Only a very limited number of funds are regularly using fair-value prices to calculate their NAVs.

Given the magnitude of dilution of long-term shareholders, the industry's surprisingly slow response to the arbitrage issue is suggestive of a conflict between the interests of shareholders and those of either the management company or its employees. One can use this issue to size the extent of these agency problems: simple calculations imply that fund companies that fail to fair value or that consciously allow arbitrage activity in order to increase the short-term size of their funds care less than five cents on the dollar about shareholder returns. Given the relationship between a fund's performance and its future size, these decisions do not maximize the net present value (NPV) of fund company profits for any reasonable discount rate, suggesting an agency problem within management companies as well as between fund managers and shareholders.

Funds have boards of directors that are charged with representing shareholder interests, and I find that funds with more outside directors are more likely to have introduced short-term trading fees or fair-value pricing.[1] This is also the case for funds with lower expense ratios, which is consistent since expense ratios are the result of bargaining between a fund's manager and its board, and a low expense ratio for a fund within a given asset class and management style should indicate stronger representation of shareholder interests (Tufano and Sevick, 1997). Despite these correlations, the slow response by the industry in general suggests that fund boards have been ineffective in protecting investors on this issue, perhaps because they have been captured by managers, as Jensen (1993) argues is the case for corporate boards. Agency problems and governance quality in

1. This echoes the findings of Weisbach (1988), who finds that outsider-dominated corporate boards are more likely to remove managers after poor performances.

asset management are of interest beyond this particular issue, particularly given the debate over social security privatization and the emergence of tax-advantaged savings plans, such as state Section 529 educational savings plans, that require the use of particular asset managers in order to obtain the tax advantages.

Several academic articles have discussed NAV predictability and the associated arbitrage opportunity: Bhargava, Bose, and Dubofsky (1998), Chalmers, Edelen, and Kadlec (2001), Goetzmann, Ivkovic, and Rouwenhorst (2001), Greene and Hodges (2002), and Boudoukh et al. (2002).[2] These articles focus on different asset classes and aspects of the problem: Bhargava, Bose, and Dubofsky (1998) and Goetzmann, Ivkovic, and Rouwenhorst (2001) focus on international funds while Chalmers, Edelen, and Kadlec (2001) studies small-cap U.S. equity funds as well. Goetzmann, Ivkovic, and Rouwenhorst (2001) and Greene and Hodges (2002) provide estimates of dilution, while Boudoukh et al. (2002) examines the extent to which arbitrage trading strategies can be hedged. Relative to those articles, this article focuses on examining the industry response to the issue and the role of fund governance, although it also extends past work on estimating arbitrage returns and dilution. In doing so, it contributes to the literature on agency in fund management that includes work by Chevalier and Ellison (1997) on fund company incentives and risk taking, Tufano and Sevick (1997) on board independence and management fees, and Sigglekow (2003) on 12b1 fees and soft-dollar commissions.

The remainder of the article is organized as follows. The next section provides background on the NAV arbitrage and shareholder dilution issues. Sections 3 and 4 provide estimates of fund arbitrageability and shareholder dilution by asset class. These sections extend past work (1) by providing comparable estimates of arbitrage profitability by asset class, noting for the first time that arbitrage profits are also high in high-yield bond and convertible bond funds, and (2) by providing more disaggregated and more recent calculations of shareholder dilution that highlight both its recent growth and high level in certain asset classes. Section 5 analyzes the effectiveness of solutions that are currently popular in the industry, with results that generally support the current SEC position that they are not substitutes for calculating NAVs using fair-value prices. Section 6 discusses the emerging SEC position and official industry resistance to fair valuation in more detail. Section 7 provides the evidence of a correlation between fund governance and proactiveness on the arbitrage issue that is suggestive of governance as an explanation for the slow

2. These articles draw on earlier work on the underlying financial market phenomena. On international financial market correlations see Eun and Shim (1989), Becker, Finnerty, and Gupta (1990), Engle, Ito, and Lin (1990), Becker, Finnerty, and Friedman (1993), and Lin, Engle, and Ito (1994). On predictability of indices of illiquidly traded domestic securities, see Lo and MacKinlay (1990) and Boudoukh, Richardson, and Whitelaw (1994). On the dilution of a retirement plan from an unrelated form of stale price trading, see Stanton (1999).

response of the industry to the issue in general. A conclusion follows, summarizing what this issue teaches us about agency problems in the fund industry in general.

2. Background

The existence of NAV arbitrage has been known to industry experts for at least 20 years, but it has become more widely known since the circulation of academic studies in late 1999 and early 2000 and financial press coverage shortly thereafter. In 1981 the SEC issued a no-action letter to two Putnam funds, taking no action against the international equity fund's practice of calculating NAVs using local closing prices on all days except if "some extraordinary event were to occur after the close." The Putnam request letter had recognized that postclose information could cause local closing prices to be "no longer a reasonable estimate of such securities values as of 4:00 P.M." This suggests that both Putnam and the SEC understood the nature of the problem, as should have other funds, to whom the letters were available.

Although the no-action letter allowed Putnam and other funds to "fair value" their assets if they concluded that local closing prices did not reflect current market value, in practice, funds did so extremely rarely. This practice was justified at the time by funds and the SEC as resulting from fair valuing being "too costly in light of the small risk that significant dilution would result from a failure to fair value."[3] One widely discussed exception occurred on October 28, 1997, when Asian markets closed following a 9% prior-day drop in the S&P 500, but, after Asian markets closed, the U.S. market rallied by 10% from its morning lows. Most U.S.-based Asian funds priced using local closes, allowing arbitrageurs to earn one-day returns of 8–10%, but Fidelity determined that a significant event had occurred and fair-value priced its Asian funds. The SEC investigated Fidelity following complaints from some investors (presumably arbitrageurs), but concluded that Fidelity had acted correctly. The SEC clarified its position in December 1999 and April 2001 letters to the Investment Company Institute, stating in increasingly clear terms that funds were responsible for monitoring for "significant events," including market volatility, that would cause local closing prices to not be considered "readily available market prices."

Net asset value arbitrage is receiving increasing attention from the SEC in part because of increased awareness of it outside the industry. All but one of the academic articles listed above were circulated in late 1999 and early 2000, along with the first draft of this article, and coverage in the financial press followed shortly thereafter (Bullard, 2000a, b; Hulbert, 2000; Lucchetti, 2000). As Section 4 discusses, dilution of long-term

3. Then Director of the SEC's Division of Investment Management Barry Barbash, as paraphrased in Bullard (2000b).

shareholders was substantial before these reports but has increased following them.

The current NAV arbitrage problem is not the first example of arbitrageurs with knowledge of mutual fund pricing practices diluting long-term investors. Prior to the passage of the Investment Company Act of 1940, NAVs were typically calculated at 4:00 P.M., but did not become effective for transactions until 10:00 A.M. the following day. Mutual fund insiders could transact after 4:00 P.M. at the prior-day NAV with full knowledge of the current-day NAV and earn riskless arbitrage returns based on the difference. Insiders were also sometimes sold mutual fund shares at a discount to the NAV, diluting the other shareholders of the fund. The Investment Company Act was at least partly a response to the impression that these arbitrage opportunities were leading to fairly widespread dilution; one of the primary goals of the 1940 act was to eliminate the opportunity for insiders to trade fund shares at prices that differ from their true value.

The act eliminated the opportunities described above, but until 1968, most funds processed transactions at the most recent *prior* NAV, allowing investors to transact at prior-day NAVs on days that the market had moved significantly. The SEC eliminated this practice and adopted rule 22c-1, requiring the current practice of "forward pricing," that is, of processing transactions at the next calculated NAV *after* orders are received. Both the pre-1940 and pre-1968 arbitrage opportunities reportedly led to substantial dilution of long-term shareholders, and in both cases, action by Congress or the SEC was required before the dilution was eliminated; the interests of long-term shareholders were not well enough represented at most funds to lead to change in the absence of government regulation.[4]

3. Excess Returns to NAV Arbitrage

This section provides estimates of excess returns to arbitrage strategies that exploit predictabilities in NAV changes. In particular, it analyzes an arbitrage strategy that switches between a fund and cash depending on the sign of the expected next-day fund return. Since the source of the arbitrage opportunity is that stale-price NAVs do not fully reflect recent market movements, a trading strategy would involve predicting next-day fund returns using current-day changes in the prices of related assets and then buying the fund when predicted next-day returns are positive. The analysis in this section assumes that arbitrageurs trade at maximum frequency, can make decisions up until 4:00 P.M. ET, and do not face transaction costs; this was usually the case in practice for investors trading directly with fund families in the late 1990s. Section 5 discusses the efficacy of short-term trading fees and trading frequency restrictions in reducing arbitrage and dilution.

4. For more detail on pre-1968 arbitrage and dilution, see Securities and Exchange Commission (1992) and Ciccotello et al. (2002).

The other articles listed above that have studied NAV arbitrage have also provided excess return estimates; the main contribution of this section is to provide them for all 48 Morningstar asset classes using a consistent methodology. Doing so highlights the breadth of NAV predictability: there are statistically and economically significant arbitrage opportunities in 44 of 48 Morningstar fund categories; the exceptions being the large-cap U.S. equity and specialty-utilities categories. It also provides useful background for the subsequent discussion of dilution and industry responses. Although arbitrage activity and the resulting losses to long-term shareholders are currently concentrated in international funds, the existence of opportunities in so many other asset classes suggests that any solution that only solves the problem in international funds will simply redirect activity to other asset classes.

3.1 Data

Standard sources of monthly mutual fund return data, such as Center for Research in Security Prices (CRSP) and Morningstar, do not have daily data for fund returns or net inflows, which one needs in order to estimate dilution. Funds are required to report their inflows and outflows only on a monthly basis, but TrimTabs (TT) surveys about 12% of U.S.-based open-ended funds on a daily basis in an attempt to obtain more timely information. Like Chalmers, Edelen, and Kadlec (2001), Goetzmann, Ivkovic, and Rouwenhorst (2001), and Greene and Hodges (2002), this article uses TT as its data source for daily flows, but like Goetzmann, Ivkovic, and Rouwenhorst, it supplements the TT daily return data using a more comprehensive data source, in this case, data from quote.yahoo.com.

Supplementing the TT data is useful for two reasons. First, TT is only a 12% sample of funds, and thus there are inevitable questions about its representativeness of the universe of funds. Second, the coverage of asset classes such as convertible bonds, precious metals, real estate, and European, Japanese, and Latin American equities is limited: each of these asset classes are represented by fewer than 10 funds in TT.

I attempted to collect daily NAVs for every mutual fund in the Morningstar universe that has a ticker symbol from quote.yahoo.com, and succeeded for 11,556 of 11,599 funds. The Yahoo data do not contain information on daily flows, but one can use it to confirm that TT is roughly representative of the Morningstar universe in terms of the excess returns available to arbitrageurs. The results reported in the tables use the Yahoo data; average arbitrage returns for the TT sample, using either TT or Yahoo data, are within 1 percentage point for all asset classes.

3.2 Predicting Returns

The first step in measuring excess returns to an arbitrage strategy is to predict next-day fund returns using information available at 4:00 P.M. ET. Since the source of the arbitrage opportunity is that NAVs calculated using

stale prices do not fully reflect recent market movements, one would expect a positive relationship between next-day fund returns and current-day changes in the value of similar assets. I therefore regress next-day fund returns on current-day market indices and use the resulting model to predict next-day returns out of sample.

When applying a predictive model out of sample, one usually obtains better results when one limits the number of predictive variables to limit any data-snooping bias in estimation. I limit the model to three market indices that one would expect to be predictive of future returns on a priori grounds. For international equity funds, I use (1) the difference between the 4:00 P.M. price of the Chicago Mercantile Exchange (CME) Nikkei 225 future and its 2:00 A.M. ET closing value in Tokyo, (2) the change in the S&P 500 index after 11:30 A.M. ET, when most European markets close, and (3) the change in the S&P 500 index from 4:00 P.M. the prior day until 11:30 A.M.[5] For the Japan stock category, one might expect the Nikkei future to be the best single indicator of their value as of 4:00 P.M. ET, and thus the future-local close difference as the best predictor of the next-day return in a fund that prices using local closing prices. Likewise, for a Europe stock fund, the change in the S&P 500 index after the close of most European markets at 11:30 P.M. ET should be the best single predictor of next-day fund returns.

For other assets classes, I use the best available measures of recent changes in the value of similar assets. For domestic equity funds I use the 2:00–4:00 P.M. change in the S&P 500 along with the 24-hour change in the Russell 2000 and S&P 500. For hybrid funds and convertibles, I replace the 24-hour S&P 500 change with the change in the 10-year Treasury yield, and for specialty equity funds, I replace it with an index appropriate to the equity category. For bond asset classes such as high-yield and municipal bonds, indices are less widely available in real time, so I use the current-day average NAV change as a proxy for an index that an arbitrageur might calculate on her own.[6]

Table 1 presents the results of these predictive regressions. The results in Table 1 are estimated using data from the January 1998–October 2001 period; the arbitrage returns estimated below estimate the same predictive model using two years of prior data and apply the results out of sample (i.e., they assume that arbitrageurs traded in 1998 using a model estimated

5. The value of the S&P 500 index at a certain time is measured using the most recent transaction price for the S&P 500 exchange-traded fund (ticker symbol SPY) from the New York Stock Exchange (NYSE Trades and Quotes) data. The 4:00 P.M. Nikkei futures price is the most recent transaction price as of 4:00 P.M. from the CME time and sales data (which differs from the closing price since the CME closes at 4:15 P.M.).

6. Current-day NAVs are not published until approximately 5:30 P.M. ET, so strictly speaking, the average current-day NAV for a category will not be known at 4:00 P.M. All of the prices that are used to calculate it will be, however, and so in principle an arbitrageur could estimate the average current-day NAV change using recent bond quotes reasonably well.

Table 1. Regressions Predicting Next-Day Fund Returns, January 1998–October 2001

	Regression predicting next-day NAV change using three indices								
	Index 1		Index 2		Index 3		Predictive indices used for asset class		
Morningstar category	Coefficient	SE	Coefficient	SE	Coefficient	SE	Index 1	Index 2	Index 3
International equity	0.31*	0.04	0.16*	0.05	0.17*	0.05	SPY 11:30–4	SPY pre-11:30	Nikkei future
Diversified emerging markets	0.33*	0.06	0.21*	0.06	0.19*	0.06	SPY 11:30–4	SPY pre-11:30	Nikkei future
Europe stock	0.43*	0.05	0.11*	0.05	0.07	0.06	SPY 11:30–4	SPY pre-11:30	Nikkei future
Foreign stock	0.34*	0.04	0.14*	0.05	0.16*	0.05	SPY 11:30–4	SPY pre-11:30	Nikkei future
Latin America stock	0.25*	0.10	0.14	0.11	0.06	0.12	SPY 11:30–4	SPY pre-11:30	Nikkei future
World stock	0.27*	0.05	0.12*	0.05	0.09*	0.05	SPY 11:30–4	SPY pre-11:30	Nikkei future
Diversified Pacific/Asia	0.43*	0.06	0.17*	0.06	0.25*	0.06	Nikkei future	SPY pre-11:30	SPY 11:30–4
Japan stock	0.46*	0.08	0.03	0.08	0.20*	0.07	Nikkei future	SPY pre-11:30	SPY 11:30–4
Pacific/Asia ex-Japan	0.37*	0.08	0.30*	0.07	0.26*	0.07	Nikkei future	SPY pre-11:30	SPY 11:30–4
Mid- and small-cap equity	0.29*	0.10	0.14*	0.06	–0.07	0.07	SPY 2–4	Russell 2000	S&P 500
Equity-debt hybrids	0.06*	0.01	0.07*	0.01	–0.01*	0.01			
Convertibles	0.27*	0.06	0.12*	0.03	–0.05	0.03	SPY 2–4	Russell 2000	10-year T-bond
Domestic hybrid	0.06	0.04	0.03	0.02	–0.04	0.02	SPY 2–4	Russell 2000	10-year T-bond
High-yield bond	0.56*	0.06	0.03*	0.005	–0.01	0.01	Own NAV	Russell 2000	10-year T-bond
Multisector bond	0.01	0.01	0.04*	0.01	–0.02	0.01	Own NAV	Russell 2000	10-year T-bond
International bonds	0.12*	0.07	0.01*	0.02	–0.03*	0.02			
Emerging markets bond	0.23*	0.09	0.03	0.02	–0.01	0.02	Own NAV	Russell 2000	10-year T-bond
International bond	0.07*	0.03	0.011	0.007	–0.05*	0.01	Own NAV	Russell 2000	10-year T-bond
International hybrid	0.09*	0.04	0.10*	0.01	–0.03*	0.01	Own NAV	Russell 2000	10-year T-bond
Municipal bonds	0.38*	0.05	0.003	0.003	–0.002	0.01	Own NAV	Russell 2000	10-year T-bond
Specialty equity	0.14*	0.09	0.10*	0.06	–0.04*	0.06			
Specialty-Communication	0.04*	0.13	0.09*	0.02	–0.14*	0.07	SPY 2–4	Phil Semi (SOXX)	10-year bond
Specialty-Financial	0.22*	0.10	0.04	0.04	–0.07	0.05	SPY 2–4	NYSE Financial	10-year bond

Continued

Table 1. *Continued*

	Regression predicting next-day NAV change using three indices								
	Index 1		Index 2		Index 3		Predictive indices used for asset class		
Morningstar category	Coefficient	SE	Coefficient	SE	Coefficient	SE	Index 1	Index 2	Index 3
Specialty-Health	0.29*	0.10	0.07	0.04	–0.05	0.05	SPY 2–4	Russell 2000	10-year bond
Specialty-Natural Resources	0.11*	0.03	0.08*	0.04	–0.01	0.07	Oil Index (XOI)	Russell 2000	SPY 2–4
Specialty-Precious Metals	0.11*	0.02	0.10*	0.05	–0.17	0.10	Gold Index (XAU)	Russell 2000	SPY 2–4
Specialty-Real Estate	0.30*	0.05	–0.02	0.02	0.14	0.04	MS REIT (RMS)	Russell 2000	SPY 2–4
Specialty-Technology	0.17*	0.05	–0.14	0.09	0.10	0.18	Phil Semi (SOXX)	Russell 2000	SPY 2–4
Specialty-Utilities	0.05	0.03	0.04	0.03	0.02	0.06	DJ Utilities	Russell 2000	SPY 2–4
Large-cap equity	0.10	0.09	0.03	0.06	–0.01	0.06	SPY 2–4	Russell 2000	S&P 500
Vanguard 500 Index	0.04	0.10	0.01	0.06	–0.02	0.07	SPY 2–4	Russell 2000	S&P 500
Investment-grade bonds	0.39*	0.12	0.005	0.005	0.05*	0.02	Own NAV	Russell 2000	10-year T-bond

Each row reports a regression that predicts the (equal-weighted) average next-day return for a given Morningstar asset class using current-day changes in three predictive indices. Current-day changes are close ($t-1$) to close (t), except for the Nikkei future, which is the 4:00 P.M. CME futures price less the spot close in Tokyo, and the SPY (S&P 500 exchange-traded fund) changes, which are intraday. "10-year T-bond" refers to the yield on the 10-year Treasury bond. "Own NAV" is the current-day return for that fund category. For space reasons, funds classified as "Mid- and small-cap equity," "Municipal bonds," "Large-cap equity," and "Investment-grade bonds" are aggregated into super-categories.

*Significant at 5%.

using 1996 and 1997 data). The index that one would expect to be most important on a priori grounds is listed as Index 1. For international funds, the relative importance of the predictive indices is as expected: the Nikkei future is the best predictor for Japanese and Asian funds, while the post-11:30 A.M. change is the best predictor for Europe. Of interest is that even the pre-11:30 A.M. price change has predictive power for European stock funds, suggesting that European equity prices do not fully respond to U.S. market movements even when their markets are still open.

3.3 Measurement of Excess Returns

The simplest way to measure the excess returns to an arbitrage strategy is to compare the returns to the strategy with what the investor would most likely do in the absence of an arbitrage opportunity: buying and holding either the fund in question or a money market, or some combination. Whereas most other studies have measured excess returns relative to a 100% buy-and-hold strategy, this study measures excess returns relative to a mixture of the fund and cash that yields the same average daily exposure to the fund.

This measure of excess returns has the useful property that it is independent of the average return to a fund or asset class in the time period studied.[7] In contrast, a comparison of the excess returns to arbitrage to 100% buy-and-hold would yield lower (higher) excess returns in periods when the fund outperforms (underperforms) cash. Having measured excess returns as independent of asset class performance is particularly helpful when making cross asset class comparisons. This definition of excess returns is also a cleaner measure of the market timing ability of a strategy, since the expected excess returns to a strategy that randomly chose which days to hold a fund would be zero in expectation, regardless of the average returns to the fund in the time period studied.[8]

Daily excess returns as defined above can be written as

$$\frac{\sum[R_t^{fund} \cdot Own_t + R_t^{cash} \cdot (1 - Own_t)]}{T} - \left[\frac{\sum R_t^{fund}}{T} \cdot \frac{\sum Own_t}{T} + \frac{\sum R_t^{cash}}{T} \cdot \frac{\sum 1 - Own_t}{T}\right], \quad (1)$$

7. The wild-card option value calculated by Chalmers, Edelen, and Kadlec (2001) also has this property.

8. Another advantage of this definition is that any error in measuring fund returns (e.g., due to omitted distributions, which is a problem in the Yahoo data) will not bias estimates of excess returns, so long as those measurement errors are not correlated with whether an arbitrageur would have held the fund (i.e., with prior-day market returns). Any definition of excess returns relative to a benchmark that involves holding mutual funds does have the disadvantage of slightly overstating excess returns relative to a market model, since almost all mutual funds are not on the risk-adjusted return frontier. For example, if the fund being studied has risk-adjusted excess returns (or an alpha) of −2% then the excess returns reported in this article will be roughly 1% higher than the returns relative to a market model.

where R_t^{fund} and R_t^{cash} are the returns to the fund and cash, respectively, on day t and Own_t is equal to one if the investor owns the fund and zero otherwise. Define the following notation for the returns conditional on ownership and the share of days the fund is owned:

$$\overline{R}^{fund}|Own = \frac{\sum R_t^{fund} \cdot Own_t}{\sum Own_t}$$

$$s(Own) = \frac{\sum Own_t}{T}.$$

If the returns to holding cash are constant or otherwise uncorrelated with ownership of the fund, Equation (1) can be rewritten as

$$(\overline{R}^{fund}|Own - \overline{R}^{fund}|NotOwn) \cdot s(Own) \cdot [1 - s(Own)]$$
$$= (\overline{R}^{fund}|Own - \overline{R}^{fund}) \cdot s(Own). \quad (2)$$

As is clear from Equation (2), excess returns are positive if and only if the average return on days the fund is owned is higher than the average return on days it is not owned.

3.4 Results

Table 2 reports the annualized excess returns to arbitrage trading at maximum frequency from January 1998 to October 2001. Results are presented for a single-index model that uses only the "Index 1" for a particular asset class given in Table 1 and for a model that uses all three. Excess returns are highest for international funds, but double-digit excess returns are also present for small and mid-cap U.S. equities, specialty equity funds, and high-yield, convertible, and emerging market bonds. Municipal bond funds have highly statistically significant return predictabilities, but price volatility is so low for this asset class that excess returns are as well.

Table 3 reports excess returns for general international funds by year since 1986, the first year for fund return data is available from Yahoo. The arbitrage returns in a given year are a function of the volatility and the extent to which international returns are correlated in that year. To see this, note that excess returns as given in Equation (2) can be written as

$$\text{Avg}[y - \overline{y}|E(y - \overline{y}|x) > 0)] \cdot s, \quad (3)$$

where y is the next-day return on the fund, x is the vector of market information known at 4:00 P.M. ET, $\overline{y}$ is the expectation of y unconditional on x, and s is the share of days when expected excess returns are positive, that is, when $E(y - \overline{y}|x) > 0$. Given the linear predictive model, the expectation of $E(y - \overline{y}|x) = \beta(x - \overline{x})$, one can write the expectation of Equation (3) as

$$E[\beta(x - \overline{x})|(x - \overline{x}) > 0] \cdot s = \beta \cdot E[(x - \overline{x})|(x - \overline{x}) > 0] \cdot s$$
$$= \beta \cdot E(|x - \overline{x}|) \cdot s. \quad (4)$$

Table 2. Estimates of Maximum-Frequency Trading Strategy Excess Returns, January 1998–October 2001

	Annualized excess returns estimates			
	Single-index model		Multi-index model	
Morningstar category	Estimate	SE	Estimate	SE
International equity	32.8*	3.8	40.2*	3.7
Diversified emerging markets	36.5*	4.8	44.5*	4.8
Diversified Pacific/Asia stock	59.5*	4.6	53.5*	4.7
Europe stock	39.1*	4.5	36.2*	4.5
Foreign stock	34.1*	3.8	37.8*	3.8
Japan stock	58.0*	5.6	43.2*	5.7
Latin America stock	24.6*	7.7	31.1*	7.7
Pacific/Asia ex-Japan stock	54.1*	5.5	51.1*	5.6
World stock	26.1*	3.8	29.9*	3.8
Mid- and small-cap equity	20.1*	5.5	26.2*	5.5
Equity-debt hybrids	7.7*	1.1	11.6*	1.1
Convertibles	22.7*	3.7	28.6*	3.8
Domestic hybrid	5.6*	2.5	7.1*	2.5
High-yield bond	12.3*	0.7	12.8*	0.8
Multisector bond	3.2*	0.7	4.9*	0.7
International bonds	9.9*	1.8	7.4*	1.8
Emerging markets bond	20.2*	3.7	16.7*	3.5
International bond	5.7*	1.0	6.5*	1.0
International hybrid	13.3*	1.4	16.4*	1.4
Municipal bonds	5.7*	0.5	3.6*	0.5
Specialty equity	12.5*	5.2	18.3*	5.3
Specialty-Communication	18.9*	7.7	28.5*	7.6
Specialty-Financial	12.5*	5.6	19.8*	5.7
Specialty-Health	23.3*	6.2	25.1*	6.3
Specialty-Natural Resources	20.6*	5.2	16.5*	5.3
Specialty-Precious Metals	20.6*	7.0	22.5*	7.0
Specialty-Real Estate	25.6*	2.7	23.4*	2.7
Specialty-Technology	30.0*	11.1	38.6*	11.0
Specialty-Utilities	3.0	3.6	3.0	3.3
Large-cap equity	7.4	5.0	12.7*	5.2
Vanguard 500 Index	1.7	5.3	–1.7	5.2
Investment-grade bonds	3.0*	0.8	2.5*	0.8

The annualized excess returns to a simulated trading strategy are reported for the (equal-weighted) average fund in each Morningstar category. For each year, 1998–2001, the predictive model in Table 1 is estimated using two years of prior data and applied out-of-sample. The single-index model uses only the "Index 1" given in Table 1 for the category; the multi-index model uses all three. Arbitrageurs are assumed to hold the asset class when predicted returns are greater than zero. Excess returns are defined as in Equation (2) in the text: they are the returns to the arbitrage strategy less a proportionate mix of the fund and cash that has the same average exposure to the asset class.

*Significant at 5%.

Table 3. Annualized Excess Returns by Year—International Equity Funds

Year	S&P coefficient	Average absolute daily S&P change	Annualized excess returns single-index model
1986	0.22	0.67	18.9
1987	0.22	1.13	31.8
1988	0.18	0.74	17.0
1989	0.25	0.58	18.4
1990	0.34	0.77	33.3
1991	0.28	0.67	23.6
1992	0.30	0.46	17.4
1993	0.21	0.40	10.6
1994	0.37	0.46	21.8
1995	0.42	0.37	19.7
1996	0.28	0.56	19.5
1997	0.36	0.85	38.5
1998	0.29	0.92	33.9
1999	0.32	0.90	36.6
2000	0.36	1.06	48.1
2001 (Jan.–Oct.)	0.25	1.08	34.3
1986–91	0.25	0.76	23.8
1992–96	0.31	0.45	17.6
1997–2001	0.32	0.96	38.8

As discussed in Section 3.4 of the text and summarized in Equation (4), expected excess returns from a single-index model are proportional to the product of the NAV predictability coefficient and the average absolute deviation in the predictive variable. This table reports expected returns for a single-index model by year for international equity funds. In addition, it provides predictability coefficients and average absolute change data by year, so that, for example, the increase in arbitrage profitability from 1992–96 to 1997–2001 can be decomposed into changes in market comovement and volatility.

In other words, one can multiplicatively decompose expected excess returns into the slope of the relationship between next-day NAV change and the market variables and then average absolute deviation of the market index. From this decomposition in Table 3, one can see that arbitrage returns have more than doubled from 1992–1996 to 1997–2001, and that this doubling was due mainly to increased market volatility.

3.5 Further Refinements

This analysis ignores several ways in which trading strategies could be further refined. First, it assumes that arbitrageurs trade an equal-weighted portfolio of funds in a given asset class; this is equivalent to assuming that they choose the fund to arbitrage randomly. For example, international funds that hold higher beta and smaller capitalization equities and fewer American Depository Receipts (ADRs) or other instruments traded in the United States will have higher arbitrage returns. By focusing on the 10% of funds with the highest predicted arbitrage returns, arbitrageurs can raise their expected returns by a factor of approximately 1.2.[9]

9. See Table 5 of the March 2002 version of this article (available from the author). This analysis was removed for space reasons.

Second, it assumes that arbitrageurs are restricted to trading in and out of a single fund, but an arbitrageur can do better by trading multiple asset classes. For example, on days when markets rise between the time when Asian and European markets close (usually 2:00–6:00 A.M. and 11:00 A.M.–2:00 P.M. ET, respectively) it will be optimal to buy an Asian fund, whereas on days when markets decline during this time but rise after European markets close, it will be optimal to buy a European fund. Simulations of a three asset-class trading strategy suggest that by switching among European, Japanese, and Asian funds and cash, arbitrageurs can earn excess returns of 69% compared with 38% by switching between a general international fund and cash.[10]

Further refinements are possible. Arbitrageurs can select funds within a region with holdings in sectors that have appreciated globally since local close. They can add sector funds to the multiregion strategy described above; it might be particularly useful to add gold funds, since gold stocks are inversely correlated with other equities. They can monitor for post-local close news items that affect particular foreign stocks and then buy funds with large holdings of that stock. They can condition trading on exchange rate movements, by either buying funds with holdings in stocks that would benefit from post-local close exchange rate movements or by taking advantage of the fact that most funds convert local prices to dollars using exchange rates as of 12:00 P.M. ET, so foreign exchange appreciation after this time predicts NAV appreciation. These additional refinement opportunities are small relative to the ones analyzed in this section, but they are additional reasons to believe that the extremely high returns to maximum frequency trading documented in this section may actually be underestimates.

4. Estimating Dilution

This section uses data from the TT sample to estimate the losses to long-term shareholders from arbitrage trading. Dilution is defined as the losses to buy-and-hold shareholders due to arbitrageurs trading at stale-price NAVs rather than fair-value NAVs. The dilution occurring on a given day is

$$d_t = \frac{\Delta shares_t \cdot (NAV_t^{FV} - NAV_t^{ACT})}{assets_t} = \frac{flow_t}{assets_t} \cdot \frac{NAV_t^{FV} - NAV_t^{ACT}}{NAV_t^{ACT}}, \tag{5}$$

where

$$\begin{aligned} \Delta shares_t &= \frac{assets_t}{NAV_t^{ACT}} - \frac{assets_{t-1}}{NAV_{t-1}^{ACT}} \\ flow_t &= assets_t - assets_{t-1} \cdot \frac{NAV_t^{ACT}}{NAV_{t-1}^{ACT}} \\ NAV_t^{FV} &= E(NAV_{t+1}^{ACT} | \Omega_t). \end{aligned} \tag{6}$$

10. See Table 6 of the March 2002 version. This analysis was removed for space reasons.

The fair-value NAV_t^{FV} is defined for the purposes of this calculation as the statistical expectation of NAV_{t+1}^{ACT} given all the information known at 4:00 P.M. ET (Ω_t). NAV_t^{FV} is estimated using the same multi-index predictive model applied out of sample as in Section 3. Dilution, defined as above, is also equal to the profits of the arbitrageurs from transacting at stale-price rather than fair-value NAVs. Dilution is zero-sum, but funds may incur other costs from handling the arbitrage flow (e.g., extra transactions, extra cash holdings, administrative costs).[11]

Table 4 reports the results of this formula. Although arbitrage is possible in many asset classes, dilution is understandably concentrated in the asset classes with the highest arbitrage profits. Long-term shareholders of regionally focused international equity funds in the TT sample lost about 1.6% of their assets per year to arbitrageurs from 1998 to 2001. Dilution was lower but still statistically significant in general international equity funds (81 basis points), specialty equity funds (33 basis points), Latin American and global equity funds (23 basis points), and small and mid-cap U.S. equity funds (12 basis points).

If one assumes that TT funds are representative of their asset classes and scales these results up to the Morningstar universe, the total annualized dilution in the first three quarters of 2001 can be estimated at $4.9 billion per year, $4.3 billion of which is in international equity funds. Of course, the decision to participate in the TT sample may depend on the arbitrage activity a fund is experiencing. A fund may be less likely to participate if they are experiencing heavy arbitrage and are thus more concerned about releasing their asset data. If this is the case, then estimates of industry-wide dilution based on the TT sample will be downwardly biased. Alternatively, funds that are more aware of the arbitrage issue may have both less dilution and be less willing to cooperate with TT, leading the TT sample to be upwardly biased.

Comparing the estimated arbitrage returns in the TT and broader Yahoo samples yields only small differences, but one can obtain more direct evidence on the direction of any selection bias in the TT data by examining the 35% of the 167 international funds in TT that exit the sample before the data ends in September 2001. Controlling for asset class and time period fixed effects, the exiting funds have dilution that is roughly 40 basis points higher than both the nonexiting funds and the funds that replace them in the sample, suggesting that selection may be downwardly biasing estimates of dilution using the TT sample. In any case, one might argue that even the $480 million worth of dilution that is occurring in the international TT funds themselves is a large number, regardless of total industry-wide dilution.

11. Greene and Hodges (2002) regress buy-and-hold fund returns on market performance and the dilution for a particular and find a coefficient on dilution of 2.8. Giving this a causal interpretation would imply that the direct effect of dilution is less than half of the total negative effect on returns.

Table 4. Annualized Dilution of Mutual Funds in the TrimTabs Sample

	TrimTabs sample						Morningstar universe	
		Annualized dilution						
	Funds in sample	2/98–12/98	1999	2000	1/01–9/01	Average	Assets 6/01 ($billions)	Annualized dilution at 2001 rate ($billions)
International equity	165	0.66	0.46	0.63	1.14	0.69	416.7	4.34
Regionally focused funds (European, Japan, Pacific)	25	2.00	1.05	1.35	2.28	1.60	32.2	0.73
Global, Latin, and diversified emerging markets	74	0.32	0.20	0.18	0.25	0.23	167.5	0.41
General international funds	66	0.59	0.51	0.81	1.47	0.81	217.0	3.20
Small- and mid-cap equity	170	0.17	0.14	0.10	0.08	0.12	470.9	0.37
Equity-debt hybrids	134	0.01	0.01	0.01	0.01	0.01	402.2	0.05
International bonds	40	0.01	0.01	0.04	0.00	0.01	37.7	0.00
Municipal bonds	135	0.00	0.00	0.00	0.00	0.00	280.6	0.00
Specialty equity	67	0.42	0.36	0.36	0.14	0.33	214.3	0.29
Precious metals	8	1.57	1.25	1.28	0.26	1.17	1.8	0.00
Large-cap equity	335	0.04	0.02	0.02	−0.01	0.02	2089.8	−0.15
Investment-grade bonds	119	0.00	0.00	0.01	0.00	0.00	368.2	0.00
Total	1165	0.16	0.11	0.13	0.17	0.14	4698.9	4.90

Daily dilution is calculated as the percentage difference between today's actual NAV and what today's NAV would have been if yesterday's inflows had been priced at the expected (fair value) rather than the actual stale-price NAV: $\text{dilution}(t) = [A(t)/\text{NAV}(t) - A(t-1)/\text{NAV}(t-1)]^{*}[\text{NAV\_FV}(t-1) - \text{NAV}(t-1)]/A(t)$. Fair-value NAVs are estimated exactly as predicted returns are estimated in Tables 1 and 2. Standard errors of the point estimates of dilution for the entire period are all less than 1 basis point for all categories except international equity, for international equity they are less than 10 basis points (SEs are heteroscedasticity-robust and adjusted for clustering within days). The last two columns report the total assets of all funds in the category according to Morningstar as of June 2001 and an estimate of total dilution, assuming that TrimTabs funds are representative. Given that TrimTabs funds may not be representative, this estimate should be treated with some caution.

4.1 Relationship with Prior Estimates of Dilution

Two other articles have calculated dilution using TT data. Greene and Hodges (2002) report dilution of 50 basis points from February 1998 to June 1999 for all international equity funds; this appears to be consistent with my results for that asset class and time period. The main difference between Greene and Hodges and this article is that they substitute the actual next-day NAV_{t+1}^{ACT} for its expectation. This causes the results to be noisier in a small sample, which may explain why this article is able to report dilution for smaller time periods and subsamples than they do. On average, however, I obtain an only slightly higher dilution figure (56 basis points versus 50 basis points) for all international funds for the 1998–1999 period.

The extra detail provided in Table 4 yields important additional conclusions: (1) that dilution of up to 2% of assets is occurring in some asset classes, (2) that dilution is worse in exactly the asset classes one would expect, given the results in Table 2, and (3) that some dilution is occurring even in less profitable asset classes such as global and small-cap equity funds. This third conclusion suggests that some investors know about the arbitrage opportunity and yet are trading in channels in which they do not have access to the highest-profit asset classes; the fact that arbitrageurs are using multiple distribution channels has implications for the effectiveness of certain antiarbitrageur measures, as discussed in the next section.

The other article that uses TT data to measure dilution, Goetzmann, Ivkovic, and Rouwenhorst (2001), reports a much lower dilution estimate of 1.6 basis points for the same period and sample as Greene and Hodges. The source of the difference is in its treatment of the timing of the flows in the TT data. As described in Edelen and Warner (2001), TT surveys funds in the morning and collects asset data for the prior day. In principle, these assets figures should include all inflows that are priced at the prior-day NAV, that is, "postflow," in practice, however, it is not certain that funds are aware of all flows in time to include them in the asset figures. This is especially true of funds whose customers trade mainly through intermediaries, such as brokerages or 401(k) plan providers, as opposed to directly with the fund family.

Generally accepted accounting principles (GAAPs) require that the asset figures in annual reports be postflow. Goetzmann, Ivkovic, and Rouwenhorst verified that TT asset data match CRSP data on the last day of the month, and concluded from this that both TT and CRSP asset figures were therefore likely to be postflow. Greene and Hodges, however, compared TT assets with N-SAR and N-30D reports filed with the SEC and found that TT asset figures matched better for two-thirds of funds if one assumes that they are either entirely or largely preflow. In estimating dilution, Greene and Hodges treated the TT asset figures for these two-thirds of funds as if they were preflow, and the remaining third of funds as if they were postflow.[12]

12. In a recent article coauthored by Goetzmann, Brown et al. (2002) adopt the Greene and Hodges approach of determining fund flow timing by matching with SEC reports.

In doing so, they assumed that the funds whose TT assets matched their SEC reports matched because both were postflow, that is, that all funds followed GAAPs with respect to this issue. Another possibility, however, is that the asset figures matched because both were preflow: that TT figures are always (or at least largely) preflow, and that only two-thirds of funds follow GAAPs with respect to this issue.

Table 5 contains evidence consistent with this second possibility. In Table 5, I regress flows on current and three lagged changes in the S&P 500. If one assumes that TT asset data are preflow, that is, that today's flows show up tomorrow, the coefficients estimated for international funds imply that there are inflows of 0.45% of assets on a day with a 1% S&P increase, followed by outflows of 0.34% of assets over the next two days. This is exactly what one would expect to see if funds were being arbitraged by short-term traders. On the other hand, if one assumes that TT asset data are postflow, then Table 5 would imply that market timers do not buy on the day that it would be profitable to do so; instead they buy a day late and then sell most of what they bought over the next two days. While one might expect to see some returns-chasing behavior on the day after a large market movement, the magnitudes and almost immediate outflow seem very inconsistent with behavioral returns-chasing, and very consistent with arbitrage flows, reported a day late.[13]

When I disaggregate international funds into those classified as preflow and postflow by Greene and Hodges (they were kind enough to share their classification), I find that there is essentially no difference in the apparent timing of flows. The timing of flows appears similar, albeit with much smaller magnitudes, for noninternational funds, with one exception that helps prove the rule. The so-called "timer funds" (i.e., the Rydex, ProFunds, and Potomac families) that cater primarily to short-term traders appear to report postflow to TT. These funds experience a very high variance in daily inflows (their net inflow:asset ratio has a standard deviation of 8.2%, compared with 2.2% for the average fund) and track indices, and they thus need to closely monitor their inflows so that they can remain properly invested.

For the reasons discussed above, it seems highly implausible that even the funds classified as postflow by Greene and Hodges really are, and more plausible to assume that one-third of funds simply do not follow GAAPs with respect to this issue. I repeat the analysis in Table 5 for individual funds, looking for funds with current-day S&P coefficients that are

13. Other evidence consistent with these flows being arbitrage reported a day late includes the fact that the flows target the most arbitrageable funds (coefficients on dS&P($t-1$) are 0.75, 0.48, and 0.22 for Europe/Japan/Pacific, general international funds, and global funds, respectively), and do so on the most advantageous days, targeting Europe funds when the S&P change is largely in the afternoon, Asian funds when the change is in the morning or when its accompanied by a change in the Nikkei futures, and specialty equity funds when there is a large change in the relevant sector index (see Table 11 and Appendix A in the March 2002 version of this article).

Table 5. Timing of Inflows in TrimTabs Data

			dS&P(t)		dS&P($t-1$)		dS&P($t-2$)		dS&P($t-3$)	
	Observations	Funds	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
International equity funds	102,891	165	0.000	0.013	0.453*	0.018	−0.217*	0.014	−0.125*	0.013
Preflow, per Greene and Hodges	71,108	90	−0.002	0.013	0.409*	0.016	−0.188*	0.014	−0.103*	0.013
Postflow, per Greene and Hodges	23,889	32	−0.003	0.026	0.558*	0.027	−0.279*	0.020	−0.165*	0.022
Not classified by GH	7,048	43	0.029	0.040	0.538*	0.061	−0.295*	0.051	−0.206*	0.061
Market timer funds (non-international)	2,730	3	1.332*	0.115	−0.175	0.127	−0.373*	0.115	−0.046	0.123
All other funds	660,652	997	0.001	0.003	0.028*	0.003	−0.012*	0.003	−0.002	0.003

Dependent variable: change in log of shares outstanding (assets/NAV).
Each line is a regression of the change in the log of shares outstanding in a fund (a measure of the inflow-to-assets ratio) on current and lagged changes in the S&P 500 for a subset of the funds covered by TrimTabs. The coefficients for international equity funds imply that large inflows are reported to TrimTabs the day after an increase in the S&P 500, and that these inflows are followed by outflows the next two days. The dependent variable is log change in the number of shares outstanding, calculated as the end-of-day assets reported to TrimTabs divided by that day's NAV. As we argue in the text, the evidence in this table is consistent with TT assets not reflecting current day flows, except for the market-timer funds. While the purpose of this analysis is to determine whether TrimTabs assets data include current-day flows, it is fairly clear from the data that current-day NAV changes are consistently reflected in current-day asset figures. So assets(t)/NAV(t) as reported in TrimTabs is shares outstanding either before or after day t inflows.
*Significant at 5%.

statistically different from zero. I find that I can reject this null hypothesis at the 5% significance level for 6% of funds (10 of 165), close to the rejection rate one would expect if the null were true for all funds. Rather than classify these funds as postflow, which would induce a data-snooping bias given that I would be using the same data to classify funds as I am using to measure dilution, I choose instead to classify all funds as preflow.

5. Analyzing Currently Popular Solutions

This section examines the effect of short-term trading fees, restrictions on trading frequency, and partial fair-value pricing on arbitrage trading profits. These are currently the most popular solutions to the NAV arbitrage problem, but as this section discusses, they have serious shortcomings.

5.1 Short-Term Trading Fees

Short-term trading fees are currently a popular device for limiting arbitrage flows; 30% of international mutual funds have adopted them as of November 2001. Dilution is lower in funds with short-term trading fees: in the first three quarters of 2001 dilution was 61 versus 166 basis points of dilution for general international funds in the TT sample with and without fees, respectively, and 138 versus 232 basis points for region-specific funds with and without fees. Despite their popularity, short-term trading fees have at least three shortcomings.

First, short-term fees reduce the attractiveness of mutual funds to the average investor. Zero transaction costs are not available to investors in financial markets, they are a unique feature of no-load mutual funds, and a potential competitive advantage over individual stocks or the recently introduced exchange-traded funds. So long as inflows and outflows are roughly balanced and not opportunistically timed, mutual funds can match buy and sell orders internally and provide zero transaction cost liquidity without significantly altering their holdings or trading themselves. Unfortunately NAV predictability, once understood by investors, guarantees that these conditions will not be met. Funds ultimately face a choice between achieving NAV nonpredictability through fair-value pricing or abandoning one of the competitive advantages of their product; so far more funds have chosen the latter.

In addition to their effect on the attractiveness of funds to nonarbitrageurs, there are also limitations to the effectiveness of short-term trading fees in preventing arbitrage. The first effectiveness issue is that short-term fees are difficult and/or costly to apply uniformly across channels. Under the terms of most existing variable annuity contracts, short-term trading fees cannot be imposed.[14] In addition, fees are difficult to apply to 401(k)

14. While new variable annuity contracts typically either allow management companies to restrict the frequency of trading or impose transaction fees, many existing variable annuity contracts do not. Anecdotally, some investors that are grandfathered into unrestricted annuities have been aggressively taking advantage of the absence of restrictions.

and 403(b) accounts; many funds that charge short-term trading fees in regular accounts do not charge them in 401(k)s. Since fees cannot be applied uniformly to all investors, funds that attempt to prevent NAV arbitrage through only the use of short-term trading fees are open to the criticism that they are selectively allowing certain investors to dilute their funds. Selectively allowing certain investors to dilute the fund may open a management company to criticism, particularly if the investors who benefit are disproportionately those whom a management company might otherwise have an incentive to favor (e.g., favored clients, industry insiders, management company employees, fund directors).

A second effectiveness issue is that short-term trading fees have to be fairly large and of long duration to eliminate the arbitrage opportunity. The SEC has thus far limited short-term trading fees to 2%.[15] Although fees of this magnitude are sufficient to redirect arbitrage activity to other funds, once all funds have adopted them, they will not be sufficient to prevent arbitrage activity.

Table 6 analyzes the profitability of arbitrage trading with various levels of short-term trading fees. As in Table 2, I estimate a predictive model using two years of prior data and then apply the model out of sample. Since predicted returns can be noisy due to imprecise coefficient estimates, I multiply them by a discount factor that is estimated from a regression of prior-year actual returns on predicted returns (i.e., actual year $Y-1$ returns on predicted returns from a model estimated on year $Y-2$ and $Y-3$ data). For the fund categories in Table 6, this discount factor averages 0.9. I assume that an arbitrageur trades when the absolute value of predicted next-day returns is greater than 50% of the short-term trading fee.

From Equation (2), excess returns are given as

$$(\overline{R}^{fund}|Own - \overline{R}^{fund}) \cdot s(Own). \tag{7}$$

This can be decomposed and written as

$$\begin{aligned}&\overline{R}^{fund}|Own\&B \cdot s(Own\&B) + \overline{R}^{fund}|Own\&WB \cdot s(Own\&WB)\\ &\quad + \overline{R}^{fund}|Own\&NotS \cdot s(Own\&NotS) - \overline{R}^{fund} \cdot s(Own),\end{aligned} \tag{8}$$

15. The SEC's no-action letter to Fidelity Korea on March 7, 2001, allowed Fidelity Korea to temporarily impose a 4% short-term redemption fee during the period of its conversion from a closed-end to an open-end fund, but it reiterated the requirement that short-term fees be limited to a reasonable estimate of the administrative and transaction costs for that asset class and an upper bound of 2% on that estimate. This limitation is consistent with the SEC position that funds should not use short-term fees as a substitute for accurate valuation of the fund.

Table 6. Annualized Excess Returns with Short-Term Trading Fees, January 1998–October 2001

Category and short-term fee	Round-trips per year	Excess return per RT		Annualized excess return estimates: Day-after-signal returns only			Annualized excess return estimates: Simulation results		
		Coefficient	SE	Gross	Net	SE	Gross	Net	SE
Pacific/Asia ex-Japan stock									
0	56.2	0.97*	0.10	54.7*	54.7*	5.4	54.1*	54.1*	5.4
0.25	51.3	1.04*	0.10	53.5*	40.7*	5.0	53.4*	40.6*	5.5
0.5	38.8	1.28*	0.12	49.8*	30.4*	4.5	50.4*	31.0*	5.5
0.75	28.6	1.56*	0.14	44.6*	23.2*	4.0	47.0*	25.6*	5.6
1	19.5	1.79*	0.16	34.9*	15.4*	3.0	44.5*	25.0*	5.6
1.5	10.3	2.23*	0.22	23.0*	7.5*	2.3	29.2*	13.8*	5.7
2	5.8	2.74*	0.33	15.7*	4.2*	1.9	13.2*	1.7	5.8
2.5	3.7	2.98*	0.48	11.0*	1.8	1.8	0.3	−9.0	5.7
3	1.9	4.03*	0.73	7.5*	1.9	1.3	13.9*	8.3	6.3
3.5	1.0	4.59*	0.93	4.7*	1.1	1.0	−3.7	−7.2	4.1
Europe stock									
0	54.2	0.75*	0.08	40.8*	40.8*	4.5	40.6*	40.6*	4.5
0.25	46.7	0.90*	0.08	42.1*	30.4*	3.8	41.4*	29.7*	4.5
0.5	31.1	1.11*	0.10	34.5*	18.9*	3.1	37.0*	21.4*	4.6
0.75	19.6	1.30*	0.13	25.5*	10.8*	2.5	29.3*	14.6*	4.6
1	12.1	1.41*	0.17	17.1*	5.0*	2.0	19.2*	7.2	4.7
1.5	4.4	1.92*	0.30	8.4*	1.8	1.3	8.6*	2.0	4.7
2	1.4	2.32*	0.46	3.2*	0.4	0.6	−3.8	−6.6	3.8
Small growth									
0	50.8	0.73*	0.13	36.8*	36.8*	6.6	36.5*	36.5*	6.5
0.25	42.9	0.83*	0.13	35.5*	24.8*	5.7	34.9*	24.1*	6.6
0.5	25.0	1.04*	0.19	26.1*	13.6*	4.8	37.9*	25.4*	6.6
0.75	14.4	1.22*	0.28	17.6*	6.8	4.0	19.5*	8.7	6.7
1	8.5	1.65*	0.35	14.0*	5.5	2.9	10.9	2.4	6.5
1.5	2.6	2.03*	0.60	5.2*	1.4	1.6	11.3	7.5	5.9

This table examines the effect of short-term trading fees on arbitrage excess returns. The multi-index predictive model from Table 1 is estimated for each asset class and applied out of sample. Arbitrageurs are assumed to trade when expected excess returns are greater than 50% of the short-term trading fee. Expected excess returns are adjusted for the fact that out-of-sample actual returns tend to be slightly less than predicted returns, as described in the text. The table first reports an estimate of the excess returns on the day following trading signals. The next set of columns uses this estimate to construct an estimate of annual excess returns, assuming that returns are symmetrically distributed and that excess returns on days when there is no trading signal are zero. The final set of columns report excess returns from the simulated trading strategy that does not make this assumption.
*Significant at 5%.

where *Own&B* means that the arbitrageur bought the fund yesterday, *Own&WB* means the arbitrageur would have bought the fund if she did not already own it, and *Own&NotS* means that the arbitrageur owns the fund but would not have bought or sold it.

If the distribution of future returns in the fund beyond the next day is independent of past fund or market returns and if fund returns are

distributed symmetrically, then

$$\overline{R}^{fund}|Own\&NotS = \overline{R}^{fund} \tag{9}$$

$$\overline{R}^{fund}|Own\&WB - \overline{R}^{fund} = \overline{R}^{fund} - \overline{R}^{fund}|NotOwn\&WS \tag{10}$$

$$s(Own\&WB) = s(NotOwn\&WS), \tag{11}$$

and Equation (8) can be written as

$$\overline{R}^{fund}|Own\&B \cdot s(Own\&B) - \overline{R}^{fund}|NotOwn\&S \cdot s(NotOwn\&S), \tag{12}$$

where $NotOwn\&S$ means that the arbitrageur sold the fund yesterday and $NotOwn\&WS$ means that the arbitrageur would have sold the fund if she owned it. Note that in a large sample, $s(Own\&B)$ and $s(NotOwn\&S)$ will be approximately equal and will both equal the rate at which round-trip trades are made in the fund.

The intuitive interpretation of Equations (12) and (8) is that the excess returns to an arbitrage strategy per round-trip trade is the difference between the returns following buys and the returns following sells plus a "drift" that is zero if returns are symmetric and independent of market changes more than one day old.

Table 6 reports excess returns with and without "drift" for different levels of short-term trading fees. Since excess returns are more precisely estimated without drift, I will focus on those results. Next-day excess returns remain positive for Pacific stock, Europe stock, and small growth funds even with short-term trading fees of 3.5%, 2.0%, and 1.5%, respectively. Returns are statistically significant and greater than 5% per year even with fees of 2.0%, 1.0%, and 0.5%, respectively. Results including drift imply higher returns for Pacific stock funds and lower returns for Europe stock and small growth funds than those without drift, although in the latter case the difference is not statistically significant.

The results in Table 6 also suggest the ability of arbitrageurs to "wait out" short-term fees. In order to accommodate legitimate investor demand for liquidity and to avoid being accused of using short-term fees to "trap" money in their funds, many funds have limited fees to the sale of shares within 30 or 90 days of purchase.[16] Table 6 suggests that arbitrageurs can earn annualized gross excess returns of approximately 10%, 6%, and 4% in the three asset classes by making three round-trip trades per year.

To summarize, the 2% short-term trading fees currently allowed by the SEC are sufficient to eliminate arbitrage opportunities in asset classes other than Asian stock, so long as they are of sufficient duration to prevent arbitrageurs from waiting them out. They are also certainly large enough to reduce arbitrage profits enough to divert activity to funds without short-term fees, so long as there are some remaining.

16. As of November 2001, of the funds that had imposed short-term trading fees, 42% and 92% did not charge fees when the investors had held the shares for at least 30 and 90 days, respectively.

5.2 Trading Frequency Restrictions and Monitoring

Another popular device for controlling arbitrage is to either explicitly limit the number of round-trip trades an account may engage in or to monitor accounts for frequent trading. This approach can be effective in diverting arbitrage activity to other funds, but it has some of the same shortcomings as short-term trading fees.

First, like short-term trading fees, frequency restrictions and monitoring cannot be applied across all channels. Many existing variable annuity contracts do not allow fund companies to limit trading frequencies. Limiting trading through channels such as fund supermarkets or retirement plans is difficult, and investors can to some extent evade monitoring by moving between accounts or trading multiple funds. In addition, monitoring conducted on a case-by-case basis is even more subject to the selectivity criticism than short-term trading fees that are applied consistently according to predetermined rules. As with short-term trading fees, there is a trade-off between limiting arbitrage and the attractiveness of the fund along other dimensions. Frequency restrictions can be made more effective by restricting access to only investors who trade directly with the fund family, but this obviously has significant costs to investor convenience and the competitiveness of the fund.

Second, the evidence in Table 6 shows that frequency restrictions do not eliminate dilution opportunities, since arbitrageurs can earn excess returns of up to 10% by making just three round-trip trades per year. In addition, no amount of monitoring will prevent investors who are knowledgeable about the NAV arbitrage issue from timing their purchases and redemptions so as to earn extra returns at the expense of investors who are not knowledgeable about the issue.

5.3 Partial Fair-Value Pricing

Two types of partial fair-value pricing have been proposed or adopted by fund management companies. One is using fair-value pricing only on days with extreme market movements. The other is using one of a variety of partial fair-value pricing methodologies. These partial methodologies often have some intuitive appeal, but they remove only part of the arbitrage opportunity, for reasons discussed below.

5.3.1 Fair-Value Pricing on Extreme Days.

The idea of using fair-value pricing only on extreme movement days is appealing to fund companies. Currently most do not have a system in place for calculating fair-value prices, and fair valuing involves convening a valuation subcommittee of the board of directors and calculating fair-value prices in a nonautomated fashion. Given the seniority of the people involved, this is, of course, extremely expensive.

Often, fair valuing only on extreme days is justified by arguing that the difference between calculated and fair-value NAVs on other days is not

material. Unless the postclose change in markets is extreme, funds argue that a "significant event" has not occurred, and thus they are under no obligation to fair-value price. An executive from a large fund complex recently announced in a public conference that his funds used fair-value pricing when the Japanese market was believed to be 2% different from its closing level or when individual Asian markets were believed to be 3% different.

Table 6 indirectly provides evidence about whether such a fair valuation approach is likely to prevent a significant amount of the arbitrage opportunity. Assume that the fund in question fair values much more often than the fund discussed above; assume they fair value whenever the fair-value NAV is more than 1.5% different from the stale-price NAV. An arbitrageur who faced a 3% short-term trading fee would trade precisely on the days fair-value and stale-price NAVs were more than 1.5% different when a fund's fair-value NAV was 1.5% different from its actual NAV. Table 6 suggests that an arbitrageur trading a Pacific stock fund only on such days would earn annualized gross next-day excess returns of 4.3% compared with the total annualized returns of 50.6% that they would earn from trading every day. Likewise, if fair-value pricing eliminated the excess returns on these extreme-move days, a maximum frequency trader would earn excess returns of 50.6% less 4.3%. In this example, fair valuing only on extreme days removes less than 10% of the arbitrage opportunity.

Another issue with fair valuing infrequently using valuation committees is that it potentially introduces discretion into the decisions of whether and how to fair value. Zitzewitz (2002) reports evidence that discretion already enters into fair-value decisions: the few funds that were occasionally fair valuing between January 2001 and December 2002 were much less likely to do so on Friday evenings, when the effort costs of fair valuation are presumably higher. Conceivably discretion could also be abused to provide dilution opportunities to those with inside knowledge of fair-valuation procedures.

5.3.2 Mark-to-ADR Pricing. Another partial fair-value pricing methodology that has been proposed is pricing foreign assets using the prices of comparable assets that trade when the U.S. market is open. The most common version of this is mark-to-ADR pricing, where the most recent ADR price is taken to be a "readily available" market price.

The issue with mark-to-ADR pricing is foreshadowed by the high NAV predictability for U.S. small-cap stock funds. Three-quarters of ADRs had lower trading volumes in 2000 than U.S. stocks in NYSE/AMEX decile 6 (most U.S. small-cap funds have holdings in deciles 6–8). As with small-cap stocks, ADR prices do not instantly reflect changes in the general market, but high round-trip trading costs prevent arbitrageurs from taking advantage of this phenomenon. The last traded price for a relatively illiquid ADR, like the last traded price for a small-cap equity, will be

systematically below that which would prevail in a liquid market when the U.S. market is rising, and systematically too high when the U.S. market is falling.

Table 7 reports regressions of the next-day change in an ADR price on the current-day change in the S&P 500. The average slope for all ADRs is 0.12. This result suggests that the predictability for a mutual fund priced entirely using ADRs is about 40% of that of a mutual fund priced using local closes (as suggested by the coefficient of 0.32 reported for the average international fund in Table 3). Interaction regressions suggest that the predictability coefficient is greater than 0.3 for the least-liquid and smallest-cap ADRs and not significantly different from zero for the most-liquid, largest-cap ADRs, which is consistent with illiquidity being the source of predictability of ADR prices.

Some in the industry have advocated the use of exchange-traded foreign index funds, or iShares, in fair-value pricing. All but the Japanese iShares are fairly illiquid and thus, like ADRs, have predictable next-day price

Table 7. Predictability of Next-Day ADR Returns, 1995–2000

ADRs Observations	666 579,116	666 579,116	666 579,116
dS&P(t)	0.12* (0.03)	0.34* (0.07)	0.38* (0.07)
dS&P(t)*ln(market cap)		−0.018* (0.005)	
dS&P(t)*ln[daily volume in $]			−0.020* (0.006)
ln(market cap)/100		0.010* (0.005)	
ln(daily volume in $)/100			−0.007 (0.005)
Quartiles for interaction variables		ln(market cap)	ln(volume)
0		0.6	1.8
25		10.7	11.3
50		11.9	13.1
75		13.3	14.8
100		18.6	22.1
Predictability slope at quartiles			
0		0.33	0.35
25		0.14	0.16
50		0.12	0.12
75		0.09	0.09
100		−0.01	−0.06

Dependent variable: log returns($t+1$).
The predictability of next-day returns using current-day change in the S&P 500 is examined for securities identified as ADRs in the CRSP dataset. Interaction regressions suggest less predictability for large-cap and more heavily traded ADRs. Tests for nonlinearities in the interaction terms do not reveal statistically significant quadratic or cubic effects (not reported). Average predictability is not significantly different in different years (not reported). Standard errors are adjusted for clustering within trading days.

changes. iShares prices, like ADR prices, may be a useful input into a fair-value pricing formula, especially if their liquidity improves, but a mark-to-iShares fair-value pricing methodology will have the same shortcomings as a mark-to-ADRs methodology.

The evidence on ADR pricing also suggests issues with another argument sometimes made by practitioners, that fair-value pricing will become moot once exchanges move to 24-hour trading. The ADR evidence suggests that unless foreign issues are liquidly traded at 4:00 P.M. ET, their next-day price changes will still be predictable. A test of whether after-hours trading in foreign markets is likely to be liquid can be conducted using the German market, which extended trading until 2:00 P.M. ET (8:00 P.M. German time) in June 2000. A regression of the next-day change in the DAX index on the change in the S&P futures before 11:30 A.M. ET, between 11:30 A.M. and 2:00 P.M., and between 2:00 and 4:00 P.M. yields coefficients of 0.00, 0.15, and 0.62 (with standard errors of about 0.09), suggesting that German stocks are not sufficiently liquid after regular trading hours to fully incorporate changes in the U.S. market. If German stocks are not sufficiently liquid from 6:00 to 8:00 P.M. German time to exhibit no price predictability, it is hard to believe that Asian stocks will be in the middle of the night Asian time.

5.4 True Fair-Value Pricing

Given the number of partial solutions to the NAV arbitrage problem that have been adopted or at least proposed by the industry, one might expect that a full solution was impossible or prohibitively expensive. This is actually not the case. Goetzmann, Ivkovic, and Rouwenhorst (2001) outline a simple methodology that estimates a top-down correction to a fund's NAV based on historical relationships between its NAV and market indices. Ciampi and Zitzewitz (2001) advocate a related bottom-up methodology that estimates fair-value prices at the security level. The idea behind both methodologies is that a reasonable fair-value price is the statistical expectation of the price that would prevail in a liquid market, given all information reflected in market indices as of 4:00 P.M. ET.

Fair-value pricing at the security level is likely to be more accurate given that the median international fund has holdings turnover of 80% per year, but either methodology is substantially better than the alternative solutions discussed above. Properly constructed fair-value pricing should completely eliminate dilution and should substantially reduce market timing activity and the associated costs to funds. At least two third-party pricing services are currently offering to provide fair-value prices for international equities calculated using a bottom-up methodology. Out-of-sample tests of one service's prices suggest that it removes more than 95% of NAV predictability, yet neither has been widely adopted as of mid-2002. The pricing information I have obtained from one of the services implies a cost to the median-size fund complex of 5 basis points of international assets.

6. SEC Guidance and Industry Response

The most recent formal guidance given by the SEC to funds on this issue is their letter to the Investment Company Institute of April 30, 2001. The letter states that "with regard to a foreign security, a fund *must* evaluate whether a significant event (i.e., an event that will affect the value of a portfolio security) has occurred after the foreign exchange or market has closed, but before the fund's NAV calculation. If the fund determines that a significant event has occurred . . . then the closing price for that security would not be considered a 'readily available' market quotation, and the fund *must* value *the security* pursuant to a fair value pricing methodology." It further states that "significant fluctuations in domestic or foreign markets *may* constitute a significant event" and that "funds should continuously monitor for events that might necessitate the use of fair value prices" and should "evaluate the appropriateness of their fair value methodology for foreign securities by reviewing next-day opening prices" (all emphasis added). The letter motivates these requirements by specifically mentioning that "the failure to determine the fair value of portfolio securities following significant events may result in dilution."

Although the SEC's formal guidance emphasized that fair valuing individual securities is a requirement, it leaves funds the latitude to make their own determinations in good faith as to when significant events have occurred and what constitutes an appropriate fair valuation methodology. An examination of recent NAV changes suggests that the vast majority of international funds have not fair valued on even a single day in the May 2001–September 2002 period, a sustained period of high market volatility (Zitzewitz, 2002). This implies that these funds have thus far used this latitude to define a significant event such that they essentially never occur or that they are using fair-value prices that are statistically indiscernible from local closing prices, even on high-volatility days.[17]

The formal response from industry groups to the SEC guidance has tended to defend a broad interpretation of "good faith." A March 2002 white article by the Investment Company Institute (2002) argues that "even if *future* prices in a foreign market tend to be correlated with either a particular financial instrument or the U.S. market, this does not necessarily mean that prices in the foreign market *as of the close of the U.S. market* are similarly correlated" (second emphasis added).[18] A June 21, 2001, letter to the SEC from the Committee on Investment Management

17. Surveys in late 2001 by Deloitte and Touche, PriceWaterhouseCoopers, and Capital Market Risk Advisors revealed that 20–40% of funds did not monitor for significant events, as required by the April 2001 letter, and only 4% of funds made fair-value adjustments to account for time zone differences (Dodds, 2001; Sahoo, 2001a, b).

18. Note that this statement is positing an extreme violation of market efficiency: that, for example, *all* of the correlation between the 11:30 A.M. to 4:00 P.M. ET change in the U.S. market and the 11:30 A.M. to 11:30 A.M. next day change in the price of a European security is due to post-rather than pre-4:00 P.M. changes in the true value of the European security. While we do not observe the 4:00 P.M. values of most foreign securities, the evidence for the most

Regulation of the Association of the Bar of New York City states that "we are skeptical of the premise that, if one market moves after another closes, there is necessarily a change in value," that "any fair value is but one value within a range of possible fair values" and that "this inherent uncertainty is not a basis to contest the good faith of directors in making fair value determinations." It adds that "the dilution issues raised in the 2001 Valuation Letter are better addressed by redemption fees, limitations on exchange privileges and other trading controls."

The SEC normally avoids being overly proscriptive, preferring to allow the industry the latitude to develop innovative ways of addressing the SEC's concerns. In this case, however, many fund companies appear to be abusing that latitude to essentially not respond to the SEC's concerns about shareholder dilution, and some have called for the SEC to become more proscriptive, particularly on the definition of a significant event and on the standards for the appropriateness of fair-value prices.[19] But the SEC has been subject to considerable political pressure on the issue from an industry that opensecrets.org ranks as the second largest political donor.[20] On one particular issue, the question of whether funds can substitute top-down adjustments for security-level valuation, some have interpreted Paul Roye, head of the SEC's Investment Management Division, as backing away from comments by Doug Scheidt, chief counsel of the division and author of the 2001 letter, that making only top-down adjustments is inadequate (Investment Company Institute, 2002; Sahoo, 2001d, f). According to industry sources and Sahoo (2001e), the SEC has placed more emphasis on fair valuation in its recent compliance visits to mutual funds, but it is unclear whether they plan to require funds to fair value often and fully enough to substantially limit dilution or whether they will simply require funds to "monitor for significant events."

7. Who Cares About Shareholders?

The fact that the mutual fund industry is lobbying aggressively to avoid being forced to adopt a fairly low-cost solution to rather substantial shareholder dilution is suggestive of a conflict of interest between fund managers and their shareholders. An alternative hypothesis offered by some in the industry is that the funds' resistance is motivated by legal concerns, particularly the fear of shareholder lawsuits based on the ex post difference between fair value and future prices. There are reasons to doubt the legal

liquid ADRs (Table 7) and the Nikkei future suggests that essentially all of the correlation is due to pre-4:00 P.M. changes in the value of the foreign securities, consistent with market efficiency.

19. For example, Ciccotello et al. (2002) and industry sources cited in Sahoo (2001c).

20. The SEC has also received other political pressure. An example is a September 13, 2001, letter from Congressman Thomas Tancredo (R-CO) expressing "alarm" at fair-value pricing and at restrictions being imposed on international market timers. Congressman Tancredo specifically complained that he had had trading restrictions imposed on his personal account by a fund family. This letter and the Bar Association letter were obtained from the SEC via a Freedom of Information Act request.

explanation, particularly the fact that the SEC's position provides some cover for funds and that, arguably, continued dilution provides even greater grounds for shareholder action, but further light can be shed on these competing hypotheses by examining the relationship between fund governance and aggressiveness on the arbitrage issue.

Although the industry response to the arbitrage problem has been slow in aggregate, there are some exceptions. About 30% of international funds have short-term trading fees by the end of 2001, mostly adopted by funds in 2000–2001. As discussed above, short-term trading fees have limitations in their effectiveness in preventing arbitrage, but having them offers more protection to shareholders than not having them. In addition, a very limited number of funds have started either full or partial fair-value pricing. Using a method for measuring the degree to which predictable future changes in foreign closing prices are incorporated in current-day NAVs described in Zitzewitz (2002), I find that the average fund incorporated 5% of predictable next-day NAV changes from January 2001 to December 2002.[21] Most of this came from funds valuing ADR holdings using their ADR rather than their local prices; only five international funds incorporated more than 80% of predictable stale price changes without having significant ADR holdings.[22] But fair valuing via ADRs is better than not at all, and therefore it seems reasonable to include it in a measure of investor protection. In some cases, funds shift their holdings toward ADRs to reduce NAV predictability, the most extreme example being ProFunds Europe, which limits itself to holding 35 very liquid ADRs, since it caters to high-frequency traders.

If protecting funds from dilution is in the interests of long-term shareholders, but most fund managers view it as not being in their interest, then one would expect to see better protection in funds where governance gives greater weight to shareholder interests. This appears to be the case. Table 8 reports regressions predicting the adoption of short-term trading fees and fair-value pricing. Funds with a lower share of the board that are "interested parties" (who are indicated as such by an asterisk in a fund's

21. In brief, the method is to first estimate a predictive model for next-day returns in the (stale-price) Morgan Stanley Capital International (MSCI) index relevant for each Morningstar category, where the predictive variables are the three used in Table 1 (the pre- and post-11:30 A.M. changes in the S&P 500 and the CME Nikkei future less its local close). Second, regress a fund's current-day NAV change on the current-day MSCI index change and the difference between today and yesterday's predicted next-day changes in the appropriate MSCI index. The second coefficient divided by the sum of the two gives the extent to which predictable changes in stale prices are incorporated in current-day NAVs.

22. The five are AMIDEX 35 (AMDEX), Rydex Europe (RYEUX), Rydex Japan (RYJPX), ProFunds Japan (UJPIX), and Vanguard Pacific Stock Index (VPACX). It is unsurprising that Rydex and ProFunds fair value, given that they specialize in accommodating high-frequency traders. Rydex and ProFunds Japan index the Nikkei 225, so they can "fair-value price" using the 4:00 P.M. ET Nikkei future price from the CME. An additional group of funds, including American and Delaware's international funds (e.g., AEPGX and DEGCX) began fair valuing fully during 2002.

Table 8. Determinants of Arbitrage Countermeasures by International Equity Mutual Funds

Specification	Probit regression		OLS			
Dependent variable	Fund has short term fee?		Fair valuing coefficient			
Mean of dependent variable	0.31	0.33	0.051	0.040		
					Summary statistics of RHS variables	
Observations	1003	720	1309	676		
Pseudo/adjusted R^2	0.09	0.12	0.25	0.34	Mean	SD
Expense ratio (in percent)	−0.18*	−0.14	−0.045*	0.011	1.9	0.7
	(0.09)	(0.11)	(0.012)	(0.013)		
Percent of board that are "interested parties"		−2.26*		−0.086*	0.2	0.2
		(0.43)		(0.032)		
ln(median market cap of holdings)	−0.18*	−0.23*	0.055*	0.054*	9.2	1.2
	(0.09)	(0.05)	(0.006)	(0.006)		
ln(fund assets)	0.03	0.04	0.001	0.005	3.4	2.1
	(0.02)	(0.03)	(0.003)	(0.003)		
Load fund dummy	−0.13	−0.04	0.076*	−0.006	0.6	0.5
	(0.11)	(0.14)	(0.014)	(0.016)		
ln(brokerage networks distributed through)	0.65*	0.40*	−0.015*	−0.008	2.8	0.8
	(0.09)	(0.14)	(0.007)	(0.014)		

Regressions measure the correlation between the adoption of countermeasures against arbitrage (short-term trading fees and fair valuing) and proxies for independent fund governance (expense ratio and share of insiders on the board). The short-term trading fee variable captures whether a short-term fee was mentioned in the prospectus at the end of 2001. The fair valuing coefficient captures the extent to which the predictable next-day return in the MSCI index for the region covered by the fund is captured in the current-day fund NAV change (0 implies pricing using stale prices; 1 would imply completely removing the predictability from next-day returns; see footnote 21 in the text for the estimation procedure). Annualized dilution is the dilution of a specific fund in percent, measured as in Table 4. Regressions include fixed effects for Morningstar fund categories. Standard errors are adjusted for clustering within fund families.
*Significant at 5%.

Statement of Additional Information) and lower expense ratios are more likely to have adopted short-term trading fees and fair-value pricing. The magnitudes of these relationships are large: for example, a standard deviation reduction in expense ratio increases the likelihood of a short-term trading fee by 3 percentage points, while a standard deviation reduction in the insider share of board seats increases it by 16 percentage points.

These relationships are robust to control for characteristics of a fund's holdings (asset class, portfolio size, and median market cap) and distribution (load/no load, number of supermarkets distributed through). The control variables enter the regression in a logical fashion: widely distributed funds are more likely to have fees. Funds with small capitalization holdings are more likely to have fees but appear to be doing less fair valuing, probably because they are less likely to have ADRs. Analyzing fair-value pricing using a discrete variable (does a fund fair value make more than x% of a full adjustment, where x is between 20 and 80) yields qualitatively similar results, with less statistical power. I also examined whether fund-level dilution varied with governance, but with dilution measures only available for 10% of funds, the sample size was too small to yield meaningful results.

It is important to note that since we observe no source of exogenous variation in fund governance, these correlations are not necessarily causal.[23] For example, the fact that low-expense-ratio funds are more likely to have fees or fair value may be the result of these funds having previously attracted proportionately more arbitrage activity, since arbitrageurs are presumably more sophisticated than average mutual fund investors, and thus may be more sensitive to expenses. Anecdotally, Vanguard, a low-expense-ratio fund family, was among the first fund families to implement fees and fair-value pricing. But a similar alternative causal story is more difficult to construct for board composition, since once expense ratios are controlled for there is little reason an arbitrageur should be attracted to a fund with a more independent board.

8. Conclusion

This article makes several points. First, NAV arbitrage is a widespread problem, and the resulting dilution of long-term shareholders has roughly doubled since 1998–99 to more than $4 billion per year. Second, the solutions adopted and advocated to date by the fund management industry have serious shortcomings, and most funds appear willing to defy regulators to avoid adopting fairly low-cost full solutions. Third, while the industry has been surprisingly slow in moving to close the NAV arbitrage loophole, funds that appear to be better governed seem to be moving faster.

23. This is, of course, a common problem with empirical work on corporate or fund governance.

This set of facts is consistent with fairly severe agency problems in delegated fund management. The fact that funds are unwilling to spend 5 basis points per year to eliminate annual dilution of more than 100 basis points suggests that they care less than 5 cents on the dollar about shareholder welfare.[24]

A similar estimate can be made using the fact that Daly (2002) reports that at least three fund families that discourage market timing at daily frequencies are willing to allow it at monthly or quarterly frequencies in order to increase the size of their funds. From Table 6, one can infer that 12 and 4 well-timed round-trips per year yield excess returns of 15–25% and 8–12% in international and small-cap funds without fees. The size-weighted average expense ratio of international funds is 115 basis points, and most asset management costs are fixed, so for simplicity assume that marginal fund company profit from additional assets is 100 basis points. By allowing an additional $1 of market timing, average annual assets increase by 50 cents and fund company profits by 0.5 cents, but shareholders lose 8–25 cents. This suggests that fund companies that consciously allow monthly or quarterly market timing to increase their asset base care less than 2–6 cents on the dollar about shareholder assets.

But a simple back-of-the-envelope calculation suggests that fund management companies actually have greater incentives to prevent dilution than these calculations imply. Recent research on the slope of the inflow-performance relationship (e.g., Chevalier and Ellison, 1997) suggests that $1 of dilution reduces future inflows by roughly another $1, thus reducing the future size of the fund by $2. If one again assumes that margin profit from additional assets is 100 basis points, then $1 of dilution costs a fund company 2 cents in flow profit per year. Applying a net discount rate of 10% (cost of capital less average future fund growth rate) in perpetuity suggests that $1 of dilution costs the fund management 20 cents in reduced NPV of flow profits. Although these exact assumptions may be debatable, reasonable alternatives are unlikely to change the conclusion that fund management companies have a substantial interest in reducing dilution.

Taken together, these calculations imply that there is another layer of agency problems inside the management companies. One might expect that fund managers would have high-powered incentives based on the performance of their funds and thus have a strong interest in eliminating dilution, but in many management companies, decisions about fair-value pricing are not made by fund managers, but rather by functional experts who could conceivably face strong incentives to maintain the status quo. Even if this is the case, one would need to explain why functional experts' incentives are determinant in this case.

24. This assumes that none of the 5 basis points could be passed onto shareholders in the form of higher expense ratios. It also ignores any additional costs of implementing fair-value pricing other than fees paid to the data provider, but since fair valuing would eliminate the need for the monitoring that many funds were engaged in as of 2001, net of this saving, the additional cost may be minimal.

Two other possibilities exist. One is the legal risk argument mentioned above, although as discussed, it is far from clear that funds minimize their legal risk by allowing dilution, especially given the SEC position. Another possibility, which one would hesitate to even suggest until all others are exhausted, is that fund management company employees directly benefit from allowing arbitrage. This might also explain why short-term trading fees and monitoring have been the dominant responses thus far, since these can be applied (or not applied) selectively. Even if this is not, in fact, the explanation, one might expect that the perception that it could be will be sufficient to spur action in the future, as NAV arbitrage becomes more widely understood.

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