Marking to Market, Trading Activity and Mutual Fund Performance

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Abstract:

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This paper analyzes the portfolio decisions of a mutual fund manager who cares about her short-term performance as measured by the Net Asset Value of her fund. We show that such preferences lead to trading even without favorable information in order to enhance short-term rewards. We show that information about the fund's portfolio position is valuable and that closed-end funds may trade at discounts or premia to measured asset values. Patterns in closed-end fund premia are easily explained with the help of the paper's model.

1 Introduction

Mutual funds play an increasingly important role in financial markets around the world. According to the Investment Company Institute[2], the number of mutual funds worldwide has increased from 50,835 in 1998 to 54,015 in 2004[3]. This growth in numbers has been accompanied by a remarkable rise in the the value of assets held by mutual funds: from \$9.34 trillion in 1998 to \$13.96 trillion at the end of 2003. Over the last twenty years, mutual funds have been a prime investment vehicle for individual investors. In fact, for most this time period, purchases of equity by households through mutual funds have been positive every year while net purchases made outside mutual funds have mostly been negative. Consequently, there has been a continued shift in ownership of equities from individual ownership to ownership through mutual funds. At end-2003, assets of U.S. equity mutual funds stood at \$3.68 trillion, while total mutual fund assets, including money market funds, bond funds and hybrid funds stood at \$7.41 trillion. The total amount of financial assets owned through mutual funds is comparable to the total loans and investments of all commercial banks in the United States and total equity holdings by mutual funds account for about 20% of all U. S. equities by value. This increasing trend of indirect holdings through mutual funds is not just a characteristic of domestic markets, but also has been a feature of most international markets throughout the 1990s. In fact, a large portion of the divestment of government owned asset by countries restructuring their economies in Eastern Europe and Asia, has been undertaken with the help of new or existing mutual funds.

It is clear, then, mutual funds are important investment vehicles and, thus, merit the attention of researchers. While there has been a significant body of work built up during the last three decades regarding the performance of mutual funds[4], there seems to have been a paucity of theoretical models investigating the decision criteria used by mutual fund managers. Consequently, while in the area of corporate finance, the

[2]See the Investment Company Institute's publication *Mutual Fund Factbook* for data on trends in the mutual fund industry. Data reported here are from the 2004 issue (*44th* edition) .

[3]The corresponding numbers for the U.S. are 7,314 and 8,126 respectively.

[4]For an overall view of the empirical facts and trends, see Sirri and Tufano (1993).

paradigm of agency costs has been well explored and applied to generate implications for corporate managers, there does not exist a cogent body of work which attempts to apply similar insights to world of mutual funds[5]. The literature that exists to date has concentrated on the structure of fees for mutual fund managers (Chordia (1996)), the structure of mutual funds and optimal managerial strategies (Nanda, Narayanan and Warther (1998), Nanda and Singh (1999)) and the effect of performance measures on the portfolio composition undertaken by fund managers (see Huddart (1998)). In this paper, we focus, instead, on the incentives of fund managers who are rewarded based on their asset holdings, to deviate from the interests of long-term value maximization.

The basic model examines the incentive of informed fund managers to trade excessively in the direction of their portfolio holdings. Such trading is an attempt at bolstering the value of the existing portfolio even though this may detract from maximizing long-term profits. We demonstrate that managers' incentives to engage in such trade goes up with the size of their holdings. While such trading may very well be anticipated and accounted for in the pricing of traded securities, we show that, nevertheless, there will be incentives to engage in such trade. In face of such anticipation by price setters in the financial markets, it is costly, in terms of short-term portfolio values, not to engage in such trade. We show that this incentive is strong enough to generate trade even in the absence of liquidity traders who care only about execution and not profitability. Thus, we are able to provide some justification to the thesis that greater institutional holdings generate higher trading activity in markets. Our trading results rely only on the agency problems between managers and long-term investors and we do not need to invoke diversification as a motive for trade.

We extend our analysis to ask whether fund managers should disclose their historic portfolio holdings to reduce the impact of inventory uncertainty on their portfolio values. We establish that, even though long-term investors prefer such disclosure, the manager (and investors who need to liquidate in the short-term) do not favor such disclosure. We show that this result arises because increases in Net Asset Value (NAV) in the short-run are aided by this lack of disclosure, which makes it hard for market participants to distinguish between price moves that are caused by a change

[5]Prominent exceptions are Dow and Gorton (1997) and Berk and Green (2004).

in fundamentals and those caused by order imbalances. Finally, we demonstrate that having access to the outstanding portfolio composition of a mutual fund has value to an investor who is ready to trade strategically on that information. As a result, the manager has even greater incentive to withhold such information.

While much of our analysis is performed in the context of no-load, open-end mutual funds, our model also has implications for the closed-end fund puzzle. A long-standing anomaly in the finance literature has been the persistent downward bias of market values of closed-end funds from their Net Asset Values. There exists an extensive literature on the subject and a wide variety of proposed solutions to the puzzle. Some of these explanations concentrate on tax and illiquidity factors to argue for an upward bias in reported NAVs, while others focus on market sentiment to argue for variable biases in the market value of closed-end funds[6]. Our model generates an upward bias in the short-run NAV due to market's inability to distinguish between price moves caused by fundamental information and by non-informational trading by mutual fund managers. In this setting, we show that closed-end funds may very well sell at a premium or at a discount to their NAVs. We derive conditions under which either situation prevails. In our model, it is entirely reasonable for closed-end funds to start off at a premium to their NAVs and to then drift downwards with time. Our model generates several other empirically testable propositions.

In terms of its motivation, our model is most closely related to work by Dow and Gorton (1997) who also look at the incentives of mutual fund managers to engage in excessive trading. In their model, excessive trading results from an attempt by an agent to convince the principal that she possesses private information about security values since, otherwise, her actions could not be distinguished from those of uninformed managers. In contrast, our model does not generate trading to induce such separation in types: Excessive trading results from an attempt to influence prices, whether successful or not. More recently, Berk and Green (2004) present an analysis of mutual fund trading activity where managerial talent has decreasing returns to scale. They calibrate their model to show that it can explain several stylized facts

[6] See Dimson and Minio-Kozerski (1999) for a recent survey of the literature on closed-end funds.

about profitability of mutual funds and its relationship to flows into and out of funds[7]. Their analysis does not address the market impact issues directly, although decreasing returns to scale is consistent with this factor.

Finally, Carhart *et al* (2002) provide empirical support for several of our results. They provide evidence that fund managers inflate quarter-end portfolio prices with last-minute purchase of stocks already held and that there is a surge in trading in the last minutes of a quarter. They offer a couple of hypotheses as to why such an empricial pattern emerges and conclude that it is likely that such behavior is caused by managerial compensation considerations. Our model, indeed, establishes formally that such patterns would be expected when managerial compensation considerations are important.

The paper proceeds as follows. In Section 2, we consider the case of the manager of an open-end mutual fund who ignores the impact of her own trading strategy on market parameters and estabish the basic result of excessive trading. In Section 3, we consider the more general case of market participants anticipating the impact of their trading strategies on market parameters. In Section 4, we examine the incentives of various parties to disclose information about portfolio holdings. In Section 5, we extend our analysis to the case of closed-end funds, while implications and extensions are presented in Section 6. Section 7 concludes.

2 The Base Model

For the base model, we consider the case of a single open-end, no-load, mutual fund that trades in two securities: a risk-free asset and a risky asset. The risky asset is traded in a batched order market *a la* Kyle (1985): all market orders and submitted simultaneously and a market-clearing position is taken by a market maker. There are three dates. At date 0, there are no asymmetries in information about the prospects for the risky security and its per-unit price is given by P_0. The mutual fund has an inventory of z units of the risky security and $I_0 - zP_0$ invested in the risk-less asset.

[7]See also Edelen (1999) for an empirical examination of related issues.

Sometime during the first period, the fund manager receives private information about the payoff of the risky security and decides on the market order to place with the market maker. At date 1, the market maker batches all market orders received during the period and clears the market for the risky security, thus establishing a trading price. At the end of trading on date 1, the fund announces its Net Asset Value (NAV), computed using the market prices of its holdings. At date 2, the payoff to the risky security is realized. For simplicity, we assume that there is no other new information or trading during the second period. All players are assumed to be risk-neutral and the risk-free rate is normalized to be zero.

The mutual fund manager is assumed to have perfect information about the risky security's payoff. We denote this payoff by the random variable $\tilde{v}$ and the manager's market order by $\tilde{x}(v)$. In the base model, we do not specify the trading strategies of other traders but take it as given that they have either information or liquidity needs to engage in trading. The market maker gets to observe the aggregate order flow, $\tilde{y}$, and sets a price at which the market clears. For now, we assume that the market maker's price setting process results in a linear price schedule of the form $P_1 = P_0 + \lambda y$, where $\lambda > 0$ is a parameter that reflects the market depth. The slope of the price schedule could arise, for present purposes, due to either the anticipated presence of other informed traders or due to inventory-theoretic considerations that affect the market maker's pricing strategy[8]. We assume that the mutual fund manager takes the value of λ as given and that the competition between market makers ensures that market-clearing prices are semi-strong form efficient. Note that this implies that $E(P_1) = P_0$ and that $E(y) = 0$.

In order to analyze the optimal choice of the market order placed by the mutual fund manager, we need to first specify an objective function for the manager. We assume that the mutual fund manager places a weight of γ on the NAV of the fund at date 1 and a weight of $(1 - \gamma)$ on the liquidation value of the fund, where $0 < \gamma < 1$. This objective function is motivated by the commonly observed compensation

[8]Glosten and Milgrom (1985), Easley and O'Hara (1987), among others, analyze models of market-making where price responds to order size due to adverse selection considerations. Ho and Stoll (1981) is an example where the responsiveness of price to volume is due to inventory-theoretic considerations.

functions prevalent in the mutual fund industry, in which a substantial portion of managerial fees are in the form of a set percentage of (the current market value of) total assets under management. In addition, Sirri and Tufano (1998) and Chevalier and Ellison (1997) have shown that fund flows in to and out of mutual funds are strongly related to lagge measures of performance. Thus, it stands to reason that fund managers would have strong incentives to care about both short and long term performance in making trading decisions[9].The flow of funds argument can also be formalized without considering investor response to current performance. Suppose, for example, that the fund manager acts in the interest of *ex ante* identical investors who have claims on the fund. With some probability, each investor suffers a liquidity shock at time 1, which leads to the redemption of his entire claim at that point in time[10]. Given the open-end nature of the fund, redemptions are computed using the NAV figure at date 1. The remaining investors stay invested in the fund up until date 2 and realize liquidation proceeds when the risky asset pays off. In this environment, it is *ex ante* optimal for the manager to be provided with incentives to maximize an objective function that involves both the liquidation value of the fund and its NAV at date 1[11].

It is also worth noting that this form of an objective function has been used in the context of agency considerations which would, clearly, apply in the context of decisions by a professional fund manager. For example, Miller and Rock (1985) consider such an objective function in the context of a corporate manager making a decision on dividend and investment policies. It is relatively straightforward to show that an attempt to elicit optimal actions on the part of a manager in a situation where either managerial tenure is stochastic or investor response to performance is rational would also involve incentive schemes which reward both short and long-term performance . Finally, managerial concern about near-term performance also arise when they borrow money to finance their activities: borrowers' concerns about being

[9]The linearity feature is not essential for our results but allows for closed form solutions.

[10]This argument is similar to the one found in many banking models. See, for example, Diamond and Dybvig (1986).

[11]Nanda and Singh (1999) discuss the effect of early redemption on the incentives of other investors to remain with the fund. For the sake of simplicity, we do not explicitly account for the cost of early redemption on investors who do not redeem early.

repaid also makes a manager care about short-term performance. In recent times, perhaps the most dramatic illustration of this principle was seen in the case of Long Term Capital Management (LTCM). It has been argued by several observers that the trading strategy pursued by LTCM could reasonably have been expected to result in profits over the long run. However, unanticipated short-term movements that widened historical credit spreads made LTCM's portfolio lose a significant proportion of its value and resulted in its inability to sustain its leverage.

The structure laid out above is sufficient for us to determine the optimal trading strategy of the fund manager for a given value of λ. When the fund manager's private information of the payoff of the risky security is v, she chooses her order x to maximize her objective function

$$I_0 + \gamma[z(E(P_1) - P_0) + x(E(P_1) - E(P_1))] + (1-\gamma)[z(v - P_0) + x(v - E(P_1))]$$

The first bracketed term in the objective function measures the contribution of the change in the portfolio value at time 1, while the second term measures the contribution from the final payoff. Note that the first term itself has two components: the enhancement in the value of the existing inventory of the risky security, and the profits made in the net acquisition in the first period. Since the market maker sets a clearing price after observing the total net order flow, the latter component is identically zero. That is, in the short-run, the accumulation of a position, even when it drives up prices, does not harm measured performance *per se*. Similarly, the second bracketed term is also composed of two components: the payoff to the position in the risky security outstanding at time 0 and that of the net position accumulated at time 1. Note that, at time 2, the cost of accmulating an inoptimal position is realized when the true value is realized.

Given our assumption about the price-setting process, from the perspective of the fund manager, the expected market clearing price is given by $E(P_1) = P_0 + \lambda x$. Hence, we can rewrite the last equation as:

$$I_0 + \gamma[zP_0 + \lambda zx - zP_0)] + (1-\gamma)[zv - zP_0 + xv - xP_0 - \lambda x^2] \tag{1}$$

Clearly, the expression above is strictly concave in the decision variable x. Thus, the first order condition is sufficient for a maximum. Taking derivatives with respect to x yields the following first order condition:

$$\gamma z\lambda + (1-\gamma)(v - P_0 - 2\lambda x) = 0$$

which yields the optimal trading strategy of the manager, x^*, as:

$$x^* = \frac{(v - P_0)}{2\lambda} + \frac{\gamma}{1-\gamma}\frac{z}{2} \tag{2}$$

Observe here that the inventory level z affects the trading strategy of the fund manager. For $\gamma = 0$, the trading strategy of the manager would reduce to that found in Kyle (1985), where the informed trader only cares about his final payoffs. We call this reference strategy the *optimal informational trading strategy.* Our fund manager, on the other hand, also cares about the NAV of her portfolio at the interim stage and is, therefore, willing to modify her trading order to affect the interim NAV at a cost to her payoff-date performance. The adjustments she makes in her trading decision depend directly on her level of concern with the interim performance of her portfolio. Thus, we have:

Proposition 1 *The informed fund manager's trading strategy is influenced by the position of her inventory in the risky security. The higher the level of her inventory, and the more she cares about interim performance, the greater is her deviation from her optimal informational trading strategy. Moreover, the extent of her deviation is independent of the price impact of each unit of trade in the market.*

Deviating from her optimal informational trading strategy and trading more in the direction of her inventory of the risky security allows the manager to support the price of her inventory position at time 1. To see how this affects the manager's trading strategy, consider the case of a manager who has no private information but still places a trading order. At an order level of x, an additional unit of trade in the risky security yield a marginal benefit of $\gamma z \lambda$, a benefit that increases with the level of her existing inventory position. Taking the case of $z > 0$, the marginal unit bought increases the cost of acquisition of all the units purchased but, at the same time, benefits the value of her inframarginal position. On the other hand, the marginal cost of the incremental unit is composed of two components. The direct effect of an increased price on the marginal acquisition is $(1-\gamma)\lambda x$, and the impact via the increased cost of the the inframarginal acquisition is also $(1-\gamma)\lambda x$. Setting marginal cost equal to marginal benefit shows that even an uninformed manage would trad in the direction of her inventory and that the larger her inventory of the risky security the larger is her imperative to deviate from the optimal informational trade level.

What is most interesting, however, is the fact that her deviation from the optimal informational level does not depend on the liquidity characteristics of the market, unlike an order strategy which conforms to long-term value maximization. This is because both marginal benefit and marginal cost of trading an extra unit depend linearly on the liquidity parameter λ. Hence, the level of λ plays no role in the equalization of marginal benefit and marginal cost. This fact has a striking implication: no matter what the liquidity level of the market, the fund manager's deviation from the optimal informational trade level is solely determined by (i) her inventory position and (ii) by the extent of her short-term orientation. Of course, the price impact of such a deviation would be higher in an illiquid market than in a liquid market. A similar pattern will hold when one considers the change in prices between periods 1 and 2. Thus, volatility of prices in an illiquid market would be higher in the presence of mutual funds than it would be in a more liquid market.

So far, our simplistic characterization of trading decisions has ignored two crucial factors. First, the liquidity parameter in the market for the risky security is not affected by the presence of the informed mutual fund manager. Second, even though the market maker knows that such a manager has incentives to trade without an informational reason, he still expects zero net trade at time 1. The only way to take these factors into account is to embed our analysis in a fully specified market micro-structure model. And this is the task we turn to in the next section.

3 An Equilibrium Model

As would be natural to expect based on the earlier section, we choose to use the market micro-structure model of Kyle (1985) since it yields a tractable equilibrium in linear strategies. For now, we maintain the twin assumptions of a single perfectly[12] informed mutual fund manager and the existence of a single risky security. At time 0, however, we assume that the market maker views the time 2 liquidation value as a random variable with the following characteristics: $\widetilde{v} \sim N(P_0, \sigma_v^2)$. Informed trading is made possible by the presence of liquidity traders who trade for unspecified non-informational reasons. Their collective order flow is known to be a random variable denoted by $\widetilde{u}$, where $\widetilde{u} \sim N(0, \sigma_u^2)$. The net order flow observed by the market maker prior to setting the market clearing price is, then, given by $\widetilde{y} = \widetilde{x} + \widetilde{u}$. As in Kyle (1985), it is assumed that competition among market makers ensures that $P_1 = E(\widetilde{v}|y)$. Since we have already shown that our informed mutual fund manager will have incentives to deviate from her long-term value maximization strategy due to non-informational reasons, we now assume that the market maker is sophisticated enough to anticipate such a deviation. Since such a deviation has no information content about the value of the traded security, competition among market managers should ensure that the realization of this anticipated trade level does not move prices. Hence, denoting the level of anticipated deviation by k, we can write the price schedule imposed by the market maker as:

$$P_1 = P_0 + \lambda(y - k), \qquad \lambda > 0 \tag{3}$$

where λ and k both need to be determined by equilibrium considerations.

Given these changes, it is straightforward to show that the optimal trading strat-

[12]Relaxing the assumption of perfect information for the fund manager is a trivial exercise that does not add much to the principal points of the paper.

egy of our informed fund manager is now given by:

$$x^* = \frac{(v - P_0)}{2\lambda} + \frac{\gamma}{1-\gamma}\frac{z}{2} + \frac{k}{2} \tag{4}$$

We now need to make appropriate assumptions about what the market maker knows about the fund manager's holding level of the risky security. Since funds are only required to disclose detailed information about their portfolio holdings at half yearly intervals[13], it seems reasonable to treat holding levels as private information of the manager. Therefore, we assume that the market maker regards z as a random variable desribed as: $\widetilde{z} \sim N(\overline{z}, \sigma_z^2)$. We will comment on alternative interpretations of σ_z^2 later in this section.

From the fund manager's optimal strategy given in equation (4), and remembering that the expected level of trades by liquidity traders is zero, we have the expected net trades to be:

$$\begin{aligned}\bar{y} &= E\{\frac{1}{2\lambda}[(\tilde{v} - P_0) + \frac{\gamma}{1-\gamma}\lambda\tilde{z} + \lambda k] + \tilde{u}\} \\ &= \frac{\gamma}{1-\gamma}\frac{\bar{z}}{2} + \frac{k}{2} \\ &= k, \qquad \text{(by assumption)}\end{aligned}$$

which yields the result that $k = \frac{\gamma}{1-\gamma}\bar{z}$.

We can, then, rewrite the fund manager's optimal trading strategy as:

$$\begin{aligned}x^* &= \frac{1}{2\lambda}[(v - P_0) + \frac{\gamma}{1-\gamma}\lambda z + \frac{\gamma}{1-\gamma}\lambda\bar{z}] \\ &= \frac{(v - P_0)}{2\lambda} + \frac{\gamma}{1-\gamma}\frac{(z - \bar{z})}{2} + \frac{\gamma}{1-\gamma}\bar{z} \qquad (5)\end{aligned}$$

[13]The six monthly requirement is in U.S. markets. In other markets, mandatory disclosure requirements are different. Also, some funds voluntarily disclose portfolio information at quarterly intervals.

and the market maker's price schedule as:

$$
\begin{aligned}
P_1(y) &= P_0 + \lambda(y - \frac{\gamma}{1-\gamma}\bar{z}) \\
&= P_0 + \frac{v - P_0}{2} + \frac{\gamma}{1-\gamma}\frac{\lambda(z-\bar{z})}{2} + \lambda u
\end{aligned} \tag{6}
$$

The results above are formalized in the next proposition and show that the basic insight established in the last section carry over to the case where the market maker anticpates the trading strategy of the fund manager:

Proposition 2 *The expected level of trade in the market for the risky security is proportional to the expected level of the risky security held by the mutual fund at the commencement of trading. The expected price impact of trade is, however, zero. The greater the fund's concern about short-term returns, the higher is the expected level of trading in the market,* ceteris paribus*.*

The result tells us that as the level of holdings by the mutual fund goes up, more trade is expected in the market for the risky security. What is important to note is that this result does not depend in any way on the level of liquidity in the market for the risk security. Instead, it is the fund's concern with short-term performance and the total inventory levels that drive this result. The result suggests that the average trading volume in equity markets increases with aggregate fund holdings. In addition, on a proportional basis, this impact is likely to be more visible in the case of security markets with lower liqudity levels where informed trading is more costly due to price pressure associated with order flow.

Note that the fact that the market maker anticipates the manager's incentives to boost short-term performance (and sets prices accordingly) does not dampen the manager's tendency to trade excessively. In fact, such an anticipation sets up a signal-jamming situation: if the manager does not follow up with the anticipated level of non-informational orders, the fund's NAV may suffer. Hence, the manager is forced to trade on the margin not because he hopes to fool the market maker on average but because he does not want to suffer the price consequences of not submitting non-information based orders.

Finally, to complete our description of the equilibrium in the market for the risky security, we need to derive the value of the liquidity parameter in the market maker's price schedule. We do this following the procedure outlined in Kyle (1985). Thus, invoking the properties of the Normal distribution and our assumption on the competition between players in the security markets, we have:

$$
\begin{aligned}
\lambda &= \frac{Cov(\tilde{y}, \frac{\tilde{v}}{2\lambda})}{Var(\tilde{y})} \\
&= \frac{\frac{1}{2\lambda}\sigma_v^2}{\frac{1}{4\lambda^2}\sigma_v^2 + \beta^2\frac{\sigma_z^2}{4} + \sigma_u^2} \qquad \text{where } \beta = \frac{\gamma}{1-\gamma}
\end{aligned}
$$

which, on simplification, reduces to:

$$
\lambda = \frac{\sigma_v}{2(\beta^2\frac{\sigma_z^2}{4} + \sigma_u^2)^{\frac{1}{2}}} \tag{7}
$$

With respect to the liquidity parameter, λ, note the presence of an extra term, $\beta^2\frac{\sigma_z^2}{4}$, compared to the expression for the liquidity parameter in Kyle (1985). As explained above, from the market maker's point of view, this is the variance of the non-informational component of the order flow originating with the mutual fund. The greater the short term focus on performance, the greater are the incentives for the mutual fund to try and affect the market clearing price at time 1. However, variations of trading orders on this account have no information content about future value and, thus, a competitive market maker regards such variation as noise. Thus, the uncertainty about the fund's holdings serves to make a component of its trading strategy similar to that of liquidity traders and makes, on the whole, the market more liquid. This implies, in turn, that the component of fund order flow that depends on its manager's informational advantage will be larger in magnitude than in Kyle (1985). This is because the per unit cost of an order, in terms of its impact on trade price is now smaller. These observations are presented in the following proposition:

Proposition 3 *Uncertainty about a fund's holding of a risky security makes the market in the security more liquid. This, in turn, implies that informed orders at any level of private information are larger in scale.*

Thsi result leads to an interesting conclusion: it is possible, in our context, to have both expected and realized trading activity even in the absence of uninformed liquidity traders. Such trading arises due to two reasons. First, from the market maker's perspective, variation in inventory levels is nothing but an endowment shock for the fund manager. Given our assumption of universal risk-neutrality, however, an endowment shock by itself should not generate trading since a reallocation of endowments does not benefit either the investors or the market maker. However, this is where the second factor kicks in. Notice that although the trade that takes place is, ultimately, between the mutual fund investors and the market maker, the quantity of trade is determined by the mutual fund manager who has an utility function that is not dependent only on final payoffs. She actually cares about the temporal distribution of market values of the fund and is willing to distort her trading strategies in order to maximize her objectives. Her concern with the *pattern* of prices over time makes our situation qualitatively similar to an endowment shock in a model with traders who care about risk. From the no-trade results in Milgrom and Stokey (1982), we know that such endowment shocks can, indeed, generate trade. It is thus, the manager's concern with the short-run performance coupled with the uncertainty about her portfolio that jointly allow for trade without the participation of separate uninformed liquidity traders. This leads to the following observation:

Corollary 1 *When an fund manager is concerned with short term performance and when her inventory of the risky asset is private information, it is possible to have trade in equilibrium without the presence of liquidity traders.*

In the situation we describe, therefore, a market maker receiving an order from a mutual fund manager is uncertain as to the extent to which this order is driven by the manager's informational advantage. She has, thus, no choice but to make a conjecture in this regard and set prices accordingly. To the extent that he knows the manager's objective to be short-term performance, he is willing to accomodate the order with minimal movement in prices. Hence, the more uncertainty in the manager's endowment of the risky asset, we should expect to see greater levels of trade and lesser impact of trade on prices. Of course, in this setting, the mutual fund manager loses through excessive trading all the gains she expects to make from her superior information.

In order to see more clearly the benefits and costs associated with the fund manager's trading activity, we need to establish the expected long-term profits of the investors in the fund. In this also, we follow the methods in Kyle (1985). We take the point of view of participants in the market and characterize the unconditional expected profits of the long-term investors. In other words, we are not characterizing the expected profits of the fund manager who knows what her endowment of $\tilde{z}$ is at time 0 but her unconditional expectation before she acquires her inventory. The expected long-term profits are given by:

$$
\begin{aligned}
E(\pi) &= E[\tilde{z}(\tilde{v}-P_0)+\tilde{x}^*(\tilde{v}-P_1)] \\
&= E[\tilde{x}^*(\tilde{v}-P_1)] \qquad \text{since } E(\tilde{v})=P_0 \\
&= E[\{\frac{\tilde{v}-P_0}{2\lambda}+\beta\frac{(\tilde{z}+\bar{z})}{2}\}\{\tilde{v}-P_0-\lambda(\frac{\tilde{v}-P_0}{2\lambda}+\beta\frac{(\tilde{z}-\bar{z})}{2}+\tilde{u})\}] \\
&= E[\frac{(\tilde{v}-P_0)^2}{4\lambda}-\frac{\beta v(z-\bar{z})}{4}-\frac{u(v-P_0)}{2}+\frac{\beta v(\tilde{z}+\bar{z})}{4}-\frac{\lambda\beta^2(z^2-\bar{z}^2)}{4}-\frac{\beta u\lambda(\tilde{z}+\bar{z})}{2}] \\
&= \frac{\sigma_v^2}{4\lambda}-\frac{\lambda\beta^2\sigma_z^2}{4} \qquad (8) \\
&= \frac{\sigma_v(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)^{\frac{1}{2}}}{2}-\frac{\sigma_v\beta^2\frac{\sigma_z^2}{4}}{2(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)^{\frac{1}{2}}}, \qquad \text{using } \lambda=\frac{\sigma_v}{2(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)^{\frac{1}{2}}} \\
&= \frac{\sigma_v(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)-\sigma_v\beta^2\frac{\sigma_z^2}{4}}{2(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)^{\frac{1}{2}}}=\frac{\sigma_v\sigma_u^2}{2(\beta^2\frac{\sigma_z^2}{4}+\sigma_u^2)^{\frac{1}{2}}} \qquad (9)
\end{aligned}
$$

Note that the expression for expected profits reduces to the one found in Kyle (1985), $\frac{\sigma_v\sigma_u}{2}$, when either $\sigma_z^2=0$ or when $\beta=0$. A positive value of β, indicating a focus on short-term results, serves to decrease the long-term profitability of the fund when there is uncertainty about her holdings of the risky security. It is important to note, though, that in the absence of uncertainty about her inventory position, a focus on short-term results does not reduce her profitability. This is not because the absence of such uncertainty reduces her deviation from the optimal informational trade level. Indeed, she still trades based on her inventory position but such trade is perfectly anticipated by the market maker and, therefore, imposes no price penalty on her, in equilibrium. In the absence of noise about her inventory, however, liquidity trading is obviously needed to generate any trade at all.

The framework laid out above can easily be extended to the case of multiple informed mutual fund managers who have perfect information about the payoff of the risky asset. We provide without proof the relevant expressions in the proposition below in that case:

Proposition 4 *For* N ex ante *identical mutual fund managers with inventory levels in the risky security distributed independently as* $\tilde{z}_j \sim N(\frac{\bar{z}}{N}, \frac{\sigma_z^2}{N^2})$, $j = 1, ..., N$, *a concern with both short and long-term performance gives rise to the following equilibrium trading strategies:*

$$x_j^* = \frac{(v - P_0)}{(N+1)\lambda} + \frac{\beta(z_j - \bar{z})}{N(N+1)} + \beta\frac{\bar{z}}{N}, \qquad j = 1, ..., N$$

$$P_1 = P_0 + \lambda[\frac{N}{N+1}\frac{(v - P_0)}{\lambda} + \frac{\beta}{N(N+1)}\sum_{j=1}^{N}(z_j - \bar{z}) + u] + \beta\bar{z}$$

$$\lambda = \frac{\sigma_v}{(N+1)(\beta^2\frac{\sigma_z^2}{N(N+1)^2} + \sigma_u^2)^{\frac{1}{2}}} \rightarrow 0, \ \textit{as } N \rightarrow \infty$$

The proposition shows that, as expected, an increase in the number of perfectly informed mutual fund investors tends to dissipate their collective informational advantage, as they collectively trade more and more aggressively with respect to their information. In terms of the trading induced by the motive of supporting the valuation of inventories, the idiosyncratic variation in trades also goes down with N. However, the total trading on this account stays constant. That is, our original conclusion of expected trading even in the absence of purely exogenous liquidity trades still survives and, indeed, becomes relatively more important as N increases. In fact, as short-term performance evaluation becomes more and more important, the expected level of trade rises as the market maker takes into account each manager's incentive to keep on trading in order to bolster the value of her portfolio. In other words, trading activity that is meant to enhance the value of an existing portfolio does not decrease as the market's become more informationally efficient, although its price impact does go down[14].

We would like to emphasize also the fact that our demonstration that expected levels of trading are positive when the fund is concerned with its short-term performance, has nothing to do with the unobservability of its inventory position. The unobservability of the inventory of risky assets is only responsible for the deviation in the fund's actual trading from a level expected by other market participants. When the fund's inventory is common knowledge, there is, of course, no such deviation. However, its incentive to trade in order to bolster its NAV still remains as strong as when its inventory is not known. Thus, our results on the magnitude of expected trade do not depend on our assumption that inventory positions are asymmetrically known. Our asymmetric information assumption will, however, be more important in the sections that follow.

4 Inventory as information

In this section, we investigate whether asymmetry of information about the inventory of the risky assets helps or hurts the mutual fund's investors or its manager. To examine this question, we return to the one fund model used earlier, in order to keep the exposition simple. Given the fund manager knows her own inventory position, the first question to ask is how a commitment to disclose this information before trading starts affects various parties. Obviously, the competitive market maker's payoffs are unaffected by such a commitment. Consequently, we examine the effect of

[14] It is stratightforward to generalize to the case when each fund manager receives a noisy signal of value. In this case, too, the expected trade levels increase with N.

a commitment to disclose on the mutual fund's investors and on its manager's payoffs.

Proposition 5 *A commitment to disclose the position in the risky asset prior to submitting trading orders unambiguously helps the long-term profits of investors but hurts the interests of the fund manager.*

Proof: From equation (9), we know that the *ex ante* expected long-term profits of the investors is given by: $\frac{\sigma_v \sigma_u^2}{2(\beta^2 \frac{\sigma_z^2}{4} + \sigma_u^2)^{\frac{1}{2}}}$. Clearly, this is monotonically decreasing in the variance of the inventory information σ_z^2. Thus, a commitment to disclose is in the interest of the fund's investors.

The manager, however, is interested in a weighted average of the long-term profits and the NAV in period 1. The first term in her *ex ante* objective function is given by $\gamma E[z(E(P_1) - P_0)]$. Substituting for $E(P_1)$ and simplifying this expression yields:

$$\begin{aligned}\gamma E[z(E(P_1) - P_0)] &= \gamma E[z(\frac{v - P_0}{2} + \beta \frac{\lambda(z - \bar{z})}{2})] \\ &= \frac{\gamma \lambda \beta}{2} E[z(z - \bar{z})] = \frac{\gamma \lambda \beta \sigma_z^2}{2}\end{aligned}$$

Recalling the manager's objective function as a weighted average of the period 1 NAV and the long-term expected profits, and using equation (8), we have the value of the manager's objective under her optimal trading strategy as:

$$\begin{aligned}&\gamma \frac{\beta}{2} \lambda \sigma_z^2 + (1 - \gamma)(\frac{\sigma_v^2}{4\lambda} - \frac{\lambda \beta^2 \sigma_z^2}{4}) \\ &= (1 - \gamma)\lambda[\frac{\sigma_v^2}{4\lambda^2} + \beta^2 \frac{\sigma_z^2}{4}] \\ &= (1 - \gamma)\frac{\sigma_v}{2(\beta^2 \frac{\sigma_z^2}{4} + \sigma_u^2)^{\frac{1}{2}}}[2\beta^2 \frac{\sigma_z^2}{4} + \sigma_u^2]\end{aligned}$$

which is, clearly, increasing in σ_z^2. Therefore, the manager's *ex ante* payoff increases with the noise in her inventory signal. In other words, she prefers not to commit to disclose her inventory position. ♦

Even though investor's may prefer to commit to disclose the fund's inventory position, it seems impracticable that it will be possible to monitor such disclosure very easily. On top of this is the issue of time consistency - the temptation to renege on such commitments is high. Accordingly, we assume that disclosure of the holdings of the risky asset will not take place prior to commencement of trading.

In this situation, the fund manager is clearly vulnerable to the designs of other market participants who may have knowledge of her inventory positions. In other words, profitable trading is possible based on either fundamental information on asset values, or on information regarding the inventory position of the fund. What we have in mind is the existence of organizations which try to monitor trading by major funds and tailor their own trading to try and take advantage of the fund's trading imperatives. To this end, we modify our base case scenario to allow for a strategic investor who gets to observe the inventory position of the fund manager before the commencement of trading. This strategic trader gets to submit a market order based on his information on inventory. To isolate the value of inventory information by itself, we assume that the trader has no private payoff information about the risky asset. We can, then, derive the following result:

Proposition 6 *Information on the inventory holdings of the mutual fund is valuable for trading. The* ex ante *value of such information is proportional to* σ_z^2.

Proof: To simplify the notation, we consider the case when the expected inventory level is 0 and the initial price level, $P_0 = 0$. The proof is easily extended to the general case. Consider, then, the situation of a mutual fund manager who has an inventory level, z, of the risky security. The strategic trader, who has access to this information, places an order of x_s. In equilibrium, this order is correctly anticipated by the mutual fund manager and, hence, building on the analysis of the earlier section, we can show that the order strategy of the fund manager will now be given by:

$$x^* = \frac{v}{2\lambda} + \beta\frac{z}{2} - \frac{x_s}{2}$$

For the strategic trader, his order strategy will be chosen to maximize:

$$x_s[0 - \lambda E(x^* + x_s)]$$

since, from his perspective, $E(v) = 0$.

Setting the first derivative to zero yields:

$$-\lambda(E(x^*) + 2x_s) = 0$$

Substituting for $E(x^*)$ from above yields:

$$\beta\frac{z}{2} + \frac{3x_s}{2} = 0$$

$$\Rightarrow \quad x_s = -\frac{\beta}{3}$$

which, on substitution into the trader's objective function, yields an expected profit level of:

$$\Pi_s = \frac{1}{9}\lambda\beta^2\sigma_z^2$$

Since the market maker makes zero expected profits, the profits for the strategic trader must come at the expense of the fund manager and her investors. ♦

It is clear then, that in a market populated by mutual funds whose managers care about their short-term performance as measured by their NAVs, there is scope for profitable trading even without any knowledge of fundamental values of risky assets. Hence, it pays an investor to engage in costly search for such information. Similarly, it pays the fund manager to hide his inventory information from potential competitors, even though this information is not, by itself, payoff relevant.

5 Closed-end Funds

Up to this point, we have talked about open-end funds, although we have not explicitly accounted for withdrawals or deposits by investors at date 1. As alluded to earlier, our choice not to model fund flows for the mutual fund is partly dictated by a desire to directly compare and contrast the performance of open-end and closed-end funds. Unlike an open-end fund, a closed-end fund does not permit an investor to withdraw his funds before the liquidation of the fund[15]. To satisfy investors' liquidity needs, however, the fund is listed on a stock exchange and its shares are actively traded. As mentioned in the introduction, closed-end funds typically trade at a discount to the NAV of the fund, although some funds occasionally trade at a premium. Discounts of 10 to 20 per cent are quite common and have been regarded as an anomaly in markets that have otherwise been regarded as reasonably efficient. The persistence of the discrepancy between market values and NAV of closed-end funds has been called the " closed-end fund puzzle". In this section, we demonstrate that our model is capable of generating the prediction of an expected discount for closed-end funds.

The earliest attempts at explaining the closed-end fund puzzle relied on the hypothesis that the NAV of funds may overestimate the market value of the fund portfolio. Three main classes of factors have been explored in this approach: agency costs, tax liabilities and the illiquidity of asset holdings. The agency cost theories argue that NAV figures do not take into account management expenses and expectations of future managerial performance, while market values do. In the tax explanations, it is argued that the tax liabilities on unrealized capital gains are not captured by the NAV, while the market prices have these impounded in them. The liquidity approach focuses on the holdings of restricted or letter securities to argue that reported NAVs may overestimate the actual market values of these illiquid holdings. While each of these explanations has significant conceptual appeal, extensive empirical analysis has failed to demonstrate convincingly that they explain a significant amount of the magnitude of these discounts. In addition, time-series properties of the discount have been found to be related to both overall market performance and to the market

[15] Alternatively, a closed-end fund may be opened up. In our simple, three date model, we do not have to distinguish between these two outcomes.

performance of small stocks.[16]

Partially motivated by the failure of these approaches to explain satisfactorily either the magnitude or the time-series properties of the discount, Lee, Shleifer and Thaler (1991), advance the case for a behavioral approach. Building on the ideas in Zweig (1973) and Delong, Shleifer, Summers and Waldmann (1990), they argue that fluctuations in the sentiment of small investors may be responsible for deviations of the market value from fundamental value. Such deviations are not subject to exploitation by arbitraguers because, in the presence of unpredictable sentiments, attempts to arbitrage deviations become inherently risky. Moreover, Lee, Shleifer and Thaler (1991) argue that the investor sentiment models are consistent with the patterns in the time-series variation of these discounts, while earlier approaches fail to satisfy in this regard.[17] In our explanation outlined below, we show that fund discounts and premia may exist even in a world in which taxes and dissipative transaction costs are not present and in which correlated investor actions do not serve to move prices of closed-end funds. Providing empirical support for our arguments is, however, beyond the scope of the current paper.

We need only minor modifications to our basic model to cover the case of closed-end funds. Since fund manager compensation for closed-end funds is also usually related to funds under management, we do not need to modify the manager's objective function from the earlier sections. Also, since we did not account for deposits or withdrawals by investors, we do not need to modify our structure to fit the case of closed-end funds. However, we do need to specify the mechanics of how and when a closed-end fund is priced in the market. The assumptions we make in this regard are the simplest possible. Obviously, at time 2, there is no discrepancy between the NAV of the fund and its market price, since payoffs are realized at this point. At time 1, we assume that the prices of both the fund and the risky asset are established in market

[16]Malkiel (1977) studies the influence of several of the factors reported above, while Barclay, Holderness and Pontiff (1993) focus on agency costs. Brickley, Manaster and Schallheim (1991) and Pontiff (1995) study the impact of tax issues, while Pontiff (1996) studies the influence of trading costs.

[17]See, however, Banerjee (1996), Oh and Ross (1994), Chordia and Swaminathan (1997) and Spiegel (1998) for alternate approaches to explaining closed-end fund disounts and their time-series patterns.

trading before the fund uses the closing market price of the security to compute and announce its NAV[18]. However, we do not explicitly model the price discovery mechanism of the closed-end fund, since we do not want to introduce effects of any kind of transactions costs into this process. Consequently, we simply assume that investors establish the price of the fund based on the net order flow in the market for the risky security and its clearing price. The investors being risk neutral, then, the price of the closed-end fund is, then, simply its expected time 2 value, conditional on the price in the market for the risky security. At time 0, the NAV of the fund is already given by I_0 and we assume that the price of the fund is its (unconditional) expectation of the fund's period 2 payoffs.

With these simple extensions in place, we are ready to state the central result in this section:

Proposition 7 *At time* 1*, the closed-end fund's price exceeds its expected NAV by the factor* $\frac{\lambda}{2}(2\sigma_u^2 - \beta\sigma_z^2)$*. Therefore, for* $\beta\sigma_z^2 > 2\sigma_u^2$*, the closed-end fund is expected to have a discount from its Net Asset Value, while a premium is expected if the inequality goes the other way.*

Proof:

At time 1, after the order flow, y, and the market price, P_1, for the risky security are observed, but before the NAV has been announced, the price of the fund is given by:

$$\begin{aligned}
&I_0 + E_y[z(v - P_0) + x(v - P_1)] \\
&= I_0 + E_y[z(v - P_1) + x(v - P_1) + z(P_1 - P_0)] \\
&= I_0 + E_y[(x + z)(v - P_1)] + E[z(P_1 - P_0)]
\end{aligned}$$

where the operator $E_y(\cdot)$ denotes the expectation conditional on y. But $I_0 + E_y[z(P_1 - P_0)]$ is nothing but the expected NAV of the fund. Hence, the difference between the

[18] Observe that we continue to use the single fund and single risky security structure of our basic model in this section.

market price of the fund and its expected NAV is given by $E_y[(x+z)(v-P_1)]$. Now, recalling that $E_y(v) = P_1$, we can rewrite this expression as:

$$E[(x-\bar{x}_y)(v-\bar{v}_y)] + E[(z-\bar{z}_y)(v-\bar{v}_y)] \tag{10}$$

where $\bar{x}_y$, $\bar{z}_y$, and $\bar{v}_y$ denote the conditional expectations of these variables. Recall that, by the properties of the Normal distribution, we can denote the generic conditional expectation of a variate as:

$$\bar{m}_y = \bar{m} + \frac{\sigma_{my}}{\sigma_y^2}(y-\bar{y})$$

Thus, we can write the first term in equation (10) as:

$$\begin{aligned}
E[(x-\bar{x}_y)(v-\bar{v}_y)] &= E[(x-\bar{x}-\frac{\sigma_{xy}}{\sigma_y^2}(y-\bar{y}))(v-\bar{v}-\frac{\sigma_{vy}}{\sigma_y^2}(y-\bar{y}))] \\
&= E[(x-\bar{x})(v-\bar{v}) - \frac{\sigma_{xy}\sigma_{vy}}{\sigma_y^2}] \\
&= \frac{\sigma_v^2}{2\lambda}(1-\frac{\sigma_x^2}{\sigma_y^2}) = \frac{\sigma_v^2\sigma_u^2}{2\lambda\sigma_y^2}
\end{aligned}$$

since $y = x + u$. However, we know from the definition of λ that $\frac{\sigma_v^2}{4\lambda^2} = \beta^2\frac{\sigma_z^2}{4} + \sigma_u^2$, while we must have $\sigma_y^2 = \sigma_x^2 + \sigma_u^2 = \frac{\sigma_v^2}{4\lambda^2} + \beta^2\frac{\sigma_z^2}{4} + \sigma_u^2$. Using these equalities in the equation above gives us the value of $E[(x-\bar{x}_y)(v-\bar{v}_y)] = \lambda\sigma_u^2$.

Similarly, the second term in equation (10) can be shown to be:

$$\begin{aligned}
E[(z-\bar{z}_y)(v-\bar{v}_y)] &= E[(z-\bar{z}-\frac{\sigma_{zy}}{\sigma_y^2}(y-\bar{y}))(v-\bar{v}-\frac{\sigma_{vy}}{\sigma_y^2}(y-\bar{y}))] \\
&= 0 - \frac{\beta\sigma_z^2\sigma_v^2}{4\lambda\sigma_y^2} = -\frac{\beta}{2}\lambda\sigma_z^2
\end{aligned}$$

Thus, the fund trades at an expected premium over its NAV of:

$$\lambda(\sigma_u^2 - \frac{\beta}{2}\sigma_z^2)$$

which translates into a discount when $2\sigma_u^2 < \beta\sigma_z^2$. ♦

Note that the expected discount or premium is independent of the net order flow y. This property is, of course, a consequence of our using the Normal distribution, where conditional variances do not depend on the realization of the conditioning variable. In a more general case, however, this property may not hold. However, we are not aware of micro-structure models which do not use the Normality assumption in which our analysis could be conducted.

Note that, since we do not introduce any kind of market imperfections in our attempt to derive the market price of the mutual fund at time 1, the market price of the fund is always an unbiased expectation of the liquidation value. On the other hand, the NAV figure is always biased upwards. The reason behind such a bias is simple: Though the price P_1 is unbiased conditional on y, the fund manager's trading strategy results in the inventory level z and the market clearing price P_1 being positively correlated. On average, the fund manager succeeds in distorting P_1, by trading in the direction of his inventory. This, as indicated in the proof to proposition 7, results in the NAV being biased upward by $E([z(P_1 - P_0)] = \lambda\frac{\beta}{2}\sigma_z^2)$. In the absence of this upward bias to the NAV, the market price of the fund would reflect the profits $\lambda\sigma_u^2$ and would be at a premium relative to NAV. As we show in the proposition, as long as $2\sigma_u^2 < \beta\sigma_z^2$, the upward bias in the NAV will overwhelm the expected profits reflected in the market price and result in the fund trading at a discount relative to NAV.

It is instructive to note that our explanation for the discount or premium of a closed-end fund is consistent with some of the patterns seen in the data. While explanations of the discount that rely on the NAV being an overestimate of actual value have managed to explain some of these patterns - at least qualitatively - there exists no explanation of the phenomenon that closed-end funds that trade at a discount start out at a premium to NAV after their initial public offering[19]. This portion of the puzzle is particularly troublesome from the point of view of efficient markets since no rational investor should buy into a newly formed closed-end fund while clearly anticipating the fall in prices later. However, our analysis points out that it is not the price of the fund that is biased but that it is the NAV that is biased upwards. At the time of the initial public offering, when information asymmetry about the fund's holdings is very little, the uncertainty in its holdings of the risky asset is clearly low. Assuming the fund manager is viewed as having some informational advantage, we should expect the fund to trade at a premium to NAV at this point in time. As the fund gets to implement its portfolio strategy, the uncertainty with respect to its holdings of the risky asset grows. In such a situation, provided the condition derived above is satisfied, the fund may very well trade at a discount to its NAV. Thus, we have the following corollary:

Corollary 2 *A closed-end fund managed by a manager who is presumed to be informationally advantaged, will start out at a premium to NAV which will decrease over time as its inventory position in the risky asset becomes more uncertain. At sufficiently high levels of the uncertainty in its inventory position, the fund will be expected to trade at a discount to its NAV.*

In our world, therefore, there is nothing surprising about either a closed-end fund trading at a discount to its NAV, nor in its transition from a state in which it trades at a premium to one in which it trades at a discount. The obvious question to ask, then, is about what would happen if a closed-end fund were to announce a transition to an open-end status. Clearly, then, investors would have the right to cash out at the NAV of the fund. Under the assumption that such a transition is feasible, meaning that such an open-end fund would not immediately trigger an unsustainable rush of redemptions, the value of the fund would rise towards its NAV. However, its NAV would not fall since neither its inventory position, nor the market prices of its holdings would be affected by the announcement. Thus, we have:

[19] See, for example, Peavy (1990) for a description of this phenomenon.

Corollary 3 *When a conversion from a closed-end structure to an open-end one is made for a fund trading at a discount, its market value is expected to rise towards its NAV. However, the NAV should not react to such an announcement.*

As Lee, Shleifer and Thaler (1991) point out, it is not only the fact that closed-end funds usually sell at a discount to their NAVs that is a puzzle. The puzzle is augmented by several other side observations. Important among these are the transition from a premium to discount status after funds' initial public offerings and the movement in fund value towards NAV on the announcement of the fund's opening up. At least in the context of our simple model, both of these puzzles are easily explained.

6 Implications and Extensions

The analysis up to this point has used the market micro-structure model of Kyle (1985) and confined itself, for the most part, to the case of single mutual fund and a single risky security. Clearly, these results need to be extended to more general cases for our conclusions to pass muster. However, we are currently in the process of undertaking these extensions. Below, we provide previews of several extensions that we intend to incorporate in future versions of this paper.

Extension to other market structures: Although we have used the structure of Kyle (1985) in the analysis, many of our results should hold without the structure of a market maker who sees the net order flow. For example, suppose that the market maker setting prices for the risky security imposes a price schedule for inventory purposes. Even in this case, the analysis of the mutual fund manager's trading strategy remains essentially similar to the case we have analyzed and the clearing price reveals information to market participants about the value of the fund itself. Although the liquidity parameter, λ, in this case is determined by means other than the one we have analyzed, there is no reason why most of our analysis would not survive in this alternate case.

Extension to multiple securities: At a basic level, the extension to the case of multiple securities should be straightforward, as long as the position in each security can be independently analyzed via an assumption of independent price setting in markets for each security in the fund's portfolio. However, we have not yet attempted a formal analysis of the multiple-security case. Note, however, that in the multiple security case, we would expect discounts or premia for closed-end funds to be even more tightly distributed around expected values. This should arise due to the reduction in idiosyncratic variances associated with individual securities.

Extension to multiple funds: The text contains a preliminary analysis of extending our results to the multi-fund case. However, this analysis is somewhat incomplete in that we assume a symmetric, independent structure for mutual fund holdings. In reality, there is likely to be an upper bound on the variance of the holdings of the mutual fund sector as a whole. Consequently, the determination of λ in this setting may require some modifications.

Analyzing the choice between mutual fund structures: Clearly, our analysis has implications for the choice of structure chosen by a mutual fund manager who is about the raise funds to manage on behalf of investors. Consider, for example, whether she will choose to go with exit fees or not in case she chooses an open-end structure. Clearly, if she can commit to reduce her incentives for short term results and can convince investors of her superior abilities, the market value of her fund may be higher than her expected NAV. In such a case, to reduce opportunism on the part of investors who might want to enter the fund at the expense of existing investors, she may decide to charge an entry fee. On the other hand, if the market value of her fund is expected to be less than the NAV, similar reasoning demands that she consider the introduction of exit fees. A similar issue arises with respect to her choice between an open-end and a closed-end structure. Clearly, without exit fees, it is not feasible to run an open-end fund when one expects the trading decisions of managers to lead to discounts since opportunist investors may choose to redeem early. Thus, we would expect more closed-end funds to be exactly those in which the managers/originators concluded *ex ante* that the fund would likely be trading at a discount. On the other hand, without fees of some kind, no open-end fund would be sustainable unless the managers anticipated the fund being valued by the market at a premium to NAV. This argument, in itself, lends support to the likelihood of finding closed-end funds being at a discount relative to their NAVs.

Our results clearly have the greatest impact in markets that are less liquid. It is not surprising, therefore, to note that closed-end funds are more prevalent in less-developed capital markets and that closed-end funds in the United States tend to have more small company shares in their portfolios than open-end funds. However, it is important to note that our analysis of the manager's trading strategy does not require us to restrict our attention to the case of relatively illiquid securities. The extensions outlined above will enable us to answer the obvious questions as to how important our conclusions may be in the context of markets with different degrees of liquidity.

7 Conclusion

We have analyzed the trading decisions of a mutual fund manager in a simple model using a variation of well known market-microstructure model. As a result, we have been able to integrate the analysis of mutual fund trading decisions with issues of market liquidity that are well studied in the micro-structure area. Our main analytical contribution has been to introduce a modeling strategy that manages to parameterize the short-horizon focus of fund managers in a simple way. In doing so, we have demonstrated that trading activity is expected to increase along with holdings by mutual funds in the economy and along with increases in short-term performance measurement of mutual fund managers. Our model shows that the differential incentives between mutual fund managers and long-term investors alone is able to generate trading in a world where diversification to reduce risk is not a motive for trade. In doing so, our analysis highlights the role that large mutual funds with substantial holdings may play in the price-setting process in financial markets.

We have also shown that the closed-end fund puzzle may be explained with the help of our model and that inventory risk, coupled with trading in financial markets by players who are interested in the marked-to-market value of their assets may account for premia and discounts for closed-end funds. These conclusions are reached even in the absence of factors that have already been stressed in the existing literature that has tried to explain the deviation in prices of funds from their Net Asset Values. We view inventory risk as another factor that contributes to the explanation of the closed-end fund puzzle and not an alternative to extant explanations.

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