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Measuring the Impact of Behavioral Traders on the Market for Closed-End Country Funds

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This work investigates whether traders' state-dependent expectations biases can account for anomalous country fund discount movements. I provide a multiple-agent asset pricing model that includes both rational traders and traders who display biases in expectations formation following market states with large amounts of price variance or CNN financial news. Importantly, traders' biased behavior is based on evidence of state-dependent over- or underreaction biases observed in asset price forecasting experiments. Closed-form solutions from a multi-agent pricing model predict a multiple driver property of fund prices. Empirical tests for these drivers' influence in field data finds that up to 21% of the out-of-sample country fund discount variance can be explained by dummies representing the occurrence of behavioral bias trigger states.

A diverse body of empirical evidence demonstrates deviations of market prices from their fundamental values (see Thaler and coauthors' *Anomalies* series in the *Journal of Economic Perspectives* for examples of the many field anomalies). Smith, Suchanek, and Williams [1988] is an early study that also documents these bubbles in experimental markets. One anomaly, however, has received a substantial amount of attention but remains largely unexplained: the large and variable discount between closed-end country fund prices and their exchange rate-adjusted net asset values (NAV) (see Lee, Shleifer, and Thaler [1991]).

To account for this and other field anomalies, theorists have tried to inject more reality into asset pricing models. One strain of the literature has attempted to model the institutional environment within which agents trade by including realistic features like market incompleteness, forms of market segmentation, unknown risk features, asymmetric private information, transaction costs, and price stickiness. Increased theoretical reality may also be beneficial for specifying the expectations formation traits of economic agents.

Some of the earliest extensions to the rational expectations expected utility maximizing agent included state-invariant features like risk aversion and discounting of future utility. More recent theories postulate the presence of state-dependent irrational biases on the part of agents. In these theories, the information state of the environment, which refers to the amount and characteristics of the public financial news, influences traders' expectation formation abilities. In subsequent tests of these behavioral theories, the *magnitude* of price deviations from fundamental value are shown to be a function of the severity of agents' state-dependent boundedly rational beliefs, and the *timing* is related to the timing of bias trigger states.

Unfortunately, in many of the early behavioral models, the irrational traders incorporated into theory were hypothesized, rather than based on direct experimental evidence. The natural criticism of such an approach, well described in Daniel, Hirshleifer, and Subrahmanyam [2000], is that the potential universe of conceivable cognitive bias is unbounded. As a result, almost any in-sample pricing behavior can be reproduced with enough cognitive biases.

To address this problem, many authors argue that the goal of the behavioral literature should be to find the one "top quark," or *top bias*, describing all anomalous economic behavior. Unfortunately, this approach operates on the assumption that there are a small number of non-rational behaviors that produce all these observed anomalies, which is strongly rejected by experimental data. However, we can reduce this universe by using experimental evidence as a basis for our assumptions about trader expectations formation behavior. This allows more rigorous specifications of the non-rational agents, while avoiding the pitfalls of identifying an all-encompassing bias that is probably non-existent.

The primary purpose of this research is to determine whether a model incorporating one rational and two experimentally based behavioral traders can provide additional insight into the timing and magnitude of NYSE closed-end country fund discount movements. The study provides several methodological extensions relative to earlier studies. First, to provide a more rigorous basis for the new behavioral traders, the state-dependent over- and underreaction biases incorporated into theory have direct experimental support from fi-

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nancially oriented forecasting experiments. Second, the information that we use to define the financial news states are obtained from a newly constructed data set from transcripts of the CNN program, *Lou Dobbs Moneyline*. Third, empirical tests of the model's out-of-sample predictive ability uses a recent sample of weekly data for a large number of country funds.

The general result of the behavioral model is a predicted relationship between the timing and magnitude of country fund discount changes and experimentally based behavioral variables constructed to quantify particular event states. These behavioral variables interact with indicator variables summarizing the variance/noise in the forecasted variable or the volume of relevant CNN news *with* information describing the sign of the rationally expected NAV revision. Out-of-sample tests with field country fund data indicate that up to 21% of unexplained discount movements can be explained by these behavioral variables.

Related Behavioral Literature

Empirical Literature

The *empirical* literature that motivates this study describes anomalous closed-end country fund price movements relative to their underlying stocks' overall NAVs, i.e., the weighted average of the prices of the underlying stocks of the countries' mutual funds (see Lee, Shleifer, and Thaler [1991]). Like most closed-end funds, these country funds trade at persistent and variable discounts to their NAVs. And some of the most dramatic deviations from NAV occur after prominent news events about the fund's host country, or following previous episodes of NAV and discount volatility.

Country fund data provide a particularly useful data set for exploring behavioral hypotheses because 1) they have a well defined measure of fundamental value, the NAV, 2) there is substantial evidence of anomalous fund price movements relative to the NAV, and 3) fund prices can be related to relevant regional news as reported on CNN's *Moneyline*.

The presence and variability of country fund discounts themselves represent a pricing anomaly. The value-additivity principal predicts that, in an efficient market, the prices of the funds should match their NAVs. Two branches of literature have developed to explain these price anomalies, one focusing on institutional incompleteness or market frictions, and the other focusing on the potential bounded rationality of individual traders. (See Bosner-Neal et al. [1990] and Diwan, Vihang, and Lemma [1993] for applications of the former theory to the country fund literature, and Heaton and Korajczyk [2002] for a more general review.)

In subsequent tests of these theories, the *magnitude* and to some extent the *timing* of price deviations from fundamental value can be related to specific institutional features. However, market institutions are fairly slow to evolve, so this approach doesn't fully explain the timing of price discount movements, which occur at a much higher frequency than institutional changes. The competing theories postulate that closed-end fund discounts are more generally a result of the interaction between boundedly rational and rational market participants.

Behavioral Theory

The *theoretical* behavioral literature that motivates this study considers hypothetical asset markets with traders who form heterogeneous expectations about the distribution of revisions to a risky asset. Typically, these *distributional uncertainty* theories include both: 1) rational agents, who can correctly identify the mean and variance of this distribution, and 2) behavioral agents, whose beliefs about this distribution may be biased and mistaken.

The most directly comparable theoretical paper is DeLong et al. [1990] (henceforth DSSW90), which combines rational expectations traders with Black's [1986] "noise" traders, whose expectations about asset returns are randomly distributed around the true mean. An extension by Klibanoff, Lamont, and Wizman [1998] (KLW98) includes behavioral traders who display state-dependent inertia in their expectations updating. The *states* in KLW98's model refer to periods with larger or smaller amounts of *New York Times* front page financial news coverage. They argue that in *usual* states, traders display inertia, i.e., their expectations of the random walk mean return is a weighted average of many lagged returns. But in *event* states, i.e., periods with a large amount of financial news, this inertia evaporates, and trader expectations of the mean return are based simply upon last period returns, which should be the case for a random walk variable.

Our model provides predictions about the timing of country fund discount movements and suggests that these movements should be related to the salience of *New York Times* news. We successfully test the model's predictions regarding the timing of discount movements with NYSE country fund data and *New York Times* news information.

Odean [1998] examined the effects of including behavioral traders who show overconfidence toward privately available information. This overconfidence intuitively takes the form of overreaction to information signals due to their perceived high importance. Varian [1989] and Harris and Raviv [1993] also postulate that traders have different expectations about the mean of the returns distribution due to differences in their processing of public information. In Varian, traders use the same Bayesian processing methodology but have different priors; in Harris and Raviv, agents are assumed to use heterogonous information processing methods with similar information.

Kandel and Pearson [1995] include behavioral traders whose perceptions of the mean and the variance of the returns distribution differ from rational traders' beliefs. In all these models, traders' heterogenous expectations lead to irrational demands for assets, and therefore distorted equilibrium prices.

Shefrin and Statman [1994] provide another relevant model. They develop a model with 1) rational traders, who use Bayes's rule for forming expectations about a stochastic asset's mean returns, and 2) behavioral traders, who display two types of cognitive errors. Based on earlier experimental evidence, they postulate that one behavioral trader overweights recent information while neglecting priors, i.e., displays "base rate neglect" (see Gluck and Bower [1988]). The second is susceptible to the "gamblers' fallacy," and expects short-run probabilities to mimic long-run probabilities more than is justified (see Camerer [1995]). Shefrin and Statman's [1994] model shows that in the presence of only rational traders, the market has a "single driver" property, and prices are only based on rational Bayesian processing of fundamental information. Alternatively, in the presence of behavioral traders, the market has a "multiple drivers" characteristic, and prices depend on both fundamental information and traders' irrational beliefs.

Importantly, a key feature of these distributional uncertainty models is the assumption that there are some institutional or other limits to rational traders' abilities to arbitrage away country fund price differentials from fundamental value. As a result of this incomplete market, behavioral biases can potentially persist and affect prices.

Remaining consistent with the earlier literature, this study assumes that some segmentation exists between the country fund and NAV markets. This assumption can be justified for country fund data because international markets have at least limited market segmentation, and because the funds are closed-end. A crucial point is that this market segmentation is not the sole source of the anomalous price movements. Instead, it simply allows individual behavior to be incompletely arbitraged out of the market.

In summary, these empirical and theoretical studies demonstrate that additional insights into the behavior of asset prices can be provided by multi-agent models that allow investor bounded rationality. Theoretically, price deviations from fundamental value can be shown to be a function of traders' misperceptions. Empirically, the timing of states that trigger these biases can significantly predict the timing of anomalous price movements.

Given this solid precedent, the paper proceeds as follows. The next section presents experimental evidence for the new forms of bounded rationality that we consider. The third section presents a general model that combines rational traders and traders displaying state-dependent over- and underreactions. The last section tests model predictions about the timing and magnitude of discount variations with NYSE and CNN field data from 1998–2002.

Experimental Evidence of Cognitive Bias

The Relevance of Experimental Results for Behavioral Theory

A key aspect of this study is the use of experimental evidence as a basis for the theoretical assumptions about traders' potentially boundedly rational behavior. Although some notable studies link their assumptions about non-rational behavior to experimental evidence (see in particular Shefrin and Statman [1994], Laibson [1997], and Odean [1998]), many others simply assume the presence of some bias. These studies certainly extend our knowledge of financial markets by demonstrating how prices will behave *if* traders of the postulated type are present. However, experimental evidence provides even more insight about market price movements by incorporating agent types actually *observed* in financially oriented forecasting experiments.

The Experimental Evidence

A large body of experimental economics and psychology evidence demonstrates that humans display a variety of cognitive errors when forming expectations and making decisions. Evidence of cognitive bias described as systematic over- or underreaction to information has been observed in earlier experimental studies by Estes [1954] and Dudycha and Naylor [1966], and later by Griffin and Tversky [1992]. More recent articles include Friedman and Massaro [1997], Kitzis et al. [1998], and Gillette et al. [1999]. It is generally believed that over- and underreaction biases are permanent characteristics of some subset of subjects.

Other experimental research has begun to investigate if human forecasting biases are actually triggered by some feature or *state* of the experimental information environment. If we can show that trader bias is triggered by a specific information state, we could theoretically provide out-of-sample predictions about when country fund price discounts will have the multiple driver feature described by Shefrin and Statman [1994].

Kelley and Friedman [1998, 2003] investigate the state-dependency of bias with a financially oriented individual choice experiment. Subjects were asked to provide a forecast f of a continuous and stochastic target price change p. The target was dependent on two observed stochastic stimuli realizations, $x = [x_1, x_2]$, and the indirectly observed stochastic term $\varepsilon \sim \sigma(0, \sigma^2_\varepsilon)$ via the functional relationship $p = a \cdot x + e$. The authors presented several treatment states to subjects designed to mimic variable field forecasting conditions. The primary manipulation of interest was motivated by heteroscedasticity, the financial market regularity.

The simplification studied in these experiments postulated the presence of two forecasted price variance states, a low and a high noise/variance state. We note that most subjects attempting to forecast in the *high noise* information state *overreacted* or overweighted the importance of all current information.

Other experimental work by Edgell et al. [1996] and Kelley and Busemeyer [2003] asked subjects to forecast a probabilistic price change p that was dependent on a large number of predictors x_j, for $j > 2$. This high information manipulation was designed to determine if the field regularity, variable news level, influences subjects' ability to form expectations. As expected, cognitive errors emerged in the *high information* states as subjects became overwhelmed with information. But surprisingly, these errors proved to be systematic: Across all trials, individuals *underreacted*, or underweighted all current information.

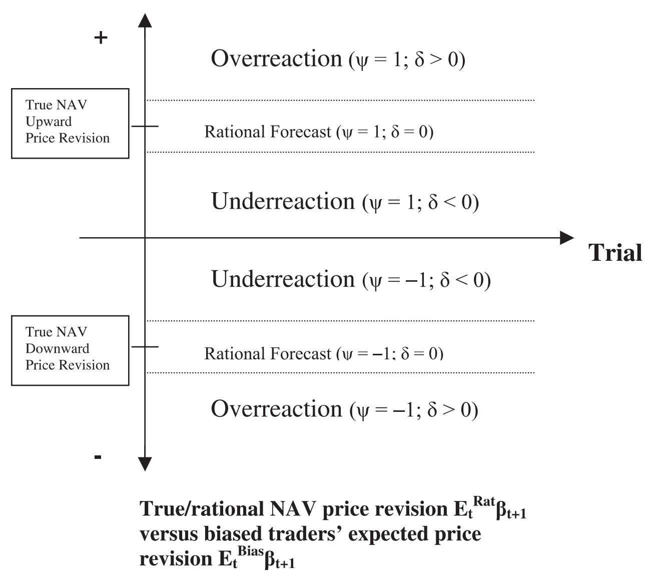
Figure 1 is a graphic representation of both the over- and underreaction forecasting patterns. Both are measured relative to what would be the rational expectations response to NAV change information. From the figure, we can see that overreaction can correspond to jumping too high or too low relative to what fundamental information rationally predicts. Similarly, underreaction means a subject did not jump far enough upward or downward in response to fundamental information. To test for these behaviors in the field we need 1) to know the sign of the rationally expected NAV revision, $\psi = 1$ or -1, i.e., an appreciation or depreciation of the NAV, and 2) to have an indicator of the presence and severity of the event state, i.e., d describing the level of variance or news in the environment.

The Information State

The institutional and informational settings of these individual choice experiments are very similar to the context of the model in Section III. As a result, we can draw a connection between *information states* in these two settings. In theory, we can simply postulate the existence of unique market states, and hypothesize that some traders alter their behavior during these states.

To provide empirical content to these information states, however, we need to be more specific. The information states that trigger over- and underreaction behaviors in the individual choice experiments were ei-

FIGURE 1
Representation of Experimentally Observed Forecasting Patterns for Over- or Underreaction Given Two Potential NAV Price Changes



Note: Forecasting bias patterns observed in experimental data, and how the model's rational and the over- and underreaction traders' NAV price forecasts would be related to the true NAV price change for two possible NAV price revisions. Expected prices are denoted $E(n_{t+1}|\beta_t) = n_t + E_t\beta_{t+1} + \psi\delta$. The rational forecast is indicated by the confidence interval around the true price change. $\Psi = 1$ refers to rationally expected NAV appreciation, while $\Psi = -1$ refers to a rationally expected depreciation. Overreaction ($\delta > 0$) corresponds to the outer regions where traders overweight fundamental information and jump too high or too low in the expectations. Underreaction ($\delta < 0$) corresponds to the inner regions where traders do not jump far enough upward or downward in their expectations.

ther: 1) the presence of high noise, i.e., high variance of the forecasted price, or 2) the presence of a large amount of predictor information. The empirical counterpart of these states for the *field country fund* data are either: 1) a high sample variance of the country funds' NAVs, or 2) a large amount of *CNN Moneyline* financial news. We provide details for constructing the behavioral variables corresponding to the field data in Section IV.

Cognitive Bias in Field Financial Markets

Why are we likely to observe these individual trader biases in field markets? In addition to the ubiquitous *experimental* evidence, there is a large amount of *field* evidence that prices seem to over- or underreact relative to the change predicted by fundamental information. Examples are provided by many authors, particularly Shiller [1981] and Hong and Stein [1999].

A second reason concerns the complexity of the field forecasting setting relative to the experimental environment. In many experimental settings, subjects face a favorable information environment that should facilitate accurate forecasts. They are usually aware that the forecasted target is largely dependent on only a few observed predictors, and they receive quick and clear feedback about their forecasting accuracy. Also, there are no endogenous aspects of price determinations vis-à-vis their own or others' past decisions. Yet, despite the simplicity of the financial market, subjects still display persistent expectation biases. We can reasonably expect that actual traders in the field setting will display similar behavior, if only because of the increased complexity of the field markets.

A common counterargument to this assertion, though, is that there may be insufficient financial motivations for the experimental subjects to provide accurate forecasts. Field traders have much more to gain or lose, so their forecasts are forced to be efficient through Darwinian profit forces. This criticism cannot be avoided, but it could be applied to any experimental study. However, Holt and Laury [2002] find that behavior remains fairly consistent over relatively large ranges of payments, so this is most likely not the major source of the biased behavior.

Finally, it is possible that experimental subjects make systematic errors because they are relatively inexperienced in a particular forecasting task. Alternatively, some argue that in field financial markets, successful traders who have not succumbed to Darwinian profit forces have more experience, and will therefore not display bias. However, some financial research suggests that experienced traders may display more bias than novice traders due to overconfidence in perceived successful theories and models (see DeBondt and Thaler [1990] and Gervais and Odean [2001]).

In general, these experimental results extend our knowledge of financial markets by offering direct evidence about asset price forecasting behavior. First, as we noted earlier, the Section II.B evidence suggests that overreaction to information may be triggered by *high noise* states. Second, underreaction toward information may be triggered by *high information* states. Most importantly, these results indicate that the over- and underreaction biases are state-dependent, i.e., dependent on the previous measurable information state of the environment. The next step is to describe an analytical model that aggregates both rational and behavioral traders' expectations into an aggregate equilibrium price.

The Experimentally Based Behavioral Model

The model used to aggregate traders' expectations and asset demands into an equilibrium price is an overlapping generations distributional uncertainty approach. It is based on DSSW90 and KLW98, but is unique in that the characteristics of the behavioral trader class are based on evidence from related asset price forecasting experiments. The purpose of the model is to analytically quantify the influences of both fundamental information and behavioral traders' biased expectations on the equilibrium price of a country fund asset.

The key aspects of our model are:

1. There are two markets of interest, the home market with rational and behavioral traders, and the foreign market with only rational traders.[1]
2. There are two states of the world, *usual* states, which trigger no biased behavior, and *event* states, which cause some fraction of agents in the home market to display biases in their expectations about risky asset price changes.
3. The home market is assumed to contain riskless (known return) and risky (probabilistic return) assets. The riskless asset earns the rate of return $1 + r$, is elastically supplied, and has price p_t normalized to one unit of a consumable good. In an optimally balanced portfolio, a domestic investor should be indifferent between investing in the riskless asset and the domestically traded country fund. Thus, the riskless asset price is representative of the rationally expected return to the country fund. The risky asset, which represents the net asset value (NAV) or the weighted average of the security prices underlying the country fund, has supply normalized to 1 and price n_t.
4. Traders are assumed to live for two periods.

Traders in the home market receive an endowment that they invest at the end of period t. They then consume the proceeds of their investment at the end of period $t + 1$, and leave no bequests. These investors are assumed to have constant absolute risk aversion utility functions incorporating the proceeds from investments in risky and riskless assets. The goal of each agent is to maximize the expected value of their portfolio in the second period given expectations about revision to the foreign asset n underlying p.

Each period the investors receive a public signal β describing the actual revision to the price of the risky assets n, i.e., $n_{t+1} = n_t + \beta_{t+1}$. This signal could be interpreted as information describing the dividend payments or retained earnings of the productive assets within the country fund's NAV. Furthermore, the efficient markets hypothesis (EMH) suggests that all relevant information needed to predict the revisions to n should already be incorporated into the market price. As a result, any new relevant information should randomly arrive, so the NAV revision process should objectively follow a random walk.

The key distinction between rational and behavioral traders hinges on the expectations they form about the revision process for the risky NAV asset n. Since the EMH states that asset prices should evolve randomly, the rationally expected revision β to the risky asset n has the objective distribution:

$$E_t\beta_{t+1} \sim N(\beta_t(1+r), \sigma^2\beta) \qquad (1)$$

That is, the time t rational expectation of the next period revision $E_t\beta_{t+1}$ is simply the interest rate-adjusted revision observed last period, $E_t\beta_{t+1} = \beta_t(1+r)$.

However, it is also assumed that some fraction of investors in the home market are behavioral and display state-dependent biases in their expectations about the revision to the risky asset. These behavioral traders' expectations are described by:

$$E^B{}_t\beta_{t+1} \sim N((\beta_t + \pi_t)(1+r),\ \sigma\beta^2) \qquad (2)$$

The superscript B refers to behavioral traders' expectations, which include some state-dependent over- or underreaction bias p_t in the perceived mean of the NAV revisions distribution. This bias equals zero during usual states, but is non-zero during event states.

Since the country fund is composed of the NAV asset, its price p should reflect investor expectations about revisions to the NAV n. Thus, the domestic country fund price will have the multiple driver characteristic and reflect both fundamental NAV information and the biased expectations of behavioral traders if 1) there are some behavioral traders present, and 2) they over- or underreact in their expectations of NAV revisions following event states. We can obtain closed-form expressions that quantify this multiple driver property of country fund prices by assuming that the conditional variance of the country fund asset $\sigma^2{}_p$ is constant through time, and can be related to the variance of the true revision process $\sigma^2{}_\beta$.

A key aspect of this multi-state pricing model is that there will be two equilibrium expressions for country fund prices, one for usual states and one for event states. The differences in the expressions define the event state impact of bias on the country fund price. The usual state equilibrium price for the country fund is

$$p_{t+1,u} = a_u \cdot n_{t+1} - A_u \cdot \sigma^2\beta + B_u \cdot \pi_t - C_u \cdot \sigma^2\pi \qquad (3)$$

while the event state price is

$$p_{t+1,e} = a_u \cdot n_{t+1} - A_e \cdot \sigma^2\beta + B_e \cdot \pi_t - C_e \cdot \sigma^2\pi \qquad (4)$$

In both expressions, a_u represents the usual level of market sentiment, i.e., bullish versus bearish expectations, which are assumed not to change across states. n represents the NAV price of the stocks underlying the country fund price p, $\sigma^2\beta$ represents the variance of the NAV revision process, πt represents any state-dependent bias in traders' NAV revision expectations, and $\sigma^2{}_\pi$ represents the variance of these biased expectations. Note that $A_u = A_e$ and $C_u = C_e$, but $B_u \neq B_e$.

It is useful to construct the following variable to represent the deviation of the country fund p from its fundamental or NAV n:

$$D_{t+1} = \left(\frac{n_{t+1}}{p_{t+1}}\right) - 1 \qquad (5)$$

These deviations can represent a discount $D_{t+1} > 0$ or a premium $D_{t+1} < 0$.

Price Effects of Behavioral Traders

Equations (3) and (4) summarize the model's predictions about the drivers that may cause the fund's price to deviate from its NAV. The first two terms and the fourth term represent conflicting *state-invariant* influences on the equilibrium price. In both expressions, any bearish market sentiment, $a_u < 1$, and the "create space" or risk adjustment terms, $\sigma^2{}_\beta$ and $\sigma^2{}_\pi$, tend to imply state-invariant market price discounts relative to their NAVs. Any bullish sentiment, $a_u > 1$, would imply *state-invariant* price premia.

Finally, if some traders do display bias in their expectations following event states, the two pricing equations will differ, since $B_e \neq B_u$.. The state-dependent prediction of the model is summarized by the difference $p_{t+1,e} - p_{t,u}$, i.e., Equation (4) minus lagged (3).

$$p_{t+1,e} - p_{t,u} = a_u \cdot (n_{t+1} - n_t) - E \cdot \pi_t \qquad (6)$$

$E = B_e - B_u > 0$ for all parameter values. This expression describes the change in the observed fund price when moving from a time t usual state to a $t + 1$ event state. The difference $n_{t+1} - n_t$ represents the change in the country fund price attributable to changes in the fund's NAV, i.e., its fundamental value after adjusting for market sentiment. The last right-hand side term represents the state-dependent effect that biased traders have on country fund prices. Rearranging (6) gives:

$$a_u \Delta n_{t+1} - \Delta p_{t+1} = E \cdot \pi_t \tag{7}$$

where $\Delta n_{t+1} = n_{t+1} - n_t$, $\Delta p_{t+1} = p_{t+1} - p_t$. Intuitively, the timing of country fund price deviations from NAV should correspond to the event states that create expectations bias, and the magnitude of the deviation should reflect the severity of the event state.

Defining State-Dependent Expectations Bias

Equation (7) indicates market prices will deviate from NAV based on the extent of the behavioral traders' bias π. For this variable to mimic the expectations biases observed in the experimental results of section II.B, it needs to be a function of the sign of the rationally expected NAV revision ψ, and of an event state indicator δ.

Let the indicator variable ψ represent the sign of the expected NAV revision:

$$\psi_t = \begin{cases} 1 & \text{if} \quad E_t \beta_{t+1} > 0 \\ 0 & \text{if} \quad E_t \beta_{t+1} = 0 \\ -1 & \text{if} \quad E_t \beta_{t+1} < 0 \end{cases} \tag{8}$$

Next, let the indicator variable δ identify the type and severity of an event state. $\delta > 0$ describes an overreaction trigger state, $\delta < 0$ describes an underreaction state, and $\delta = 0$ describes a usual state. The specific data used to relate these indicator variables to measurable data are described in Section IV, Equations (11) and (12). δ will intuitively characterize either the level of NAV variance or the level of financial news.

This then allows us to define the behavioral bias term as:

$$\pi_t = \psi_t \delta_t \tag{9}$$

Figure 1 graphically represents the expectations bias patterns observed in the forecasting experiments, and the forecasting patterns associated with the behavioral variable $\pi_t = f(\psi, \delta)$. Overreaction means jumping too far up or down in expectation of price change. Underreaction means not jumping far enough in either direction. Intuitively, we observe that a bias variable with the properties of (9) can generate the expectations bias patterns described in Figure 1. Then, combining the solution to the behavioral pricing model (7) with the definition of the bias term (9), we obtain four predictions regarding possible discount movements (see Figure 2).

If there is *overreaction* (underreaction) and a rationally expected NAV *appreciation*, then $\delta > 0$ ($\delta < 0$) and $\psi = 1$. The sign of the bias term will be $\delta > 0$ ($\delta < 0$) and with (7) this predicts an increase (decrease) in the discount following event states.[2]

If there is *overreaction* (underreaction) and a rationally expected NAV *depreciation*, then $\delta > 0$ ($\delta < 0$) and $\psi = -1$. The sign of the bias term will be $\pi < 0$ ($\pi > 0$) and with (7) this predicts a decrease (increase) in the discount following event states.

FIGURE 2
Possible Discount Movements Predicted By the Behavioral Model Equations (7)–(9)

Rationally Expected NAV Change at *t* / **Forecasting Bias at *t***	**Overreaction** $\delta > 0$	**Underreaction** $\delta < 0$
Appreciation of Fundamental Value $\psi = 1$	Discount Increases at $t + 1$	Discount Decreases at $t + 1$
Depreciation of Fundamental Value $\psi = -1$	Discount Decreases at $t + 1$	Discount Increases at $t + 1$

Testable Hypotheses

The section III.D predictions suggest two testable propositions regarding changes in the country fund discount and traders' state-dependent expectations biases π:

Proposition 1: If agents overreact to price signals in high noise event states, the discount should increase if there is a rationally expected NAV appreciation and decrease if there is an expected depreciation.

Proposition 2: If agents underreact to price signals in high information event states, the discount should decrease if there is an expected NAV appreciation and increase if there is an expected depreciation.

If we define $\delta > 0$ for both event trigger states and $\delta = 0$ for usual states, the estimated sign of θ from Equation (10) will allow us to distinguish whether over- or underreaction is influencing prices for a particular event state *i*.

$$\Delta D_{t+1} = \theta_i \pi_{i,t} + e_t \tag{10}$$

Overreaction would be described by $\theta > 0$, while $\theta < 0$ would signify underreaction. The significance of these coefficients describes the extent to which the timing of discount movements can be related to the timing of event trigger states. The absolute size of the coefficient describes the magnitude of the behavioral driver's influence on country fund prices.

The next section defines specific behavioral terms and tests the validity of the two propositions for a sample of field country fund data.

Data

Country Fund Summary Statistics

The sample of country fund data used to test the model propositions includes forty-two single and multi-country funds spanning January 1998 to May 2002 on a weekly basis. The data, covering thirty countries, are obtained from Bloomberg, and represent the approximately synchronous Friday closing values for the country fund and NAV prices.[3] The NAVs are reported by the funds themselves and converted into dollars with the most recent spot exchange rate. There are 227 observations for each fund, for a total of 9,497 observations.

Table 1 provides summary statistics describing each country fund's NAV and market price changes. Several stylized facts stand out. First, both average NAV and market price changes lie within one standard deviation of zero. This suggests we cannot reject the hypothesis that these price revisions evolve as a random walk at the 1% significance level.

Second, comparing the standard deviations for the NAVs (column 4) and market prices (column 6) indicates that thirty of the forty-two funds' prices are more variable than would be expected from variations in their fundamental or net asset values. To illustrate this effect, column 7 provides an indicator variable with a value of 1 if the fund price standard deviation exceeds the fundamental NAV standard deviation. This result is consistent with Shiller's [1981] observation that market prices seem to display "excess volatility" with respect to fundamental information.

Table 2 provides summary statistics demonstrating the central anomaly of the study, the average and volatile country fund discount. We first observe that thirty-three of the funds have statistically significant average discounts during this sample period, i.e., discounts two or more standard deviations from zero, which implies significance at the 5% level (see column 7, which reports an indicator variable with a value of 1 for funds with significant discounts).

Second, discounts and premia vary significantly, from a maximum premium of 155% for the Thailand fund, to a maximum discount of 42% for the Morgan Stanley India fund. This suggests that something other than fundamental information is driving price changes, probably investors' biased expectations.

State-Dependent Bias in the Country Fund Market

We must define the event state indicator variable δ and the expected sign of the revision ψ to construct the behavioral variable π that represents the state-dependent bias of traders in the country fund market. In the experimental data, an event state was represented by either high forecasted variable variance, or large amounts of predictor information. For the country fund market, an event state is defined by either the NAV variance or by the volume of relevant investing news. Furthermore, since we observe in Table 1 that the NAV prices evolve as a random walk, the sign of the expected revision is simply the sign of the previously observed revision, i.e., $\psi_t = f[sgn(\beta_{t-1})]$ (see section III.D).

Next, let the indicator for the high forecasted variable variance, i.e., an overreaction event state, take the general form $\delta_{HN} = \delta^2_n$. The high noise behavioral variable $\pi_{1,t}$ is then:

$$\pi_{1,t} = \psi_t \sigma^2_{n,t} \tag{11}$$

In other words, the overreaction bias displayed by traders is a function of the sign of the rationally ex-

Table 1. *Country Fund NAV (n) and Country Fund Price (p) Change Summary Statistics*

Fund	Nobs	$n_{t+1} - n_t$ Mean	σ_n Std. Dev.	$p_{t+1} - p_t$ Mean	σ_p Std. Dev.	Excess Volatility? ($\sigma_n > \sigma_p$) (yes = 1)
APB	226	–0.01	0.38	–0.01	0.40	1
BZF	226	0.02	0.84	0.04	0.95	1
BZL	226	0.02	0.29	0.02	0.31	1
CH	226	0.04	0.42	0.05	0.50	1
CHN	226	–0.01	0.49	–0.01	0.57	1
CRF	226	0.02	0.42	0.02	0.36	0
EF	226	0.04	0.65	0.03	0.58	0
EWF	226	0.05	0.83	0.06	0.80	0
FPF	226	0.02	0.30	0.02	0.30	1
FRF	226	0.01	0.47	0.02	0.48	1
GCH	226	0.00	0.44	–0.01	0.50	1
GER	226	0.03	0.54	0.04	0.62	1
GF	226	0.03	0.52	0.04	0.59	1
GRR	226	0.00	0.33	0.00	0.35	1
IAF	226	0.01	0.20	0.01	0.21	1
IFN	226	–0.01	0.61	–0.02	0.80	1
IGF	226	0.00	0.61	0.00	0.78	1
IIF	226	–0.01	0.57	–0.01	0.62	1
IRL	226	0.03	0.69	0.03	0.59	0
ISL	226	0.02	0.55	0.02	0.54	0
ITA	226	0.02	0.66	0.02	0.71	1
JEQ	226	0.00	0.37	0.00	0.25	0
JFC	226	0.01	0.35	0.01	0.40	1
JFI	226	0.00	0.45	–0.01	0.63	1
JOF	226	–0.01	0.47	–0.01	0.44	0
KEF	226	0.00	0.20	–0.01	0.25	1
KF	226	–0.05	0.60	–0.08	0.73	1
LAQ	226	0.00	0.48	0.01	0.57	1
LDF	226	0.03	0.62	0.03	0.82	1
MF	226	0.01	0.37	0.00	0.23	0
MSF	226	0.01	0.52	0.00	0.59	1
MXE	226	0.00	0.41	0.01	0.46	1
MXF	226	0.01	0.79	0.02	0.98	1
ROC	226	0.02	0.39	0.01	0.35	0
SAF	226	0.00	0.49	0.00	0.55	1
SGF	226	0.00	0.32	0.00	0.27	0
SNF	226	0.02	0.64	0.04	0.61	0
SOA	226	0.01	0.49	0.01	0.59	1
SWZ	226	0.01	0.39	0.01	0.46	1
TCH	226	0.00	0.34	0.00	0.38	1
TKF	226	0.01	0.72	0.01	1.03	1
TTF	226	0.00	0.45	0.00	0.23	0

pected revision ψ times the NAV variance from last week to the week including the current time t Friday, i.e., $t - 1$ to t.

Next, let the indicator for the high information state δ_{NEWS} take the general form $\delta_{NEWS} = news_t$, where news refers to the quantity of news events regarding a particular investing area. The high news behavioral variable π_2 is then:

$$\pi_{2,t} = \psi_t news_t \tag{12}$$

These news data are obtained from historical transcripts of the CNN program *Lou Dobbs Moneyline*, as reported by LexisNexis. We use this program because it provides a historical sequence of transcripts, reported in a high-quality digital format, for the five years of the sample.

The $news_t$ variable tallies the number of specific keywords representing relevant investment areas on *Moneyline* during the trading week including the Friday at t. For all funds, keywords for country name, country fund name, and ticker symbol, and the company names of the top ten underlying foreign constituents were included for each country. The search was case-sensitive and included spaces after defined keywords to avoid picking up unrelated similar words. Visual inspec-

Table 2. *Country Fund Discount Summary Statistics Equation (5) $D_{t+1} = ((n_{t+1} / p_{t+1}) - 1)$*

Fund	Nobs	Average Discount avg(D)	σ_D Std. Dev.	Minimum Discount (Premium)	Maximum Discount	Significant Disc.? (yes = 1) $\lvert avg(D)\rvert - 2^*\sigma_D > 0$
APB	226	–0.19	0.07	0.08	–0.34	1
BZF	226	–0.21	0.05	–0.10	–0.34	1
BZL	226	–0.19	0.06	–0.05	–0.30	1
CH	226	–0.23	0.05	–0.10	–0.34	1
CHN	226	–0.21	0.06	–0.02	–0.35	1
CRF	226	–0.20	0.04	–0.09	–0.34	1
EF	226	–0.12	0.03	–0.01	–0.24	1
EWF	226	–0.17	0.07	0.01	–0.28	1
FPF	226	–0.15	0.07	0.19	–0.29	1
FRF	226	–0.15	0.03	–0.08	–0.23	1
GCH	226	–0.21	0.06	0.02	–0.33	1
GER	226	–0.09	0.03	–0.01	–0.22	1
GF	226	–0.19	0.03	–0.11	–0.28	1
GRR	226	–0.20	0.06	0.04	–0.34	1
IAF	226	–0.16	0.04	–0.06	–0.29	1
IFN	226	–0.24	0.07	–0.05	–0.41	1
IGF	226	–0.25	0.07	0.01	–0.40	1
IIF	226	–0.24	0.08	0.09	–0.42	1
IRL	226	–0.19	0.06	–0.05	–0.32	1
ISL	226	–0.19	0.02	–0.11	–0.28	1
ITA	226	–0.14	0.04	–0.05	–0.26	1
JEQ	226	0.02	0.18	0.45	–0.30	0
JFC	226	–0.21	0.05	0.02	–0.34	1
JFI	226	–0.24	0.07	–0.06	–0.38	1
JOF	226	–0.05	0.18	0.42	–0.33	0
KEF	226	–0.13	0.16	0.55	–0.35	0
KF	226	–0.12	0.16	0.57	–0.35	0
LAQ	226	–0.22	0.04	–0.14	–0.32	1
LDF	226	–0.18	0.07	0.55	–0.30	1
MF	226	0.12	0.34	1.08	–0.24	0
MSF	226	–0.19	0.05	0.03	–0.28	1
MXE	226	–0.14	0.07	–0.01	–0.29	1
MXF	226	–0.22	0.07	–0.06	–0.34	1
ROC	226	–0.16	0.04	–0.07	–0.29	1
SAF	226	–0.19	0.05	0.03	–0.29	1
SGF	226	–0.13	0.09	0.21	–0.26	0
SNF	226	–0.06	0.09	0.21	–0.21	0
SOA	226	–0.21	0.04	–0.09	–0.30	1
SWZ	226	–0.18	0.02	–0.13	–0.25	1
TCH	226	–0.21	0.06	0.01	–0.36	1
TKF	226	–0.13	0.10	0.21	–0.28	0
TTF	226	0.46	0.41	1.55	–0.17	0

tion of the series demonstrates that the search method accurately identifies relevant news events.

Results

The goal of the empirical analysis is to quantify the extent to which state-dependent trader bias π can explain country fund discount movements ΔD. Equation (10) summarizes the model predictions about this relationship, and is estimated for each country fund individually.[4]

Table 3 reports the model fits of Equation (10) for π_1 and π_2 simultaneously. Columns (3) and (4) provide the estimates for θ_i and the t-ratios. If all agents forecast rationally, we should observe $\theta_i = 0$, which means we cannot reject the null hypothesis that the discount simply evolves as a random walk. If agents display consistent state-dependent forecasting bias, we should observe $\theta_i \neq 0$. Specifically, $\theta_i > 0$ implies that agents' overreaction to information is influencing the country fund discount following event state *i*, while $\theta_i < 0$ implies agents' underreaction is influencing the discount after event state *i*.

Table 3 shows that the parameter θ_1 for the high noise bias variable is positive and significant for forty of the forty-two funds at the 10% level. This is consistent with the experimental results, and indicates

Table 3. *Country Fund Discount Model Fits Multivariate OLS Equation (10)'* $\Delta D_{t+1} = \theta_1\pi_{1,t} + \theta_2\pi_{2,t} + e_t$

Fund	Nobs	High Variance ($\pi_{1,t}$) θ_1 (t-ratio)	High News ($\pi_{2,t}$) θ_2 (t-ratio)	R^2	Pr-Value > |t| q_1, q_2
APB	226	0.39 (5.40)**	–0.21 (2.98)**	0.14	0.00, 0.00
BZF	226	0.05 (4.74)**	0.02 (0.66)	0.09	0.00, 0.51
BZL	226	0.26 (3.22)**	–0.00 (0.01)	0.04	0.00, 0.99
CH	226	0.10 (6.30)**	0.00 (0.18)	0.15	0.00, 0.86
CHN	226	0.47 (6.45)**	–0.02 (0.80)	0.16	0.00, 0.43
CRF	226	0.74 (7.20)**	0.01 (1.48)*	0.19	0.00, 0.14
EF	226	0.14 (4.64)**	0.00 (0.21)	0.09	0.00, 0.83
EWF	226	0.09 (5.02)**	0.00 (0.04)	0.10	0.00, 0.97
FPF	226	0.60 (5.72)**	0.11 (0.75)	0.13	0.00, 0.45
FRF	226	0.15 (4.32)**	–0.03 (0.99)	0.08	0.00, 0.33
GCH	226	0.29 (5.91)**	–0.04 (1.13)	0.14	0.00, 0.26
GER	226	0.07 (2.50)**	0.01 (1.12)	0.03	0.01, 0.27
GF	226	0.09 (4.48)**	0.14 (4.63)**	0.16	0.00, 0.00
GRR	226	0.47 (5.10)**	–0.19 (2.97)**	0.14	0.00, 0.00
IAF	226	1.43 (5.94)**	0.09 (0.53)	0.14	0.00, 0.59
IFN	226	0.10 (4.54)**	–0.08 (1.05)	0.09	0.00, 0.30
IGF	226	0.12 (3.64)**	0.01 (0.17)	0.06	0.00, 0.87
IIF	226	0.17 (5.70)**	–0.10 (1.20)	0.13	0.00, 0.23
IRL	226	0.15 (7.47)**	0.06 (1.17)	0.21	0.00, 0.24
ISL	226	0.17 (5.54)**	–0.03 (1.15)	0.13	0.00, 0.25
ITA	226	0.08 (4.53)**	–0.06 (2.76)**	0.11	0.00, 0.01
JEQ	226	1.65 (4.99)**	–0.18 (1.59)*	0.11	0.00, 0.11
JFC	226	0.55 (6.59)**	–0.08 (1.36)	0.16	0.00, 0.18
JFI	226	0.12 (3.61)**	–0.06 (0.79)	0.06	0.00, 0.43
JOF	226	0.24 (3.84)**	–0.15 (1.61)*	0.07	0.00, 0.11
KEF	226	0.98 (1.99)**	0.60 (3.92)**	0.08	0.05, 0.00
KF	226	0.04 (0.66)	0.23 (1.07)	0.01	0.51, 0.29
LAQ	226	0.10 (4.36)**	0.02 (0.81)	0.09	0.00, 0.42
LDF	226	0.26 (3.77)**	–0.02 (0.13)	0.06	0.00, 0.90
MF	226	1.92 (6.82)**	–0.11 (0.47)	0.17	0.00, 0.64
MSF	226	0.10 (3.98)**	0.01 (0.39)	0.07	0.00, 0.70
MXE	226	0.25 (3.52)**	–0.38 (1.82)**	0.06	0.00, 0.07
MXF	226	0.04 (2.42)**	–0.00 (0.04)	0.03	0.02, 0.97
ROC	226	0.72 (6.50)**	–0.11 (1.46)*	0.16	0.00, 0.15
SAF	226	0.06 (3.46)**	0.05 (1.44)*	0.06	0.00, 0.15
SGF	226	0.95 (5.84)**	–0.26 (1.93)**	0.15	0.00, 0.05
SNF	226	0.11 (3.94)**	–0.09 (1.33)	0.07	0.00, 0.19
SOA	226	0.12 (3.40)**	–0.80 (3.23)**	0.08	0.00, 0.00
SWZ	226	0.24 (3.07)**	0.06 (1.64)**	0.05	0.00, 0.10
TCH	226	1.31 (5.76)**	–0.15 (2.90)**	0.15	0.00, 0.00
TKF	226	–0.03 (1.25)	–0.18 (1.40)	0.02	0.21, 0.16
TTF	226	1.25 (5.90)**	–0.38 (1.00)	0.14	0.00, 0.32

Note: Significance level: **10%, *15%.

failure to reject the hypothesis that the timing and magnitude of country fund discount movements can be related to traders' overreaction to information following high forecasted variable variance states.

For the *high information* bias variable, the results are less significant and consistent. The experimental result predicting underreaction to high information suggests that these coefficients would be significantly negative. Only ten (fifteen) of the forty-two coefficients for the high information variable θ_2 are significant at the 10% (15%) level. Ten of the fifteen coefficients were significantly negative, failing to reject the hypothesis that the timing of country fund discount movements can be related to traders' underreaction to information following high news information states. This result is consistent with the evidence from the forecasting experiments. However, five of the significant estimates are positive, suggesting that trader overreaction influences discounts. This is contrary to the experimental results and implies that overreaction is triggered by large amounts of news.

Discussion

This study investigates whether traders' state-dependent expectations biases can account for anomalous country fund discount movements. A distributional uncertainty model is provided that includes both rational traders and two types of behavioral traders. The characteristics assumed for the behavioral traders are based on the biased behaviors observed in financially oriented forecasting experiments. In particular, overreaction to current information was triggered by states with high forecasted price variance, and underreaction to current information was triggered by states characterized by a large amount of predictor information.

The closed-form equilibrium price solutions of the model demonstrate a multiple driver property of fund prices. We see that country fund prices are a function of their fundamental NAVs and risk adjustment terms, as well as behavioral variables that identify the timing and severity of bias-triggering event states.

Some caveats are necessary, however. First, this study does not argue that all discount variance can be accounted for with these two biases. There is substantial evidence of many more forms of bias in individual forecasting ability, as noted in Hogarth and Reder [1987]. The motivation for considering these two biases is the fact that they obtain in an experimental setting directly comparable to the analytical model.

Second, several empirical studies have identified a variety of other discount predictors that are not included in this model and are significant predictors of discount movements. Since these drivers are not an aspect of the analytical model, they are absent.

The model suggested two key testable propositions regarding the timing of country fund discount movements.

1. First, if agents overreact to current information following high forecasted price variance states, the discount should increase if there is an expected NAV appreciation and decrease if there is an expected depreciation.
2. Second, if agents underreact to current information following event states with large amounts of predictor information, the discount should decrease if there is an expected NAV appreciation and increase if there is an expected depreciation.

The empirical results are consistent with these two propositions. A simple regression comparing changes in the discounts to the high variance overreaction bias variable finds that these terms can predict the timing and direction of discount movements for forty of forty-two funds at the 10% significance level. We also found that contemporaneous underreaction, triggered by high CNN news levels, can predict the timing and direction of discount movements for fifteen of forty-two funds, but only at the 15% level.

Notes

The analysis described in this article used SAS for data organization and analysis.

1. The assumption that only rational traders are present in the home market is based on research describing the observed characteristics of traders in country fund versus foreign markets. See Lee, Shleifer, and Thaler [1991].
2. This is true because the values for δ and ψ with (7) imply that $\Delta n_{t+1} > 0$, $\Delta p_{t+1} > 0$, and $\Delta n_{t+1} - \Delta p_{t+1} > 0$. As a result, the NAV increases more than the country fund price, so the discount increases or the premium decreases.
3. These include: Australia, Brazil, Chile, China, France, Germany, Hong Kong, India, Ireland, Israel, Italy, Japan, Luxembourg, Malaysia, Mexico, the Netherlands, New Zealand, the Philippines, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the United Kingdom, and the United States.
4. Equation (10) is estimated for each fund individually since earlier fixed effects analyses of fund returns reject the hypothesis of fund homogeneity, implying a pooled analysis would not be appropriate.

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