Strategic Interactions and Portfolio Choice in Money Management

Evidence from Colombian Pension Funds

Alvaro Pedraza Morales

WORLD BANK GROUP

Development Research Group

Finance and Private Sector Development Team

July 2014

Abstract

This paper studies the portfolio choice of strategic fund managers in the presence of a peer-based underperformance penalty. Evidence is taken from the Colombian pension fund management industry, where six asset managers are in charge of portfolio allocation for the mandatory contributions of the working population. These managers are subject to a peer-based underperformance penalty, known as the Minimum Return Guarantee. The trading behavior by the managers is studied before and after a change in the strictness of the guarantee in June 2007.

The evidence suggests that a tighter minimum return guarantee results in more trading in the direction of peers, a behavior that is more pronounced for underperforming managers. These managers rebalance their portfolios by buying securities in which they are underexposed relative to their peers, as opposed to selling assets in which they are overexposed. Overall, the results suggest that incentives for managers to be close to industry benchmarks play an important role in the portfolio allocation of these funds.

This paper is a product of the Finance and Private Sector Development Team, Development Research Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The author may be contacted at apedrazamorales@worldbank.org.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Strategic Interactions and Portfolio Choice in Money Management: Evidence from Colombian Pension Funds

Alvaro Pedraza Morales*

JEL Classification: G11, G23, C73, C61

Keywords: Portfolio Choice, Strategic Interactions, Relative Performance, Institutional Investors, Pension Funds.

*Email address: apedrazamoraless@worldbank.org. I am indebted to Pete Kyle and John Shea for their invaluable guidance. This study has benefited from the comments of Anton Korinek, John Rust, Giorgio Sertsios, Paula Tkac, Russ Wermers and two anonymous referees. I also thank Shu Lin Wee, Pablo Cuba and seminar participants at the Midwest Macro, Federal Reserve Bank of Atlanta, Inter-American Development Bank and University of Maryland for comments and suggestions. All errors are my own.

1. Introduction

In financial markets, institutional investors manage a significant portion of the total assets and comprise an even greater portion of the trading volume. Given the size of the portfolio management industry, models addressing the agency issues of delegated portfolio management and their effects on asset pricing have become popular over the last few years.

In this paper, I study the portfolio choice of strategic fund managers in the presence of a peer-based underperformance penalty. While the penalty might generate crowd effects among managers even under competitive behavior, correlated trading is potentially exacerbated when strategic behavior is considered.

Relative performance concerns among managers may be present for several reasons. The most common explicit compensation schemes in the asset management industry depend linearly on the volume of assets under management and non-linearly on excess performance relative to a benchmark (as exemplified by success fees or performance bonuses). Another implicit source for relative performance concerns is the potential increase in funds flowing towards the best performing managers. Such empirical regularities have been documented by [Chevalier and Ellison \(1997\)](#) for mutual funds and [Agarwal et al. \(2004\)](#) for the hedge fund industry. The evidence suggests that a manager will get additional money flows and thus a higher future compensation if her relative return is above a threshold.

A less studied source of relative performance concerns comes from regulation. In particular, in countries that have moved from pay-as-you-go (PAYGO) pension systems to Defined Contributions (DC) systems based on individual accounts, regulation typically includes a Minimum Return Guarantee (MRG) or an underperformance penalty levied on portfolio managers. The rationale for such regulations is to discourage excessive risk taking by the managers of these accounts. In most cases, the formula to determine the MRG is calculated based on peer performance.¹ Hence, managers have an explicit reason to care about the returns of their peers.

Relative performance concerns generated by excess performance fees or the performance-flow relationship typically imply a convex payoff based on relative performance, which gives rise to more risk taking among managers. In contrast, an underperformance penalty represents the opposite kind of performance incentive—a serious penalty for being the loser, as opposed to a big price for being the winner—and therefore one would expect to find the opposite sort of behavior, namely herding. More specifically, an underperformance penalty based on peer returns introduces an explicit reason for managers to track each

¹See for instance [Turner and Rajnes \(2001\)](#) for a review on these systems. [Castaneda and Rudolph \(2010\)](#) present a theoretical analysis of portfolio choice under peer-based and index-based MRG.

others' portfolios, possibly generating crowd effects as managers minimize the risk from behaving differently from others. Of course managers might also herd into (or out of) the same securities over some period of time for other reasons not related to underperformance penalties. First, managers may receive correlated private information, perhaps from analyzing the same indicator (Hirshleifer et al. (1994)). Second, a manager might infer private information from the prior trades of better-informed managers and trade in the same direction (Bikhchandani et al. (1992), Sias (2004)). Third, managers might disregard private information and trade with the crowd due to the reputational risk of acting differently from other managers (Scharfstein and Stein (1990)). Finally, managers might simply have correlated specific preferences over certain types of securities. An underperformance penalty, such as the MRG, resembles a reputational risk, in that the manager might be penalized for having lower returns than her peers. With the MRG, the risk is explicit as the manager will be penalized financially if returns are below the maximum allowed shortfall relative to the peer benchmark.

When the number of competing money managers is small, relative performance concerns might lead to strategic behavior. In this environment, strategic interactions imply that a manager's optimal portfolio choice needs to take into account the impact of his trades on other managers' decisions. In such setting, the effects from a peer performance penalty on portfolio strategies and trading dynamics might be more pronounced.

The DC pension industries in several Latin American and Eastern European countries are natural candidates to display strategic interaction, because they consist of a small number of competing Pension Fund Administrators (PFA), who act as asset managers and make portfolio choices on behalf of the working population.

I use detailed data on the security allocations chosen by Colombian PFAs between 2004 and 2010 to study the strategic interaction between managers under relative performance concerns. The Colombian institutional set up satisfies several key conditions necessary for testing for strategic behavior of managers. PFAs manage the savings of a captive market, namely individual retirement accounts, so their set of competitors is restricted to other PFAs, and excludes other asset managers. Each PFA must comply with a MRG that is calculated based on peer performance, creating an explicit incentive to care about the portfolio choice and performance of other managers. Since the number of PFAs is small (six), strategic behavior might be more pronounced than with a large number of competitors. Previous empirical work on strategic behavior has examined data on managers' broad asset allocation or overall portfolio returns. By using monthly detailed portfolio holdings, I am able to test richer implications of models with strategic

behavior. Finally, the Colombian government changed the MRG formula in June 2007, increasing the maximum allowed shortfall and thereby loosening the MRG. This policy experiment allows me to measure the change in behavior associated with the change in the underperformance penalty, arguably holding constant other possible explanations for correlated trading.

The evidence suggests that a tighter MRG results in more trading in the direction of peers and a smaller cross-section dispersion of returns between pension funds. Moreover, the ranking among managers in terms of performance seems to play a role in portfolio balancing decisions. With a tighter MRG, underperforming managers are more likely than their competitors to trade in the direction of their peers. This is done by buying stocks in which the manager has smaller weights in her portfolio relative to her peers, as opposed to selling stocks with larger weights relative to her peers. Since these pension funds were in an accumulation stage during the sample period, managers were presumably able to reduce their participation in stocks to which they were overexposed simply by maintaining a fixed number of shares.

The rest of the document is organized as follows: In section 2 I review the leading literature on strategic behavior by fund managers. The empirical evidence is presented in section 3, where I conduct two empirical exercises that describe the overall trading behavior of Colombian PFAs. Finally, in section 4, I present the conclusions and discuss future work.

2. Related Literature

This paper is related to several strands of the literature. The empirical literature on strategic behavior of money managers has focused on the trading strategies of asset managers competing for leadership to gain status, higher compensation or increased future flows of funds. The game is similar to a typical tournament, where winners get a large prize and the losers end up with much less. In such tournaments, managers optimally increase their risk taking to maximize the probability of reaching a top position at some target date (usually at year end). Using U.S. data, [Chevalier and Ellison \(1997\)](#) document strong gambling incentives among top-performing mutual funds. Examining strategic behavior in the context of fund families, [Kempf and Ruenzi \(2008\)](#) document that mutual fund managers belonging to families with a small number of funds behave differently from managers belonging to large families. They argue that this result is driven by strategic interactions that might be more pronounced in small fund families. For UK funds, [Jans and Otten \(2008\)](#) present evidence of strategic behavior, finding that fund managers recognize the impact of their own decisions on the actions of their peers, rather than treating competing

managers as exogenous benchmarks. A possible explanation for the findings of [Kempf and Ruenzi \(2008\)](#) and [Jans and Otten \(2008\)](#) is that, with strategic managers, the interim leader expects the laggard to increase risk, and therefore the leader also increases risk to maintain his lead ([Taylor \(2003\)](#)).

I complement this literature by presenting empirical evidence on the trading behavior of Pension Fund Administrators in Colombia, where a small number of managers compete and set their strategies to avoid a peer-based underperformance penalty. With only six PFAs, it is highly likely that managers are strategic, as they recognize that the other managers will react to their own portfolio choice as it will affect each manager's future compensation. In contrast to the previous literature, where risk taking behavior arises as managers try to outperform their peers, I study the effects of the opposite kind of performance incentive, a serious penalty for being the loser. In this setting one would expect to find the opposite outcome, meaning herding among managers.

Despite strong theoretical foundations and a common perception that professional investors herd, earlier studies found little evidence of herding behavior, and in most cases herding was mostly associated with only particular types of assets, like small stocks ([Wermers \(1999\)](#) for US mutual funds and [Lakonishok et al. \(1992\)](#) for US pension funds). In a more recent study, however, [Sias \(2004\)](#) shows that changes in security positions of institutional asset managers over a quarter are strongly correlated with the trades of other institutions over the previous quarter. The author also finds that changes in positions on particular stocks are weakly but positively related to returns over the following year. The results favor the hypothesis that herding is a result of institutions inferring information from each other's trades. [Raddatz and Schmukler \(2013\)](#) find that Chilean pension funds, also subject to a peer-based MRG, tend to herd, buying and selling the same assets at the same time. The authors also find differences in the extent of herding across assets. By comparing the trading behavior of PFAs before and after the MRG change, I am able to identify the effects of the underperformance penalty holding other factors constant.

3. Empirical Evidence

3.1. The Colombian Private Pension Industry

In 1993 the Colombian Congress approved Law 100, which among other reforms introduced major changes in the pension system. The country adopted a dual pension scheme, in which a defined contribution (DC) system of individual accounts was created in addition to the already existing defined benefit system. Under the new system, pensions were financed by compulsory contributions made by both the employer and the

employee. The law also provided guiding principles for the establishment, operation and supervision of Pension Fund Administrators (PFAs). Under the new scheme, all workers who chose the DC system were required to select a PFA to manage their retirement accounts. The worker's investment decision was restricted to the choice of the PFA, while the government regulated PFAs' portfolio strategies by imposing limits on specific asset classes and individual securities,² and through other provisions such as banning short selling. Workers were allowed to switch PFAs every six months.

The law also determined the compensation structure of the PFAs and the Minimum Return Guarantee (MRG). The PFAs were allowed to charge fees for collecting contributions, managing the fund and giving benefits. In particular, PFAs charge a front end load fee of 5.5% on new contributions. On average, the fee on new contributions represents close to 90% of the annual compensation of the PFAs. If a worker makes consistent contributions he does not face any additional charges.³

The MRG is a lower threshold of returns that each individual PFA needs to guarantee for its investors. If a PFA fails to provide at least this return, the PFA must transfer part of its own net worth to the fund to make up the shortfall. The MRG is assessed monthly by comparing the fund's average annual return over the previous three years to the average of the six PFAs.⁴ Between January 2004 and June 2007, the minimum return guarantee was calculated as the average across PFAs of the average annual return over the previous three years (Π_t), minus 30%, so that $MRG_t = 70\%\Pi_t$. After June 2007 the government changed the formula to $MRG_t = \min\{70\%\Pi_t, \Pi_t - 2.6\%\}$. For average industry returns below 8.66%, the new formula implies a MRG equal to $\Pi_t - 2.6\%$, as $70\%\Pi_t > \Pi_t - 2.6\%$. Effectively, for this set of returns, the new formula yielded a lower MRG (equivalently, a larger allowed shortfall) than what would have been calculated before June 2007.⁵

Within this institutional setting, the MRG creates an explicit reason for each PFA to track peer portfolios and performance. The penalty for falling too far behind the industry average returns may lead the PFA to bankruptcy. Given the size of each PFA, and the total value of assets under management, a typical Colombian PFA falling 50bps below the MRG threshold would use up its entire net worth compensating its investors.⁶ With such a severe penalty, one should expect that the MRG is of first order

²In June 2008 some of the limits were: (i) Maximum 50% in domestic government debt. (ii) Maximum 40% in equity securities. (iii) Maximum 40% in foreign securities.

³Other smaller fees apply in special cases (e.g. there is a fee when the worker changes PFA, as well as a proportional fee on the value of the account when the worker has not made a contribution for six consecutive months.)

⁴A similar provision is in place in other countries, including Chile, Peru, the Dominican Republic and Uruguay.

⁵As an example of how this new formula loosened the MRG constraint (increased the maximum allowed shortfall) consider the date December 31, 2009. Between December 31, 2006 and December 31, 2009 the industry annual average returns were 6.01%. With the new formula in place, the MRG was 3.41%, instead of the 4.20% that would have occurred under the older formula.

⁶In the 15 year history of the private pension system (between 1996 and 2010), no PFA ever yielded returns below the

importance when PFAs set their strategies.

[Insert Table 1 about here]

Data on Colombian pension funds was provided by ASOFONDOS (Colombian Association of Pension Fund Administrators). The database includes the detailed security allocations for the funds managed by each of the six PFAs, on a monthly basis for the period 2004:1 to 2010:12. Summary statistics for this data set are presented in Table 1 at two-year intervals. As of June 2010, total assets under management were US\$44.1 billion (equal to 17% of Colombian GDP). At that time, 32% of these funds were invested in Colombian stocks, which amounted to 7.1% of the total domestic market capitalization. Throughout the sample period, net flows to these funds were positive, which reflects the fact that most of the workers contributing to these funds were still young (more than 70% were younger than 40 years old).

In addition to the pension funds, PFAs manage voluntary retirement funds in separate accounts. These voluntary accounts supplement the compulsory retirement savings in the pension funds. Contrary to pension funds, these accounts are subject to very few regulations. In particular, they are not subject to the MRG and do not have limits on individual securities or asset classes.⁷ Moreover, workers are typically directly involved in the asset allocation of their voluntary portfolios. Panels D and E in Table 1 present summary statistics of the voluntary funds.

In the following sections I present two empirical exercises suggesting that relative performance concerns are important for the portfolio dynamics of PFAs. For this, I introduce two measures that describe trading activity by PFAs. The first is an aggregate fund measure that describes how each manager rebalances her portfolio relative to the peer portfolio. The second focuses on fund trades of individual stocks. For both empirical exercises, I focus on the trading behavior across domestic stocks. While these represent only a fraction of the total portfolio, correlated behavior among managers is likely to be more pronounced for these securities, which display higher dispersion of returns than other assets in PFAs portfolios.

3.2. Trading Strategies and Relative Performance

In this section I introduce a measure of the direction of a PFA's trades relative to its peers. The objective is to summarize the trading behavior and strategies of Colombian pension fund managers in a parsimonious way.

MRG. Even in the turmoil of October 2008, the PFA with the lowest returns managed to have returns 118bps above the MRG (this is the closest any PFA was to the MRG in the sample period)

⁷The only major restriction that these funds share is the short selling ban.

At the end of each month, each fund's location is defined by its portfolio weights. The vector of portfolio weights for a fund i in month t is denoted $w_t^i \in \mathbb{R}^{S+1}$, where each element $s = \{1, 2, \dots, S\}$ represents a domestic stock in the fund's portfolio, $w_{st}^i = \frac{\text{shares}_{st}^i * p_{st}}{VF_t^i}$. Here shares is the number of shares of stock s held by the fund, p is the stock price and VF_t^i is the total value of the fund. The element $w_{S+1,t}^i$ in the vector of portfolio weights represents the fund's participation in assets other than domestic stocks (i.e. domestic corporate debt and government debt). For each PFA $i = 1, 2, \dots, 6$, the average peer fund portfolio has weights denoted by the vector $\pi_t^i = \frac{1}{5} \sum_{-i} w_t^i$, where $\sum_{-i}$ is the sum of all funds excluding fund i .

[Insert Figure 1 about here]

To measure a fund's trading strategy, or its change in portfolio weights, I first adjust for passive portfolio evolution due to changes in prices. Including changes in weights due to price changes may overstate the degree of coordination among funds. If the gross return of stock s between period t and $t+1$ is defined as ret_{st} , the adjusted vector of weight changes for fund i from t to $t+1$ can be denoted Δw_t^i , where each element s is defined by $\Delta w_{st}^i = w_{st+1}^i - \frac{w_{st}^i \times ret_{st}}{\sum_s w_{st}^i \times ret_{st}}$. The last term accounts for the change in the weights due to differences in returns among stocks in the portfolio. To measure the position of fund i 's portfolio relative to its peers at period t , I calculate a vector of differences between the fund and its competitors, $d_t^i = \pi_t^i - w_t^i$. To capture the direction of portfolio weight changes, I measure the angle between the change of a PFA's weights and the distance from its peers' portfolio, as follows:

$$\text{direction}_t^i = \cos(\theta) = \frac{\Delta w_t^i \cdot d_t^i}{\|\Delta w_t^i\| \|d_t^i\|} \quad (1)$$

In this specification, *direction* measures the correlation across securities between portfolio weight changes for fund i and the initial distance between i and its peers.⁸ If fund i is moving exactly towards its peers, the angle is zero and direction is equal to 1. If the manager is rebalancing the portfolio in exactly the opposite direction of its peers, the angle is 180 degrees and the direction measure equals -1.

Figure 1 displays two examples of the angle between the vector of weight changes for fund manager i and the vector of initial distance between i and the other managers. This figure assumes that there are three securities; given that the portfolio weights add up to one, the third dimension is redundant. Initially, the peer portfolio π_t^i has a larger share of stock A than manager i . In panel (a) the manager

⁸A similar measure of direction was first introduced by Koch (2012). Here I define the angle between the active change in weights and the initial distance to the peer benchmark, as opposed to the angle between the active change in weights and the peer benchmark active change in weights as in Koch (2012).

increases her participation in stock A, moving towards peers. In panel (b) the manager increases her participation in stock B, moving away from the peer portfolio.

If there is a constraint on short selling, the space becomes a Simplex of portfolio weights and the measure would be naturally biased towards higher values of *direction*. For example, if fund i is currently invested only in stock B, it is located along the vertical axis, and the only way to continue to move away from its competitors would be to move along the axis, in which case the angle would be smaller than 180 degrees and *direction* would be greater than -1. In this example, moving away from one's peers would mean buying more of what you already own, as opposed to short selling securities in which your peers have larger weights.

[Insert Figure 2 about here]

Figure 2 depicts the time series behavior of the measure of direction for both pension funds and voluntary funds. For each month in the sample, I calculate the direction of weight changes for each PFA over the next quarter, and take the average across PFAs. A high value indicates that PFAs on average are moving towards their peers. Evidently, for the pension funds, PFAs on average traded more in the direction of their peers prior to the MRG formula change in June 2007 than after this date. For the voluntary funds, the behavior of direction seems to be same before and after the policy change.

[Insert Table 2 about here]

Table 2 presents summary statistics on *direction*. The statistics are split for the period before and after the change in the MRG. For the pension funds, mean direction fell from 0.32 in the early period to 0.14 after the change in the MRG, suggesting that the policy change may have affected managers' behavior.

Table 2 also reports statistics on the relative performance between pension funds before and after the MRG change. Relative performance with respect to the peer portfolio is defined as $rel_t^i = R_t^i - R_t^{-i}$, where R_t are 36 month returns prior to t (consistent with the measurement period of the MRG). The relative performance variable rel_t^i measures whether fund i is over-performing ($rel_t^i > 0$) or under-performing ($rel_t^i < 0$) at time t relative to the other managers. After June 2007, there seems to be some increase in the cross-section dispersion of PFA returns. If portfolios are less alike, returns are likely to vary more cross-sectionally.

A separate question is whether managers' strategies depend on relative performance. Panel C in Table 2 presents the correlation between $direction_{it}$ and rel_t^i . The negative correlation between relative

performance and *direction* indicates that before June 2007, PFAs with poor relative performance tended to move more strongly towards peers. After June 2007 there is no evidence that relative performance is correlated with the direction of trades.

To summarize, the loosening in the MRG in June 2007 is associated with three important changes in the data for pension funds: **(F1)** less trading in the direction of peers; **(F2)** increase in cross-section dispersion of returns between funds; and **(F3)** a disappearance of the negative correlation between relative performance and trading in the direction of peers.

3.3. Individual Stocks and Trading Strategies

In this section I further investigate herding behavior using data on individual stock trades. For each stock, the fund's distance to the peer benchmark is measured as $d_{st}^i = \pi_{st}^i - w_{st}^i$, where the fund can be overexposed ($d_{st}^i < 0$), underexposed ($d_{st}^i > 0$) or have the same weight ($d_{st}^i = 0$) as its peers. I estimate the following model of a fund's changes in individual stock weights:

$$\Delta w_{st}^i = \beta_0 + \sum_{m=1}^M \beta_m x_{st}^i + \gamma_0 MRG_t + \sum_{m=1}^M \gamma_m MRG_t \cdot x_{st}^i \quad (2)$$

where Δw_{st}^i is adjusted for stock returns as in the previous section, x_{st}^i are fund and stock specific characteristics and MRG_t is a time dummy equal to one for dates before July 2007 and zero thereafter, representing the policy change. The objective here is twofold, first to determine what fund based characteristics determine PFA trading on individual stocks, and second to measure whether there was any change in the impact of these characteristics after the MRG formula was modified.

More specifically, I set $x_{st}^i = (d_{st}^i, rel_t^i, d_{st}^i \times rel_t^i, size_t^i, Controls_{st}, Market_{st}^i)$. Here $size_t^i$ is the share of assets under management of fund i relative to the industry. The vector of $Controls_{st}$ contains stock specific variables. I introduce lagged returns at one, three, six and twelve months to account for momentum trading, defined as purchasing (selling) assets with positive (negative) past returns.⁹ This popular investment strategy has been widely documented for institutional investors.¹⁰ [Chan et al. \(1996\)](#) suggest that momentum trading may be caused by a delayed reaction of investors to the information in past returns and past earnings. I also control for firm size and liquidity, as institutional investors may share an aversion to stocks with certain characteristics, as documented by [Wermers \(1999\)](#), who found evidence that US mutual funds tend to herd in small stocks.

⁹Selling past losers can also be explained by window dressing. For US pension funds see [Lakonishok et al. \(1991\)](#)

¹⁰See [Grinblatt et al. \(1995\)](#), [Grinblatt and Keloharju \(2000\)](#) among many others. [Raddatz and Schmukler \(2013\)](#) also document the presence of momentum trading for Chilean PFAs

Finally, to verify that the results are driven by managers trading relative to their peers and not by trading relative to a broad market benchmark, I calculate *Market Distance* as the difference between the IGBC index weight on stock s and fund i 's weight in stock s for each period, $Market_{st}^i = \Pi_{st}^{IGBC} - w_{st}^i$. The IGBC is a widely used value and liquidity based index for the Colombian stock market. I also interact this measure with relative performance.

This previous specification is motivated by [Basak et al. \(2007\)](#), who find different behavior in U.S. equity mutual funds depending on whether managers are ahead or behind the S&P 500 index. In their specification, the authors define *risk shifting* as an increase in the absolute difference between a fund's returns and the S&P 500 returns. They regress this variable on an interaction between current relative returns and the market returns. Their question is whether underperforming funds move towards or away from the market index, thereby increasing or decreasing the size of deviations from market returns. My specification is analogous to theirs, in that one of my objectives is to measure whether underperforming funds move towards or away from a reference portfolio, the peers' portfolio (**F3**), by increasing or decreasing their holdings of stocks in which they are underexposed or overexposed. Note that while [Basak et al. \(2007\)](#) only observe return outcomes, I observe portfolio weights and thus the actual strategy of the manager. In a setting with a small number of managers it might be hard to distinguish if changes in the cross-section dispersion of returns are due to managers' strategies or to the realization of stock returns.

[Insert Table 3 about here]

Table 3 documents the results of the linear regression for adjusted weight changes Δw_{st}^i . The results suggest that regardless of relative performance, managers were more likely to increase their holdings of stocks in which they were already overexposed after the MRG was loosened in June 2007 than before this date. That is, there was less trading towards peers once the MRG was loosened. This change in behavior associated with the change in regulation is consistent with the average behavior of trading direction presented in Figure 2 and Table 2.

Figure 3 presents differences in marginal effects of *distance* on adjustments in portfolio weights before and after the policy change $\left(\frac{\partial \Delta w(MRG=1)}{\partial d} - \frac{\partial \Delta w(MRG=0)}{\partial d} \right)$ along with corresponding confidence intervals. Underperforming managers ($rel < 0$) were more likely to increase their holdings of stocks in which they were underexposed ($d > 0$) prior to June 2007 than after this date. This result for individual stocks is consistent with the decrease after June 2007 in the correlation between direction and relative performance documented in Table 2-Panel C. To give a sense of the quantitative importance of these estimates, the

results indicate that a fund lagging in returns by 200bps relative to its peers, and with 5% underexposure in an individual stock s , would increase the weight on s by 0.89% more prior to June 2007 than after the MRG was loosened.

[Insert Figure 3 about here]

For high performing managers (with relative returns above 182bps in figure 3), the estimated marginal effects on *distance* are negative but not statistically significant. That is, there is no evidence that the change in the strictness of the penalty affected the way top-performing managers traded stocks with overexposure, perhaps because the MRG impacts more strongly the average and worst-performing managers. Top-performing managers, unconstrained by the MRG, might deviate from the peer portfolio to possibly attract more funds. However, as the results indicate, the MRG policy change does not seem appropriate to identify the effects of such incentives for managers in the high end of the return spectrum.

The second column at Table 3 adds variables including distance from the market portfolio to the benchmark specification. These variables are insignificant both before and after the MRG policy change. This suggests that managers' trading strategies are sensitive to the position relative to their PFA peers in particular, rather than to their position relative to the market portfolio.

3.3.1. Buy and Sell Strategies

In a final empirical exercise, I complement the above results by distinguishing buys and sells of individual stocks. This is a discrete version of the previous specification. Here, fund i 's trading strategy for a particular stock s is measured by whether the fund buys or sells the stock prior to the following period:

$$(buy_{st}^i, sell_{st}^i) = \begin{cases} (1, 0) & shares_{st+1}^i > shares_{st}^i \\ (0, 1) & shares_{st+1}^i < shares_{st}^i \\ (0, 0) & shares_{st+1}^i = shares_{st}^i \end{cases}$$

corrected for stock splits at period t . In this setting, the analog to the direction measure introduced before is as follows: When a fund buys shares in stocks in which it is already overexposed (underexposed), it moves away from (towards) the peer benchmark. When a fund sells shares in stocks in which it is already overexposed (underexposed), it moves towards (away from) the peer benchmark.

Panel B in Table 1 shows some trading statistics for different months within the data set. For example, in June 2008, PFAs collectively held 44 different stocks and each fund on average had 26.3 stocks in its

portfolio. That month, each PFA traded on average 8.33 stocks, with 6.66 of those trades as buys. In this setting a trading strategy is measured by the probability at time t that fund i buys or sells stock s within the set of stocks owned by all PFAs (i.e. the probability of fund i buying stock s from among the 44 total stocks is the likelihood that s was among the 6.6 stocks that fund i bought that period).

Note on Short Selling: As was the case for the direction measure discussed in the previous section, the short selling ban for these funds introduces a bias against using sales to move away from peers. Consider the previous example. The average PFA sold 1.67 stocks during June 2008. Given the short selling constraint, those sells must come from the set of stocks owned in the previous month (25.8 as of May 31, 2007) not from the total set of stocks held by the PFA industry (44 as of May 31, 2007). Hence, a measure of the probability of selling a stock that considers the entire set of securities is naturally biased towards smaller values, as opposed to a measure of the probability of buying a stock since a fund can buy any stock in the peer portfolio whether owned at the beginning of the period or not. For this reason I examine buying and selling strategies separately in what follows. Moreover, when estimating the probability of selling a stock, I condition on stock ownership at the beginning of the previous period.

I estimate a Probit specification of the probability of buying ($y = buy$) or selling ($y = sell$) a stock as $Pr(y_{st}^i = 1) = \Phi(\beta_0 + \sum_m \beta_m x_{st}^i + \sum_m \gamma_m MRG_t \cdot x_{st}^i)$, where Φ is the cumulative distribution function of the standard normal, and the vector of independent variables x is the same as in equation (2).

[Insert Table 4 about here]

Columns one and two of Table 4 document the results of the Probit regression for the probability of buying a stock (buy_{st}^i). Consistent with the results in the continuous regression, managers were more likely to buy stocks in which they were already overexposed after the MRG was loosened in June 2007 than before. Meanwhile, an underperforming manager ($rel < 0$) was more likely to buy stocks in which she was underexposed ($d > 0$) prior to June 2007 than after this date. Columns three and four of Table 4 present the results from the Probit regression for the probability of selling a stock ($sell_{st}^i$) conditional on stock ownership. The coefficients on the interactions between MRG, Peer Distance and Relative Performance are all indistinguishable from zero, suggesting that the policy change in June 2007 had no impact on how PFAs sold stocks in which they were overexposed, regardless of relative performance. Given that between 2004 and 2010 the yearly net flows to these funds were about 8.5% of the value of the fund, underperforming managers had the option of reducing their relative participation in any given stock by holding their number of shares constant, as opposed to selling shares.

To summarize the main empirical findings, the evidence suggests that a more strict MRG prior to June 2007 is associated with more trading in the direction of peers, and in particular more buying of stocks in which managers were underexposed. Meanwhile, underperforming managers traded more heavily towards the peer portfolio prior to June 2007, by buying stocks in which they were underexposed, as opposed to selling stocks in which they were overexposed. This asymmetric behavior between buys and sells could be explained by the fact that these funds were growing within the sample period.

3.4. Alternative Explanations

The specification strategy above assumes that the policy change is exogenous to the domestic stocks' return process. In the estimation I control for stock-specific attributes such as past returns and trading volume. However, one cannot control for all stock characteristics that might have changed after July 2007 and that might have induced the funds to adjust their trading behavior. For example, PFAs might have received more good signals about the fundamentals of stocks in which they were underexposed prior to July 2007 than after, inducing them to buy more of those stocks before the policy change than after. The shortcoming of this argument is that if a PFA is underexposed in a particular stock relative to the peer portfolio, by construction there must be at least one PFA overexposed in the same stock. As favorable new information arrives about a stock, both underexposed and overexposed PFAs should increase their holdings. Hence, one would need some sort of argument for why PFAs with underexposure were the only ones receiving good signals.

Another possible explanation for the results is that PFAs altered their trading strategies due to managerial changes around the time of the policy change. For example, trading strategies might result from changes in management within the firms or shifts in preferences among the top investment officials. A closer look at PFAs' CEO replacement indicates that, while there were some changes in management over the sample period, there is no evidence of an industry wide event before or after the MRG adjustment.¹¹ In terms of preference shocks, interactions between PFAs dummies and the MRG dummy should account for individual PFA changes before and after the policy experiment. However, an industry wide taste shock occurring in mid 2007 would be indistinguishable from the policy experiment. While such event is unlikely, it cannot be ruled out under the current empirical specification.

¹¹According to ASOFONDOS, four of the six PFAs had only one CEO replacement each during the sample period, occurring on the following dates: October 2006, February 2008, October 2008 and May 2010. The other two PFAs changed their CEO four times each between January 2004 and December 2010.

4. Conclusions

In this paper I study portfolio choices of strategic fund managers in the presence of a peer-based underperformance penalty. The penalty generates herding behavior, and the extent of correlated trading is exacerbated when a strategic setting is considered.

I document empirical evidence suggesting strategic behavior of asset managers when facing a peer-based underperformance penalty. The evidence is taken from the Colombian pension industry, where six Pension Fund Administrators compete to manage the saving accounts of the working population, and are subject to a Minimum Return Guarantee based on peer performance. The evidence suggests that a tighter MRG is associated with more trading in the direction of peers and a smaller cross-section dispersion of returns between pension funds. Moreover, the ranking among managers in terms of performance seems to affect how PFAs rebalance their portfolio. When the MRG is tight, underperforming managers are more likely than their competitors to trade in the direction of their peers; this is not true when the MRG is slack. Underperforming managers rebalance their portfolio by buying more heavily stocks in which the manager is underexposed relative to her peers, as opposed to selling stocks in which she is overexposed. Since these pension funds were in an accumulation stage during the sample period, with new flows accounting for an average of 8.5% the value of the fund each year, managers were presumably able to reduce their participation in stocks to which they were overexposed simply by maintaining a fixed number of shares.

There is an interesting time dimension that is not studied in this paper: managers' behavior close to the MRG evaluation date. Unfortunately, since the data provided was for monthly portfolio holdings, same as the MRG evaluation period, I cannot study whether PFAs altered their trading strategies by the end of the month. This is an important analysis but it requires access to portfolio data at higher frequencies.

Finally, given the size of the pension fund industry, regulatory constraints such as the MRG in Colombia or other implicit forms of compensation based on peer performance among managers, might have important asset price implications. For example, if the size of the portfolio rebalancing due to peer effects is large enough, such rebalancing could generate abnormal stock returns or perhaps affect the correlation between stock returns. Such analysis is left for future work.

References

- Agarwal, V., N. Daniel, and N. Naik**, “Performance and managerial incentives in hedge funds,” *Workin Paper, London Business School*, 2004.
- Basak, S., A. Pavlova, and A. Shapiro**, “Optimal asset allocation and risk shifting in money management,” *Review of Financial Studies*, 2007, 20.
- Bikhchandani, S., D. Hirshleifer, and I. Welch**, “A theory of fads, fashion, custom, and cultural change as informational cascades,” *Journal of Political Economy*, 1992, 100 (5), 992–1026.
- Castaneda, P. and H. Rudolph**, “Portfolio Choice, Minimum Return Guarantees, and Competition in DC Pension Systems,” *In: Hinz, R., Rudolph, H., Antolin, P., and J. Yermo (eds.). Evaluating the Financial Performance of Pension Funds. The World Bank.*, 2010.
- Chan, Louis K.C., N. Jegadeesh, and J. Lakonishok**, “Momentum Strategies,” *Journal of Finance*, 1996, 51 (5), 1681–1713.
- Chevalier, J. and G. Ellison**, “Risk taking by mutual funds as a response to incentives,” *Journal of Political Economy*, 1997, 105.
- Grinblatt, M. and M. Keloharju**, “The investment behavior and performance of various investor types: a study of Finland’s unique data set,” *Journal of Financial Economics*, 2000, 55 (1), 43–67.
- , **S. Titman, and R. Wermers**, “Momentum investment strategies, portfolio performance, and herding: A study of mutual fund behavior,” *American Economic Review*, 1995, 85 (5), 1088–1105.
- Hirshleifer, D., A. Subrahmanyam, and S. Titman**, “Security analysis and trading patterns when some investors receive information before others,” *Journal of Finance*, 1994, 49 (5), 1665–1698.
- Jans, R. and R. Otten**, “Tournaments in the UK mutual fund industry,” *Managerial Finance*, 2008, 34 (11), 786–798.
- Kempf, A. and S. Ruenzi**, “Tournaments in Mutual-Fund Families,” *Review of Financial Studies*, 2008, 21.
- Koch, A.**, “Herd behavior and Mutual fund performance,” *Working Paper, University of Pittsburgh*, 2012.

- Lakonishok, J., A. Shleifer, and R.W. Vishny**, “The impact of institutional trading on stock prices,” *Journal of Financial Economics*, 1992, *32* (1), 23–43.
- , – , **R. Thaler, and R.W. Vishny**, “Window dressing by pension fund managers,” *American Economic Review*, 1991, *81* (2), 227–231.
- Raddatz, C. and S.L. Schmukler**, “Deconstructing herding: Evidence from pension fund investment behavior,” *Journal of Financial Services Research*, 2013, *43* (1), 99–126.
- Scharfstein, D. and J. Stein**, “Herd behavior and investment,” *American Economic Review*, 1990, *80* (3), 465–479.
- Sias, R.W.**, “Institutional herding,” *Review of Financial Studies*, 2004, *17* (1), 165–206.
- Taylor, J.**, “Risk-taking behavior in mutual fund tournaments,” *Journal of Economic Behaviour and Organization*, 2003, *50* (3), 373–383.
- Turner, J.A. and D.M. Rajnes**, “Rate of return guarantees for mandatory defined contribution plans,” *International Social Security Review*, 2001, *54* (4), 49–66.
- Wermers, R.**, “Mutual fund herding and the impact on stock prices,” *Journal of Finance*, 1999, *54* (2), 581–622.

A. Appendix: Tables

Table 1

Summary Statistics for Colombian Pension Funds and Voluntary Fund Holdings

Key statistics are provided below (at two-year intervals) for the Colombian pension funds and voluntary funds. For each column, statistics are shown for the portfolios reported by June 30 of each year, except as noted. The database, made available by the Association of Pension Fund Administrators (ASOFONDOS), includes monthly portfolio holdings of each security in every pension fund and voluntary fund from January 31, 2004 to December 31, 2010. Panel A documents the total number of funds, the total assets under management and the share invested in stocks traded publicly in the domestic capital market. Panel B shows the average number of stocks held per fund at each date, the number of different stocks held by all six pension funds as a group and the number of stocks in the IGBC index, which is a major stock index for the Colombian stock market. Panel B also provides trading data, inferred from the difference in portfolio holding between May 31 and June 30 of each year. Panel C shows key statistics on relative performance between funds and portfolio differences between each fund and the peer portfolio and between each fund and the market portfolio. Relative performance is measured as the difference between the peer returns and individual fund returns, for annual returns measured over a three year rolling window. Distance measures a fund's exposure to each stock relative to the benchmark: $d_{st}^i = \pi_{st}^i - w_{st}^i$. Panels D and E present key statistics for voluntary funds.

	Year			
	2004	2006	2008	2010
Panel A. Pension Fund Count, Assets and Asset Allocation				
Number of funds	6	6	6	6
Total assets (\$billions)	8.2	13.8	27.8	44.1
Net flows (contributions minus withdraws \$billions)	0.8	1.5	2.4	1.7
Percent invested in domestic stocks	5.0	12.6	22.4	32.1
Largest fund share (percentage over the pension industry)	27.1	26.6	27.2	27.2
Smallest fund share (percentage over the pension industry)	2.9	3.8	4.5	4.8
Panel B. Pension Funds Domestic Stock Count and Trading Statistics				
Average number of stocks held per fund	16.2	21.2	26.3	30.0
Number of distinct stocks held by all pension funds	41	50	44	47
Number of stocks in the market index	26	33	27	32
Average stocks traded per fund	7.2	5.2	8.3	7.0
Proportion of trades that are buy (percent)	65.1	61.3	80.0	54.8
Total buys (\$millions)	14.1	20.3	82.7	50.7
Total sells (\$millions)	4.5	16.3	23.9	80.0
Average yearly sells (percentage of sell volume over total trades)	27.4	25.4	29.2	65.4
Panel C. Pension Funds Performance and Portfolio Differences (standard deviation in parenthesis)				
Average relative returns (percent)	-0.10 (0.49)	0.13 (0.79)	0.27 (1.30)	0.29 (1.30)
Average peer distance (percent)	0.02 (3.83)	0.00 (2.01)	0.00 (1.23)	0.00 (2.09)
Average market distance (percent)	0.06 (5.39)	0.00 (3.10)	-0.00 (2.94)	0.00 (3.08)
Panel D. Voluntary Funds Count, Assets and Asset Allocation				
Total assets (\$billions)	1.2	2.1	4.8	4.3
Percent invested in domestic stocks	1.8	4.5	9.2	14.5
Largest fund share (percentage over the pension industry)	38.1	28.0	47.0	36.1
Smallest fund share (percentage over the pension industry)	1.9	3.5	2.1	4.7
Panel E. Voluntary Funds Domestic Stock Count and Trading Statistics				
Average number of stocks held per fund	5.2	13.8	17.8	20.3
Number of distinct stocks held by all pension funds	23	30	36	34
Average stocks traded per fund	0.8	6.5	10.2	12.8
Proportion of trades that are buy (percent)	79.5	38.5	39.4	59.2
Total buys (\$millions)	1.9	10.9	12.8	34.3
Total sells (\$millions)	0.5	7.75	32.9	77.8
Average yearly sells (percentage of sell volume over total trades)	19.8	41.5	71.9	69.4

Table 2
Direction of portfolio weight changes

The direction measure, $direction_t^i$, for a given fund i at some month t equals $\frac{\Delta w_t^i d_t^i}{||\Delta w_t^i|| ||d_t^i||}$, where Δw_t^i is the active change in portfolio weights between t and $t + 1$ adjusted by stock individual returns. d_t^i is the distance in month t between fund i 's portfolio and the peer portfolio. Statistics are calculated for measures of direction across funds ($direction_t^i$). Direction captures whether each fund is moving towards or away from the peer benchmark.

	Mean	Median	Min	Max	std dev
Panel A. Statistics for Direction					
Pension Funds					
Before June 2007	0.32	0.32	-0.21	0.71	0.19
After June 2007	0.14	0.16	-0.68	0.50	0.18
Voluntary Funds					
Before June 2007	0.13	0.10	-0.73	0.99	0.38
After June 2007	0.13	0.16	-0.93	0.96	0.42
Panel B. Statistics for Pension Funds Relative Performance					
Relative Returns (in bps)					
Before June 2007	0.07	0.13	-3.63	3.71	1.29
After June 2007	-0.07	-0.35	-4.98	5.45	1.86
Panel C. Correlation between Direction and Relative Performance for Pension Funds					
Before June 2007 = -0.31***					
After June 2007 = 0.08					

Table 3

Linear Regression for Adjusted Weight Changes

The dependent variable is the change in weight Δw_{st+1}^i for stock s between period t and $t + 1$ for fund i adjusted by the stock returns as follows: $\Delta w_{st+1}^i = w_{st+1}^i - \frac{w_{st}^i \times ret_{st}}{\sum_s w_{st}^i \times ret_{st}}$, where ret_{st} are the gross returns for stock s between t and $t + 1$. The unit of observation is a month. “MRG” is a dummy variable, equal to one for dates prior June 2007 and zero thereafter. “Peer (Market) Distance” is the difference between the weight of stock s in the peer (market) portfolio and the weight of s in fund i ’s portfolio. The market portfolio is the IGBC, a major index in the Colombian stock market. “Relative Performance” is the difference in returns between manager i and the overall pension industry, measured over the previous 36 months for each date. “Size” is the share of assets under management of pension fund i as a percentage of the entire pension industry. Standard errors are in parenthesis. Note: ***/**/* indicate that the coefficient estimates are significantly different from zero at the 1%/5%/10% level.

Dependent variable	(1)	(2)
MRG x Peer Distance	0.0599** (0.0250)	0.0867*** (0.0257)
MRG x Relative Performance	0.0598 (0.0479)	0.0547 (0.0478)
MRG x Peer Distance x Relative Performance	-4.1280*** (1.2137)	-4.6414*** (1.4519)
MRG x Size	-0.0058 (0.0110)	-0.0040 (0.0110)
MRG x Size x Peer Distance	0.0774 (0.1414)	0.1234 (0.1412)
MRG	0.0011 (0.0008)	0.0011 (0.0008)
Peer Distance	-0.0195 (0.0231)	-0.0183 (0.0235)
Relative Performance	-0.0270 (0.0377)	-0.0255 (0.0376)
Peer Distance x Relative Performance	4.2870*** (1.1573)	4.8586*** (1.3222)
Size	0.0074 (0.0088)	0.0074 (0.0088)
Size x Peer Distance	0.0961 (0.1306)	0.0989 (0.1302)
MRG x Market Distance		-0.0396 (0.076)
MRG x Market Distance x Relative Performance		1.0673 (0.7078)
Market Distance		-0.0134*** (0.0048)
Market Distance x Relative Performance		-0.4948 (0.5700)
Constant	-0.0014** (0.0006)	-0.0014** (0.0006)
Controls	yes	yes
Pension fund fixed effects	YES	YES
Number of observations	18960	18960

Table 4
Probit Regression of Buying or Selling a Stock

The dependent variable is the dummy variable buy_{st+1}^i or $sell_{st+1}^i$, which indicates whether a given fund i in period $t + 1$ increases or decreases the number of shares in stock s . The unit of observation is a month. “MRG” is a dummy variable equal to one for dates prior June 2007 and zero thereafter. “Peer (Market) Distance” is the difference between the weight of stock s in the peer (market) portfolio and the weight of s in fund i ’s portfolio. The market portfolio is the IGBC, a major index in the Colombian stock market. “Relative Performance” is the difference in returns between manager i and the overall pension industry, measured over the previous 36 months for each date. “Size” is the share of assets under management of pension fund i as a percentage of the entire pension industry. Standard errors are in parenthesis. Note: ***/**/* indicate that the coefficient estimates are significantly different from zero at the 1%/5%/10% level.

Dependent variable	Probability of buying a stock		Probability of selling a stock conditional on stock ownership	
	(1)	(2)	(3)	(4)
MRG x Peer Distance	54.52*** (15.99)	59.13*** (16.78)	-25.85 (21.76)	-16.16 (22.62)
MRG x Relative Performance	13.40*** (4.52)	13.97*** (4.53)	2.59 (5.78)	3.26 (5.79)
MRG x Peer Distance x Relative Performance	-2693.39*** (605.10)	-3230.73*** (889.02)	475.88 (597.18)	-948.96 (999.69)
MRG x Size	2.23*** (0.82)	2.19*** (0.82)	5.25** (2.35)	5.24** (2.35)
MRG x Size x Peer Distance	-239.79*** (87.55)	-243.95*** (87.96)	66.18 (112.49)	62.56 (112.64)
MRG	-0.02 (0.03)	-0.03 (0.03)	-0.26*** (0.03)	-0.26*** (0.03)
Peer Distance	-26.65*** (7.68)	-26.42*** (7.84)	-70.00*** (10.17)	-72.49*** (10.37)
Relative Performance	-12.35*** (3.28)	-12.20*** (3.28)	-6.16 (3.84)	-6.18 (3.85)
Peer Distance x Relative Performance	1444.90*** (502.71)	1077.75* (557.29)	-777.43* (455.33)	-696.76 (518.89)
Size	-4.35*** (0.50)	-4.34*** (0.50)	-6.52*** (1.56)	-6.55*** (1.56)
Size x Peer Distance	77.59* (43.62)	76.15* (43.58)	287.68*** (52.50)	289.21*** (52.58)
MRG x Market Distance		-13.66 (8.35)		-15.55 (9.84)
MRG x Market Distance x Relative Performance		503.32 (586.81)		823.02 (717.23)
Market Distance		0.10 (1.66)		2.12 (1.73)
Market Distance x Relative Performance		375.87 (236.87)		-74.64 (232.74)
Constant	238.14*** (29.27)	238.25*** (29.28)	-130.57*** (35.21)	-130.61*** (35.23)
Pension fund fixed effects	YES	YES	YES	YES
Number of observations	18960	18960	11299	11299

B. Appendix: Figures

Figure 1. Economy with three assets. This figure presents two examples of changes in the portfolio composition in the space of weights for stocks A and B. The portfolio of fund i moves from w_t^i to $w_t^i + \Delta w_t^i$. The distance vector is $d_t^i = \Pi_t^i - w_t^i$, which represents the initial difference between fund i and the peer portfolio at the beginning of the period t . θ is the angle formed between the change in the portfolio of manager i and the distance vector. Direction is defined as $\cos \theta$. When manager i moves towards the peer portfolio, θ is smaller and direction is closer to 1, as in panel (a). In panel (b) the manager moves away from the peer benchmark and direction takes smaller values as the angle increases.

Figure 2. Average direction of portfolio change. The direction measure, $direction_t^i$, for a given fund i at some month t equals $\frac{\Delta w_t^i d_t^i}{||\Delta w_t^i|| ||d_t^i||}$, where Δw_t^i is the active change in portfolio weights between t and $t + 1$ adjusted by stock individual returns. d_t^i is the distance between fund i 's portfolio and the peer portfolio as of month t . The figure reports the monthly value of direction averaged across the six PFAs, for pension funds (solid line) and voluntary funds (dotted line).

Figure 3. Marginal effects. Difference in marginal effects of *distance* on adjustments in portfolios weights before and after the policy change $\frac{\partial \Delta w(MRG=1)}{\partial d} - \frac{\partial \Delta w(MRG=0)}{\partial d}$ with 95% confidence intervals.