Essays on Mutual Funds and their Impact on Financial Stability

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Abstract

This dissertation consists of two chapters that explore some of the financial stability issues that concern mutual funds. The first chapter demonstrates that the massive sale by US funds of Mexican equity in 2008 triggered the underpricing of US-fund-held Mexican stocks. Mexican funds that also owned these stocks joined the US funds in selling, while those that did not bought them. Ultimately, I find that the Mexican fund purchases counterbalanced the price pressure from US funds, while the sales exacerbated stock mispricing. In the second chapter, I present a novel mechanism by which fund managers can have risk-taking incentives when monetary policy is loose. I develop a model of portfolio allocation with costly information and show that poor fund returns are penalized less by investor outflows when the risk-free rate is lower. I likewise establish that this effect is more pronounced for funds with higher information costs. Using the Federal funds rate as the riskless rate and fund age as a proxy for information costs, I provide empirical support for these predictions.

Resumen

Esta tesis consta de dos capítulos que estudian algunos de los aspectos de estabilidad financiera que afectan a los fondos de inversión. El primer capítulo muestra cómo la gran venta de acciones mexicanas por parte de los fondos estadounidenses en 2008 desencadenó la subvaloración de las acciones mexicanas que tenían en propiedad los fondos estadounidenses. Los fondos mexicanos que tenían estas acciones también las vendieron, mientras que los fondos que no las tenían las compraron. Como consecuencia, encuentro que las compras de los fondos mexicanos contrarrestaron la presión sobre los precios ocasionada por los fondos de EE.UU., mientras que las ventas agravaron la infravaloración de las acciones. En el segundo capítulo, presento un mecanismo novedoso por el cual los gestores de fondos pueden tener incentivos para asumir riesgo cuando la política monetaria está relajada. Desarrollo un modelo de asignación de cartera con información costosa y muestro que el rendimiento bajo de un fondo resulta menos castigado por la salida de los inversionistas cuando la tasa libre de riesgo es menor. También establezco que este efecto es más pronunciado para los fondos con mayor coste de información. Utilizando la tasa de fondos federales como la tasa sin riesgo y la edad del fondo como un indicador del coste de información, aporto evidencia empírica de las predicciones del modelo.

Preface

Mutual funds, which are portfolios of assets owned by shareholders but whose purchase and sale decisions are delegated to a fund manager, have enjoyed rising popularity as an investment vehicle in recent years. Together with the industry's expansion in size, mutual funds have garnered a greater share of the business of financial intermediation; their holdings of stocks and bonds have steadily grown, transforming them into an important source of funding for firms and governments alike.

In light of the increasingly significant role mutual funds play in the financial system, policymakers have become concerned about the potential contribution of these institutional investors to systemic risk. For one, coordinated sell-offs of the assets owned by mutual funds can lead to a decline in prices and to a disruption to financial markets. Fire sales of fund holdings have been attributed in the literature to substantial shareholder outflows or to an anticipation of such an episode. Since investors of mutual funds can always redeem their shares at the prevailing net asset value at any time, a fund may need to sell its assets to satisfy redemptions when a large number of shareholders choose to exit the fund. If many mutual funds unload their portfolio positions simultaneously, the resulting selling pressure can facilitate the collapse of asset prices.

Another problem that has been pointed out is that the sensitivity of shareholder flows to fund performance can serve as an implicit incentive scheme that encourages fund managers to take more risks. Studies have found that the flow-performance relationship is convex, that is, shareholders react more to good fund returns than to bad fund returns. Because most managers receive compensation as a percentage of fund assets, the tendency of shareholders to punish bad performance less than they reward good performance may motivate the fund manager to invest in assets that offer superior returns in exchange for higher risk.

The objective of this doctoral dissertation is to advance the understanding of these two issues that relate to the consequences of the rapidly developing mutual fund sector for financial stability. The first chapter, entitled "The Domestic Transmission of International Shocks: Evidence from US and Mexican Mutual Funds," shows that the negative effect on prices of mutual funds' asset sales can cross national borders. In particular, I demonstrate that international mutual funds (i.e., those mutual funds that invest in foreign securities) can cause temporary stock price deviations from fundamentals in the country they have positions in. The setting of the study's empirical investigation is the sale by US mutual funds of 26% of the Mexican equity they held in their portfolios when the crisis was developing in the second quarter of 2008. I find that, on average, Mexican stocks that were most exposed to this US fund sale experienced abnormal returns in the following year that were 27% less than those of the least exposed stocks.

It is not obvious why this is the case even though there are other domestic investors in Mexico who could, in theory, take advantage of this mispricing, buy the undervalued stocks, and in the process thwart the divergence of stock prices from fundamental values. The first chapter continues and explores this seeming anomaly by further considering the trades implemented by Mexican mutual funds in the wake of the US fund sale. I establish that Mexican funds that owned the most exposed stocks joined the US funds in selling, while those that did not bought the undervalued Mexican stocks. This trading pattern is consistent with Mexican funds' fear of poor fund returns, which usually precipitates a substantial outflow from shareholders. Funds that had a bigger portion of their portfolios invested in the exposed stocks foresaw a possible deterioration of performance and, hence, rebalanced their holdings away from these stocks. On the other hand, Mexican funds that held little of the exposed stocks loaded on the stocks that were temporarily cheap as they were not expecting a shareholder exit.

I conclude this part of the dissertation by providing evidence that the investment decisions of Mexican mutual funds likewise had an impact on Mexican equity prices. I obtain that there was heterogeneity in the negative price impact of the US fund sale on affected Mexican stocks. In particular, exposed stocks that were not in the portfolios of selling Mexican funds were in fact not subject to (a statistically significant) undervaluation, while those that were had abnormal returns that were 34% less than the least exposed stocks. It appears that the purchases by some

Mexican funds were successful in counterbalancing the pressure from US funds, while the sales by others exacerbated the mispricing. The empirical exercise suggests that had Mexican funds not been exposed to the US fund sale through their Mexican stock holdings, they all could have traded to correct the distortion in prices and no negative repercussion of the fire sales could have materialized.

In the second chapter, entitled "Monetary Policy and the Flow-performance Relationship of Mutual Funds," I examine how shareholder flows are influenced by the monetary policy stance of the central bank. The Federal Reserve, as a response to less dynamic economic activity after the financial crisis of 2008, cut short-term interest rates down to zero. From a financial stability standpoint, concerns were raised as very low returns from safe assets have been shown to promote the search for yield and excessive risk-taking by investors. This chapter of the dissertation highlights a novel mechanism by which open-end mutual funds can be incentivized to invest in riskier assets when interest rates are low; I demonstrate that when monetary policy is loosened, mutual fund investor flows increase more for the worst performers than for the best performers. Poor fund returns are thus penalized to a lesser extent when short-term interest rates are lowered, which may then drive fund managers to take more risk.

I start this part of the dissertation by developing a theoretical model based on costly information to explain how shareholder flows are affected by the risk-free rate. In the two-period model, there are risk-averse, borrowing-constrained investors that seek to maximize payoffs at time-2 by choosing a portfolio composed of a riskless asset and a risky mutual fund at time-1. The time-invariant skill of managers to generate returns in excess of a benchmark is unknown to investors, but the fund payoff in period 1, which is a noisy public signal of manager ability, can be used to more precisely estimate the period-2 payoff. Before the realization of the period-1 payoff, investors can also choose to observe a perfect private signal of manager skill. While this resolves all the uncertainty about manager ability, private information acquisition entails a cost.

I solve this model and determine how the investors' optimal information and portfolio choices change with the risk-free rate. First, I show that more private information increases investment if the fund has a low period-1 payoff, while it decreases the shareholders' holdings of the fund if period-1 payoff is high. Without the private signal, investors only have the first-period payoff to infer ability from, so poor past performance leads to minimum (zero) investment, while an excellent period-1 payoff encourages investors to hit their borrowing limit and obtain the maximum ownership of the fund possible. With private information, investment in the fund for these two cases is not too extreme, as low past performance can sometimes come from a fund manager with high ability and vice versa.

Next, I find that there is less private information acquisition if the risk-free rate is increased. A higher return from holding the riskless asset disincentivizes investment in the mutual fund, and hence, discourages the purchase of the private signal.

I advance by establishing the main empirical prediction of the model, which is that a higher risk-free rate diminishes investment in the mutual fund but more so in the lower end of the performance distribution. This outcome is derived from two effects, which I call the *yield effect* and the *information effect*. A better payoff for the riskless asset not only makes the mutual fund less attractive as an investment option (yield effect) but it also curtails the incentives to obtain private information (information effect). The yield effect results in reduced holdings in the fund for all levels of performance. On the other hand, less information makes investors rely more on the public signal, which further decreases investment for bad performance while counteracting the yield effect for good performance.

To improve the identification of the costly information channel of the effect of the risk-free rate on fund flows, I likewise present a cross-sectional implication of the model. I demonstrate that when private information is more expensive, the information effect becomes more pronounced. In particular, increasing the riskless rate lowers investment more for a high-cost fund than for a low-cost fund when period-1 payoff is poor.

I close the second chapter by empirically proving the predictions of the model. I use the effective Federal funds rate as the risk-free interest rate and demonstrate that a 1% increase in the Federal funds rate lessens shareholder flows into the best-performing funds by 0.19% of total assets. The effect on the worst performers is a decrease of 0.26%, with the difference between the two groups being statistically significant. These numbers translate to an average outflow of 2.07 million USD in the higher end of the performance distribution and 2.37 million USD in the lower end. Finally, I use the age of a fund as a proxy for information costs and show that for young funds (i.e., high-cost funds), the decline in flows for superior performance is in fact 0.14% less than for old funds while the reduction in flows for unsatisfactory past returns is greater by 0.14%. That is, for every percent increase in the effective Federal funds rate, the impact of high information costs on young funds is an inflow of almost half a million USD if the fund is one of last month's winners and an outflow of 390 thousand USD if it is one of the losers.

The growth in the mutual fund sector is a welcome development in the evolution of financial intermediation, as these institutional investors serve as an alternative to traditional sources of corporate and government financing (e.g., banks) when the latter fail to function well. This dissertation hopes to guide policymakers by shedding light on the vulnerabilities inherent to mutual funds. With the goal of preventing these intermediaries from causing the next crisis, optimal regulation can bolster the stability not just of the mutual fund industry, but of the financial system as a whole.

Contents

List of Figures

List of Tables

Chapter 1

The Domestic Transmission of International Shocks: Evidence from US and Mexican Mutual Funds

1.1 Introduction

Financial markets across the world have increasingly become more connected in recent years. According to the Bank for International Settlements (BIS), bank lending to foreign counterparties rose from $8 trillion in 2000 to about $18.6 trillion in the first quarter of 2016.[1] Foreign mutual funds have likewise grown to be an important source of funding for firms and governments alike; gross portfolio flows to emerging markets went from $132 million in 1997 to about $421 billion in 2009 (Gelos, 2011).[2] Despite the positive effects of international financial integration, such as better risk-sharing (Flood et al., 2012) or an improvement in the efficiency of the domestic financial sector (Unite and Sullivan, 2003; Sturm and Williams, 2004; Mishkin, 2009), recent events have once again raised concerns regarding the possibility that these linkages became conduits for the cross-border transmission of the financial crisis, which eventually led to the global recession.

A number of studies indeed document that crisis-hit banks that were lending in-

[1]See the "Locational banking statistics" of the BIS, available at http://www.bis.org/statistics/stats_research_and_analysis.htm (accessed August 4, 2016).

[2]Similarly, the assets of US mutual funds that invest in equity abroad increased from $542 billion in 2000 (Collins, 2001) to $2.67 trillion in the first quarter of 2016 (Investment Company Institute, 2016).

ternationally extended less credit to firms abroad (Cetorelli and Goldberg, 2009; de Haas and van Horen, 2012a,b; Popov and Udell, 2012; de Haas and Lelyveld, 2014) and reallocated liquidity from affiliates abroad to the home office (Cetorelli and Goldberg, 2012a,b). During the 2008 crisis, a lot of mutual funds, including those that invested in foreign equity, simultaneously decreased their equity positions as a result of massive outflows from investors.[3] The selling pressure resulted in *temporarily* lower abnormal stock returns (Hau and Lai, 2016) and reduced corporate investment (Hau and Lai, 2013) for the stocks in their portfolios.

Countries, nevertheless, have their own domestic financial institutions to potentially take over when external capital dries up. If these intermediaries are perfectly able to do so, one does not expect to observe any impact of crises that is attributable to firms' bank or mutual-fund links overseas. Previous research shows that this is sometimes not the case for banks, as local banks may themselves be exposed to international crises through a reduction in cross-border interbank lending (Cetorelli and Goldberg, 2011; Aiyar, 2012; Schnabl, 2012; Ongena et al., 2015). The literature, however, has so far been silent on why the undervaluation of stocks held by crisis-hit foreign mutual funds persists even in the presence of arbitrage-seeking domestic investors. In particular, these agents can profit from buying the temporarily underpriced stocks, and, in the process, erase the price drop induced by the sale of foreign funds. What then are the reasons for the inability of domestic investors to do so, and how significant is this factor in the realization of the transmission of international crises to the domestic stock market?

I explore this issue by examining how one class of local institutional investors, Mexican mutual funds, responded to the spread of the 2008 financial crisis from the US to the Mexican stock market via US mutual funds. At the start of April 2008, US funds held an estimated 3.16% of the total market capitalization of all non-financial stocks in Mexico.[4] Following the dumping of Mexican equity by US funds during the crisis, I establish that Mexican funds, which held 1.62% of Mexican market capitalization, played a very important role in the *temporary* price

[3]This happens mainly because they have the obligation to always satisfy these shareholder redemptions (Coval and Stafford, 2007).

[4]This number is calculated from my sample of US funds.

decline of US-fund-owned Mexican stocks I observe. In particular, I demonstrate that some Mexican funds likewise sold these affected stocks, which consequently reinforced underpricing. In contrast, others bought the US-fund-owned stocks, which then served to counteract the selling pressure from US funds. Ultimately, I find that the price decrease was not present for all Mexican stocks directly affected by the US fund sale, but only for those that were also largely held by selling Mexican mutual funds.

The different response of the Mexican funds in my sample can be attributed to fund performance concerns emanating from their open-end structures, which entail the contractual commitment to buy shares back from their investors at the prevailing net asset value at any point in time. It has been found that shareholders of funds with this structure tend to leave after bad fund performance (Ippolito, 1992; Chevalier and Ellison, 1997; Sirri and Tufano, 1998; Edelen and Warner, 1999; Del Guercio and Tkac, 2002; Huang et al., 2007; Spiegel and Zhang, 2013) and that the ease of investor redemption subjects these funds to shareholder panic runs[5] (Chen et al., 2010). Considering that fund manager fees are tied to assets under management, there is, therefore, a high incentive for a manager to maintain high risk-adjusted returns for the fund.

A possible rationale for my empirical findings is that Mexican funds that had a bigger portion of their portfolios invested in the US-fund-owned stocks foresaw a possible deterioration of fund performance. To avoid investor outflows, they rebalanced their holdings away from these stocks and towards those that were not involved in the US fund sale. On the other hand, funds that held little of the affected Mexican stocks did not expect a performance-induced shareholder exit. They were, thus, able to profit from the non-permanent underpricing and load on the stocks that were temporarily cheap.

[5]Outflows can sometimes lead to forced sales of a fund's stocks, undermining the fund manager's ability to form her optimal portfolio. Indeed, Edelen (1999) documents that flows affect the fund's abnormal returns. Anticipating a decline in performance after an expected exit of other investors, a shareholder might decide to redeem her shares now as well to avoid the lower price she would be paid if she decided to leave later. These strategic complementarities among investors expose an open-end mutual fund to runs.

I start the empirical analysis by showing that the second quarter of 2008, a quarter before the quarter of the Lehman default, saw the start of a massive unloading of Mexican equity in the portfolios of US mutual funds that invest in Mexican stocks. By the end of June 2008, US funds on average sold 25.6% of the market value of Mexican stocks they held at the start of April 2008. This amounts to 2.62 billion USD of the 10.23 billion dollars of Mexican equity owned by US mutual funds in my sample. I also document that these funds began to load up on US stocks during the same period. This trading pattern is consistent with the strengthening of fund managers' local bias, which intensifies during periods of market turmoil (Giannetti and Laeven, 2016), or with a flight to liquidity, as US stocks are more liquid than their Mexican counterparts.

I next resolve whether this led to the underpricing of Mexican stocks by exploiting the stock-level variation in US fund ownership of the outstanding shares of non-financial Mexican stocks at the start of April 2008. I employ a difference-in-differences strategy to obtain that, from April 2008 to April 2009, stocks that were 4% owned by US funds (the treatment group or Stocks HH and HL in Figure 1.1) suffered 27.1% less cumulative abnormal returns than those that were at most 1% owned (the control group or Stock L in the same figure).[6] In the absence of firm-level data on import-export or bank loan connections with the US, I also include in the regressions time-varying return betas with respect to a couple of US stock market variables to control for time-dependent correlations with market conditions in the US. To further give credence to the claim that this result is not related to stock fundamentals, I follow the methodology of Coval and Stafford (2007), and of Mitchell et al. (2007), and confirm that the sign of the difference in cumulative abnormal returns between the treatment and the control groups changes from May 2009 to December 2009. That is, the stocks in the treatment group had 12.9% more cumulative abnormal returns than those in the control during this period.[7]

[6]Instead of the actual percentage of US fund holdings sold, I use a stock's *ex-ante* exposure to the US fund sale as the treatment variable due to the possible endogeneity of the former. A stock that has worsening fundamentals is likely to both experience a price decline and be sold by US funds.

[7]The idea of this robustness check is that if the decrease in the price of the treated stocks were driven by fundamentals, the price would have permanently stayed at a lower level and it would not have gone back up.

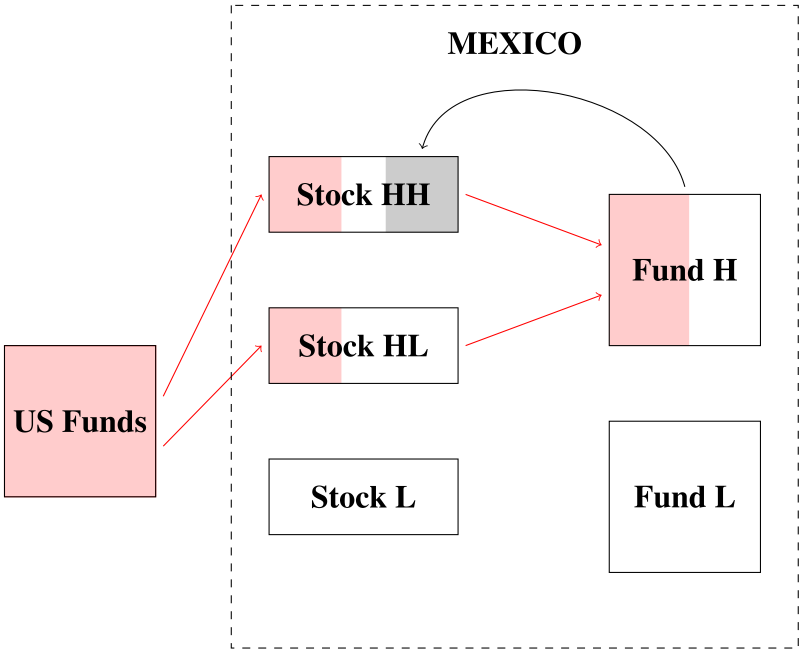


Figure 1.1
GROUPS OF MEXICAN STOCKS AND MEXICAN FUNDS
ACCORDING TO EXPOSURE TO US FUNDS

This diagram illustrates the connections among US funds, Mexican stocks, and Mexican funds that I consider in this study. The arrows depict the direction of the transmission of the US crisis. The red shading for Mexican stocks and Mexican funds indicate, respectively, direct and portfolio exposure to US funds, while the gray shading for Mexican stocks represents their indirect exposure. A Mexican stock's direct exposure is measured as the fraction of its common shares outstanding owned by US funds at the start of 2008Q2. A Mexican fund's portfolio exposure is the average direct exposure of the Mexican stocks it held at the start of 2008Q2. A Mexican stock's indirect exposure is the average direct exposure of its peers, i.e., those Mexican stocks that it shared a Mexican fund with. Red arrows from US funds to Mexican stocks is for US fund ownership of the Mexican stocks. Red arrows from Mexican stocks to Mexican funds mean that Mexican funds owned the Mexican stocks. The black arrow from Mexican funds to Mexican stocks depicts indirect exposure of Mexican stocks to US funds by virtue of being owned by Mexican funds. "H" means that the exposure was high, while "L" means that it was low. The first letter for each stock group's name is for direct exposure, while the second is for indirect exposure.

I proceed by establishing that Mexican funds that invested in Mexican equity reacted to the temporary mispricing of Mexican stocks differently. To this end, I exploit the fund-level heterogeneity in the percentage of the funds' portfolio that was *ex-ante* exposed to the US fund sale. For each Mexican fund, I calculate the average US fund ownership of the Mexican stocks in its portfolio at the beginning of April 2008 . Consistent with low portfolio exposure funds taking advantage of cheaper stocks, I show that funds with zero portfolio exposure bought stocks in the treated group more than than those in the control. These funds' MXN purchases of treated stocks is 0.189% more than of those in the control group, implying that had the average fund had zero portfolio exposure, it would have bought 87.45 million MXN more of the treated stocks than of the control stocks. Consequently, I find that the effect of a two-standard-deviation or a 3.38-percent increase in portfolio exposure is an increase equal to 114.55 million MXN in the sales of treated stocks relative to the control. This is compatible with the explanation that high portfolio exposure funds unloaded the treated stocks due to concerns about fund performance. In the context of Figure 1.1, these results suggest that Fund H tended to sell Stocks HH and HL, whereas Fund L bought them.

The last part of the empirical exercise consists of examining whether these Mexican mutual fund trades after the US fund sale of Mexican equity eased or intensified stock underpricing. I divide the Mexican stocks along another dimension, which I call *indirect exposure*, that takes into account their differences in exposure to the rebalancing of Mexican funds. I compute indirect exposure for each stock as the average US fund ownership of the other Mexican stocks it shared Mexican funds with (henceforth, its fund peers) at the start of April 2008. Using the same difference-in-differences technique as in a previous part of this study, I demonstrate that, in fact, not all stocks that were at least 4% owned by US funds (the treated stocks in the earlier regressions) suffered lower abnormal returns. With the control group still being Stock L, I establish that stocks with high direct exposure and low indirect exposure (Stock HL) were not subject to underpricing. This can be explained by the buying pressure from Mexican funds being successful in counterbalancing the selling pressure from US funds. On the contrary, since stocks with high values for both direct and indirect exposure (Stock HH) were sold by US and Mexican funds alike, their cumulative abnormal returns were 34.3% less than those in the control group from April 2008 to April 2009. Again, consistent with this being unrelated to stock fundamentals, there was a reversal of this trend from May 2009 to December 2009, when the cumulative abnormal returns of this group were 17.1% more relative to the control.

In sum, the empirical exercise reveals that had Mexican funds not been exposed to the US fund sale through their Mexican stock holdings, they could have traded to bring stock prices back closer to fundamentals, and no negative repercussions of the market turmoil in the US could have materialized. Indeed, domestic mutual funds, though overlooked by previous papers, are main actors in the transmission of crises from abroad to the local stock market.

This study is related to various strands of the literature. It is connected to a growing number of papers that find that one way crises are spread from one country to another is through financial intermediaries, like banks (Schnabl, 2012; Peek and Rosengren, 1997, 2000; Cetorelli and Goldberg, 2009, 2011, 2012a,b; Aiyar, 2012; de Haas and van Horen, 2012a,b; Popov and Udell, 2012; de Haas and Lelyveld, 2014; Ivashina et al., 2015; Ongena et al., 2015). There are those that also delve into international contagion through investment funds (Kaminsky et al., 2004; Boyer et al., 2006; Broner et al., 2006; Jotikasthira et al., 2012; Raddatz and Schmukler, 2012), but none so far has considered the role of domestic mutual funds in the propagation mechanism.

The findings of my analysis also contribute to the literature that explores how institutional investors respond to departures of stock prices from fundamentals. Some prior studies solely focus on whether these agents buy and sell in the direction of or against mispricing (Brunnermeier and Nagel, 2004; Edelen et al., 2016; Cao et al., 2016; Giannetti and Kahraman, 2016). On the other hand, this chapter shows that these trades can themselves consequently lead prices back to fundamental values, as in the case of Stock HL in Figure 1.1, or move them further away, as in the case of Stock HH.[8]

This study adds itself to the list of papers that establish that stocks that are held by the same funds exhibit excess return correlation (e.g., Lou (2012), Greenwood and Thesmar (2011), Antón and Polk (2014)), while being the first one to consider an international shock as a source of identification. Finally, the results of my empiri-

[8]Cao et al. (2016) attempt to do the same but the positive relationship they find between hedge fund trading and the disappearance of stock undervaluation may just be a product of hedge funds purchasing stocks whose prices have increased, consistent with these institutions practicing momentum trading (Brunnermeier and Nagel, 2004).

cal analysis echo those of Shleifer and Vishny (1992), Coval and Stafford (2007), Mitchell et al. (2007), Ellul et al. (2011), Mitchell and Pulvino (2012), and Cella et al. (2013) by exhibiting that stock prices can temporarily deviate from fundamentals due to selling pressure from investors. I contribute to this literature by providing evidence that fire sales by one type of investor (US funds) can promote fire sales by another (Mexican funds) through their overlapping portfolios.

The remainder of the chapter is organized as follows. Section 2 discusses the data sources and describes the samples used for the analysis. The empirical results are contained in Section 3. Section 4 concludes.

1.2 Data

Information on US and Mexican open-end mutual funds, and on US and Mexican stocks come from different sources. Data on monthly returns, monthly total net assets, expense ratios, fees, investor clientele, and age for US mutual fund classes originate from the the Center for Research in Security Prices (CRSP) Survivorship Bias Free Mutual Fund Database. Each mutual fund class is designated to a mutual fund using the Mutual Fund Links database of the Wharton Research Data Services (WRDS). Information on Mexican stocks, which include monthly stock prices and balance sheet variables (i.e., total assets, market capitalization, leverage, market-to-book ratio, and return on assets) are from Bloomberg. Mexican stocks in the portfolios of US and Mexican funds, and data on returns, total net assets, expense ratios, clientele, and age of Mexican funds are in turn taken from Morningstar. The US stocks in US fund portfolios are from the Thomson Reuters Mutual Fund Holdings database, and their stock prices are from the CRSP US Stock Databases.

1.2.1 US funds

The sample of US funds consists of 524 US open-end equity mutual funds that held Mexican equity at least once from January 2007 to December 2011 and that were active from July 2007 to September 2008. To build this sample, I start with the mutual fund classes in the CRSP Mutual Fund Database and obtain their

CUSIPs. I use Bloomberg to get the ticker symbol for each CUSIP, which then identifies the funds in the Morningstar database. I exclude small (i.e., those that had monthly total net assets less than 5 million USD) and young fund classes (i.e., those that were active for less than 36 months). The class-level variables in the CRSP Mutual Fund Database database are aggregated to come up with the fund-level variables by weighting each class by its fraction of the fund's total net assets at the start of each month. The summary statistics for the fund-level variables from July 2007 to September 2008 are in Panel A of Table 1.1.

Fund performance is defined here as the Carhart 4-factor alpha Alpha_{im}:

$$\text{Alpha}_{im} = \frac{1}{6} \sum_{m'=m-5}^{m} \Big[R^e_{im'} - \hat{\beta}^{\text{MKT}}_{im'} \text{MKT}^{\text{US}}_{m'} - \hat{\beta}^{\text{SMB}}_{im'} \text{SMB}^{\text{US}}_{m'} - \hat{\beta}^{\text{HML}}_{im'} \text{HML}^{\text{US}}_{m'} - \hat{\beta}^{\text{MOM}}_{im'} \text{MOM}^{\text{US}}_{m'} \Big],$$

where $R^e_{im'}$ is the excess return of fund i in month m', $\text{MKT}^{\text{US}}_{m'}$, $\text{SMB}^{\text{US}}_{m'}$, and $\text{HML}^{\text{US}}_{m'}$ are the three US Fama-French factors, and $\text{MOM}^{\text{US}}_{m'}$ the US momentum factor. These factors are available at Kenneth French's website.[9] The betas are estimated using a rolling window of 36 months. The volatility of excess returns is the standard deviation of the past year's monthly excess returns. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{im-1} - \text{ACQ}_{im},$$

where TNA_{im} is the total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Per-unit flow, which is used as a control in the empirical section of this study, is defined as flow divided by the total net assets at the start of the period. Class age is the number of months since the inception date of each class, while fund age is the age of the oldest class of the fund. The maximum front load is the maximum percentage charge for purchasing shares of a fund. The redemption fee and the CDSC (contingent deferred sales charge) load are two fees (in percentage terms) for redeeming shares. I also have

[9]See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Table 1.1

SUMMARY STATISTICS

The tables below show the summary statistics for the 542 US mutual funds (Panel A), 52 Mexican stocks (Panel B), and 32 Mexican funds (Panel C) included in the empirical analysis. The US funds were active from July 2007 to September 2008 and held Mexican equity at least once from January 2007 to December 2011. A stock needs to be from a non-financial Mexican firm that was actively traded in the Mexican stock market from December 2007 to December 2009 to be part of the sample. Finally, the Mexican funds used were either equity or allocation (i.e., they invested both in equity and fixed income securities) funds active from July 2008 to September 2008. The variable definitions are in the main text.

Panel A: Summary statistics for US funds

Variable	Mean	Median	Std. dev.	Min	Max
Net purchases of MEX stocks (in m USD)	-0.230	0	11.626	-195.251	135.055
Holdings of MEX stocks (in m USD)	18.519	0.743	76.878	0	1,183.389
Net purchases of US stocks (in m USD)	8.934	0	295.261	-4,860.461	5,402.938
Holdings of US stocks (in m USD)	1,519	70	6,316	0	116,490
Market value of portfolio	4,456	963	13,427	6	193,453
Performance	0.000	-0.001	0.010	-0.023	0.028
Volatility of excess returns	0.036	0.033	0.012	0.011	0.074
Net flows (in m USD)	-5.331	-2.925	374.131	-5,100.623	5,046.229
Expense ratio	0.012	0.012	0.004	0.002	0.023
TNA (in m USD)	3,788	913	9,102	14	58,484
Age (in months)	170.315	148.018	113.665	37.000	647.215
Maximum front load	0.013	0	0.018	0	0.056
Maximum redemption fee	0.008	0	0.009	0	0.020
Maximum CDSC load	0.001	0	0.002	0	0.012
I(Retirement fund)	0.007	0	0.033	0	0.251
I(Retail fund)	0.429	0.323	0.429	0	1

(Continued)

Table 1.1–*Continued*

Variable	Mean	Median	Std. dev.	Min	Max
I(Institutional fund)	0.216	0	0.344	0	1
I(Index fund)	0.028	0	0.163	0	1

(Continued)

Table 1.1–*Continued*

Panel B: Summary statistics for Mexican stocks

Variable	All stocks					Low exposure	High exposure
	Mean	Median	Std. dev.	Min	Max	Mean	Mean
% in US funds	0.040	0.026	0.047	0	0.211	0.002	0.100
Risk-adjusted returns	-0.001	0.000	0.040	-0.098	0.100	-0.005	0.002
Volatility of excess returns	0.101	0.096	0.034	0.040	0.199	0.109	0.092
MEX market beta	0.637	0.648	0.729	-1.026	2.488	0.299	0.838
MEX SMB beta	0.517	0.520	0.760	-1.111	2.450	0.739	0.299
MEX HML beta	0.296	0.350	0.604	-1.483	1.680	0.503	0.090
MEX MOM beta	0.047	0.057	0.559	-1.373	1.510	0.292	-0.020
US market beta	-0.002	0.009	0.772	-2.257	1.747	0.187	-0.196
US SMB beta	0.078	0.088	0.780	-1.581	1.770	-0.190	0.268
US HML beta	-0.033	-0.044	1.140	-3.122	2.270	0.240	0.165
US MOM beta	-0.041	-0.051	0.616	-1.540	1.246	-0.117	-0.016
US VIX beta	-0.114	-0.059	0.494	-1.418	0.909	-0.073	-0.086

(Continued)

Table 1.1–*Continued*

Variable	All stocks					Low exposure	High exposure
	Mean	Median	Std. dev.	Min	Max	Mean	Mean
US liquidity shock beta	0.034	0.016	0.261	-0.570	0.790	0.096	-0.063
Total assets (in m MXN)	6,071	2,057	9,743	69	47,482	4,713	6,295
Market cap (in m MXN)	4,441	1,602	7,592	34	39,202	2,701	4,932
Leverage	0.516	0.532	0.200	0.056	0.949	0.597	0.469
Market-to-book ratio	0.303	0.169	0.561	0.005	3.615	0.424	0.207
Return on assets	0.013	0.013	0.019	-0.061	0.097	0.008	0.019

Panel C: Summary statistics for Mexican funds

Variable	Mean	Median	Std. dev.	Min	Max
Fund exposure	0.031	0.038	0.017	0	0.058
Performance	-0.010	-0.010	0.007	-0.021	0.006
Volatility of excess returns	0.039	0.044	0.012	0.002	0.055
MEX market beta	0.571	0.699	0.332	-0.091	0.958
MEX SMB beta	0.351	0.248	0.315	-0.262	1.286
MEX HML beta	0.130	0.116	0.170	-0.281	0.657
MEX MOM beta	-0.045	0.008	0.157	-0.337	0.287
US market beta	0.073	0.052	0.259	-0.469	0.963
US SMB beta	-0.141	-0.192	0.196	-0.626	0.436
US HML beta	-0.262	-0.171	0.327	-1.619	0.343
US MOM beta	-0.017	0.005	0.170	-0.586	0.201

(Continued)

Table 1.1–*Continued*

Variable	Mean	Median	Std. dev.	Min	Max
US VIX beta	-0.073	-0.063	0.105	-0.272	0.226
US liquidity shock beta	0.047	0.048	0.090	-0.123	0.271
Net flows (in m MXN)	-30.757	-0.981	117.100	-439.711	152.987
TNA (in m MXN)	1,287	423	2,651	1	13,257
Age (in months)	134.890	145.501	85.037	22	257
Expense ratio	0.020	0.020	0.012	0	0.045
I(Retail fund)	0.258	0	0.427	0	1
I(Institutional fund)	0.001	0	0.003	0	0.019
I(Index fund)	0.250	0	0.440	0	1
% cash in portfolio	0.137	0	0.302	0	1

dummies for whether a fund is an index fund, for whether the fund class is mainly used for saving up for retirement, and for whether it caters to individuals (i.e., retail funds) or to institutional investors.

On average, US mutual funds held 18.52 million USD of Mexican equity from July 2007 to September 2008, which is just 0.42% of the average portfolio market value in the same period. Nonetheless, I calculate that at the start of April 2008, the US funds' aggregate holdings of non-financial Mexican stocks is 25.72% (i.e., 8.42 billion USD of 32.72 billion USD) of these assets' total market capitalization. This points to potentially large effects in the Mexican stock market should US funds decide to sell Mexican equity en masse. Moreover, an average of 230,000 USD of Mexican equity was sold by each fund per quarter during the sample period, with the maximum being a quarterly sale of 195 million USD. On the other hand, the mean net purchases of US stocks was positive and equal to 8.93 million USD. Together, these allude to the presence of a general local bias among US fund managers in the run-up to the crisis (Giannetti and Laeven, 2016) or to a flight to liquidity, as US stocks are more liquid than their Mexican counterparts.

1.2.2 Mexican stocks

In the sample, there are 52 non-financial Mexican stocks that were actively traded in the Mexican stock market from December 2007 to December 2009. The summary statistics for the stock-level variables I include in the empirical analysis are in Panel B of Table 1.1. Risk-adjusted returns are, once again, the Carhart 4-factor alpha, but, this time, using the market, SMB, HML, and MOM factors of Mexico. The Mexican factors are obtained using the methodology of Fama and French (1993). As in the case of the US mutual funds, the volatility of excess returns is the standard deviation of the past year's monthly returns in excess of the risk-free rate (i.e., the one-month CETES return). Market capitalization is the number of outstanding shares multiplied by the stock price. Leverage is found by dividing total liabilities by total assets. Market-to-book ratio is the market capitalization divided by the difference between total assets and total liabilities, and return on assets is the net income over the total assets.

To control for *time-dependent* return correlation with US market conditions, I calculate each Mexican stock's *time-varying* betas with respect to the three US Fama-French factors, to the US momentum factor, to the volatility index of S&P 500 (i.e., the VIX), and to a measure of the aggregate liquidity shock in the US stock market computed by Pastor and Stambaugh (2003). The US betas of stock s in month m are the OLS estimates of $\beta_{sm}^{\text{MKT}*}$, $\beta_{sm}^{\text{SMB}*}$, $\beta_{sm}^{\text{HML}*}$, $\beta_{sm}^{\text{MOM}*}$, $\beta_{sm}^{\text{VIX}*}$, and $\beta_{sm}^{\text{LIQ}*}$ in the regression

$$R_{sm'}^{e} = \beta_{sm}^{0} + \beta_{sm}^{\text{MEX}'}\text{MEX}_{m'} + \beta_{sm}^{\text{US}'}\text{US}_{m'} + \beta_{sm}^{\text{VIX}*}\text{VIX}_{m'} + \beta_{sm}^{\text{LIQ}*}\text{LIQ}_{m'} + \varepsilon_{sm}^{0}$$

for $m' = m - 36, \ldots, m - 1$, where $\text{MEX}_{m'}$ is the vector of the four Mexican Carhart factors, $\text{US}_{m'}$ the vector of the four US Carhart factors, $\text{VIX}_{m'}$ the volatility index, $\text{LIQ}_{m'}$ the aggregate liquidity shock, ε_{sm}^{0} the error term, and $\beta_{sm}^{\text{US}'} = \begin{bmatrix} \beta_{sm}^{\text{MKT}*} & \beta_{sm}^{\text{SMB}*} & \beta_{sm}^{\text{HML}*} & \beta_{sm}^{\text{MOM}*} \end{bmatrix}'$.

The percentage of outstanding shares of the Mexican stocks in my sample that were US-fund-held at the start of April 2008 were, on average, 4%, reaching a maximum value of 21.1%. In the difference-in-differences estimation of the *direct* effect on Mexican stock prices of the dumping by US funds of Mexican equity, I divide the 52 stocks into three groups depending on US fund ownership at the beginning of 2008Q2. A stock has low exposure if this percentage is below 1% (15 stocks), medium exposure if it is between 1 and 4% (22 stocks), and high exposure if it is above 4% (15 stocks). The threshold values are chosen so as to have an equal number of low and high exposure stocks. The last two columns of Panel B of Table 1.1 display the variable means for the low and high exposure groups. Low exposure stocks, on average, had 0.2% of their shares in US funds at the start of April 2008, while high exposure stocks had 10%.

Comparing the two sets of stocks during the sample period, one sees that high exposure stocks were bigger (both in terms of total assets and of market capitalization) than low exposure stocks. This might pose a problem for the identification of the transmission channel, as larger firms are more likely to have more import-export or bank loan linkages with the US, neither of which I observe. It is for this reason that I include size and time-varying US market betas as controls in the regressions. Nevertheless, the estimates of the betas with respect to the US market factor and to the aggregate liquidity shock in the US both suggest that high exposure stocks were less sensitive to these US variables than low exposure stocks.[10] This is consistent with US fund managers investing in those Mexican stocks whose returns comove less with the US market as a hedge against aggregate risk in the US. Indeed, high exposure stocks having lower US market betas strengthens the evidence for the fact that finding a differential effect of the US fund sale on high exposure stocks does not come from their ex-ante exposure to US market conditions.

1.2.3 Mexican funds

There are 31 Mexican open-end mutual funds that were active from July 2008 to September 2008 in the sample. The summary statistics are displayed in Panel C of Table 1.1. These funds are either equity or allocation (i.e., they invested in both equity and fixed-income securities) funds. The Morningstar database contains information on mutual fund classes; I weight them by the fund class' fraction of the each fund's total net assets at the beginning of July 2008 to obtain variables that are at the fund-level. Small classes (i.e., those with less than 1 million MXN in total net assets) were not included. I likewise require that I be able to observe at least 80% of a fund's portfolio for it to be part of the sample. Performance, volatility of excess returns, and net flows are computed in the same way as in the case of US funds. The Mexican and US betas are found following the same procedure used for Mexican stocks. For the section where I determine whether Mexican funds rebalanced their portfolios in response to the US fund sale, I calculate fund exposure, which is the average percentage of US-fund-held outstanding shares for the stocks in their portfolios. The mean of this variable is 3.1%, while the maximum is 5.8%.

[10] A negative value for the high exposure stocks' mean US liquidity shock beta means that these stocks tend to have higher returns when there is a negative liquidity shock in the US stock market.

1.3 Empirical results

The empirical analysis consists of four steps. First, I provide evidence that US funds massively sold Mexican equity during the second quarter of 2008 as a response to the looming financial crisis. I next show that this dumping of Mexican stocks exerted selling pressure on prices in the Mexican stock market. That is, Mexican stocks that had high US fund ownership at the start of April 2008 experienced lower abnormal returns as compared to those that had low US fund ownership. Third, I demonstrate that Mexican funds had heterogeneous reactions to the US fund sale, which were determined by their holdings of teh most affected Mexican stocks. Some bought the stocks with high US fund ownership, while others sold them. Finally, I obtain that the relative decline in the price of stocks with high US fund ownership was only present if they were simultaneously held by selling Mexican mutual funds, stressing that Mexican mutual funds were a vital actor in the transmission of the US crisis to the Mexican stock market.

1.3.1 Sales of Mexican equity by US Funds

The run-up to the crisis culminated in the filing for Chapter 11 bankruptcy of Lehman Brothers in September 15, 2008, when the volatility index of S&P 500 shot up and the one-month risk-free rate dropped thereafter. In verifying if US mutual funds reacted to the crisis by unloading the Mexican stocks in their portfolios, the Lehman default would be the most natural event to designate as the start of the financial crisis. There, however, were warning signs already as early as 2007 of a brewing market-wide financial turmoil. In July 2007, two of the hedge funds of Bear Stearns, one of the largest securities firms at that time, collapsed because they were heavily invested in mortgage-backed securities. The investment bank eventually failed in March 2008 and it was sold to JPMorgan Chase. Indeed, US funds could have started selling their foreign equity even before the bankruptcy of Lehman, and specifying when they did so thus becomes an empirical question.

To determine the point when these US funds reduced their positions in Mexican equity, I run a regression of quarterly sales by US funds of Mexican stocks on quarter dummies and fund-level characteristics. The idea is to pinpoint the quarter where US funds systematically sold Mexican equity while taking into account that fund characteristics, like percentage of the portfolio invested in US stocks, could likewise change the trading behavior of these funds. Specifically, the model I use is the following:

$$
\begin{aligned}
\text{PctNetPurchMEX}_{iq} = &\beta_0^1 + \beta_*^1 \text{PctMEX}_{iq} \\
&+ \sum_{Q'=-3}^{0} \left[\beta_{Q'}^1 \text{I}_q(Q') + \beta_{*Q'}^1 \text{PctMEX}_{iq} \times \text{I}_q(Q') \right] \\
&+ \gamma^{1'} X_{iq}^{US} + \eta^{1'} X_{iq}^{US} \times \text{PctMEX}_{iq} + \varepsilon_{iq}^1, \qquad (1.1)
\end{aligned}
$$

where $\text{PctNetPurchMEX}_{iq}$ is fund i's percentage net USD purchases of Mexican equity in quarter q, PctMEX_{iq} the percentage of the portfolio invested in Mexican equity at the start of q, $\text{I}_q(Q')$ the dummy for quarter Q', X_{iq}^{US} a vector of fund-level controls, and ε_{iq}^1 the error term. The time period I consider is from July 2007 to September 2008. Quarter Q' is Q' quarters from the Lehman default quarter (i.e., from July 2008 to September 2008). Fund controls include the percentage of US equity in the portfolio, previous fund performance, the volatility of excess returns, the lag of quarterly per-unit investor flow, the expense ratio, the lag of the logarithm of total net assets, the logarithm of fund age, the maximum front-end load, the maximum redemption fee, the maximum back-end load, a dummy for retirement funds, a dummy for retail funds, a dummy for institutional funds, and a dummy for index funds.

The dependent variable is calculated by dividing the quarterly net USD purchases of Mexican equity NetPurchMEX_{iq} by the market value of the portfolio at the start of the quarter. Because I do not observe the actual number of stocks the funds sold or purchased, I define monthly net USD purchases of a specific stock as the change in the number of shares held by the fund during a specific month multiplied by the end-of-month stock price. Subsequently, the quarterly net USD purchases of Mexican equity is

$$\text{NetPurchMEX}_{iq} = \sum_{m=\underline{m}_q}^{\bar{m}_q} \sum_{s \in S} P_{sm} \left(N_{ism} - N_{ism-1} \right),$$

where $\underline{m}_q$ is the first month in quarter q, $\bar{m}_q$ the last month, N_{ism} the number of shares of stock s held by fund i at the end of month m, P_{sm} the last price of s, and S the set of all Mexican stocks.

Because PctNetPurchMEX$_{iq}$ and PctMEX$_{iq}$ are both USD values divided by the portfolio market value at the start of quarter q, the coefficient of interest, $\beta^1_{*Q'}$, can be thought of as the average value of Mexican equity purchased by all funds in quarter Q' as a percentage of the value of Mexican equity in the funds' portfolio at the beginning of Q'. An estimate for $\beta^1_{*Q'}$ that is negative and statistically significant implies that US funds unloaded Mexican equity during quarter Q'. Indeed, as the results of the regression, shown in Columns 1 and 2 of Panel A of Table 1.2, indicate, the US fund sale of Mexican stocks occurred even before the Lehman quarter. In the second quarter of 2008, net purchases of Mexican equity were 12.2% less than in the third quarter of 2007. More importantly, the estimate for $\beta^1_{*Q'}$ is not significant for $Q' < -1$, which is consistent with the explanation that US funds started to become worried about the crisis in 2008Q2. Moreover, I use positive net purchases (i.e., PctNetPurchMEX$_{iq} \times$ I(PctNetPurchMEX$_{iq} > 0$)) and negative net purchases (i.e., $|$PctNetPurchMEX$_{iq}| \times$ I(PctNetPurchMEX$_{iq} < 0$)) as proxies for purchases and sales, respectively, to find out whether the estimate I obtain is only driven by lower purchases and not by higher sales. From Columns 3 to 6, one sees that the results in Columns 1 and 2 are in fact a consequence of both a decline in purchases and a surge in sales. By the end of June 2008, US funds on average sold 25.6% of the market value of the Mexican stocks they held at the start of April 2008. This amounts to 2.70 billion USD of the 10.54 billion USD of Mexican equity the US mutual funds in my sample owned right before the second quarter of 2008.

Investors tend to move to more liquid assets during episodes of market stress. In the current set-up, if fund managers were increasingly worried about the crisis,

Table 1.2

SALES OF MEXICAN AND US EQUITY BY US FUNDS

The tables below contain the estimates of fund-quarter-level regressions of net purchases of Mexican (Panel A) and US equity (Panel B) on quarter dummies. The dependent variable for the results in columns 1 and 2 is a US fund's quarterly net USD purchases of Mexican or US equity as a percentage of the market value of the portfolio at the beginning of the quarter. For columns 3 and 4, the dependent variable is the positive part of net USD purchases, while that for columns 5 and 6 is the negative part. The value for the quarterly net USD purchases is the sum of the monthly net USD purchases of all Mexican or US stocks over the whole quarter. Net USD purchases are computed as the change in the number of shares held within the month multiplied by the stock's last monthly price in USD. The variable *% MEX (US) in portfolio* is the percentage of the start-of-quarter portfolio invested in Mexican (US) stocks. The quarterly observations are taken from July 2007 to September 2008. The dummy variable I($Q = Q'$) equals 1 if the observation is taken Q' quarters from the Lehman default quarter (i.e., from July 2008 to September 2008) and zero otherwise. The included fund controls are discussed in the main text. Standard errors clustered at the fund level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Net purchases of Mexican equity

	Net purchases		Net purchases× (Net purchases > 0)		|Net purchases|× (Net purchases > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
% MEX in portfolio	−0.066	−0.055	0.100*	0.117*	0.166	0.173*
	(0.126)	(0.128)	(0.057)	(0.062)	(0.103)	(0.101)
I($Q = -3$)	−0.000		−0.000		0.000	
	(0.000)		(0.000)		(0.000)	
% MEX in portfolio×I($Q = -3$)	0.041	0.087*	0.033*	0.027	−0.008	−0.060*
	(0.031)	(0.051)	(0.018)	(0.022)	(0.019)	(0.037)
I($Q = -2$)	0.000		−0.000		−0.000	
	(0.000)		(0.000)		(0.000)	

(Continued)

Table 1.2–*Continued*

	Net purchases		Net purchases× (Net purchases > 0)		|Net purchases|× (Net purchases > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
% MEX in portfolio×I($Q = -2$)	−0.047	−0.048	−0.008	−0.029	0.039	0.018
	(0.040)	(0.049)	(0.016)	(0.023)	(0.031)	(0.039)
I($Q = -1$)	0.000		0.000		−0.000	
	(0.000)		(0.000)		(0.000)	
% MEX in portfolio×I($Q = -1$)	−0.077*	−0.122***	0.000	−0.039*	0.077***	0.083***
	(0.041)	(0.042)	(0.021)	(0.023)	(0.026)	(0.032)
I($Q = 0$)	0.000		−0.000		−0.000	
	(0.000)		(0.000)		(0.000)	
% MEX in portfolio×I($Q = 0$)	−0.108***	−0.039	−0.032**	−0.038	0.075**	0.001
	(0.041)	(0.042)	(0.015)	(0.024)	(0.034)	(0.036)
Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls×% MEX in portfolio	Yes	Yes	Yes	Yes	Yes	Yes
Style fixed effects	Yes		Yes		Yes	
Style×Quarter fixed effects		Yes		Yes		Yes
Number of observations	2,471	2,471	2,471	2,471	2,471	2,471
R^2	0.041	0.038	0.038	0.017	0.048	0.053

Panel B: Net purchases of US equity

	Net purchases		Net purchases× (Net purchases > 0)		|Net purchases|× (Net purchases > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
% US in portfolio	0.056^{*}	0.067^{*}	0.063^{**}	0.073^{**}	0.007	0.006
	(0.034)	(0.035)	(0.029)	(0.030)	(0.017)	(0.018)
$\mathrm{I}(Q=-3)$	0.003		0.001		−0.002	
	(0.003)		(0.003)		(0.001)	
% US in portfolio×$\mathrm{I}(Q=-3)$	−0.007	−0.029	−0.002	-0.028^{*}	0.005	0.001
	(0.010)	(0.022)	(0.007)	(0.015)	(0.005)	(0.012)
$\mathrm{I}(Q=-2)$	0.003		0.002		−0.001	
	(0.004)		(0.003)		(0.001)	
% US in portfolio×$\mathrm{I}(Q=-2)$	-0.019^{*}	−0.031	-0.016^{**}	−0.022	0.003	0.009
	(0.010)	(0.021)	(0.006)	(0.014)	(0.006)	(0.012)
$\mathrm{I}(Q=-1)$	0.009^{***}		0.007^{**}		-0.003^{*}	
	(0.003)		(0.003)		(0.002)	
% US in portfolio×$\mathrm{I}(Q=-1)$	0.005	−0.010	−0.007	−0.023	−0.011	−0.013
	(0.011)	(0.020)	(0.008)	(0.015)	(0.008)	(0.013)
$\mathrm{I}(Q=0)$	0.010^{*}		0.007		-0.003^{*}	
	(0.005)		(0.005)		(0.002)	

(Continued)

Table 1.2–*Continued*

	Net purchases		Net purchases× (Net purchases > 0)		|Net purchases|× (Net purchases > 0)	
	(1)	(2)	(3)	(4)	(5)	(6)
% US in portfolio×I($Q = 0$)	−0.019	−0.040	−0.019**	−0.037*	−0.000	0.002
	(0.014)	(0.026)	(0.009)	(0.020)	(0.009)	(0.013)
Fund controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls×% MEX in portfolio	Yes	Yes	Yes	Yes	Yes	Yes
Style fixed effects	Yes		Yes		Yes	
Style×Quarter fixed effects		Yes		Yes		Yes
Number of observations	2,471	2,471	2,471	2,471	2,471	2,471
R^2	0.015	0.004	0.011	0.005	0.015	0.005

they would rebalance their portfolios from Mexican stocks to US stocks, which are more liquid. In the same vein, Giannetti and Laeven (2012a) and Giannetti and Laeven (2012b) document a strengthening of the home bias of banks during deteriorating economic conditions. In particular, they determine that banks originate less new loans to firms abroad when prospects at home are bleak. Giannetti and Laeven (2016) likewise discover this phenomenon among mutual fund managers. They show that during times of elevated market volatility a manager is more likely to sell stocks of companies that are not headquartered in the fund's state as compared to stocks of "local" firms.

In light of these findings, I check if, concurrent to the substantial decrease in the positions in Mexican equity, the US funds loaded on US stocks. From Panel B of Table 1.2, one obtains that during the second quarter of 2008, all mutual funds, even those that did not have US equity at the start of the quarter, bought US stocks amounting to 0.70% of their portfolios. As in the case of the net purchases of Mexican equity, the estimates for the coefficients of the quarter dummies suggest that the tilting of these funds' holdings towards US equity did not start before April 2008. In sum, the US funds' sale of Mexican stocks, coupled with the simultaneous purchase of US stocks, points to an intensification of the fund managers' local bias or to a flight to liquidity, both of which tend to happen when fund managers become concerned about the worsening state of the economy.

1.3.2 Underpricing of Mexican stocks: Direct exposure

In this section, I aim to ascertain if the sale by US funds of Mexican equity led to a downward pressure on the prices of Mexican stocks. A natural way to proceed would be to verify whether there is a relationship between the value of Mexican stocks sold by US funds in 2008Q2 and the change in their stock prices after the quarter. This procedure is, however, subject to an endogeneity problem. It could be the case that the correlation is merely a consequence of the stocks' fundamentals worsening during the crisis. One would observe both a price decline and the unloading of the stocks from the portfolios of informed US funds if this were the case. Due to these considerations, I elect to exploit the stock-level variation in the

Table 1.3

EX-ANTE STOCK EXPOSURE ACROSS INDUSTRIES

The table contains the number of Mexican stocks in each industry across different groups of stock exposure. A stock's exposure is measured as the fraction of its common shares outstanding owned by US funds at the start of 2008Q2. A stock has high exposure if US funds held at least 4% of the stock's outstanding shares. Low exposure stocks, on the other hand, were at most 1% US-fund-owned at the start of April 2008. Stocks with medium exposure had US fund ownership of outstanding shares between 1% and 4%.

Industry	Number of stocks according to exposure			
	All	Low	Medium	High
Beverages	5	0	2	3
Building materials	7	1	4	2
Chemicals	3	3	0	0
Engineering & construction	5	2	2	1
Environmental control	1	0	1	0
Food	4	1	2	1
Diversified holding companies	4	1	3	0
Home builders	3	1	0	2
Household products	1	0	0	1
Iron or steel	2	2	0	0
Diversified machinery	1	0	1	0
Media	2	0	1	1
Mining	2	0	1	1
Packaging & containers	2	1	1	0
Retail	3	0	1	2
Telecommunications	7	3	3	1
All	52	15	22	15

ex-ante exposure of a Mexican stock to the US fund sale in order to find out if this event affected stock prices. I measure a Mexican stock's ex-ante exposure as the percentage of its outstanding shares held by US funds right before their systematic dumping of Mexican equity at the beginning of April 2008. Indeed, the stock would be more likely to be sold if the number of its US-fund-owned shares right before the US fund sale was higher. From Table 1.1, the average Mexican stock had 4% of its shares in US funds at the start of 2008Q2, and the maximum value of US fund ownership is 21%.

I divide the Mexican stocks into three groups according to their levels of ex-ante exposure. A stock has low exposure if the percentage of its outstanding shares owned by US funds at the start of April 2008 is below 1% (15 stocks), medium exposure if it is between 1 and 4% (22 stocks), and high exposure if it is above 4% (15 stocks). The threshold values are chosen so as to have an equal number of low and high exposure stocks. From Table 1.1, the average exposure of low exposure stocks is 0.20%, while that of high exposure stocks is 10%. There are differences other than US fund ownership between the two groups (e.g., the mean of the volatility of excess returns of high exposure stocks is greater than that of low exposure stocks), so I control for these stock characteristics in the regressions.

Furthermore, Table 1.3 contains the number of stocks per industry in each group. A fifth of all high exposure stocks are in the beverage industry, while the same fraction of low exposure stocks are in chemicals and in telecommunications. To ensure that the results I get are not driven by these disproportionately represented industries, I incorporate industry-time fixed effects in the regressions.

Effects on prices are assessed by looking at changes in abnormal monthly returns AR_{sm}, which I define as the excess returns of stock s in month m after adjusting for risk and *controling for stock characteristics* (e.g., the market-to-book ratio) that may explain variation in returns. In particular, AR_{sm} is the residual from running the following regression:

$$\text{Alpha}_{sm} = \beta_0^2 + \beta_*^{2'} Z_{sm} + \sum_{M'=\underline{M}}^{\bar{M}} \Big[\beta_{M'}^2 \text{I}(M' = m) + \beta_{*M'}^{2'} Z_{sm} \times \text{I}(M' = m)\Big] + \varepsilon_{sm}^2, \tag{1.2}$$

where Alpha_{sm} is the 4-factor Carhart alpha, Z_{sm} a vector of stock characteristics, $\text{I}(M' = m)$ the dummy for month M', $\underline{M}$ is December 2007, $\bar{M}$ December 2009, and ε_{sm}^2 the error term. In the absence of firm-level data on import-export or bank loan connections with the US, I control for a stock's *time-varying* dependence on market conditions in the US by including in Z_{sm} time-dependent stock return betas with respect to the four Carhart risk factors of the US, to the level of the VIX, and to the aggregate liquidity shock in the US as computed by Pastor and Stambaugh (2003). The other stock characteristics in Z_{sm} are the volatility of excess returns, the betas with respect to Mexico's four Carhart risk factors, the logarithm of assets, the logarithm of market capitalization, leverage, market-to-book ratio, and return on assets.

The plot of the cumulative average abnormal returns CAAR_{sm}, calculated as the sum from $\underline{M}$ to m of the average abnormal monthly returns in each group, for low and high exposure Mexican stocks is shown in the top panel of Figure 1.2. One notices that the cumulative average abnormal returns (CAARs) for the high and low exposure stocks are both close to zero before April 2008 and then the two decrease after. Moreover, the decline in CAARs for the high exposure stocks is more pronounced than that for low exposure stocks. This provides preliminary evidence of a negative price effect of the massive sale by US funds of Mexican equity.

To test the conjecture of this section more rigorously, I implement a difference-in-differences estimation of the effect on abnormal returns of US funds holding at least 4% of a certain stock's outstanding shares right before the second quarter of 2008. High exposure and medium exposure stocks separately form the two treatment groups, while low exposure stocks are in the control. To further guarantee that the relative drop in the abnormal returns of the treated stocks I expect to find is truly unrelated to stock fundamentals, I follow Coval and Stafford (2007), and Mitchell et al. (2007) and check whether the sign of the difference in abnormal returns between the treated and the control is reversed after some time. The reasoning behind this strategy is that if a sale-induced dip in price is not caused by a lower intrinsic value, then it is more likely to just be temporary. That is, agents should realize eventually that the stock is undervalued and the ensuing buying pressure should push the price back up. From Figure 1.2, it seems that the price of high exposure stocks in fact evolved this way. The CAAR of the treated stocks, after being lower post-April-2008, rose to coincide once again with that of the control in September 2009.

The goal is to simultaneously establish that high exposure stocks decreased their abnormal returns more than low exposure stocks beginning 2008Q2 and that the former increased their abnormal returns more than the latter a few months later. Guided by Panel B of Figure 1.2, I define the *price drop period* as the period spanning April 2008 to April 2009 (i.e., when the difference between the CAAR of high and low exposure stocks began to drop), while the *price reversal pe-*

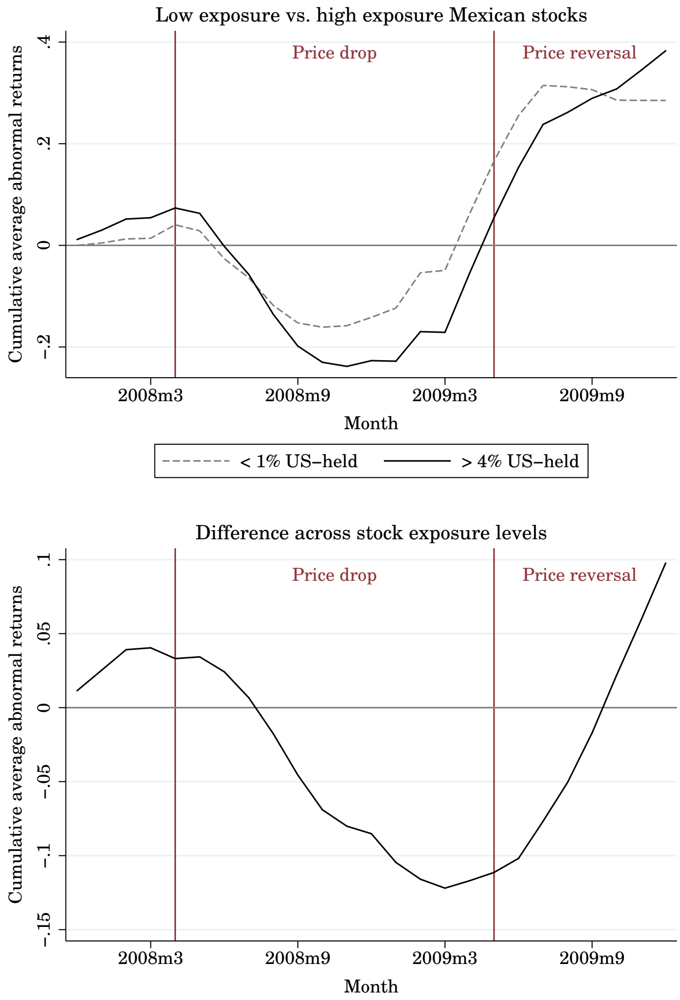


Figure 1.2

CUMULATIVE AVERAGE ABNORMAL RETURNS ACROSS STOCK EXPOSURE

The top panel shows the cumulative average abnormal returns (CAARs) for stocks with high exposure (solid line) and for stocks with low exposure (dashed line) from December 2007 to December 2009. The bottom panel contains the difference in CAARs between the two groups. For each group, the CAARs in month m are the sum from December 2007 to m of the average abnormal monthly returns in the group. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. Stocks have high exposure if, at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares. Low exposure stocks, on the other hand, are at most 1% US-fund-owned at the start of April 2008. The price drop period is from April 2008 to April 2009, while the price reversal period spans from May 2009 to December 2009.

riod is from May 2009 to December 2009 (i.e., when this difference started to increase). The outcome variable, which is the per-period cumulative abnormal returns CAR_{st}, is computed by adding each stock's abnormal returns for the pre-crisis (December 2007 to March 2008), price drop, and price reversal periods. I subsequently run regressions of CAR_{st} on stock group dummies, period dummies, and on their interaction terms. Formally, the model I employ is the following:

$$\begin{aligned}\text{CAR}_{st} =& \beta_0^3 + \beta_H^3 \text{I}_s(\text{High exposure}) + \beta_D^3 \text{I}_t(\text{Price drop}) + \beta_R^3 \text{I}_t(\text{Price reversal}) \\ &+ \beta_{H,D}^3 \text{I}_s(\text{High exposure}) \times \text{I}_t(\text{Price drop}) \\ &+ \beta_{H,R}^3 \text{I}_s(\text{High exposure}) \times \text{I}_t(\text{Price reversal}) + \varepsilon_{st}^3, \end{aligned} \quad (1.3)$$

where I_s(High exposure) is a dummy for high exposure stocks, I_t(Price drop) a dummy for the price drop period, I_t(Price reversal) a dummy for the price reversal period, and ε_{st}^3 the error term. The dummy for the other treated group, the stocks with medium exposure, and its interaction terms with the period dummies are included in the regressions but omitted from Equation 1.3 to save space.

If the hypothesis is true, then one should obtain a negative and statistically significant estimate for $\beta_{H,D}^3$, and a positive and statistically significant estimate for $\beta_{H,R}^3$. The regression results listed in Table 1.4 confirm the presence of the difference in the price pattern of treated and of control stocks, as initially suggested by Figure 1.2. In the pre-shock period, the CARs of high and low exposure stocks were not significantly distinct from zero. Afterwards, high exposure stocks, as a consequence of the US fund sale, experienced 27.1% less cumulative abnormal returns than low exposure stocks. And consistent with this price decline being unrelated to fundamentals, the CARs of the treated group improved 12.9% more than that of the control during the period from May 2009 to December 2009. As a robustness check, I rerun the regressions using longer time intervals for the pre-crisis period. The estimates, which are in Table 1.7 in the Appendix, of the effect of being a high exposure stock during the three periods are similar to those of the baseline specification.

In their paper, Jotikasthira et al. (2012) show that investor-flow-motivated sales of

Table 1.4

UNDERPRICING OF MEXICAN STOCKS: DIRECT EXPOSURE

The table below contains the estimates of stock-period-level regressions of cumulative abnormal returns on dummies for stock groups formed according to US fund ownership, period dummies, and their interaction terms. The dependent variable is a Mexican stock's cumulative abnormal monthly return during either the pre-crisis, price drop, or price reversal periods. Cumulative abnormal monthly returns are the sum of abnormal monthly returns over the period being considered. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. The pre-crisis period is from December 2007 to March 2008. The price drop period spans from April 2008 to April 2009, while May 2009 to December 2009 is the price reversal period. The variable *I(High stock exposure)* takes value 1 if, at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares and zero otherwise. The variable *I(Medium stock exposure)* is a dummy for US fund ownership of outstanding shares between 1% and 4%. Standard errors clustered at the stock level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Cumulative abnormal monthly return*	(1)	(2)	(3)
I(Medium stock exposure)	0.001	−0.005	0.003
	(0.021)	(0.029)	(0.021)
I(High stock exposure)	0.003	−0.001	0.007
	(0.026)	(0.038)	(0.032)
I(Price drop)	0.090*	0.090*	
	(0.052)	(0.052)	
I(Medium stock exposure)×I(Price drop)	−0.080	−0.080	−0.129*
	(0.063)	(0.063)	(0.073)
I(High stock exposure)×I(Price drop)	−0.194***	−0.194***	−0.271***
	(0.065)	(0.065)	(0.078)
I(Price reversal)	−0.063**	−0.063**	
	(0.028)	(0.028)	
I(Medium stock exposure)×I(Price reversal)	0.096*	0.096*	0.121***
	(0.049)	(0.049)	(0.043)
I(High stock exposure)×I(Price reversal)	0.077*	0.077*	0.129***
	(0.041)	(0.041)	(0.045)
Industry fixed effects		Yes	
Industry×Period fixed effects			Yes
Number of observations	156	156	147
R^2	0.104	0.110	0.155

emerging market equity by funds in developed markets negatively influence prices in emerging markets. Their study is done at the country-level; they reveal that country market return indices underperform if they are exposed to forced sales by developed-market funds. The results of this section confirm these authors' findings and, at the same time, serve as the first within-country evidence of the effect of portfolio reallocation decisions of foreign funds on domestic stock prices.

1.3.3 Rebalancing of Mexican fund portfolios

Faced with the undervaluation of some Mexican stocks, Mexican mutual funds should have reacted by buying the stocks that were suddenly less expensive and, in the process, profited from the mispricing. I demonstrate that this was not the case for all Mexican *open-end* funds. The open-end structure of these funds entails the contractual commitment to buy shares back from their investors at the prevailing net asset value at any point in time. It has been found that shareholders tend to leave after bad fund performance (Chevalier and Ellison, 1997; Sirri and Tufano, 1998; Huang et al., 2007; Spiegel and Zhang, 2013) and that the ease of shareholder redemption this fund structure allows subjects the fund to investor panic runs[11] (Chen et al., 2010). Considering that fund manager fees are tied to assets under management, there is an incentive for a manager to maintain high risk-adjusted returns for the fund. It is possible that Mexican funds that had a bigger portion of their portfolios invested in the US-fund-owned stocks foresaw a potential deterioration of fund performance. Consistent with these Mexican funds attempting to avoid shareholder outflows, I establish that they rebalanced their holdings away from these stocks and towards those that were not subject to the US fund sale. On the other hand, funds that held little of the affected Mexican stocks (i.e., those that were less likely to experience a performance-induced investor exit) were able to profit from the non-permanent underpricing and load on the stocks that were temporarily cheap.

To prove the claim, I exploit the fund-level variation in the average exposure to the US fund sale of the Mexican stocks they had in their portfolios. The aim is to see (1) whether higher values of average portfolio exposure were related to more sales of the mispriced stocks, and (2) whether lower values were, in contrast, associated with more purchases. Using the same reasoning as in the previous section,

[11] See Footnote 5.

I employ an *ex-ante* measure of portfolio exposure, instead of one that is based on the actual number of shares sold by US funds of each Mexican stock. Specifically, I define a Mexican fund's (average) portfolio exposure as the mean *ex-ante* exposure, as in Section 1.3.2, of the Mexican stocks it owned at the beginning of April 2008. In other words, fund j's portfolio exposure PortExposure_j is calculated as

$$\text{PortExposure}_j = \sum_{s \in S} w_{js} \frac{N_s^{US}}{N_s}, \tag{1.4}$$

where w_{js} is the weight of stock s in j's portfolio at the start of 2008Q2, N_s the total number of shares outstanding, and N_s^{US} the number of shares held by US funds. From the summary statistics in Table 1.1, the percentage of the Mexican funds' portfolios that were exposed to the US fund sale had a mean of 3.1% and a maximum value of 5.8%.

At a quarterly frequency and separately for two Mexican fund groups, Figure 1.3 displays, the cumulative aggregate net purchases of high and low exposure stocks as a percentage of the aggregate portfolio value at the start of April 2008. Funds are in the low portfolio exposure group if PortExposure_j is less than or equal to 4%, while they are in the high portfolio exposure group if PortExposure_j is greater than 4%. The quarterly net purchases are similarly defined as in Section 1.3.1. Even at the aggregate level, one already observes a heterogeneity in how the high and low portfolio exposure funds shuffled their stock holdings as a result of the US fund sale. It appears that low portfolio exposure funds sold their low exposure stocks and increased their positions in high exposure stocks. High portfolio exposure funds did the reverse; they unloaded their high exposure stocks and bought low exposure stocks.

To properly test for these opposing portfolio reallocation decisions across portfolio exposure levels, I run the following stock-fund-level regression model using

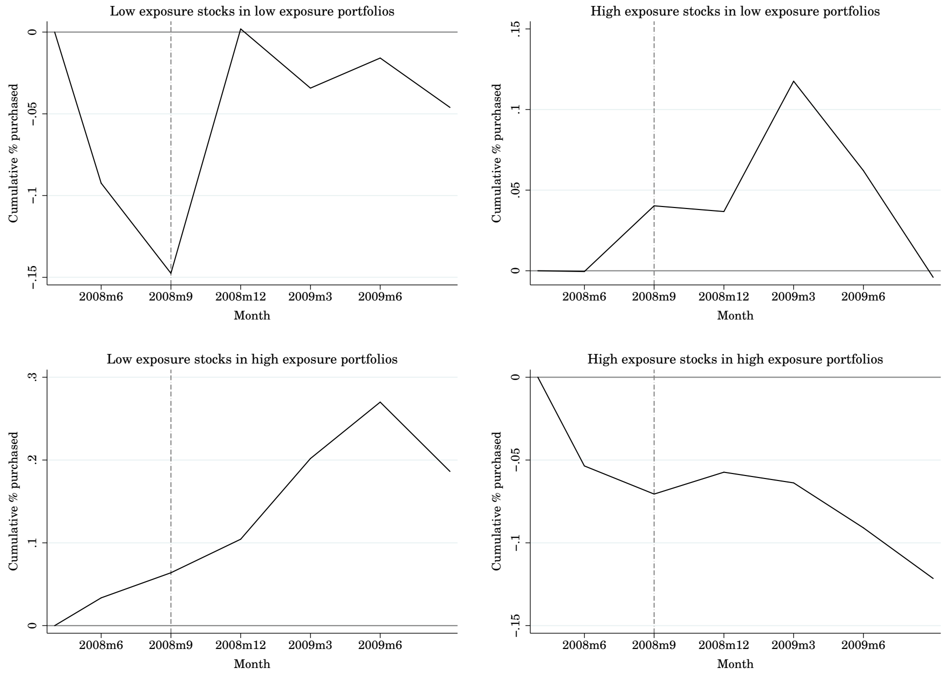


Figure 1.3

AGGREGATE CUMULATIVE NET PURCHASES BY MEXICAN FUNDS
OF HIGH AND LOW EXPOSURE MEXICAN STOCKS ACROSS PORTFOLIO EXPOSURE

The four panels illustrate the cumulative aggregate net purchases of high and low exposure stocks by high and low portfolio exposure funds as a percentage of the aggregate portfolio value at the start of April 2008. Stocks have high exposure if, at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares. Low exposure stocks, on the other hand, are at most 1% US-fund-owned at the start of April 2008. Funds are in the low portfolio exposure group if portfolio exposure is less than or equal to 4%, while they are in the high portfolio exposure group if portfolio exposure is greater than 4%. The quarterly net purchases are the sum of monthly net purchases, where monthly net USD purchases of a specific stock are the change in the number of shares held by the fund during a specific month multiplied by the end-of-month stock price.

data from 2008Q2:[12]

$$\begin{aligned}\text{PctNetPurch}_{js} = &\beta_0^4 + \beta_S^4 \text{I}_s(\text{High exposure}) + \beta_F^4 \text{PortExposure}_j \\ &+ \beta_{SF}^4 \text{I}_s(\text{High exposure}) \times \text{PortExposure}_j + \psi^{4'} Z_s \\ &+ \xi^{4'} Z_s \times \text{PortExposure}_j + \eta^{4'} X_j^{MEX} + \varepsilon_{js}^4, \end{aligned} \tag{1.5}$$

[12]Stronger conclusions would be achieved by employing a difference-in-differences estimation technique in this case, but the earliest information on Mexican fund holdings available in the Morningstar database is only from March 2008.

where PctNetPurch_{js} is the net purchases by fund j of stock s divided by j's portfolio market value at the start of April 2008, Z_s a vector of stock characteristics, X_j^{MEX} a vector of fund characteristics, and ε_{js}^4 the error term. I include the interaction term of PortExposure_j with the stock characteristics to make sure that any effect I obtain is not driven by other stock-level variables that are correlated with stock exposure. Again, the dummy for the other treated group, I_s(Medium exposure), and its interaction term with PortExposure_j are in the regressions but omitted from Equation 1.5 for brevity. Fund controls include the lag of fund performance, the volatility of excess returns, the betas with respect to Mexico's and the US' four Carhart risk factors, the beta with respect to the level of VIX, the beta with respect to the aggregate liquidity shock in the US, the lag of quarterly per-unit flow, the lag of the logarithm of total net assets, the log of the age in months, the expense ratio, a dummy for retail funds, a dummy for institutional funds, a dummy for index funds, and the percentage of cash in the portfolio at the start of 2008Q2. The stock controls are the variables in Z_{sm} of Equation 1.2 and the lag of the 4-factor Carhart alpha.

If low portfolio exposure funds systematically bought high exposure stocks, then the estimate for β_S^4 must be positive and statistically significant. On the other hand, if high portfolio exposure funds tilted their portfolios away from these US-fund-owned stocks, then the estimate for β_{SF}^4 must be significantly negative. The results in the first three columns of Table 1.5 are supportive of the hypothesis. If the average Mexican fund, with portfolio value equal to 1.73 billion MXN, had zero portfolio exposure, it would have 87.45 million MXN[13] more net purchases of high exposure stocks than of low exposure stocks. Because the estimate for β_{SF}^4 is negative, the difference between the net purchases of high and low exposure stocks shrinks as portfolio exposure is increased. A two-standard-deviation or a 3.38-percent increase in portfolio exposure decreases this difference by 114.55 million MXN. As in Section 1.3.1, I differentiate between positive and negative net purchases to determine if these findings are driven solely by lower purchases and not by increased sales. The estimates for β_{SF}^4 that are negative in Columns 4

[13]This is calculated by multiplying the estimate for β_S^4 by the average portfolio market value and by the number of high exposure stocks (15).

Table 1.5

SALES AND PURCHASES OF MEXICAN EQUITY BY MEXICAN FUNDS

The table below contains the estimates of stock-fund-level regressions of net MXN purchases by a fund of a particular stock on dummies for stock groups formed according to US fund ownership, portfolio exposure of the fund, and their interaction terms. The dependent variable for the regression results shown in columns 1, 2 and 3 is a Mexican fund's net MXN purchases of a particular stock in 2008Q2 as a percentage of the market value of the portfolio at the beginning April 2008. For columns 4, 5 and 6, the dependent variable is the positive part of net MXN purchases, while that for columns 7, 8 and 9 is the negative part. Net MXN purchases is similarly defined as in Table 1.2. Fund-level portfolio exposure is the portfolio-value-weighted average of the percentage of Mexican stocks' outstanding shares held by US funds at the start of April 2008. The variable *I(High stock exposure)* take value 1 if, at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares and zero otherwise. The variable *I(Medium stock exposure)* is a stock-level dummy for US fund ownership of outstanding shares between 1% and 4%. The included fund and stock controls are discussed in the main text. Standard errors that are two-way clustered at the fund and stock levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

	Net purchases in %			Net purchases in %× (Net purchases > 0)			|Net purchases in %|× (Net purchases < 0)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Portfolio exposure	11.618	8.831	11.618	−24.918	−4.029	−24.918	−36.536***	−12.860	−36.536***
	(29.470)	(17.951)	(29.471)	(23.018)	(12.969)	(23.088)	(11.844)	(9.478)	(12.020)
I(Medium stock exp.)	0.274***	0.341***	0.341***	0.086*	0.118**	0.118**	−0.188***	−0.223***	−0.223***
	(0.101)	(0.119)	(0.120)	(0.049)	(0.048)	(0.048)	(0.054)	(0.072)	(0.072)
I(Medium stock exp.)×	−6.905***	−6.905***	−6.905***	−0.101	−0.101	−0.101	6.804***	6.804***	6.804***
Portfolio exp.	(2.452)	(2.449)	(2.469)	(1.119)	(1.144)	(1.163)	(1.936)	(1.957)	(1.969)
I(High stock exp.)	0.273**	0.337**	0.337**	0.105*	0.189***	0.189***	−0.168*	−0.148	−0.148
	(0.107)	(0.141)	(0.141)	(0.063)	(0.071)	(0.071)	(0.094)	(0.130)	(0.131)
I(High stock exp.)×	−13.060***	−13.060***	−13.060***	−4.069***	−4.069***	−4.069***	8.990**	8.990**	8.990**

(Continued)

Table 1.5–*Continued*

	Net purchases in %			Net purchases in %× (Net purchases > 0)			|Net purchases in %|× (Net purchases < 0)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Portfolio exp.	(3.554)	(3.540)	(3.571)	(1.443)	(1.449)	(1.469)	(3.539)	(3.564)	(3.571)
Fund and stock controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stock controls×Port. exp.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund style fixed effects	Yes		Yes	Yes		Yes	Yes		Yes
Industry fixed effects		Yes	Yes		Yes	Yes		Yes	Yes
Number of observations	1,953	1,953	1,953	1,953	1,953	1,953	1,953	1,953	1,953
R^2	0.011	0.011	0.011	0.012	0.013	0.015	0.015	0.016	0.018

to 6 and positive in Columns 7 to 9 suggest that this is not the case.

Some authors find that institutional investors act in a way that reinforces departures of prices from fundamental values (Brunnermeier and Nagel, 2004; Edelen et al., 2016), while others document the opposite (Akbas et al., 2015; Kokkonen and Suominen, 2015; Cao et al., 2016). Similar to Giannetti and Kahraman (2016), the results in this section put forward a fund characteristic, portfolio exposure to the mispricing, that could possibly explain the divergent conclusions of the other papers.

1.3.4 Underpricing of Mexican stocks: Indirect exposure

The buying pressure of low portfolio exposure funds was a counterbalancing force to the selling pressure from US funds. On the other hand, prices of high exposure stocks that were largely held by high portfolio exposure funds received further strain from these Mexican funds that were likewise selling these US-fund-owned Mexican stocks. In this section, I seek to find out if the Mexican fund trades were able to affect the undervaluation of Mexican stocks. In particular, I ask whether low portfolio exposure funds were successful in dampening the negative price effects of the US fund sale, and whether high portfolio exposure funds played any role in strengthening stock mispricing.

Aside from classifying Mexican stocks according to their ex-ante *direct* exposure to the US fund sale, I divide them along another dimension. For each stock, I compute a measure of its exposure to the Mexican funds' buying and selling decisions in the first quarter of 2008. Because Mexican funds with low ex-ante portfolio exposure had a greater propensity to buy high exposure stocks, while those with high values tended to sell them, a natural candidate for this measure would be the *average* ex-ante portfolio exposure of the Mexican funds that held the stock at the start of April 2008. The higher the value of the stock-level average portfolio exposure is, the more likely it is for a high exposure stock to be sold by both US and Mexican funds in 2008Q2, and the more extreme is the expected decline in abnormal returns. There, however, is an obvious problem with working with this measure since this, by construction, is greater for stocks with higher *direct* exposure. This means that the conclusions I would reach if I were to use it could be attributable to having more shares in US fund portfolios rather than to belonging to a Mexican fund that was more likely to sell it.

I resolve to employ a measure similar to the average portfolio exposure, but I remove the contribution of a particular stock's direct exposure on the portfolio exposure of each Mexican fund that owned it. In effect, this quantifies the average direct exposure of all the other Mexican stocks that it shared a Mexican fund with or, in other words, the average direct exposure of its *fund peers*. Given stock s, I compute the variable PeerExposure_{sj} for each Mexican fund j:

$$\text{PeerExposure}_{sj} = \frac{\displaystyle\sum_{s' \in S \cap \{s\}^C} w_{js'} \frac{N_{s'}^{US}}{N_{s'}}}{\displaystyle\sum_{s' \in S \cap \{s\}^C} w_{js'}} = \frac{\text{PortExposure}_j - w_{js} \dfrac{N_s^{US}}{N_s}}{\displaystyle\sum_{s' \in S \cap \{s\}^C} w_{js'}},$$

where $S \cap \{s\}^C$ is the set of all Mexican stocks other than s and the other variables are defined in the same way as in Equation 1.4. The new variable $\text{IndirectExposure}_s$ that categorizes the stocks depending on their exposure to the Mexican mutual fund trades is just the average of PeerExposure_{sj}, weighted by the percentage owned by each fund of the stock's outstanding shares:

$$\text{IndirectExposure}_s = \sum_{j \in J} \frac{N_{sj}}{N_s} \text{PeerExposure}_{sj},$$

where N_{sj} is the number of shares of s present in the portfolio of j at the beginning of April 2008 and J the set of all Mexican funds.

The conjecture is that stocks with both high direct and high indirect exposure (HH stocks, as in the notation of Figure 1.1) suffered more severe underpricing than high direct and low indirect exposure stocks (HL stocks). To test this, I perform a similar difference-in-differences estimation as in Section 1.3.2, but, this time, I differentiate between low and high indirect exposure stocks in the high direct exposure stock category. Specifically, I assign high direct exposure stocks to low, medium, and high indirect exposure groups, with the cutoff values being the terciles of indirect exposure for high direct exposure stocks. The regression model in Equation 1.3 now becomes

$$\begin{aligned}\text{CAR}_{st} =& \beta_0^5 + \beta_{HL}^5 \text{I}_s(\text{HL}) + \beta_{HH}^5 \text{I}_s(\text{HH}) + \beta_D^5 \text{I}_t(\text{Drop}) + \beta_R^5 \text{I}_t(\text{Reversal}) \\ &+ \beta_{HL,D}^5 \text{I}_s(\text{HL}) \times \text{I}_t(\text{Drop}) + \beta_{HL,R}^5 \text{I}_s(\text{HL}) \times \text{I}_t(\text{Reversal}) \\ &+ \beta_{HH,D}^5 \text{I}_s(\text{HH}) \times \text{I}_t(\text{Drop}) + \beta_{HH,R}^5 \text{I}_s(\text{HH}) \times \text{I}_t(\text{Reversal}) + \varepsilon_{st}^5,\end{aligned} \tag{1.6}$$

where I_s(High, low) is a dummy for HL stocks, I_s(High, high) a dummy for HH stocks, I_t(Drop) a dummy for the price drop period, I_t(Reversal) a dummy for the price reversal period, and ε_{st}^5 the error term. The regressions are run with I_s(Medium exposure) and I_s(High, medium) (i.e., the dummy for high direct and medium indirect exposure stocks), but they are excluded from Equation 1.6 to save space.

The results are presented in Table 1.6. They confirm that the lower cumulative abnormal returns during the price drop period obtained in Section 1.3.2 were in fact concentrated in HH stocks. The statistically significant effect of the simultaneous US and Mexican fund sales was a 34.3% decrease in cumulative abnormal returns relative to the low direct exposure stocks (i.e., the control group). On the other hand, the decline in CARs of HL stocks, since they did not experience any additional selling pressure from Mexican funds, was around 17% lower and only statistically significant for the third specification. In all three regression specifications, the difference between the estimates for $\beta_{HH,D}$ and $\beta_{HL,D}$ is significant at the 10% level. Lastly, as proof that this deterioration in prices was not related to fundamentals, the CARs of HH stocks were greater than those of the control from May 2009 to December 2009.[14] Taken together, this implies that the portfolio rebalancing of Mexican mutual funds after the US fund sale was instrumental to mitigating the propagation of the financial crisis to HL stocks, while at the same time being partly responsible for the underpricing of HH stocks.

[14]The difference between $\beta_{HH,R}$ and $\beta_{HL,R}$ is significant at the 10% level only for the first two specifications.

Table 1.6

UNDERPRICING OF MEXICAN STOCKS: INDIRECT EXPOSURE

The table below contains the estimates of stock-period-level regressions of cumulative abnormal returns on dummies for stock groups formed according to direct and indirect exposure to the US fund sale, period dummies, and their interaction terms. The dependent variable is a Mexican stock's cumulative abnormal monthly return during either the pre-crisis, price drop, or price reversal periods. Cumulative abnormal monthly returns are the sum of abnormal monthly returns over the period being considered. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. The pre-crisis period is from December 2007 to March 2008. The price drop period spans from April 2008 to April 2009, while May 2009 to December 2009 is the price reversal period. A stock had high direct exposure if at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares. Medium direct exposure pertains to US fund ownership of outstanding shares between 1% and 4%. High direct exposure stocks are further divided into three groups according to indirect exposure. A Mexican stock's indirect exposure is the average direct exposure of its peers, i.e., those Mexican stocks that it shared a Mexican fund with. Stocks had low, medium, or high indirect exposure if the value is in the first, second, or third tercile, respectively. The variable *I(High direct, high indirect)* is a dummy for a stock that had both high direct and indirect exposure. The dummy *I(High direct, low indirect)* is defined similarly. The terms with *I(High direct, Medium indirect)* are included in the regressions but omitted from the table to conserve space. Standard errors clustered at the stock level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Cumulative abnormal monthly return*	(1)	(2)	(3)
I(Medium direct exposure)	0.001	0.000	0.007
	(0.021)	(0.028)	(0.020)
I(High direct, low indirect)	0.019	0.031	0.025
	(0.025)	(0.045)	(0.035)
I(High direct, high indirect)	−0.042	−0.034	−0.025
	(0.045)	(0.049)	(0.046)
I(Price drop)	0.090*	0.090*	
	(0.052)	(0.052)	
I(Medium direct exposure)×I(Price drop)	−0.080	−0.080	−0.121*
	(0.063)	(0.063)	(0.073)
I(High direct, low indirect)×I(Price drop)	−0.116	−0.116	−0.175*
	(0.075)	(0.075)	(0.100)
I(High direct, high indirect)×I(Price drop)	−0.291***	−0.291***	−0.343***
	(0.089)	(0.089)	(0.083)

(Continued)

Table 1.6–*Continued*

Dependent variable: *Cumulative abnormal monthly return*	(1)	(2)	(3)
I(Price reversal)	-0.063^{**}	-0.063^{**}	
	(0.028)	(0.028)	
I(Medium direct exposure)×I(Price reversal)	0.096^{*}	0.096^{*}	0.116^{***}
	(0.049)	(0.049)	(0.045)
I(High direct, low indirect)×I(Price reversal)	0.028	0.028	0.104^{*}
	(0.055)	(0.055)	(0.055)
I(High direct, high indirect)×I(Price reversal)	0.145^{**}	0.145^{**}	0.171^{***}
	(0.060)	(0.060)	(0.060)
Industry fixed effects		Yes	
Industry×Period fixed effects			Yes
Number of observations	156	156	147
R^2	0.155	0.159	0.192

To show that these conclusions are robust to the definition of the pre-crisis period used, I rerun the regressions using two alternative specifications. Table 1.8 in the Appendix demonstrates that the findings still hold even when either September 2007 or June 2007 is chosen as the start of the pre-crisis period. One can additionally argue that, since fund managers may have the tendency to hold stocks with similar characteristics, stocks that have higher indirect exposure may also be those with higher direct exposure. This may mean that the underpricing of HH stocks in fact comes from their having higher direct exposure than HL stocks and not from their being grouped with other high direct exposure stocks. To address this issue, I perform a similar difference-in-differences estimation as in Equation 1.6, but this time I divide the high direct exposure stocks into three terciles depending on their direct exposure. The results are in Table 1.9 in the Appendix. It can be seen that the estimates of the effect of the price drop period on the high direct exposure stocks in the bottom and top terciles are similar. This enables one to rule out the alternative explanation.

These findings validate the claim of other papers (Akbas et al., 2015; Kokkonen and Suominen, 2015; Cao et al., 2016) that the reaction of institutional investors to price deviations from fundamental values can, in turn, influence the degree of mispricing. Their empirical strategies are, however, not free of issues. All these studies define an *ex-post* measure of mispricing and regress this variable (or changes in it) on a measure of institutional trading. This set-up, however, begs the following question: Why did these investors not act earlier? In other words, why is the price anomaly even found in the data if there were agents to rectify it in the first place? In addition, the positive relationship they find between institutional trading and the disappearance of mispricing may just be a product of momentum trading (Brunnermeier and Nagel, 2004). In particular, higher institutional trading coexisting with higher prices of previously underpriced stocks could just mean that these agents are buying a stock whose price has started to increase. The current study solves these problems by using a stock's *ex-ante* susceptibility to the mispricing, instead of an *ex-post* measure, to conclude that the trades of some Mexican mutual funds were the reason why one does not observe (statistically significant) lower abnormal returns for some stocks (i.e., HL stocks) that should have been undervalued.

1.4 Concluding remarks

In this chapter, I have presented empirical evidence that Mexican mutual funds were not mere spectators, but instead were very involved in the transmission of the US crisis to the Mexican stock market at the beginning of April 2008. I have shown that due to deteriorating market conditions in the US, US mutual funds sold their Mexican equity at the start of 2008Q2 en masse. On average, this sale lowered the returns of the Mexican stocks in the US funds' portfolios. I have found that Mexican funds, as a reaction to this underpricing, rebalanced their stock holdings, albeit in different ways. Potentially due to fear of substantial outflows from their investors, Mexican funds that held a large amount of the US-fund-owned Mexican stocks decreased their positions in these undervalued stocks to protect fund returns. On the other hand, funds that did not have as much sought to profit from the mispricing, bought the US-fund-owned stocks, and functioned as arbitrageurs by acting to lead prices back closer to fundamental values. Finally, I have established that these trades further affected the magnitude of the price decline of Mexican stocks; US-fund-owned stocks that were also mostly held by the selling Mexican funds were, in fact, the only ones that suffered underpricing.

Domestic mutual funds can, therefore, play a crucial role in mitigating the effects of international crises on the stock market. My empirical findings allude to possible constraints from doing so arising from fund performance concerns. Insomuch as these fund considerations are a product of the open-end structure of the Mexican mutual funds in my sample, my results indirectly contribute to the debate on the optimal organization of the mutual fund industry (Edelen, 1999; Stein, 2005; Chen et al., 2010; Liu and Mello, 2011). Proponents of the open-end structure cite the disciplining effect on managers of the easy withdrawal of fund shares, in the same way Calomiris and Kahn (1991) reason in favor of demandable bank deposits. On the other hand, Giannetti and Kahraman (2016) demonstrate that higher share redemption restrictions lead hedge funds to buy undervalued stocks more. Hence, they increase the possibility that mispricing is corrected. The conclusions in this chapter imply that, in an increasingly connected global financial system, an open-end structure for institutional investors might inadvertently expose financial markets to international contagion.

1.5 Appendix

Table 1.7

UNDERPRICING OF MEXICAN STOCKS (DIRECT EXPOSURE)

DIFFERENT PRE-CRISIS PERIODS

The table below contains the estimates of stock-period-level regressions of cumulative abnormal returns on dummies for stock groups formed according to US fund ownership, period dummies, and their interaction terms. The dependent variable is a Mexican stock's cumulative abnormal monthly return during either the pre-crisis, price drop, or price reversal periods. Cumulative abnormal monthly returns are the sum of abnormal monthly returns over the period being considered. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. The pre-crisis period is either from September 2007 to March 2008 (columns 1 to 3) or from June 2007 to March 2008 (columns 4 to 6). The price drop period spans from April 2008 to April 2009, while May 2009 to December 2009 is the price reversal period. The variable *I(High stock exposure)* takes value 1 if, at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares and zero otherwise. The variable *I(Medium stock exposure)* is a dummy for US fund ownership of outstanding shares between 1% and 4%. Standard errors clustered at the stock level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Pre-crisis period					
Cumulative abnormal	Sep 2007 to Mar 2008			Jun 2007 to Mar 2008		
monthly return	(1)	(2)	(3)	(4)	(5)	(6)
I(Medium exp.)	0.013	0.005	0.002	−0.005	0.004	0.013
	(0.037)	(0.043)	(0.040)	(0.045)	(0.049)	(0.050)
I(High exp.)	0.005	0.009	0.009	−0.025	0.003	0.020
	(0.041)	(0.051)	(0.051)	(0.048)	(0.054)	(0.058)
I(Price drop)	0.102**	0.102**		0.091	0.091	
	(0.052)	(0.052)		(0.056)	(0.056)	
I(Medium exp.)×	−0.107*	−0.107*	−0.134*	−0.094	−0.094	−0.151*
I(Price drop)	(0.063)	(0.063)	(0.074)	(0.067)	(0.067)	(0.082)
I(High exp.)×	−0.197***	−0.197***	−0.255***	−0.171**	−0.171**	−0.268***
I(Price drop)	(0.066)	(0.066)	(0.080)	(0.074)	(0.074)	(0.092)
I(Price reversal)	−0.056*	−0.056*		−0.065	−0.065	
	(0.033)	(0.033)		(0.039)	(0.039)	
I(Medium exp.)×	0.083	0.083	0.118***	0.094	0.094	0.123**
I(Price reversal)	(0.053)	(0.053)	(0.044)	(0.061)	(0.061)	(0.055)
I(High exp.)×	0.074	0.074	0.134**	0.086	0.086	0.133**

(Continued)

Table 1.7–*Continued*

Dependent variable:	Pre-crisis period					
Cumulative abnormal	Sep 2007 to Mar 2008			June 2007 to Mar 2008		
monthly return	(1)	(2)	(3)	(4)	(5)	(6)
I(Price reversal)	(0.050)	(0.050)	(0.055)	(0.061)	(0.061)	(0.063)
Industry FE		Yes			Yes	
Industry×Period FE			Yes			Yes
No. of obs.	153	153	144	147	147	138
R^2	0.095	0.095	0.126	0.091	0.084	0.139

Table 1.8

UNDERPRICING OF MEXICAN STOCKS (INDIRECT EXPOSURE)

DIFFERENT PRE-CRISIS PERIODS

The table below contains the estimates of stock-period-level regressions of cumulative abnormal returns on dummies for stock groups formed according to direct and indirect exposure to the US fund sale, period dummies, and their interaction terms. The dependent variable is a Mexican stock's cumulative abnormal monthly return during either the pre-crisis, price drop, or price reversal periods. Cumulative abnormal monthly returns are the sum of abnormal monthly returns over the period being considered. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. The pre-crisis period is either from September 2007 to March 2008 (columns 1 to 3) or from June 2007 to March 2008 (columns 4 to 6). The price drop period spans from April 2008 to April 2009, while May 2009 to December 2009 is the price reversal period. A stock had high direct exposure if at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares. Medium direct exposure pertains to US fund ownership of outstanding shares between 1% and 4%. High direct exposure stocks are further divided into three groups according to indirect exposure. A Mexican stock's indirect exposure is the average direct exposure of its peers, i.e., those Mexican stocks that it shared a Mexican fund with. Stocks had low, medium, or high indirect exposure if the value is in the first, second, or third tercile, respectively. The variable *I(HH)* is a dummy for a stock that had both high direct and indirect exposure. The dummy *I(HL)* is for a stock that had high direct but low indirect exposure. The terms with *I(HM)* are included in the regressions but omitted from the table to conserve space. Standard errors clustered at the stock level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Pre-crisis period					
Cumulative abnormal	Sep 2007 to Mar 2008			Jun 2007 to Mar 2008		
monthly return	(1)	(2)	(3)	(4)	(5)	(6)
I(Med. exp.)	0.013	0.010	0.007	−0.005	0.011	0.021
	(0.037)	(0.042)	(0.039)	(0.045)	(0.047)	(0.049)
I(HL)	0.036	0.081*	0.061	−0.002	0.072	0.087
	(0.038)	(0.044)	(0.045)	(0.056)	(0.052)	(0.054)
I(HH)	−0.043	−0.042	−0.041	−0.068	−0.051	−0.044
	(0.064)	(0.068)	(0.069)	(0.066)	(0.072)	(0.076)
I(Price drop)	0.102**	0.102**		0.091	0.091	
	(0.052)	(0.052)		(0.056)	(0.056)	
I(Med. exp.)×	−0.107*	−0.107*	−0.127*	−0.094	−0.094	−0.144*
I(Price drop)	(0.063)	(0.063)	(0.075)	(0.067)	(0.067)	(0.082)
I(HL)×	−0.146*	−0.146*	−0.164	−0.121	−0.121	−0.198*
I(Price drop)	(0.077)	(0.077)	(0.105)	(0.089)	(0.089)	(0.116)
I(HH)×	−0.284***	−0.284***	−0.323***	−0.265**	−0.265**	−0.322***

(Continued)

Table 1.8–*Continued*

Dependent variable:	Pre-crisis period					
Cumulative abnormal	Sep 2007 to Mar 2008			Jun 2007 to Mar 2008		
monthly return	(1)	(2)	(3)	(4)	(5)	(6)
I(Price drop)	(0.095)	(0.095)	(0.084)	(0.112)	(0.112)	(0.104)
I(Price reversal)	-0.056^{*}	-0.056^{*}		-0.065	-0.065	
	(0.033)	(0.033)		(0.039)	(0.039)	
I(Med. exp.)×	0.083	0.083	0.113^{**}	0.094	0.094	0.115^{**}
I(Price reversal)	(0.053)	(0.053)	(0.045)	(0.061)	(0.061)	(0.055)
I(HL)×	0.010	0.010	0.089	0.021	0.021	0.055
I(Price reversal)	(0.054)	(0.054)	(0.062)	(0.071)	(0.071)	(0.078)
I(HH)×	0.147^{*}	0.147^{*}	0.183^{***}	0.160^{*}	0.160^{*}	0.198^{**}
I(Price reversal)	(0.075)	(0.075)	(0.071)	(0.092)	(0.092)	(0.086)
Industry FE		Yes			Yes	
Industry×Period FE			Yes			Yes
No. of obs.	153	153	153	147	147	147
R^2	0.139	0.149	0.175	0.136	0.146	0.197

Table 1.9

UNDERPRICING OF MEXICAN STOCKS (DIRECT EXPOSURE)

DIVIDING HIGH DIRECT EXPOSURE STOCKS INTO DIRECT EXPOSURE TERCILES

The table below contains the estimates of stock-period-level regressions of cumulative abnormal returns on dummies for stock groups formed according to direct exposure to the US fund sale, period dummies, and their interaction terms. The dependent variable is a Mexican stock's cumulative abnormal monthly return during either the pre-crisis, price drop, or price reversal periods. Cumulative abnormal monthly returns are the sum of abnormal monthly returns over the period being considered. Abnormal monthly returns are the residuals of a regression of the stock's monthly 4-Factor Carhart alpha on stock-level variables (as discussed in the main text), monthly dummies, and their interaction terms from December 2007 to December 2009. The pre-crisis period is from December 2007 to March 2008. The price drop period spans from April 2008 to April 2009, while May 2009 to December 2009 is the price reversal period. A stock had high direct exposure if at the beginning of April 2008, US funds held at least 4% of the stock's outstanding shares. Medium direct exposure pertains to US fund ownership of outstanding shares between 1% and 4%. High direct exposure stocks are further divided into three groups according to, again, direct exposure; these stocks can be in the low, medium, or high terciles. The variable *I(High direct, high tercile)* is a dummy for a stock (1) that has high direct exposure and (2) that also is in the top tercile of direct exposure among high direct exposure stocks. The dummy *I(High direct, low tercile)* is defined similarly. The terms with *I(High direct, Medium tercile)* are included in the regressions but omitted from the table to conserve space. Standard errors clustered at the stock level are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Cumulative abnormal monthly return*	(1)	(2)	(3)
I(Medium direct exposure)	0.001	-0.004	0.010
	(0.021)	(0.029)	(0.021)
I(High direct, low tercile)	0.041	0.010	0.061
	(0.030)	(0.048)	(0.043)
I(High direct, high tercile)	−0.033	−0.020	−0.027
	(0.042)	(0.066)	(0.062)
I(Price drop)	0.090*	0.090*	
	(0.052)	(0.052)	
I(Medium direct exposure)×I(Price drop)	−0.080	−0.080	−0.130*
	(0.063)	(0.063)	(0.074)
I(High direct, low tercile)×I(Price drop)	−0.153***	−0.153***	−0.312***
	(0.057)	(0.057)	(0.090)
I(High direct, high tercile)×I(Price drop)	−0.282***	−0.282***	−0.359***
	(0.085)	(0.085)	(0.099)
I(Price reversal)	−0.063**	−0.063**	

(Continued)

Table 1.9–*Continued*

Dependent variable: *Cumulative abnormal monthly return*	(1)	(2)	(3)
	(0.028)	(0.028)	
I(Medium direct exposure)×I(Price reversal)	0.096*	0.096*	0.102**
	(0.049)	(0.049)	(0.045)
I(High direct, low tercile)×I(Price reversal)	−0.013	−0.013	−0.008
	(0.046)	(0.046)	(0.083)
I(High direct, high tercile)×I(Price reversal)	0.130**	0.130**	0.227**
	(0.056)	(0.056)	(0.096)
Industry fixed effects		Yes	
Industry×Period fixed effects			Yes
Number of observations	156	156	147
R^2	0.148	0.146	0.187

Chapter 2

Monetary Policy and the Flow-performance Relationship of Mutual Funds

2.1 Introduction

The recent financial crisis that led to one of the worst global recessions since the Great Depression has sparked a lively debate regarding its origins. A widely-held view is that one of the main culprits is the loose monetary policy regime in the run-up to the crisis. Theory suggests that a reduction in the risk-free return encourages investors to search for yield by abandoning safe assets (Fishburn and Porter, 1976), and induces banks to increase leverage while assuming more risk (Dell'Ariccia et al., 2014). A number of studies confirm these hypotheses by demonstrating that when short-term interest rates are decreased, banks lower loan spreads for risky firms (Paligrova and Santos, 2017), provide more new loans with high risk ratings (Dell'Ariccia et al., 2017), extend credit to firms with greater *ex-ante* expected probability of default (Ioannidou et al., 2015), ask for less collateral while committing larger loan volumes to firms with low *ex-ante* creditworthiness (Jiménez et al., 2014), and increase their funding from more volatile non-core liabilities (Angeloni et al., 2015).

There have likewise been a few papers that tackle the nexus between monetary policy and risk-taking in the asset management industry (Chodorow-Reich, 2014), wherein there is a clear incentive to beat a certain benchmark and to boost relative performance. Di Maggio and Kacperczyk (2017) establish that money market funds (i.e., those funds that are legally bound to invest only in safe short-term securities) reallocated their portfolios toward the riskiest asset class they had access to (i.e., bank obligations) as a response to the Federal Reserve's decision to maintain zero short-term nominal rates after the crisis. The same phenomenon of reaching for yield when interest rates are low is documented by Choi and Kronlund (2017) in the corporate bond mutual fund market.

The implication of the portfolio allocation model of Fishburn and Porter (1976) is that a higher return from investing in safe assets leads to a reallocation from risky securities to safer ones, which then diminishes overall portfolio risk. Though this is a possible reason for the negative relationship between interest rates and risk-taking among fixed-income mutual funds, it is not immediately obvious why this should also apply to mutual funds that hold equity. Risk-free assets are, in principle, not part of the investment opportunity set of equity fund managers and it is not clear whether rate cuts have a heterogeneous and risk-dependent impact on risk premia.[1]

In this chapter, I propose a novel mechanism by which open-end mutual funds can be incentivized to take more risk when interest rates are depressed. I establish by developing a model and then empirically testing its predictions that when monetary policy is loosened, shareholder flows increase more for the worst-performing funds than for the best performers. In other words, poor fund returns are penalized to a lesser extent when rates decline. Because fund manager compensation is usually a percentage of total assets under management, the tendency of unsatisfactory returns not to induce proportional outflows (i.e., in comparison to the inflows superior returns attract) may motivate managers to invest in riskier securities.[2]

The main insight of this study is that the risk-free rate can affect the sensitivity of

[1] In fact, Bernanke and Kuttner (2005) hint that the opposite is happening. The authors detail that a surprise rate decrease results in higher stock prices, which they show come from lower expected excess returns, and that this effect is more pronounced for higher-beta stocks (i.e., riskier securities). See Drechsler et al. (2017) for a theoretical model that can explain these findings.

[2] See Brown et al. (1996), Chevalier and Ellison (1997), Sirri and Tufano (1998), Koski and Pontiff (1999), and Elton et al. (2003).

shareholder flows to performance through a costly information channel. I consider a two-period model with risk-averse, borrowing-constrained investors that seek to maximize payoffs at time-2 by choosing a portfolio composed of a riskless asset and a risky mutual fund at time-1. Taking into account that information about the manager's ability to generate returns is in reality asymmetric between a fund manager and her investors, I assume that time-invariant manager skill is unknown to investors. Nevertheless, fund performance is persistent, implying that the fund payoff in period 1, which is a noisy public signal of manager ability, can be used to more precisely estimate the period-2 payoff.

Aside from this public signal, investors can choose to acquire supplemental information about the fund (e.g., in the form of carefully studying a fund's prospectus and its historical performance). In particular, shareholders can decide to observe a perfect private signal of manager skill before the realization of the period-1 payoff, albeit at a cost. Solving the model yields that there is less private information acquisition if the risk-free rate is increased. Indeed, a higher return from holding the riskless asset disincentivizes investment in the mutual fund, and hence, discourages the purchase of the private signal.

The model additionally demonstrates that the effect of less private information on flows is that it decreases fund investment for low period-1 payoffs, while it increases the shareholders' holdings of the fund for high period-1 payoffs. This is due to the fact that without the private signal, investors only have the first-period payoff to infer ability from, so poor past performance leads to minimum (zero) investment, while an excellent period-1 payoff encourages investors to hit their borrowing limit and obtain the maximum ownership of the fund possible. With private information, investment in the fund for these two cases is not too extreme, as low past performance can sometimes come from a fund manager with high ability and vice versa.

In the end, the main empirical prediction of the model, which is that a higher risk-free rate diminishes investment in the mutual fund but more so in the lower end of the performance distribution, is derived from two effects, which I call the *yield effect* and the *information effect*. A better payoff for the riskless asset not only makes the mutual fund less attractive as an investment option (yield effect) but it also curtails the incentives to obtain private information (information effect). Whereas the yield effect results in reduced holdings in the fund for all levels of performance, less information makes investors rely more on the public signal, which further decreases investment for bad performance while counteracting the yield effect for good performance.

To improve the identification of the costly information channel of the effect of the risk-free rate on fund flows, I likewise present a cross-sectional implication of the model. I show that when private information is more expensive, the information effect becomes more pronounced. In particular, increasing the riskless rate lowers investment more for a high-cost fund than for a low-cost fund when period-1 payoff is poor.

I close the second chapter by providing empirical evidence for the predictions of the model. I use the effective Federal funds rate as the risk-free interest rate and demonstrate that a 1% increase in the Federal funds rate lessens shareholder flows into the best-performing funds by 0.19% of total assets. The effect on the worst performers is a decrease of 0.26%, with the difference between the two groups being statistically significant. These numbers translate to an average outflow of 2.07 million USD in the higher end of the performance distribution and 2.37 million USD in the lower end. I verify that these results are robust to the inclusion of macroeconomic variables and their forecasts as additional regressors (since they may be correlated with the Federal funds rate) and to using the 1-year Treasury yield as an alternative definition of the riskless rate.

Finally, because young funds only have a short time series of past returns to learn manager ability from, I use the age of a fund as a proxy for information costs and show that for young funds (i.e., high-cost funds), the decline in flows for superior performance is in fact 0.14% less than for old funds while the reduction in flows for unsatisfactory past returns is greater by 0.14%. That is, for every percent increase in the effective Federal funds rate, the impact of high information costs on young funds is an inflow of almost half a million USD if the fund is one of last month's winners and an outflow of 390 thousand USD if it is one of the losers.

The findings do not change when I add return volatility as an independent variable in the regression or when I control for prior belief of manager ability, as proxied by past long-term return and prior fund family performance.

As its main contribution, this study draws special attention to a novel dimension of the risk-taking channel of monetary policy. Prior research on this topic has suggested that a low policy rate leads to portfolio reallocation toward risky securities due (1) to lower-yielding safe assets (Fishburn and Porter, 1976; Rajan, 2005) and (2) to reduced risk perceptions brought about by low asset price volatility (Gambacorta, 2009; Adrian and Shin, 2010; Borio and Zhu, 2012). In contrast to these explanations that only center on the agent in the principal-agent relationship inherent to the asset management industry, the model presented here considers how the tightness of monetary policy changes the behavior of the principal, which then affects the tendency of the agent to take more risk.

Furthermore, this chapter is related to previous papers that highlight how the central bank's monetary policy stance can be a determinant of mutual fund flows (Feroli et al., 2014; Banegas et al., 2016). While their authors mainly consider the risk-free rate's effect on aggregate flows, this chapter additionally emphasizes its consequences for the shape of fund-level flows. Subsequently, my empirical results likewise put monetary policy at the forefront as another reason for the asymmetry of the flow-performance relationship, in addition to fund age (Chevalier and Ellison, 1997; Berk and Green, 2004), information costs (Sirri and Tufano, 1998; Huang et al., 2007), aggregate flows to the mutual fund industry (Fant and O'Neal, 2000), clientele characteristics (Del Guercio and Tkac, 2002), and the level of development of the country where the fund is headquartered (Ferreira et al., 2012).

The remainder of the chapter is organized as follows. Section 2 develops and solves the model of portfolio allocation with costly information. The data sources and the definition of the variables used for the empirical analysis are in Section 3. Section 4 tests the implications of the model, while Section 5 concludes.

2.2 Model

To explore the costly information channel of the effect of the risk-free rate on the response of mutual fund flows to past performance, I consider a theoretical set-up that is a modified version of that of Huang et al. (2007) (henceforth, HWY). Their framework seeks to explain the asymmetric flow-performance relationship through differences in the participation cost of mutual fund shareholders. In particular, they establish that flows into funds with low participation costs react more to medium performance and less to high performance than higher-cost funds.

2.2.1 Set-up

The economy consists of three dates, $t = 0, 1, 2$, and two periods. There are two types of agents, namely, risk-averse investors and a mutual fund manager. There is a measure-1 continuum of investors who all have initial wealth of 1, which they allocate at $t = 1$ between a risk-free asset and the mutual fund. Every unit invested in the riskless asset yields a payoff of $R_F \geq 1$ at $t = 2$. Investors are likewise allowed to borrow at the risk-free rate $R_F - 1$.

Mutual fund shares are risky. The fund's publicly-observable one-period per-unit payoff R_t at $t = 1, 2$ is persistent and can be expressed as

$$R_t = R + \frac{1}{\sqrt{\alpha_T}}\varepsilon_t, \tag{2.1}$$

where R is time-invariant manager ability, the noise ε_t is independently and identically distributed across time with a standard normal distribution, and $\alpha_T > 0$.[3] As in HWY, R can be viewed as the skill of the manager to generate returns in excess of a benchmark. I assume that R is unknown to investors but that they do have a common prior belief concerning manager ability; that is, it is common knowledge that R is normally distributed with mean $\mu > R_F$ and variance $1/\alpha_0$.

[3]The persistence of mutual fund manager skill has been studied extensively. Empirical evidence on whether fund returns persist through time or not is mixed (Grinblatt and Titman, 1992; Hendricks et al., 1993; Brown and Goetzmann, 1995; Malkiel, 1995; Gruber, 1996; Carhart, 1997; Wermers, 2003; Bollen and Busse, 2004; Berk and Tonks, 2007).

Specifically, R can be represented as

$$R = \mu + \frac{1}{\sqrt{\alpha_0}}\varepsilon_0, \tag{2.2}$$

where ε_0 is a noise term with a standard normal distribution.

Investors are Bayesian updaters who, while constructing their portfolios at $t = 1$, use the first-period per-unit payoff R_1 to more precisely estimate R.[4] The public signal is however not the only source of information available to investors. Shareholders can additionally choose to acquire information by reading news about the fund, by studying the historical composition of its portfolio (and, hence, its investment strategies), and by finding out how it is rated by investment research companies. At the end of the first period and right before R_1 is made public, investors can decide to observe a private signal that is revealed together with R_1. An investor who chooses to do so (i.e., the investor is *informed*) learns R with certainty, but this comes at a cost that is paid at $t = 1$. The investor-level information cost c_i is heterogeneous across investors and is uniformly distributed over $[0, \bar{c}]$. After the realization of R_1, an informed investor's posterior distribution of the payoff R_2 is therefore

$$R_2|R_1, R \sim \mathrm{N}(R, 1/\alpha_T), \tag{2.3}$$

while that of an *uninformed* investor (i.e., one who does not invest in private information acquisition) is

$$R_2|R_1 \sim \mathrm{N}(\mu_R, \sigma^2_{R_2|R_1}), \tag{2.4}$$

where

$$\mu_R = \mathrm{E}[R_2|R_1] = \mu + \frac{\alpha_T}{\alpha_0 + \alpha_T}(R_1 - \mu) \text{ and}$$
$$\sigma^2_{R_2|R_1} = \mathrm{Var}[R_2|R_1] = \frac{1}{\alpha_T} + \frac{1}{\alpha_0 + \alpha_T}. \tag{2.5}$$

[4]Indeed, research shows that fund flows chase past performance. Shareholders exit funds that have poor prior returns, and they invest more in funds that did well in the previous period (Ippolito, 1992; Edelen and Warner, 1999; Huang et al., 2007; Spiegel and Zhang, 2013).

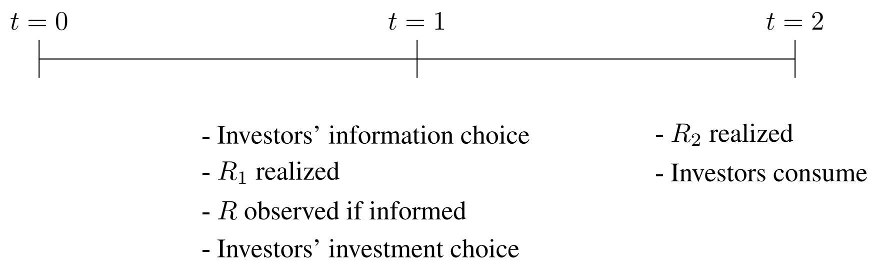


Figure 2.1
MODEL TIMELINE

Investors have exponential utility over terminal wealth at $t = 2$; that is, the utility function of investor i is $U(W_{2i}) = -\exp(-\rho W_{2i})$, where W_{2i} is the value of i's portfolio at $t = 2$ and $\rho > 0$ is the coefficient of risk aversion common to all investors. Similar to HWY, I impose a short-sale constraint on mutual fund shares as open-end funds cannot be sold short in real life. In addition, I assume that, because of credit risk, investors can borrow at most $\bar{B} \geq 0$ to invest in the mutual fund, that is, portfolio holdings of the fund cannot exceed $1 + \bar{B}$. The model timeline is displayed in Figure 2.1.

2.2.2 Investment choice

The goal of the model is to show how the risk-free rate affects private information acquisition and, consequently, flows into the fund at $t = 1$. Just like in HWY, investor i has two decisions at $t = 1$. First, she determines whether to pay c_i to observe R simultaneously with the costless public signal R_1. Afterwards, she chooses how much of her wealth to allocate between the risk-free asset and the mutual fund subsequent to the realization of her signals.

Solving the model backwards, I start by separately characterizing the optimal portfolio decisions of an informed and an uninformed investor as a function of their signals. Observing a high R_1 or a high R improves the conditional mean of R_2, which then increases the optimal investment in the fund. The lemma below summarizes the results.

Lemma 1. *The mutual fund investment I_1^U of an uninformed investor at $t = 1$ after observing R_1 is given by*

$$I_1^U(R_1, R_F) = \begin{cases} 0 & \text{if } R_1 < \underline{R}_1^U \\ \dfrac{\mu_R - R_F}{\rho\sigma^2_{R_2|R_1}} & \text{if } \underline{R}_1^U \leq R_1 \leq \bar{R}_1^U \\ 1 + \bar{B} & \text{if } \bar{R}_1^U < R_1 \end{cases}, \tag{2.6}$$

where

$$\underline{R}_1^U = R_F - \frac{\alpha_0}{\alpha_T}(\mu - R_F) \text{ and } \bar{R}_1^U = \underline{R}_1^U + \left(1 + \frac{\alpha_0}{\alpha_T}\right)\rho(1 + \bar{B})\sigma^2_{R_2|R_1}, \tag{2.7}$$

and μ_R and $\sigma^2_{R_2|R_1}$ are as defined in Equation 2.5. On the other hand, the mutual fund investment I_1^I of an informed investor at $t = 1$ after observing R_1 and R is given by

$$I_1^I(R_1, R, R_F) = I_1^I(R, R_F) = \begin{cases} 0 & \text{if } R < R_F \\ \dfrac{\alpha_T}{\rho}(R - R_F) & \text{if } R_F \leq R \leq \bar{R}_1^I \\ 1 + \bar{B} & \text{if } \bar{R}_1^I < R \end{cases}, \tag{2.8}$$

where

$$\bar{R}_1^I = R_F + \frac{1}{\alpha_T}\rho(1 + \bar{B}). \tag{2.9}$$

Proof. See Appendix. □

Notice that the informed investors' decision does not depend on R_1, as they already know managerial ability with certainty. Moreover, because the investors' utility function is exponential and fund payoffs are normally distributed, mutual fund investment for both investor types is linear and increasing for intermediate values of their respective signals. On the other hand, for very low values of the signals, the updated expected value of the period-2 payoff is low enough such that investors would want to short sell the mutual fund if they could. For these signal realizations, the short-sale constraint binds and optimal investment is zero. Conversely, high values of R_1 and R lead to a high conditional mean of the period-2 payoff and consequently to more investment in the mutual fund. For very high signal realizations, the borrowing constraint binds and optimal investment is equal to $1 + \bar{B}$.

To understand how private information influences mutual fund investment, the next lemma presents the average investment of informed and uninformed investors as a function of past returns.

Lemma 2. *Given R_1 and R_F, the average investment $\tilde{I}_1^U$ of all uninformed investors at $t = 1$ is equal to $I_1^U(R_1, R_F)$, while that of all informed investors is*

$$\tilde{I}_1^I(R_1, R_F) = \frac{\alpha_T \sigma_R}{\rho} \left[F\left(z_R\right) - F\left(z_R - \frac{\rho}{\alpha_T \sigma_R}(1 + \bar{B})\right)\right], \tag{2.10}$$

where

$$\sigma_R^2 = \mathit{Var}[R|R_1] = \frac{1}{\alpha_0 + \alpha_T}, \; z_R = \frac{\mu_R - R_F}{\sigma_R}, \tag{2.11}$$

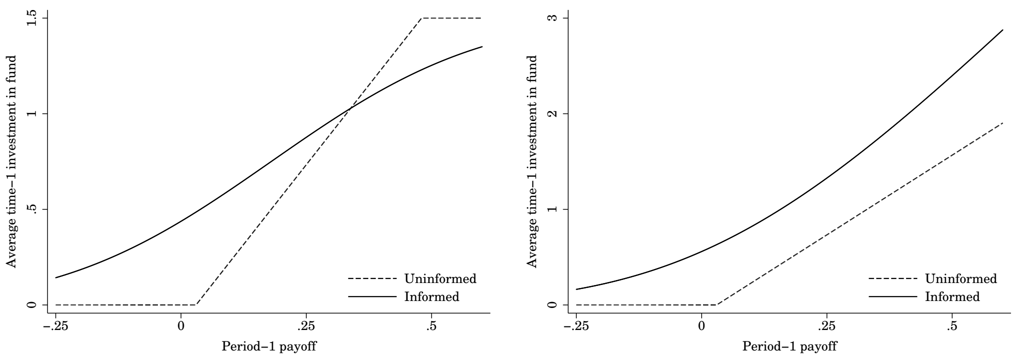
and the function $F(z)$ is positive and strictly increasing in z. In addition, $\tilde{I}_1^I(R_1, R_F)$ is positive and strictly increasing in R_1, with $\lim_{R_1 \to -\infty} \tilde{I}_1^I = 0$ and $\lim_{R_1 \to \infty} \tilde{I}_1^I = 1 + \bar{B}$.

Proof. See Appendix. □

The definition of F can be found in the lemma's proof. Just like the average fund investment of uninformed investors, that of informed investors is increasing in R_1. Because uninformed investors have zero investment for very low values of R_1 and maximum investment for high values of R_1, Lemma 2 readily leads to the corollary below.[5]

Corollary 1. $\tilde{I}_1^I(R_1, R_F) > \tilde{I}_1^U(R_1, R_F) = 0$ *for* $R_1 < \underline{R}_1^U$ *and* $\tilde{I}_1^I(R_1, R_F) <$

[5]The model of Berk and Green (2004) yields a similar result.



(a) With borrowing constraint (b) Without borrowing constraint

Figure 2.2
AVERAGE TIME-1 INVESTMENT OF UNINFORMED AND INFORMED PAYOFF AS A FUNCTION OF PERIOD-1 FUND PAYOFF

In the two panels above, the solid lines correspond to informed investors, i.e., those who observe managerial ability R, while the dashed lines are for uninformed investors, i.e., those who only see period-1 payoff R_1 and not R. The risk-free rate used is $R_F = 1.04$, while the coefficient of risk aversion is $\rho = 2$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$. The borrowing constraint for Panel (a) is $\bar{B} = 0.5$, while that for Panel (b) is $\bar{B} = \infty$.

$$\tilde{I}_1^U(R_1, R_F) = 1 + \bar{B} \textit{ for } \bar{R}_1^U < R_1.$$

The average informed investor invests more than the average uninformed investor when past returns are low because there is always a positive mass of informed investors who, despite observing a low R_1, receive high private signals. Similarly, for high R_1, the average informed investor places less portfolio weight on the mutual fund as compared to the average uninformed investor since some of the informed investors privately observe low values of R. These results are illustrated in Figure 2.2a.

In other words, Corollary 1 states that, in comparison to a more informed investor, having less private information about the mutual fund results in *underinvestment* for very low past returns and *overinvestment* for very high past returns. Fund investment of uninformed investors are, in a sense, more sensitive to R_1 since the public signal is the only piece of information they possess to learn managerial ability from.

This result is an important point of departure of the current model from that of HWY. In their study, less information increases the conditional variance of the second-period payoff, which then decreases a risk-averse investor's portfolio allocation in the mutual fund for *all* levels of past returns. The current model likewise features underinvestment of uninformed investors due to risk aversion, but only for low values of R_1. Overinvestment in the best-performing funds emerges from two ingredients in the present set-up, namely, (1) the borrowing constraint and (2) the absence of the requirement that one has to be informed to invest in the mutual fund. Figure 2.2b shows the average investment of uninformed and informed investors when there is no borrowing limit. That is, the plots are the limits of $\tilde{I}_1^I$ and $\tilde{I}_1^U$ as $\bar{B}$ approaches infinity. As one can see, allowing for infinite holdings of the mutual fund reverts the implication of the model to that of HWY.[6] Moreover, if there were an information prerequisite for investment in the fund, less information would also lead to less portfolio allocation in the risky asset. I argue that this condition is restrictive; intuitively, very high past returns should encourage investment in the mutual fund even without private information.

2.2.3 Information choice and total investment

After establishing the optimal fund investment of informed and uninformed investors as a function of their signals, I next consider the investors' costly information decision. The following lemma characterizes the expected utilities of being uninformed and being informed, which investors compare to decide whether to observe a private signal of managerial ability before the first period returns are realized. Here, I assume that investors borrow at $t = 1$ to pay the information cost c_i and that this loan does not affect the borrowing limit $\bar{B}$. That is, an informed investor's maximum portfolio allocation in the mutual fund is still $1 + \bar{B}$, as assumed in the previous section.[7]

[6] See Appendix for the proof that the average investment of informed investors is always greater than that of the uninformed when there is no borrowing constraint.

[7] This assumption is made for tractability. Requiring that the sum of c_i and the investment in the mutual fund be less than or equal to $1 + \bar{B}$ results in c_i interacting with the investment choice, which greatly complicates the analysis. One can justify this assumption by saying that the loan

Lemma 3. *Investor i's expected utilities $E[U_i^I]$ and $E[U_i^U]$ of, respectively, being informed and being uninformed can be expressed as*

$$E[U_i^U] = -exp\left(-\rho R_F\right) H\left(R_F, a^U\right) \text{ and}$$
$$E[U_i^I] = -exp\left(-\rho R_F(1-c_i)\right) H\left(R_F, a^I\right), \tag{2.12}$$

where $a^U = 1 + \alpha_0/\alpha_T$ and $a^I = \sqrt{1 + \alpha_0/\alpha_T}$, and the positive function H is increasing in a.

Proof. See Appendix. □

The definition of H is in the proof of Lemma 3. The functions $H(R_F, a^U)$ and $H(R_F, a^I)$ are just $\mathrm{E}[\exp(-\rho I_1^U(R_2 - R_F))]$ and $\mathrm{E}[\exp(-\rho I_1^I(R_2 - R_F))]$, respectively, where I_1^U and I_I^U are as defined in Lemma 1. One can thus view H as the expected *additional* utility derived from optimally investing in the risky asset after observing the first-period return.

Since $H\left(R_F, a^I\right) < H\left(R_F, a^U\right)$, private information increases investors' expected utility if c_i is equal to zero. This is the case because the private signal results in a more precise prediction of the second-period payoff, which a risk-averse investor prefers. The lower conditional variance of R_2 however comes with a cost c_i, which can offset the benefits of more information if c_i is sufficiently high. As a consequence of Lemma 3, Corollary 2 asserts that there is a cutoff level of the information cost, below which investors acquire information and above which they do not.

Corollary 2. *Investor i pays information cost c_i if $c_i \leq c^*(R_F)$, where*

$$c^*(R_F) = \frac{1}{\rho R_F} ln\left(\frac{H(R_F, a^U)}{H(R_F, a^I)}\right). \tag{2.13}$$

---

that funds private information acquisition is less risky than the one extended to finance investment in the mutual fund.

Knowing the optimal decisions of investors (as described in Corollary 2 and Lemma 1), I can now obtain the total assets of the mutual fund after R_1 is made public. Because c_i is uniformly distributed on $[0, \bar{c}]$, there is a mass $\min\{c^*/\bar{c}, 1\}$ of informed investors and $1 - \min\{c^*/\bar{c}, 1\}$ of uninformed investors in the economy. Moreover, the aggregate investment of each type of investor is just the average investment multiplied by the mass. This leads to Lemma 4, which expresses the total investment in the mutual fund as a function of c^*, $\tilde{I}_1^U$, and $\tilde{I}_1^I$.

Lemma 4. *The total investment I_1 at $t = 1$ as a function of R_1 and R_F is*

$$I_1(R_1, R_F) = \min\left\{\frac{c^*(R_F)}{\bar{c}}, 1\right\} \tilde{I}_1^I(R_1, R_F) + \left(1 - \min\left\{\frac{c^*(R_F)}{\bar{c}}, 1\right\}\right) \tilde{I}_1^U(R_1, R_F). \tag{2.14}$$

Figure 2.3 shows the total assets in the mutual fund using the same parameter values as in Figure 2.2a. The investors' total investment in the fund is a linear combination of the average investment of uninformed and informed investors. This implies that I_1 is higher for low past returns and lower for high past returns if there are more investors who choose to observe the private signal. In particular, aggregate fund investment is less sensitive to past returns if the average investor is more informed.

2.2.4 Effects of the risk-free rate

I continue the theoretical exercise by demonstrating how time-1 mutual fund assets, as a function of the first-period return, are influenced by the risk-free rate. To do so, I perform a sensitivity analysis to determine how R_F affects the two decisions investors make, specifically, how much to allocate in the fund and whether to invest in private information acquisition or not.

A higher risk-free rate makes the riskless asset a more attractive investment vehicle than the mutual fund. The average portfolio allocation in the fund is therefore decreasing in R_F for uninformed and informed investors alike. This result is for-

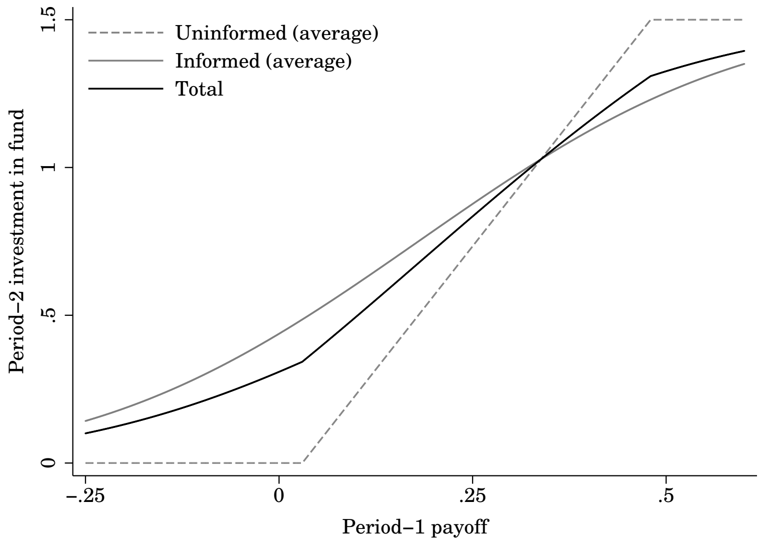


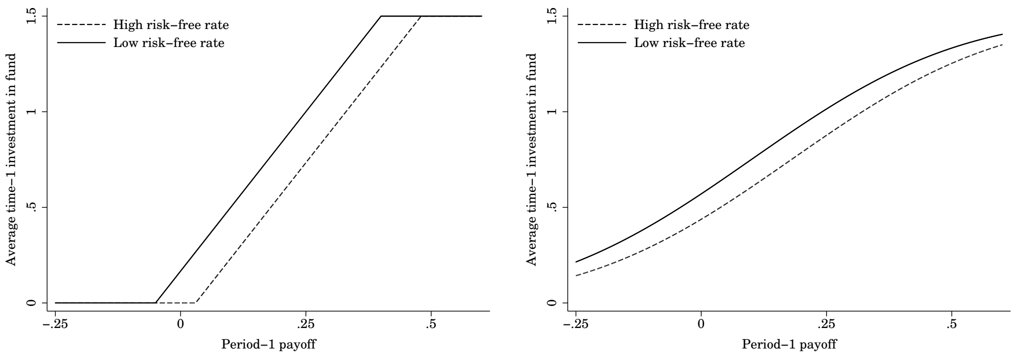
Figure 2.3
TOTAL TIME-1 INVESTMENT AS A FUNCTION OF PERIOD-1 FUND PAYOFF
The gray solid and dashed lines are the average time-1 investment of, respectively, informed and uninformed investors as a function of period-1 payoff, R_1. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The black solid line is the total time-1 investment of all of the fund's investors as a function of R_1. The risk-free rate used is $R_F = 1.04$, the coefficient of risk aversion is $\rho = 2$, the borrowing constraint is $\bar{B} = 0.5$, and the maximum investor-level information cost is $\bar{c} = 0.0478$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

malized in Proposition 1, and illustrated in Figures 2.4a and 2.4b.

Proposition 1. *$\tilde{I}_1^U(R_1, R_F)$ and $\tilde{I}_1^U(R_1, R_F)$ are both decreasing in R_F.*

Proof. See Appendix. □

Proceeding to the information choice of investors, one can see from the definition of c^* in Corollary 2 that the risk-free rate can influence the cutoff level of information costs by way of three channels. First, a higher R_F increases the opportunity cost of investing in private information, which then lowers c^*. Raising



(a) Uninformed (b) Informed

Figure 2.4
EFFECT OF THE RISK-FREE RATE ON AVERAGE TIME-1 INVESTMENT
The solid and dashed lines in the panels above are the the average time-1 investment as a function of period-1 payoff when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). Panel (b) is for informed investors, i.e., those who observe managerial ability R, while Panel (a) is for uninformed investors, i.e., those who only see period-1 payoff R_1 and not R. The coefficient of risk aversion used is $\rho = 2$ and the borrowing constraint is $\bar{B} = 0.5$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

the risk-free rate makes borrowing to finance c_i more expensive and consequently discourages investor i to acquire a private signal of managerial ability. The second and third channels of how R_F can impact the threshold level of information costs are through $H(R_F, a^I)$ and $H(R_F, a^U)$. The lemma below specifies how H changes with the riskless rate.

Lemma 5. *$H(R_F, a)$ is increasing in R_F, with $\lim_{R_F \to -\infty} H = 0$ and $\lim_{R_F \to \infty} H = 1$.*

Proof. See Appendix. □

The function H increases with the risk-free rate because a higher R_F encourages the tilting of the portfolio away from the fund, which then makes the expected utility of both informed and uninformed investors closer to their expected utility if they only hold the risk-free asset.

Raising the risk-free rate increases $H(R_F, a^I)$ because the option to invest in the mutual fund while being informed is less valuable. Investors prefer private information less and the cost cutoff is hence lowered. However, a higher R_F also increases $H(R_F, a^U)$, which produces the opposite outcome. That is, a greater value for $H(R_F, a^U)$ disfavors being uninformed, which raises c^* as a consequence. Despite these conflicting results, I demonstrate in the following proposition that if the risk-adjusted return of the fund is low enough, the last channel is offset by the second and the net effect of increasing the risk-free rate is that the average investor becomes less informed. This is the case because a very high risk-adjusted return means that a higher R_F will minimally change the portfolio holdings of an informed investor, indicating that the impact of the second channel is very small.

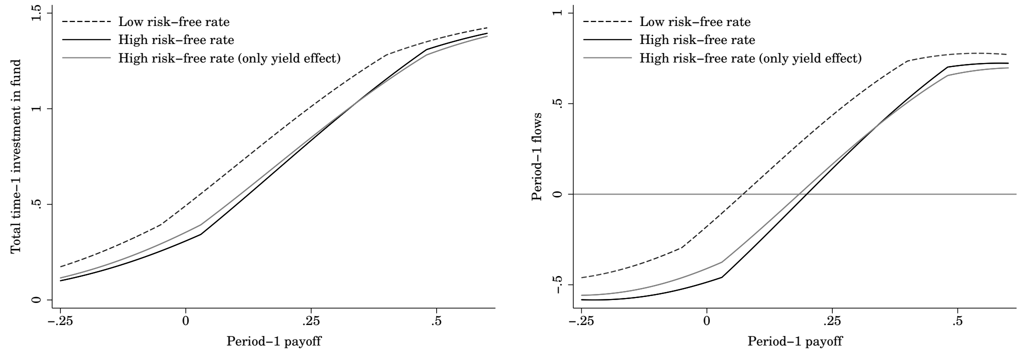
Proposition 2. *If* $\frac{\mu - 1}{\rho\sigma^2_{R_1}} < \frac{1 + \bar{B}}{2}$, *then* $c^*(R_F)$ *is decreasing in* R_F *for* $R_F \in [1, \mu)$.

Proof. See Appendix. □

Given these two propositions, I now establish the overall effect of an increase in the risk-free rate on fund assets at the start of period 2 by taking the partial derivative of I_1 in Lemma 4 with respect to R_F. Assuming that $c^*(1) < \bar{c}$, which implies that $c^*(R_F) < \bar{c}$ and that there is always a positive mass of uninformed investors in the economy, I obtain that

$$\frac{\partial I_1}{\partial R_F} = \frac{c^*}{\bar{c}} \frac{\partial \tilde{I}_1^I}{\partial R_F} + \left(1 - \frac{c^*}{\bar{c}}\right) \frac{\partial \tilde{I}_1^U}{\partial R_F} + \frac{1}{\bar{c}} \frac{\partial c^*}{\partial R_F} \left(\tilde{I}_1^I - \tilde{I}_1^U\right). \tag{2.15}$$

The first two terms, which are negative by Proposition 1, represent the *yield effect* of a change in the risk-free rate; a higher return for the riskless asset leads to a lower portfolio weight on the mutual fund. This is illustrated as a downward shift from the dashed black line to the gray line in Figure 2.5a. On the other hand, the last term in Equation 2.15 exhibits the *information effect*, which is positive for high values of R_1 and negative for low values of R_1. An increase in the risk-free



(a) Total time-1 investment (b) Period-1 flows

Figure 2.5

EFFECT OF THE RISK-FREE RATE ON TOTAL TIME-1 INVESTMENT AND ON PERIOD-1 FLOWS

Panel (a) shows the total time-1 investment $I_1(R_1, R_F)$ of all the fund's investors as a function of period-1 payoff R_1, while Panel (b) contains the period-1 flows as a function of R_1. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_0 = 0.6$ is the fund's assets at time 0. The black solid and dashed lines in both panels correspond to the case when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). The gray solid lines are for the case when the risk-free rate is high, but the fraction of the informed among the fund's investors is the same as when the risk-free rate is low. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The coefficient of risk aversion is $\rho = 2$, the borrowing constraint is $\bar{B} = 0.5$, and the maximum investor-level information cost is $\bar{c} = 0.0478$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

rate decreases private information acquisition (Proposition 2) and moves the curve of total investment closer to that of uninformed investors' average investment. This is depicted as the counterclockwise "rotation" of the gray line towards the black solid line in Figure 2.5a. In other words, the information effect reinforces the yield effect for the worst-performing funds, while the former mitigates the latter for the best performers. The decrease in fund assets following a rise in the risk-free interest rate is therefore greater the lower the past returns are.

2.2.5 Model predictions and final comments

The principal objective of this study is to show theoretically and empirically how the riskless rate affects the flow-performance relationship of mutual funds. To guide the empirical investigation in the next sections, I define period-1 flows f_1 as new money invested in the fund in the first period. Suppose that the mutual fund has assets $I_0 > 0$ at $t = 0$. I have that

$$f_1(R_1, R_F) = \frac{I_1(R_1, R_F) - I_0 R_1}{I_0}. \tag{2.16}$$

Taking the partial derivative of f_1 with respect to R_F,

$$\frac{\partial f_1}{\partial R_F} = \frac{1}{I_0}\frac{\partial I_1}{\partial R_F}. \tag{2.17}$$

Equation 2.17 details the first prediction of the model: Conditional on keeping the same level of I_0, an increase in R_F generally lowers flows into the fund, with the decrease being more pronounced for low values of R_1. This model implication, which is similar to one on the impact of the risk-free rate on total time-1 investment, is illustrated in Figure 2.5b. The individual effects of the yield and information channels are highlighted in the plot, similar to what is done in Figure 2.5a.

Aside from a hypothesis regarding the time series of fund flows, the model likewise offers predictions concerning the cross-sectional variation in the sensitivity of f_1 to the risk-free rate. As in HWY, the maximum *investor-level* information cost $\bar{c}_j$ can be viewed as a measure of *fund-level* information costs for fund j. That is, funds that are harder to get information about (e.g., newly opened ones) have higher values of $\bar{c}_j$.

Consider two funds with the same total assets at $t = 0$ but different levels of $\bar{c}_j$: a high-cost fund H with $\bar{c}_H > c^*(1)$ and a low-cost fund L with $\bar{c}_L < c^*(\mu)$. That is, for all values of the risk-free rate, fund H always has a positive mass of uninformed investors, while fund L has a sufficiently low fund-level information cost that all its investors choose to acquire private information. One can think of fund H as a young fund that only has a short time series of past returns to learn manager ability from, whereas fund L is a mature fund with an already long track record.

I am interested in the difference f_1^{L-H} between the flows of the two funds, where

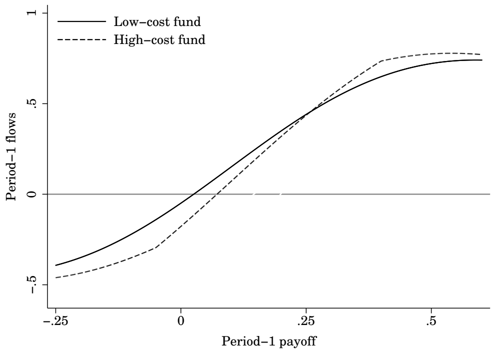
$$\begin{aligned} f_1^{L-H}(R_1, R_F) =& f_1^L(R_1, R_F) - f_1^H(R_1, R_F) \\ =& \frac{1}{I_0}\left(1 - \frac{c^*(R_F)}{\bar{c}_H}\right)\left(\tilde{I}_1^I(R_1, R_F) - \tilde{I}_1^U(R_1, R_F)\right). \end{aligned} \tag{2.18}$$

Note that f_1^{L-H} is positive for low past returns and negative for high past returns, since the more uninformed investors there are, the more sensitive flows are to the public signal. I analyze how this flow difference changes with the risk-free rate for extreme values of past returns. That is, I consider the case where $R_1 < \underline{R}_1^U$ or $R_1 > \bar{R}_1^U$. In this range, $\partial\tilde{I}_1^U/\partial R_F = 0$, as uninformed investors who observe very high or very low returns do not change their investment decision (i.e., either to have $I_1^U = 0$ or $I_1^U = 1 + \bar{B}$) after a small increase in R_F. The partial derivative of f_1^{L-H} with respect to the risk-free rate becomes

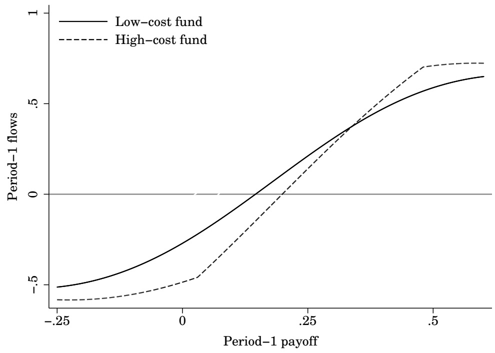
$$\frac{\partial f_1^{L-H}}{\partial R_F} = \frac{1}{I_0}\left[\left(1 - \frac{c^*}{\bar{c}_H}\right)\frac{\partial\tilde{I}_1^I}{\partial R_F} - \frac{1}{\bar{c}_H}\frac{\partial c^*}{\partial R_F}\left(\tilde{I}_1^I - \tilde{I}_1^U\right)\right]. \tag{2.19}$$

The first term in the square brackets, which is the difference between the yield effects for funds L and H, is negative. The yield channel functions less for fund H than for fund L because a proportion $1 - c^*/\bar{c}_H$ of fund H's investors do not react to R_F while all of fund L's investors do. Aside from this downward shift, there is also a "rotation" of the curve of f_1^{L-H}, which is attributable to the information effect for fund H. The second term in the square brackets in Equation 2.19 is negative for $R_1 > \bar{R}_1^U$ and positive for $R_1 < \underline{R}_1^U$, as a higher risk-free rate discourages information acquisition of fund H's investors. This then makes f_1^{L-H} more negative for high R_1 and less negative (or more positive) for low R_1. Taken altogether, the model predicts that, controling for I_0, a higher risk-free rate results in a general decrease in the difference between the flows of low-cost funds and high-cost funds. Furthermore, this change in f_1^{L-H} is less for the worst performers in comparison to funds with superior returns. These implications are depicted in Figure 2.6.

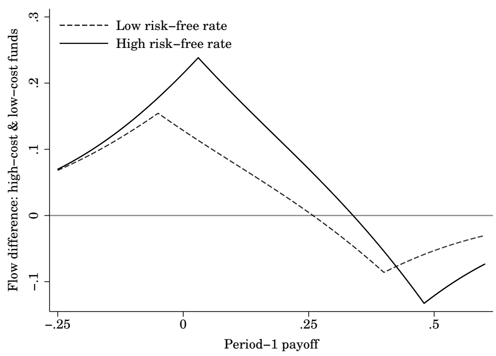
I close the analysis of the model by discussing the significance of the borrow-



(a) Low risk-free rate



(b) High risk-free rate



(c) Difference in flows

Figure 2.6

EFFECT OF THE RISK-FREE RATE ON PERIOD-1 FLOWS
OF HIGH-INFORMATION-COST AND LOW-INFORMATION-COST FUNDS

The solid and dashed lines in Panels (a) and (b) correspond to the period-1 flows into the fund as a function of period-1 payoff R_1 for, respectively, a low-information-cost and a high-information-cost fund. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_1(R_1, R_F)$ is the total time-1 investment in the mutual fund and $I_0 = 0.6$ is the fund's assets at time 0. The fund with low information costs has a maximum investor-level information cost of $\bar{c}_L = 0$, while that of the high-information-cost fund is $\bar{c}_H = 0.0478$. Panels (a) and (b) are, respectively, for a low ($R_F = 1$) and high ($R_F = 1.04$) risk-free rate regimes. The solid and dashed lines in Panel (c) are, respectively, the difference between the flows of the low and high-information-cost funds when the risk-free rate is (1) high and (2) low. The coefficient of risk aversion is $\rho = 2$ and the borrowing constraint is $\bar{B} = 0.5$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

ing limit $\bar{B}$ for the main results. Suppose there is no constraint on the amount investors could borrow (i.e., as $\bar{B}$ goes to infinity). From Section 2.2.2, having more uninformed investors means less investment in the mutual fund for any level of past returns. A higher risk-free rate lowers private information acquisition (Proposition 2), which then leads to a decrease in flows for all R_1 (see Figure 2.7a). Because all the terms in Equation 2.15 are negative, there are no obvious differences in $\partial I_1/\partial R_F$ across performance levels. Furthermore, Equation 2.19 without a borrowing constraint is

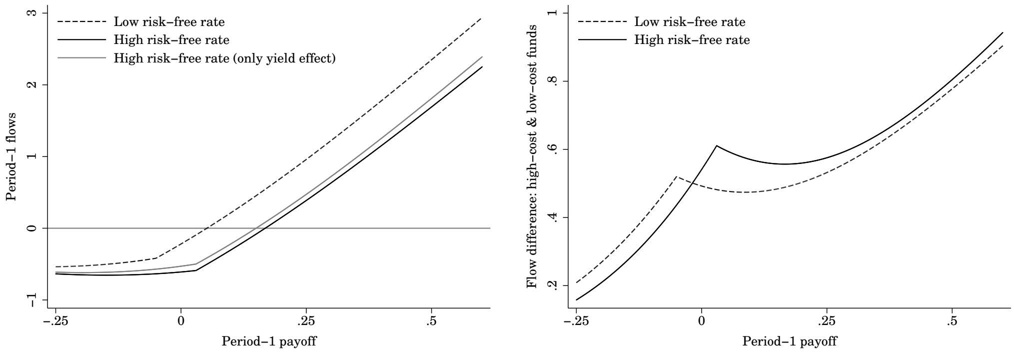
$$\frac{\partial f_1^{L-H}}{\partial R_F} = -\frac{\alpha_T}{I_0\rho}\left[\left(1-\frac{c^*}{\bar{c}_H}\right)(\Phi(z_R)-\nu)+\frac{\sigma_R}{\bar{c}_H}\frac{\partial c^*}{\partial R_F}(F(z_R)-\nu z_R)\right], \quad (2.20)$$

where $\nu = (\alpha_0+\alpha_T)(\alpha_0+2\alpha_T)^{-1}$. As z_R approaches infinity, $\partial f_1^{L-H}/\partial R_F$ also goes to infinity. This suggests that the difference between the flows of low-cost and high-cost funds is increasing in R_F for highly-performing funds (see Figure 2.7b), which is the opposite empirical prediction when $\bar{B}$ is finite. In the succeeding sections, I show that the imposition of a borrowing constraint, though it is a non-standard assumption, is necessary for the model to explain the relationships I find in the data.

2.3 Data

The next part of this chapter aims to provide empirical evidence for the implications of the theoretical model presented in the previous section. Data on US open-end equity mutual funds mainly come from the Center for Research in Security Prices (CRSP) Survivorship Bias Free Mutual Fund Database. From this source, I obtain information on mutual fund classes' monthly returns, monthly total net assets, expense ratios, fees, investor clientele, and age. Each mutual fund class is designated to a mutual fund and, consequently, to a mutual fund family using the Mutual Fund Links database of the Wharton Research Data Services (WRDS). The values of the macroeconomic variables used in this study, which include the Federal funds rate, the gross domestic product (GDP), the consumer price index (CPI), and the unemployment rate, all originate from the FRED website of the Federal Reserve Bank of St. Louis.[8] The median forecasts of one-step ahead GDP growth rate, unemployment rate, and inflation rate are from the Survey

[8] See https://fred.stlouisfed.org.



(a) Period-1 flows

(b) Difference in flows

Figure 2.7

EMPIRICAL IMPLICATIONS IF THERE IS NO BORROWING LIMIT

Panel (a) shows the total period-1 flows as a function of period-1 payoff R_1. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_1(R_1, R_F)$ is the total time-1 investment in the mutual fund and $I_0 = 0.6$ is the fund's assets at time 0. The black solid and dashed lines in Panel (a) correspond to the case when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). The gray solid line is for the case when the risk-free rate is high, but the fraction of the informed among the fund's investors is the same as when the risk-free rate is low. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The solid and dashed lines in Panel (b) are, respectively, the difference between the flows of the low and high-information-cost funds when the risk-free rate is (1) high and (2) low. The fund with low information costs has a maximum investor-level information cost of $\bar{c}_L = 0$, while that of the high-information-cost fund is $\bar{c}_H = 0.1064$. The coefficient of risk aversion is $\rho = 2$ and the borrowing constraint is $\bar{B} = \infty$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

of Professional Forecasters.

2.3.1 Mutual funds

The sample of US funds consists of 4,002 US open-end equity mutual funds that were active at least once between January 1994 and December 2011. To build this sample, I start from the class-level information in the CRSP Mutual Fund Database and aggregate each variable to come up with the fund-level variables. I do so by weighting each class by its fraction of the fund's total net assets at the start of each month. I exclude small (i.e., those that had monthly total net assets less than 5 million USD) and very young funds (i.e., those that were active for less than 36 months). The summary statistics for the fund-level variables are in Table 2.1.

Fund performance is defined here as the Carhart 4-factor alpha Alpha_{im}:

$$\text{Alpha}_{im} = \frac{1}{6} \sum_{m'=m-5}^{m} \Big[R^e_{im'} - \hat{\beta}^{\text{MKT}}_{im'} \text{MKT}_{m'} - \hat{\beta}^{\text{SMB}}_{im'} \text{SMB}_{m'} - \hat{\beta}^{\text{HML}}_{im'} \text{HML}_{m'} - \hat{\beta}^{\text{MOM}}_{im'} \text{MOM}_{m'} \Big],$$

where $R^e_{im'}$ is the excess return of fund i in month m', $\text{MKT}_{m'}$, $\text{SMB}_{m'}$, and $\text{HML}_{m'}$ are the three Fama-French factors, and $\text{MOM}_{m'}$ the momentum factor. These factors are available at Kenneth French's website.[9] The betas are estimated using a rolling window of 36 months. The volatility of excess returns is the standard deviation of the past year's monthly excess returns. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{im-1} - \text{ACQ}_{im},$$

where TNA_{im} is the total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Per-unit flow, which is the main dependent variable in this study, is defined as flow divided by the total net assets at the start of the month. Class age is the number of months since the inception date of each class, while fund age is the age of the oldest class of the fund. The maximum front load is the maximum percentage charge for purchasing shares of a fund. Maximum exit fees are the sum of the maxima of the redemption fee and the CDSC (contingent deferred sales charge) load, which are two fees (in percentage terms) for redeeming shares. I also have dummies for whether a fund is an index fund, for whether a class is mainly used for saving up for retirement, and for whether it caters mainly to institutional investors.

In the empirical analysis that follows, the main proxy for the cost an investor has to pay to acquire information about a mutual fund is the fund's age. Younger

[9] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Table 2.1

SUMMARY STATISTICS

The table below shows the summary statistics for the 4,002 US open-end equity mutual funds included in the empirical analysis. The funds were active at least once from January 1994 to December 2011. The definitions of the variables are in the main text.

Variable	All funds					Young	Old
	Mean	Median	SD	Min	Max	Mean	Mean
Per-unit flows	0.000	-0.003	0.044	-0.161	0.208	0.007	-0.002
Performance	-0.001	-0.001	0.010	-0.144	0.142	-0.001	-0.001
Volatility of returns	0.053	0.050	0.023	0.002	0.216	0.054	0.053
Age (in months)	167	119	152	37	1,052	57	204
TNA (in millions)	1,426	264	5,623	5	202,306	382	1,786
Expense ratio	0.012	0.012	0.005	0.001	0.026	0.012	0.012
Max. front load	0.013	0	0.018	0	0.058	0.010	0.013
Max. exit fees	0.006	0	0.009	0	0.040	0.006	0.006
I(Institutional fund)	0.198	0	0.345	0	1	0.211	0.193
I(Retirement fund)	0.015	0	0.101	0	1	0.024	0.012
I(Index fund)	0.076	0	0.265	0	1	0.119	0.061

funds have a shorter history of past returns from which future performance can be inferred. Hence, the lower the fund's age, the more costly it is for investors to learn about managerial ability. Every month, I rank all funds according to age, and call funds belonging to the bottom quartile "young" and the others "old." The last two columns of Table 2.1 show the means of the fund-level variables for the two groups of funds.

On average, young funds have been in existence for a little less than five years, while the mean age of old funds is 17 years. As expected, old funds are also bigger; they have, on average, five times more assets than young funds. Even though these two groups are significantly different along most dimensions, the regressions in the next section includes these fund characteristics as additional independent variables to control for their potential confounding effects on fund flows.

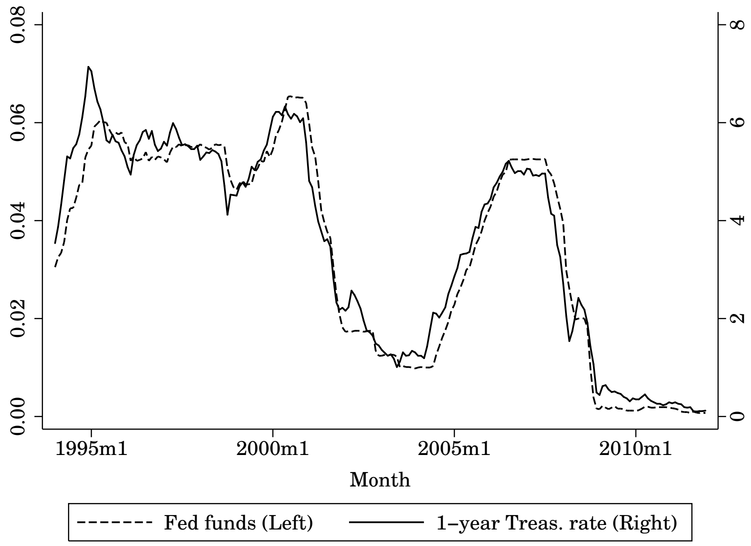


Figure 2.8
FEDERAL FUNDS RATE AND 1-YEAR TREASURY RATE
The figure above plots the end-of-month effective Federal funds rate with the end-of-month 1-year Treasury constant maturity rate from January 1994 to December 2011.

2.3.2 Macroeconomic variables

As a determinant of the monetary policy stance of the Federal Reserve, I use the Federal funds rate, which is the overnight rate at which depositary institutions lend and borrow the balances they hold at the central bank to each other. The main variable of interest is the effective Federal funds rate, which is the volume-weighted median rate of overnight Federal funds transactions. In some model specifications, I substitute the 1-year Treasury constant maturity rate for the Federal funds rate to prove that the findings are robust to the definition of the risk-free rate. In any case, one should not expect any differences in the empirical results as the two alternatives are very highly correlated (see Figure 2.8).

The effective Federal funds rate closely tracks the target Federal funds rate set by the Federal Reserve. This decision of the central bank is, however, influenced by the contemporaneous state of the economy. For example, the Federal Reserve may raise the interest rate to curb inflation or it may lower rates to stimulate economic activity during recessions. To better identify the effect on mutual fund flows that is derived from the Federal funds rate and cleanly separate it from the impact of economic conditions, I include in the regressions the quarterly values of three macroeconomic variables: the inflation rate, the GDP growth rate, and the unemployment rate. The inflation rate is the annualized percentage change in the Consumer Price Index, the GDP growth rate is the annualized percentage change in the Gross Domestic Product, while the unemployment rate is the rate of civilian unemployment.

It is also a possibility that the Federal Reserve adjusts the tightness of the monetary policy regime as a reaction to an expected change in inflation or in GDP growth. That is, the determination of the target Federal funds rate may have a forward-looking dimension. This is why I further incorporate the forecasts of the three macroeconomic variables in the empirical analysis, where the one-quarter ahead forecasts are the median forecasts from the Survey of Professional Forecasters.

Figure 2.9 plots the macroeconomic variables and their forecasts with the Federal funds rate. It does seem from the figure that the Federal funds rate evolves systematically with the inflation rate, the GDP growth rate, and the unemployment rate. For instance, a forecast increase in prices of consumer goods in the next quarter is related to a tighter monetary policy stance by the Federal Reserve. Moreover, the Federal funds rate comoves negatively with the level and the forecast of the unemployment rate. And as expected, steep drops in the expected GDP growth rate coincide with drastic interest rate cuts.

2.4 Empirical results

I now proceed by testing the predictions of the model presented in Section 2.2. That is, through an analysis of the flows to US open-end equity mutual funds from 1994 to 2011, I aim to verify that investors react to an increase in the Federal funds rate by lowering flows to the worst performers to a greater extent than they do to the best-performing funds. Furthermore, I attempt to determine whether this impact is more pronounced for younger funds, which I argue have higher information costs.

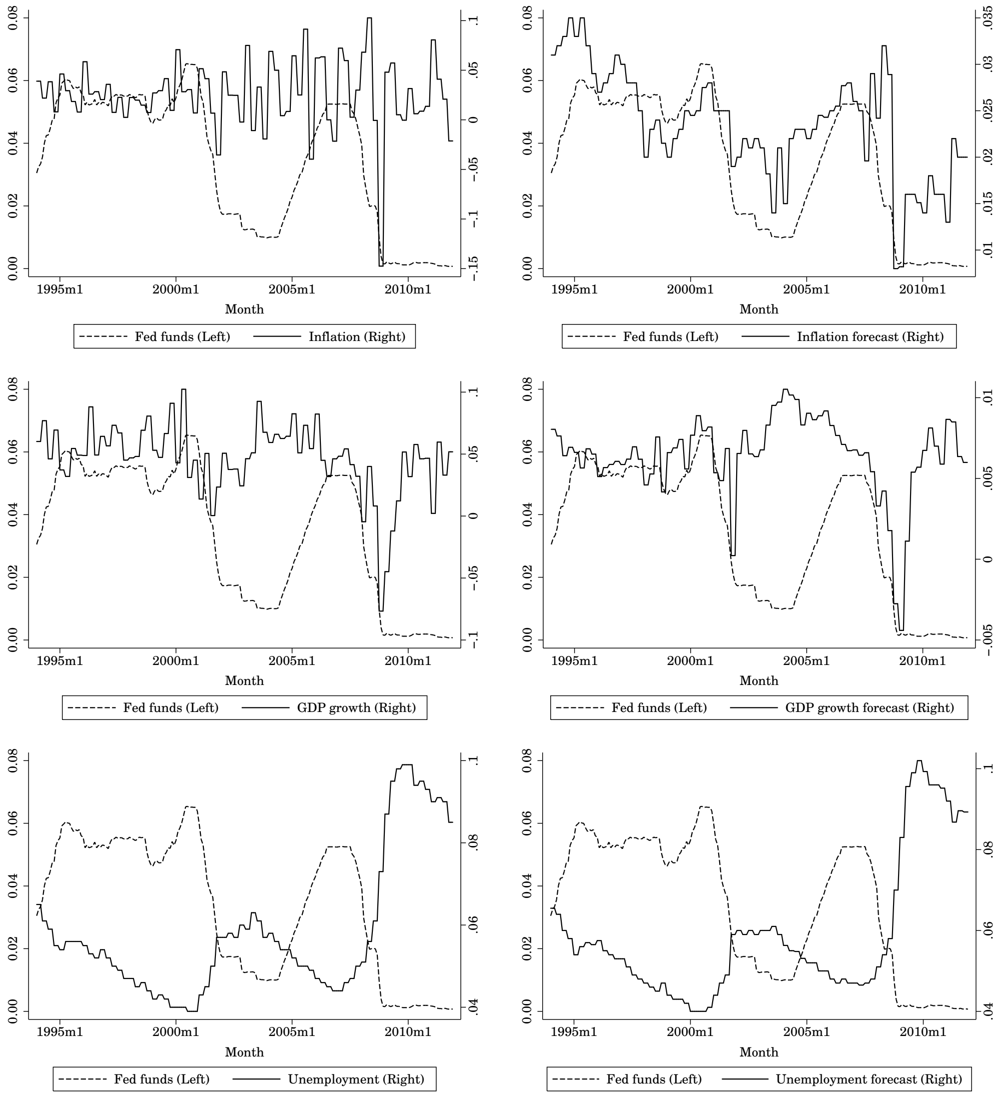


Figure 2.9

FEDERAL FUNDS RATE AND OTHER MACROECONOMIC VARIABLES

The six panels show the plot of the end-of-month effective Federal funds rate juxtaposed with the quarterly values of six other macroeconomic variables from January 1994 to December 2011. Inflation rate is the annualized percentage change in the Consumer Price Index, while GDP growth rate is the annualized percentage change in the Gross Domestic Product. Unemployment rate is the rate of civilian unemployment. The forecasts are the median one-step ahead forecasts from the Survey of Professional Forecasters.

2.4.1 Effect of the Federal funds rate on flows

I start the empirical exercise by running a regression of monthly per-unit flows on the Federal funds rate, fund performance, and their interaction term. Specifically, the model I use is the following:

$$\begin{aligned}
\text{Flow}_{im} =& \beta_0^1 + \beta_L^1 \text{I}_{im-1}(\text{Low performance}) + \beta_M^1 \text{I}_{im-1}(\text{Medium performance}) \\
&+ \beta_F^1 \text{FedFunds}_{m-1} \\
&+ \beta_{LF}^1 \text{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\
&+ \beta_{MF}^1 \text{I}_{im-1}(\text{Medium performance}) \times \text{FedFunds}_{m-1} \\
&+ \gamma^{1'} X_{im}^1 + \varepsilon_{im}^1, \qquad (2.21)
\end{aligned}$$

where Flow_{im} is the per-unit flow of fund i in month m, FedFunds_m is the end-of-month effective Federal funds rate, $\text{I}_{im}(\text{Low performance})$ is a variable that takes a value of 1 if i is in the bottom quintile of performance at the end of month m, $\text{I}_{im}(\text{Medium performance})$ is a dummy for funds that are in the middle three quintiles, X_{im}^1 is a vector of fund characteristics, and ε_{im}^1 is the error term. The dummy $\text{I}_{im}(\text{High performance})$ for funds with the highest performance is omitted, which means that the effect of the Federal funds rate on the funds with the best risk-adjusted returns is measured by β_F^1. The fund controls are the log of total net assets, the volatility of excess returns, lagged flows, the log of age, the expense ratio, the maximum front load, the maximum exit fees, the dummy for institutional funds, the dummy for retirement funds, and the dummy for index funds.

If the hypothesis is true, I should obtain that (1) the estimate for β_F^1 is negative, as increasing the risk-free rate reduces flows even to the best-performing funds, and that (2) the estimate for β_{LF}^1 is also less than zero since the model suggests that this decline is more severe for the worst performers. Table 2.2 summarizes the regression results. Here, the standard errors are two-way clustered at the fund and the month levels.

From Columns 2 and 3, one notices that even though the estimates for β_{LF}^1 are negative and statistically significant, it seems that the Federal funds rate does not

Table 2.2

FEDERAL FUNDS RATE AND THE FLOW-PERFORMANCE RELATIONSHIP

The table below contains the estimates of the regressions of monthly per-unit flows on lagged end-of-month effective Federal funds rate, fund performance dummies, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
Federal funds rate	-0.030	0.001		-0.191^{***}	
	(0.021)	(0.029)		(0.045)	
I(Low performance)	-0.013^{***}	-0.011^{***}	-0.011^{***}	-0.011^{***}	-0.011^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×		-0.076^{***}	-0.079^{***}	-0.071^{***}	-0.074^{***}
Federal funds rate		(0.025)	(0.025)	(0.025)	(0.025)
I(Medium performance)	-0.007^{***}	-0.007^{***}	-0.007^{***}	-0.006^{***}	-0.006^{***}
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×		-0.029	-0.030	-0.035^{*}	-0.037^{*}
Federal funds rate		(0.020)	(0.020)	(0.020)	(0.020)
Log MTNA	-0.003^{***}	-0.003^{***}	-0.004^{***}	-0.004^{***}	-0.005^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log MTNA×				0.033^{***}	0.035^{***}
Federal funds rate				(0.005)	(0.005)
Volatility of returns	0.005	0.004	-0.045^{*}	0.002	-0.046^{**}
	(0.020)	(0.020)	(0.023)	(0.020)	(0.023)
Lagged per-unit flows	0.234^{***}	0.234^{***}	0.232^{***}	0.233^{***}	0.231^{***}
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Log age	-0.014^{***}	-0.014^{***}	-0.013^{***}	-0.014^{***}	-0.014^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expense ratio	-0.846^{***}	-0.840^{***}	-0.913^{***}	-0.836^{***}	-0.895^{***}

(Continued)

Table 2.2–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
	(0.117)	(0.117)	(0.113)	(0.116)	(0.112)
Maximum front load	−0.025	−0.025	−0.025	−0.023	−0.024
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Maximum exit fees	0.114***	0.114***	0.117***	0.103***	0.105***
	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)
I(Institutional fund)	−0.002*	−0.002*	−0.002*	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Retirement fund)	−0.001	−0.000	−0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
I(Index fund)	0.002	0.003	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Fund fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects			Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.154	0.154	0.165	0.155	0.166

affect the flows to funds in the highest performance quintile. The estimates for β_F^1 is not different from zero and on top of that, has the opposite sign. Recall, however, that the model implications are derived while keeping the size of the mutual fund (i.e., I_0 in the notation of Section 2.2) constant. I therefore need to take into account that assets under management may vary with the risk-free rate. It may well be that the estimate for β_F^1 in Column 2 is positive because funds tend to be smaller under tight monetary conditions. That is, it may be the case that the denominator in the definition of monthly per-unit flows is less when interest rates are high, which may then cancel the negative effect of a greater risk-free rate on monthly net flow (i.e., the numerator). Indeed, in adding the interaction term of the log of total net assets and the Federal funds rate (see Columns 4 and 5), one achieves the predicted sign of β_F^1.

The regression estimates imply that a 1% increase in the Federal funds rate lessens shareholder flows into the best-performing funds by 0.19% of total assets. The impact on the funds in the bottom quintile of risk-adjusted returns is a decrease of

0.26%, with the difference between the two groups being statistically significant. Given that the average size of top performers is 1.09 billion USD and that of the worst performers is 910.82 million USD, these numbers translate to an average outflow of 2.07 million USD in the higher end of the performance distribution and 2.37 million USD in the lower end.

One may be concerned that these findings are driven not by the Federal funds rate, but by the prevailing state of the economy that determines the Federal Reserve's target short-term rate. For example, the central bank may opt to tighten monetary policy when the economy is experiencing fast growth in order to contain inflation. In a boom, asset returns are generally high and if a fund has bad performance when everyone else is doing well, it may mean that fund manager ability is in reality very low. The findings in Table 2.2 can thus be interpreted as investors exiting more from funds with poor risk-adjusted returns when the economy is growing.

To address this issue, I control for the effect of the general conditions of the economy by additionally including three macroeconomic variables in the analysis, namely, the prior quarter's inflation rate, GDP growth rate, and unemployment rate. In the regressions, I likewise consider these three new variables and their interactions with fund performance in order to ascertain that the previous results on flows can in fact be attributed to the Federal funds rate. Panel A of Table 2.2 displays the coefficient estimates when the macroeconomic variables are interacted with the performance percentile. From Columns 1 and 2, one can see that the estimates for β_F^1 and β_{LF}^1 are all less than zero and statistically significant even when the new controls are added.

Interestingly, I obtain that a greater GDP growth rate makes flows more sensitive to performance. Further interacting the macroeconomic variables with the performance dummies (see Columns 1 and 2 of Panel B) provides empirical evidence for the alternative explanation discussed earlier. It appears that a higher GDP growth rate indeed leads to more flows, but less so for the worst performers.

Because monetary policy might not just be a response to the realized values of

Table 2.3

CONTROLING FOR OTHER MACROECONOMIC VARIABLES

The tables below contain the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, and their interaction terms. The two panels likewise contain macroeconomic variables, which are interacted with performance in Panel A and with performance dummies in Panel B. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The levels and forecasts of the macroeconomic variables are their values from the previous quarter. Inflation rate is the annualized percentage change in the Consumer Price Index, while GDP growth rate is the annualized percentage change in the Gross Domestic Product. Unemployment rate is the rate of civilian unemployment. The forecasts are the median one-step ahead forecasts from the Survey of Professional Forecasters. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Interactions of macro variables with performance

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.169^{***}		-0.158^{***}		-0.182^{***}	
	(0.048)		(0.049)		(0.053)	
I(Low performance)	-0.001	-0.001	-0.002	-0.001	-0.002^{*}	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×	-0.113^{***}	-0.117^{***}	-0.085^{***}	-0.091^{***}	-0.078^{**}	-0.083^{***}
Federal funds rate	(0.026)	(0.026)	(0.029)	(0.029)	(0.030)	(0.030)
I(Medium performance)	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{***}	-0.002^{**}

(Continued)

Table 2.3–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×	−0.056***	−0.058***	−0.042*	−0.045**	−0.038*	−0.041*
Federal funds rate	(0.020)	(0.020)	(0.021)	(0.021)	(0.022)	(0.021)
Inflation rate	0.015				0.021*	
	(0.011)				(0.011)	
Performance×	−0.026*	−0.027*			−0.029*	−0.029*
Inflation rate	(0.015)	(0.015)			(0.016)	(0.015)
GDP growth rate	−0.112*				−0.119	
	(0.063)				(0.091)	
Performance×	0.332***	0.333***			0.396***	0.403***
GDP growth rate	(0.074)	(0.075)			(0.137)	(0.137)
Unemployment rate	−0.037				−0.391	
	(0.030)				(0.245)	
Performance×	0.132***	0.134***			0.253	0.262
Unemployment rate	(0.014)	(0.014)			(0.328)	(0.329)
Inflation rate forecast			−0.242**		−0.250***	
			(0.095)		(0.088)	
Performance×			0.203**	0.192**	0.184**	0.173*
Inflation rate forecast			(0.079)	(0.078)	(0.089)	(0.088)
GDP growth rate forecast			0.006		0.101	

(Continued)

Table 2.3–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
			(0.150)		(0.211)	
Performance×			0.220	0.223	−0.388	−0.397
GDP growth rate forecast			(0.207)	(0.204)	(0.335)	(0.332)
Unemployment rate forecast			−0.015		0.345	
			(0.029)		(0.240)	
Performance×			0.089***	0.093***	−0.147	−0.152
Unemployment rate forecast			(0.021)	(0.021)	(0.328)	(0.329)
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects		Yes		Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.156	0.167	0.156	0.167	0.157	0.167

Panel B: Interactions of macro variables with performance dummies

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	−0.056		−0.009		−0.062	
	(0.054)		(0.055)		(0.065)	
I(Low performance)	−0.004	−0.001	−0.005	−0.002	−0.006	−0.003

(Continued)

Table 2.3–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
I(Low performance)×	−0.096**	−0.120***	−0.108**	−0.128***	−0.097*	−0.120**
Federal funds rate	(0.045)	(0.044)	(0.043)	(0.041)	(0.052)	(0.049)
Inflation rate	−0.023				−0.017	
	(0.017)				(0.016)	
I(Low performance)×	0.021	0.021*			0.019	0.020
Inflation rate	(0.012)	(0.012)			(0.013)	(0.013)
GDP growth rate	0.295***				0.462***	
	(0.081)				(0.142)	
I(Low performance)×	−0.228***	−0.239***			−0.381***	−0.389***
GDP growth rate	(0.066)	(0.065)			(0.119)	(0.118)
Unemployment rate	−0.016				−0.335	
	(0.055)				(0.410)	
I(Low performance)×	−0.074	−0.100**			−0.286	−0.356
Unemployment rate	(0.050)	(0.049)			(0.316)	(0.313)
Inflation rate forecast			−0.113		−0.151	
			(0.145)		(0.145)	
I(Low performance)×			−0.012	−0.021	0.023	0.018
Inflation rate forecast			(0.110)	(0.108)	(0.123)	(0.121)
GDP growth rate forecast			0.277		−0.594	

(Continued)

Table 2.3–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
			(0.257)		(0.400)	
I(Low performance)×			−0.138	−0.153	0.474	0.460
GDP growth rate forecast			(0.180)	(0.174)	(0.304)	(0.297)
Unemployment rate forecast			−0.014		0.287	
			(0.052)		(0.381)	
I(Low performance)×			−0.064	−0.087*	0.213	0.257
Unemployment rate forecast			(0.048)	(0.046)	(0.293)	(0.293)
I(Med. perf.)×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
I(Med. perf.)×Macro var.	Yes	Yes			Yes	Yes
I(Med. perf.)×Macro var. forecast			Yes	Yes	Yes	Yes
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects		Yes		Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.163	0.148	0.163	0.149	0.163

the macroeconomic variables but also to their forecasts, Columns 3 and 4 of both Panels A and B present the outcome when the regressions are rerun using the one-quarter-ahead forecasts in the prior quarter. Even when both the levels and the forecasts, together with their interactions with performance, are appended to the list of regressors, I again get that all the estimates for β^1_{LF} are negative and statistically significant (see Columns 5 and 6 of both panels). Those for β^1_{LF} are similarly less than zero, but are however only significant in Panel A. Nonetheless, Table 2.3 still demonstrates that the finding of the baseline specification, which is that flows to poorly-performing funds are more negatively affected by the Federal fund rate than the flows to the best performers, withstands the inclusion of various determinants of contemporaneous and expected market conditions.

2.4.2 Effect of fund age

To more cleanly attribute this effect to investors being less informed when the risk-free rate is raised, I continue by testing the second implication of the model in Section 2.2, which concerns the differential negative impact of the risk-free rate on flows of funds with heterogeneous information costs. Funds that have not been in existence for a long time have shorter histories of returns and company filings from which to retrieve information about manager ability. This implies that the investor may need to study the other funds that belong to the same fund family or to access expensive expert advice in order to evaluate a young fund's prospects. I therefore choose fund age as a proxy for fund information costs and verify whether younger funds suffer more outflows than older funds when the Federal funds rate is increased.

To this end, I run a regression of per-unit flows on the triple interaction of last month's Federal funds rate, the lagged performance dummies, and the dummy for young funds. The model I use is:

$$\begin{aligned}\text{Flow}_{im} =& \beta^2_0 + \beta^2_Y \text{I}_{im-1}(\text{Young}) + \beta^2_L \text{I}_{im-1}(\text{Low performance}) \\ &+ \beta^2_{YL} \text{I}_{im-1}(\text{Young}) \times \text{I}_{im-1}(\text{Low performance}) \\ &+ \beta^2_F \text{FedFunds}_{m-1}\end{aligned}$$

$$
\begin{aligned}
&+ \beta^2_{YF} \mathrm{I}_{im-1}(\text{Young}) \times \text{FedFunds}_{m-1} \\
&+ \beta^2_{LF} \mathrm{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\
&+ \beta^2_{YLF} \mathrm{I}_{im-1}(\text{Young}) \times \mathrm{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\
&+ \gamma^{2'} X^2_{im} + \varepsilon^2_{im}, \qquad (2.22)
\end{aligned}
$$

where $\mathrm{I}_{im}(\text{Young})$ takes a value of 1 if fund i is in the bottom quartile of age in month m and ε^2_{im} is the error term. The interactions of FedFunds_{m-1}, $\mathrm{I}_{im-1}(\text{Young})$, and $\mathrm{I}_{im-1}(\text{Low performance})$ are incorporated in the model but suppressed in Equation 2.22 to economize on space. Again, performance in the highest quintile is the omitted category. Motivated by the results in Section 2.4.1, I also include in the vector X^2_{im} of controls the following variables: (1) the interaction of the log of total net assets with the Federal funds rate, and (2) the interaction terms of the six macroeconomic variables (i.e., the levels and the forecasts) with the fund performance percentile.

The coefficient estimates, with their corresponding standard errors that are two-way clustered at the fund and the month levels, are presented in Table 2.4. The second column has the results when the Federal funds rate and its interactions are excluded from the regression. The positive estimate for β^2_Y and the negative estimate for $\beta^2_{YL}$is consistent with Corollary 1. That is, less information leads to flows being more responsive to the tails of the performance distribution, which is also documented by Chevalier and Ellison (1997).

Columns 3 and 4 display the findings when the interactions of FedFunds_{m-1} are introduced. Since the estimate for β^2_F is negative and statistically significant, there is evidence that flows to old funds generally decline with the Federal funds rate. But because the estimate for β^2_{LF} is not significantly different from zero, it seems that this effect is a parallel downward shift of flows across all levels of performance. On the other hand, the same cannot be said for young funds. A positive estimate for β^2_{YF} suggests that the decrease in flows among the top performers is less for young funds, while a negative estimate for β^2_{YLF} means that young funds experience more outflows than old funds if risk-adjusted returns are poor. These conclusions confirm those of the sensitivity analysis of the difference f_1^{L-H}

Table 2.4

FUND AGE, THE FEDERAL FUNDS RATE, AND THE FLOW-PERFORMANCE RELATIONSHIP

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Federal funds rate			-0.172^{***}	
			(0.051)	
I(Young fund)	0.008^{***}	0.010^{***}	0.006^{***}	0.003^{*}
	(0.001)	(0.001)	(0.002)	(0.001)
I(Young fund)×			0.095^{**}	0.137^{***}
Federal funds rate			(0.039)	(0.038)
I(Low performance)	-0.013^{***}	-0.012^{***}	-0.003^{***}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×			-0.036	-0.047
Federal funds rate			(0.030)	(0.029)
I(Low performance)×		-0.002^{**}	0.002	0.002
I(Young fund)		(0.001)	(0.002)	(0.002)
I(Low performance)×			-0.147^{***}	-0.143^{***}
I(Young fund)×			(0.043)	(0.043)
Federal funds rate				
I(Medium performance)	-0.007^{***}	-0.007^{***}	-0.002^{***}	-0.002^{**}
	(0.000)	(0.000)	(0.001)	(0.001)
I(Medium performance)×			-0.018	-0.024
Federal funds rate			(0.022)	(0.021)

(Continued)

Table 2.4–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
I(Medium performance)×		-0.002^{**}	-0.000	-0.000
I(Young fund)		(0.001)	(0.001)	(0.001)
I(Medium performance)×			-0.056	-0.055
I(Young fund)×			(0.034)	(0.034)
Federal funds rate				
Log MTNA×Fed funds rate			Yes	Yes
Performance×Macro variables			Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects				Yes
Observations	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.149	0.153	0.166

between the flows of low-cost and high-cost funds in the discussion of the implications of the model in Section 2.2.5.

The drop in flows for superior performance is found to be 0.14% less than for old funds while the reduction in flows for unsatisfactory past returns is greater by 0.14%. Given that the average size of young funds is 353.23 million USD in the highest performance quintile and 278.24 million USD in the lowest, the impact of high information costs on young funds is an inflow of almost half a million USD (for every percent increase in the effective Federal funds rate) if the fund is one of last month's winners and an outflow of 390 thousand USD if it is one of the losers.

2.4.3 Further robustness checks

I close the empirical analysis by discussing some of the robustness checks I perform to rule out other explanations that could drive the discussed results. The tables containing the regression estimates in this section are in the Appendix.

First, it may be the case that the there are less flows to young funds when the interest rate is raised because they have more volatile returns in comparison to old funds. The difference of 0.001 in the volatility of young and old funds (see Table 2.1) is statistically significant at the one-percent level. When returns from safe assets are high, risk-averse investors may tilt their portfolios away from risky assets, and the securities that may be most affected are the riskiest ones (i.e., those with the highest volatility) among the poor performers.

I hence take the interaction terms of return volatility with the fund performance dummies and include them as controls in the regression model in Equation 2.22. The results in Table 2.5 indicate that the estimates for β^2_{YF} and β^2_{YLF} are still significant, of the desired sign, and of a similar magnitude as in Table 2.4 even when fund volatility is taken into account. In addition, the negative estimates for the coefficients of the interaction of volatility with the dummy for the lowest performance quintile, though insignificant in Column 4, hint that the alternative channel is at work, but it does not explain all of the variation in flows between young and old funds.

Next, as in Dell'Ariccia et al. (2017), I verify whether the findings are robust to the definition of the risk-free rate. One may argue that the Federal funds rate is not the riskless borrowing and lending rate available to mutual fund investors, so I rerun the model in Equation 2.22 employing the 1-year Treasury yield as the risk-free interest rate. It has already been commented that the two definitions for the short-term rate almost perfectly track each other during the sample period (see Figure 2.8), so it does not come as a surprise that, as seen in Table 2.6, the results survive this robustness check.

Finally, one can conjecture that the difference in reactions of the shareholders of young and old funds to rate changes is derived from having dissimilar prior beliefs of managerial skill. In other words, investors may think that managers of funds that have existed longer have higher *ex-ante* ability because the fund would have already closed if the opposite were true. Using the notation of the model in Section 2.2, it may well be the case that the μ of old funds is greater than that of young funds and that this drives the empirical findings. Particularly, a tighter monetary policy may encourage the shift towards safe assets, and the first securities investors dump may be the ones with worse prior belief of manager ability.

Accordingly, I attempt to control for the prior belief of manager skill in two ways. First, I compute a measure of performance previous to observing the prior month's 4-Factor Carhart alpha. Since performance in month m is the average of the raw alphas from $m-5$ to m, *ex-ante* manager ability $\text{Alpha}_{im}^{\text{12m}}$ at the beginning of m is computed as the 12-month average of raw alphas from $m-18$ to $m-7$:

$$\begin{aligned}\text{Alpha}_{im}^{\text{12m}} = \frac{1}{12}\sum_{m'=m-18}^{m-7}\Big[R_{im'}^{e} - \hat{\beta}_{im'}^{\text{MKT}}\text{MKT}_{m'} - \hat{\beta}_{im'}^{\text{SMB}}\text{SMB}_{m'} \\ - \hat{\beta}_{im'}^{\text{HML}}\text{HML}_{m'} - \hat{\beta}_{im'}^{\text{MOM}}\text{MOM}_{m'}\Big].\end{aligned}$$

Each month, I rank funds according to $\text{Alpha}_{im}^{\text{12m}}$ and assign each fund to a decile. I then include manager ability decile by month fixed effects, together with fund fixed effects, in the regression model of Equation 2.22 to take the prior belief of manager skill into account in the analysis. The outcome of this step is displayed in Panel A of Table 2.7. As one can see, the estimates for β_{YF}^2 and for β_{YLF}^2 are very similar to those of the baseline specification.

Second, I use the funds' mutual fund family designation to control for the manager's *ex-ante* capacity to generate risk-adjusted returns. Elton et al. (2007) demonstrate that fund returns are very correlated within fund families due to common exposures to individual stocks and to specific industries. Moreover, fund managers are chosen at the fund family level, which may imply that when a new fund opens, the best estimate for its future performance is the average performance of the mutual fund family.

I thus elect to check whether the baseline results continue to hold if fund family by month fixed effects are introduced to Equation 2.22. Panel B of Table 2.7 has the estimates of the resulting regression coefficients with their standard errors, which are two-way clustered at the fund family and the month levels, in parentheses. The estimates for β_{YF}^2 and for β_{YLF}^2 are still, respectively, significantly positive and significant negative, downplaying the possibility that the original findings are principally driven by the difference in prior belief of managerial skill among young and old funds.[10]

2.5 Concluding remarks

This chapter has presented a theoretical framework that is able to explain the response of mutual fund flows to the monetary policy stance of the central bank. The main driver of this relationship is found to be the decrease in investors' information acquisition when the returns of safe assets are higher. Fund shareholders invest less in information collection when the risk-free rate is increased. This then depresses their holdings of the mutual fund across the whole performance distribution, but more so in the leftmost tail. Furthermore, I have demonstrated that this reaction of flows varies across funds with different information costs. In particular, funds that are costlier to get information about suffer greater outflows for very poor performance when rates are raised.

I have additionally provided empirical evidence for these model predictions. Using the effective Federal funds rate as the risk-free rate, this chapter has established that a 1% increase in short-term rates lessens shareholder flows into the best-performing funds by 0.19% of total assets. The effect on the worst performers is likewise a decrease of 0.26%, with the difference between the two groups being statistically significant. In relation to the model's cross-sectional result, I have employed the age of a fund as a proxy of information costs and confirmed that the decline in flows for superior performance is in fact 0.14% less than for old funds while the reduction in flows for unsatisfactory past returns is greater by 0.14%.

This study highlights the role of fund information costs in the risk-taking channel of monetary policy in open-end mutual funds. A main finding is that changes in the risk-free rate do not differentially affect flows to the best and worst-performing old funds (i.e., those funds that are the least expensive to obtain information

[10]It is worth nothing at this point that most of the measures of fund information costs used by Huang et al. (2007) and by Sirri and Tufano (1998) (e.g., family size, family star status) are at the fund-family level. In contrast, the empirical strategy of this chapter utilizes a fund-level measure of information costs (i.e., fund age) whose effect on flows survives even when family-level fixed effects are added.

about). An implication of this result is that lowering the barriers to information (e.g., through more frequent and more informative reporting) may lead to the shape of the flow-performance relationship being less sensitive to variations in short-term rates and, ultimately, to a mitigation of the fund managers' risk-taking incentives.

2.6 Appendix

2.6.1 Proofs

Proof of Lemma 1. It is a known result that if an investor has exponential utility with risk aversion parameter ρ and if the return of the risky asset is normally distributed with mean μ and variance σ^2, the proportion ω_R of wealth invested in the risky asset is given by $\omega_R = \frac{\mu - r}{\rho\sigma^2}$, where r is the risk-free rate. Using (2.3) and (2.4), one obtains the second line of (2.6) and (2.8). The first line of (2.6) and (2.8) results from the binding short-selling constraint (i.e., $I_1^I \geq 0$ and $I_1^U \geq 0$), while the third line comes from the binding borrowing constraint (i.e., $I_1^I \leq 1+\bar{B}$ and $I_1^U \leq 1+\bar{B}$). □

Proof of Lemma 2. The investment decision of uninformed investors is dependent only on the public signal R_1, which means that all of them invest $I_1^U(R_1)$ in the mutual fund and, as a result, that $\tilde{I}_1^U(R_1) = I_1^U(R_1)$. For informed investors, it is the case that $\tilde{I}_1^I(R_1) = \mathrm{E}[I_1^I(R)|R_1]$. Agents' beliefs must be correct, which implies that $R|R_1$ is a normally distributed variable with mean $\mathrm{E}[R|R_1] = \mu_R$ and variance $\sigma_R^2 = \mathrm{Var}[R|R_1] = (\alpha_0 + \alpha_T)^{-1}$. Hence,

$$
\begin{aligned}
\tilde{I}_1^I(R_1) =& \mathrm{E}[I_1^I(R)|R_1] = \int_{R_F}^{\bar{R}_1^I} \frac{\alpha_T}{\rho}(R - R_F)\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR \\
&+ \int_{\bar{R}_1^I}^{\infty}(1+\bar{B})\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR \\
=& \frac{\alpha_T\sigma_R}{\rho}\left[F(z_R) - F\left(z_R - \frac{\rho}{\alpha_T\sigma_R}(1+\bar{B})\right)\right],
\end{aligned}
$$

where $z_R = (\mu_R - R_F)/\sigma_R$, $F(x) = \phi(x) + x\Phi(x)$ for $x \in (-\infty, \infty)$, and ϕ and Φ are the pdf and the cdf, respectively, of a standard normal variable. The function F is positive and strictly increasing everywhere since $\lim_{x\to-\infty} F(x) = 0$ and $F'(x) = \Phi(x) > 0$.

Because F is strictly increasing, $\tilde{I}_1^I(R_1) > 0$. The first derivative of $\tilde{I}_1^I(R_1)$ is

$$\tilde{I}_1^{I'}(R_1) = \frac{\alpha_T^2}{\rho(\alpha_0 + \alpha_T)} \left[\Phi\left(z_R\right) - \Phi\left(z_R - \frac{\rho}{\alpha_T \sigma_R}(1 + \bar{B})\right)\right] > 0,$$

which means that $\tilde{I}_1^I(R_1)$ is itself strictly increasing. Finally, it is straightforward to see that $\lim_{R_1 \to -\infty} \tilde{I}_1^I(R_1) = 0$ and $\lim_{R_1 \to \infty} \tilde{I}_1^I(R_1) = 1 + \bar{B}$. □

Proof that $\tilde{I}_1^I > \tilde{I}_1^U$ when there is no borrowing constraint. As $\bar{B}$ goes to ∞, $\tilde{I}_1^I \to \alpha_T \sigma_R F(z_R)/\rho$. Since F is positive everywhere, $\lim_{\bar{B} \to \infty} \tilde{I}_1^I > \lim_{\bar{B} \to \infty} \tilde{I}_1^U = 0$ for $R_1 \leq \underline{R}_1^U$. For the remaining values of R_1, the difference between $\tilde{I}_1^I$ and $\tilde{I}_1^U$ without a borrowing constraint is

$$\lim_{\bar{B} \to \infty} \tilde{I}_1^I - \lim_{\bar{B} \to \infty} \tilde{I}_1^U = \frac{\alpha_T \sigma_R}{\rho} \left(F(z_R) - \frac{\alpha_0 + \alpha_T}{\alpha_0 + 2\alpha_T} z_R\right) = \frac{\alpha_T \sigma_R}{\rho} Q(z_R).$$

The function Q is convex since $Q''(z_R) = \phi(z_R) > 0$. The minimum value of Q is achieved at $\underline{z}_R < \infty$, where

$$Q'(\underline{z}_R) = \Phi(\underline{z}_R) - \frac{\alpha_0 + \alpha_T}{\alpha_0 + 2\alpha_T} = 0,$$

which means that the minimum value of Q is $Q(\underline{z}_R) = \phi(\underline{z}_R) > 0$. This implies that Q is positive everywhere and, hence, that $\lim_{\bar{B} \to \infty} \tilde{I}_1^I > \lim_{\bar{B} \to \infty} \tilde{I}_1^U$ also for $R_1 > \underline{R}_1^U$. □

Proof of Lemma 3. If investor i is uninformed, her terminal wealth at $t = 2$ is equal to $W_{2i}^U = \omega_R^U R_2 + (1 - \omega_R^U) R_F$, where $\omega_R^U \in [0, 1 + \bar{B}]$ is the investment at $t = 1$ in the mutual fund. This implies that

$$\mathrm{E}[U_i^U | R_1] = -\exp\left(-\rho R_F\right) \exp\left[-\rho \omega_R^U (\mu_R - R_F) + \frac{\rho^2}{2} \left(\omega_R^U\right)^2 \sigma_{R_2|R_1}^2\right]$$

$$
= \begin{cases} -\exp\left(-\rho R_F\right) \text{ if } R_1 < \underline{R}_1^U \\ -\exp\left(-\rho R_F\right)\sqrt{2\pi}\phi\left(\dfrac{\mu_R - R_F}{\sigma_{R_2|R_1}}\right) \text{ if } \underline{R}_1^U \le R_1 \le \bar{R}_1^U \\ -\exp\left[-\rho R_F - \rho(1+\bar{B})\left(\mu_R - R_F - \dfrac{\rho(1+\bar{B})}{2}\sigma^2_{R_2|R_1}\right)\right] \text{ if } \bar{R}_1^U < R_1 \end{cases}.
$$

Taking the expectation of $\mathrm{E}[U_i^U|R_1]$ over all possible values of R_1, I then have that

$$
\begin{aligned}
&\mathrm{E}[U_i^U] = \mathrm{E}[\mathrm{E}[U_i^U|R_1]] \\
&= -\exp\left(-\rho R_F\right)\Bigg\{\Pr[R_1 < \underline{R}_1^U] + \int_{\underline{R}_1^U}^{\bar{R}_1^U} \sqrt{2\pi}\phi\left(\frac{\mu_R - R_F}{\sigma_{R_2|R_1}}\right)\frac{1}{\sigma_{R_1}}\phi\left(\frac{R_1-\mu}{\sigma_{R_1}}\right)dR_1 \\
&\quad + \int_{\bar{R}_1^U}^{\infty}\exp\left[-\rho(1+\bar{B})\left(\mu_R - R_F - \frac{\rho(1+\bar{B})}{2}\sigma^2_{R_2|R_1}\right)\right]\frac{1}{\sigma_{R_1}}\phi\left(\frac{R_1-\mu}{\sigma_{R_1}}\right)dR_1\Bigg\} \\
&= -\exp\left(-\rho R_F\right)\hat{H}(z^*, a^U, \sigma_{R_1}),
\end{aligned}
$$

where $a^U = 1 + \alpha_0/\alpha_T$, $z^* = (\mu - R_F)/\sigma_{R_1}$, and $\sigma^2_{R_1} = \mathrm{Var}[R_1] = 1/\alpha_0 + 1/\alpha_T$, . Here,

$$
\begin{aligned}
\hat{H}(z,a,\sigma) =& \Phi\left(-az\right) + \frac{\sqrt{2\pi(a^2-1)}}{a}\phi(z)\left[\Phi\left(\sqrt{a^2-1}z\right) - \Phi\left(\sqrt{a^2-1}\eta(z,\sigma)\right)\right] \\
&+ \exp\left(-\lambda(z,\sigma)\right)\Phi(a\eta(z,\sigma)),
\end{aligned}
$$

where $\eta(z,\sigma) = z - \rho\sigma(1+\bar{B})$, and $\lambda(z,\sigma) = \rho\sigma(1+\bar{B})\left(z - \frac{1}{2}\rho\sigma(1+\bar{B})\right)$.

On the other hand, if the investor is informed, her terminal wealth is $W^I_{2i} = \omega^I_R R_2 + (1 - \omega^I_R - c_i)R_F$. Her expected utility as a function of R is therefore

$$
\mathrm{E}[U_i^I|R] = -\exp\left(-\rho R_F(1-c_i)\right)\exp\left[-\rho\omega^I_R(R - R_F) + \frac{\rho^2}{2}\left(\omega^I_R\right)^2\frac{1}{\alpha_T}\right]
$$

$$
= \begin{cases} -\exp\left(-\rho R_F(1-c_i)\right) \text{ if } R < R_F \\ -\exp\left(-\rho R_F(1-c_i)\right)\sqrt{2\pi}\phi\left(\sqrt{\alpha_T}(R-R_F)\right) \text{ if } R_F \le R \le \bar{R}_1^I \\ -\exp\left[-\rho R_F(1-c_i) - \rho(1+\bar{B})\left(R - R_F - \dfrac{\rho(1+\bar{B})}{2\alpha_T}\right)\right] \text{ if } \bar{R}_1^I < R \end{cases}.
$$

Remembering that $R|R_1 \sim \mathrm{N}(\mu_R, \sigma_R)$, the expected utility of an informed investor given R_1 is

$$
\begin{aligned}
&\mathrm{E}[U_i^I|R_1] = \mathrm{E}[\mathrm{E}[U_i^I|R]|R_1] = -\exp\left(-\rho R_F(1-c_i)\right)\{\Pr[R < R_F] \\
&\quad + \int_{R_F}^{\bar{R}_1^I} \sqrt{2\pi}\phi\left(\sqrt{\alpha_T}(R - R_F)\right)\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR \\
&\quad + \int_{\bar{R}_1^I}^{\infty} \exp\left[-\rho(1+\bar{B})\left(R - R_F - \frac{\rho(1+\bar{B})}{2\alpha_T}\right)\right]\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR\Bigg\} \\
&= -\exp\left(-\rho R_F\right)\hat{H}(z', a', \sigma_{R_2|R_1}),
\end{aligned}
$$

where $z' = (\mu_R - R_F)/\sigma_{R_2|R_1}$ and $a' = \sqrt{2 + \alpha_0/\alpha_T}$. Calculating the expected utility of an informed investor before observing R_1, I obtain that

$$
\mathrm{E}[U_i^I] = \mathrm{E}[\mathrm{E}[U_i^I|R_1]] = -\exp\left(-\rho R_F(1-c_i)\right)\hat{H}(z^*, a^I, \sigma_{R_1}),
$$

where $a^I = \sqrt{1 + \alpha_0/\alpha_T}$.

The first part of the lemma is proved by letting $H(R_F, a) = \hat{H}(z^*, a, \sigma_{R_1})$. The function H is positive because $z^* > \eta(z^*, \sigma_{R_1})$. Finally, the partial derivative of H with respect to a is

$$
\frac{\partial}{\partial a}H(R_F, a) = \sqrt{2\pi}\frac{1}{a^2\sqrt{a^2-1}}\phi(z^*)\left[\Phi\left(\sqrt{a^2-1}z^*\right) - \Phi\left(\sqrt{a^2-1}\eta^*\right)\right], \tag{2.23}
$$

which is positive because Φ is strictly increasing. □

Proof of Proposition 1. The threshold values $\underline{R}_1^U$ and $\bar{R}_1^U$ of $\tilde{I}_1^U$, defined in Lemma 1, are increasing in R_F. Since the function in the strictly increasing part of $\tilde{I}_1^U$ is decreasing in R_F, one obtains that $\partial\tilde{I}_1^U/\partial R_F \leq 0$. Similarly, the partial derivative of $\tilde{I}_1^I$ with respect to R_F is

$$
\frac{\partial}{\partial R_F}\tilde{I}(R_1, R_F) = -\frac{\alpha_T}{\rho}\left[\Phi\left(z_R\right) - \Phi\left(z_R - \frac{\rho}{\alpha_T\sigma_R}(1+\bar{B})\right)\right],
$$

which is also negative because Φ is strictly increasing. □

Proof of Lemma 5. Taking the partial derivative of H with respect to R_F,

$$\frac{\partial H}{\partial R_F} = \frac{1}{\sigma_{R_1}} \left\{ \frac{\sqrt{2\pi}}{a}\phi(z^*) \left[F\left(\sqrt{a^2-1}z^*\right) - F\left(\sqrt{a^2-1}\eta^*\right) \right] \right.$$
$$\left. -\exp(-\lambda^*)\sigma_{R_1}\rho(1+\bar{B}) \left[\frac{\sqrt{2\pi(a^2-1)}}{a} \Phi\left(\sqrt{a^2-1}\eta^*\right)\phi(\eta^*) - \Phi(a\eta^*) \right] \right\}, \tag{2.24}$$

where F is as in Lemma 2, $\eta^* = \eta(z^*, \sigma_{R_1})$, and $\lambda^* = \lambda(z^*, \sigma_{R_1})$. To figure out the sign of (2.24), I start by determining the sign of the expression in the second set of square brackets. Let

$$G(x) = \frac{\sqrt{2\pi(a^2-1)}}{a}\Phi\left(\sqrt{a^2-1}x\right)\phi(x) - \Phi(ax).$$

The derivative of G with respect to x is

$$G'(x) = -\frac{2\pi}{a}\phi(x)F\left(\sqrt{a^2-1}x\right),$$

which is negative because F is everywhere positive (Lemma 2). Since G is strictly decreasing and $\lim_{x\to-\infty} G(x) = 0$, G is negative for all x. This, together with the result that F is strictly increasing (Lemma 2), means that $\partial H/\partial R_F$ is positive. □

Proof of Proposition 2. Let $H^I = H(R_F, a^I)$ and $H^U = H(R_F, a^U)$. The derivative of c^* with respect to R_F is

$$\frac{\partial c^*}{\partial R_F} = -\frac{1}{R_F}c^* + \frac{1}{\rho R_F}\left[\frac{1}{H^U}\frac{\partial H^U}{\partial R_F} - \frac{1}{H^I}\frac{\partial H^I}{\partial R_F}\right] \tag{2.25}$$

Let $D(R_F, a) = \partial H(R_F, a)/\partial R_F$ (i.e., equation (2.24)) and consider the function $V(R_F, a) = D(R_F, a)/H(R_F, a)$, with $a \geq 1$. Taking the partial derivative of V

with respect to a,

$$\frac{\partial V}{\partial a} = \frac{1}{H^2}\left[H\frac{\partial D}{\partial a} - D\frac{\partial H}{\partial a}\right], \tag{2.26}$$

where the function parameters are suppressed for brevity. It can be shown that

$$\frac{\partial D}{\partial a} = \frac{1}{\sigma_{R_1}}\left[z^*\frac{\partial H}{\partial a} - A\right],$$

where $\partial H/\partial a$ is as in (2.23) and

$$A = \frac{\sqrt{2\pi}}{a^2}\phi(z^*)\left[\phi\left(\sqrt{a^2-1}z^*\right) - \phi\left(\sqrt{a^2-1}\eta^*\right)\right].$$

Notice that $A > 0$ since the assumption that $\frac{\mu-1}{\rho\sigma_{R_1}^2} < \frac{1+\bar{B}}{2}$ implies that $z^* < -\eta^*$ for all $R_F \in [1,\mu)$. Equation (2.26) is now

$$\frac{\partial V}{\partial a} = \frac{1}{H^2}\left[\left(\frac{1}{\sigma_{R_1}}z^*H - D\right)\frac{\partial H}{\partial a} - \frac{1}{\sigma_{R_1}}AH\right]. \tag{2.27}$$

To determine the sign of $\partial V/\partial a$, I focus on the expression in parentheses in (2.27). After some calculations, it becomes

$$\frac{1}{\sigma_{R_1}}z^*H - D = \frac{1}{a\sigma_{R_1}}\phi(z^*)\left(J(\eta^*) - J(-z^*)\right), \tag{2.28}$$

where $J(x) = F(ax)/\phi(x)$ and F is as defined in Lemma 2. I ascertain the sign of (2.28) by computing for the derivative of J with respect to x:

$$J'(x) = \frac{1}{\phi(x)}\left[a\Phi(ax) + xF(ax)\right] = \frac{1}{\phi(x)}K(x).$$

The derivative of K is equal to $(a^2-1)\phi(ax)+2F(ax)$, which is positive because $a \geq 1$ and F is positive everywhere (Lemma 2). Additionally using the fact that $\lim_{x\to-\infty} K(x) = 0$, I have that $K(x) > 0$ for all x, which means that $J'(x) > 0$ (i.e., J is increasing in x). Because $\eta^* < -z^*$, (2.28) is negative. Equation (2.27) is likewise negative (i.e., V is decreasing in a), as $\partial H/\partial a$ and H are both positive (Lemma 3). Furthermore, $a^I < a^U$ implies that $V(R_F, a^U) < V(R_F, a^I)$. Finally, the expression in brackets in (2.25) is negative, leading to the conclusion that ${c^*}'(R_F) < 0$. □

2.6.2 Additional tables

Table 2.5

FUND AGE, VOLATILITY, THE FEDERAL FUNDS RATE, AND THE FLOW-PERFORMANCE RELATIONSHIP

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, fund return volatility, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The volatility of excess returns is the standard deviation of the past year's monthly excess returns. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Federal funds rate			-0.339^{***}	
			(0.073)	
I(Young fund)	0.008^{***}	0.010^{***}	0.006^{***}	0.003^{*}
	(0.001)	(0.001)	(0.002)	(0.001)
I(Young fund)×			0.094^{**}	0.134^{***}
Federal funds rate			(0.039)	(0.037)
Volatility of returns	0.007	-0.028	-0.104^{***}	-0.134^{***}
	(0.018)	(0.025)	(0.039)	(0.037)
Volatility of returns×			3.020^{***}	2.591^{**}
Federal funds rate			(1.034)	(1.099)
I(Low performance)	-0.013^{***}	-0.017^{***}	-0.012^{***}	-0.010^{***}
	(0.001)	(0.001)	(0.002)	(0.002)
I(Low performance)×			0.098	0.054
Federal funds rate			(0.062)	(0.057)
I(Low performance)×		-0.002^{**}	0.002	0.002
I(Young fund)		(0.001)	(0.002)	(0.002)
I(Low performance)×			-0.138^{***}	-0.136^{***}

(Continued)

Table 2.5–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
I(Young fund)× Federal funds rate			(0.043)	(0.042)
I(Low performance)× Volatility of returns		0.087^{***}	0.153^{***}	0.116^{***}
		(0.023)	(0.035)	(0.031)
I(Low performance)× Volatility of returns× Federal funds rate			-1.908^{*}	-1.367
			(1.068)	(0.997)
I(Medium performance)	Yes	Yes	Yes	Yes
I(Med. perf.)×Interacted variables		Yes	Yes	Yes
I(Med. perf.)×Fed funds rate			Yes	Yes
I(Med. perf.)×Int. var.× FF rate			Yes	Yes
Log MTNA×Fed funds rate			Yes	Yes
Performance×Macro variables			Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects				Yes
Observations	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.150	0.153	0.166

Table 2.6

FUND AGE, THE 1-YEAR TREASURY YIELD, AND THE FLOW-PERFORMANCE RELATIONSHIP

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month 1-year Treasury constant maturity rate, fund performance dummies, a fund age dummy, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
1-year Treasury yield	-0.040^{*}	-0.242^{***}		-0.190^{***}	
	(0.022)	(0.057)		(0.053)	
I(Young fund)				0.005^{***}	0.002
				(0.002)	(0.002)
I(Young fund)× 1-year Treasury yield				0.108^{**}	0.159^{***}
				(0.043)	(0.041)
I(Low performance)	-0.013^{***}	-0.002	-0.001	-0.002^{**}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)× 1-year Treasury yield		-0.085^{***}	-0.088^{***}	-0.040	-0.049
		(0.032)	(0.031)	(0.031)	(0.030)
I(Low performance)× I(Young fund)				0.003	0.003
				(0.002)	(0.002)
I(Low performance)× I(Young fund)× 1-year Treasury yield				-0.158^{***}	-0.154^{***}
				(0.047)	(0.047)
I(Medium performance)	-0.007^{***}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)× 1-year Treasury yield		-0.047^{**}	-0.049^{**}	-0.025	-0.029
		(0.023)	(0.023)	(0.023)	(0.023)

(Continued)

Table 2.6–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
I(Medium performance)× I(Young fund)				0.000	0.000
				(0.001)	(0.001)
I(Medium performance)× I(Young fund)× 1-year Treasury yield				−0.066*	−0.066*
				(0.037)	(0.036)
Log MTNA×1-yr Treas. yield		Yes	Yes	Yes	Yes
Performance×Macro variables		Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects			Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.154	0.157	0.167	0.153	0.166

Table 2.7

CONTROLING FOR PRIOR BELIEF OF MANAGERIAL ABILITY

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, and their interaction terms. Previous 12-month performance decile fixed effects are added in Panel A, while fund family fixed effects are included in Panel B. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. Previous 12-month performance is computed as

$$\text{Alpha}_{im}^{\text{12m}} = \frac{1}{12} \sum_{m'=m-18}^{m-7} \left[R_{im'}^{e} - \hat{\beta}_{im'}^{\text{MKT}} \text{MKT}_{m'} - \hat{\beta}_{im'}^{\text{SMB}} \text{SMB}_{m'} - \hat{\beta}_{im'}^{\text{HML}} \text{HML}_{m'} - \hat{\beta}_{im'}^{\text{MOM}} \text{MOM}_{m'} \right]$$

where $R_{im'}^{e}$ is the excess return of fund i in month m', $\text{MKT}_{m'}$, $\text{SMB}_{m'}$, and $\text{HML}_{m'}$ are the three Fama-French factors, and $\text{MOM}_{m'}$ the momentum factor. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors are shown in parentheses below the point estimates. In Panel A, they are two-way clustered at the fund and the month levels. Standard errors are two-way clustered at the fund family and the month levels in Panel B. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: 12-month performance decile fixed effects

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.125^{***}			-0.149^{***}		
	(0.046)			(0.046)		
I(Young fund)				0.001	-0.001	-0.000
				(0.001)	(0.001)	(0.001)

(Continued)

Table 2.7–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
I(Young fund)×				0.124***	0.148***	0.137***
Federal funds rate				(0.041)	(0.040)	(0.040)
I(Low performance)	−0.002***	−0.002**	−0.002**	−0.003***	−0.002***	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×	−0.054*	−0.061**	−0.064**	−0.038	−0.047*	−0.051*
Federal funds rate	(0.028)	(0.028)	(0.027)	(0.028)	(0.027)	(0.027)
I(Low performance)×				0.002	0.002	0.002
I(Young fund)				(0.002)	(0.002)	(0.002)
I(Low performance)×				−0.133***	−0.119**	−0.110**
I(Young fund)×				(0.050)	(0.050)	(0.049)
Federal funds rate						
I(Medium performance)	−0.002***	−0.002***	−0.002***	−0.003***	−0.002***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×	−0.009	−0.013	−0.019	0.002	−0.003	−0.009
Federal funds rate	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)	(0.018)
I(Medium performance)×				0.002	0.002	0.002
I(Young fund)				(0.001)	(0.001)	(0.001)
I(Medium performance)×				−0.095***	−0.093***	−0.088**
I(Young fund)×				(0.035)	(0.035)	(0.035)

(Continued)

Table 2.7–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate						
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Performance×Macro variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
12-mo. perf. decile fixed effects	Yes	Yes		Yes	Yes	
Month fixed effects		Yes			Yes	
12-mo. perf. decile×Month FE			Yes			Yes
Observations	279,590	279,590	279,590	279,590	279,590	279,590
Adjusted R^2	0.177	0.192	0.198	0.178	0.192	0.198

Panel B: Fund family fixed effects

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.033			-0.097^{*}		
	(0.056)			(0.055)		
I(Young fund)				0.006^{***}	0.006^{***}	0.006^{***}
				(0.002)	(0.002)	(0.002)
I(Young fund)×				0.103^{**}	0.107^{**}	0.135^{***}
Federal funds rate				(0.042)	(0.042)	(0.046)

(Continued)

Table 2.7–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
I(Low performance)	−0.002**	−0.002*	−0.002	−0.002	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×	−0.075**	−0.088***	−0.093***	−0.044	−0.059*	−0.059*
Federal funds rate	(0.032)	(0.031)	(0.034)	(0.031)	(0.031)	(0.032)
I(Low performance)×				−0.001	−0.002	−0.002
I(Young fund)				(0.002)	(0.002)	(0.002)
I(Low performance)×				−0.103**	−0.099**	−0.118**
I(Young fund)×				(0.051)	(0.050)	(0.056)
Federal funds rate						
I(Medium performance)	−0.002***	−0.002***	−0.002***	−0.002**	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×	−0.034	−0.042*	−0.031	−0.022	−0.030	−0.016
Federal funds rate	(0.024)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)
I(Medium performance)×				−0.002	−0.002	−0.002
I(Young fund)				(0.002)	(0.002)	(0.002)
I(Medium performance)×				−0.039	−0.035	−0.050
I(Young fund)×				(0.041)	(0.041)	(0.047)
Federal funds rate						
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes

(Continued)

Table 2.7–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Performance×Macro variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Family fixed effects	Yes	Yes		Yes	Yes	
Month fixed effects		Yes			Yes	
Family×Month FE			Yes			Yes
Observations	343,148	343,148	298,856	343,148	343,148	298,856
Adjusted R^2	0.130	0.143	0.185	0.133	0.146	0.189

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