

# When in Peril, Retrench: Testing the Portfolio Channel of Contagion

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## Abstract

The impact of past gains and losses on international investors' risk aversion is an important factor in the propagation of financial shocks across countries. We first present a stylized model illustrating how changes in investors' risk aversion affect portfolio decisions and stock prices. We then examine empirically the behavior of international mutual funds. When funds' returns are below average, they reduce their exposure to countries in which they were overweight and vice versa. An index of "financial interdependence" that reflects the extent to which countries share overexposed funds helps explain the pattern of stock market comovement across countries and the pattern of contagion during crises.

Keywords: Contagion, international investors, risk aversion, emerging markets, portfolio choice, financial crises.

JEL Classification: F30, G15.

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Through what channels do financial crises spread across countries? Largely owing to the numerous currency and banking crises of the past decade, a growing body of research has been devoted to answering this question.

While some papers have pointed to trade linkages as the channel through which contagion is transmitted, there is a growing consensus that financial linkages and frictions are likely to play a more central role in the propagation of shocks across national borders.<sup>1</sup>

At the theoretical level, various authors have sought to explain international financial contagion with models of investor portfolio choice. Schinasi and Smith (2000) highlight that contagion effects can be the result of simple portfolio rebalancing within a mean-variance or VaR framework. In Kodres and Pritsker (2002), differentially informed investors transmit idiosyncratic shocks from one market to others by rebalancing their portfolios' exposures to common macroeconomic risks. Kyle and Xiong (2001) model contagion as a wealth effect in a model with two risky assets and different types of traders. Wealth effects as a source of contagion also figure prominently in the models of Goldstein and Pauzner (2001) and Yuan (2004). In a different approach, Calvo and Mendoza (2000) describe fund managers' investment decisions using a mean-variance framework with short-selling constraints, including fixed costs of information acquisition about countries and assuming that fund managers' performance schemes create incentives against deviating too much from benchmark indices.<sup>2</sup>

Empirically, there are also some indications that financial links matter. Kaminsky and Reinhart (2000), Hernández and Valdés (2001), Van Rijckeghem and Weder (2001), and Caramazza, Ricci, and Salgado (2000) provide evidence that countries that borrow from the same creditor as the initial crisis country are more vulnerable to contagion than those countries that borrow from other creditors that are not engaged in lending to the crisis country. Providing empirical support for Calvo and Mendoza's model, Disyatat and Gelos (2001) show that emerging market funds' asset allocation can be well approximated by model with short-sale constraints and mean-variance optimization around benchmark indices. Van Rijckeghem and Weder (2003) provide evidence

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<sup>1</sup> See Kaminsky, Reinhart, and Végh (2003) for a recent discussion of the evidence on contagion.

<sup>2</sup> Allen and Gale (2000) analyze how liquidity shocks can be transmitted across banks, leading to contagion of banking crises. Bernardo and Welch (2004) show that such crises are also possible in asset markets since, in the absence of perfect execution sequentiality, investors cannot be sure of whether they are selling before or after prices collapse.

that bank exposures to crisis countries can help predict flows to third countries after the Mexican and Asian crises.

These papers, however, do not explicitly identify the particular mechanism(s) that accounts for this phenomenon and none of these studies has used cross-sectional information of portfolio positions at the micro level to identify more precisely the nature of financial linkages. For example, the studies stressing common lender effects through commercial banks are based on aggregate information on bank positions, as reported by the Bank of International Settlements (BIS).

In this paper, we study the trading behavior of emerging market mutual funds and the role it plays in the transmission of shocks across countries. We take advantage of a large database of emerging market funds that contains disaggregated information on the investments of hundreds of funds. For each fund, the database contains monthly data on its asset allocation by country for the period January 1996 through December 2000. This detailed information allows us to characterize the behavior of international investors to a greater extent than was possible in previous studies. Our analysis takes advantage of the heterogeneity in portfolios and investment behavior across mutual funds. This heterogeneity implies not only that funds are affected to different extents by country shocks, but also that the resulting portfolio reallocations transmit these shocks to some countries more than to others.<sup>3</sup>

The paper proceeds as follows: In section 1, we present a stylized model that facilitates the interpretation of our empirical results. The model incorporates three main ingredients: (i) investors have heterogeneous beliefs and, thus, hold heterogeneous portfolios; (ii) investors care about their performance relative to that of other investors; and (iii) portfolio decisions affect stock prices. In this setting, we analyze the effect of changes in investors' risk aversion on portfolio decisions and stock prices. If we further assume that risk aversion is a function of past relative performance, the model suggests that: (i) in response to weak past relative performance an investor would shift his/her portfolio towards the average portfolio, selling assets of countries in which he/she is "overexposed," and buying the assets of countries in which the portfolio is "underexposed;" and (ii) crises are

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<sup>3</sup> Mutual funds represent a non-trivial fraction of equity flows to emerging markets. For example, the funds in our sample are responsible for 10% of total portfolio equity flows to developing countries in 1998. In addition, their behavior is likely representative of the behavior of other types of investors as well.

transmitted through common overexposed investors, as these effects have their greatest impact on those investors who are most exposed to the crisis country.<sup>4</sup>

In the empirical analysis that takes up the remainder of the paper (after describing the data in section 2) we examine the effect of gains and losses on investors' behavior as regards their portfolio choices. We construct a time-varying index of "financial interdependence," based on the extent to which countries share overexposed funds and assess whether it helps in explaining the transmission of shocks. We do this both continuously to assess the transmission mechanism of shocks in general, and specifically during the Thai (1997), Russian (1998), and Brazilian (1999) crises, to examine who suffered most from contagion effects.

Our main findings can be summarized as follows:

First, we find that when the returns of a particular fund are low relative to the returns of other funds, the underperforming fund's reaction is to reduce its weight in countries in which it was overexposed and increase its weight in countries in which it was underexposed, thereby adjusting its portfolio in the direction of the average portfolio. We interpret this result as suggesting that past performance has an effect on funds' risk aversion, and that changes in risk aversion affect fund portfolios in the direction suggested by the model.<sup>5,6</sup>

Second, the evidence suggests that our financial interdependence index helps explain stock market comovement across emerging markets above and beyond trade linkages. The index aids in explaining the transmission of stock market shocks throughout the sample period. Moreover, there is a negative correlation

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<sup>4</sup> In the model, investors care about both absolute returns and returns in excess of those of other investors. The model is related to, but simpler than, models in which investors' utility is a decreasing function of the variance of their excess returns over that of other investors (tracking error variance). See Disyatat and Gelos (2001).

<sup>5</sup> Such changes in risk aversion may result from a wealth effect or be due to compensation schemes for managers that strongly penalize losses in excess of the industry average, such as hypothesized in Calvo and Mendoza (2000). There is a substantial literature examining the risk-taking behavior of domestic U.S. fund managers in response to prior performance (see Chevalier and Ellison, 1997, Brown, Harlow, and Starks, 1996, and Daniel and Wermers, 2000, among many others). Although this is not the focus of our paper, a discussion of these issues is provided in Appendix A. More generally, changes in risk aversion by investors have occasionally been cited as a possible source of contagion. See, for example, Kumar and Persaud (2001).

<sup>6</sup> Broner, Lorenzoni, and Schmukler (2003) show that the behavior of the term structure of emerging market sovereign bonds also suggests that investors' risk aversion increases during crises.

between countries' stock market performance during crises and the degree to which these countries shared overexposed funds with the initial crisis country. The effect of the financial interdependence index remains significant in a variety of specifications even after controlling for trade or commercial bank linkages.

Lastly, we conclude that the predictive power of our index of financial exposure based on international mutual funds likely reflects the fact that these funds are representative of other kinds of investors, such as commercial and investment banks.

Taken together, our findings may help explain why some countries are affected by financial crises in other countries and some are not. Indeed, the financial transmission mechanism stressed in this paper is present even when countries do not have weak fundamentals or common features with the initial crisis country. These results suggest that policymakers might benefit from closely monitoring the micro composition of investments across funds in order to become aware which countries may be most vulnerable to contagion.

These findings may also have interesting implications for understanding momentum trading at the country level. The fact that, in response to below-average overall performance, funds tend to reduce their investments in countries in which they are overexposed can account for the observation that, in the aggregate, funds reduce their investments in countries in which returns are low (positive-feedback trading).<sup>7</sup> The reason is that when returns in a country are low, funds that are overexposed to that country tend to have below-average gains. As a result, they reduce their exposure to all countries in which they are overexposed, including the affected country. Likewise, the funds whose gains are above average further reduce their exposure to countries in which they are underexposed, including the affected country. Both effects lead to positive feedback trading in the aggregate.

## **1. A stylized model**

In this section, we present a stylized model to help in the interpretation of our empirical results on fund behavior and the transmission of crises. The model has three main features: investors have heterogeneous beliefs and, thus, hold heterogeneous portfolios; they care about their performance relative to that of other investors; and

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<sup>7</sup> Among others, Borensztein and Gelos (2003), Kaminsky, Lyons, and Schmukler (2004), and Froot, O'Connell, and Seasholes (2001) present evidence of positive feedback trading in emerging markets.

portfolio decisions affect stock prices. The model explores the effect of changes in an investor's risk aversion on his portfolio decisions and stock prices.

We assume that investors hold different portfolios because they have different beliefs about expected dividends. Investors agree to disagree, in the sense that they choose to ignore the beliefs of other investors even though these may be reflected in prices.<sup>8</sup> We also assume that investors are risk averse and may differ in their levels of risk aversion.<sup>9</sup> The existence of heterogeneity across these two dimensions, beliefs and risk aversion, are necessary to show how a change in an investor's risk aversion affects his portfolio decisions. The mechanism works through the interaction of risk aversion and beliefs: we show that an increase in an investor's risk aversion leads to a desire to shift his portfolio away from countries about which he is relatively optimistic, and towards those about which he is relatively pessimistic.<sup>10</sup>

However, the effect of demand shifts on actual portfolio adjustments and asset prices depend on the supply of assets faced by investors. We consider two polar cases. At one extreme, we consider the case in which the supply of assets is completely inelastic. In this case, the price of the assets adjusts so that, in equilibrium, total asset demand equals the fixed asset supply. At the other extreme, we consider the case in which the supply of assets is completely elastic. In this case, the quantities of assets adjust so that in equilibrium their prices are constant.

Which assumption is more plausible empirically? The answer to that question is it depends. In our empirical analysis, we use monthly data and focus on relatively high frequency effects, in which case it may be more

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<sup>8</sup> There exist several models of asset pricing in which investors agree to disagree, especially in the bubbles literature. See for example Harrison and Kreps (1978), Scheinkman and Xiong (2003), and Hong and Stein (2003). There may be other reasons why investors hold different portfolios. For example, countries may differ in the volatility of dividends, or the correlation between a country's dividends and investors' marginal utility may be different for different investors. We chose to assume differences in beliefs for simplicity.

<sup>9</sup> To be able to solve the model analytically, we consider the case of CARA preferences and normally distributed dividends, as in Calvo and Mendoza (2000), Kodres and Pritsker (2002), and Yuan (2004).

<sup>10</sup> We assume that there exists heterogeneity in investors' beliefs and risk aversion, but investors are otherwise similar. Other papers assume the existence of different classes of investors, but homogeneity within each class. For example, Kodres and Pritsker (2002) assume the existence of informed investors, uninformed investors, and noise traders, while Kyle and Xiong (2001) assume the existence of long-term value-based investors, convergence traders, and noise traders.

reasonable to assume that the supply of assets is quite inelastic. However, the effective supply of assets faced by global mutual funds may be increasing in the price they are willing to pay both because the actual supply of assets may be somewhat elastic even in the short run, and also because the demand by other investors on which we do not have data may be somewhat elastic.<sup>11</sup>

## 1.1 Demand

There are two periods. There are two investors or fund managers,  $i \in \{-1, 1\}$ , which purchase assets in period 1 and consume in period 2. Investors can invest in three assets: two countries,  $c \in \{-1, 1\}$ , and a safe asset. The countries pay stochastic dividends  $D_{-i}$  and  $D_i$  in period 2 (and have zero residual value), and the safe asset has gross return 1. Investor  $i$ 's utility is CARA with coefficient of absolute risk aversion  $\gamma_i$ .

We assume that an investor values his own period 2 wealth  $W'_i$  and also the difference between his wealth and that of the other investor  $W'_{-i}$ .

$$U_i = -e^{-\gamma_i((1-\alpha)W'_i + \alpha(W'_i - W'_{-i}))} \text{ for } i \in \{-1, 1\},$$

where  $\alpha$  measures the degree to which investors care about relative returns as opposed to absolute returns.<sup>12</sup> In period 1, investors allocate their wealth  $W_i$  between each of the two countries and the safe asset.

Investor  $i$  is relatively optimistic about country  $i$  and relatively pessimistic about country  $-i$ . In particular, investor  $i$  believes  $D_i \sim N(D^H, \sigma^2)$  and  $D_{-i} \sim N(D^L, \sigma^2)$ , where  $D^H > D^L$ . The correlation between  $D_{-1}$  and  $D_1$  is 0.<sup>13</sup>

We now calculate the demand for the two risky assets by each investor. Let  $P_c$  denote the price of country  $c$  shares in period 1, and  $X_{i,c}$  the number of country  $c$  shares held by investor  $i$ . Wealth levels in period 2 are thus given by

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<sup>11</sup> The papers by Calvo and Mendoza (2000) and Schinasi and Smith (2000) take returns as exogenous, which is analogous to assuming a perfectly elastic supply of assets and exogenous prices. The papers by Kodres and Pritsker (2002), Yuan (2004), and Kyle and Xiong (2001) assume a perfectly inelastic supply of assets, so that returns and prices are endogenous but quantities are exogenous.

<sup>12</sup> See Disyatat and Gelos (2001) for a discussion of this issue using a slightly different framework.

<sup>13</sup> Since we are only concerned with equilibrium in period 1, the actual probability distribution of the dividends is irrelevant.

$$W'_i = W_i + \sum_c X_{i,c} \cdot (D_c - P_c) \text{ for } i \in \{-1,1\}.$$

where  $W_i$  denotes initial wealth. Given the properties of CARA preferences and the fact that returns are normally distributed, it is straightforward to obtain the four first order conditions

$$\frac{\partial U_i}{\partial X_{i,c}} = 0 = I_{c=i} \cdot (D^H - P_c) + I_{c=-i} \cdot (D^L - P_c) - \gamma_i \cdot \sigma^2 \cdot (X_{i,c} - \alpha \cdot X_{-i,c}) \quad (1)$$

for  $i \in \{-1,1\}$  and  $c \in \{-1,1\}$ . The first order conditions are easy to interpret. Other things equal, an investor prefers to invest in the country about which he is relatively optimistic. However, when an investor cares about relative returns ( $\alpha > 0$ ), he has an incentive not to choose a portfolio very different from that of the other investor. This later effect is relatively more important the more risk averse the investor is.

We now turn to the supply of assets. We consider the two polar cases of perfectly inelastic supply (fixed quantities) and perfectly elastic supply (fixed prices).

## 1.2 Inelastic supply

Let the (fixed) number of country  $i$  shares be denoted by  $K_i$ . As a result, the market clearing conditions for the two assets are

$$K_c = X_{-1,c} + X_{1,c} \text{ for } c \in \{-1,1\}. \quad (2)$$

Equations (1) and (2) form a system of 6 linear equations and 6 unknowns:  $P_{-1}$ ,  $P_1$ ,  $X_{-1,-1}$ ,  $X_{-1,1}$ ,  $X_{1,-1}$ ,  $X_{1,1}$ . After some straightforward algebra, we get

$$P_c = \frac{D^H + D^L}{2} - \left( \frac{1}{\gamma_c^{-1} + \gamma_{-c}^{-1}} \right) \cdot \sigma^2 \cdot (1 - \alpha) \cdot K_c - \left( \frac{\gamma_c - \gamma_{-c}}{\gamma_c + \gamma_{-c}} \right) \cdot \left( \frac{D^H - D^L}{2} \right) \text{ for } c \in \{-1,1\}, \text{ and} \quad (3)$$

$$X_{i,c} = \frac{K_c}{2} - \left( \frac{\gamma_i - \gamma_{-i}}{\gamma_i + \gamma_{-i}} \right) \cdot \left( \frac{1 - \alpha}{1 + \alpha} \right) \cdot \frac{K_c}{2} + \left( \frac{1}{\gamma_i + \gamma_{-i}} \right) \cdot \left( \frac{1}{1 + \alpha} \right) \cdot \left( I_{c=i} \cdot \frac{D^H - D^L}{\sigma^2} - I_{c=-i} \cdot \frac{D^H - D^L}{\sigma^2} \right) \quad (4)$$

for  $i \in \{-1,1\}$  and  $c \in \{-1,1\}$ . Share prices in the two countries are equal to their average expected dividend,  $(D^H + D^L)/2$ , plus two additional terms. The first term is due to the fact that, since the assets are risky, they need to pay a premium for investors to hold them. This effect is stronger the higher the variance of dividends  $\sigma^2$ ,



the higher the quantity of assets  $K_c$ , the higher the levels of risk aversion  $\gamma_i$ , and the less investors care about relative returns (low  $\alpha$ ).

The second term is the most important result of the model. It shows that share prices reflect the beliefs of the investor that is relatively less risk averse more than those of the investor that is relatively more risk averse. In other words, if investor  $i$  is less risk averse than investor  $-i$  the country about which investor  $i$  is relatively optimistic will tend to have a higher price than the country about which investor  $i$  is relatively pessimistic. The intuition is that very risk-averse investors tend not to act that much on their beliefs, so the demand for the countries about which risk-averse investors are optimistic is relatively low. Since the supply is inelastic, this lower demand is reflected in lower prices. The transmission mechanism proposed in this paper hinges on this interaction between risk aversion and beliefs.

With respect to asset allocations, each investor holds one half of each country's shares,  $K_c/2$ , plus two additional terms. The first term is due to the fact that the less risk-averse investor will tend to hold more of each of the two assets. The second term reflects the fact that each investor will invest more in the country about which he is relatively optimistic and less in the country about which he is relatively pessimistic.

Let  $b_{i,c} \equiv X_{i,c}/(X_{i,1} + X_{i,2})$  be investor  $i$ 's country  $c$  weight, defined as the share of total investment in both countries that he invests in  $c$ . It is easy to show that, for all parameter values,  $b_{1,1} > b_{-1,1}$  and  $b_{1,-1} < b_{-1,-1}$ . Namely, an investor tends to invest more than other investors in the countries he is relatively optimistic about.

We can now describe how crises are transmitted across countries in this environment. Assume that risk aversion depends on past performance, both absolute and relative (positive  $\alpha$ ). Assume that there is a crisis in a third country in which investor 1 is more heavily invested because he is relatively more optimistic about that country. As a result of the crisis, investor 1 becomes more risk averse, both because he suffered absolute losses and because his losses are higher than those of investor -1. Investor -1 may or may not become more risk averse but, even if he became more risk averse, it would be to a lesser extent than investor 1. As a result, the crisis leads to an increase in  $\gamma_1 - \gamma_{-1}$ . From equations (3), we see that the price of country 1 shares would fall by a larger amount than those of country -1. The model suggests that the crisis should be transmitted to a larger extent to the country that shares optimistic investors with the crisis country. Empirically, it is difficult to measure investor optimism. However, from equations (4) we see that optimism is reflected in higher country exposures. As a

result, the model suggests that crises should affect to a greater extent countries that share overexposed investors with the crisis country.

When the supply of assets is perfectly inelastic, portfolios do not adjust much as a result of past performance. The reason is that while changes in risk aversion lead to changes in asset demand, asset prices adjust so that investors end up holding the fixed quantity of assets. To study the behavior of investors' portfolios, we next study the case in which the supply of assets is perfectly elastic.

### 1.3 Elastic supply

Let the (fixed) price of country  $i$  shares be denoted by  $\bar{P}_i$ . As a result, the market clearing conditions (2) are replaced by

$$P_c = \bar{P}_c \text{ for } c \in \{-1,1\}. \quad (5)$$

Replacing the prices in equations (1), we get a system of 4 linear equations and 4 unknowns:  $X_{-1,-1}$ ,  $X_{-1,1}$ ,  $X_{1,-1}$ ,  $X_{1,1}$ . After some straightforward algebra, we get

$$X_{i,c} = \frac{1}{\sigma^2 \cdot (1 - \alpha^2)} \cdot \left[ I_{c=i} \cdot \left( \frac{D^H - \bar{P}_c}{\gamma_i} + \alpha \cdot \frac{D^L - \bar{P}_c}{\gamma_{-i}} \right) + I_{c=-i} \cdot \left( \frac{D^L - \bar{P}_c}{\gamma_i} + \alpha \cdot \frac{D^H - \bar{P}_c}{\gamma_{-i}} \right) \right] \quad (6)$$

for  $i \in \{-1,1\}$  and  $c \in \{-1,1\}$ . Two effects, reflected in the two terms in the second factor, drive each investor's portfolio decisions. First, an investor wants to invest relatively more in the country he is optimistic about. This effect is stronger the larger the difference between the expected dividend (given his beliefs) and the country price and the lower his level of risk aversion. Second, he wants to invest in the country where the other investor is investing. This effect is stronger the higher the weight on relative performance  $\alpha$ . In addition, the first factor shows that the lower the volatility of dividends and the more investors care about relative performance, the more they invest in all countries.

We now turn to study the properties of country weights. In order for country weights to be meaningful, we need to assume that the total investment in the two countries,  $X_{i,-1} + X_{i,1}$ , is positive for both investors. It is easy to show that  $\left( (D^H + D^L)/2 - \bar{P}_1 \right) + \left( (D^H + D^L)/2 - \bar{P}_2 \right) > 0$  is a necessary and sufficient condition for this to be the case. This condition is quite reasonable and it just states that the average country risk premium is positive. As

in the case of inelastic supply of assets, the fact that an investor tends to invest more than other investors in the countries he is relatively optimistic about is reflected in the fact that  $b_{1,1} > b_{-1,1}$  and  $b_{1,-1} < b_{-1,-1}$  for all parameter values.

How do investors' country weights respond to changes in risk aversion? In particular, what is the effect of an increase in the risk aversion of investor  $i$ ,  $\gamma_i$ , on the portfolio of each investor? It is easy to show that

$$\frac{db_{i,i}}{d\gamma_i} < 0, \quad \frac{db_{i,-i}}{d\gamma_i} > 0, \quad \frac{db_{-i,i}}{d\gamma_i} < 0, \quad \frac{db_{-i,-i}}{d\gamma_i} > 0. \quad (7)$$

Namely, the investor whose risk aversion increases decreases his weight in the country he is relatively optimistic about and increases it in the country he is relatively pessimistic about. The other investor increases his weight in the country he is optimistic about and decreases it in the country he is pessimistic about. The intuition behind these results is straightforward. The increase in risk aversion makes investor  $i$  want to move his portfolio closer to that of investor  $-i$ . Since  $b_{i,i} > b_{-i,i}$  and  $b_{i,-i} < b_{-i,-i}$ , this implies a shift from country  $i$  to country  $-i$ . In turn, since investor  $-i$ 's country weights also reflect an incentive not to have a portfolio very different from that of investor  $i$ , he responds to the shift in investor  $i$ 's portfolio by shifting his own portfolio in the same direction.

How do investors adjust their portfolios as a result of past performance? As in the case of inelastic supply, we assume that risk aversion increases when investors' past performance is weak. As a result, weak past performance induces investors to move towards the average investor's portfolio by decreasing their exposure to countries in which they were overexposed and increasing their exposure to countries in which they were underexposed. In case of strong past performance, investors should adjust their portfolios in the opposite direction. These effects are reinforced by a positive feedback mechanism. If investor  $i$  suffers higher losses than investor  $-i$ , he should move towards the average portfolio. But investor  $-i$  should move away from the average portfolio both because his relative performance was positive and also because the adjustment by investor  $i$  shifts the average portfolio in the direction of investor  $-i$ 's portfolio. This adjustment by investor  $-i$  shifts the average portfolio away from investor  $i$ 's, which gives investor  $i$  incentives to adjust his portfolio even

further from his initial portfolio. And so forth. As a result, we should expect relative performance to affect investors' portfolios more than is suggested by the weight of relative performance in investors' utilities  $\alpha$ .

#### **1.4 Some comments on the model**

The transmission mechanism we propose in this paper consists of three steps: (i) weak relative performance due to an overexposure to the crisis country increases investors' risk aversion; (ii) the increase in risk aversion, in turn, produces a retrenchment towards the average portfolio; and (iii) the retrenchment of overexposed investors, in turn, leading to a drop in stock prices in countries that share overexposed investors with the crisis country.

Indeed, this explanation de-emphasizes the role of macroeconomic fundamentals in explaining which countries are impacted by the crisis or the so-called "wake-up hypothesis" in which investors "wake-up" and begin to take note of other countries' similarities with the original crisis country.<sup>14</sup> The model illustrates steps (ii) and (iii).

However, the transmission mechanism depends on the assumption that risk aversion increases with weak relative performance, needed for step (i). Although we cannot directly test this assumption, it is consistent with the behavior of investors' portfolios, as shown below. In addition, this assumption is consistent with some findings in the finance literature that analyze the behavior of mutual fund managers: inflows and outflows out of mutual funds depend to a large extent on the relative performance of funds, and fund managers' income increases with assets under management.<sup>15</sup> In our model, investors' portfolios do not display wealth effects due to our use of CARA preferences. Under more realistic preferences that display diminishing absolute risk aversion (such as CRRA), a decrease in wealth due to past losses and a withdrawal of funds would tend to decrease risk taking by investors without needing to assume changes in their utility function. We did not study such preferences because

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<sup>14</sup> The term "wake-up hypothesis" was coined by Goldstein (1998).

<sup>15</sup> See Appendix A for a more complete discussion of these findings, and for some complementary evidence based on our data. Related assumptions are also often used in the literature on herding; see, for example, Scharfstein and Stein (1990).

CARA preferences are necessary to obtain closed-form solutions. However, the results from a model with diminishing absolute risk aversion and wealth effects would be qualitatively similar to our results.<sup>16</sup>

In our analysis, we study separately the cases of perfectly inelastic and perfectly elastic asset supply. Under perfectly inelastic supply we examine the transmission of crises, while under perfectly elastic supply we analyze the behavior of investors' portfolios. In reality, the supply of assets faced by global mutual funds is likely neither perfectly elastic nor perfectly inelastic. In such a case, both sets of results would hold, although the effects would be quantitatively smaller.

In the following sections we examine both the behavior of investors' portfolios and the transmission of shocks. We study whether poor past performance leads investors to "retrench" towards the average portfolio. (We do so by regressing changes in country weights on the interaction of past performance and country overexposure.) We then examine whether a crisis in one country is transmitted to a greater extent to countries that share overexposed investors with the crisis country—this is done by constructing an index of financial exposure that reflects such common-investor links, and testing the power of this financial exposure index in explaining stock market comovements and in predicting three recent crises episodes.

## 2. Data

The mutual fund data used in this paper are from a comprehensive database purchased from eMergingPortfolio.com. The database covers (on a monthly basis), the geographic asset allocation of hundreds of equity funds with a focus on emerging markets for the period 1996:1-2000:12. The funds are domiciled in different countries around the world. At the beginning of the sample, the database contains 382 funds with assets totaling US\$117 billion. At the end of the sample, the number of funds increased to 639, with US\$120 billion in assets. While the total number of funds rose over the period, some funds were dropped from the database if they

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<sup>16</sup> Our mechanism is related to the one in Shleifer and Vishny (1997). They also assume that past relative performance affects funds under management by investors (in their case, by arbitrageurs). As a result, in their model weak relative performance leads to a decrease in the amount of funds investors can invest in assets they are relatively more optimistic about, due to financial constraints. In our model, investors decrease their exposure to countries about which they are relative more optimistic because we further assume that the decrease in funds under management increases risk aversion. As mentioned above, this last assumption would not be necessary under diminishing absolute risk aversion.

discontinued providing information on their holdings. We focus on global dedicated emerging funds, i.e. funds that invest in emerging markets worldwide.<sup>17</sup> For stock market returns, we used monthly IFC US\$ total returns for the period 1990-2000, complementing them whenever needed with data from MSCI or national sources.

In December 2000, the subsample consisted of 117 global emerging market funds. Approximately one quarter of the funds are closed-end funds. The assets of these funds represent a modest, but not negligible fraction of the total market capitalization in the countries they invest. For example, in the case of Argentina, funds held approximately 2.7% of the total stock market capitalization in August of 1998, while the share was around 1.3% for Korea.

While precise numbers on total equity flows are hard to obtain, a substantial fraction of all equity flows to emerging markets seems to occur through the funds in our database. According to the World Bank (2003), in 1998, total portfolio equity flows to developing countries amounted to US\$7.4 billion, compared to US\$ 0.8 billion flows recorded in our sample.

The company providing this data aims for the widest coverage possible of emerging market funds without applying any selection criteria. According to the provider, the complete database covers roughly 80% of all dedicated emerging market funds, with coverage of about 90% of total emerging market fund assets. We do not have data on holdings of individual stocks or on the timing of funds' purchases and sales over the month. We calculate the implied flows from the asset position data, assuming that within countries, funds hold a portfolio that is well proxied by the IFC US\$ total return investable index.<sup>18</sup> We also assume that flows occur halfway through the month.

### **3. Portfolio dispersion over time**

To obtain a first impression of the data, in this section we compute the dispersion of fund portfolios over time. We measure dispersion as the root mean squared distance over country weights between each fund and the average portfolio, where the average portfolio is weighted by fund size. Figure 1 shows the median of this

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<sup>17</sup> For more details on the data, see Borensztein and Gelos (2003). Kaminsky, Lyons and Schmukler (2004) also examine mutual fund behavior in emerging markets worldwide but use data at a more aggregate level.

<sup>18</sup> This turns out to be a good approximation in emerging markets. See Borensztein and Gelos (2003).

dispersion for the group of global funds, together with the cumulated mean fund returns (set equal to 100 at the beginning of the sample). The picture shows that fund portfolios started converging during the Asian crises – possibly back to more normal levels after the run up –, at the same time that funds started facing large portfolio losses. This suggests that during turbulent times, funds tend to retrench towards the average. However, improvements in performance after the Russian crisis were not accompanied by an increase in fund dispersion. In the next section, we examine in detail how fund portfolio choices depend on their performance. We show that funds do retrench towards the mean during periods of low returns, but they react to returns relative to those of other funds as opposed to absolute returns. This distinction has important implications for the transmission of shocks during crises, since relative returns are very sensitive to whether funds are overexposed to crisis centers.

#### 4. Fund performance and portfolio choice

This section analyzes the trading behavior of emerging market mutual funds. We concentrate on the effect of portfolio returns – both absolute and relative to the average portfolio – on funds’ portfolio decisions. For this purpose, we regress changes in portfolio weights (one observation per fund-country-date) on overexposure, excess gains (or losses), gains, and the interactions of excess gains and gains with overexposure. We find that, as predicted by the model, when fund returns are lower than that of the average portfolio, funds reduce their exposure to countries in which they were “overweight” and increase their exposure to countries in which they were “underweight.”

Let sub-indices  $i$  denote fund,  $c$  country, and  $t$  time. Let  $a_{i,c,t}$  denote assets and  $r_{c,t}$  the stock index return. Let  $s_{i,t} = \sum_c a_{i,c,t}$  denote the size of a mutual fund,  $b_{i,c,t} = a_{i,c,t}/s_{i,t}$  its country weight, and  $\bar{b}_{c,t}$  the average (weighted by fund size) country weights across funds. Let overexposure  $oe_{i,c,t}$ , fund gains  $g_{i,t}$ , and fund excess gains  $exg_{i,t}$  be defined as

$$\begin{aligned} oe_{i,c,t} &= b_{i,c,t} - \bar{b}_{c,t}, \\ g_{i,t} &= \sum_c b_{i,c,t-1} r_{c,t}, \\ exg_{i,t} &= g_{i,t} - \sum_c \bar{b}_{c,t-1} r_{c,t}. \end{aligned}$$

The change in country weight,  $db_{i,c,t}$ , is given by

$$db_{i,c,t} = b_{i,c,t} - b_{i,c,t-1}.$$

It is not clear that we should focus on  $db_{i,c,t}$  as a measure of portfolio adjustment by funds. For example, if the market capitalization of a country as a fraction of total world market capitalization changed, one would expect that, on average, mutual funds' country weights would adjust as well. In particular, it is obvious that it would not be possible for all investors (mutual funds and others) to keep a constant country weight.

At one extreme, if the supply of assets were totally inelastic market capitalization would change proportionately to country returns  $r_{c,t}$ .<sup>19</sup> As a result, even if funds acted passively without buying or selling shares, the country weight would change by an amount

$$adj_{i,c,t} = \left( \frac{b_{i,c,t-1}}{1 + g_{i,t}} \right) (r_{c,t} - g_{i,t}).$$

In this case, one would want to use an “adjusted” change in weights,  $db'_{i,c,t}$ , that solely captured the change in weights that arose from funds actively buying and selling assets,

$$db'_{i,c,t} = db_{i,c,t} - adj_{i,c,t}. \quad (8)$$

From the discussion in section 1.2, we see that share prices and expected returns would adjust in order to keep investors content holding the resulting portfolio. For example, if in one country returns are lower than average, we would expect share prices not to fall proportionately as much as expected dividends, since the expected returns need to fall to keep investors from wanting to reestablish their prior country weights.

At the other extreme, if the supply of assets were totally elastic expected returns would remain constant and, thus, we would expect funds to keep constant country weights. In this case, one would want to use the unadjusted change in weights,  $db_{i,c,t}$ , in the regressions. Finally, for intermediate cases one would want to adjust  $db_{i,c,t}$ , but by less than in equation (8).

We run the following regression

$$db_{i,c,t} = \alpha \cdot oe_{i,c,t-1} + \beta \cdot adj_{i,c,t} + \gamma \cdot exg_{i,t} + \delta \cdot oe_{i,c,t-1} \cdot exg_{i,t} + \varepsilon_{i,c,t}.$$

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<sup>19</sup> This would not be exactly true if firms paid dividends. However, at monthly frequencies dividends are not an important fraction of returns, especially for emerging markets.



The first term captures possible mean reversion in portfolios. The role of the second term should be clear from the discussion above. We run three types of regressions: one constraining  $\beta$  to be 1 which corresponds to the case of perfectly inelastic supply, one constraining  $\beta$  to be 0 which corresponds to the case of perfectly elastic supply, and one in which  $\beta$  is unconstrained, letting the regression tell us what the appropriate adjustment term is.

If our hypothesis were true, fund  $i$  should increase its weight on country  $c$  ( $db_{i,c,t}$  positive) if the fund was overexposed to country  $c$  ( $oe_{i,c,t-1}$  positive) when the fund is doing relatively well ( $exg_{i,t}$  positive). Likewise, the fund should increase its weight on country  $c$  ( $db_{i,c,t}$  positive) if the fund was underexposed to country  $c$  ( $oe_{i,c,t-1}$  negative) when the fund is doing relatively badly ( $exg_{i,t}$  negative). As a result, we focus on the coefficient  $\delta$ , which should be positive according to our hypothesis.

Funds indeed tend to buy into countries in which they are overexposed (underexposed) when their gains are higher (lower) than that of other funds. Tables 1.a and 1.b summarize our results for the three cases in which  $\beta \equiv 1$ ,  $\beta \equiv 0$ , and  $\beta$  is unconstrained.<sup>20</sup> We report results including excess gains as well as gains to determine whether funds care more about relative or absolute performance. In all cases, the coefficient  $\delta$  is positive and statistically significant at the 1% level. There is also a significant reversion to the mean in the sense that on average funds buy into countries where they are underexposed. It is interesting to note that excess gains seem to be more important than absolute gains, both in levels and when interacted with overexposure. When including absolute gains, the interaction term of lagged overexposure and absolute gains is small and not always significant. Finally, when unconstrained, the coefficient on the adjustment term is always significantly greater than 0 and significantly lower than 1, suggesting that indeed mutual funds face neither a perfectly elastic nor a perfectly inelastic supply of assets.

The economic significance of the effect of funds' relative performance on whether or not they retrench to the benchmark is moderate, but by no means negligible. For example, consider a country in which half the funds

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<sup>20</sup> We restricted the sample to countries that represent at least 1% of average fund portfolio. We observed that we could explain portfolio adjustments for large countries better than for small countries. One possible explanation is that the index is mismeasured for small countries due to rounding off in portfolio reporting by funds. The raw data indeed seems to be rounded.

(weighted by fund size) invest 15% of their assets and half the funds invest 5% of their assets, so that the former have overexposure of +5% and the latter of -5%. Assume that the first group of funds has losses of 10% while the second group has gains of 10. According to the results in Table 1.a (unconstrained  $\beta$ ), both groups of funds would reduce their weight in the country by 0.44%. In addition, the first group of funds will now manage 0.5 · 90% of total fund assets while the second group of funds will correspond to 0.5 · 110% of total fund assets. As a result, the average weight of the country in total fund assets would drop from 10% to 9.07%, which implies that total funds' investment in the country would drop by almost 10%. In addition, the 10% drop in funds' investment in the country would take place despite the fact that the expected returns in the country would have increased, since the supply of assets is not perfectly elastic.

We also ran regressions including control variables. There, we added variables such as changes in risk as reported by the International Country Risk Guide (ICRG); we included such control variables independently and as interactions with lagged excess gains.<sup>21</sup> Table 1.c. shows the results of adding to our base regression changes in economic risk, financial risk, and political risk (all from ICRG), both in levels and interacted with overexposure. The table shows that these variables do not have any effect on the estimates of the coefficients of interest shown in Tables 1a and 1b. Furthermore, these risk measures are not statistically significant.

## 5. An index of financial interdependence

The results in the previous section suggest that the effect of crises on fund flows depends systematically on funds' degree of overexposure to the crisis country. In particular, since the funds that were overexposed to the crisis country are likely to have larger losses than those that were underexposed, we should expect those funds to take capital out of the countries in which they were overexposed and into the countries in which they were underexposed.

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<sup>21</sup> In an earlier version, we also looked at the differences between open-end and closed-end funds. We found that the two types of funds behave similarly. The coefficient  $\delta$  was always positive and significant at the 1% level, and its magnitude was slightly higher for closed-end funds.

In this section we construct a matrix or index of “financial interdependence” between countries based on whether countries share overexposed fund investors. We define country  $c_1$ ’s reliance on fund  $i$ ,  $re_{c_1,i,t}$ , as the contribution of fund  $i$  to total investment in the country by all funds,

$$re_{c_1,i,t} = \frac{a_{i,c_1,t}}{\sum_i a_{i,c_1,t}}.$$

We define country  $c_1$ ’s reliance on investors overexposed to country  $c_2$ ,  $d_{c_1,c_2,t}$ , as

$$d_{c_1,c_2,t} = \sum_i re_{c_1,i,t} \times oe_{i,c_2,t},$$

namely, the sum of every fund’s overexposure to country  $c_2$ , weighted by  $c_1$ ’s reliance on each fund. For short, we also refer to  $d_{c_1,c_2,t}$  as country  $c_1$ ’s exposure to country  $c_2$ . The relationship between this definition of exposure and the results in section 4 can be illustrated by noting that  $d_{c_1,c_2,t}$  can be rewritten as

$$d_{c_1,c_2,t} = \sum_i \frac{s_i}{S} \frac{oe_{i,c_1,t}}{\bar{b}_{c_1,t}} \times oe_{i,c_2,t},$$

where  $S = \sum_i s_i$ , the sum of the assets of all funds. (See Appendix B for details.) As shown in section 4, a fund should reduce its investments in country  $c_1$  in response to low excess gains if that fund is overexposed to country  $c_1$ . This explains why the exposure measure is related to the correlation between funds overexposure to the crisis country and to  $c_1$ . The reason why  $oe_{i,c_1,t}$  is divided by  $\bar{b}_{c_1,t}$  is that the effect of a given reduction in funds investments in country  $c_1$  will depend on the size of that reduction relative to total investments in the country. That is why the exposure measure is not symmetric,  $d_{c_1,c_2,t} \neq d_{c_2,c_1,t}$ . Note that this does *not* mean that small countries are, in general, more exposed to crises, since funds overexposure to small countries tends to be small. On the other hand, it is true that countries, in general, have low exposures to small countries.

## 6. Financial interdependence and contagion

If the financial exposure index developed here contains useful information about financial linkages across countries, one would expect it to help explain comovement patterns across stock markets. In particular, while a country’s stock market return is likely to be influenced by those of other countries through a variety of channels,

our results so far suggest that sharing common overexposed investors with another market will increase the transmission of shocks from that market (Table 2). To address this question, we run the following regression over the whole sample period,

$$r_{c,t} = \alpha + \beta \cdot \sum_{c' \neq c} w_{c'} \cdot r_{c',t} + \gamma \cdot \sum_{c' \neq c} t_{c,c'} \cdot r_{c',t} + \delta \cdot \sum_{c' \neq c} d_{c,c',t-1} \cdot r_{c',t} + \varepsilon_{c,t}$$

where  $r_{c,t}$  is country  $c$ 's stock return at time  $t$ ,  $w_c$  is country  $c$ 's stock market size (as measured by the IFC investable index),  $t_{c,c'}$  is the trade share of country  $c'$  in country  $c$ 's total trade, and  $d_{c,c',t}$  is the financial exposure of country  $c$  to country  $c'$ , as defined earlier. In other words, we assess whether the extent to which country  $c$ 's stock returns are influenced by those in country  $c'$  depends on the size of the stock market of country  $c'$ , the trade linkages between countries  $c$  and  $c'$ , and country  $c$ 's financial exposure to country  $c'$  through common investors.

Our index of financial exposure does help explain country's stock returns. In both simple OLS and country-fixed effects regressions,  $\delta$  enters significantly with a positive sign. This result is robust to the inclusion of lagged dependent and independent variables. When all three, the size-weighted, trade-weighted, and financial-links-weighted returns of the rest of the emerging market world are included, the trade-weighted returns become insignificant, suggesting that financial linkages as identified here may be more important in the transmission of shocks across stock markets than trade connections. Given that we are examining only a subset of international investors, such a positive finding could be interpreted as an indication that mutual funds are representative of international investors in general. However, a causal interpretation remains difficult. To address this aspect more directly, we now examine the impact of crises.

Does our index of financial exposure help predict which countries are likely to be affected by contagion?

We now take a closer look at the pattern of cross-country stock market movements during the Thai, Russian and Brazilian crises (Table 3a).<sup>22</sup> For the three crises, we run separate regressions of stock market returns on

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<sup>22</sup> The crisis dates were chosen as follows: In Thailand, difficulties were apparent since the beginning of 1997, the currency was devalued in June, and the biggest drop in the stock market took place in August. As a result, for the Thai crisis we study accumulated stock market returns during the period April 1997 – August 1997. In Russia, interest rates on T-bills increased substantially in July 1998, the default took place in August, and the large drops in the stock market took place in August and September. As a result, for the Russian crisis we study accumulated stock market returns during the period July 1998 –

exposure restricting the sample to countries that represent at least 1% and 2% of the average fund portfolio, respectively.<sup>23</sup>

For all crises, the coefficient on the financial exposure variable is negative and statistically significant, albeit not always at high confidence levels. For the Thai crisis, the financial exposure variable is significant at the 1% level. Furthermore, the exposure variable explains between 28% and 52% of the cross-sectional variation in country returns. For the Russian crisis, the financial exposure variable is significant at the 5% level and explains 15% of the cross-sectional variation in country returns. For the Brazilian crisis, the financial exposure variable is significant at the 10% level for countries with weights greater than 1%. In addition, both significance and explanatory power increase, as the sample is restricted to larger countries. For countries with weights greater than 3%, the exposure variable explains 45% of the cross-sectional variation in stock returns – not shown.

Figure 2 illustrates the effect of exposure on returns, restricting the sample to countries with weights greater than 1%. First, it seems clear that the results are not due to outliers.<sup>24</sup> Second, it shows that focusing on financial exposure, we can explain why some countries with no other obvious links to the crisis country suffered contagion, while others that ex-ante might have seemed connected did not. During the Thai crisis, among the Asian countries Taiwan was relatively unaffected, perhaps due to the fact that it did not share overexposed investors with Thailand. Malaysia, on the other hand, was the country most affected and also the country most exposed. During the Brazilian crisis, Argentina was the country most exposed and also one of the 3 with lowest returns and the lowest among Latin-American countries. In addition, both among European countries and among Asian countries, those with high exposure had lower returns than those with low exposure (China being the exception).

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September 1998. In Brazil, it is difficult to pinpoint to a start of the crisis, as pressure started mounting beginning with the Russian default. As a result, for the Brazilian crisis we study the returns during January 1999, the month when both the devaluation and the largest stock market drop took place.

<sup>23</sup> We observed that the index of financial interdependence explains returns in large countries better than in small countries. This parallels our finding that portfolio adjustments could also be explained for large countries better than for small countries.

<sup>24</sup> One might suspect that Malaysia could be such an outlier in Figure 2. When removing Malaysia from the sample, the standard errors in the first column of Table 3a do become substantially larger. However, the coefficients remain highly significant in the second column.

Next, we examine the importance of three important control variables, adding them one at a time to each regression (Table 3b). First, the presence of trade linkages is an important potential candidate for explaining the pattern of financial shock comovements across countries. Therefore, we include an index of the degree of direct trade competition as used in Van Rijckeghem and Weder (2001). Second, we use two variables measuring the degree to which country  $i$  competes for funding from the same bank lenders as the crisis country, as proposed by Kaminsky and Reinhart (2000) and Van Rijckeghem and Weder (2001).<sup>25</sup> The first of these indices is based on the absolute value of credits obtained from the common lender, and the second is based on the share of borrowing from the common lender. Third, we use the financial risk score from ICRG. Due to the limited number of observations, we cannot include lists of potentially relevant macroeconomic fundamentals.<sup>26</sup>

The small number of observations limits inference but some patterns are observable. For the Thai crisis, none of the control variables are significant in explaining the pattern of the stock market reaction across countries, and the coefficient on our financial exposure variable remains broadly unchanged and statistically significant when including the control variables. For the Russian crisis, the trade variable is significant and alone explains a similar share of the total variance in stock returns. The “absolute” bank competition variable used by Van Rijckeghem and Weder (2001) for the Russian crisis does not enter significantly. However, the “share”-based bank competition variable is significant, and explains 30% of stock returns variation. When including both the financial exposure index and one of the three control variables at a time, the results are mixed. The financial exposure index becomes insignificant when including the trade competition variable or the “share”-based bank competition index. The financial exposure variable, does however, survive the inclusion of the “absolute” bank competition index and the inclusion of the ICRG financial risk index. For the Brazil crisis, the pattern is similar: trade linkages matter, and the financial interdependence variable remains statistically significant when controlling for bank linkages (which do not seem to matter) and financial risk (insignificant) but becomes

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<sup>25</sup> See “funds competition” in Table 1, p. 300 in Van Rijckeghem and Weder (2001). We are grateful to the authors for sharing their data with us. (The Brazil crisis was not covered in their study and we constructed the data for this case.)

<sup>26</sup> We experimented with probabilities of currency crises as predicted by the early warning system used at the IMF and described in Berg and Pattillo (1999). This variable summarizes the information contained in a variety of macroeconomic variables. However, it is only available for a subset of countries in our sample, reducing our sample size further. When included, the variable was never significant at the 5% confidence level.

insignificant when adding trade competition.<sup>27</sup> However, all these results must be interpreted with care, as restricting our sample to the crises episode severely reduces the number of observations.

## 7. Conclusions

We have shown that the tendency of mutual funds to respond to relative losses (gains) by moving closer (further away) to (from) the average portfolio helps in explaining the transmission of shocks across countries. This behavior may exacerbate the effect of crises, by creating both contagion between countries and momentum trading at the country level. This, in turn, prompts the question of whether countries should limit participation of international funds in their stock markets to index funds (i.e., funds that passively follow the index). However, there is reason to believe that such a measure would likely be counterproductive. Information gathering by investors such as emerging market funds plays a useful role, and if all investors blindly followed indices, the indices themselves might become arbitrary, yielding herding in an extreme form.<sup>28</sup>

The predictive power of our index of financial exposure based on international mutual funds we conjecture may reflect the fact that these funds are representative of other kinds of investors, such as commercial banks and investment houses. In order to gain a more complete picture of the functioning of international capital markets, however, this strand of research can be complemented by a similar examination of other market players' behavior. In particular, it would be useful to gain insight into the portfolio decisions of international institutional investors investing in fixed-income securities, both in local as well as in international markets. While data remain scarce in this area, some data sources are becoming available, offering opportunities for deepening our understanding of the vagaries of international financial flows—particularly in times of market stress.

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<sup>27</sup> Johnson et al (2000) have argued that corporate governance indices can help explain the pattern of stock market declines during the Asian crisis. In a related vein, Gelos and Wei (forthcoming), show that funds tend to avoid intransparent countries during crises. We did not investigate this issue here.

<sup>28</sup> This point has been made by Calvo and Mendoza (2000). More generally, this question touches on one of the paradoxes of the efficient market hypothesis: if markets are efficient, it does not pay to gather information, but markets cannot be efficient if nobody bothers to gather information. See Grossman and Stiglitz (1980).

## **Appendix A: Fund performance and redemptions**

The relationship between relative performance, inflows and outflows of assets, and risk taking by mutual funds has been studied previously in the finance literature, especially in the context of US domestic funds. There is clear evidence that mutual funds with weak relative performance suffer withdrawals of assets relative to better performing funds (see Ippolito, 1992). It is also clear that mutual funds earnings are increasing in, and approximately proportional to, the amount of assets under management, with fees around 0.5% of assets.

With respect to the relationship between performance and risk taking, the evidence is less clear. Initial studies pointed to the presence of “gambling behavior” by fund managers who fall behind in their performance (see Brown, Harlow, and Starks, 1996, Chevalier and Ellison, 1997, and Sirri and Tufano, 1998). The reason is that mutual funds with the best performance capture the lion’s share of new inflows while funds that perform poorly are not penalized equally, so managers seem to have incentives to choose more risky portfolios if they are falling behind. More recent studies, however, have questioned this result. Busse (2001) finds that mid-year losers decrease their risk during the second half of the year. Koski and Pontiff (1999) report a positive correlation between current risk taking and past-year performance. Daniel and Wermers (2000) find that prior risk-taking behavior is a much better predictor than prior performance in explaining future risk-taking behavior by fund managers. Chen and Pennachi (2002) argue that while fund managers do increase a fund’s tracking error as its relative performance declines, this does not result in a higher variance of the fund’s returns.

To our knowledge, ours is the first paper that studies the effect of performance on risk taking by dedicated emerging market funds. Given our short sample and the fact that we do not have precise data about inflows of assets, we cannot conduct an analysis comparable to those above. Instead, we carried out the following crude exercise. First, we constructed data on inflows and outflows of assets for global funds indirectly, subtracting imputed fund gains from increases in reported size, and dividing by fund size. Then, we estimated nonparametrically the relationship between excess inflows in a given quarter and past year’s excess returns. The relationship, plotted in Figure A1, seems to be positive, but there is no evidence that funds gain more by being top performers than they lose by being worst performers.



## Appendix B: Equivalence of indices of interdependence

We start from the first index of financial interdependence

$$d_{c_1, c_2} = \sum_i r e_{c_1, i} \times o e_{i, c_2},$$

where we have removed time sub-indices for simplicity. This expression can be rewritten as

$$\begin{aligned} d_{c_1, c_2} &= \sum_i \frac{a_{i, c_1}}{S \bar{b}_{c_1}} \left( \frac{a_{i, c_2}}{s_i} - \bar{b}_{c_2} \right) = \\ &= \frac{1}{S \bar{b}_{c_1}} \left( \sum_i s_i b_{i, c_1} b_{i, c_2} - S \bar{b}_{c_1} \bar{b}_{c_2} \right) = \\ &= \frac{1}{S \bar{b}_{c_1}} \left( \sum_i s_i b_{i, c_1} b_{i, c_2} - \sum_i s_i b_{i, c_1} \bar{b}_{c_2} - \sum_i s_i \bar{b}_{c_1} b_{i, c_2} + \sum_i s_i \bar{b}_{c_1} \bar{b}_{c_2} \right) = \\ &= \frac{1}{S \bar{b}_{c_1}} \sum_i s_i (b_{i, c_1} - \bar{b}_{c_1}) (b_{i, c_2} - \bar{b}_{c_2}) = \\ &= \sum_i \frac{s_i}{S} \frac{o e_{i, c_1}}{\bar{b}_{c_1}} o e_{i, c_2}, \end{aligned}$$

where we have used  $\sum_i a_{i, c_1} = S \bar{b}_{c_1}$  in the first equality;  $a_{i, c_1} = s_i b_{i, c_1}$ ,  $a_{i, c_2} = s_i b_{i, c_2}$ , and  $\sum_i a_{i, c_1} = S \bar{b}_{c_1}$  in the second equality; and  $S \bar{b}_{c_1} = \sum_i s_i b_{i, c_1}$ ,  $S \bar{b}_{c_2} = \sum_i s_i b_{i, c_2}$ , and  $S = \sum_i s_i$  in the third equality.

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Table 1.a: Portfolio adjustment: 1996:1 – 2000:12

	Assuming inelastic supply ( $\beta \equiv 1$ )	Assuming perfectly elastic supply ( $\beta \equiv 0$ )	No assumption on supply elasticity ( $\beta$ unconstrained)
adjustment term	1	0	0.436 <sup>***</sup> (0.007)
overexposure (t-1)	-0.044 <sup>***</sup> (0.002)	-0.069 <sup>***</sup> (0.002)	-0.061 <sup>***</sup> (0.002)
excess gains	3.360 <sup>***</sup> (0.23)	-0.831 <sup>***</sup> (0.244)	1.045 <sup>***</sup> (0.233)
overexposure (t-1) × excess gains	0.647 <sup>***</sup> (0.092)	1.035 <sup>***</sup> (0.094)	0.870 <sup>***</sup> (0.090)
R <sup>2</sup>	0.02	0.02	0.12
Observations	40,946	38,353	38,353

Notes: Dependent variable: change in country weight, as defined in equation (8). This analysis is based on one observation per fund-time-country. All variables normalized by beginning of period fund size. <sup>\*\*\*</sup>, <sup>\*\*</sup>, and <sup>\*</sup> represents statistical significance at the 1%, 5%, and 10% level respectively. Standard errors are in parenthesis.

Table 1.b: Portfolio adjustment: 1996:1 – 2000:12

	Assuming inelastic supply	Assuming inelastic supply	Assuming perfectly elastic supply	Assuming perfectly elastic supply	No restriction on supply elasticity	No restriction on supply elasticity
Adjustment term	1	1	0	0	0.435 <sup>***</sup> (0.007)	0.433 <sup>***</sup> (0.007)
Overexposure (t-1)	-0.044 <sup>***</sup> (0.002)	-0.045 <sup>***</sup> (0.002)	-0.069 <sup>***</sup> (0.002)	-0.070 <sup>***</sup> (0.002)	-0.061 <sup>***</sup> (0.002)	-0.061 <sup>***</sup> (0.002)
excess gains	3.289 <sup>***</sup> (0.253)	-	-1.568 <sup>***</sup> (0.262)	-	0.588 <sup>**</sup> (0.251)	-
overexposure (t-1) × excess gains	0.843 <sup>***</sup> (0.100)	-	1.211 <sup>***</sup> (0.102)	-	1.062 <sup>***</sup> (0.097)	-
Gains	0.106 <sup>*</sup> (0.078)	0.487 <sup>***</sup> (0.072)	0.651 <sup>***</sup> (0.080)	0.488 <sup>***</sup> (0.074)	0.420 <sup>***</sup> (0.076)	0.500 <sup>***</sup> (0.071)
overexposure (t-1) × gains	-0.173 <sup>***</sup> (0.034)	-0.053 <sup>***</sup> (0.031)	-0.179 <sup>***</sup> (0.034)	-0.028 (0.032)	-0.182 <sup>***</sup> (0.032)	-0.043 (0.030)
R <sup>2</sup>	0.02	0.01	0.03	0.02	0.12	0.12
Observations	40,946	40,946	38,353	38,353	38,353	38,353

Notes: Dependent variable: change in country weight, as defined in equation (8). This analysis is based on one observation per fund-time-country. All variables normalized by beginning of period fund size. <sup>\*\*\*</sup>, <sup>\*\*</sup>, and <sup>\*</sup> represents statistical significance at the 1%, 5%, and 10% level respectively. Standard errors are in parenthesis.

Table 1.c: Portfolio adjustment with control variables: 1996:1 – 2000:12

	Assuming inelastic supply	Assuming perfectly elastic supply	No restriction on supply elasticity
adjustment term	-	-	0.427** (0.007)
overexposure (t-1)	-0.044*** (0.002)	-0.070*** (0.002)	-0.061*** (0.002)
excess gains	3.415*** (0.237)	-0.814*** (0.245)	1.045*** (0.235)
overexposure (t-1) × excess gains	0.665*** (0.094)	1.023*** (0.095)	0.872*** (0.091)
Δ economic risk (t-1)	-0.005 (0.004)	0.014*** (0.004)	0.006*** (0.004)
Δ financial risk (t-1)	-0.005 (0.004)	-0.009*** (0.004)	-0.007*** (0.004)
Δ political risk (t-1)	0.006** (0.003)	0.005 (0.003)	0.005** (0.003)
overexposure (t-1) × Δ economic risk (t-1)	-0.002 (0.002)	0.001 (0.002)	-0.001 (0.002)
overexposure (t-1) × Δ financial risk (t-1)	0.003* (0.002)	0.007*** (0.002)	0.006*** (0.002)
overexposure (t-1) × Δ political risk (t-1)	0.000 (0.001)	-0.002 (0.001)	-0.001 (0.001)
R <sup>2</sup>	0.02	0.03	0.11
Observations	39,691	37,174	37,174

Notes: Dependent variable: change in country weight. This analysis is based on one observation per fund-time-country. All variables normalized by beginning of period fund size. \*\*\*, \*\*, and \* represents statistical significance at the 1%, 5%, and 10% level respectively. Standard errors are in parenthesis. The Δ's denote first differences. Economic, financial, and political risk refer to the International Country Risk Guide's (ICRG) monthly economic, financial, and political risk indices.

Table 2. Transmission channels: 1996:2 – 2000:12

	(1)	(2)	(3)	(4)	(5)	(6)
Stock Market Size	0.0087*** (0.0005)			0.0087*** (0.0006)		0.0085*** (0.0006)
Trade Linkages		0.8522*** (0.2561)			0.8932*** (0.2631)	0.1325 (0.1772)
Financial Exposure			0.00077*** (0.00017)	0.00064*** (0.000123)	0.00084*** (0.00015)	0.00064*** (0.00012)
R <sup>2</sup>	0.24	0.03	0.03	0.26	0.06	0.26
Observations	990	1,079	1,108	929	1,049	880

Notes: Dependent variable: monthly country stock market returns. \*\*\*, \*\*, and \* represents statistical significance at the 1%, 5%, and 10% level respectively. Robust standard errors in parentheses.

Table 3a. Stock market returns during three crises: Thailand 1997, Russia 1998, and Brazil 1999

	Thailand		Russia		Brazil	
	weight>1	weight>2	weight>1	weight>2	weight>1	Weight>2
Financial Exposure	-0.368*** (0.124)	-0.504*** (0.093)	-0.081** (0.033)	-0.057* (0.031)	-0.021* (0.012)	-0.039* (0.020)
R <sup>2</sup>	0.28	0.52	0.15	0.09	0.08	0.20
Observations	19	14	19	15	21	14

Notes: Stock market returns as a function of a country's exposure to crisis countries. The Thai crisis regression corresponds to cumulative returns during April 1997—August 1997, the Russian crisis regression to July 1998—September 1998, and the Brazilian crisis regression to January 1999. Weight refers to the minimum weight of a country in the average portfolio to be included in regressions. Exposure variable lagged one from beginning of crisis. Crisis countries excluded from regressions. \*\*\*, \*\*, and \* means statistical significance at the 1%, 5%, and 10% level respectively. Robust standard errors are in parentheses.

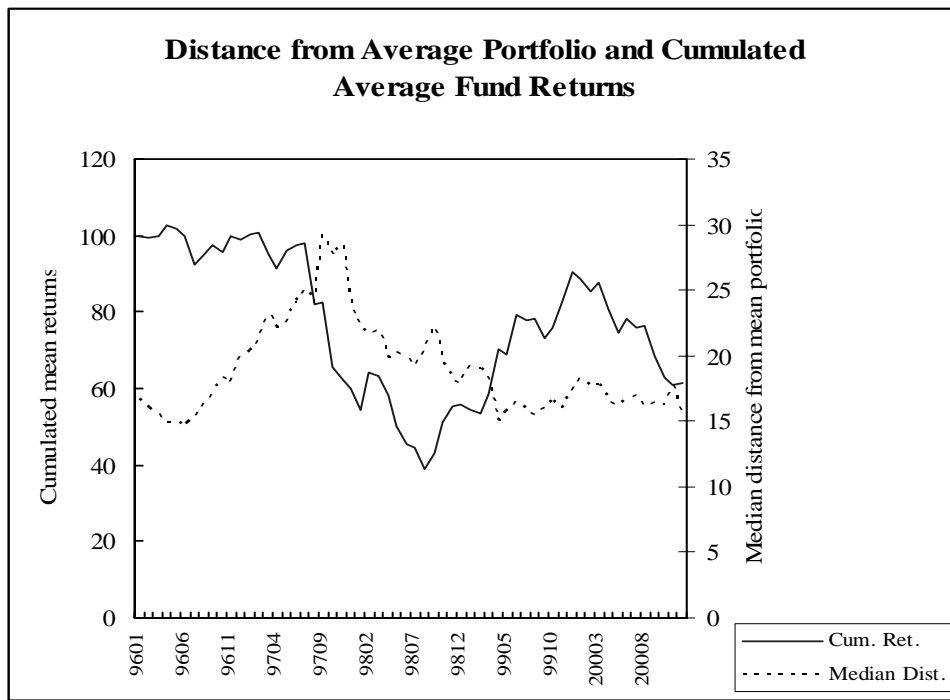
Table 3b. Stock market returns during crises, including control variables

	Thailand								
Financial Exposure (lagged)	-0.368*** (0.124)	-	-	-	-	-0.324*** (0.106)	-0.378*** (0.088)	-0.406*** (0.115)	-0.341*** (0.123)
Trade Competition	-	-0.551 (0.387)	-	-	-	-0.366 (0.275)	-	-	-
Competition for bank funds (share)	-	-	-0.608 (0.503)	-	-	-	0.039 (0.458)	-	-
Competition for bank funds (absolute)	-	-	-	0.319 (0.334)	-	-	-	0.472 (0.328)	-
ICRG Financial Risk Index (lagged)	-	-	-	-	-0.015 (0.011)	-	-	-	-0.010 (0.007)
R <sup>2</sup>	0.28	0.13	0.11	0.04	0.08	0.33	0.28	0.37	0.31
Observations	19	19	19	19	19	19	19	19	19
	Russia								
Financial Exposure (lagged)	-0.081** (0.033)	-	-	-	-	-0.039 (0.043)	-0.023 (0.039)	-0.084** (0.033)	-0.074* (0.040)
Trade Competition	-	-3.996** (1.682)	-	-	-	-3.537* (1.923)	-	-	-
Competition for bank funds (share)	-	-	-0.827*** (0.255)	-	-	-	-0.732* (0.362)	-	-
Competition for bank funds (absolute)	-	-	-	-0.096 (0.254)	-	-	-	-0.150 (0.239)	-
ICRG Financial Risk Index (lagged)	-	-	-	-	0.005 (0.006)	-	-	-	0.004 (0.006)
R <sup>2</sup>	0.15	0.18	0.30	0.01	0.05	0.20	0.32	0.17	0.21
Observations	19	18	19	19	18	18	19	19	19
	Brazil								
Financial Exposure (lagged)	-0.021* (0.021)	-	-	-	-	-0.016 (0.012)	-0.028* (0.015)	-0.025 (0.019)	-0.021* (0.011)
Trade Competition	-	-0.713*** (0.200)	-	-	-	-0.581** (0.250)	-	-	-
Competition for bank Funds (share)	-	-	0.001 (0.137)	-	-	-	0.013 (0.138)	-	-
Competition for bank funds (absolute)	-	-	-	-0.095 (0.209)	-	-	-	0.078 (0.284)	-
ICRG Financial Risk Index (lagged)	-	-	-	-	0.001 (0.003)	-	-	-	0.000 (0.003)
R <sup>2</sup>	0.08	0.10	0.00	0.01	0.08	0.14	0.10	0.08	0.08
Observations	21	21	21	21	21	21	21	21	21

Notes: Stock market returns as a function of a country's exposure to crisis countries. The regressions correspond to cumulative returns during April 1997—August 1997 for the Thai crisis, July 1998—September 1998 for the Russian crisis, and January 1999 for the Brazilian crisis. We only included countries with an average weight in fund portfolios of at least 1%. Exposure variable lagged one from beginning of crisis. Crisis countries excluded from regressions. \*\*\*, \*\*, and \* means statistical significance at the 1%, 5%, and 10% level respectively. Robust standard errors are in parentheses. For the variables “trade competition” and “competition for bank funds” see Van Rijckeghem and Weder (2001).

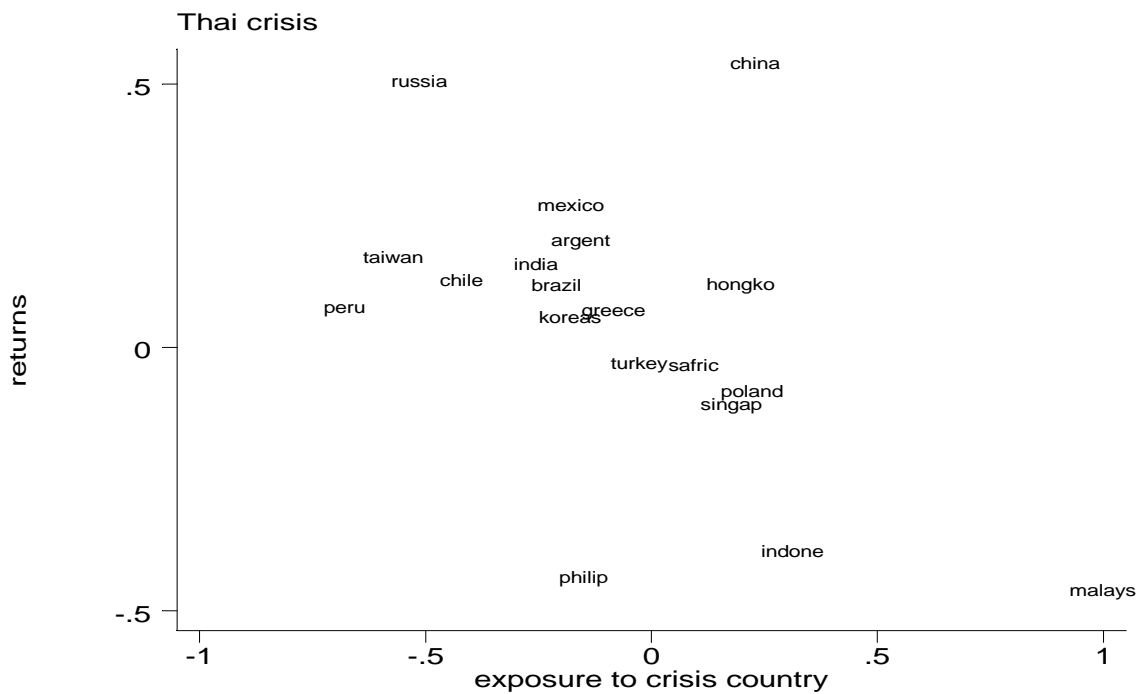


Figure 1: Portfolio dispersion over time



Note: Distance from average portfolio is the median portfolio distance from the mean portfolio. The distance is measured as the root mean squared difference over country weights. These averages are based on global funds only.

Figure 2. Exposure to Crisis Country and Stock Market Returns



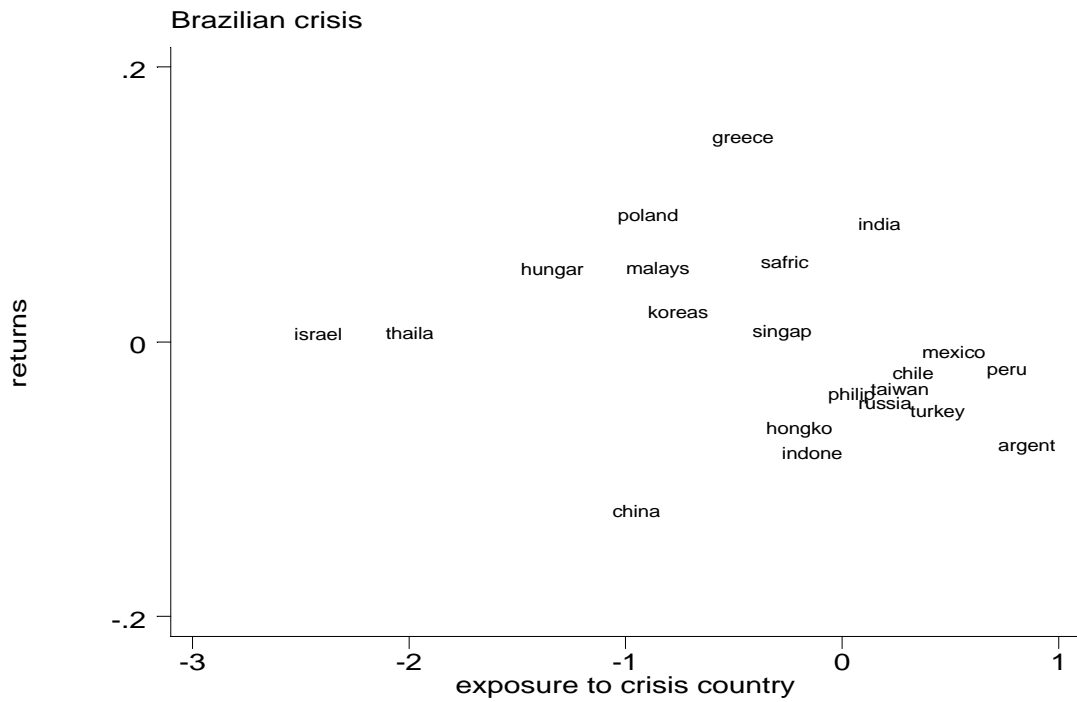
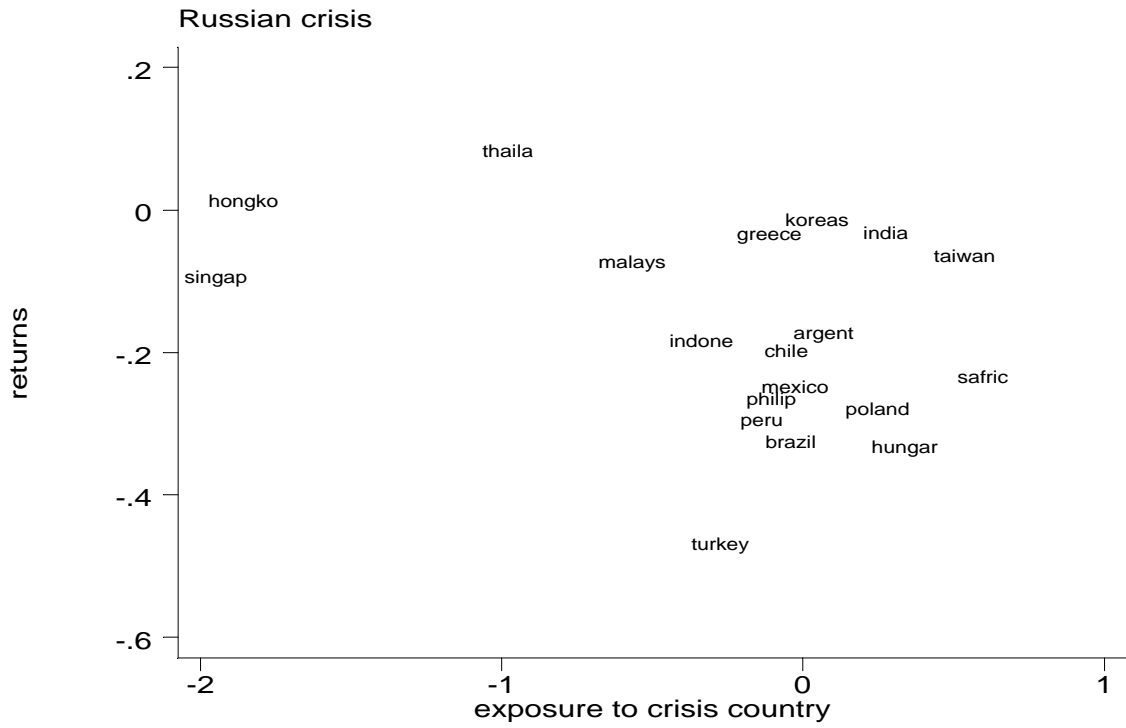
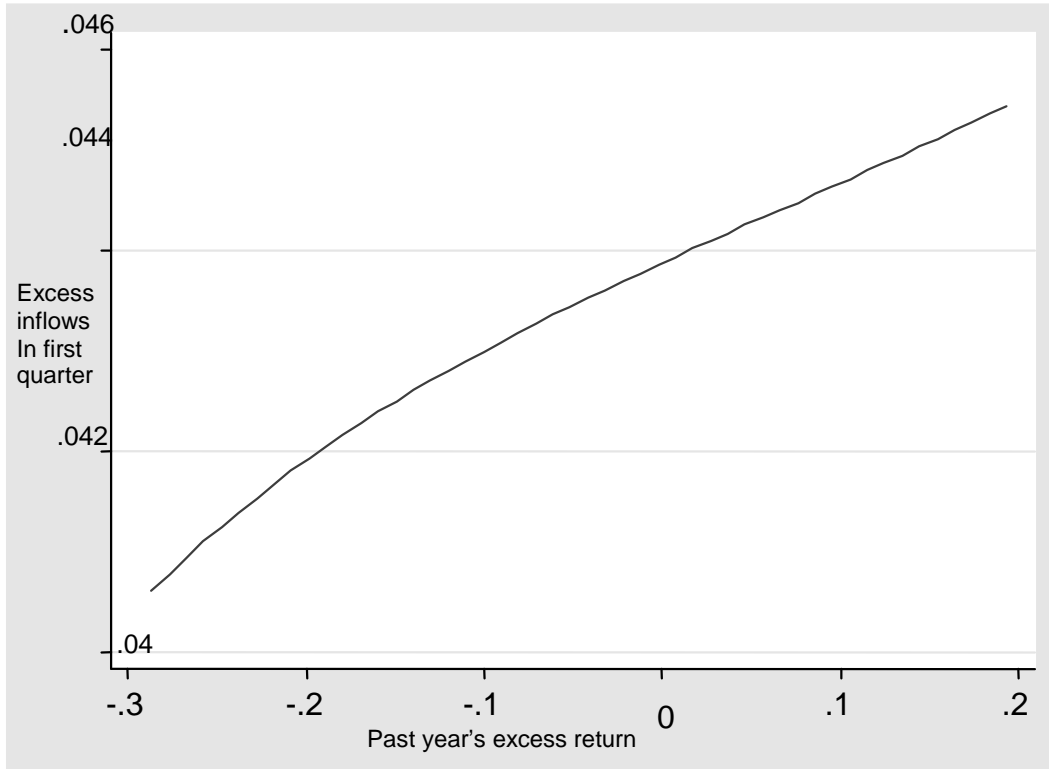


Figure A1. Fund performance and inflows



Note: Local polynomial regression of excess inflows (in excess of average inflows across funds) in the first quarter of a year on past year's excess return (in excess of average fund returns). The estimation uses an Epanechnikov kernel with a width of 0.3.