Testing the portfolio channel of contagion: the role of risk aversion

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Abstract

It has frequently been argued that portfolio adjustments by international investors may transmit financial shocks across markets and borders. This notion, however, has not yet been examined with microeconomic data. One plausible mechanism through which shocks may propagate is through changes in investors' risk aversion in response to gains and losses. We test this hypothesis using a unique data set of the monthly country asset allocation of hundreds of emerging market funds. Our results show that if funds' returns are relatively low compared to those of other funds, they adjust their holdings towards the average (or benchmark) portfolio. In other words, they tend to sell the assets of countries in which they were "overweight" and increase their exposure to countries in which they were "underweight." Building on this insight, we construct a matrix of financial interdependence reflecting the extent to which countries share a set of overexposed funds. Comparing this measure to indices of trade or bank linkages indicates that our index can improve predictions about which countries are likely to be affected by contagion from crisis centers.

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

JEL Classification: F30, G15

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1. Introduction

How do financial crises spread across countries? As a result of the large number of currency and banking crises observed over the last decade, substantial research effort has been devoted to answer this question. Recently, a growing consensus has been emerging that financial linkages and frictions are likely to play a significant role in the propagation of shocks across countries.

At a theoretical level, various authors have sought to explain international financial contagion effects 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), 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 (2002). 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.

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 if two countries borrow from banks located in a common third country, crises are transmitted more easily. However, they do not directly identify the particular mechanism accounting for this phenomenon. Providing empirical support for Calvo's 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 that bank exposures to crisis countries can help predict flows to third countries after the Mexican and Asian crises. None of these studies, however, has used cross-sectional information in portfolio positions at the micro level to identify the exact nature of financial linkages. For example, the studies stressing common lender effects through banks are based on aggregate information on bank positions, as reported by the BIS.[1]

[1] See Kaminsky, Reinhart, and Vegh (2003) for a recent discussion of the evidence on contagion.

In this paper, we examine the extent to which contagion can be explained by changes in "effective" risk aversion in response to gains and losses using a large data set containing disaggregated information on mutual fund investments in emerging markets. Such changes in effective 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).[2]

For each mutual fund, our database contains monthly data on the asset allocation by country for the period January 1996 through December 2000. The portfolio allocation of mutual funds is heterogeneous. This heterogeneity might reflect differences in expectations, or differences in the stochastic marginal utilities of the agents who invest in each fund. In this paper we do not attempt to explain this heterogeneity. However, these cross-sectional differences imply that funds are affected to different extents during crises, which allows us to identify the mechanisms we are interested in.

We find that when the profits of a fund are relatively low compared to the returns of other funds, it indeed tends to sell its positions in those countries in which it was "overexposed;" namely, its portfolio gets closer to the average portfolio. This behavior is consistent with mutual funds' "utility" being a decreasing function of the variance of their excess returns over other funds, the so-called "tracking error". The weight on this variance, a form of risk aversion, increases when funds under-perform relative to the benchmark.[3]

Following this insight, we construct a time-varying matrix of financial interdependence, based on the extent to which countries share overexposed funds. We then examine whether during the Thai, Russian, and Brazilian currency crises, our measure of financial interdependence helps explain the degree to which stock markets fell across the world. There is a negative correlation between countries' stock market performance during these crises and the degree to which these countries shared overexposed funds with the crisis country. The effect of financial interdependence index remains significant in various cases even after controlling for trade or bank linkages. This suggests that policymakers could benefit from closely monitoring the micro composition of investments across funds in order to predict and possibly avert contagion effects.

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[2] 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, 1996, Brown, Harlow, and Starks, 1996, and Daniel and Wermers, 2000, among others many others). This is not the focus of our paper, but a discussion of these issues is provided in Appendix I. 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).

[3] Disyatat and Gelos (2001) use a tracking error model with constant risk aversion. Broner, Lorenzoni, and Schmukler (2003) show that the behavior of the term structure of emerging market sovereign bonds suggests that investors' risk aversion increases during crises.

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).[4] The reason is that when returns in a country are low, funds which 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.

2. Data

The 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 located 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 period, the number of funds covered is 639, managing US$120 billion of assets. While the total number of funds increased over the period, some funds were dropped from the database if they discontinued providing information on their holdings. We focus on global emerging funds, i.e. funds that invest in emerging markets worldwide.[5] For stock market returns, we used monthly IFC US$ total returns for the period 1990-2000, complementing them whenever needed with data from MSCI or national sources.

In December 2000, the sample consisted of 20 international funds (not exclusively focusing on emerging markets), 117 global emerging market funds (restricted to investing in emerging markets worldwide), 339 Asian regional or single-country funds, 92 regional Latin American funds, and 74 funds focusing on other geographic areas. Approximately one quarter of the funds are closed-end funds. The assets of these funds represent a small, but not negligible fraction of the total market capitalization in the countries they invest. For example, in the case of Argentina, funds held

[4] Among others, Borensztein and Gelos (2003a), Kaminsky, Lyons, and Schmukler (2000), and Froot, O'Connell, and Seasholes (2001) present evidence of positive feedback trading in emerging markets.
[5] For more details on the data, see Borensztein and Gelos (2003a). Kaminsky, Lyons and Schmukler (2001) also examine mutual fund behavior in emerging markets worldwide but use data at a more aggregate level.

approximately 6.5 percent of the total stock market capitalization in August of 1998, while the share was around 4.5 percent for Hungary and Korea.

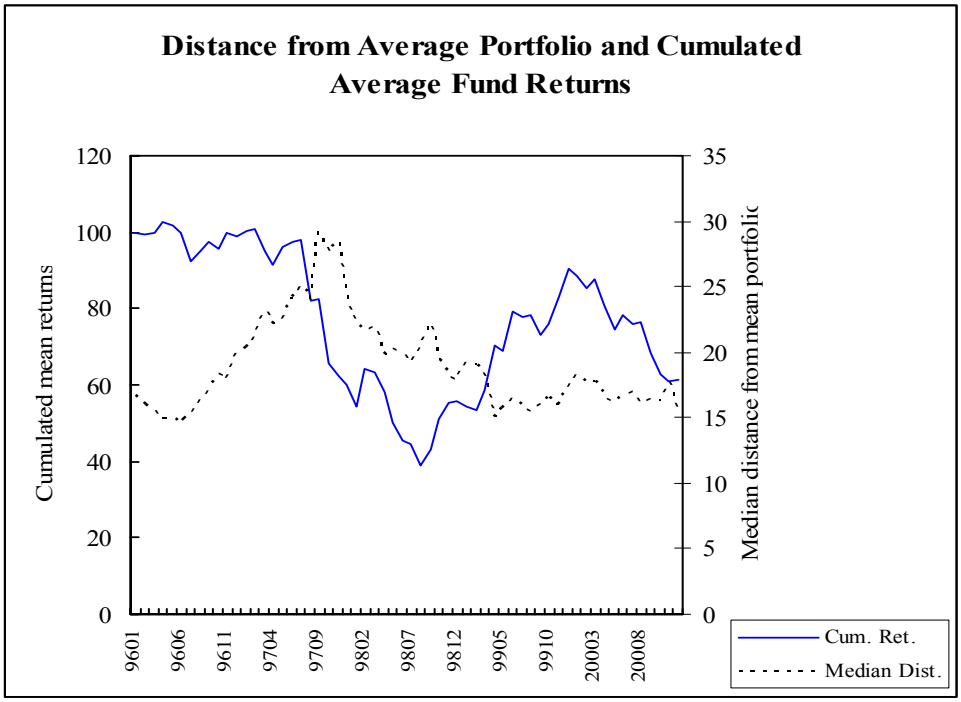
While precise numbers on total equity flows are hard to obtain, a substantial fraction of all equity flows to emerging markets seems to occur through the funds in our database. According to the World Bank (2003), in 1998, total portfolio equity flows to developing countries amounted to US$7.4 billion, compared to US$ 1.25 billion flows recorded in our sample.

The providing company aims for the widest coverage possible of emerging market funds without applying any selection criteria. According to the provider, the database covers roughly 80 percent of all dedicated emerging market funds, with a coverage of about 90 percent of total emerging market fund assets. We do not have data on holdings of individual stocks nor on the timing of funds' purchases and sales over the month. We calculate the implied flows from the asset position data, assuming that funds hold a portfolio that is well proxied by the IFC US$ total return investable index.[6] We also assume that flows occur halfway through the month.

3. Portfolio dispersion over time

Simple pictures suggest that during turbulent times, funds retrench to the average. To obtain a first impression of the data, we compute the dispersion of fund portfolios over time, where the dispersion is the root mean squared deviation from the average portfolio. Figure 1 shows the median of this dispersion of portfolios 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 suggests that fund portfolios started converging when sharp losses started piling in during the Asian crisis. Improvements in performance after the Russian crisis were, however, not accompanied by an increase in mean distance. In the following, we will examine whether this observation is driven by a generalized retrenching or whether the funds that suffer heavier loses are more likely to liquidate their positions in the countries in which they are overexposed.

[6] This turns out to be a good approximation in emerging markets. See Borensztein and Gelos (2003a).



Note: Distance from average portfolio is the median distance from the mean portfolio, where distance is measured by the root mean squared error (RMSE) over country weights. Based on global funds only.

4. Fund performance and portfolio choice

This section examines portfolio allocations at the fund level testing whether, when their returns are lower than that of the benchmark, funds sell assets in countries in which they are "overweight" and buy assets in countries in which they are "underweight." 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.

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

$$oe_{i,c,t} = b_{i,c,t} - \bar{b}_{c,t}, \qquad (1)$$

$$g_{i,t} = \sum_c b_{i,c,t-1} r_{c,t}, \qquad (2)$$

$$exg_{i,t} = g_{i,t} - \sum_{c} \bar{b}_{c,t-1} r_{c,t} \ . \qquad (3)$$

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

$$db_{i,c,t} = b_{i,c,t} - b_{i,c,t-1} . \qquad (4)$$

Focusing on $db_{i,c,t}$ as a measure of changes in funds portfolio allocations would be slightly misleading. The reason is that even if funds do not buy or sell assets, portfolio weights would change unless returns were identical in all countries. We thus define an "adjusted" change in weights, $db'_{i,c,t}$, that solely captures the change in weights that arise from funds actively buying and selling assets,[7]

$$db'_{i,c,t} = db_{i,c,t} - \left(\frac{b_{i,c,t-1}}{1+g_{i,t}} \right) \left(r_{c,t} - g_{i,t} \right). \qquad (5)$$

If our hypothesis is true, fund i should buy assets in country c ($db'_{i,c,t}$ positive) if the fund is overexposed to country c ($oe_{i,c,t}$ positive) when the fund is doing relatively well ($exg_{i,t}$ positive). Likewise, the fund should buy assets in country c ($db'_{i,c,t}$ positive) if the fund is underexposed to country c ($oe_{i,c,t}$ negative) when the fund is doing relatively badly ($exg_{i,t}$ negative). To test this hypothesis, we run the regression

$$db'_{i,c,t} = \alpha \cdot b_{i,c,t-1} + \beta \cdot exg_{i,t} + \gamma \cdot b_{i,c,t-1} \cdot exg_{i,t} + \varepsilon_{i,c,t} , \qquad (6)$$

and focus on the coefficient γ, which should be positive according to our hypothesis.

Tables 1.a and 1.b summarize our results for closed and open-end funds.[8] We report results including excess gains as well as gains to determine whether funds care more about relative or absolute

[7] The adjustment term follows from the fact that if the fund did not buy or sell any assets, its weight in country c at time t would equal $b_{i,c,t} = \left(\frac{1+r_{c,t}}{1+g_{i,t}} \right) b_{i,c,t-1}$.

[8] 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.

performance. In all cases, the coefficient γ is positive and statistically significant at the 1% level. Funds indeed tend to buy into countries in which they are overexposed (underexposed) when their gains are higher (lower) than that of other funds. The result is true for both open-end and closed-end funds, although the coefficient is larger for closed-end funds.[9,10] There is also a significant reversion to the mean in the sense that on average funds buy into countries were they are underexposed.[11]

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 enters positively and significantly for closed-end funds, but the coefficient becomes insignificant when including both absolute and relative gains. For open-end funds, the interaction term of lagged overexposure and absolute gains enters with a negative coefficient although its size is smaller than that of the interaction of overexposure with excess gains.

[9] In the regressions including absolute gains, the difference between open-end and closed-end funds in the coefficient of the interaction of excess gains with overexposure is not statistically significant.
[10] See Borensztein and Gelos (2003b) for differences in the behavior of closed- end open-end emerging market funds.
[11] Of course, this does *not* mean that there is a trend and that over time funds are getting closer to the mean.

Table 1.a: Portfolio adjustment

	All	open-end	closed-end
overexposure (t-1)	-0.044***	-0.033***	-0.088***
	(0.002)	(0.003)	(0.005)
excess gains	3.360***	-1.726***	5.417***
	(0.23)	(0.42)	(0.283)
overexposure (t-1) × excess gains	0.647***	0.405***	0.694***
	(0.092)	(0.156)	(0.116)
observations	40,946	32,768	8,178
R^2	0.02	0.01	0.08

Notes: Dependent variable: adjusted change in country weight, as defined in equation (5). One observation per fund-time-country. All variables normalized by beginning of period fund size. ***, **, and * means statistical significance at the 1%, 5%, and 10% level respectively.

Table 1.b: Portfolio adjustment

	open-end	open-end	closed-end	closed-end
overexposure (t-1)	-0.033***	-0.034***	-0.076***	-0.091***
	(0.002)	(0.003)	(0.004)	(0.006)
excess gains	-1.323	-	3.503***	-
	(0.358)		(0.275)	
overexposure (t-1) × excess gains	0.594***	-	0.739***	-
	(0.140)		(0.134)	
gains	0.039	-0.016	0.194	1.864
	(0.070)	(0.083)	(0.140)	(0.142)
overexposure (t-1) × gains	-0.179***	-0.149***	-0.062	0.245***
	(0.032)	(0.036)	(0.071)	(0.063)
observations	41,127	32,768	11,515	8,178
R^2	0.01	0.001	0.06	0.06

Notes: Dependent variable: adjusted change in country weight, as defined in equation (5). One observation per fund-time-country. All variables normalized by beginning of period fund size. ***, **, and * means statistical significance at the 1%, 5%, and 10% level respectively.

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 (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% and that all funds are closed-end. According to the results in Table 1.a, both groups of funds would reduce their weight in the country by 0.35%. 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 9.15%, which implies that total investments in the country would drop by 8.5%.

We have also run regressions including control variables. There, we added variables such as changes in risk as reported by the International Country Risk Guide; we included such control variables independently and as interactions with lagged excess gains. While many of these variables helped to improve the fit of our regressions, none significantly reduced the importance of the channel stressed here. The results are reported in Appendix II.

5. A measure of financial interdependence

The results in the previous section suggest that the effect of crises on fund flows depends 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.

In this section we construct a matrix of financial interdependence between countries based on whether countries share overexposed 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,

$$re_{c_1,i,t} = \frac{a_{i,c_1,t}}{\sum_{i'} a_{i',c_1,t}}. \qquad (7)$$

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

$$d_{c_1,c_2,t} = \sum_i re_{c_1,i,t} \times oe_{i,c_2,t}, \qquad (8)$$

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

$$d_{c_1,c_2,t} = \sum_i \frac{s_i}{S} \frac{oe_{i,c_1,t}}{\bar{b}_{c_1,t}} \times oe_{i,c_2,t}\,, \qquad (9)$$

where $S = \sum_i s_i$, the sum of the assets of all funds (see Appendix III 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.[12]

6. Financial interdependence and contagion

We have shown that, in average, funds take their capital out of countries that rely heavily on funds overexposed to crisis countries. Does this mean that the matrix of financial exposure can predict which countries are likely to be affected by contagion? In particular, in this section we study whether the degree of financial exposures to crisis countries can explain the cross-section of stock returns during crises. This is of course a challenging task since we are examining only a subset of all foreign investors.

We find that our index of financial exposure helps explain the pattern of cross-country stock market movements during the Thai, Russian and Brazilian crises (Table 2a).[13] For the three crises, we

[12] This index only takes into account "direct" links. Higher order links can be calculated estimating first the effect of the direct link, adding higher order terms discounted using this estimated effect, and iterating.

[13] 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

run three separate regressions of stock market returns on exposure restricting the sample to countries that represent at least 1%, 2%, and 3% of average fund portfolio respectively.[14] For all crises, the coefficient on the financial exposure variable is negative and statistically significant. 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. However, it loses significance when restricting the regression to countries with weights higher than 3%, although this regression only has 9 observations. 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.

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increased substantially in 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 – 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.

[14] 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.

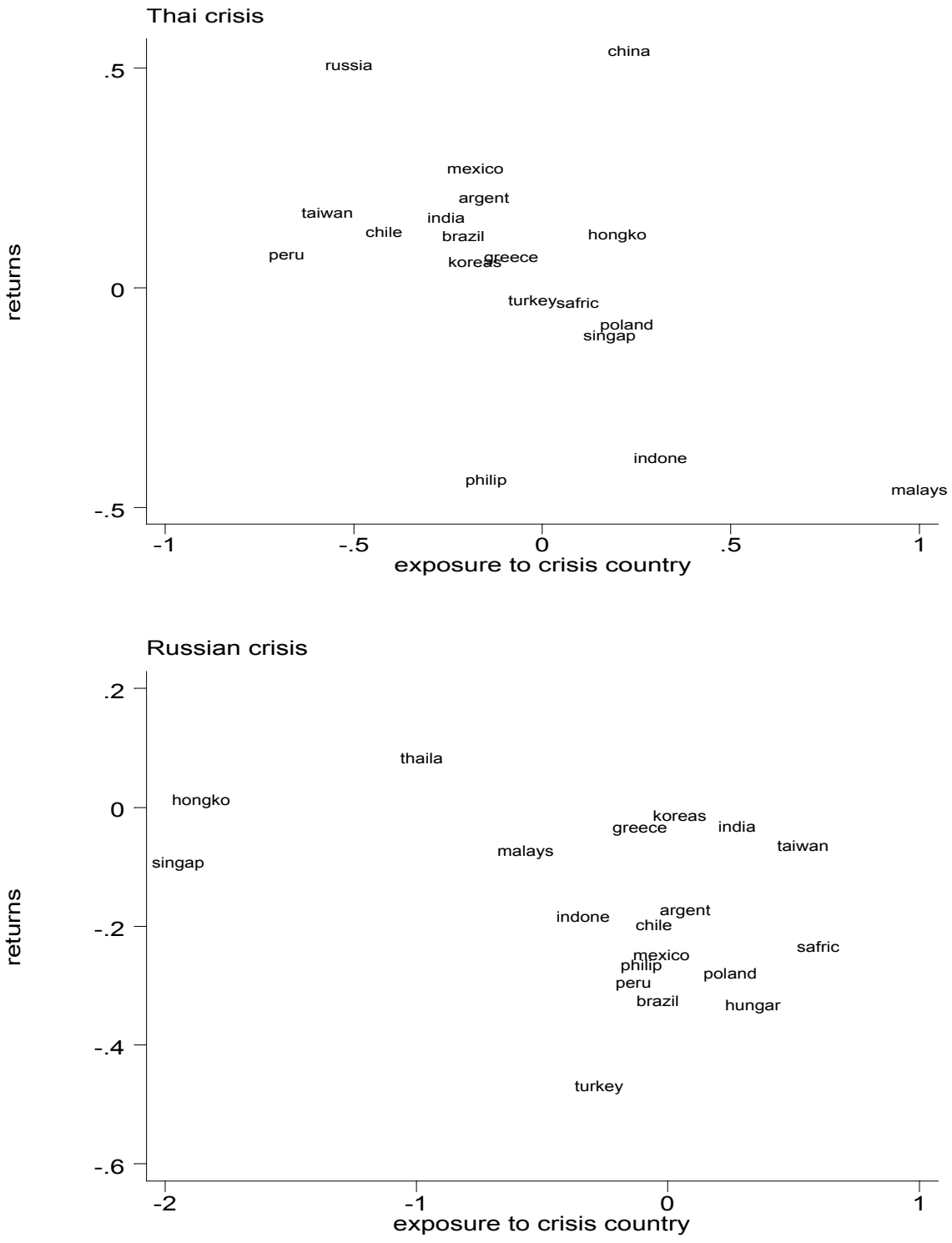
Table 2a. Stock market returns during crises

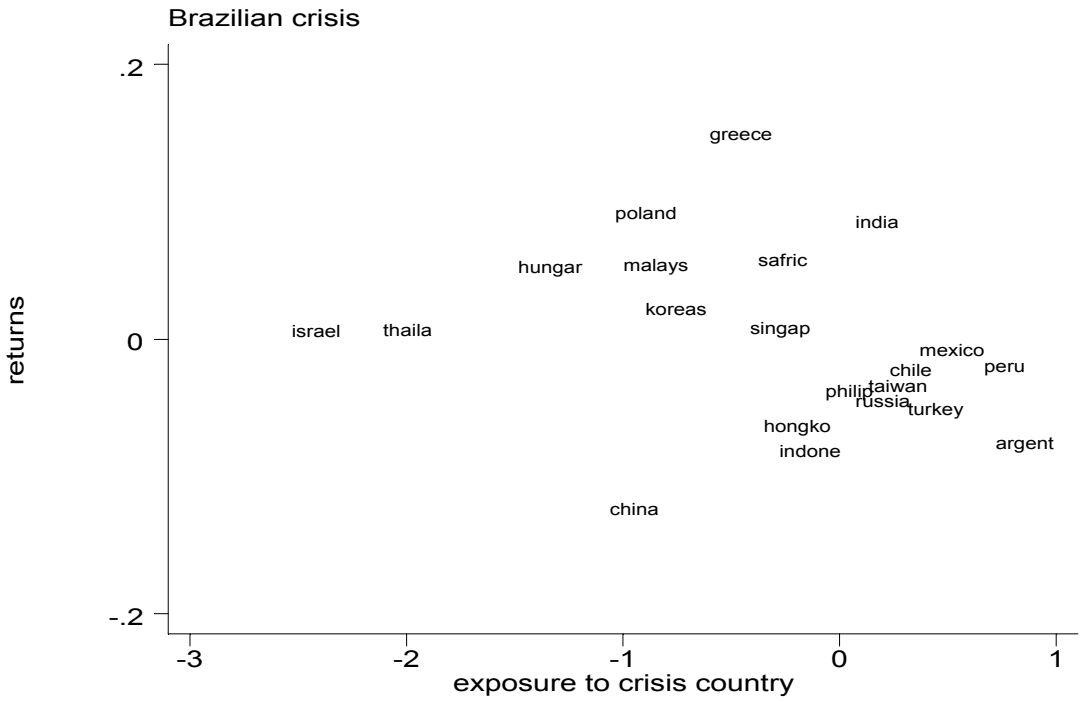
	Thailand			Russia			Brazil		
	weight>1	weight>2	weight>3	weight>1	Weight>2	weight>3	weight>1	weight>2	weight>3
Financial Exposure	-0.368*** (0.124)	-0.504*** (0.093)	-0.520*** (0.104)	-0.081** (0.033)	-0.057* (0.031)	-0.050 (0.066)	-0.021* (0.012)	-0.039* (0.020)	-0.096** (0.043)
R^2	0.28	0.52	0.52	0.15	0.09	0.06	0.08	0.20	0.45
No. of obs.	19	14	12	19	15	9	21	14	10

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 shown in parentheses.

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 driven by outliers. 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)

Figure 2. Exposure to Crisis Country and Stock Market Returns





Next, we examine the importance of two important control variables, adding them one at a time to each regression (Table 2b). First, the presence of trade linkages is an important 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 Van Rijckeghem and Weder (2001).[15] 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. Due to the limited number of observations, we cannot include lists of potentially relevant macroeconomic fundamentals.[16]

[15] 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 the data for this case were constructed by us).

[16] 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 five percent confidence level.

Table 2b. Stock market returns during crises, including control variables

	Thailand	Thailand	Thailand	Thailand	Thailand	Thailand	Thailand
Financial Exposure (lagged)	-0.368*** (0.124)	-	-	-	-0.324*** (0.106)	-0.378*** (0.088)	-0.406*** (0.115)
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 (absol.ute)	-	-	-	0.319 (0.334)	-	-	0.472 (0.328)
R^2	0.28	0.13	0.11	0.04	0.33	0.28	0.37
No. of obs.	19	19	19	19	19	19	19

	Russia	Russia	Russia	Russia	Russia	Russia	Russia
Financial Exposure (lagged)	-0.081** (0.033)	-	-	-	-0.039 (0.043)	-0.023 (0.039)	-0.084** (0.033)
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 (absol.ute)	-	-	-	-0.096 (0.254)	-	-	-0.150 (0.239)
R^2	0.15	0.18	0.30	0.01	0.20	0.32	0.17
No. of obs.	19	18	19	19	18	19	19

	Brazil	Brazil	Brazil	Brazil	Brazil	Brazil	Brazil
Financial Exposure (lagged)	-0.021* (0.021)	-	-	-	-0.016 (0.012)	-0.028* (0.015)	-0.025 (0.019)
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 (absol.ute)	-			-0.095 (0.209)	-	-	0.078 (0.284)
R2	0.08	0.10	0.00	0.01	0.14	0.10	0.08
No. of obs.	21	21	21	21	21	21	21

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. Includes only countries with an average weight in fund portfolios of at leas one percent. 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 shown in parentheses. For the variables "trade competition" and "competition for bank funds" see Van Rijckeghem and Weder (2001). "Absolute" competition for bank funds is based on the value of credits obtained from the common lender, "share" is based on the share of borrowing from the common lender.

The small number of observations limits inference but some patterns are observable. For the Thai crisis, neither 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 either control variable at a time. 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 percent of stock return variation. When including both the financial exposure index and one of the two control variables at a time, 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. 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) but becomes insignificant when adding trade competition.[17]

7. Conclusions

We have shown that the portfolio choices of international funds depend in part on their past relative performance. In particular, they respond to relative losses (gains) by moving closer (further) to the benchmark portfolio. These results are consistent with the hypothesis that fund managers' effective risk aversion depends on their fund's relative performance.

This behavior by international funds can help explain why some countries are affected by financial market spillovers even if they do not seem to share fundamental weaknesses with crisis countries. We constructed an index of financial interdependence reflecting the extent to which countries share "overexposed" funds. We found that this index contributes to explain the pattern of stock returns during three crises. In the case of the Thai crisis, it outperforms trade and bank linkages as explanatory variable, while for the Russian and Brazilian crises, trade linkages seem to be at least as important in explaining the extent to which other countries were affected. These results suggest that our index of

[17] 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 (2002), show that funds tend to avoid intransparent countries during crises. We did not investigate this issue here but plan to address it in future research.

financial interdependence could be helpful in predicting which countries are likely to be affected by a crisis in a particular country.

The tendency of mutual funds to reduce their overexposures in response to low relative performance may exacerbate the effect of crises, by creating both contagion between countries and momentum trading at the country level. This 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, we believe that such 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 may become arbitrary, yielding herding in an extreme form.[18]

Lastly, 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. However, in order to gain a more complete picture of the functioning of international capital markets, we hope that our research will be complemented in the future by similar examination of other market players' behavior.

[18] This point has been made by Calvo and Mendoza (1999). 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).

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Appendix I

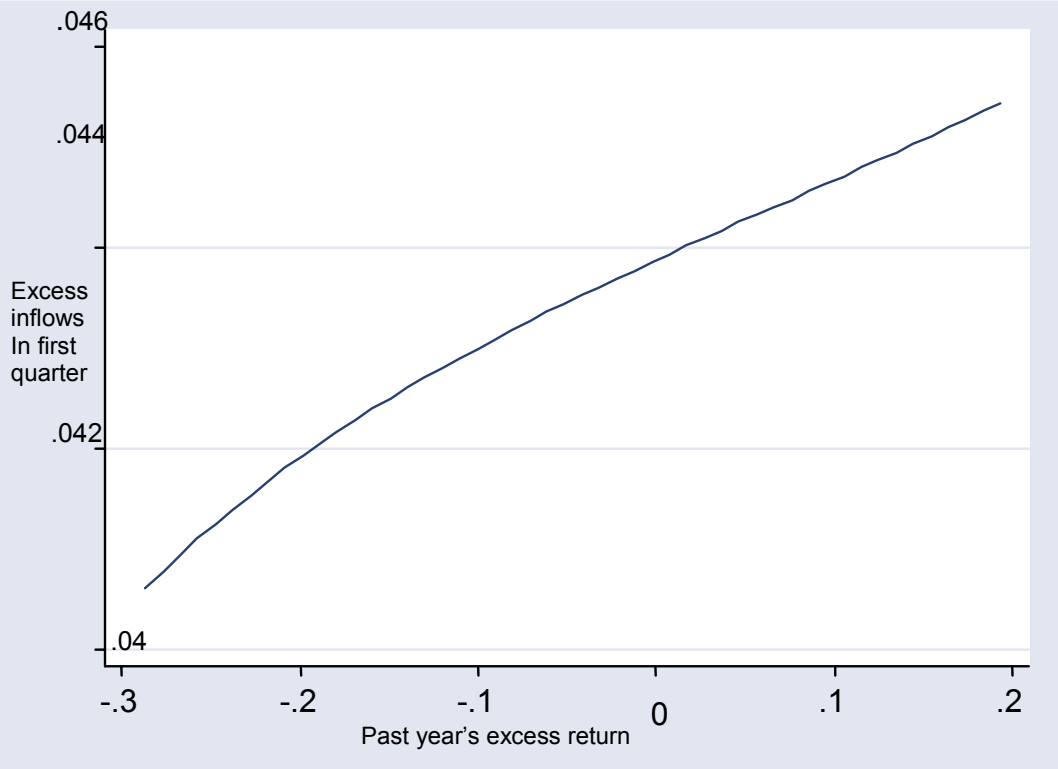
Fund performance and redemptions

In the finance literature, the question of the relationship between past performance and risk taking by mutual funds has been studied repeatedly. 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). One reason for such behavior might be that fund managers' compensation rises with assets under management; if mutual funds with the best performance capture the lion's share of new inflows while funds that perform poorly are not penalized equally, this might create an incentive for managers to choose more risky portfolios if they are falling behind.

More recent studies, however, have questioned this hypothesis. Busse (2000) finds that mid-year losers decrease their risk during the second half of a calendar 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 the future risk-taking behavior by fund managers. Chen and Pennachi (2002) argue that while fund managers do increase the fund's "tracking error" as its relative performance declines, this does not result in an increased variance of the fund's returns.

The incentives of dedicated emerging market funds have to our knowledge not yet been investigated in the literature, and a detailed analysis of this question is beyond the scope of this paper. One reason for this is that we do not have precise data about inflows, which we have to infer indirectly subtracting imputed fund gains from increases in reported size. A look at the data for global funds (Figure A1) however, does not suggest the presence of incentives to gamble: the nonparametrically estimated relationship between excess inflows in a given quarter and past year's excess inflows is positive, but not convex.

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.

Appendix II. Portfolio adjustment regressions with control variables

Table A.1 shows the results of adding to our base regression changes in economic risk, financial risk, and political risk, both in levels and interacted with overexposure. The table shows that these variables do not have any effect on the estimates of the coefficient we had previously estimated. In addition, they are not statistically significant.

Table A.1: Portfolio adjustment (with control variables)

	open-end	open-end	closed-end	closed-end
overexposure (t-1)	-0.032***	-0.032***	-0.088***	-0.089***
	(0.003)	(0.002)	(0.006)	(0.006)
excess gains	-1.839***	-1.835***	5.426***	5.427***
	(0.442)	(0.442)	(0.285)	(0.285)
overexposure (t-1)	0.441***	0.453***	0.688***	0.691***
× excess gains	(0.162)	(0.162)	(0.116)	(0.116)
Δ economic risk (t-1)	-0.001	-0.002	-0.012	-0.012
	(0.004)	(0.004)	(0.008)	(0.008)
Δ financial risk (t-1)	-0.008*	-0.008*	0.004	0.002
	(0.005)	(0.005)	(0.007)	(0.007)
Δ political risk (t-1)	0.011**	0.010**	0.010	0.002
	(0.004)	(0.004)	(0.005)	(0.005)
overexposure (t-1)	-	-0.002	-	-0.002
× Δ economic risk (t-1)		(0.002)		(0.004)
overexposure (t-1)	-	0.003**	-	0.004
× Δ financial risk (t-1)		(0.002)		(0.003)
overexposure (t-1)	-	0.002	-	-0.002
× Δ political risk (t-1)		(0.002)		(0.002)
observations	31,696	31,696	7,995	7,995
R^2	0.01	0.01	0.08	0.08

Notes: Dependent variable: adjusted change in country weight, as defined in equation (5). One observation per fund-time-country. All variables normalized by beginning of period fund size. ***, **, and * means statistical significance at the 1%, 5%, and 10% level respectively. Δ denote first differences. Economic, financial, and political risk refer to the International Country Risk Guide's (ICRG) monthly economic, financial, and political risk indices.

Appendix III

Equivalence of indices of interdependence

We start from the first index of financial interdependence

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

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

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

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.