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Research Department

**Sources of Contagion: Finance or Trade?**

Prepared by Caroline Van Rijckeghem and Beatrice Weder<sup>1</sup>

Authorized for distribution by Donald J. Mathieson

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**Abstract**

This paper presents evidence that spillovers through bank lending, as opposed to trade linkages and country characteristics, can help explain contagion. We construct a measure of competition for bank funds and find evidence in favor of a common lender effect in the Mexican, Thai, and Russian crises, after controlling for macroeconomic fundamentals. The results are quite robust to the definition of the finance indicator. In the case of the Asian crisis, results are not always robust to the inclusion of trade competition, reflecting the high correlation between competition for funds and trade.

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## I. INTRODUCTION

Contagion in the wake of the Russian crisis has pointed to the role of investors' portfolios in accentuating and transmitting financial crises from country to country. While a good case could be made that contagion following a number of earlier crises was related to trade (Glick and Rose, 1999), such an argument does not easily carry over to the case of Russia. Indeed, many observers have noted the insignificance of Russia as a destination for exports or as a trade competitor in third nations. Observers have rather pointed to two types of financial market linkages to explain contagion following the Russian crisis: (1) an enhanced perception of risks in emerging markets and/or an increase in risk aversion by investors; and (2) the need to restore capital adequacy ratios, which were dented by losses in Russia, meet margin calls, and/or to rebalance portfolios to contain "value at risk." The second type of explanation points to the importance of liquidity as opposed to a country's macroeconomic fundamentals in the pricing of emerging market assets. By the same token, it suggests that investors' portfolios, rather than characteristics of countries, can help explain the pattern of contagion.

The aim of this paper is to test the importance of financial contagion relative to trade contagion in the most recent episodes of currency crises in emerging markets. The paper concentrates on bank lending as a channel and ignores other players such as hedge funds, institutional investors (pension and insurance funds) and dedicated mutual funds. It focuses on the effect on money and debt markets, not on equity markets. The concentration on the bank channel can be justified based on the size and the volatility of bank credits (Table 1). In Asia, for example, banks were the single largest group of creditors before the crisis and bank lending was the most volatile component of capital flows during the crisis. In 1996, net flows from banks into 29 emerging markets accounted for US\$ 120 billion, or about a third of total private inflows. In 1997 banks had reduced their share to about 9 percent of private inflows and by 1998 net inflows had turned into net outflows of about US\$ 30 billion. By comparison, private capital flows have been much more stable.

To test the importance of bank credit in transmitting currency crises we construct a measure of competition for bank funds based on BIS data. The idea is that if a country competes intensively for funds from a bank which is highly exposed to a crisis country (the common bank lender), adjustments to restore capital adequacy, meet margin calls, or adjust exposures (as dictated by Value-at-Risk-like models used by banks) will lead to reduced credit lines to the second country. In the absence of data on bank-by-bank lending, BIS data by nationality of lender are used as a proxy.<sup>2</sup>

Market participants have been skeptical of the usefulness of this data, pointing out that it captures only on-balance sheet positions, whereas banks typically hedge their positions with

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<sup>2</sup> This is an unavoidable limitation of the data. To the extent that within a country, some banks specialize in one emerging market, and some in others, the data will not capture financial linkages between countries well; this could lead to insignificant results, even when the common lender effect is present.

off-balance sheet positions (using instruments in the country at hand, or correlated ones, for example, ahead of the February 1999 Brazilian devaluation, some investors shorted the Mexican peso in lieu of the Real). Maintaining such hedges is nevertheless expensive, and hence tends to be done more when a crisis is widely anticipated, as was the case in Brazil. For the Mexican, Asian, and Russian crises, which were generally not anticipated, the data is more likely to capture overall positions closely.<sup>3</sup>

The remainder of the paper is organized as follows. Section II places the paper in the context of the channels of contagion identified in the theoretical and empirical literature. Section III describes our methodology and data. The main results are presented in section IV. Section V concludes.

## II. CHANNELS OF CONTAGION

Both the theoretical and empirical literature on currency crisis and contagion has ballooned over the past few years. A recent comprehensive summary of the literature is provided, for instance, by Dornbusch, Park, and Claessens (1999) or by Wolf (1999). This section gives only a brief overview of the main channels of contagion that have been suggested and in some cases also tested empirically. It greatly clarifies the exposition to classify contagion in two categories, following Masson (1998), namely spillovers, and pure contagion.<sup>4</sup>

*Spillovers*, where a crisis in a “ground zero” country (the first country to experience a balance of payments crisis) spills over into deterioration of fundamentals in other countries, arise from a number of factors, including through reduced competitiveness, lower commodity prices, or loss of liquidity.

*Spillovers through trade links* have been prominent in the discussion about contagion. The most direct form of link is through bilateral trade. With high levels of bilateral trade, a financial crisis in one country will negatively affect all trading partners, both through losses in competitiveness (see e.g. Gerlach and Smets, 1995) and through the fall in demand in the

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<sup>3</sup> Off-balance sheet data is not available which would permit us to accurately calculate exposures and risks. First, this data is generally not compiled, except for the US, where the Federal Financial Institutions Examination Board compiles comprehensive information which comprises off-balance sheet data. Second, even when the data is available, true exposures and risks are difficult to calculate. This is because off-balance sheet positions include a myriad of factors, including interbank deposits, commitments, derivatives, and letters of credit. Some (e.g. letters of credit) go in the direction of increasing exposure, some in the direction of reducing exposure (derivatives). However, in the data, derivative positions which reduce risk (hedges) are counted as part of the off-balance sheet position, because of exposure to the counterparty which has to fulfil the contract, and hence appear to increase exposure (see “Mature Banking System Exposures to Asia,” IMF memorandum (March, 6, 1998)).

<sup>4</sup> Masson (1996) distinguishes an additional set of reasons--monsoonal effects--for why currency crises tend to be closely bunched in time. Monsoonal effects arise from economic shifts in industrialized countries, such as increases in industrialized country interest rates.

country experiencing the financial crisis. Obviously, for emerging markets this link is not very significant because trade with other emerging markets typically represents only a small share of total exports.<sup>5</sup> The second trade link is through competition in third markets. In this case, a financial crisis (and the associated depreciation of the exchange rate) in one country affects other countries that export to the same markets. The role of trade competition in explaining contagion has been documented by Eichengreen, Rose, and Wyplosz (1996) for industrial countries and by Glick and Rose (1999) worldwide and for emerging markets in particular. The latter conclude that “trade is an important channel for contagion, above and beyond macroeconomic influences. Countries who trade and compete with the targets of speculative attacks are themselves likely to be attacked. [...] This linkage is intuitive, statistically robust, and important in understanding the regional nature of speculative attacks.” (pp. 604-5).

*Financial market linkages* may also be an important source of spillovers, as this paper aims to show empirically, at least for bank lending. There are several, possibly simultaneous, mechanisms at work that can cause cross-border spillovers. Losses in one country could lead banks to sell off assets in other countries in an attempt to restore their capital-adequacy ratios. A similar mechanism is at work if investors upon receiving a margin call based on the decline in price in one asset decide to sell assets in other countries (Calvo, 1999). Importantly, if banks are confronted with losses on their securities portfolio or a rise of non performing loans in one country they are likely to try to reduce their overall value at risk. Risk management techniques may then dictate a reduction in exposure in the riskiest markets or in credit lines in historically correlated markets (Folkerts-Landau and Garber, 1998). To the extent that investors allocate fixed proportions of their assets to (individual) emerging markets, changes in the weight given to the emerging market asset class as a whole affect all countries equally (Buckberg, 1996). Asymmetric information can amplify the effects of portfolio rebalancing (Kodres and Pritsker, 1999).<sup>6</sup> Lack of liquidity is a further reason why a crisis in one market may lead financial intermediaries to liquidate other emerging market assets (Goldfajn and Valdes, 1997). Finally, regulations involving ratings, such as regulations which disallow holdings of non-investment grade securities, or link capital requirements to them, may also play a role. To the extent that downgrades are implemented more frequently in emerging markets after a crisis, this may well add to the sell dynamics in a crisis.

*Pure contagion*, refers to those crises triggered by a crisis elsewhere but which cannot be explained by changes in fundamentals or by any sort of the rather “mechanical” spillovers discussed above, but are possibly caused by shifts in market sentiments (increased risk

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<sup>5</sup> However for some countries this channel may be important. For instance the fallout of the Brazilian crisis for Argentina is mainly through trade given that Brazil accounts for 30 percent of Argentinian exports.

<sup>6</sup> Kodres and Pritsker (1999) categorize linkages into a correlated information channel, a correlated liquidity shock channel, and a cross-market hedging channel, and simulate the role of these channels based on their theoretical framework. See Froot, O’Connell, and Seasholes (1998) and Wei (1999) for empirical evidence on the behavior of international investors, including on feedback trading.

aversion) or changes in interpretation given to existing information (an increased perception of risk or a “wake-up call”).<sup>7</sup>

### **The common bank lender channel**

In this paper we focus only on spillovers resulting from financial linkages, not on pure contagion, and only on spillovers channeled through banks, the so-called “common bank lender effect.” Bank lending covers both loans per se and holding of securities. The underlying presumption is that bank exposures in countries affected by financial crisis were large, implying substantial potential losses, and hence the need to restore capital asset ratios, meet margin calls, or readjust risk exposures, thus accounting for the common bank lender effect.

By a number of accounts international banks lost a sizable amount of money in the Asian and Russian crises. In the 4 Asian crisis countries (Korea, Indonesia, Malaysia, and Thailand), exposures ranged from 20-30 percent of capital for banks from the United States, France, Germany and the United Kingdom, and 70 percent of capital in Japan.<sup>8</sup> The aggregate non-performing rate on loans to the four crisis countries was expected to be about 25-30 percent. Citing exposure to Asia, rating agencies put a large number of mature market banks on review, and implemented a number of downgrades.<sup>9</sup> In Russia, exposures were smaller, but expected losses greater—about 90 cents on the dollar. For European banks, exposure of 9 selected banks is estimated at \$8 billion in Russia, compared to \$48 billion in the 4 Asian crisis countries. Provisions as of October 1998, were \$2.3 billion in Russia and \$7.1 billion in the 4 Asian crisis countries respectively. Based on market views of ultimate losses of 90 percent of exposure in Russia and 30 percent in Asia, this means losses are expected to be about half as large in Russia as in the four Asian crisis countries.<sup>10</sup> German

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<sup>7</sup> See Masson (1998, p. 4).

<sup>8</sup> Capital refers to aggregate tier 1 capital for the ten largest banks, except for Germany where the concept used is shareholders' equity. The source of data is “Mature Banking System Exposures to Asia,” IMF memorandum (March, 6, 1998), based on Moody's (1998).

<sup>9</sup> In early January 1998, Moody's put 10 European banks on review (5 from France, 4 from Germany, and one from Britain). Moody's also put on review the ratings of Bank of Tokyo-Mitsubishi and Dai-Ichi Kangyo Bank and shifted to a negative outlook for Sumimoto Bank and Industrial Bank of Japan. In the US, it shifted to a negative outlook for JP Morgan, Citicorp, and Bankers' Trust. IBCA and Standard and Poor's generally took similar actions, with IBCA implementing a number of downgrades (IMF, 1998).

<sup>10</sup> Casualties of the Russian crisis included Deutsche Bank (which lost its AAA S&P rating in end-August 1998), Austrian RZB (whose short-term rating was placed on CreditWatch with negative implications by S&P), JP Morgan (which was placed on review for a possible downgrade by Moody's citing its exposure to emerging markets), Bankers Trust (which was downgraded by S&P and Fitch-IBCA), and Merrill Lynch (S&P revised its ratings outlook to negative). Based on Salomon Smith Barney, “European Banks: The Time to Buy Has Arrived,” (October 14, 1998).

(both commercial and Landes-banken), Swiss, Austrian, French, and US banks had the largest exposures.<sup>11</sup>

Earlier work on the “common bank lender” channel of contagion has been conducted by Kaminsky and Reinhart (1998) and Caramazza, Ricci, and Salgado (1999). Kaminsky and Reinhart (KR) identify a bank lending channel, a liquidity channel, and a trade channel. They proceed to form clusters of countries based on these channels and show that these clusters tend to be regional, a fact that could explain regional contagion. In the case of bank lending, they distinguish a cluster of countries which borrows from Japanese banks and one which borrows from US banks.<sup>12</sup> They show that the probability of a crisis conditional on crises having happened in a certain bank lending cluster tends to be higher than the unconditional probability of crisis.<sup>13</sup> However, given the large overlap between lending clusters and regional clusters, the results do not constitute a definite case that the pattern of contagion is caused by the common bank lender effect as opposed to a different type of regional effect, such as the trade channel.<sup>14</sup> Caramazza, Ricci, and Salgado (CRS), using BIS data, define a common bank lender for each crisis as the country that lent the most to the first country in crisis in each of the major crises.<sup>15</sup> In the Mexican crisis the common bank lender is the United States, in the Asian crisis, it is Japan, and in Russia, it is Germany. They then show that countries experiencing crises relied more on the common bank lender for funding than non-crisis countries (the share of external bank liabilities held by the common bank lender was 10 percent higher). Also, crisis countries were somewhat more important to common bank lenders than non-crisis countries (they accounted for a 5 percentage point higher share of the external loan portfolio of the common lender than the average noncrisis country).<sup>16</sup> The common bank lender effect appears strongest in the Mexican and Asian crisis; weak findings for the Russian crisis are seen by the authors as “the result of a global flight to quality and liquidity affecting a broad group of countries, not just those with close financial

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<sup>11</sup> “European Banks Weather the Russian Storm,” Standard and Poor’s Credit Analysis Service (October 7, 1998) and US Banking Quarterly Review, Third Quarter 1998.

<sup>12</sup> The Japanese bank cluster comprises Indonesia, Malaysia, and Thailand; the US bank cluster includes Argentina, Brazil, Chile, Colombia, Mexico, the Philippines, Uruguay, and Venezuela.

<sup>13</sup> The sample covers the period 1970-1998 and 20 countries. The Korean and Russian crises are not included reflecting country coverage. The authors find that, conditional on the majority of countries in a bank cluster experiencing a crisis, the probability of crisis jumps to 83.5 percent, compared to an unconditional probability of crisis of only 31 percent; they also find that including information on crises elsewhere in a bank cluster improves the quadratic probability scores compared to forecasts which control for fundamentals only (KR, Table 6).

<sup>14</sup> Using the same method, the authors also find evidence in favor of both a regional and a trade effect.

<sup>15</sup> Their sample includes 41 emerging markets.

<sup>16</sup> The authors hypothesize that the latter facet might be important as creditors might prefer to reduce exposures more than proportionately in countries where their exposure is high, “simply because of the greater availability [of assets] in their portfolio”, rather than carrying out across the board cuts (CRS, p. 69).

market linkages to Russia.” (p. 81) We reconstruct the measures of KR and CRS below in a comprehensive examination of the common lender effect.

The approach proposed in this paper adds to the existing literature described above in a number of ways. First, we test several channels of contagion simultaneously when investigating the common bank lender channel. KR and CRS do not directly control for trade linkages (they do examine regional effects and trade linkages by themselves, while controlling for macro-economic fundamentals). Second, we propose a more comprehensive measure of competition for funds, which looks beyond the role of the most important lender, to provide a summary measure of competition for funds. This measure takes into account the role of European banks, which as a whole, even if not individually, tended to be more important than the US banks in the Mexican crisis and the Japanese banks in the Asian crisis.<sup>17</sup> Finally, we examine a number of alternative finance indicators (including indicators in the spirit of KR and CRS) to test the robustness of our results and we also use a continuous indicator of exchange market pressure to offer more nuanced differentiation across countries.

### III. EMPIRICAL STRATEGY AND DATA

In order to gauge the relative importance of financial contagion as opposed to other channels of contagion we expand the framework provided by Glick and Rose (1999).<sup>18</sup> Following those authors we define contagion as the spread of a currency crisis from a “ground zero” country. The “ground zero” country is the country where a balance of payments crisis first occurs in each episode of currency instability. Then we attempt to explain the incidence of currency crisis in other countries.

Vulnerability to spillovers (and to pure contagion) is a function of economic fundamentals of emerging markets, and research on contagion to date is mostly cast in terms of the characteristics of emerging markets, not of the characteristics of investors in these markets. The “tequila” effect was cast in terms of the macroeconomic fundamentals, notably the state of the banking sector and external competitiveness (Sachs, Tornell, and Velasco, 1996); similarly for the Asian crisis (Radelet and Sachs, 1998 or Tornell 1998).<sup>19</sup> Our aim is to test the role of the characteristics of investors while taking into account the characteristics of emerging markets, notably fundamentals and the trade channel.

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<sup>17</sup> European banks’ exposure to Latin America was about double that of US banks at end-1994 and European banks’ exposure to Asia was about 40 percent greater than that of Japanese banks in mid-1997 (BIS, various issues).

<sup>18</sup> See Glick and Rose (1998).

<sup>19</sup> The same is true for research on currency crises in general, as opposed to contagion. See Frankel and Rose (1996), Kaminsky, Lizondo, and Reinhart (1997).

We focus on three episodes of financial instability in emerging market, the ones originating with Mexico, Thailand and Russia.

For each episode we run regressions of the following form:

$$\text{Contagion}_i = a_0 + a_1 \text{Trade}_i + a_2 \text{FundsComp}_i + a_3 \text{Macro-Controls}_i + u_i$$

where contagion is either a binary variable that takes the value 1 if the country had a currency crisis in the particular episode, or, a continuous indicator of exchange market pressure. We are interested in contagion which is sufficiently severe to be reflected in monthly data.<sup>20</sup>

Trade linkages are captured in two ways—as direct trade and as trade competition in third markets. Competition for funds (FundsComp) measures the extent to which country *i* competes for funding from the same bank lenders as the ground zero country. The macrofundamentals include a set of standard control variables.

### **Definition of contagion**

Contagion is defined at the spread of a currency crisis from the ground zero country. We identify Mexico (1994), Thailand (1997), and Russia (1998) as ground zero countries and do not attempt to explain the reasons of their respective currency crisis. We only attempt to explain the subsequent targets of attacks.

We use several contagion variables. The main one is a binary variable from Glick and Rose (1999) for the Mexican and the Asian episodes. They used newspaper reports to determine which countries were victims of contagion. We then constructed an analogous crisis indicator for the Russian episode based on the views of IMF economists to determine if a particular country suffered from contagion in the wake of the Russian crisis.<sup>21</sup> We defined contagion broadly as “sufficiently persistent fallout to raise worries about a possible currency crisis, and involving a change on the order of 10 percent in either reserves, the exchange rate, or interest rates (i.e. 1000 basis points).” This binary variable has the advantage that it captures what was widely perceived as a crisis. The disadvantage is that the classification as a crisis is subjective and not available for a large number of small countries (respondents were asked to indicate when they did not know the answer for a country). The list of countries is shown in Appendix Table 1.

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<sup>20</sup> At the daily frequency, almost all emerging markets were affected after the Mexican, Asian, and Russian crises, but we are only concerned with pressures which are sufficiently large and persistent as to lead to worry about a possible balance of payments crisis.

<sup>21</sup> For the FSU countries, the data is based on Owen (1999).

We also use a continuous variable of exchange market pressure that is a weighted average of the depreciation rate, the percent decline in reserves, and the normalized change in domestic interest rates.<sup>22</sup> This pressure index is calculated 1, 3, and 6 months following the month in which the initial crisis occurs. While objective, this measure captures pressures which are unrelated to contagion from Russia, but reflect idiosyncracities (e.g. war) of the countries.

### Competition for funds variable

Our main indicator of the intensity of competition for bank funds is the analog to the indicator of trade competition in third markets by Glick and Rose (1999). It is calculated as follows:

$$\text{FundsComp}_i(\text{shares}) = \frac{\sum_c (b_{0c} + b_{ic}) / (b_0 + b_i) * [1 - |((b_{0c}/b_0) - (b_{ic}/b_i))| / ((b_{0c}/b_0) + (b_{ic}/b_i))]}{(1)}$$

where 0 stands for the “ground zero” country, c stands for the common lender,  $b_{ic}$  represents bank lending from a country c to country i. The indicator measures, for each debtor country, the similarity in borrowing patterns (in terms of shares in total borrowing) to that of the “ground zero” country. The first component of the equation is a measure of the overall importance of the common lender (say German Banks) for countries i and 0 (say Korea and Thailand). The second component captures the extent to which countries i and 0 compete for funding from the same creditor countries.<sup>23</sup>

A variant of this measure uses the *absolute* value of credits obtained from the common lender, rather than the *share* of borrowing from the common lender, as follows:

$$\text{FundsComp}_i(\text{absolute}) = \frac{\sum_c (b_{0c} + b_{ic}) / (b_0 + b_i) * [1 - |((b_{0c}) - (b_{ic}))| / ((b_{0c}) + (b_{ic}))]}{(2)}$$

<sup>22</sup> We normalize the change in interest rates by dividing it by 1 plus the level in interest rates. When normalized in this fashion a change in interest rates is proportional to the percent change in the price of the underlying instrument, irrespective of the level of interest rates. Hence pressure from capital outflows, as proxied by the change in price of instruments, is comparable across countries.

<sup>23</sup> For instance, if Korea and Thailand receive the same share of their bank lending from German banks, the second component of the equation is at the maximum, namely 1. If German banks then also contribute an important share of borrowing by Korea and Thailand, then there will be a high contribution to the overall measure of competition. Competition for funds between the two countries will be intense, which in turn means that Korea’s vulnerability to a cut-off from funding caused by losses of German banks in Thailand will be high.

We use the BIS' semi-annual consolidated data covering banking systems in 18 industrialized countries (the "reporting area"<sup>24</sup>). The data include lending through banking offices located outside the reporting area, but of the same nationality as countries in the reporting area (BIS, 1995, p. 82). Claims on affiliates of banks with head offices outside of the host country (e.g. the London branch of a Brazilian bank), are in principle included under the country of the parent bank (i.e. as claims on Brazil) (BIS, 1995, p. 93). The data in principle cover all on-balance sheet claims on countries outside the reporting area, including deposits and balances placed with banks, loans and advances to banks and non-banks, holdings of securities, and participations. The data in principle include local claims of affiliates in outside-area countries in non-local currency, as well as net asset positions in local currency. (p. 83). There are only a few exceptions to these rules (pp. 83-84). Investment banks are generally covered, the U.K. being the exception.

We use the BIS data to calculate the two indicators described above. Other indicators exist in the literature to test the common lender hypothesis and we replicate and utilize them here, using the same BIS data. We construct two alternative sets of indicators of competition for funds: the first is a binary indicator in the spirit of Kaminsky and Reinhart (KR) and the second is a set of three continuous variables based on the definitions of Caramazza, Ricci, and Salgado (CRS).

The KR indicator takes the value 1 if a country obtained the majority of its funds from US banks ahead of the Mexican crisis, from Japanese banks ahead of the Thai crisis, or from German banks ahead of the Russian crisis. These three countries are chosen because they were the most important common lender to the ground zero countries during their crises. In terms of the notation introduced above, taking the Mexican crisis as an example,  $KR_i=1$  if  $b_{iUS}/b_i$  exceeds the ratio for other creditor countries.

Three CRS indicators are derived. The first (CRS1) measures the importance of the common lender (the one most affected by the crisis in the ground zero country) *to the borrowers*, and is calculated as the share of funds obtained from US banks, Japanese banks, and German banks, respectively in the three crises we study. It is the continuous counterpart of the binary KR indicator. The second indicator (CRS2) measures the importance of a borrower *to the common lender* (again the one most affected by the crisis in the ground zero country). It is captured by the share of a borrower in total cross-border lending by the US, Japanese, and German banks, respectively. The third indicator (CRS) is calculated based on the interaction (multiplication) of the first two CRS indicators. Again taking the Mexican crisis as an example,  $CRS1_i = b_{iUS}/b_i$ ,  $CRS2_i = b_{iUS}/b_{US}$ , and  $CRS_i = CRS1_i * CRS2_i$ .

All indicators refer to the positions of banks on the eve of the respective crisis episodes (December 1994 for Mexico, June 1997 for Thailand, and June 1998 for Russia).

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<sup>24</sup>The countries that report bank lending by nationality of lender are: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Spain, Sweden, United Kingdom, United States.

### **Trade competition variables**

A first indicator of trade competition we consider is direct trade, calculated as the percent of total exports destined for the ground zero country.<sup>25</sup> A second indicator of trade linkages is indirect trade competition, that is competition in third markets. We use the concept of the trade share index provided by Glick and Rose (1999), which is based on a formula similar to equation (1).<sup>26</sup> A high value of this index indicates that the country's exports compete intensely with the ground zero country in third markets.

### **Control variables**

The macroeconomic controls are drawn from a set of variables that have been used in the empirical literature on currency crises.<sup>27</sup> We include the variables that have been shown to be relevant in explaining the incidence of currency crisis; the level of M2 over international reserves, the percentage change in credit to the private sector, the percentage change in the real effective exchange rate,<sup>28</sup> and the current account balance as a percent of GDP.

All variables are computed from IFS and are compiled for the period previous to the beginning of each episode of currency instability to avoid contamination of the annual data by the crisis (i.e. we use 1994 data for Mexico, 1996 data for Thailand, and 1997 data for Russia). Using data prior to the realization of a currency crisis is necessary since the crisis will usually completely alter the macroeconomic picture.

## **IV. RESULTS**

This section presents a number of findings pertaining to the common lender effect, as well as the relative roles of trade and finance in explaining contagious currency crises.

Table 2 reports probit estimates for the three crisis episodes using our preferred indicators of competition for funds and trade. The dependent variable is our binary variable which takes the value one if the country experienced substantial balance of payments pressures following a crisis in a ground zero country. In our estimates the macro-variables

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<sup>25</sup> Calculated for 1994, 1996 and 1997 from "Direction of Trade Statistics" IMF, Washington.

<sup>26</sup> For the Russian crisis we calculated the trade share indicator for 1997 from the "Direction of Trade Statistics" IMF, Washington.

<sup>27</sup> See e.g. Kaminsky, Lizondo and Reinhart (1997).

<sup>28</sup> Defined as in Rose and Glick as the average in the 12 months before the crisis divided by the average in the previous 3 years.

are not very powerful in explaining contagion.<sup>29</sup> Competition for funds is significantly associated with a higher probability of contagion<sup>30</sup> while trade links are less significant, and not significant at all in the Asian crisis, after accounting for the effect of funds competition.<sup>31</sup>

Table 3 is an extension of Table 2. It summarizes the results of 18 regressions with alternative definitions for funds competition. All estimates include the four macro-control variables but only the z-Statistics of the variables of interest are displayed. Trade-competition is not included as a control variable at this stage. Almost all indicators of funds competition are significant in these regressions.

The first set of regressions present results for funds competition based on shares while the second set is based on absolute values. Competition based on shares carries the highest level of significance during the Thai crisis, whereas that based on absolute values does so during the Mexican and Russian crises. The third set of regressions tests the finance indicators proposed by CRS. Interestingly, and somewhat surprisingly, the results point to a strong role for the exposure of the most affected common lender (i.e. the US, Japan, or Germany) in a given emerging market, as opposed to the reliance of that emerging market on the most affected common lender. Furthermore, it is the former indicator which seems to drive the significant results for the CRS interactive measure. The last set of regressions shows the findings for the KR finance indicator. This indicator is significant, except in the Russian crisis.

Table 4 presents the same regressions as Table 3, but also controls for trade competition. As can be seen from the table, a number of competition for funds variables, notably the CRS finance indicator based on the reliance of borrowers on the common lender, and the KR indicator, lose their significance, once trade linkages are excluded from the regressions. Similarly, trade linkages are not always robust to the inclusion of financial linkages<sup>32</sup> even though they are always significant when financial linkages are excluded (Table 3). That is, at least one of the trade indicators is significant in regressions which include both trade indicators and macro-controls.

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<sup>29</sup> The fact that it is difficult to systematically predict currency crisis with macroeconomic fundamentals has been documented before, for instance by Berg and Pattillo (1999).

<sup>30</sup> We report the measure for competition for funds (i.e. based on shares or absolute values) with the highest significance level (see Table 3).

<sup>31</sup> As a control variable, we chose the trade link which is the most significant in a regression which includes both trade link variables and 4 macro-controls, but which excludes competition for funds variables (see Table 3).

<sup>32</sup> Interestingly, direct trade is always significant in the case of Russia, reflecting strong BOP pressures in the many countries of the former Soviet Union, though this could reflect omitted variables as direct financial links between Russia and these countries are not controlled for.

Figures 1-3 demonstrate that trade linkages and competition for funds tended to be highly correlated ahead of the three crisis episodes, and in particular ahead of the Asian crisis. The figures illustrate the relationship between trade competition in third markets (a measure of how much a country shared the same export markets with a ground zero country) and competition for funds based on shares (a measure how much a country shared the same creditors with a ground zero country). Appendix Table 2 shows that this high correlation with trade linkages is present for most indicators of competition for funds.

The role of trade finance contributes to this high correlation; furthermore, it is likely that the historical expansion of bank lending started by financing trade (where the issue of collateral is not problematic) and then gradually expanded into other lending as banks became more knowledgeable about a country. This would lead to a pattern of bank lending that follows the trading routes. This would also help explaining regional contagion: not only is trade mostly regional but finance would also be largely regional. Note also that the indicators for competition of funds and for trade are more general than the above argument suggests. They are not measuring the extent to which trade and finance are linked between any two pairs of countries, that is, a high correlation does not necessarily imply that for instance Swiss banks lend to Asian countries and also take in a large share of their exports. It is sufficient that Swiss banks lend mostly to Asian countries and that Asian countries' exports compete intensely in another third market (e.g. the US).

We conducted a series of sensitivity tests. First, we tested the sensitivity of our results to the definition of contagion. As an alternative contagion indicator we use a continuous indicator of exchange market pressures measured at 1, 3, and 6 months after the initial crisis. This indicator has the advantage of taking into account the intensity of the crises and also allows us to investigate the question of timing in contagion.<sup>33</sup>

Table 5 summarizes the results for 45 regressions, for three time horizons, three crisis episodes, and for each of the three indicators of finance and both trade indicators. The regressions include macro-controls but not trade controls when finance is examined, nor finance controls, when trade is examined. Trade nor finance are significant in Mexico, with the exception of the KR indicator. In Thailand, by contrast, both sets of variables are significant at the 3 and 6 month horizons. Finally, there is some evidence that trade matters at the 3 month horizon for Russia, while some financial indicators are also significant (KR at the 1 month horizon and CRS at the 6 month horizon). Recall that a drawback of using a statistical indicator such as the pressure indicator is that it captures non-contagious exchange market pressure. This may explain the lack of results for Mexico, in particular, where the

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<sup>33</sup> For instance, one might expect that financial contagion would act instantly while trade contagion could take longer to work its way through. However, expectations of trade contagion would tend to make the distinction irrelevant. One might also expect the timing of financial contagion to be linked to the start of a recession which would cause an increase in non-performing loans, although, again, expectations of losses could bring this effect forward.

pressure index at the three month horizon ranges from a negative -159 in Zambia to a positive 17 in Chad (compared to a pressure index in Mexico of 38).

Last, Table 6 examines a subset of 45 emerging markets, to address the concern that the results may be driven by the inclusion of a number of developing countries which attract no capital flows to speak of. The dependent variable is the binary crisis indicator. The control variables are as in Tables 3 and 5. The results from Table 3 are largely confirmed—7 out of 18 finance indicators are now insignificant (compared to 3 out of 18 in Table 3). Where finance loses its significance is in the Russian crisis episode, for which the power to reject the null hypothesis is low, however, because the number of observations is rather small (30).

## V. CONCLUSIONS

This paper has provided empirical evidence in support of the view that spillovers through common bank lenders were important in transmitting the Mexican, Thai, and Russian currency crises. Some, but not all, indicators of competition for funds from a common lender are robust to the inclusion of trade linkages in the regressions, with more comprehensive indicators and indicators which emphasize the role of the exposure of lenders (rather than that of borrowers) tending to be more robust. Trade and financial linkages appear to be highly correlated, especially in Asia, a phenomenon which probably has historical roots and deserves closer attention. Excluding trade linkages, measures of competition for funds are almost always significant. Similarly, trade linkages are not always robust to the inclusion of financial linkages, but are always significant when financial linkages are excluded. Results are somewhat dependent on our choice of crisis indicator—being more consistently significant for a binary crisis indicator than for a market pressure index, and appear largely robust to the sample of countries used, with the possible exception of the Russian crisis.

One question that arises, following the Brazilian crisis, is whether this phenomenon is only of historical interest. After all, it seems that there was little contagion—financial or otherwise—after the Brazilian devaluation. A possible explanation is that investors have learned to differentiate between emerging markets and that risk assessment instruments such as VAR have been adjusted to take into account the probabilities of rare, high risk events. It is more likely, however, that the Brazilian crisis is not a good test of the importance of financial contagion because the crisis appears to have been widely anticipated (cfr. high interest rates) and investors were mostly hedged against a devaluation. Thus, financial contagion might well continue to be an important channel of contagion in future unexpected crisis episodes.

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Table 1. Net Private Capital Flows to 29 Emerging Market Economies

	1994	1995	1996	1997	1998
<i>in Billions of US Dollar</i>					
Banks	43.4	99.5	120.4	30.9	-29.1
Other Creditors	30.0	23.4	78.8	88.7	49.4
Direct Investment	67.2	81.4	93.3	116.2	120.4
Portfolio Equity	29.4	24.4	35.7	25.7	2.4
Total Private Flows	170.0	228.7	328.2	261.5	143.1

Source: IIF (1999).

Table 2. Contagion and Competition for Funds  
 Probit estimates. Dependent Variable: Binary Contagion Variable

	(1) Mexico	(2) Thailand	(3) Russia
Constant	-4.14 <i>-2.05</i>	-3.53 <i>-1.19</i>	-0.46 <i>-0.21</i>
Funds Competition 1/	<b>4.97</b> <i>2.67</i>	<b>3.31</b> <i>2.00</i>	<b>3.75</b> <i>2.40</i>
Trade Competition 2/	<b>34.30</b> <i>1.68</i>	1.42 <i>0.88</i>	<b>5.28</b> <i>1.86</i>
Credit to private Sector (%change)	-0.01 <i>-0.35</i>	-0.02 <i>-0.75</i>	0.05 <i>1.49</i>
M2/ Reserves	-0.13 <i>-1.25</i>	0.03 <i>1.26</i>	0.10 <i>1.38</i>
Real Exchange Appreciation	2.18 <i>1.22</i>	0.80 <i>0.30</i>	-1.40 <i>-0.75</i>
Current Account	-0.03 <i>-0.83</i>	0.01 <i>0.13</i>	0.02 <i>0.44</i>
McFadden R-squared	0.39	0.36	0.30
Number of observations	85	68	42

*z*-Statistic in Italics

Bold entries have the expected sign and are significant at the 10 percent level or better.

\*) Definition of contagion following the Mexican and Thai crisis are from Glick and Rose (1999), for the Russian crisis based on assessments of IMF economists given in Appendix Table 1.

1/ Competition for funds based on absolute amounts in Mexico and Russia and based on shares in Thailand.

2/ Direct trade for Mexico and Russia. Competition in third markets for Thailand.

Table 3: Alternative Trade and Finance Indicators. Summary of Results  
z-Statistics of Probit Estimates. Dependent Variable: Binary Contagion Variable

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	Mexico	Thailand	Russia
Funds Competition			
Shares	<b>2.66</b>	<b>3.44</b>	0.32
Absolute values	<b>3.10</b>	<b>3.13</b>	<b>2.04</b>
CRS Finance Indicators			
Interactive	<b>2.74</b>	<b>2.02</b>	<b>1.84</b>
% Borrower	<b>1.83</b>	<b>2.41</b>	0.71
% Lender	<b>3.10</b>	<b>2.16</b>	<b>1.81</b>
KR Finance Indicator	<b>2.23</b>	<b>1.79</b>	0.71
Direct Trade	<b>2.04</b>	0.69	<b>1.77</b>
Trade Competition in Third Markets	-0.04	<b>2.98</b>	-0.03

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Each entry is the result of a separate regression based on the specification in Table 2, excluding trade controls in the first 6 regressions and finance controls in the next two. That is, control variables are M2/reserves, growth of credit to private sector, and real exchange rate appreciation. Regressions with trade variables include both trade variables simultaneously. Bold entries have the expected sign and are significant at the 10 percent level or better.

Table 4. Trade versus Finance Indicators. Summary of Results  
z-Statistics of Probit Estimates. Dependent Variable: Binary Contagion Variable

	Mexico	Thailand	Russia
Funds Competition, Shares	<b>2.02</b>	<b>2.00</b>	0.58
Trade 1/	0.57	0.88	<b>1.73</b>
Funds Competition, Absolute Values	<b>2.67</b>	1.41	<b>2.40</b>
Trade 1/	<b>1.68</b>	1.58	<b>1.80</b>
CRS Finance Indicator, interactive	<b>2.44</b>	0.93	<b>2.18</b>
Trade 1/	1.11	<b>2.42</b>	<b>1.87</b>
CRS Finance Indicator, %borrower	0.63	0.64	-1.11
Trade 1/	<b>1.79</b>	<b>2.26</b>	<b>2.16</b>
CRS Finance Indicator, %lender	<b>2.79</b>	1.17	<b>2.29</b>
Trade 1/	1.16	<b>2.14</b>	<b>1.94</b>
KR Finance Indicator	1.04	-0.24	-0.14
Trade 1/	1.10	<b>2.64</b>	<b>1.72</b>

Results from 21 regressions, all based on the specification in Table 2: control variables are M2/reserves, growth of credit to private sector, real exchange rate appreciation, and one trade measure. (Coefficients of controls are suppressed). Bold entries have the expected sign and are significant at the 10 percent level or better.

1/ Direct trade for Mexico and Russia. Competition in third markets for Thailand.

Table 5. Continuous Contagion Indicators. Summary of Results  
T-Statistics of OLS estimates, Dependent Variable:  
Continuous exchange market pressure Index

	Mexico	Thailand	Russia
<i>1 Month after ground zero</i>			
Funds Competition 1/	1.01	0.35	1.38
CRS Finance Indicator, Interactive	1.23	0.82	1.25
KR Finance Indicator	0.61	1.00	<b>2.26</b>
Direct Trade	1.19	1.07	<b>1.88</b>
Trade Competition in Third Markets	-2.10	0.97	1.20
<i>3 Month after ground zero</i>			
Funds Competition 1/	0.94	<b>1.79</b>	0.99
CRS Finance Indicator, Interactive	1.29	<b>1.76</b>	0.45
KR Finance Indicator	<b>1.81</b>	<b>1.99</b>	1.25
Direct Trade	1.31	<b>1.79</b>	<b>3.46</b>
Trade Competition in Third Markets	-1.01	<b>2.56</b>	<b>1.98</b>
<i>6 Month after ground zero</i>			
Funds Competition	1.32	<b>3.43</b>	<b>2.29</b>
CRS Finance Indicator, Interactive	1.59	<b>1.90</b>	<b>1.90</b>
KR Finance Indicator	1.17	<b>2.33</b>	1.03
Direct Trade	1.31	1.63	-0.38
Trade Competition in Third Markets	-0.39	<b>4.88</b>	1.35

Each entry is the result of a separate regression based on the specification in Table 2, excluding trade controls in the finance regressions and finance controls in the trade regressions. Regressions with trade variables include both trade variables simultaneously. Bold entries have the expected sign and are significant at the 10 percent level or better.

1/ Competition for Funds in absolute terms in Mexico and Russia; based on shares in Thailand.

Table 6. Summary of Results for 45 Emerging Markets  
z-Statistics of probit estimates, Dependent Variable:  
Binary Contagion Variable

	Mexico	Thailand	Russia
Funds Competition			
Shares	<b>1.71</b>	<b>2.26</b>	0.16
Absolute values	<b>2.14</b>	<b>2.02</b>	<b>1.88</b>
CRS Finance Indicators			
Interactive	<b>2.34</b>	<b>1.85</b>	1.31
%Borrower	<b>1.80</b>	1.33	-1.05
%Lender	<b>2.49</b>	<b>2.14</b>	1.56
KR Finance Indicator	<b>1.67</b>	0.97	-0.61
Direct Trade	1.54	<b>1.79</b>	-0.24
Trade Competition in Third Markets	0.31	0.85	0.64

Each entry is the result of a separate regression based on the specification in Table 2, excluding trade controls in the first 6 regressions and finance controls in the next two. Regressions with trade variables include both trade variables simultaneously. Bold entries have the expected sign and are significant at the 10 percent level or better.

The sample of 45 economies includes: Argentina, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Czech Republic, Ecuador, Egypt, Ghana, Greece, Hong Kong, Hungary, India, Indonesia, Israel, Jordan, Kenya, Korea, Latvia, Lithuania, Malaysia, Mauritius, Mexico, Morocco, Nigeria, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Russia, Singapore, South Africa, Sri Lanka, Taiwan Province of China, Thailand, Turkey, Ukraine, Uruguay, Venezuela, Zimbabwe. Actual sample varies because of missing variables.

Figure 1: Trade versus Finance in the Mexican Crisis

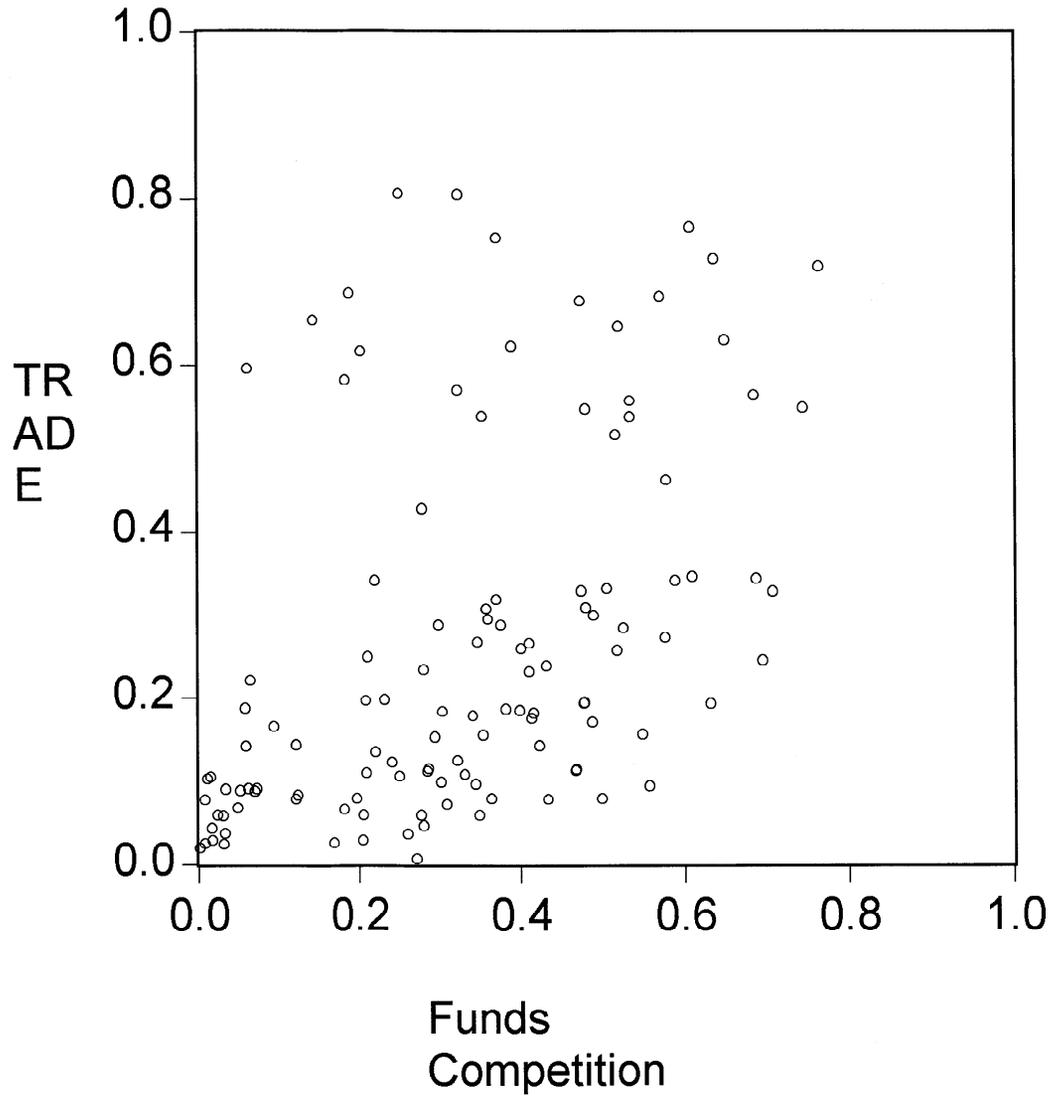


Figure 2: Trade versus Finance in the Thai Crisis

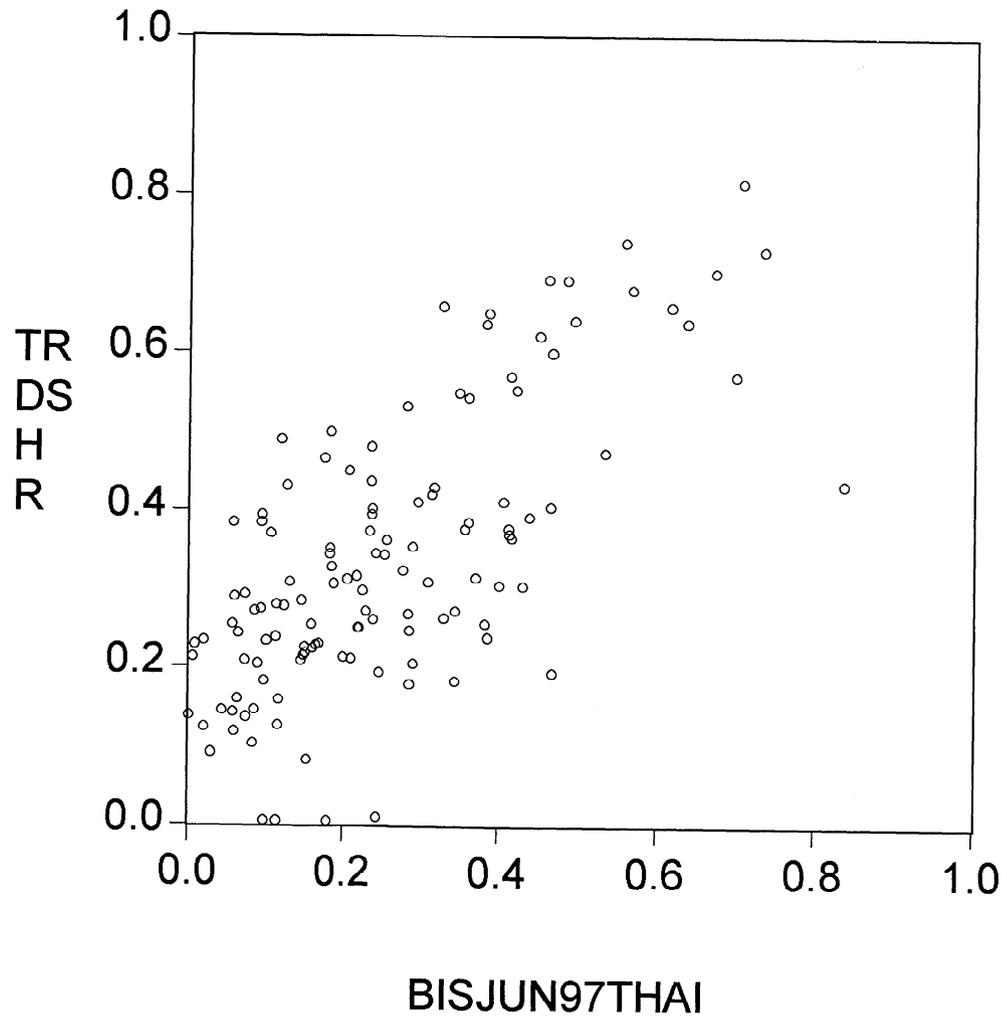


Figure 3: Trade versus Finance in the Russian Crisis

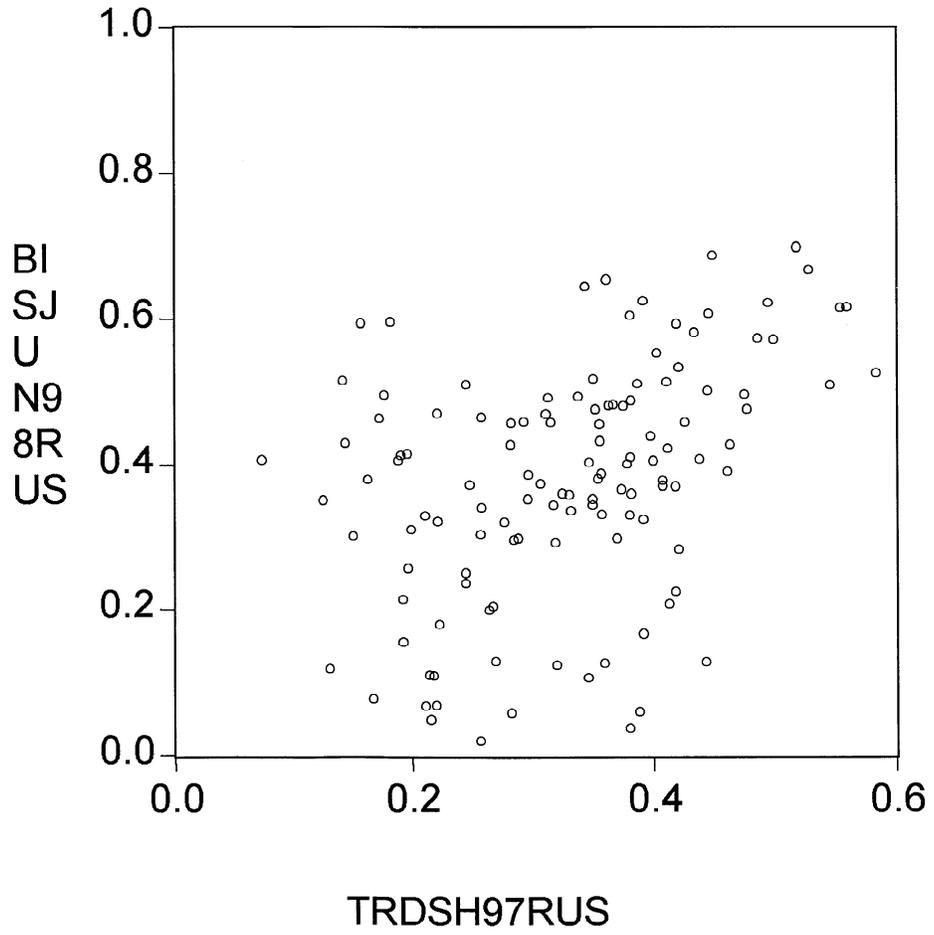


Table 7. Countries that were Affected in the Crisis Episode\*

Mexican Crisis	Asian Crisis	Russian Crisis
Argentina	Argentina	Argentina
Brazil	Brazil	Belarus
Hong Kong	Czech Republic	Bolivia
Hungary	Hong Kong	Brazil
Indonesia	Hungary	Colombia
Peru	Indonesia	Czech Republic
Philippines	Korea	Ecuador
Thailand	Malaysia	Georgia
Venezuela	Mexico	Hong Kong
	Pakistan	Indonesia
	Philippines	Korea
	Poland	Mexico
	Singapore	Moldova
	South Africa	Pakistan
	Taiwan Province of China	Paraguay
	Viet Nam	Poland
		South Africa
		Tajikistan
		Thailand
		Turkey
		Turkmenistan
		Ukraine
		Uruguay
		Uzbekistan
		Venezuela

\*Some of these countries are not included in the regressions for lack of available data.

Table 8. Correlation Matrix for Trade and Finance Indicators

<b>Mexican Crisis for 113 Countries</b>									
	FC94 Shares	FC94 Absolute	CRS94 Interactive	CRS94 %Borrower	CRS94 %Lender	KRUS94	TRDSH94	TRDDIR94	
FC94 Shares	1.00								
FC94 Absolute	0.56	1.00							
CRS94 Interactive	0.47	0.58	1.00						
CRS94 %Borrower	0.48	0.08	0.35	1.00					
CRS94 %Lender	0.47	0.68	0.87	0.20	1.00				
KRUS94	0.54	0.13	0.49	0.80	0.32	1.00			
TRDSH94	0.45	0.15	0.15	0.38	0.13	0.38	1.00		
TRDDIR	0.48	0.24	0.42	0.36	0.37	0.51	0.45	1.00	
<b>Thai Crisis for 118 Countries</b>									
	FC97 Shares	FC97 Absolute	CRS97 Interactive	CRS97 %Borrower	CRS97 %Lender	KRJA97	TRDSH96	TRDDIR96	
FC97 Shares	1.00								
FC97 Absolute	0.73	1.00							
CRS97 Interactive	0.48	0.30	1.00						
CRS97 %Borrower	0.87	0.60	0.65	1.00					
CRS97 %Lender	0.50	0.35	0.99	0.64	1.00				
KRJA97	0.58	0.52	0.63	0.79	0.64	1.00			
TRDSH96	0.70	0.58	0.31	0.57	0.34	0.42	1.00		
TRDDIR96	-0.04	-0.05	0.02	0.00	0.03	0.14	0.04	1.00	
<b>Russian Crisis for 120 Countries</b>									
	FC98 Shares	FC98 Absolute	CRS98 Interactive	CRS98 %Borrower	CRS98 %Lender	KRGE98	TRDSH97	TRDDIR97	
FC98 Shares	1.00								
FC98 Absolute	0.33	1.00							
CRS98 Interactive	0.38	0.51	1.00						
CRS98 %Borrower	0.52	-0.12	0.21	1.00					
CRS98 %Lender	0.28	0.67	0.89	0.01	1.00				
KRGE98	0.55	-0.14	0.20	0.71	0.01	1.00			
TRDSH97	0.41	0.17	0.26	0.18	0.23	0.26	1.00		
TRDDIR97	0.08	-0.18	-0.04	0.56	-0.10	0.37	0.20	1.00	

FC=funds competition indicators, derived in the paper, based on equations (1) and (2).

CRS=measures suggested by Caramazza, Ricci, and Salgado (1999).

KR=measures suggested by Kaminsky and Reinhart (1998). US, JA, and GE= the main lender in crisis episode

TRDSH=trade competition in third markets.

TRDDIR=direct trade competition.



