# On crises, contagion, and confusion

Reinhart, Carmen and Kaminsky, Graciela

University of Maryland, College Park, Department of Economics

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# On Crises, Contagion, and Confusion[1]

Graciela L. Kaminsky
*George Washington University*
Department of Economics

Carmen M. Reinhart
*University of Maryland*
School of Public Affairs,
Department of Economics and NBER

Abstract

Since the Tequila crisis of 1994-95, the Asian flu of 1997, and the Russian virus of 1998, economists have been busy producing research on the subject of contagion. Yet, few studies have examined empirically through which channels the disturbances are transmitted if there are, indeed, fundamental reasons for the spillovers we observe. We attempt to fill this gap by analyzing how both trade links and the largely ignored financial sector links influence the pattern of fundamentals-based contagion. We examine the role of international bank lending, the potential for cross-market hedging, and bilateral and third-party trade in the propagation of crises.

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[1] Graciela L. Kaminsky, *George Washington University,* Washington DC 20052. Carmen M. Reinhart (corresponding author), *University of Maryland*, College Park, Maryland 20742, (301) 405-7006, FAX (301) 403-8107, e-mail: creinhar@wam.umd.edu. This paper was prepared for the Duke University conference "Globalization, Capital Market Crises and Economic Reform." The authors wish to thank Patrick Conway, Alan Drazen, Aart Kray, Gian Maria Milesi-Ferretti, Vincent Reinhart, Roberto Rigobon, Jorge Roldos, Andres Velasco, two anonymous referees, and conference participants at *Globalization, Capital Markets Crises, and Economic Reform,* Arizona State University, the Bank of England, University of California, San Diego, and the World Bank for useful comments and discussion, Sergio Schmukler for kindly providing the data on mutual funds and Ian Anderson, Mark Giancola, and Ioannis Tokatlidis for superb research assistance.

*Earlier this year, so many families living in the fashionable suburb of San Pedro Garza Garcia invested in Russian bonds that it became known as San Pedrosburgo. Now this wealthy enclave feels more like Stalingrad...*

The Wall Street Journal, November 18, 1998
On explaining why the Mexican stock market plummeted in August and September as leveraged investors faced margin calls.

## I. Introduction

No doubt, historians will remember the early 1980s as a period of systemic crisis in the emerging world. The Latin American countries, with their high debt burdens, fell like dominoes into an abyss of successive devaluations, banking crises, and deep and protracted recessions. Several countries in Asia were also deeply shaken. Yet, possibly, because much of the blame was placed on poor domestic policies and high real interest rates in the United States, little attention was given at the time to the possibility that financial crises could be contagious. After the Tequila crisis of 1994-95, the Asian flu of 1997, and the Russian virus of 1998, not to mention the Exchange Rate Mechanism Crisis of 1992 and 1993, economists are now producing a growing volume of research on the "new" subject of contagion.

Yet, contagion has been understood to be different things across different studies. Crises could be synchronous across countries because of a common adverse shock (i.e. a rise in world interest rates). But symmetric shocks are usually not included in most definitions of contagion. In an early study on the subject, Calvo and Reinhart (1996) distinguish between fundamentals-based contagion, which arises when the infected country is linked to others via trade or finance, and "true" contagion which is the kind that arises when common shocks and all channels of potential interconnection are either not present or have been controlled for. Most often, true contagion is associated with herding behavior on the part of investors--be it rational, as in Calvo and Mendoza (1998), or not.

Few studies have attempted to examine empirically the channels through which the disturbances are transmitted. In this paper, we attempt to fill this gap by analyzing how fundamentals-based contagion could arise due to both trade links and the largely ignored financial sector links. We examine the role of

various creditors, including international banks and mutual funds, traders' potential cross-market hedging, and bilateral and third-party trade in the propagation of crises. Some of the conclusions that emerge from our analysis are:

First, as other studies have suggested, we find evidence that contagion is more regional than global.[1] But evidence on the channels of transmission, suggest there are dangers in extrapolating from history. While inter-regional trade in goods and services has not increased markedly in the past few years (a notable exception is Chile's rising trade with Asia), inter-regional trade in assets has skyrocketed. This makes it more likely that if Korean asset prices fall, so too will Brazilian asset prices.

Second, susceptibility to contagion is highly nonlinear. A single country falling victim to a crisis is not a particularly good predictor of crisis elsewhere, be it in the same region or in another part of the globe. However, if several countries fall prey, then it is a different story. That is, the probability of a domestic crisis rises sharply if a core group of countries are already infected.

Third, observational equivalence is a serious obstacle in understanding the channels of transmission. Is the regional complexion of contagion due to trade links, as some studies have suggested, or is it due to financial links--particularly through the role played by banks? Our results suggest that it is difficult to distinguish among the two, because most countries that are linked in trade are also linked in finance. In the Asian crises of 1997, Japanese banks played a similar role in propagating disturbances to that played by U.S. banks in the debt crisis of the early 1980s. Indeed, when we group countries in accordance with their exposure to a common creditor, knowing that there is a crisis in that core group has a higher predictive power than knowing that a country in the same bilateral or third-party trade clusters. The improvement obtained in forecasting performance of controlling for financial sector links in our sample is greater than the improvement gained by controlling for trade links.

Fourth, an analysis of two potential victims of contagion, Argentina after Mexico and Indonesia after Thailand indicates that financial linkages were the more likely culprits, given that both bilateral and

third party trade links with the infected country were weak. In the case of Indonesia, it was also part of the same Japanese commercial bank borrowing cluster as Thailand.

The paper is organized as follows. Section II briefly reviews the theories of contagion and takes stock of the existing empirical evidence on these issues. Section III assesses the incidence of contagion across regions and time, while Section IV attempts to discriminate across the various channels of transmission. Section V discusses some of the recent contagious episodes and concludes.

## II. Theory and Evidence: A Review

Models of contagion have attempted to provide a framework that explains why a shock in one country may be transmitted elsewhere. Our review of this literature emphasizes the empirical implications of these models.

*1. Defining contagion*

As noted, the definition of contagion has varied considerably across papers. Eichengreen, et. al. (1996) focused on contagion as a case where knowing that there is a crisis elsewhere increases the probability of a crisis at home. This is the definition of contagion that we will explore in the remainder of this paper. Specifically, we control for a broad range of country-idiosyncratic fundamentals (i.e. real exchange rate, reserves, etc.) and for fundamentals which are common across countries (i.e., international interest rates). What we are really interested in are the possible links, be it through trade or finance, that give rise to "fundamentals-based" spillovers. Hence, our analysis does not directly speak to the issue of "animal spirits" or herding behavior.

*2. Theories of contagion and their empirical implications*

To explain why crises tend to be bunched, some recent models have revived Nurkse's story of competitive devaluations, which emphasized trade, be it bilateral or with a third party.[2] Once one country has devalued, it makes it costly (in terms of a loss of competitiveness and output) for other countries to maintain their parity. Hence, an empirical implication of this type of model is that we should observe a

high volume of trade among the "synchronized" devaluers.[3]

Another family of models has stressed the role of trade in financial assets, particularly in the presence of information asymmetries. Calvo and Mendoza (1998) present a model where the fixed costs of gathering and processing country-specific information give rise to herding behavior, even when investors are rational. Kodres and Pritsker (1998) focus on the role played by investors who engage in cross-market hedging of macroeconomic risks. In either case, these models suggest that the channels of transmission come from the global diversification of financial portfolios. As such, they have the empirical implication that countries which have more internationally-traded financial assets and more liquid markets are likely to be more vulnerable to contagion. Cross-market hedging usually requires a moderately high correlation of asset returns. The implication is that countries whose asset returns exhibit a high degree of comovement with the infected country (such as Argentina with Mexico or Malaysia with Thailand) will be more vulnerable to contagion via cross-market hedges.

Calvo (1998) has emphasized the role of liquidity. A leveraged investor facing margin calls needs to sell (to an uninformed counterpart) his or her asset holdings. Because of the information asymmetries, a "lemons problem" arises and the asset can only be sold at a firesale price. A variant of this story can be told about an open-end fund portfolio manager who needs to raise liquidity in anticipation of future redemptions. In either case, the strategy will be not to sell the asset whose price has already collapsed but other assets in the portfolio. In doing so, however, other asset prices are depressed and the original disturbance spreads across markets.

One potential channel of transmission that has been largely ignored in the contagion literature but that is stressed in this paper is the role of common lenders, in particular commercial banks. U.S. banks had an extensive exposure to Latin America in the early 1980s, much in the way that Japanese banks did during the Asian crisis of 1997.[4] The behavior of foreign banks can both exacerbate the original crisis, by calling loans and drying up credit lines, but can also propagate crises by calling loans elsewhere. The need to re-

balance the overall risk of the bank's asset portfolio and to recapitalize and provision following the initial losses can lead to a marked reversal in bank credit across markets where the bank has exposure.

The bulk of the empirical literature suggests that there is evidence of contagion, be it of the fundamentals-based spillovers or of the animal spirit, sunspot variety. Very few studies, however, have aimed at examining the possible underlying causes. Eichengreen, et.al. (1996) attempted to discriminate among a bilateral trade link channel and a "wake-up call hypothesis," where similarities to the crisis country in fundamentals lead investors to reassess the risk of the other countries. Glick and Rose (1998) studied these issues further in a broader country context, while Wolf (1997) sought to explain the pairwise correlations in stock returns by bilateral trade and other common macroeconomic fundamentals. All studies conclude that trade linkages play an important role in the propagation of shocks. Because trade tends to be more intra- than inter-regional in nature, some of these studies conclude that this helps explain why contagion tends to be regional rather than global. With a couple of exceptions, financial sector linkages have been largely ignored (see Baig and Goldfajn, 1998, Frankel and Schmukler, 1998 and Kaminsky and Schmukler, 1999).

## III. The Incidence of Contagion

In this section we examine the links among currency crises both globally and regionally. To proceed, we need to identify the dates of currency crises, gauge the odds of a crisis in a country when other countries are in turmoil, and control for the relevant economic fundamentals. Our sample is based on monthly data for 1970-1998 and it includes 80 currency crises episodes for a number of industrial and developing countries. The former include: Denmark, Finland, Norway, Spain, and Sweden. The latter focus on: Argentina, Bolivia, Brazil, Chile, Colombia, Indonesia, Israel, Malaysia, Mexico, Peru, the Philippines, Thailand, Turkey, Uruguay, and Venezuela. An analysis of transition economies in the aftermath of Russia would have provided useful insights on contagion channels, but our methodology requires sufficiently long time series so as to allow us to distinguish between what is the "normal" behavior

of an indicator during "tranquil" periods and "anomalous" behavior during crises periods. The transition economies offer little capacity to assess what is normal.[5]

*1. Definition of crisis*

Most often, speculative attacks have been resolved through a devaluation of the currency or its flotation. But central banks can and do use contractionary monetary policies and sell their foreign exchange reserves to defend the currency. High interest rate defenses were not uncommon in the wake of the Asian and Russian crises, while Argentina lost 20 percent of its foreign exchange reserves in a few weeks following the Mexican peso crisis of 1994. Thus an index of currency crises should capture these different manifestations of speculative attacks, be they successful or otherwise. However, in the 1970s and early 1980s many of the countries in our sample had regulated financial markets with no market-determined interest rates. For this reason, our crisis index only incorporates reserve losses and depreciation. The index is a weighted average of these two indicators with weights such that the two components have equal sample volatility. This weighting scheme prevents the much greater volatility in the exchange rate (owing to several episodes of mega-devaluations) to dominate the crisis measure.[6] Because changes in the exchange rate enter with a positive weight and reserves enter with a negative weight, large positive readings of this index indicate speculative attacks. Readings that are three standard deviations above its mean are classified as crises. Less extreme readings (say two-standard deviations from the mean), which we do not examine here, would identify periods of turbulence. The crises readings from this index do map well onto the chronology of events (i.e. devaluations, suspension of convertibility, etc.) for these countries.

*2. Contagion: Preliminary Assessment*

To examine whether the likelihood of crises is higher when there are crises in other countries, we begin by calculating the unconditional probability of a crisis. The unconditional probability that a crisis will occur in the next 24 months over the entire sample is simply the number of currency crises in the sample times 24 divided by the number of observations. As shown in Table 1, under the heading P(C),

these calculations yield an unconditional probability of 29 percent. We next calculate a family of conditional probabilities. If knowing that there is a currency crisis elsewhere helps predict a currency crisis at home, then, the probability of a currency crisis, conditional on that information, denoted by P(C*CE), should be higher than the unconditional one. The table also reports the noise-to-signal ratio for the various groupings.[7] The lower the noise-to-signal ratio, the more reliable is the indicator.

First, as regards the results presented in Table 1, at least at the global level, knowing that there is a single crisis elsewhere is not a particularly helpful piece of information for predicting a future crisis. This contrasts with the results presented in Eichengreen,et.al. (1996), who find stronger evidence of the predictive capacity of a crisis elsewhere variable. We suspect, however, that their results are influenced by the heavy representation of European countries in their sample. As we will discuss below, the pattern of contagion seems to be more regional than global in scope and the predictive ability of knowing that there is a crisis elsewhere depends importantly on where elsewhere happens to be. However, if one-half or more of the countries in the sample are having currency crises, this increases the likelihood of a crisis to 55 percent, or almost double the unconditional probability of crisis of 29 percent. Indeed, this result is similar to those found in some of the empirical papers on bank contagion. When the problem becomes that systemic, the chances of escaping unscathed are slim. Thus, it appears that the relationship between the probability of a crisis at home and the number of crises elsewhere is highly nonlinear.

We also examined these probabilities at the regional level (Table 2). There are three groups: Asia, which includes Indonesia, Malaysia, the Philippines, and Thailand; Europe, which encompasses the four Nordic countries in our sample plus Israel, Turkey and Spain: and Latin America, which consists of Argentina, Bolivia, Brazil, Colombia, Chile, Mexico, Peru, Uruguay, and Venezuela. In all three regions the probability of crisis conditioned on crisis elsewhere increases sharply as the number of casualties rise. When the proportion of infected countries increases over the 50 percent hurdle, the conditional probability of crisis increases from about 27 percent to 67 percent in Asia; in Latin America it increases from 29 to 69

percent if half or more of the countries are in crisis.

*3. Macroeconomic fundamentals*

Naturally, an epidemic may arise when multiple individuals are exposed to a common virus. The global analogy to the common virus can be found in international interest rate fluctuations, which have had much to do in explaining the cycles in capital flows to emerging markets.[8] Since, in turn, abrupt swings in capital flows have done much to trigger currency crises we need to control for such common fundamentals as well as those that are country specific. The approach taken here follows the "signals" approach described in detail in Kaminsky and Reinhart (1996) and the construction of a composite leading indicator of currency crises outlined in Kaminsky (1998). A brief sketch of this methodology follows and the interested reader is referred to those papers for greater detail.

We begin by constructing a composite index that captures the fragility of the economy on the eve of crises. The index summarizes the behavior of 18 individual financial and macroeconomic time series. Each indicator may issue one or more signals or warnings in the 24 months preceding the crisis.[9] For example, there may be an unusually sharp decline in foreign exchange reserves or in stock prices. If a signal is issued, it is assigned a value of one. Hence, if all 18 indicators issued a signal on a given month the value of the composite indicator would be 18 if all signals are weighted equally. However, as shown in earlier papers, the quality of the indicators is highly heterogenous.[10] For this reason, we weigh each signal by the inverse of the noise-to-signal ratio of the particular indicator that is issuing the signal. We can then construct a sample-based vector of conditional probabilities for currency crises. One set of probabilities will control for the macroeconomic fundamentals, denoted by $P(C^*F)_t$, another set of probabilities will control for both the fundamentals and information about crises elsewhere, $P(C^*F, CE)_t$, and a third, which we call the "naive" forecast controls for neither--hence, it is the simple unconditional probability of crisis. To assess the marginal contribution of knowing whether and how many crises are elsewhere we conduct a horserace between the naive forecasts, those that take into account the fundamentals, and those that also

add information on crises elsewhere. To evaluate the average closeness of the predicted probabilities of crises and the actual realizations, as measured by a zero-one dummy variable, we calculate the quadratic probability score (QPS),

$$QPS^{k} = 1/T \sum_{t=1}^{T} 2(P_t^{k} - R_t)^2 \qquad \textbf{(1)}$$

where $k=1,2,3$ refers to the indicator, $P_t^{k}$, refers to the probability associated with that indicator and $R_t$ are the zero-one realizations. The QPS ranges from zero to two, with a score of zero corresponding to perfect accuracy. Table 3 reports the scores, for the naive forecasts, the forecasts on the basis of the macroeconomic fundamentals and the forecasts that also take into account information about crises elsewhere. The scores are given for the entire sample, as well as the regional groups. The main result that arises from this exercise is that adding information about crisis elsewhere reduces the prediction error, even after the fundamentals have been accounted for. The gains from incorporating information on crises elsewhere are highest for Asia (a 29 percent improvement in forecasting accuracy, shown in the last column). For Latin America and Europe, the gains are more modest and in the 5-6 percent range.

## IV. On the Channels of Transmission

We next turn our attention toward investigating what some of the international propagation mechanisms may be. Specifically, we consider four channels through which shocks can be transmitted across borders; two channels deal with the linkages among financial markets, be it through foreign bank lending or globally diversified portfolios, and two deal with trade in goods and services.

*1. Common bank creditor*

As discussed in Section II, the studies that have attempted to analyze the channels through which contagion arises have found a prominent role for linkages on the basis of trade in goods and services. However, this line of enquiry does not speak to the fact that countries that engage in trade in goods and

services typically also have strong connections through financial arrangements that facilitate trade--particularly through commercial banks. Just as there appears to be natural regional trade blocs, so there appear to be regional blocs that depend on a single common creditor country. This may help explain cross-border spillovers, since if a bank is confronted with a marked rise in nonpeforming loans in one country, it is likely to be called upon to reduce the overall risk of its assets by pulling out of other high risk projects elsewhere--possibly in other emerging markets. Furthermore, it will lend less (if at all), as it is forced to recapitalize, provision, and adjust to its lower level of wealth.

Tables 4 and 5 present evidence on the incidence of regional borrowing arrangements from both the perspective of the borrower as well as the perspective of the lender for Asia and Latin America. On the eve of the Thai crisis, 54 percent of Thai liabilities were to Japanese banks. Most of the other countries in the region, with the exception of the Philippines which has fared well by comparison, also depended heavily on Japanese commercial bank lending. From the perspective of the Japanese banks, Thai exposure was also not trivial. It accounted for the highest share of claims on emerging markets (22 percent) and more than twice that of China. As the Thai crisis unraveled, taking advantage of the short-term nature of their credits, Japanese banks began to call loans--not just in Thailand but all over the region. Commercial bank credit to the five affected countries (Indonesia, Korea, Malaysia, the Philippines, and Thailand) shifted from an inflow of over $50 billion in 1996 to an outflow of $21 billion in the following year. A regional liquidity crunch got under way.

While it is tempting to conclude that such transmission mechanisms are new to the global economy, they have been with us for some time. Mexico's share of U.S. claims on total claims on emerging markets was also the highest among emerging markets in 1982 and, like its Thai counterparts, it was also 22 percent (Table 5). Also like the Asian cluster, Latin American countries obtain their lion's share of their commercial bank credit from U.S. banks and like in the Asian crises, U.S. banks pulled out from Latin America at the time of the debt crisis.

To step beyond the anecdotal evidence and systematically investigate whether common creditors (banks) are a possible channel of contagion, we clustered a subset of the countries in our sample into two groups--that group which borrows mostly from U.S. banks and that group which relies heavily of Japanese commercial bank lending. We could not identify a common European bank cluster in our sample. The first group encompasses most (but not all) of the Latin American countries in our sample and includes: Argentina, Brazil, Chile, Colombia, Mexico, Uruguay, and Venezuela. Bolivia and Peru were excluded as they have more heterogeneous sources of international bank credit. The Philippines, which has an exposure to U.S. banks that is about three times the average for Asia and comparable to many of the Latin American countries, is also included in this cluster. The Japanese bank cluster thus comprises of Indonesia, Malaysia, and Thailand. Had China and Korea been part of our sample, these would have been included in the Japanese bank cluster, as these countries relied on Japanese bank credit (Table 4).

Table 6 reports the results for the joint estimation of conditional and unconditional probabilities for the two banks clusters. We estimate these jointly as disaggregation among the two clusters can be subject to small sample problems, in that the number of crises in the sub-sample is relatively small. The marginal contribution of knowing that a country in that cohort has a crisis does not add much information when there are few crises. However, once several countries in the cohort become infected, the conditional probability of a crisis jumps to 83.5 percent, well above the comparable conditional probability of 54.7 percent for a crisis elsewhere reported in Table 1 and the unconditional probability of 31.5 percent for the bank clusters.[11] These results suggest, that perhaps much of what has been attributed to trade has to do with financial sector linkages. Furthermore, the QPS scores for forecasts that include information on both fundamentals and crises elsewhere in the bank cluster are significantly lower at all standard confidence levels than those that do not control for crises in the cluster (Table 6, column 5).

*2. Liquidity channels, mutual funds, and cross-market hedging*

While banks are important common lenders, they are not the only lenders to the emerging world.

Portfolio flows to emerging markets surged in the early-to-mid-1990s. Hence, just as a commercial bank may call its loans to Malaysia after Thailand has a crisis, so can a diversified investor choose (or be forced by margin calls) to sell his or her Argentinean bond and equity holdings after Mexico devalues. Some of the models that stress this form of contagion were discussed in Section II. In order to be of any consequence, however, this channel of transmission requires that there be sufficient asset market liquidity. If bond and equity markets are so underdeveloped that portfolio flows are trivial, then clearly this channel of transmission is not likely to be quantitatively important. In other words, if country's equity or bonds are not internationally traded to begin with, such liquidations are not a problem.

Table 8 provides a profile of emerging market mutual fund holdings on the eve of the Asian crisis. It is clear that there is a wide diversity of representation across markets, with Hong Kong, Brazil, and Mexico (in that order) being among the most highly represented (and also the most liquid) markets. It is noteworthy that two Latin American countries that did not even experience as much as a mild hiccup in their equity markets around the Mexican crisis are Colombia and Venezuela (see Calvo and Reinhart, 1996), which are barely represented in the mutual fund portfolios.

While there is broad variation across markets in the extent to which they are represented in global investor's portfolios, there is also quite a degree of diversity in the extent that asset price returns correlate across countries. Table 7, which shows the pairwise correlations of stock returns (in US dollars) across selected markets, provides evidence in this regard. For the sake of simplicity, we will classify a pairwise correlation of 0-0.20 as low, 0.21 to 0.40 as moderate, and above 0.40 as high. Using these three grids it is easy to see that the highest correlations among returns occur among the southeast Asian economies now mired in crises, Indonesia, Malaysia. Philippines, and Thailand. It is also evident that high intra-regional pairwise correlations are rare and that the highest correlation in Latin America is between Argentine and Mexican stock returns.

Hence, on the basis of liquidity and correlation considerations, one would expect a higher degree of

cross-market hedging across the four southeast Asian countries (although they are only moderately liquid) and among Argentina, Brazil, Peru, and Mexico (two of which are comparatively liquid) and all four are correlated. Yet, formally investigating this possible channel of interconnectedness is fraught with difficulty. First, unlike the prevalence of bank lending, these transmission channels are relatively recent, as emerging market funds and portfolio flows to these countries, were virtually nonexistent prior to the 1990s. Secondly, there may be marked swings in the liquidity of these markets, as sovereign debt can cease to be considered a liquid asset overnight.

With these shortcomings in mind, and taking the results as tentative, we formed two clusters of countries that exhibited a high degree of comovement in their asset returns. The first cluster includes the four southeast Asian economies in our sample. South Korea, had it been part of our sample, would have excluded from this cluster on the basis of its low historical correlations with the East Asia four. For Latin America the high correlation cluster includes Argentina, Mexico, and Peru. Needless to say, a shortcoming of these clusters is that they are based entirely on recent correlations and give no weight to the role of market liquidity. The joint conditional and unconditional probabilities for the high-correlation groupings are reported in Table 9. In terms of the comparison between conditional and unconditional probabilities, the conditional probability of this cluster at 80.4 percent (for the 50 percent and above category) is well above the unconditional probability, although the improvement is not as substantial as that obtained from the bank cluster. However, the QPS scores paint a very compelling picture–the QPS scores that control for crises elsewhere in the cluster are significantly higher than those that just control for fundamentals. Furthermore, the improvement in forecasting accuracy is bigger than that obtained with the bank clusters. However, it is important to be cautious about over- interpreting these results as the incidence of portfolio flows and the widespread use of cross-market hedges has a much shorter history than bank lending in this sample and it is a phenomenon of the 1990s.

*3. Trade links*

Perhaps because trade in goods and services has a longer history in the post World War II period than trade in financial assets, or because of far better data availability, trade links have received the most attention in the literature on contagion. In this subsection we examine two types of trade links. The most obvious is bilateral trade among other countries and the infected country(ies). The second type of link is more difficult to quantify, which involves competition in a common third market. For the countries in Asia and Latin America in our sample, identifying a common third party is not a difficult task. The United States figures prominently in trade with Latin America (not unlike the bank credit clusters) and Japan figures prominently in Asian trade. However, all five crisis countries in Asia in 1997 also export extensively to Hong Kong and Singapore. While sharing a third party is a necessary condition for the competitive devaluation story it is clearly not a sufficient one. If a country that exports bananas to the United States devalues it is not obvious why this would have any detrimental effect on a country that exports semiconductors to the United States. Hence, clearly the composition of trade will play a key role in determining whether the third party trade links carry any weight. Previous studies that have examined the trade links have not addressed this issue altogether.

Tables 10 and 11 convey information about the extent of bilateral trade and third party trade on the eve of three crises episodes, the debt crisis, the Mexican peso crisis of 1994, and the Asian crisis of 1997. There are several features worth noting. As regards the most recent crises, it is hard to see bilateral trade as the force behind contagion. The share of exports that is destined to other Asian crises countries (including Korea) is not very large. For instance, Malaysia's exports to Indonesia, Korea, the Philippines, and Thailand combined only amount to 9 percent of its exports. For this reason we do not identify an Asian bilateral trade cluster. Understanding why Brazil and Mexico have been so adversely affected in the aftermath of the Asian flu is even harder as, on average only 2.3 percent of Latin American exports go to the Asian five. The most compelling case for bilateral trade links between the Asian crises countries and Latin America is clearly Chile, whose exports to Asia have been rising over time. Similarly, on the eve of

the Tequila crisis only 1.7 percent of Argentine exports were destined for Mexico.[12] Yet clearly, important bilateral trade links are revealed in Tables 10 and 11. Most noticeable is the high level of bilateral trade among the Mercosur members (Argentina, Brazil, and Uruguay) and also Chile. Hence, a devaluation of the real would be expected to have important consequences for Argentina and Uruguay by way of trade–although it is important to remember that Argentina and Brazil are still relatively closed economies, with ratios of trade as a percent of GDP far below those recorded in the Asian and European countries in our sample.

The case for third-party trade links is much more compelling for some of the Asian countries. Table 12 shows that Malaysia and Korea, in particular, export many of the same goods to the same third parties. This leaves Indonesia largely unexplained. Third party trade also does not appear to account for the Tequila effects on Argentina and Brazil, whose exports have little in common with Mexican exports.

To examine these issues more formally, we constructed three trade clusters, a Latin American bilateral trade cluster which consists of the Mercosur members and Chile; a third-party Asian group, which does not include Indonesia as its structure of exports is very distinct from the others and; a third-party Latin group which includes Brazil, Colombia, Mexico, and Venezuela. These four countries have the largest share of bilateral trade with the United States and some similarities in the structure of their exports. For instance coffee plays a prominent role in both Colombian and Brazilian exports while oil plays a similar role for Mexico and Venezuela and, to a lesser extent, Colombia. As with the bank and correlation clusters, we jointly estimate the conditional and unconditional probabilities for the third-party trade Asian and Latin American clusters. For bilateral trade, only the results for Latin America are reported, given that no Asian bilateral trade cluster was identified.

The results are reported in Table 14. The strongest results are those for the Latin American bilateral trade cluster, where the difference between the conditional and unconditional probability is 47.3 percent, which compares favorably with the results reported in Table 1, which are on the basis of crisis

elsewhere and do not control for how elsewhere is defined. However, the third-party (and the bilateral) trade clusters do not compare favorably to the two financial linkages clusters results reported in Tables 6 and 9. Also, while the QPS scores decline when we control for crises elsewhere in the trade cluster, these improvements are not statistically significant when compared to the scores of the forecasts that control only for fundamentals. Hence, by these criteria, both types of trade clusters underperform the financial sector links previously discussed.

## V. Recent Episodes and Conclusions

To sum up, our analysis suggests that susceptibility to contagion is highly nonlinear. Furthermore, when the number of crises in a given cluster is high–financial sector links via common bank lenders are a powerful channel of fundamentals-based contagion; the difference between the conditional and unconditional probability, P(C*CE)-P(C), for the bank cluster is the highest at 52 percent (a 165 percent increase). This performance is followed by the high-correlation cluster [P(C*CE)-P(C)=47.1, which represents a 141 percent increase] , bilateral links [P(C*CE)-P(C)=47.3, which is a 126 percent increase], and a less impressive performance by the third-part trade cluster [P(C*CE)-P(C)=30.7], which is only somewhat higher than the global crisis elsewhere results [P(C*CE)-P(C)=25.7]. Besides these ordinal rankings, the QPS scores indicate an improvement in forecasting accuracy for all clusters; however, only in the case of the bank cluster and the high-correlation cluster are these improvements statistically significant at standard confidence levels. In the remainder of this final section we next turn our attention to two recent "contagious" episodes, the aftermath of the Mexican peso crisis and the floatation of the Thai baht. The aim is to assess through which channels these crises spread. We discuss both trade and financial links.

As regards the potential role of bilateral and third party trade linkages in these recent episodes, Malaysia would be the most closely linked with Thailand, with Korea and the Philippines having more moderate exposure. Trade can certainly not help explain Argentina and Brazil following the Mexican devaluation nor Indonesia following the Thai crisis. Exposure to Japanese banks, which pulled out rapidly

across the region was common to all the affected countries except Hong Kong. While both Brazil and Argentina are in the same U.S. bank cluster as Mexico, banks were not at the heart of the problem in 1994 as they were in the early 1980s.

Most of the affected Asian countries, except Korea had high asset return correlations with Thailand, although none except Hong Kong had particularly liquid markets. The same is true of stock returns in Argentina, which have the highest correlation with Mexico of any country in the region. Here it is hard to separate cause and effect. A high correlation may reflect past contagion, but to the extent that current cross-hedging strategies use such historical correlations as a guide, it could be the vehicle for future contagion. In sum, it would appear that financial sector linkages, be it through banks of through international capital markets have much to say in how shocks are propagated in recent crises episodes, particularly for Argentina, Brazil, and Indonesia.

We have examined the incidence of contagion and some of the channels through which fundamentals-based contagion can arise. Some of the arrangements that have linked countries together are quite old--trade in goods and services and strong ties through a common bank lender and can help shed light on earlier crises clusters, like the debt crisis of the early 1980s. Indeed, trade links and exposure to a common creditor appear to help explain the observed historical pattern of contagion. Yet, one should be cautious about extrapolation, as some of the channels through which shocks are transmitted are relatively new to emerging markets. After all, less than a decade ago there were only a handful of mutual funds that had any exposure to emerging markets to begin with. Cross-market hedges have become commonplace in emerging market trades. Clearly, these financial market channels need to be better understood and quantified if policymakers around the globe hope to develop a "financial architecture" that makes countries less crisis prone and susceptible to contagion.

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Table 1. The Incidence of Global Contagion: Currency Crises, 1970-1998

| Proportion of other sample countries with crises (in percent) | Noise-to-signal ratio, N/S | Unconditional probability of a crisis | Probability of a crisis conditioned on crises elsewhere, P(C*CE) | Difference between conditional and unconditional probability of a crisis, P(C*CE) - P(C) |
|---|---|---|---|---|
| 0 to 25 | 1.23 | 29.0 | 20.0 | -9.0 |
| 25 to 50 | 0.64 | 29.0 | 33.0 | 4.0 |
| 50 and above | 0.26 | 29.0 | 54.7 | 25.7 |
| Memorandum items: | | | | |
| Real exchange rate[1] | 0.10 | 29.0 | 67.0 | 38.0 |
| Imports | 1.10 | 29.0 | 26.0 | -3.0 |

1 The real exchange rate is used as a comparison as it provides the best performance among the univariate indicators considered in Kaminsky and Reinhart (1996) and Kaminsky (1998). By contrast, imports were among the indicators which fared among the worst.

Table 2. The Incidence and Evolution of Regional Contagion:
Asia, Europe and Latin America

| | Full sample: 1970 to 1998 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Proportion of other sample countries in the region with crises | Asia | | | Europe | | | Latin America | | |
| (in percent) | N/S | P(C) | P(C*CE) | N/S | P(C) | P(C*CE) | N/S | P(C) | P(C*CE) |
| 0 to 25 | 1.37 | 26.8 | 19.8 | 1.37 | 28.6 | 14.7 | 1.29 | 29.4 | 18.3 |
| 25 to 50 | 1.30 | 26.8 | 15.3 | 0.58 | 28.6 | 32.3 | 0.77 | 29.4 | 30.8 |
| 50 and above | 0.03 | 26.8 | 67.4 | 0.51 | 28.6 | 35.0 | 0.16 | 29.4 | 68.6 |

Table 3. Contagion and the Fundamentals: the Quadratic Probability Scores
1970-1998

| | **Naive (1)** | **Contagion (2)** | **Fundamentals (3)** | **Fundamentals and Contagion (4)** | **Difference between columns (4) and (3) (in percent)** |
|---|---|---|---|---|---|
| **Full Sample** | 0.386 | 0.350 | 0.313 | 0.308 | 1.6 |
| **Asia** | 0.285 | 0.239 | 0.301 | 0.213 | 29.2 |
| **Europe** | 0.378 | 0.325 | 0.316 | 0.297 | 6.0 |
| **Latin America** | 0.380 | 0.334 | 0.304 | 0.289 | 4.9 |

Table 4. Banks: Liabilities as a Percent of Borrower's Total Liabilities
on the Eve of the Tequila and Asian Flu Crises

| | Liabilities to Japan | | Liabilities to the United States | |
|---|---|---|---|---|
| **Borrower:** | **as of June 1994** | **as of December 1996** | **as of June 1994** | **as of December 1996** |
| **Asia average** | 37.2 | 30.1 | 12.8 | 12.2 |
| China | 39.5 | 32.3 | 1.9 | 4.9 |
| Indonesia | 54.0 | 39.7 | 7.7 | 9.5 |
| Korea | 29.4 | 24.3 | 10.0 | 9.4 |
| Malaysia | 40.2 | 36.9 | 11.3 | 10.5 |
| Philippines | 17.2 | 11.7 | 39.4 | 29.4 |
| Thailand | 56.8 | 53.5 | 7.1 | 7.2 |
| **Latin America average** | 7.1 | 5.2 | 28.8 | 26.3 |
| Argentina | 5.3 | 4.0 | 31.2 | 29.5 |
| Brazil | 10.6 | 7.6 | 22.7 | 27.1 |
| Chile | 8.8 | 5.2 | 31.2 | 27.9 |
| Colombia | 13.0 | 7.8 | 26.6 | 24.6 |
| Mexico | 7.3 | 8.7 | 34.2 | 28.4 |
| Peru | 7.5 | 2.9 | 15.9 | 17.4 |
| Uruguay | 0.7 | 0.8 | 35.2 | 30.2 |
| Venezuela | 3.7 | 4.2 | 33.3 | 25.6 |

Sources: Bank of International Settlements, *The Maturity, Sectoral, and Nationality Distribution of International Bank Lending* and United States Treasury, *Treasury Bulletin*.

Table 5 Banks: Liabilities as a Percent of Lender's Total Liabilities
on the Eve of the Debt, Tequila, and Asian Flu Crises

| | Liabilities to Japan | | Liabilities to the United States | | |
|---|---|---|---|---|---|
| **Borrower:** | **as of June 1994** | **as of December 1996** | **as of June 1982** | **as of June 1994** | **as of December 1996** |
| **Asia sub-total** | 53.6 | 67.3 | 10.1 | 18.1 | 24.4 |
| China | 9.7 | 10.3 | 0.1 | 0.7 | 2.1 |
| Indonesia | 11.7 | 13.0 | 0.2 | 2.6 | 4.1 |
| Korea | 9.9 | 14.3 | 5.4 | 5.2 | 7.2 |
| Malaysia | 3.9 | 4.8 | 0.2 | 1.7 | 1.8 |
| Philippines | 0.7 | 0.9 | 2.0 | 2.6 | 3.0 |
| Thailand | 14.6 | 22.1 | 0.4 | 2.8 | 3.9 |
| **Latin America sub-total** | 7.1 | 5.8 | 61.5 | 58.8 | 48.6 |
| Argentina | 1.2 | 1.1 | 8.4 | 10.6 | 10.2 |
| Brazil | 3.9 | 3.0 | 16.1 | 13.0 | 14.2 |
| Chile | 0.6 | 0.5 | 4.0 | 3.6 | 3.3 |
| Colombia | 0.8 | 0.8 | 1.9 | 2.5 | 3.2 |
| Mexico | 3.0 | 3.2 | 22.2 | 21.8 | 13.4 |
| Peru | 0.2 | 0.1 | 1.6 | 0.5 | 1.1 |
| Uruguay | 0.0 | 0.0 | 0.3 | 1.3 | 1.0 |
| Venezuela | 0.4 | 0.3 | 7.0 | 5.5 | 2.2 |

Sources: Bank of International Settlements, *The Maturity, Sectoral, and Nationality Distribution of International Bank Lending* and United States Treasury, *Treasury Bulletin*.
Notes: Lender's total claims represent the total claims on developing countries, excluding other BIS countries and offshore banking centers.

Table 6. Contagion and Banking Clusters

| **Proportion of other sample countries in the region with crises** | **Bank Clusters** | | | | |
|---|---|---|---|---|---|
| **(in percent)** | **N/S** | **P(C)** | **P(C*CE)** | **P(C*CE)-P(C)** | **[P(C*CE)-P(C)]/ P(C)** |
| 0 to 25 | 1.507 | 31.5 | 19.2 | -12.3 | -39.0 |
| 25 to 50 | 0.903 | 31.5 | 28.4 | -3.1 | -0.9 |
| 50 and above | 0.071 | 31.5 | 83.5 | 52.0 | 165.0 |
| Quadratic Probability Scores | | | | | |
| | **Naive (1)** | **Contagion (2)** | **Fundamentals (3)** | **Fundamentals and Contagion (4)** | **Difference between columns (4) and (3) and standard error[1] (5)** |
| Score | 0.394 | 0.291 | 0.304 | 0.245 | -0.059* (0.017) |

Notes: An asterisk denotes significance at standard confidence levels. The Japanese bank cluster includes Indonesia, Malaysia, and Thailand. United States bank cluster includes Argentina, Brazil, Chile, Colombia, Mexico, the Philippines, Uruguay, and Venezuela.

[1] The standard error was estimated with robust methods.

Table 7. Daily Stock Price Index Correlations: December1991 to December 1996
(US Dollars)

| Country | Arg. | Bra. | Chi. | Col. | Ind. | Kor. | Mal. | Mex. | Per. | Phi. | Rus. | Tha | Tur . | Ve n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | 1.00 | | | | | | | | | | | | | |
| Brazil | 0.37 | 1.00 | | | | | | | | | | | | |
| Chile | 0.38 | 0.24 | 1.00 | | | | | | | | | | | |
| Colombia | -0.01 | 0.15 | 0.02 | 1.00 | | | | | | | | | | |
| Indonesia | 0.38 | 0.28 | 0.39 | 0.20 | 1.00 | | | | | | | | | |
| Korea | 0.09 | 0.00 | 0.20 | 0.13 | 0.10 | 1.00 | | | | | | | | |
| Malaysia | 0.17 | -0.09 | 0.12 | 0.02 | 0.50 | 0.20 | 1.00 | | | | | | | |
| Mexico | 0.56 | 0.36 | 0.34 | -0.10 | 0.32 | 0.29 | 0.28 | 1.00 | | | | | | |
| Peru | 0.44 | 0.40 | 0.45 | 0.21 | 0.22 | 0.32 | 0.14 | 0.53 | 1.00 | | | | | |
| Philippines | 0.35 | 0.05 | 0.25 | 0.24 | 0.63 | 0.09 | 0.61 | 0.30 | 0.29 | 1.00 | | | | |
| Russia | 0.15 | 0.10 | 0.49 | -0.14 | -0.19 | -0.19 | -0.14 | 0.10 | 0.30 | 0.26 | 1.00 | | | |
| Thailand | 0.25 | 0.01 | 0.37 | 0.05 | 0.54 | 0.24 | 0.60 | 0.30 | 0.24 | 0.68 | 0.02 | 1.00 | | |
| Turkey | 0.02 | 0.11 | -0.07 | -0.05 | 0.27 | 0.11 | 0.18 | -0.04 | -0.04 | 0.18 | -0.39 | 0.14 | 1.00 | |
| Venezuela | 0.24 | 0.16 | 0.01 | 0.24 | 0.18 | 0.16 | 0.12 | -0.06 | 0.012 | 0.32 | 0.22 | 0.09 | -0.08 | 1.00 |

Source: International Finance Corporation, *Emerging Stock Markets Factbook 1997.*

Table 8. Emerging Market Mutual Fund Holdings

| Country | Major Country Holdings June 30, 1997 | |
|---|---|---|
| | US$ billions | Percent |
| Total Asia | 85.04 | 55.55 |
| Bangladesh | 0.03 | 0.02 |
| China | 3.74 | 2.44 |
| Hong Kong | 23.46 | 15.33 |
| India | 8.98 | 5.87 |
| Indonesia | 6.66 | 4.35 |
| Korea | 9.43 | 6.16 |
| Malaysia | 9.01 | 5.88 |
| Pakistan | 0.71 | 0.46 |
| Philippines | 3.68 | 2.40 |
| Singapore | 5.03 | 3.29 |
| Sri Lanka | 0.21 | 0.14 |
| Taiwan | 10.00 | 6.53 |
| Thailand | 4.11 | 2.68 |
| Total Latin America | 44.02 | 28.75 |
| Argentina | 4.56 | 2.98 |
| Brazil | 20.01 | 13.07 |
| Chile | 4.36 | 2.85 |
| Colombia | 0.81 | 0.53 |
| Mexico | 11.76 | 7.68 |
| Peru | 1.33 | 0.87 |
| Venezuela | 1.19 | 0.78 |

Notes: The figures cover all dedicated emerging market funds--both regional and single country--that are registered or listed in a developed market (excluding the emerging market funds that are registered and traded in the emerging markets themselves.)

Table 9. Contagion and High Correlation Clusters

| **Proportion of other sample countries in the region with crises** | **High Correlation Cluster** | | | | |
|---|---|---|---|---|---|
| **(in percent)** | **N/S** | **P(C)** | **P(C*CE)** | **P(C*CE)-P(C)** | **[P(C*CE)-P(C)]/ P(C)** |
| 0 to 25 | 5.100 | 33.3 | 5.5 | -27.8 | -83.5 |
| 25 to 50 | 0.577 | 33.3 | 54.1 | 20.8 | 62.5 |
| 50 and above | 0.389 | 33.3 | 80.4 | 47.1 | 141.4 |
| Quadratic Probability Scores | | | | | |
| | **Naive (1)** | **Contagion (2)** | **Fundamentals (3)** | **Fundamentals and Contagion (4)** | **Difference between columns (4) and (3) and standard error[1] (5)** |
| Score | 0.381 | 0.186 | 0.343 | 0.158 | -0.185* (0.014) |

Notes: An asterisk denotes significance at standard confidence levels. The Asian high correlation cluster includes Indonesia, Malaysia, the Philippines and Thailand. The Latin American cluster includes Argentina, Brazil, and Peru.

[1] The standard error was estimated with robust methods.

Table 10. Asia and Latin America Inter- and Intra-Regional Trade: Exports to Asia

| Country | Exports to the rest of Emerging Asia[1] | | | Exports to the rest of Emerging Asia and China, Hong Kong, Japan, and Singapore | | |
|---|---|---|---|---|---|---|
| | 1982 | 1995 | 1997 | 1982 | 1995 | 1997 |
| Asia Average | 6.8 | 9.0 | 9.6 | 48.8 | 54.7 | 54.7 |
| Indonesia | 4.4 | 12.2 | 12.8 | 69.7 | 56.6 | 55.7 |
| Korea | 4.1 | 7.8 | 9.7 | 30.0 | 48.7 | 49.6 |
| Malaysia | 8.1 | 9.0 | 9.9 | 61.1 | 56.8 | 59.3 |
| Philippines | 8.0 | 9.8 | 7.7 | 40.2 | 41.7 | 40.9 |
| Thailand | 9.4 | 6.3 | 8.0 | 41.9 | 52.6 | 52.7 |
| | Exports to Emerging Asia | | | Exports to Emerging Asia and China, Hong Kong, Japan, and Singapore | | |
| | 1982 | 1995 | 1997 | 1982 | 1995 | 1997 |
| Latin America Average | 1.2 | 2.3 | 2.0 | 9.0 | 10.5 | 8.7 |
| Argentina | 0.6 | 2.8 | 3.3 | 7.4 | 13.4 | 13.2 |
| Brazil | 1.8 | 4.6 | 3.8 | 10.7 | 17.5 | 14.4 |
| Chile | 1.4 | 8.3 | 9.9 | 16.1 | 33.7 | 37.5 |
| Colombia | 0.2 | 0.6 | 0.3 | 4.6 | 6.0 | 3.6 |
| Mexico | 1.4 | 0.2 | 0.1 | 8.8 | 2.4 | 2.0 |
| Peru | 3.2 | 5.8 | 4.1 | 21.1 | 26.0 | 23.6 |
| Uruguay | 0.2 | 1.4 | 1.4 | 3.4 | 11.7 | 10.1 |
| Venezuela | 0.3 | 0.1 | 0.1 | 5.1 | 2.7 | 1.9 |

Source: International Monetary Fund, *Direction of Trade Statistics*.

[1] Other emerging Asia includes those countries listed in the table.

Table 11. Asia and Latin America Inter- and Intra-Regional Trade: Exports to Latin America

| Country | Exports to Latin America | | | Exports to Latin America and the United States | | |
|---|---|---|---|---|---|---|
| | 1982 | 1995 | 1997 | 1982 | 1995 | 1997 |
| Asia Average | 2.4 | 2.4 | 2.5 | 20.7 | 21.8 | 21.7 |
| Indonesia | 4.2 | 1.4 | 1.1 | 20.0 | 18.1 | 17.5 |
| Korea | 3.1 | 4.7 | 4.7 | 31.9 | 24.0 | 21.0 |
| Malaysia | 0.3 | 1.6 | 1.5 | 12.0 | 22.3 | 19.8 |
| Philippines | 0.9 | 1.0 | 2.4 | 32.5 | 36.9 | 37.1 |
| Thailand | 0.2 | 1.0 | 0.9 | 12.9 | 18.7 | 20.6 |
| | Exports to the rest of Latin America | | | Exports to the rest of Latin America and the United States | | |
| | 1982 | 1995 | 1997 | 1982 | 1995 | 1997 |
| Latin America Average | 19.8 | 18.9 | 20.4 | 50.2 | 66.1 | 71.3 |
| Argentina | 20.4 | 40.9 | 49.3 | 33.8 | 49.9 | 57.1 |
| Brazil | 15.6 | 23.0 | 27.7 | 36.1 | 41.9 | 45.4 |
| Chile | 19.4 | 19.2 | 16.8 | 41.0 | 33.1 | 32.5 |
| Colombia | 21.7 | 29.7 | 28.4 | 45.0 | 63.8 | 66.6 |
| Mexico | 8.8 | 5.6 | 6.0 | 61.2 | 89.9 | 91.6 |
| Peru | 11.0 | 17.1 | 18.2 | 42.0 | 34.4 | 44.4 |
| Uruguay | 30.5 | 53.3 | 56.0 | 38.3 | 59.3 | 62.0 |
| Venezuela | 39.5 | 33.6 | 33.8 | 66.3 | 82.8 | 85.4 |

Source: International Monetary Fund, *Direction of Trade Statistics*.

Table 12 The Composition of Exports:
Argentinean and Brazilian Exports of Mexico's Top Exports
(Percent of total Exports, 1994)

| Description | Mexico | Argentina | Brazil |
|---|---|---|---|
| Oil | 10.8 | 7.1 | 0.0 |
| Automobiles | 8.6 | 1.2 | 1.2 |
| Insulated electric wire | 4.8 | 0.1 | 0.1 |
| Televisions | 4.3 | 0.1 | 0.0 |
| Engine parts | 3.8 | 0.9 | 2.0 |
| Automobile parts | 3.4 | 2.6 | 2.9 |
| Radio/amplifier parts | 3.2 | 0.1 | 0.1 |
| Electric switches, relays, etc. | 3.2 | 1.3 | 0.3 |
| Other electric machinery | 2.7 | 0.0 | 0.1 |
| Computers | 2.0 | 0.3 | 0.2 |
| Transportation vehicles | 1.6 | 1.7 | 2.0 |
| Semi conductors | 1.5 | 0.0 | 0.2 |
| Radios | 1.5 | 0.1 | 0.7 |
| Furniture | 1.4 | 0.1 | 0.7 |
| Electric power machinery | 1.3 | 0.0 | 0.3 |
| Total | 54.1 | 15.6 | 10.9 |

Source: Statistics Canada, World Trade Database.

Table 13 Composition of Exports: Asian Exports of Top Thai Exports
(Percent of exports, 1996)

| Description | Thailand | Korea | Indonesia | Malaysia | Philippines |
|---|---|---|---|---|---|
| Radio/amplifier parts | 4.8 | 3.8 | 2.0 | 7.3 | 2.5 |
| Semiconductors | 5.3 | 15.4 | 0.3 | 18.0 | 9.1 |
| Footwear | 3.7 | 1.0 | 4.3 | 0.1 | 0.9 |
| Calculation machines | 4.6 | 0.7 | 0.5 | 6.6 | 1.0 |
| Electric switches, relays, etc. | 1.7 | 1.1 | 0.4 | 1.9 | 0.8 |
| Computers and accessories | 5.1 | 3.2 | 0.4 | 2.9 | 1.5 |
| Jewelry | 1.7 | 0.3 | 0.7 | 0.6 | 0.2 |
| Televisions | 1.7 | 1.5 | 0.1 | 3.0 | 0.4 |
| Refrigerators | 1.5 | 0.4 | 0.1 | 1.4 | 0.0 |
| Shellfish | 4.3 | 0.3 | 2.3 | 0.2 | 1.7 |
| Rubber | 4.4 | 0.0 | 4.2 | 2.2 | 0.2 |
| Fish | 1.4 | 0.2 | 0.2 | 0.1 | 0.7 |
| Rice | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 44.3 | 27.9 | 15.4 | 44.4 | 18.8 |

Source: Statistics Canada, World Trade Database.

Table 14. Contagion and Trade Clusters

| Proportion of other sample countries in the region with crises | Third Party Trade Clusters | | | | | Latin American High Bilateral Trade Cluster | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (in percent) | N/S | P(C) | P(C*CE) | P(C*CE)-P(C) | [P(C*CE)-P(C)]/P(C) | N/S | P(C) | P(C*CE) | P(C*CE)-P(C) | [P(C*CE)-P(C)]/P(C) |
| 0 to 25 | 1.51 | 27.6 | 21.8 | -5.8 | -21.0 | 0.53 | 37.4 | 29.3 | -8.1 | -21.4 |
| 25 to 50 | 1.54 | 27.6 | 21.3 | -6.3 | -22.8 | 2.34 | 37.4 | 15.6 | -21.8 | -58.3 |
| 50 and above | 0.57 | 27.6 | 58.3 | 30.7 | 111.2 | 0.08 | 37.4 | 84.7 | 47.3 | 126.0 |

Quadratic Probability Scores

| | Naive (1) | Contagion (2) | Fundamentals (3) | Fundamentals and Contagion (4) | Difference between columns (4) and (3) and standard error[1] (5) |
|---|---|---|---|---|---|
| Score Third Party Trade | 0.375 | 0.354 | 0.312 | 0.283 | -0.029 (0.018) |
| Score Latin America bilateral trade | 0.433 | 0.377 | 0.345 | 0.314 | -0.031 (0.017) |

Notes: The Asian third party cluster includes Malaysia, the Philippines and Thailand. The Latin American third party includes Brazil, Colombia, Mexico and Venezuela; the bilateral trade cluster includes the Mercosur countries plus Chile. Since there is little bilateral trade among the five affected countries no bilateral cluster is reported.
[1] The standard error was estimated with robust methods.

**Footnotes**

1. Eichengreen, et. al. (1996), Glick and Rose (1998), and Wolf (1997) all examined the scope for trade links.

2. See Gerlach and Smets (1995) Corsetti et. al. (1998).

3. As a story of fundamentals-based contagion, of course, this explanation does not speak to the fact that central banks often go to great lengths to avoid the devaluation in the first place.

4. European banks had also increased their exposure to Asia in recent years.

5. Problems with limited data availability, particularly for financial indicators, precluded us from including countries in Sub-Saharan Africa. A full description of the data set is presented in Kaminsky and Reinhart (1996).

6. See Kaminsky and Reinhart (1996) for details.

7. For a detailed discussion of the construction of the adjusted noise-to-signal ratio see Kaminsky and Reinhart (1996).

8. See Calvo and Reinhart (1996).

9.Hence, we have the following two by two matrix,

| | Crisis occurs in the following 24 months | No crisis occurs in the following 24 months |
|---|---|---|
| A signal is issued | A | B |
| No signal is issued | C | D |

A "perfect" indicator would only have entries in cells A and D and a noise-to-signal ratio (calculated as [B/(B+D)/A(A+C)]) of zero.

10. The noise-to-signals ratios for the indicators are given in Kaminsky and Reinhart (1996).

11. The crisis elsewhere criteria does not distinguish between being in a particular cohort or outside it.

12. These bilateral trade statistics are not reported in the tables but are available from the authors.