Contagion and Trade: Explaining the Incidence and Intensity of Currency Crises

Reuven Glick and Andrew K. Rose*

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Abstract

Currency crises tend to affect countries in geographic proximity. This suggests that regional patterns of international trade are important in understanding how currency crises spread, above and beyond any macroeconomic phenomena. Using data for five different currency crises (in 1971, 1973, 1992, 1994, and 1997) we show that currency crises affect countries tied together by international trade. By way of contrast, macroeconomic and financial influences are not closely associated with the cross-country incidence of speculative attacks. We also show that trade linkages help explain the cross-country intensity of exchange market pressure during crisis episodes, even after controlling for macroeconomic factors.

Keywords: speculative; attack; exchange rates; international; reserves; macroeconomic; empirical.

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Reuven Glick
Federal Reserve Bank of San Francisco
101 Market St.,
San Francisco CA 94105
Tel: (415) 974-3184
Fax: (415) 974-2168
E-mail: reuven.glick@sf.frb.org

Andrew K. Rose
Haas School of Business
University of California
Berkeley, CA USA 94720-1900
Tel: (510) 642-6609
Fax: (510) 642-4700
E-mail: arose@haas.berkeley.edu

* Glick is Vice President and Director of the Center for Pacific Basin Studies, Economic Research Department, Federal Reserve Bank of San Francisco. Rose is B.T. Rocca Jr. Professor of International Trade and Economic Analysis and Policy in the Haas School of Business at the University of California, Berkeley, acting director of the NBER International Finance and Macroeconomics program, and CEPR Research Fellow. We thank Priya Ghosh and Laura Haworth for research assistance. For comments, we thank the participants of the CEPR/World Bank Conference "Financial Crises: Contagion and Market Volatility," Joshua Aizenman, Gabriele Galati, Marcus Miller, Richard Portes, Javier Suárez, Mark Taylor, and especially David Vines. The views expressed below do not represent those of the Federal Reserve Bank of San Francisco or the Board of Governors of the Federal Reserve System, or their staffs. This is a revised version of the paper entitled "Contagion and Trade: Why are Currency Crises Regional?" which is available as NBER Working Paper #6806 and CEPR DP No. 1947. The (Excel 97 spreadsheet) data set used in the paper is available at http://haas.berkeley.edu/~arose.

I. Introduction

The European Monetary System (EMS) crisis of 1992-93, the Mexican meltdown and "Tequila Hangover" of 1994-95, and the "Asian Flu" of 1997-98 are three recent samples of speculative attacks on fixed exchange rate regimes. These currency crises generally involved countries in the same region. Once a country had suffered a speculative attack—Thailand in 1997, Mexico in 1994, Finland in 1992—other countries in the same region were disproportionately likely to be attacked themselves.

Why? One explanation is that currency crises tend to spread through a region because countries are linked by trade, and trade tends to be regional.[1] Once Thailand floated the baht, its main trade competitors (e.g., Malaysia and Indonesia) were suddenly at a competitive disadvantage, and so were themselves likely to be attacked. Thus the spread of currency crises reflects international trade patterns. Countries that trade and compete with the targets of speculative attacks are themselves likely to be attacked.

Prima facie then, trade linkages seem like an obvious place to look for a regional explanation of currency crises. But most economists think about currency crises using variants of two standard models of speculative attacks. The "first generation" models of, e.g., Krugman (1979) direct attention to inconsistencies between an exchange rate commitment and domestic economic fundamentals such as an underlying excess creation of domestic credit, typically prompted by a fiscal imbalance. The "second generation" model of, e.g., Obstfeld (1986) views currency crises as shifts between different monetary policy equilibria in response to self-fulfilling speculative attacks. What is common to both classes of models is their emphasis on macroeconomic and financial fundamentals as determinants of currency crises. But macroeconomic phenomena do not tend to be regional. That is, countries in the same region do not necessarily exhibit similar macroeconomic features. Thus, from the perspective of most speculative attack models, it is hard to understand why currency crises tend to be regionally clustered, at least without an extra ingredient explaining why the relevant macro fundamentals are intra-regionally correlated.[2]

In this paper we argue that trade is indeed an important channel for contagion empirically, above and beyond macroeconomic and financial influences. Most importantly it demonstrates that trade links help explain the intensity as well as the incidence of currency crises as captured by measures of exchange rate pressure. We focus on explaining the pattern of contagion across countries for five different currency crisis episodes: the breakdown of the Bretton Woods system in 1971, the collapse of the Smithsonian Agreement in 1973, the EMS Crisis of 1992-93, the Mexican meltdown and the Tequila Effect of 1994-95, and the Asian Flu of 1997-98. We ask why some countries were hit during each of these episodes of currency instability, while others were not.

Our analysis ignores a number of related issues. For instance, in trying to model "contagion" in currency crises, we do not rule out the possibility of (regional) shocks common to a number of countries, nor the possibility of contagion spreading through non-trade related channels.[3] Moreover, we do not attempt to study the timing of currency crises. We *do* show that, given the occurrence of a currency crisis, the incidence and intensity of speculative attacks across countries is linked to the importance of international trade linkages. That is, currency crises spread along the lines of trade linkages, after accounting for the effects of macroeconomic and financial factors. This linkage is intuitive, economically significant, statistically robust, and important in understanding the regional nature of speculative attacks.

Section II motivates the analysis by discussing the regional nature of three recent waves of speculative attacks. This is followed by a section on the possible channels of contagion that provides a framework for our analysis. Our methodology and data are discussed in section IV.

Section V presents empirical results on the incidence of currency attacks; results concerning the intensity of attacks follows in Section VI. The paper ends with a brief conclusion.

II. Regional Nature of Currency Crises

The last decade has witnessed three important currency crises. In the autumn of 1992, a wave of speculative attacks hit the European Monetary System and its periphery. Before the end of the year, five countries (Finland, the UK, Italy, Sweden and Norway) had floated their currencies. Despite attempts by a number of countries to remain in the EMS with the assistance of devaluations (by Spain, Portugal and Ireland), the system was unsalvageable. The bands of the EMS were widened to ± 15% in August 1993. Eichengreen and Wyplosz (1993) provide a well-known review of the EMS crisis.

The Mexican peso was attacked in late 1994 and floated shortly after an unsuccessful devaluation. Speculative attacks on other Latin American countries occurred immediately. The most prominent targets of the "Tequila Hangover" were Latin American countries, especially Argentina and Brazil, but also including Peru and Venezuela. Not all Latin countries were attacked—Chile being the most visible exception—and not all economies attacked were in Latin America (Thailand, Hong Kong, the Philippines and Hungary also suffered speculative attacks). While there were few devaluations, the attacks were not without effect. Argentine macro-economic policy in particular tightened dramatically, precipitating a sharp recession. Sachs, Tornell and Velasco (1996) provide one of many summaries of the Mexican crisis and its aftermath.

The "Asian Flu" began with continued attacks on Thailand in the late spring of 1997 and continuing with flotation of the baht in early July 1997. Within days speculators had attacked Malaysia, the Philippines, and Indonesia. Hong Kong and Korea were attacked somewhat later on; the crisis then spread across the Pacific to Chile and Brazil. The effects of "Bhatulism" linger on as this paper is being written; Corsetti, Pesenti and Roubini (1998) provide an exhaustive survey.

All three waves of attacks were largely regional phenomena.[4] Once a country had suffered a speculative attack—Thailand in 1997, Mexico in 1994, Finland in 1992—other countries in the same region were disproportionately likely to be attacked themselves.

III. Channels of Contagion

For the purposes of this study, we think of a currency crisis as being contagious if it spreads from the initial target(s), for whatever reason. There are several different types of explanations for why contagion spreads, explanations that are not mutually exclusive.[5]

The first relies on macroeconomic or financial similarity. A crisis may spread from the initial target to another if the two countries share various economic features, making them equally vulnerable to attack. The work of Sachs, Tornell and Velasco (1996) can be viewed in this light. Sachs et. al. show that three intuitively reasonable fundamentals—real exchange rate over-valuation, weakness in the banking system, and low international reserves (relative to broad money)—can explain half the cross-country variation in a crisis index, itself a weighted average of exchange rate depreciation and reserve losses. They use data for twenty developing countries in late 1994 and early 1995. Tornell (1998) extends this analysis to include the Asia crisis.[6] Currency crises may be regional if macroeconomic features of economies tend to be regional.

A second view is that crises spread via trade links across countries. For example, a devaluation in one country adversely affects the international competitiveness of other countries, in the presence of short-run nominal rigidities. Those trade competitors most adversely affected by the devaluation are likely to be attacked next. Gerlach and Smets (1994) and Corsetti, Pesenti, Roubini, and Tille (1998) formalize this reasoning; Huh and Kasa (1997) provide related analysis. In this way, a currency crisis that hits one country (for whatever reason) may be expected to spread to its trading partners.[7] Since trade patterns are strongly negatively affected by distance, currency crises will tend to be regional.

A third explanation of contagion focuses on cross-country financial links. For example, financial problems and illiquidity in one market may force financial intermediaries to liquidate assets in other markets. Goldfajn and Valdes (1997) analyze the interaction of banking and currency crises via this channel. In this view, currency crises will be regional if the pattern of cross-border asset holdings are concentrated regionally.[8]

These different explanations are not mutually exclusive. Major trading partners are not always attacked during currency crises. Macroeconomic and financial influences are certainly not irrelevant. Ultimately determining the relative roles of the different channels of contagion is an empirical exercise.

The limited availability of data on bilateral cross-country asset holdings, particularly bank claims, precludes testing the role of financial market links. However, Eichengreen and Rose (1998) found both “macroeconomic” and “trade” channels of transmission to be empirically relevant in a large quarterly panel of post-1959 industrial country data; trade effects dominated. It is not clear *a priori* which of these mechanisms for contagion, if any, might be present in the data we examine. For this reason, we try to account for both in our empirical work.

IV. Methodology

Our objective in this paper is to demonstrate that trade provides an important channel for contagion above and beyond macroeconomic and financial similarities. As a result, we focus on the incidence and intensity of currency crises *across countries*. We ask why some countries are hit during certain episodes of currency instability, while others are not.

Empirical Strategy

Our strategy keys off the "first victim" in a given currency crisis episode. A country is attacked for some reason. We do not take a stance one way or another on whether this initial attack is warranted by bad fundamentals (as would be true in a first-generation model) or is the result of a self-fulfilling attack (consistent with a second-generation model). Instead, given the incidence of the initial attack (e.g., Mexico in 1994, Thailand in 1997), we ask how the crisis spreads from "ground zero?" Were the subsequent targets closely linked by international trade to the first victim? Do they share macroeconomic similarities? We answer this by estimating a cross-country relationship for each crisis episode which compares the incidence of crises across countries with a measure of each other country's trade linkage with the first crisis victim as well as relevant macroeconomic variables. We interpret evidence in favor of the first hypothesis as indicating the importance of the trade channel of contagion.

Clearly we do not deal with a number of related and important issues. We assume that there is contagion, and do not test for its presence. We do not attempt to explain the timing of currency crises.[9] Finally, we do not ask why some crises become contagious and spread while others do not.

Our estimation framework is of the form:

$$Crisis_i = \varphi Trade_i + \lambda M_i + \varepsilon_i$$

where: $Crisis_i$ is an indicator variable of crisis victims which is initially defined as unity if country i was attacked in a given episode, and zero if the country was not attacked; M_i is a set of macroeconomic control regressors; λ is the corresponding vector of nuisance coefficients; and ε is a normally distributed disturbance representing a host of omitted influences which affect the probability of a currency crisis.

We estimate this binary probit equation across countries via maximum likelihood. The null hypothesis of interest is Ho: $\varphi=0$. We interpret evidence against the null as being consistent with a trade contagion effect.

We also use a different set of regressands, involving more quantitative crisis indicators, to measure exchange market intensity. When the regressand is a continuous indicator of exchange market intensity, we estimate this cross-country equation by OLS. In this case we consider not just the significance of φ, but also its sign.

Data Set

We use cross-sectional data from five different episodes of important and widespread currency instability. These are: 1) the breakdown of the Bretton Woods system in the Spring of 1971; 2) the collapse of the Smithsonian Agreement in the late Winter of 1973; 3) the EMS Crisis of 1992-93; 4) the Mexican meltdown and the Tequila Effect of 1994-95; and 5) the Asian Flu of 1997-98. Our data set includes data from 161 countries, many of which were directly involved in *none* of the five episodes.[10]

Making our work operational entails: a) measuring currency crises; b) measuring the importance of trade between the “first victim” and country i; and c) measuring the relevant macroeconomic and financial control variables. We now deal with these tasks in order.

Currency Crises

To construct our simple binary indicator regressand, it is relatively easy to determine crisis victims from journalistic and academic histories of the various episodes (we rely on *The Financial Times* in particular). Our list of crisis countries attacked during each episode is included in appendix table A1.[11]

Table A1 also lists the "ground zero" countries first attacked. For some periods "ground zero" is relatively straightforward (Mexico in 1994, Thailand in 1997). For others, it is more arguable. In 1971 and 1973 we consider Germany to be ground zero. A case can be made that the U.S. should be ground 0 for the 1971 and 1973 episodes. However, since the U.S. dollar was the key currency of the international monetary system, the change in the value of the dollar during these periods can be interpreted more as a common shock. *A priori*, we choose to rule out such a common shock when testing for contagion effects transmitted through the trade channel. The 1992 crisis is more complex still. We think of the Finnish flotation as being the first important incident (making Finland "ground zero"), but one can make a case for Italy (which began to depreciate immediately following the Danish Referendum) or Germany because of the aftermath of Unification (though as the center of the EMS, German shocks are common).[12]

The five waves of currency crises we examine all appear to have a strongly regional nature. Table 1 is a series of cross-tabulations of crisis and non-crisis countries in our five episodes grouped into four regions. The chi-squared tests of independence confirm that currency crises appear to be regional.

Trade Linkages

Once our "ground zero" country has been designated, we need to be able to quantify the importance of international trade links between it and other countries. We focus on the degree to which ground zero competes with each other country in foreign export markets. Our default measure of trade competition between country 0 and each country i in all foreign (third country) export markets k is

$$\text{Trade}_i \equiv \Sigma_k \{[(x_{0k} + x_{ik})/(x_{0.} + x_{i.})] \cdot [1 - |(x_{ik} - x_{0k})|/(x_{ik} + x_{0k}]\}$$

where x_{ik} denotes aggregate bilateral exports from country i to k (k ≠ i, 0) and $x_{i.}$ denotes aggregate bilateral exports from country i (i.e., $\Sigma_k x_{ik}$). This index is a weighted average of the mutual importance of exports from countries 0 and i to each country k. The mutual importance of exports to country k is defined to be greatest when it is an export market of equal importance to both 0 and i, as measured by bilateral export levels. The weights are proportional to the importance of bilateral exports of countries 0 and i to country k relative to their combined aggregate trade. Higher values of Trade_i denote greater trade competition between 0 and i in foreign export markets.[13]

This is clearly an imperfect measure of the importance of trade linkages between country i and "ground zero." It relies on actual rather than potential trade, and aggregate data. It ignores direct trade between the two countries. Imports are ignored. Countries of vastly different size are a potential problem. Cascading effects are ignored.[14]

We have computed a number of different perturbations to our benchmark measure, and found that our trade measures are relatively insensitive to the exact way we measure the trade linkage. For example, we have calculated a measure of trade linkages which uses trade shares as our measure of competition in foreign export markets, so as to adjust for the varying size of countries:

$$\text{TradeShare}_i \equiv \Sigma_k\{[(x_{0k} + x_{ik})/(x_{0.} + x_{i.})] \cdot$$
$$[\, 1 - |\{(x_{0k}/x_{0.}) - (x_{ik}/x_{i.})\}|/\{(x_{0k}/x_{0}.) + (x_{ik}/x_{i}.)\}]\}$$

We check extensively for the sensitivity our results to ensure that our results do not depend on the exact measure of trade linkage.[15]

We computed our trade measures for our different episodes using annual data for the relevant crisis year taken from the IMF's *Direction of Trade* data set.[16, 17] The rankings of the top twenty trade competitors of "ground zero," i.e. the "first victim," for each episode are tabulated (by ranking of "$Trade_i$") in Table A2, and seem sensible. For instance, the most important export competitors for Finland in 1992 are Norway and Denmark; in 1997 all of Thailand's top 10 trade competitors and 16 of its top 20 trade competitors were located in Asia. But some of the competitors are not intuitive. For instance, some countries enter the rankings that are probably not direct trade competitors (e.g., OPEC countries); this is an artifact of the aggregate nature of our data.

Macroeconomic Controls

Our objective is to use a variety of different macroeconomic controls to account for the standard determinants of currency crises dictated by first- and second-generation models. We do this so that our trade linkage variable picks up the effects of currency crises abroad that spill over because of trade; that is, *after* taking account of macroeconomic and financial imbalances that might lead to a currency crisis.

Our controls include the annual growth rate of domestic credit (IFS line 32); the government budget as a percentage of GDP (a surplus being positive; IFS line 80 over line 99b); the current account as a percentage of GDP (IFS line 78ald multiplied by line rf in the numerator); the growth rate of real GDP (IFS line 99b.r); the ratio of M2 to international reserves (IFS lines 34+35 multiplied by line rf over line1l.d); and domestic CPI inflation (IFS line 64);

and the degree of currency under-valuation.[18] These variables are suggested by a variety of different models of speculative attacks (as discussed in Eichengreen, Rose and Wyplosz (1995)) which can be viewed as primitive determinants of vulnerability to speculative pressure.

Our data are annual, and were extracted from the IMF's *International Financial Statistics*.[19] They have been checked for outliers via both visual and statistical filters.

V. Results: Incidence of Currency Crises

Univariate Evidence on Trade and Macroeconomic Linkages

Table 2 is a series of t-tests that test for equality of cross-country means for countries affected and unaffected during each currency crisis episode. These are computed under the null hypothesis of equality of means between crisis and non-crisis countries (assuming equal but unknown variances). Thus, a significant difference in the behavior of the variable across crisis and non-crisis countries—for instance consistently higher money growth for crisis countries—would show up as a large (positive) t-statistic.

There are two important messages from Table 2. First, for all five episodes, the strength of trade linkage to the "first victim" is systematically higher for crisis countries at all reasonable levels of statistical significance, i.e., countries that become "infected" by the crisis have closer trade linkages to the "first victim" than countries that escape the disease. In contrast, none of the macroeconomic variables typically varies systematically across crisis and non-crisis countries. While some variables sometimes have significantly different means, these results are not consistent across episodes. And they are never as striking as the trade results. These findings are consistent with the importance of the trade channel in contagion.

Multivariate Probit Results for Crisis Incidence

The top panel of Table 2 is a multivariate equivalent of Table 1, including our macroeconomic variables simultaneously with the trade variable. It reports probit estimates of cross-country crisis incidence on trade linkage and macroeconomic controls for each episode. Table 2b uses a wider range of countries (since many macroeconomic observations are missing in our sample) but restricts attention to the degree of currency under- or over-valuation. This is viewed by some as a summary statistic for macroeconomic misalignment. Table 3c pools the data for all five episodes.

Since probit coefficients are not easily interpretable, we report the effects of one-unit (i.e., one percentage point) changes in the regressors on the probability of a crisis (also expressed in probability values so that .01=1%), evaluated at the mean of the data. We include the associated z-statistics in parentheses; these test the null of no effect variable by variable. Diagnostics are reported at the foot of the table. These include a test for the joint significance of all the coefficients ("Slopes") which is distributed as chi-squared with seven degrees of freedom under the null hypothesis of no effect. We also include a p-value for the hypothesis that none of the macro effects are jointly significant (i.e., all the coefficients except the trade effect).

The results are striking. The trade channel for contagion seems consistently important in both statistical and economic terms. While the economic size of the effect varies significantly across episodes it is consistently different from zero at conventional levels of statistical significance. Its consistently positive sign indicates that a stronger trade linkage is associated with a higher incidence of a currency crisis.

On the other hand, the macroeconomic controls are small economically and rarely of statistical importance. This is true both of individual variables, of all seven macroeconomic factors taken simultaneously, and of currency under-valuation.

Succinctly, the hypothesis of no significant trade channel for contagion seems wildly inconsistent with the data, while macroeconomic controls do not explain the cross-country incidence of currency crises.

We have checked for the sensitivity of our probit results with respect to a number of perturbations to our basic methodology. Our trade linkage variable remains positive and statistically significant despite these changes.[20]

We have also explored the impact of our trade variable on the results of other recent studies of contagion. Corsetti, Pesenti, and Roubini (1998) and Tornell (1998) use cross-sectional techniques and data similar to ours to examine the incidence of the Asian crisis; Tornell also considers the 1994-95 Tequila attacks. We have reproduced the results of both studies, using their own data. When we added our trade variable to the default Tornell regression (which explains crisis severity with a pooled data set from 1994 and 1997), it is correctly signed and significant at the .02 level. When we added our trade variable to the default Corsetti et. al. regression, our benchmark trade variable is again correctly signed and significant at better than the .01 level. The robustness of our key result—the important role played by trade linkages even after taking into account macroeconomic effects—is quite reassuring.

VI. Results: Intensity of Currency Crises

In the previous section we showed that our measure of trade competition worked well in explaining the incidence of currency crises defined in terms of a simple binary indicator. In this section we seek to explain both the direction and intensity of crises, using a quantitative index of exchange market pressure during crisis episodes.[21]

We employ two continuous measures of exchange market intensity. The first measure is the cumulative percent change in the nominal devaluation rate with respect to the ground zero currency for six months following the occurrence of a crisis.[22] The second measure is a weighted average of the devaluation rate and the percent decline in international reserves for six months following the crises. (We check for robustness by also examining three- and nine-month horizons). Following others (Eichengreen, Rose, and Wyplosz (1995, 1996); Frankel and Rose (1996) and Sachs, Tornell and Velasco, 1996), we weight the components so as to equalize their volatilities; that is, we weight each component by the inverse of its variance over the sum of inverses of the variances, where the variances are calculated using three years of monthly data prior to each episode. This weighting scheme gives a larger weight to the component with a smaller variance.

Our measures of exchange rate crisis intensity are not without their limitations. First, countries that successfully defend themselves against speculative attacks may show no sign of attack by experiencing either an exchange rate depreciation or reserve losses. A somewhat broader measure of possible responses to speculative attacks would include the interest rate. However, the lack of such data for many of the countries in our sample precluded doing so. Second, threatened or actual changes to capital controls are difficult to measure quantitatively, but may influence results. The same is true of international rescue packages organized by e.g., the IMF. We proceed bearing these limitations in mind.

Our null hypothesis is that in episodes in which the ground zero country depreciates (e.g., 1992, 1994, 1997) other countries will depreciate and/or lose reserves the more they compete in world export markets with country 0; i.e. Ho: $\varphi>0$. Conversely, when the ground zero currency appreciates (e.g. 1971, 1973) other countries should appreciate more (or depreciate less) the more they compete with ground zero in export markets; i.e., Ho: $\varphi<0$.

We test these hypotheses by regressing our measures of exchange rate intensity on our basic trade competition variable, $Trade_i$, as well as on the same set of macroeconomic control variables as in Table 3a. Table 4a presents the coefficients on the trade variable from regressions of (three-, six-, and nine-month) depreciation rates. The analogue for exchange market pressure measured as a weighted average of reserve losses and depreciation is presented in Table 4b. For the sake of brevity, coefficients on the macro controls are not reported. For the sake of variety we use our trade share measure of trade linkages.[23, 24]

When we use depreciation as the regressand, the sign of the trade coefficient is sensible (at all horizons) for all five episodes. For 1992, 1994 and 1997, the coefficient is positive; countries that compete more intensely with “ground zero” (Finland in 1992, Mexico in 1994, and Thailand in 1997) tend to depreciate more, after accounting for macroeconomic factors. The sign is negative for the 1971 and 1973 episodes, implying that countries which competed more with Germany tended to appreciate more (along with Germany) following the appreciation of the Deutschemark. These results are generally significant at standard levels, particularly at the longer horizons. When we consider exchange market pressure—the weighted average of depreciation and reserve losses—as the crisis measure, the overall results for the six and nine month horizons are similar, though the significance level generally declines.[25]

Table 6 reports the complete results for the six-month horizon for depreciation and exchange market pressure respectively. Only inflation is generally significant across all episodes aside from inflation. In contrast, as noted above with our cumulative depreciation measure as the regressand, the trade variable appears to provide consistent explanatory power for all crisis episodes.[26]

We conclude that our continuous quantitative indicators, particularly the cumulative depreciation rate, provide support for the hypothesis that trade contributes significant power in explaining the intensity as well as incidence of currency crises.

VII. Concluding Comments

We have found strong evidence that currency crises tend to spread along regional lines using both binary and more continuous measures of crises. This is true of five recent waves of speculative attacks (in 1971, 1973, 1992, 1994-95, and 1997). Accounting for a variety of different macroeconomic effects does not change this result. Indeed macroeconomic factors do not consistently help much in explaining the cross-country incidence or intensity of speculative attacks.

Our evidence is consistent with the hypothesis that currency crises spread because of trade linkages. That is, countries may be attacked because of the actions (or inaction) of their neighbors, who tend to be trading partners merely because of geographic proximity. If speculative attacks spread through trade links, then enhanced international monitoring on a regional basis is desirable. Moreover, if countries are more at risk to the spread of currency crisis than is apparent by looking just at domestic economic factors, a lower threshold for international or regional assistance is also warranted in order to limit the spread of speculative attacks.

Table 1: Regional Distribution of Currency Crises

1971	Americas	Europe	Asia	Africa	Total
No Crisis	27	8	31	41	107
Crisis	1	16	2	0	19
Total	28	24	33	41	126

Test for Independence $\chi^2(3) = 62$

1973	Americas	Europe	Asia	Africa	Total
No Crisis	27	9	32	41	109
Crisis	1	15	3	0	19
Total	28	24	35	42	128

Test for Independence $\chi^2(3) = 54$

1992	Americas	Europe	Asia	Africa	Total
No Crisis	28	15	37	41	121
Crisis	0	10	0	0	10
Total	31	25	37	41	131

Test for Independence $\chi^2(3) = 46$

1994	Americas	Europe	Asia	Africa	Total
No Crisis	22	30	39	40	131
Crisis	6	1	4	0	11
Total	28	31	43	40	142

Test for Independence $\chi^2(3) = 12$

1997	Americas	Europe	Asia	Africa	Total
No Crisis	25	29	35	38	127
Crisis	3	3	9	1	16
Total	28	32	44	39	143

Test for Independence $\chi^2(3) = 7$

Table 2: T-Tests for Equality by Crisis Incidence

	1971	**1973**	**1992**	**1994**	**1997**
Trade	9.5	10.9	4.7	6.9	7.5
%∆M1	-.8	-1.1	-1.2	.9	.1
%∆M2	-1.6	-.8	-1.1	.6	-.0
%∆Credit	-.8	-1.3	-.4	.2	.4
%∆Private Credit	-1.2	-.1	-.7	.5	-.3
M2/Reserves	3.5	2.6	-.3	-.5	.3
%∆Reserves	1.8	-.7	-1.3	-1.4	-2.1
%∆Exports	1.0	.9	-.1	.5	-.1
%∆Imports	1.5	1.1	-.8	1.1	.6
Current Account/GDP	2.0	2.1	.8	-.2	.8
Budget/GDP	1.6	1.9	-1.4	.9	.4
Real Growth	-.7	-.5	-1.1	1.6	2.7
Investment/GDP	3.2	2.8	-1.0	.2	2.7
Inflation	.3	-.7	-1.5	1.0	-.6
Under-valuation	.5	.9	-.6	-1.5	.6

Values tabulated are t-statistics, calculated under the null hypothesis of equal means and variances. A significant positive statistic indicates that the variable was significantly higher for crisis countries than for non-crisis countries.

Table 3a: Multivariate Probit Results with Macro Controls

	1971	**1973**	**1992**	**1994**	**1997**
Trade	2.09 (2.7)	3.18 (2.7)	.003 (2.1)	.50 (2.9)	.68 (2.6)
%ΔCredit	-.01 (1.2)	-.01 (0.4)	.00 (1.1)	.00 (0.0)	N/A.
Budget/GDP	.01 (0.3)	.04 (1.2)	-.00 (0.8)	.00 (0.9)	N/A.
Current Account/GDP	.00 (0.2)	.03 (1.0)	.00 (0.1)	-.00 (1.7)	.00 (0.0)
Real Growth	-.00 (0.2)	.04 (1.2)	-.00 (1.6)	.00 (0.1)	.04 (2.2)
M2/Reserves	.00 (0.2)	.01 (0.4)	.00 (1.0)	-.00 (0.5)	.00 (0.8)
Inflation	.01 (0.4)	.01 (0.5)	-.00 (1.3)	.00 (0.7)	.00 (0.3)
Observations	53	60	67	67	50
Slopes (7)	26	36	24	16	17 (5df)
McFadden's R^2	.38	.49	.50	.36	.38
P-value: Macro=0	.89	.64	.59	.68	.26

Absolute value of z-statistics in parentheses. Probit estimated with maximum likelihood.

Table 3b: Probit Results with Currency Misalignment

	1971	**1973**	**1992**	**1994**	**1997**
Trade	2.25 (4.5)	2.88 (4.2)	.31 (3.2)	.45 (3.8)	.54 (4.5)
Under-valuation	.00 (1.3)	.00 (1.8)	-.00 (0.5)	-.00 (1.4)	.00 (1.1)
Observations	80	85	111	109	107
McFadden's R^2	.38	.48	.21	.34	.36

Absolute value of z-statistics in parentheses. Probit estimated with maximum likelihood.

Table 3c: Pooled Probit Results with Macro Controls

Trade	.73 (4.8)	.69 (5.5)
%∆Credit	.00 (0.5)	N/A.
Budget/GDP	.01 (1.0)	N/A.
Current Account/GDP	.00 (0.5)	.00 (0.4)
Real Growth	.00 (0.1)	-.01 (1.1)
M2/Reserves	.00 (2.0)	.00 (2.1)
Inflation	-.00 (1.3)	-.00 (0.0)
Observations	189	274
Slopes (df)	53.4 (7df)	59.0 (5df)
McFadden's R^2	.30	.24

Absolute value of z-statistics in parentheses. Probit estimated with maximum likelihood. Data pooled by weighting episode cross-sections by corresponding pseudo-R^2.

Table 4a: Multivariate OLS Results for Exchange Rate Pressure

Coefficient on Trade Share Variable; Macro controls not reported

Depreciation	**1971**	**1973**	**1992**	**1994**	**1997**
3 months	-4.24 (2.4)	-10.68 (2.6)	24.00 (3.8)	5.8 (2.9)	4.99 (1.6)
6 months	-6.81 (2.1)	-21.78 (3.4)	32.92 (4.0)	10.06 (3.1)	56.69 (3.4)
9 months	-7.60 (0.7)	-24.60 (3.8)	31.76 (3.0)	6.38 (1.9)	N/A.

Absolute value of t-statistics in parentheses.

Table 4b: Multivariate OLS Results for Exchange Rate Pressure

Coefficient on Trade Share Variable; Macro controls not reported

Exchange Market Pressure	**1971**	**1973**	**1992**	**1994**	**1997**
3 months	-4.36 (1.3)	-10.30 (2.1)	22.40 (3.2)	4.91 (2.4)	6.60 (1.6)
6 months	-4.96 (0.9)	-22.22 (2.8)	23.65 (2.4)	6.46 (1.8)	66.72 (2.8)
9 months	-8.60 (0.6)	-27.55 (3.2)	32.40 (2.6)	6.01 (1.6)	N/A.

Absolute value of t-statistics in parentheses. Regressand is weighted average of depreciation and reserve losses.

Table 5: Multivariate OLS Results for Exchange Rate Pressure: 6 month Horizon

Depreciation	**1971**	**1973**	**1992**	**1994**	**1997**
Trade Share	-6.81 (2.1)	-21.78 (3.4)	32.92 (4.0)	10.06 (3.1)	56.69 (3.4)
%ΔCredit	0.02 (0.3)	-0.01 (0.1)	0.01 (1.1)	0.05 (2.0)	-0.09 (0.7)
Budget/GDP	-0.42 (2.7)	-0.68 (2.3)	-0.24 (0.7)	-0.04 (0.6)	-1.63 (1.3)
Current Account/GDP	-0.12 (1.5)	-0.13 (0.43)	0.07 (0.8)	-0.22 (2.0)	-0.39 (0.8)
Real Growth	0.26 (2.3)	0.46 (1.5)	0.06 (0.2)	0.61 (2.8)	1.57 (1.2)
M2/Reserves	0.02 (0.8)	0.04 (1.7)	-0.2 (1.5)	0.12 (1.7)	-0.20 (1.3)
Inflation	0.39 (2.5)	0.60 (3.1)	0.42 (9.9)	0.23 (4.6)	0.29 (1.3)
Observations	53	59	66	67	25
R^2	.48	.40	.75	.49	.48
P-value: Macro=0	.00	.00	.00	.00	.41

Absolute value of t statistics in parentheses.

Exchange Market Pressure	**1971**	**1973**	**1992**	**1994**	**1997**
Trade Share	-4.96 (0.9)	-22.22 (2.8)	23.65 (2.4)	6.46 (1.8)	66.72 (2.8)
%ΔCredit	0.04 (0.4)	-0.08 (0.5)	0.23 (4.2)	0.05 (2.2)	-0.13 (0.8)
Budget/GDP	-0.53 (2.4)	-0.55 (1.8)	0.28 (0.6)	0.01 (0.2)	-3.28 (1.3)
Current Account/GDP	-0.16 (1.2)	-0.17 (0.5)	-0.14 (1.2)	-0.26 (2.2)	-0.21 (0.2)
Real Growth	0.14 (0.7)	0.82 (2.4)	-0.64 (1.8)	0.41 (1.7)	2.60 (1.6)
M2/Reserves	0.04 (0.6)	0.25 (1.5)	-0.11 (0.8)	0.10 (0.9)	-0.34 (1.2)
Inflation	0.24 (1.0)	0.75 (3.5)	-0.06 (0.8)	0.14 (2.7)	0.51 (0.7)
Observations	36	47	62	64	17
R^2	.45	.46	.43	.37	.58
P-value: Macro=0	.01	.00	.00	.00	.45

Absolute value of t statistics in parentheses. Regressand is a weighted average of depreciation and reserve losses.

Appendix Table A1: Countries Affected by Speculative Attacks

	1971	1973	1992	1994	1997
U.S.A.	1	1			
U.K.	1	1	1		
Austria	1	1			
Belgium	1	1	1		
Denmark	1	1	1		
France	1	1	1		
Germany	0	0			
Italy	1	1	1		
Netherlands	1	1			
Norway	1	1			
Sweden	1	1	1		
Switzerland	1	1			
Canada				1	
Japan		1			
Finland	1	1	0		
Greece	1	1			
Iceland		1			
Ireland	1		1		
Portugal	1	1	1		
Spain	1		1		
Australia	1	1			
New Zealand	1	1			
South Africa					1
Argentina				1	1
Brazil				1	1
Mexico				0	1
Peru				1	
Venezuela				1	
Taiwan					1
Hong Kong				1	1
Indonesia				1	1
Korea					1
Malaysia					1
Pakistan					1
Philippines				1	1
Singapore					1
Thailand				1	0
Vietnam					1
Czech Republic					1
Hungary				1	1
Poland					1

“0” denotes “first victim”/“ground zero”; “1” denotes target of speculative attack.

Appendix Table A2: Default Measure of Trade Linkage, $Trade_i$

Rank	1971	1973	1992	1994	1997
0	Germany	Germany	Finland	Mexico	Thailand
1	U.K.	France	Norway	Canada	Malaysia
2	France	U.K.	Denmark	Taiwan	Indonesia
3	Italy	U.S.A.	Portugal	Hong Kong	Saudi Arabia
4	U.S.A.	Belgium	Ireland	Korea	Australia
5	Japan	Italy	Turkey	Venezuela	India
6	Belgium	Japan	Poland	China	Korea,
7	Netherlands	Netherlands	Russia	Singapore	Brazil
8	Canada	Canada	Austria	Brazil	Taiwan
9	Sweden	Sweden	Sweden	Malaysia	Philippines
10	Switzerland	Switzerland	India	Thailand	Singapore
11	Australia	Saudi Arabia	South Africa	U.K.	Israel
12	Denmark	Australia	Yugoslavia	Japan	Switzerland
13	Saudi Arabia	Brazil	Algeria	Israel	China
14	Brazil	Denmark	Israel	Saudi Arabia	South Africa
15	Hong Kong	Spain	Greece	Philippines	Un. Arab Em.
16	Spain	Hong Kong	Hungary	Indonesia	Sweden
17	Austria	Norway	Iran	Nigeria	Finland
18	Norway	Taiwan	Brazil	India	Ireland
19	Libya	Austria	Switzerland	Switzerland	Hong Kong
20	Finland	Venezuela	Spain	Colombia	Denmark

Countries listed in order of decreasing degree of trade linkage with “ground zero” for each crisis episode.

References

Calvo, Guillermo and Enrique Mendoza (1998). "Rational Herd Behavior and the Globalization of Securities Markets," unpublished manuscript.

Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini (1998). "Paper Tigers: A Model of the Asian Crisis," NBER Working Paper No. 6783.

Corsetti, Giancarlo, Paolo Pesenti, Nouriel Roubini, and Cédric Tille (1998). "Trade and Contagions Devaluations: A Welfare-based Approach," unpublished manuscript.

Eichengreen, Barry and Andrew K. Rose (1998). "Contagious Currency Crises: Channels of Conveyance" forthcoming in *Changes in Exchange Rates in Rapidly Developing Countries* (edited by T. Ito and A. Krueger).

Eichengreen, Barry, and Charles Wyplosz (1993). "The Unstable EMS," *Brookings Papers on Economic Activity*, 51-143.

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz (1995). "Exchange Market Mayhem," *Economic Policy*.

Eichengreen, Barry, Andrew K. Rose, and Charles Wyplosz (1996). "Contagious Currency Crises: First Tests," *Scandinavian Journal of Economics*.

Frankel, Jeffrey and Andrew K. Rose (1996). "Currency Crashes in Emerging Markets," *Journal of International Economics*.

Gerlach, Stefan and Frank Smets (1994). "Contagious Speculative Attacks," CEPR Discussion Paper No. 1055.

Glick, Reuven and Andrew Rose (1998). "Contagion and Trade: Why Are Currency Crises Regional? NBER Working Paper No. 6806 and CEPR Discussion Paper No. 1947.

Goldfajn, Ilan and Rodrigo Valdés (1997). "Capital Flows and the Twin Crises: The Role of Liquidity," IMF Working Paper 97/87.

Grubel, Herbert and Peter Lloyd (1971). "The Empirical Measurement of Intra-Industry Trade," *Economic Record*, 494-517.

Huh, Chan and Kenneth Kasa (1997). "A Dynamic Model of Export Competition, Policy Coordination and Simultaneous Currency Collapse," Federal Reserve Bank of San Francisco Center for Pacific Basin Studies. Working Paper No. PB97-08.

Kaminsky, Graciela, Saul Lizondo, and Carmen Reinhart (1998). "Leading Indicators of Currency Indicators," *IMF Staff Papers* 45, 1-48.

Krugman, Paul (1979). "A Model of Balance of Payments Crises," *Journal of Money, Credit and Banking* 11, 311-325.

Leamer, Edward E. and James Levinsohn (1995). "International Trade Theory: The Evidence," in *Handbook of International Economics, vol. III* (edited by G. Grossman and K. Rogoff).

Obstfeld, Maurice (1986). "Rational and Self-fulfilling Balance-of-Payments Crises," *American Economic Review* 76, 72-81.

Rigobon, Roberto (1998). "Informational Speculative Attacks: Good News is No News," MIT Working Paper.

Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Roubini (1998). "What Caused the Asian Currency and Financial Crisis?" mimeo.

Sachs, Jeffrey, Aaron Tornell, and Andrés Velasco (1996). "Financial Crises in Emerging Markets: The Lessons from 1995," *Brookings Papers on Economic Activity*.

Tornell, Aaron (1998). "Common Fundamentals in the Tequila and Asian Crises," unpublished manuscript.

Endnotes

[1] The evidence for the regional nature of trade is overwhelming; Leamer and Levinston (1995) provide a recent survey.

[2] Rigobon (1998) provides an alternate theoretical framework that argues that the regional nature of currency crises is due to investors learning about a given model of development (assuming that such models tend to be regional).

[3] Of course, currency crises may spread through other channels as well, such as international asset and debt relationships. However, these non-trade linkages tend to be correlated with trade flows. Data constraints prevent us from explicitly comparing these channels to our trade and macro channels for contagion.

[4] Trade patterns have had important effects in spreading currency crises before the 1990s, as we document below.

[5] Eichengreen, Rose and Wyplosz (1996) provide a critical survey and some early evidence.

[6] Similarity in terms of structural characteristics of the economy is analyzed in Rigobon (1998).

[7] This reasoning is strengthened if devaluing countries tend to experience contractions, as seems to the historic norm. For instance, if devaluing countries tend to have un-hedged external liabilities, devaluation may cause bankruptcies in the financial sector, a domestic credit crunch, and hence a recession. Since imports are highly cyclic, this puts even more pressure on neighboring countries.

[8] Another view is that a crisis in one country triggers a crisis elsewhere because it leads to shifts in market sentiments or to changes in the evaluation of existing information (Calvo and Mendoza, 1998).

[9] For a summary of various indicators employed to predict currency crises, see Kaminsky, Lizondo, and Reinhart (1998).

[10] The exact list (in order of IFS country code) is: U.S.A.; U.K.; Austria; Belgium; Denmark; France; Germany; Italy; Netherlands; Norway; Sweden; Switzerland; Canada; Japan; Finland; Greece; Iceland; Ireland; Malta; Portugal; Spain; Turkey; Yugoslavia; Australia; New Zealand; South Africa; Argentina; Bolivia; Brazil; Chile; Colombia; Costa Rica; Dominican Republic; Ecuador; El Salvador; Guatemala; Haiti; Honduras; Mexico; Nicaragua; Panama; Paraguay; Peru; Uruguay; Venezuela; Bahamas; Barbados; Greenland; Guadeloupe; Guinea French; Guyana; Belize; Jamaica; Martinique; Suriname; Trinidad; Bahrain; Cyprus; Iran; Iraq; Israel; Jordan; Kuwait; Lebanon; Oman; Qatar; Saudi Arabia; Syria; United Arab Emirates; Egypt; Yemen; Afghanistan; Bangladesh; Myanmar; Cambodia; Sri Lanka; Taiwan; Hong Kong; India; Indonesia; Korea; Laos; Macao; Malaysia; Pakistan; Philippines; Singapore; Thailand; Vietnam; Algeria; Angola; Botswana; Cameroon; Central Africa Republic; Congo; Zaire; Benin; Ethiopia; Gabon; Gambia; Ghana; Guinea-Bissau; Guinea; Ivory Coast;

Kenya; Lesotho; Liberia; Libya; Madagascar; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Niger; Nigeria; Reunion; Zimbabwe; Rwanda; Senegal; Sierra Leone; Sudan; Swaziland; Tanzania; Togo; Tunisia; Uganda; Burkina Faso; Zambia; Fiji; New Caledonia; Papua New Guinea; Armenia; Azerbaijan; Belarus; Georgia; Kazakistan; Kyryz Republic; Bulgaria; Moldova; Russia; Tajikistan; China; Turkmenistan; Ukraine; Uzbekistan; Czech Republic; Slovak Republic; Estonia; Latvia; Hungary; Lithuania; Mongolia; Croatia; Slovenia; Macedonia; Bosnia; Poland; Yugoslavia/Macedonia; and Romania. This set of countries was determined by economies with bilateral exports of $5 million or more to at least one trade partner in 1971. Not all countries exist for all episodes, and not all countries with trade relations have currencies.

[11] Countries that were not attacked during any of our five episodes are not included in Table A1, though they are included in our empirical analysis depending on trade and macroeconomic data availability.

[12] In Glick and Rose (1998), we show our results do not appear to be very sensitive to the exact choice of the "first victim" country.

[13] This measure has an obvious similarity to the Grubel-Lloyd measure (1971) of cross-country intra-industry trade.

[14] After Finland floated the markka in 1992, Sweden was immediately attacked. One might then ask how the crisis should spill over from both Finland and Sweden.

[15] Results of using a "direct" and "total" measure of trade are reported in Glick and Rose (1998).

[16] The timing of our data is as follows: the 1971 episode uses control data for both macroeconomic and trade linkages from 1970; the 1973 episode uses 1972 data; 1992 uses 1992; 1994 uses 1994; and 1997 uses 1996.

[17] This data set was supplemented with Taiwan trade data from *Monthly Statistics of Exports and Imports, Taiwan Area*, Department of Statistics, Ministry of Finance, Taiwan, and macro data from *Financial Statistics, Taiwan District*, Central Bank of China, Taiwan, (various issues).

[18] We measure currency undervaluation by constructing an annual real exchange rate index as a weighted sum of bilateral real exchange rates (using domestic and real CPIs) in relation to the currencies of all trading partners with available data. The weights sum to one and are proportional to the bilateral export shares with each partner. The degree of currency under-valuation is defined as the percentage change in the real exchange rate index between the average of the three prior years and the episode year. A positive value indicates that the real exchange rate is depreciated relative to the average of the three previous years.

[19] Limited availability of macroeconomic data generally reduces the number of usable observations in our

regression analysis far below the set of 161 countries for which we have trade data.

[20] In Glick and Rose (1998) we show that these results are robust to the inclusion of other macro and financial variable regressors, different measures of trade linkages, and alternative designations of ground zero for particular episodes. Our results are also unaffected by the occurrence of bank crisis or the existence of capital controls.

[21] It would be interesting to extend this analysis by using financial measures (e.g., equity prices or interest rate spreads) as regressands.

[22] For the 1971 episode, the exchange rate change is measured from the end of April; for the 1973 episode the change is measured from the end of December 1972; for 1992, from the end of August; for 1994, from the end of November; for 1997, from the end of June.

[23] We have omitted Chile from the samples for 1971 and 1973 because during both episodes it experienced depreciation rates of over 100%; Chile was an outlier in many respects during these periods.

[24] Using our default measure of trade reduces significance levels slightly, and reverses the coefficient on the trade measure for the 1994 episode, though it is not significant.

[25] For the 1971 and 1973 episodes the trade effect sign at three months is now positive, although these effects are not significant at standard levels.

[26] We get the same qualitative results using $Trade_i$ as the trade share measure.