6

Contagion

As suggested earlier, in most cases, the leading indicators signaled ahead of the 1997-98 currency and banking crises. The Indonesian case, however, is an example of an episode where ''the dog did not bark.'' Despite the fact that this country experienced a meltdown in its currency and a collapse in its banking industry, Indonesia was firmly anchored near the bottom of the list in table 5.5, as relatively few indicators gave advanced warning. In a similar vein, although Argentina was the hardest-hit country during the ''tequila effects'' that followed the Mexican financial crisis of 1994-95, it too would not have been judged as vulnerable on the basis of the fundamentals reviewed in the preceding chapters.

Of the 89 currency crises and nearly 30 banking crises in our sample, only a handful of these occur with as few indicators flashing as was the case for Indonesia (22 percent). As shown in table 6.1, less than 15 percent of the currency and banking crises shared the Indonesian silence of signals. Still, the Indonesian crisis suggests something is missing from our previous analysis. The most obvious candidate is cross-country contagion of financial crises.[1]

The empirical evidence on contagion is still limited to relatively few studies, but the weight of the empirical results suggests it is important. To the extent that contagion or spillovers matter, being near the bottom of the ''vulnerability'' list based on own-country fundamentals would not preclude a country from having a crisis. In this chapter, we briefly review

1. Of course, the political turmoil at this time in Indonesia is likely to have contributed to the meltdown of the currency and the economy.

Table 6.1 Crises that showed few signals, 1970-97

Type of crisis and sample	Number of crises	Number of crises that occurred with five or fewer indicators signaling	Proportion of crises that occurred with five or less indicators signaling
Banking, 1970-95	29	3	10.3
Currency, 1970-95	87	12	13.5
Banking, 1996-97	6	1	16.7
Currency, 1996-97	6	1	16.7

some of the theoretical underpinnings for contagion and then construct a ''contagion or spillover vulnerability index'' that attempts to capture trade and finance links among countries. We then explore the extent to which crises probabilities increased for other emerging markets following the Mexican crisis of 1994 and the Asian crisis of 1997, owing to trade and financial links.

Most of the theoretical work on contagion has attempted to provide a framework for understanding how shocks in one country are transmitted elsewhere. Our review of this literature emphasizes its empirical implications in terms of defining contagion, delineating its channels of influence, and testing for its presence.

Defining Contagion

Only one study that we are aware of examined the issue of contagion in the context of Latin America's debt crisis of the 1980s. Doukas (1989) interprets contagion as the influence of ''news'' about the creditworthiness of a sovereign borrower on the spreads charged to the other sovereign borrowers, after controlling for country-specific macroeconomic fundamentals. Most other studies, such as Valdés (1997), define contagion as excess comovement in asset returns across countries, be it for debt or equity. This comovement is said to be excessive if it persists even after common fundamentals, as well as idiosyncratic fundamental factors, have been controlled for. A recent variant to this approach (as in Forbes and Rigobon 1998) defines ''shift-contagion'' as an increase in excess comovement of asset returns during crisis periods.

Eichengreen, Rose, and Wyplosz (1996) define contagion as a case where knowing that there is a crisis elsewhere increases the probability of a crisis at home, even when fundamentals have been properly taken into account. This is the definition of contagion that we will explore in the remainder of this chapter. These fundamentals could be country-specific, along the lines analyzed in the preceding chapters, or they could be external and common to all countries or a group of countries. Changes

in international interest rates are a plausible candidate for a common shock. If international interest rates rise markedly, as they did in the early 1980s, and many countries have financial crises simultaneously, we would not attribute the common timing of the crises to contagion—we would place the blame, instead, on a common shock.

In the absence of a common shock, a crisis in one country can spread to others via links in trade and finance. Some studies would not call this contagion either but rather label it a spillover (e.g., Masson 1998). These studies would reserve the term contagion for cases where a crisis spreads from one country to another despite the absence of any trade or finance link—possibly owing to shifts in sentiment and herding behavior on the part of investors.

Since it is impossible to predict when such shifts in sentiment will take place and which countries will be most affected by changes in financial markets' expectations, our focus in the empirical part of this chapter will be on assessing countries' vulnerability to a crisis elsewhere when financial and trade links are evident.

Theories of Contagion and Their Implications

There are several explanations for why crises tend to be bunched or clustered. Some recent models have revived Nurkse's story of ''competitive devaluations.'' This explanation emphasizes trade links, be they bilateral or with a third party.[2] Once one country has devalued, it is costly (in terms of a loss of competitiveness and output) for other countries (with strong trade links to the first country) to maintain their parities. In this setting, subsequent devaluations reflect a policy choice, with a salutary effect on output. In any case, an empirical implication of this story of contagion is that we should either observe a high volume of trade among the ''synchronized'' devaluers or competition in a common third market.[3]

Calvo (1998) stresses the role of liquidity. A leveraged investor facing margin calls needs to sell his or her asset holdings to an uninformed counterpart. Because of information asymmetries, a ''lemons problem'' arises, and the asset can only be sold at a fire sale 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. The strategy will be not to sell the asset whose price has already collapsed but other assets

2. See Gerlach and Smets (1995) for a model that emphasizes bilateral trade and Corsetti et al. (1998) for one in which emerging markets compete in a common third market.

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.

in the portfolio. In doing so, other asset prices are depressed, and the original disturbance spreads across markets.

Yet another potentially important channel of transmission that has been largely ignored in the contagion literature but that is stressed by Kaminsky and Reinhart (2000) is the role of common lenders—in particular, commercial banks. US banks had large loan exposure to Latin America in the early 1980s, much in the way that Japanese banks did during the Asian crisis of 1997. The need to rebalance the overall risk of the bank's asset portfolio and to recapitalize following the initial losses can lead to a marked reversal in commercial bank credit, both in the original crisis country and for others who rely heavily on the same lender.

Another family of contagion models has deemphasized the role of trade in goods and services in favor of the role of trade in financial assets, particularly in the presence of information asymmetries. Calvo and Mendoza (2000) 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) also present a model with rational agents and information asymmetries. However, they stress the role played by investors who engage in cross-market hedging of macroeconomic risks.

In these financial contagion explanations, the channels of transmission come from the global diversification of financial portfolios. Here, the implication is that countries with more internationally traded financial assets and more liquid markets are likely to be relatively vulnerable to contagion. Small emerging economies with relatively illiquid financial markets are likely to be underrepresented in international portfolios to begin with and thus ought to be shielded from this type of contagion. In addition, cross-market hedging usually requires a moderately high correlation of asset returns. For our purposes, the key empirical implication is that countries whose asset returns exhibit a high degree of comovement with the original crisis country (for example, Argentina with Mexico in 1994-95 or Malaysia with Thailand in 1997-98) will be more vulnerable to contagion via the cross-market hedges that were in place as the crisis erupted.

Empirical Studies

Very few studies have attempted to run "horse races" among alternative models of contagion. Eichengreen, Rose, and Wyplosz (1996) tested the influence of bilateral trade links against similarities to the crisis country in macroeconomic fundamentals. Glick and Rose (1998) examined the trade issue further within a much broader country sample, while Wolf (1997) attempted to explain pairwise correlations in stock returns by bilateral trade and by common macroeconomic fundamentals. All studies

Table 6.2 Conditional probabilities and noise-to-signal ratios for financial and trade clusters

Percentile of countries sharing a cluster	Bank	High correlation	Third-party trade	Bilateral trade
Noise-to-signal ratio				
25 to 50	0.90	0.58	1.54	2.34
50 and above	0.07	0.39	0.57	0.08
Weight in vulnerability index				
25 to 50	1.10	1.73	0.64	0.42
50 and above	14.08	2.57	1.75	12.5
Probability of a crisis conditioned on crises elsewhere in the cluster minus unconditional probability of crisis				
25 to 50	−3.1	20.8	−6.3	−21.8
50 and above	52.0	47.1	30.7	47.3

Source: Based on Kaminsky and Reinhart (2000).

conclude that trade linkages play an important role in the propagation of shocks. Because trade tends to be more intra- than interregional in nature, Glick and Rose (1998) conclude that this helps explain why contagion tends to be mainly regional rather than global. Kaminsky and Reinhart (1998b) also look at trade links (both bilateral and third-party) but emphasize financial sector links. In an early paper on the subject, Frankel and Schmukler (1996) find evidence of contagion in emerging market mutual funds.

Trade and Financial Clusters and a Composite Contagion Index

As shown in chapter 5, one can construct a composite index to gauge the probability of a crisis conditioned on multiple signals from various indicators (i.e., economic fundamentals); the more reliable indicators receive greater weight in this composite index. This methodology can be readily applied to construct a composite "contagion vulnerability index."

As in Kaminsky and Reinhart (2000), we consider four channels through which shocks can be transmitted across borders: two channels deal with the interlinkages in financial markets, be they through foreign bank lending or globally diversified portfolios, and two deal with trade in goods and services. Table 6.2 reports the noise-to-signal ratios and the difference between the conditional probability of a crisis (conditioned on

knowing there is a crisis elsewhere in that particular cluster) and the unconditional probability of crisis.

Hence the four clusters—bilateral trade, third-party trade, common bank lender, and high correlations—play the same role as the indicators.[4] If a country shares a common cluster with the initial crisis country, it is a signal; if a crisis occurs in the second country within the following 24 months, it is a good signal; if a crisis does not occur, it is a false alarm. Hence for these possible linkages, the number of signals could range from zero (no common clusters) to four, in which the country shares all four clusters with the initial crisis country.

As when we weighted individual indicators, a good argument can be made for eliminating potential leading indicators that had a noise-to-signal ratio above unity (that is, those whose marginal forecasting ability is zero or less). Applying this criterion to our results, we would focus on the case in which more than 50 percent of the countries that share a common cluster are experiencing a crisis. As shown in table 6.2, the highest noise-to-signal ratio is 0.57, well below unity—but the track record of the signals in each of the clusters is far from uniform. Thus we weight the signals by the inverse of the noise-to-signal ratios reported in table 6.2 (see Kaminsky and Reinhart 2000 for details).

Formally, as we did in chapter 5 for the macroeconomic fundamentals, we construct the following composite indicator:

$$I_t = \sum_{j=1}^{n} S_t^j / \omega^j \tag{6.1}$$

In equation 6.1 it is assumed that there are n indicators (i.e., clusters). Each cluster has a differentiated ability to forecast crises, and as before, this ability can be summarized by the noise-to-signal ratio, here denoted by ω^j. S_t^j is a dummy variable that is equal to one if the univariate indicator, S^j, crosses its critical threshold and is thus signaling a crisis and is zero otherwise. As before, the noise-to-signal ratio is calculated under the

4. The countries are classified by bank clusters according to which financial center they depend on the most (on the basis of the Bank for International Settlements data). For the high-correlation asset returns cluster, we include countries that have a correlation that is 0.35 percent or higher in their daily stock returns. For the bilateral trade cluster, we include countries for which either imports or exports to the second country are 15 percent or higher. For the third-party trade cluster, we require countries to have a common third market and similar commodity export structure. We focus on the top 10 to 15 goods that account for 40 percent or more of exports in the initial crisis country; we then see if those same goods account for a significant share (20 percent or higher) of exports of the remaining countries. For example, the top 14 Thai exports account for 46 percent of total exports; these same goods account for 44 percent of Malay exports; hence Malaysia is in the same third-party trade cluster. By contrast, those goods only account for 15 percent of Indonesia's exports, leaving Indonesia outside the third-party trade cluster.

assumption that an indicator issues a correct signal if a crisis occurs within the following 24 months. All other signals are considered false alarms.

The maximum value that this composite contagion vulnerability index could score is 30.9 if a country belonged to the same four clusters as the crisis country. This score is a simple sum of the inverse of the noise-to-signal ratio. Table 6.3 records a one if a country is in the same cluster as the original crisis country in that episode and no entry otherwise.

What the Composite Contagion Vulnerability Index Reveals about Three Recent Crisis Episodes

We now consider, on the basis of the trade and financial sector linkages discussed here, which countries would have been classified as vulnerable to contagion during three recent episodes of currency crises in emerging markets.

The first of these episodes began with the devaluation of the Mexican peso in December 1994. On the heels of the Mexican devaluation, Argentina and Brazil were the countries to come under the greatest speculative pressure. In a matter of a few weeks in early 1995, the central bank of Argentina lost about 20 percent of its foreign exchange reserves and bank deposits fell by about 18 percent as capital fled the country. Such a severe outcome could hardly be attributed to trade linkages and competitive devaluation pressures, as Argentina does not trade with Mexico on a bilateral basis, nor does it compete with Mexican exports in a common third market.[5] In the case of Brazil, the speculative attack was brief, although the equity market sustained sharp losses. Both of these countries record high vulnerability index scores following the Mexican devaluation. While the effects on Asia of the Mexican crisis were relatively mild, the country that encountered the most turbulence in the region was the Philippines, which also registers a relatively high vulnerability score.

In the case of the Thai crisis, Malaysia shares both trade and finance links with Thailand. For the other Asian countries, the potential channels of transmission are fewer. As noted earlier, the Philippines is a part of the same third-party trade cluster as Thailand, which receives a weight of 1.75 (i.e., 1/0.57) in the composite index; it is also part of the Asian high-correlation cluster, which receives a weight of 2.57 (i.e., 1/0.39) in the index. Indonesia shares the same high-correlation cluster with Thailand, and it is a part of the Japanese bank cluster, which receives a weight of 14.08 (i.e., 1/0.07). Hence, as shown in table 6.4, Indonesia and the Philippines' contagion vulnerability index scores are 16.65 and 4.32,

5. See Kaminsky and Reinhart (2000) for details on the pattern of trade.

Table 6.3 Countries sharing financial and trade clusters with original crisis country or region

	Bank cluster		High-correlation cluster		Third-party trade cluster		Bilateral trade cluster
Country	Japan	US	Asia	Latin America	Asia	Latin America	Latin America
Argentina		1		1			1
Bolivia							
Brazil		1		1		1	1
Chile		1					1
Colombia		1				1	
Denmark							
Finland							
Indonesia	1		1				
Israel							
Malaysia	1		1		1		
Mexico		1		1		1	
Norway							
Peru				1			
The Philippines		1	1		1		
South Korea	1				1		
Spain							
Sweden							
Thailand	1		1		1		
Turkey							
Uruguay		1					1
Venezuela		1				1	

Source: Kaminsky and Reinhart (2000).

Table 6.4 Contagion vulnerability index

Country	Contagion vulnerability index		
	Mexican crisis (December 1994)	**Thai crisis** (July 1997)	**Brazilian crisis** (January 1999)
Argentina	16.65	0	29.15
Bolivia	0	0	0
Brazil	18.4	0	n.a.
Chile	0	0	26.58
Colombia	12.5	0	15.83
Denmark	0	0	0
Finland	0	0	0
Indonesia	0	16.65	0
Israel	0	0	0
Malaysia	0	28.33	0
Mexico	n.a.	0	18.4
Norway	0	0	0
Peru	2.57	0	2.57
The Philippines	14.08	4.32	14.08
South Korea	0	26.58	0
Spain	0	0	0
Sweden	0	0	0
Thailand	0	n.a.	0
Turkey	0	0	0
Uruguay	0	0	26.58
Venezuela	12.5	0	15.83

n.a. = not applicable

respectively. South Korea also borrowed heavily from Japanese banks. Accordingly its exposure to Thailand came more from having a common lender than from conventional competitive trade pressures.

The most recent of these emerging market crises was Brazil's devaluation of the real in early 1999. Not surprisingly, Argentina, which has both trade (through Mercosur) and financial linkages with Brazil, shows the highest vulnerability; other Mercosur countries come close in suit.

Table 6.5 provides additional details on some of the possible channels through which the crisis may have spread during these episodes. To the extent that there is herding behavior and investors lump together all emerging markets—or perhaps only those in the infected region—that would add yet another channel of transmission to those laid out in table 6.5.

As regards the potential role of bilateral and third-party trade linkages, Malaysia would be the country most closely linked with Thailand, with South Korea and the Philippines exhibiting more moderate trade exposure. Trade is certainly not the main culprit in explaining the vulnerability of Argentina and Brazil following the Mexican devaluation or of Indonesia following the Thai crisis.

Table 6.5 Characteristics of affected countries in Asian and Mexican episodes of contagion

Affected country (onset month)	Exchange rate regime at onset	Nature of contagion or spillover	Common bank lender	High correlation of returns	Level of liquid market/high representation in mutual funds, percentage of emerging market portfolio	Level of bilateral trade, percentage of exports to affected country	Level of trade with common third party in same commodities, percentage of exports competing with top exports of affected country
Tequila crisis: 1994-95 First crisis: Mexico, December 1994							
Argentina	Currency board	Turbulence	Yes	High, 0.56	Moderate, 2.98	Low, 1.7	Low, 15.6
Brazil	Peg	Turbulence	Yes	Moderate, 0.36	High, 13.07	Low, 2.4	Low, 10.9
Asian flu: 1997-98 First crisis: Thailand, July 1997							
Malaysia (July)	Managed float	Crisis	Yes	High, 0.60	Moderate, 5.88	Moderate, 4.1	High, 44.4
The Philippines (July)	Managed float	Crisis	Yes	High, 0.68	Low, 2.40	Moderate, 3.8	Low, 19.2
Indonesia (August)	Narrow band	Crisis	Yes	High, 0.54	Moderate, 4.35	Low, 1.8	Low, 15.5
Hong Kong (October)	Currency board	Turbulence	No		High, 15.33	Low, 1.0	Low
South Korea (November)	Crawling band	Crisis	Yes	Low, 0.24	Moderate, 6.16	Low, 2.0	Moderate, 27.9

Table 6.6 Asia and Latin America: added power of Thai crisis in explaining probability of contagion in bank cluster, July 1997

Country	Probability of a crisis conditioned on crises elsewhere in the cluster minus unconditional probability of crisis
Asia	
Indonesia	0.60
Malaysia	0.35
The Philippines	0.02
Latin America	
Argentina	0.02
Chile	0.02
Mexico	0.02

Turning to financial links stemming from a common lender, exposure to European and Japanese banks, which rapidly pulled out of the region after the outbreak of the Thai crisis, was common to all the affected countries except Hong Kong. Brazil and Argentina were in the same (US) bank cluster as Mexico in 1994-95, but US banks were not as exposed to Latin American borrowers as they were in the early 1980s, and portfolio flows had replaced bank lending as the main source of funding for these emerging economies.

Most of the affected Asian countries (except South Korea) had high correlations of asset returns with Thailand, although none except Hong Kong were home to relatively liquid markets. The same is true of stock returns in Argentina, which had the highest correlation of asset returns 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, while this is a preliminary assessment of contagion channels, it suggests that financial sector linkages, be it through banks or via international capital markets, could have been influential in determining how shocks were propagated in recent crises episodes, particularly for Argentina, Brazil, and Indonesia.

In table 6.6 we take this analysis one step further. Specifically, the table compares some of the larger emerging markets in Asia and in Latin America at the onset of the Thai crisis (July 1997) based on how much added explanatory power a crisis elsewhere added to the probability of crisis at home. The numbers reported in the table are the simple difference between the probability of a crisis conditioned on our composite index of fundamentals, $P(C|F)$, and the probability of crisis conditioned on the fundamentals and a crisis elsewhere related to a common lender, $P(C|F,$

CE). If knowing that a crisis elsewhere in the cluster helps predict a crisis at home, then $P(C|F, CE) > P(C|F)$. It is noteworthy that the conditional probability of a crisis does not change much for those Latin American countries and the Philippines that are not a part of the Japanese bank cluster. For them, the contagion from the Thai crisis via this channel is minimal. By way of contrast, for countries that are in the same bank cluster as Thailand, the probability of crisis increases markedly, for Malaysia and particularly for Indonesia. Malaysia's crisis probabilities conditioned on the fundamentals alone were well above Indonesia's, as shown in figure 5.1. Hence, for Malaysia, the incremental explanatory power of the crisis-elsewhere variable is smaller than for Indonesia.

To sum up, the empirical evidence contained in this chapter suggests that the analysis of fundamentals stressed in the signals approach can be strengthened by incorporating financial sector linkages, which increase the vulnerability to contagion. While assessing the predictive ability of the individual bank clusters is a useful exercise to discriminate among competing explanations of contagion, countries that are linked in trade are also often linked in finance. This implies that multiple channels of contagion may be operating at once.