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# Contagion: Understanding How It Spreads

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*Much of the current debate on reforming the international financial architecture is aimed at reducing the risks of contagion—best defined as a significant increase in cross-market linkages after a shock to an individual country (or group of countries). This definition highlights the importance of other links through which shocks are normally transmitted, including trade and finance. During times of crisis, the ways in which shocks are transmitted do seem to differ, and these differences appear to be important. Empirical work has helped to identify the types of links and other macroeconomic conditions that can make a country vulnerable to contagion during crisis periods, although less is known about the importance of microeconomic considerations and institutional factors in propagating shocks. Empirical research has helped to identify those countries that are at risk of contagion as well as some, albeit quite general, policy interventions that can reduce risks.*

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The financial turbulence that hit many East Asian countries in 1997 and then spread to other parts of the world continued unabated in 1998. Russia defaulted on its debt as confidence in global financial markets weakened. The turmoil roiled capital markets in industrial countries, dramatically altering the (relative) pricing of many financial instruments, and spilled over into speculative hedge-fund bets, leaving Long-Term Capital Management, a large U.S. hedge fund, facing near bankruptcy. The crisis subsequently hit Brazil, creating uncertainty about the country's ability to roll over its public sector debt, and spread to other emerging markets in Latin America and elsewhere.

International capital markets, particularly those in emerging markets, appear volatile, on both the downside and the upside. In the mid-1990s aggregate private capital flows into five crisis-affected East Asian countries (Indonesia, the Republic of Korea, Malaysia, the Philippines, and Thailand) averaged more than \$40 billion annually, reaching a peak of about \$70 billion in 1996. In the second half of 1997, more than \$100 billion in short-term bank loans was recalled from these same five

countries, as currencies and stock markets there collapsed. Capital flows reversed themselves again in 1999, and stock markets rebounded sharply across the region as portfolio and other foreign investors channeled resources back, slowing the reform process in some countries. The turmoil triggered recessions in many developing countries, most notably in Latin America (Perry and Lederman 1998); altogether, two-fifths of the global economy sank into recession in 1999, with the sharpest declines in gross domestic product concentrated in the developing world.

Neither the exact causes of this volatility nor the best international financial architecture for guiding the movement of international capital is yet known. Yet reducing volatility and contagion has been an important stated objective of recent reforms. Fischer (1998), for example, notes two important reasons for revamping the international financial architecture and smoothing the global economy. First, the high degree of volatility of international capital flows to emerging markets and these markets' limited ability to deal with this volatility make the recipient country vulnerable to shocks and crises that are excessively large, frequent, and disruptive. Second, international capital markets appear to be highly susceptible to contagion. Thus proposals to reform the international financial architecture must be based on a thorough understanding of the causes and consequences of contagion.

Episodes of volatility in international capital markets had occurred before the Asian crisis; an example was the "tequila effect" that followed Mexico's December 1994 devaluation and mainly affected Latin American countries. At that time, the issue of financial contagion had not yet caught the attention of policymakers in either industrial or emerging-market countries (but see Kindleberger 1989). Since the East Asian crisis, however, policymakers and economists have engaged in considerable research to identify and analyze the causes of financial contagion.

Contagion is best defined as a significant increase in cross-market linkages after a shock to an individual country (or group of countries), as measured by the degree to which asset prices or financial flows move together across markets relative to this comovement in tranquil times. An increase in comovement need not reflect irrational behavior on the part of investors. When one country is hit by a shock, liquidity constraints can force investors to withdraw funds from other countries. Because many financial transactions are conducted by agents rather than by principals, incentive issues also play a role in triggering volatility. A decision to pull funds from several countries can also reflect coordination problems among investors and insufficient mechanisms at the international level for dealing with countries' liquidity problems. Distinguishing among these various forms of investor behavior is very difficult in practice.

Although it is hard to determine whether comovements are irrational or excessive, empirical work has been able to document patterns in the vulnerability of countries to volatility and to identify possible channels through which contagion is transmit-

ted. Trade links, regional patterns, and macroeconomic similarities make countries vulnerable to volatility. Volatility can be transmitted from a particular country to other countries through common creditors and through actions of investors operating in international financial centers. These regularities have helped to identify countries that are at risk of contagion. Less is known about the importance of microeconomic conditions and institutional factors (including the actions of specific financial agents) in propagating shocks.

Governments and the private sector, as well as international financial institutions, must take action to minimize and manage the risk of financial contagion. But the balance is unclear. Should individual countries bear the burden of improving their financial sectors and enhancing the transparency of data, or is there a need to reform the rules under which international investors operate? Does contagion always represent fundamental factors, or should countries simply have more access to liquidity support to withstand the pressures of contagion? For answers, we must first look at what is known about the causes and transmission of contagion.

## Contagion and Its Causes

Contagion refers to the spread of market disturbances—mostly on the downside—from one country to the other, a process observed through comovements in exchange rates, stock prices, sovereign spreads, and capital flows. In this article, we focus on contagion in emerging economies. The causes of contagion can be divided conceptually into two categories (Masson 1998; Wolf 1999; Forbes and Rigobon 2000; Pritsker 2000). The first category emphasizes spillovers that result from the normal interdependence among market economies. This interdependence means that shocks, whether of a global or local nature, can be transmitted across countries because of their real and financial linkages. Calvo and Reinhart (1996) term this type of crisis propagation “fundamentals-based contagion.” These forms of comovements would not normally constitute contagion, but if they occur during a period of crisis and their effect is adverse, they may be expressed as contagion. Most empirical work seeks to explain the degree of comovements and the mechanisms for transmitting them—for example, how and under what conditions a speculative attack on a single currency is spread to other currencies on the basis of various fundamental relationships.

The second category involves a financial crisis that is not linked to observed changes in macroeconomic or other fundamentals but is solely the result of the behavior of investors or other financial agents. Under this definition, contagion arises when a comovement occurs, even when there are no global shocks and interdependence and fundamentals are not factors. A crisis in one country may, for example, lead investors to withdraw their investments from many markets without taking account of differences in economic fundamentals. This type of contagion is

often said to be caused by “irrational” phenomena, such as financial panics, herd behavior, loss of confidence, and increased risk aversion. But because these phenomena can be individually rational and still lead to a crisis, it is helpful to discuss each category in detail.

### *Fundamental Causes*

Fundamental causes of contagion include macroeconomic shocks that have repercussions on an international scale and local shocks transmitted through trade links, competitive devaluations, and financial links.

**COMMON SHOCKS.** Studies identify various global shocks that can trigger market adjustments in an international context. A common global cause, such as major economic shifts in industrial countries and changing commodity prices, can trigger crises in—or large capital inflows to—emerging markets. Changes in U.S. interest rates have been identified with movements in capital flows to Latin America (Calvo and Reinhart 1996; Chuhan, Claessens, and Mamingi 1998). The strengthening of the U.S. dollar against the yen in 1995–96 was an important factor in the export downturn in East Asia and the subsequent financial difficulties there (Corsetti, Pesenti, and Roubini 1998; Radelet and Sachs 1998a, 1998b). In general, a common shock can lead to comovement in asset prices or capital flows.

**TRADE LINKS AND COMPETITIVE DEVALUATIONS.** Local shocks, such as a crisis in one economy, can affect the economic fundamentals of other countries through trade links and currency devaluations. Any major trading partner of a country in which a financial crisis has induced a sharp currency depreciation could experience declining asset prices and large capital outflows or could become the target of a speculative attack as investors anticipate a decline in exports to the crisis country and hence a deterioration in the trade account.

Competitive devaluations can be another channel for transmitting contagion. Devaluation in a country hit by a crisis reduces the export competitiveness of the countries with which it competes in third markets, putting pressure on the currencies of other countries, especially when those currencies do not float freely. According to Corsetti and others (1999), a game of competitive devaluation can induce a sharper currency depreciation than that required by any initial deterioration in fundamentals. In addition, the noncooperative nature of the game can result in still greater depreciation compared with what could have been attained in a cooperative equilibrium. If market participants expect that a currency crisis will lead to a game of competitive devaluation, they will naturally sell their holdings of securities of other countries, curtail their lending, or refuse to roll over short-term loans to borrowers in those countries. This theory gains some credence from the fact that during the East

Asian crisis in 1997, exchange rates depreciated substantially even in economies such as Singapore and Taiwan, China, which did not necessarily appear vulnerable to a speculative attack on the basis of their fundamentals.<sup>1</sup>

**FINANCIAL LINKS.** Economic integration of an individual country into the world market typically involves both trade and financial links. Thus a financial crisis in one country can lead to direct financial effects, including reductions in trade credits, foreign direct investment, and other capital flows abroad. For example, firms in East Asia that are linked to, say, Thailand by trade, investment, and financial transactions would be adversely affected if a crisis were to limit the ability of Thai firms to invest abroad, extend credit, and so on. Thus a financial crisis in Thailand would rationally be reflected in other countries, leading, for example, to comovements in asset prices and capital flows.

### *Investors' Behavior*

The spread of a crisis depends on the degree of financial market integration. If a country is closely integrated into global financial markets, or if the financial markets in a region are tightly integrated, asset prices and other economic variables will move in tandem. The higher the degree of integration, the more extensive could be the contagious effects of a common shock or a real shock to another country. Conversely, countries that are not financially integrated, because of capital controls or lack of access to international financing, are by definition immune to contagion. In this sense, financial markets facilitate the transmission of real or common shocks but do not cause them. The actions of investors that are *ex ante* individually rational as well as collectively rational, even though they lead to volatility and may require policy changes, should be grouped under fundamental causes.

It can be argued, however, that investors' behavior, whether rational or irrational, allows shocks to spill over from one country to the next. The literature differs on the scope of rational versus irrational investor behavior, both individually and collectively. It is useful to start with a classification of types of investor behavior (see also Pritsker 2000). First, investors can take actions that are *ex ante* individually rational but that lead to excessive comovements—excessive in the sense that they cannot be explained by real fundamentals.<sup>2</sup> Through this channel, which can broadly be called investors' practices, contagion is transmitted by the actions of investors outside the country, each of whom is behaving rationally. Conceptually, this type of investor behavior can be further sorted into problems of liquidity and incentives and problems of informational asymmetry and market coordination. Second, cases of multiple equilibrium, similar to those in models of commercial bank runs, can imply contagious behavior among investors. Third, changes in the international financial system, or in the rules of the game, can induce investors to alter their behavior after an initial crisis.

**LIQUIDITY AND INCENTIVE PROBLEMS.** One form of rational behavior by individuals relates to liquidity and other constraints on lenders or investors. For example, the sharp currency depreciation and the decline in equity prices in Thailand and other economies affected early in the East Asian crisis resulted in large capital losses for some international institutional investors. These losses may have induced investors to sell off securities in other emerging markets to raise cash in anticipation of a higher frequency of redemptions. Liquidity problems may also face commercial banks whose lending is concentrated in particular regions. Suppose there is a single common creditor country with a heavy regional exposure, such as Japan in East Asia or the United States in Latin America. If banks from the common creditor country experience a marked deterioration in the quality of their loans to one country, they may attempt to reduce the overall risk of their loan portfolios by reducing their exposure to other high-risk investments elsewhere, possibly including other emerging markets in the region.

The incentive structure for individual financial agents can also create a tendency to sell off several markets at the same time. For example, an initial crisis may induce investors to sell off their holdings in other emerging countries because of their tendency to maintain certain proportions of a country's or a region's stock in their portfolios. As a result, equity and other asset markets in a range of emerging economies would also lose value, and the currencies of these economies would depreciate significantly. Schinasi and Smith (2000), for example, demonstrate that the value-at-risk models used by many commercial banks explain why financial institutions and other investors may find it optimal to sell most high-risk assets when a shock affects one of those assets. Although this type of behavior is individually rational, it can lead to overall adverse outcomes.<sup>3</sup> Garber (1998) analyzes the possible unpleasant dynamics associated with the use of unregulated financial derivatives in weak institutional settings.

Countries whose financial assets are widely traded in global markets and whose domestic financial markets are more liquid may be more vulnerable to financial contagion (Kodres and Pritsker 1998; Calvo and Mendoza forthcoming). Further, because global diversification of financial portfolios involves the cross-market hedging of macroeconomic risks, countries in which asset returns exhibit a high degree of comovement with a crisis-affected country in tranquil periods will be more vulnerable to contagion (Kaminsky and Reinhart 1998b).

These liquidity constraints and incentive structures could be important for all types of investors dealing with emerging markets. But it is possible that particular institutional investors—open-end emerging-market mutual funds, hedge funds, and proprietary traders—are especially susceptible to this type of behavior. Leveraged investors, such as hedge funds and banks facing margin calls, are more likely to confront liquidity problems in the wake of a crisis and be forced to sell their asset holdings in other markets. Managers of open-end funds may also need to raise li-

quidity in anticipation of future redemptions by investors. Faced with these problems, both leveraged investors and open-end-fund managers are likely to keep those assets whose prices have already collapsed and whose secondary markets have become less liquid and sell other assets in the portfolio. By doing so, investors cause other asset prices to fall, and the original disturbance can spread across different financial instruments and markets. The financial turmoil in the fall of 1998, when spreads on U.S. corporations rose from a normal level of 100 basis points to almost 200 basis points, suggests that these types of spillovers need not be limited to emerging markets but can also affect a broad spectrum of markets and borrowers.

**INFORMATION ASYMMETRIES AND COORDINATION PROBLEMS.** Another cause of contagion relates to imperfect information and differences in investor expectations. In the absence of better information to the contrary, investors may believe that a financial crisis in one country could lead to similar crises in other countries. A crisis in one country may then induce an attack on the currencies of other countries in which conditions are similar. This type of behavior can reflect rational as well as irrational behavior. If a crisis reflects and reveals weak fundamentals, investors may rationally conclude that similarly situated countries are also likely to face such problems; such reasoning helps explain how crises become contagious. This channel presumes, of course, that investors are imperfectly informed about each country's true characteristics and thus make decisions on the basis of some known indicators, including those revealed in other countries, which may or may not reflect the true state of the subject country's vulnerabilities. The information investors use may include the actions of other investors, which brings us to the effects of informational asymmetries on investor behavior.

Investors often do not have a full picture of the condition of every country as it affects their return on investment. In part, this limitation reflects the cost of gathering and processing information. Calvo and Mendoza (forthcoming) show that in the presence of information asymmetries, the fixed costs involved in gathering and processing country-specific information could lead to herd behavior, even when investors are rational. In their model, financial investors can be divided into two groups: informed and uninformed. Given the fixed cost of gathering and processing information, most small investors simply cannot afford to collect and process country-specific information individually (see also Agenor and Aizenman 1998). Instead, uninformed investors may find it less costly and therefore advantageous to follow the investment patterns of informed investors. In making asset choices, uninformed investors may then take into account portfolio decisions made by better-informed investors because such decisions provide useful market information.

Both informed and uninformed investors may tend to seek new information from those investors who acted earlier to adjust their portfolios. Thus if informed investors move to pull out of a country, the information cascade will lead less-informed

investors to disregard their own information and follow the informed investors, thereby causing even larger capital outflows (Scharfstein and Stein 1990; Wermers 1995; Calvo and Mendoza forthcoming). The tendency to herd may increase as the number of countries in which investments can be placed grows and the range of investors widens, thus raising the fixed cost of gathering and processing country-specific information. Some authors therefore argue that an increase over time in herd behavior may not be irrational (Banerjee 1992; Bikhchandani, Hirshleifer, and Welch 1992; Shiller 1995) and is instead an outcome of optimal portfolio diversification that becomes more prevalent as securities markets grow (Calvo and Mendoza forthcoming).

Another explanation for the increase in herding over time is that as investors have become more diverse and as establishing a reputation has become relatively more costly, investors may find it less expensive to follow the herd. Because some investors, particularly fund managers, may be more concerned about maintaining a reputation that depends on the performance of their portfolios, relative to that of a given market portfolio, than about their absolute performance, the risks of cascading behavior may be particularly high among institutional investors (see Kim and Wei 1997 for foreign exchange trading). Thus an individual institutional investor may refrain from acting first, even if market developments favor a new portfolio, for fear of losing his or her reputation if the decision should prove to be wrong. To be on the safe side, individual investors may follow the herd. All these outcomes involve behavior that is individually rational (albeit constrained) but that nevertheless can cause financial volatility.

**MULTIPLE EQUILIBRIUMS.** A more general explanation of contagion based on investors' behavior involves changes in expectations that are self-fulfilling in financial markets subject to multiple equilibriums. In this framework, contagion occurs when a crisis in one emerging market causes another emerging-market economy to move or jump to a bad equilibrium, characterized by a devaluation, a drop in asset prices, capital outflows, or debt default. In Diamond and Dybvig's (1983) model of bank runs, it is rational for individual depositors to either hold funds in the bank or withdraw funds, depending on the actions of all other depositors. The equilibrium result can be a bad outcome, that is, a run on the bank, or a good outcome, in which depositors keep their money in the bank. In an economic crisis, the result analogous to a bank run would be a sudden withdrawal of funds from a country sparked by investors' fears that unless they act quickly they will be too late to claim the limited pool of foreign exchange reserves.

Some observers argue that contagion is a consequence of sudden shifts in market expectations and confidence. Formal analytical models of multiple equilibriums have been developed to explain recent experience in emerging markets (Gerlach and Smets 1995; Jeanne 1997; Masson 1998). Such models, of course, do not lend themselves easily to empirical tests because the move or jump can be triggered by many factors,

some of which may appear to be fundamental causes. Drazen (1999), for example, shows that political factors may have played a role in the contagion during the 1992–93 Exchange Rate Mechanism crisis. And, of course, such changes in equilibrium are not limited to emerging markets but can also play a role in volatility and contagion in domestic financial markets.

**CHANGES IN THE RULES OF THE GAME.** Finally, contagion may result if investors change their assessment of the rules under which international financial transactions occur. The Russian default in 1998, for example, increased concern that other countries might follow similar unilateral policies regarding the treatment of foreign private creditors or that international financial institutions might not bail such creditors out as expected. The discussion on the international financial architecture itself following the East Asian financial crisis may have caused changes in the way investors viewed the rules of the game and weighed the odds of official bailouts. This concern is often alleged to have caused the turbulence in 1998 in Brazil (see Calvo 1998; Park 1998; Dornbusch 1999). Other reasons could include concern about the supply of funds from international lenders of last resort. In late 1998, for example, the International Monetary Fund (IMF) found itself called on to rescue so many countries that economists wondered whether it would be able to deal with many more liquidity crises. Thus a liquidity crisis in one country could trigger a run on other countries out of fear that the last eligible country would be out of luck.

## Empirical Evidence of Contagion

Empirical examination of the evidence on contagion has focused mainly on comovements in asset prices rather than on “excessive” comovements in capital flows or disturbances in real markets. We discuss tests under the following categories: correlation of asset prices; conditional probabilities of a currency crisis; changes in volatility; comovements of capital flows and rates of return; and other tests.

### *Correlation of Asset Prices*

The asset price tests measure the correlation among different economies in interest rates, stock prices, and sovereign spreads (Forbes and Rigobon 1999 survey the recent literature). A marked increase in correlations is considered evidence of contagion. Most of these studies find evidence of large comovements in a variety of asset returns, although there is less agreement on whether such comovements increase in the wake of a crisis. Several studies suggest that the Mexican crisis in 1994 was contagious. Calvo and Reinhart (1996) find that the comovement of weekly returns on equities and Brady bonds in emerging markets in Asia and Latin America was higher

after the Mexican crisis than before. Frankel and Schmukler (1998) show evidence that the prices of country funds in Latin America and East Asia displayed greater comovement with Mexican country funds after the crisis than before. Valdés (1997) confirms that the movements of secondary-market debt prices and credit ratings show that the Mexican crisis was contagious in Latin America. Agenor, Aizenman, and Hoffmaister (1999) report that the Mexican crisis had a sizable effect on movements in domestic interest rate spreads (and output) in Argentina. Baig and Goldfajn (1998) show that the cross-country correlations among currencies and sovereign spreads in Indonesia, Korea, Malaysia, the Philippines, and Thailand increased significantly during the East Asian crisis (from July 1997 to May 1998) compared with other periods.

A marked increase in correlations among markets in different countries may, however, not be sufficient proof of contagion. If markets are historically cross-correlated, a sharp change in one market will naturally lead to changes in other markets, and correlations during crises could increase appreciably. Forbes and Rigobon (2000) show that as volatility increases following a crisis, an increase in correlation could simply be a continuation of strong transmission mechanisms that exist in more stable periods. They also show that an increase in correlations of asset prices may result when changes in economic fundamentals, risk perception, and preferences are correlated, without any additional contagion. Because of this endogeneity, estimation of correlations must control both for comovement in these variables during normal times and for the effects of fundamentals in order to be able to identify pure contagion.

In practice, it is impossible to adjust for the effects of increases in volatility and endogeneity (as well as omitted variables) without making some more restrictive assumptions. Some papers have done so. Forbes and Rigobon (1999) investigate the evidence of contagion during the 1987 U.S. stock market crash, the 1994 Mexican peso crisis, and the 1997 East Asian crisis using daily data for stock indexes of up to 28 industrial countries and emerging markets. They show that correlation coefficients across multicountry returns are not significantly higher during crises, if one properly corrects for the problems of endogenous variables, omitted variables, and changes in the variance of residuals. Arias, Hausmann, and Rigobon (1998) also find only limited evidence of contagion.

In a test on the Exchange Rate Mechanism crisis, however, Favero and Giavazzi (2000) estimate a structural model of the behavior of European interest rates and find evidence of contagion in interest rate residuals even after controlling for normal interdependence. Using an autoregressive model, and thus controlling to some degree for structural relationships, Park and Song (2000) show that the Southeast Asian crisis did not directly trigger the crisis in Korea but that its fallout to Taiwan played an important role in the Korean crisis (see also Connolly and Wang 1998 and Tan 1998 for comovements of stock prices in Asia; Doukas 1989 for sovereign spreads).

## *Conditional Probabilities*

Another way to control for the role of fundamentals is to study conditional correlation or probabilities, rather than raw correlations, and thus use a narrower definition of contagion. The most commonly used methodology, introduced by Eichengreen, Rose, and Wyplosz (1996) and Sachs, Tornell, and Velasco (1996), examines whether the likelihood of crisis is higher in a given country when there is a crisis in one or several other countries. This literature builds on studies in single-country crisis prediction (see Dornbusch, Goldfjan, and Valdés 1995; Sachs, Tornell, and Velasco 1996). Berg and Pattillo (1999) review this literature, and Goldstein, Kaminsky, and Reinhart (2000) provide a more general exposition of early warning systems.

The research involves estimating the probability of a crisis conditional on information on the occurrence of crisis elsewhere, taking into account fundamentals or similarities. One advantage of this definition of contagion is that it readily allows for statistical tests of its existence. These tests can also try to investigate the channels through which contagion may occur, distinguishing, among others, trade and financial links. Eichengreen, Rose, and Wyplosz (1996), using a probit model and a panel of quarterly macroeconomic and political data covering 20 industrial economies from 1959 through 1993, show that the probability of a domestic currency crisis increases with a speculative attack on a currency elsewhere and that contagion is more likely to spread through trade linkages than through macroeconomic similarities. Using a similar methodology, De Gregorio and Valdés (2000) conduct an extensive test of spillovers of the 1982 debt crisis, the 1994 Mexican crisis, and the Asian crisis using indexes of exchange rate pressures over three- and twelve-month horizons, real exchange rate movements, and changes in credit ratings.<sup>4</sup> They find that the Mexican crisis was the least contagious, while the Asian crisis was as contagious as the 1982 crisis (note that their methodology does not allow them to determine whether spillovers represent normal comovements or contagion). Importantly, they find that both debt composition and exchange rate flexibility limit the extent of contagion, whereas capital controls do not appear to curb it.

Taking an even longer perspective, Bordo and Murshid (2000) examine the record of financial crises over the past 120 years and the evidence of contagion in several macroeconomic variables. They find that the core countries of the prewar and interwar gold standards (the United Kingdom and the United States) appear to be important in disseminating shocks to the rest of the world but that such patterns actually appear to be weaker during crises. In contrast, after 1973, Bordo and Murshid find that countries that are otherwise not correlated show considerable comovement in asset prices during crises. They also find, however, that the volatility in correlation coefficients can be quite high; they are therefore reluctant to interpret the increase in correlations during recent periods as evidence of contagion, especially in light of the

Forbes and Rigobon (2000) finding that such increases might be normal. On the whole, these tests find no solid evidence that contagion has been increasing over time.

Glick and Rose (1998) apply a similar approach to five episodes of currency crises and 161 countries and find that trade linkages are important in propagating a crisis. They argue that contagion tends to be regional rather than global because trade tends to be more intraregional than interregional (see also Diwan and Hoekman 1999). Kaminsky and Reinhart (1998a) find that in terms of conditional probabilities, information on a large share of crisis countries in the sample increases the ability to predict a crisis elsewhere, particularly on a regional level. Their study further supports evidence that contagion has been primarily a regional phenomenon (see also Calvo and Reinhart 1996; Frankel and Schmukler 1998; Kaminsky and Schmukler 1999).

The evidence on the trade channel as an explanation of the regional nature of contagion appears more relevant to Latin America than to East Asia. Kaminsky and Reinhart (1998a) find a high probability that a crisis will spread through third-party linkages among Latin American countries (Brazil, Colombia, Mexico, and Venezuela), while similar linkages are not significant in East Asia. Brazil, Colombia, Mexico, and Venezuela have the largest share of bilateral trade with the United States among Latin American countries. Baig and Goldfajn (1998) analyze the trade matrix of East Asian countries and find that trade linkages among those countries are weak. They argue that trade linkages were not important in the expansion of the crisis in East Asia in 1997. Alba and others (1999) investigate the effects of competitive devaluations and argue that these alone could not have explained the large depreciation of other regional currencies after the Thai devaluation.<sup>5</sup> In transition economies, Gelos and Sahay (2000) find that correlations in pressures on the exchange market can be explained by direct trade linkages but not by measures of other fundamentals. They also find that market reactions following the Russian crisis look very similar to those observed in other regions during turbulent times. Tests thus find strong evidence that contagion is related to trade links and has a regional character.

Kaminsky and Reinhart (1998b) find that the probability of contagion increases when the crisis is associated with the common creditor channel. Indonesia, Malaysia, and Thailand are heavily dependent on Japanese commercial bank lending; a crisis in one or two of these countries spread to all three. Similar results are found in Latin America, where the conditional probability of a crisis in one country when several others are in crisis is estimated to be as high as 78 percent. Latin American countries obtain a large portion of credit from U.S. commercial banks. Analogous effects appear for other types of investors. Using data on closed-end country funds, Frankel and Schmukler (1998) test whether adverse shocks from the Mexican crisis were transmitted directly, or indirectly through financial markets based in New York. They find that Wall Street spread

the Mexican crisis to East Asian countries but did not play a role in its transmission to other Latin American countries.

### *Volatility Spillover*

Another approach estimates spillovers in volatility—that is, cross-market movements in asset prices. Edwards (1998) examines Mexico's interest rate increase in 1994 and finds strong evidence of contagion from Mexico to Argentina but not from Mexico to Chile. Park and Song (1999) test volatility spillover among foreign exchange markets during the crisis period and find that the effects of the crises in Indonesia and Thailand were transmitted to the Korean foreign exchange market but that the Korean crisis did not reinfect the two Southeast Asian countries. These studies did not control for fundamentals and thus did not distinguish between a pure contagion and one based on fundamentals.

### *Capital Flows*

Capital flows can offer the best insight into the transmission of contagion, but few tests of their comovements have been conducted. Van Rijckeghem and Weder (2000) test the role of bank lending and the effect of a common lender by examining capital flows to 30 emerging markets. In the Mexican and Russian crises, they find that the degree to which countries obtained funds from common bank lenders was a fairly robust predictor of both disaggregated bank flows and the incidence of a currency crisis. Froot, O'Connell, and Seasholes (2000) study the behavior of portfolio flows into and out of 44 countries from 1994 through 1998. They find strong evidence that price increases encourage portfolio flows and that price declines lead to reduced flows. They also find that regional factors such as common creditors appear to be increasingly important over time, suggesting that the actions of institutional investors could be a channel for transmission of shocks.

In an analysis of portfolios of mutual funds, Kaminsky, Lyons, and Schmukler (forthcoming) find that emerging-markets funds exhibit positive momentum. That is, they systematically buy winners and sell losers in both crisis and noncrisis periods, with one difference: contemporaneous momentum (buying current winners and selling current losers) is stronger during crises, whereas lagged momentum (buying past winners and selling past losers) is stronger during noncrisis periods. Contemporaneous momentum was at its strongest point during the 1994 crisis in Mexico. Importantly, Kaminsky, Lyons, and Schmukler find that mutual fund managers use contagion strategies; that is, they sell assets from any country when crisis hits another—strong evidence that contagion is transferred through the actions of portfolio investors. Choe, Kho, and Stulz (1999) find that foreign portfolio investors did not add to volatility (see also Kim and Wei 1999; Stulz 1999).

## *Other Tests*

Most empirical papers find that macroeconomic weaknesses can provoke contagion because they make a country vulnerable to a crisis. Similarities in macroeconomic weaknesses can also lead to crisis because these signals are considered sorting devices and thus may induce a shift in investors' expectations. Ahlumawia (2000) attempts to separate the two effects and finds that after controlling for the direct effect of weaknesses, macroeconomic similarities can play a proximate role in contagious currency crises by coordinating investor shifts. A study of the behavior of the local lending activities of domestic- and foreign-owned banks in Argentina and Mexico reveals that foreign-owned banks may have had a stabilizing influence on overall credit growth in the banking sector, potentially reducing both countries' vulnerability to crisis (Goldberg, Dages, and Kinney 2000). There have been few tests using structural models to explain the degree of spillovers in real and financial markets. One is the application of a full trade model for crisis-affected East Asian economies (Abeyasinghe 2000). Although transmission through trade played an important role, Abeyasinghe found that the immediate economic contractions were largely a result of direct shocks attributable to pure contagion.

## Implications and Reform Options

The empirical findings show that fundamentals help predict spillovers and that trade links are important factors as well. Common creditor and other links through financial centers transmit volatility from one country to another at a particular point. This work thus helps to identify those countries that are at risk of a spillover of volatility. Less is known about the importance of microeconomic conditions and institutional factors—including actions of specific financial agents and the various channels that induce spillovers—in propagating shocks. As a result, it has been difficult to attribute the spillovers to contagion. Importantly, the degree of spillover does not appear to have increased over time, and there are many similarities in the empirical regularities across periods and countries.

These findings suggest that comovements are unavoidable and that fundamental factors are important. To reduce the risks of financial contagion, reforms will thus be necessary. Many of these are of a general nature, such as reductions in fiscal and current account deficits, better management of exchange rates, improvements in financial sector services, enhancement of data transparency, and the like. Many economists have proposed, and some have analyzed, specific policy reform options to deal with contagion. Stiglitz and Bhattacharya (2000) argue, for example, that disclosure requirements may not be needed because markets can and do provide optimal incentives for disclosure. They also argue that under certain circumstances, information

disclosure could exacerbate fluctuations in financial markets and precipitate a financial crisis. Bushee and Noe (1999), looking at U.S. equity markets, find that improved disclosure by firms increases the volatility of their stock prices because the seemingly reduced information asymmetry and increased liquidity of the market attract more transient investors. Here Furman and Stiglitz (1998) point to the fact that even countries such as Sweden, with good regulation and supervision and transparent financial markets, have had financial crises.

Many economists also agree that although improved standards (for data disclosure, regulation, supervision, and corporate governance) could have prevented the buildup of vulnerabilities and reduced the risk of currency crises, they are only a first step. Improved implementation and surveillance are necessary as well. For example, Hawkins and Turner (2000), who analyze the role of prudential and other standards for financial institutions, stress implementation issues and predict that many developing countries will continue to have difficulty complying with what are essentially industrial-country standards.

For these reasons, several observers have argued for the use of prudential controls, particularly for financial institutions, to limit the risk of sudden capital outflows. Many countries already limit the maturity mismatches on foreign exchange liabilities and assets, monitor internal risk management systems of financial institutions, and issue sanctions for poor systems. Tightening could mean putting limits on the net open positions that financial institutions can take in foreign currency markets, as well as imposing limits on the amount of gross foreign currency liabilities (as a fraction of total liabilities or as a ratio to equity). Guidelines on internal risk management systems can be issued, and financial institutions can be more intensely monitored in this area. A further precautionary measure would require banks to hold more liquid foreign exchange assets relative to total foreign exchange liabilities than they are required to hold on domestic currency liabilities. And, finally, capital controls on (some type of) inflows at the country level might be useful to prevent the buildup of vulnerabilities; there is much less agreement in this area, however.

Specific reforms to the rules under which international investors operate are less apparent. There have been calls for limits on the operations of hedge funds, and revisions to the way in which commercial banks have to hold assets against short-term loans to emerging markets. But so far, no proposals specifically aimed at curbing the role of investors in contagion have emerged, let alone been agreed on. More discussion has occurred on the need to enhance liquidity support to withstand pressures of contagion, perhaps through an international lender of last resort or standstills on payments following a crisis. Clearly, whatever reforms are implemented, liquidity crises will still arise; thus a good part of the debate on the international financial architecture has focused on improving ways for dealing with the crises. In an analysis of the supply of international liquidity, Chang and Majnoni (2000) stress that liquidity provisions entail a tradeoff: liquidity provisions conditioned on certain poli-

cies and applied at penalty rates can deepen the possibility of a full crisis. At the same time, moral hazard concerns call for conditions and higher rates. Some new facilities—the Supplemental Reserves Facility, the Contingent Credit Lines of the IMF, the guarantee facility of the World Bank, and private sector facilities—are set up *ex ante*, which may reduce these concerns. They may also induce foreign investors to avoid generating a level of debt that may place the economy in a fragile situation.

## Conclusion

Economists still do not know precisely what factors make countries vulnerable to contagion or the exact mechanisms through which it is transmitted at any given time. Although empirical evidence suggests that commercial banks and mutual funds can play a role, separating rational from irrational investor behavior is difficult in theory and in practice, as is determining whether irrational investor behavior is the sole source of contagion. Individually rational but collectively irrational behavior and (perceived) changes in the international financial system are likely to continue to have an influence. Further research—whether theoretical or empirical—on the role of international financial agents and the international financial system may shed light on these aspects. Such research could help identify characteristics that make countries vulnerable to contagion and could contribute to the development of specific policy prescriptions to reduce the risks of contagion, manage its impact, and help economies recover as efficiently as possible. In the meantime, it will be difficult to determine whether any measures—beyond strengthening the international financial architecture—can reduce the risks of contagion specifically.

## Notes

Rudiger Dornbusch is professor of economics at the Massachusetts Institute of Technology, Yung Chul Park is professor of economics at Korea University, and Stijn Claessens is lead economist in the Financial Sector Policy Group of the World Bank. An earlier version of this paper was prepared for discussion at the World Institute for Development Economics Research workshop on financial contagion held at the World Bank, June 3–4, 1999, and reflects comments from participants.

1. An interesting question is whether Singapore and Taiwan, China, let their currencies depreciate to maintain export competitiveness or to conserve foreign reserves. Corsetti and others (1999) argue that these two economies were able to defend the original parities with their massive holdings of reserves and thus to withstand irrational withdrawal but were concerned about a loss of competitiveness. It can also be argued, however, that their decision to float their currencies was motivated by their efforts to fend off possible speculative attacks driven both by arbitrary shifts in expectations and by the reaction of panicky and irrational investors. Although the response may have been rational and optimal in either case, in that the perceived welfare costs of maintaining a stable exchange rate might have been too high, the contagion aspects and policy implications underlying the two rationales are quite different.

2. Investors can follow strategies that are *ex ante* irrational given their own preferences and the behavior of other investors. Although one cannot rule out the likelihood that this category is large, its lack of conceptual definition makes it difficult to analyze.

3. In a related argument, Goldfajn and Valdés (1997) find that when foreign investors withdraw deposits and loans, asset prices decline and asset markets become illiquid. Banks and other financial institutions thus risk failure because they cannot readily liquidate their assets. The liquidation problem may cause a run on these intermediaries themselves, provoking a banking or confidence crisis, and could lead to a speculative attack on the currency as foreign investors withdraw and convert their investments into foreign exchange. Such crises can spread to other countries when international investors are forced to sell off their positions in other national markets to make up for the liquidity shortage caused by the crisis in one country.

4. Caramazza, Ricci, and Salgado (1999) investigate the East Asian, Mexican, and Russian crises using an approach similar to that of Eichengreen, Rose, and Wyplosz (1996). They find that these crises do not differ much. Fundamentals, including trade spillovers, common creditors, and financial fragility, are highly significant in explaining crises, while exchange rate regimes and capital controls do not seem to matter.

5. In contrast, Baig and Goldfajn (1998) find large trade links among East Asian countries, which could explain some spillover based on reduced demand for intraregional exports (see also Huh and Kasa 1997).

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“The Contagion Conference” refers to the conference “International Financial Contagion: How It Spreads and How It Can Be Stopped,” sponsored by the World Bank, the International Monetary Fund, and the Asian Development Bank, February 3–4, 2000, Washington, D.C. Papers from the conference are available at <<http://www.worldbank.org/research/interest/confs/past/papersfeb3-4/papers.htm>>.

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