

FINANCIAL ASSET PRICE VOLATILITY: A SOURCE OF INSTABILITY?

Financial asset price volatility, and its potential to undermine financial stability, has been a subject of concern in recent years. This chapter examines historical volatility and correlations between asset classes in the major mature markets. It discusses the links between volatility and instability, some of the policy lessons that have been learned during various crises, and the implications those lessons have today. The chapter focuses mostly on equity prices, as these have been unusually volatile in recent years, but also considers their relationship to the wider financial markets.

Asset price volatility is unavoidable and is not necessarily undesirable, since it reflects the process of pricing and transferring risk as underlying circumstances change. Indeed, if financial markets do not react to changing underlying conditions in the markets (policy changes or shocks, for example), misallocation of financial resources will occur. But if volatility leads to financial instability that too can impose real costs. Examination of past crises indicates that the biggest dangers to financial stability seem to have come not so much from a sustained high level of volatility as from sudden increases in volatility. This suggests that policymakers and market participants should focus more on reducing the instability that surrounds unexpectedly strong turbulence than on controlling the general level of volatility.

The empirical work in the chapter will show that most periods of high volatility in equity prices have been associated with negative shocks to the real economy. But there are several instances where the volatility was rooted more in financial market disturbances instead. These instances provide opportunities to look more specifically at the financial sector causes and consequences of volatility

and instability. Four case studies are examined: the Black Monday crash of 1987; the bursting of the Japanese bubble in 1990; the Long-Term Capital Management (LTCM) crisis of 1998; and market conditions following the bursting of the recent technology, media, and telecommunications (TMT) equity bubble.

From these cases, policymakers and market participants could learn lessons about how volatility can become amplified in a crisis and how to control factors such as leverage, shortage of liquidity, and lack of transparency that can turn volatility into instability. This is inevitably an ongoing process, with lessons from each crisis and subsequent innovations by the market and by policymakers. An important continuing policy question is how to avoid creating circumstances where, in a crisis, participants' attempts to control their own risk by selling into falling markets make the overall system unstable in new ways.

Concepts: Financial Market Volatility and Financial System Instability

Since the terms “market volatility” and “financial instability” are often used interchangeably in the public debate, it may be useful first to define and distinguish these concepts. Volatility, simply put, refers to the degree to which prices vary over a certain length of time. (This chapter limits itself to discussing volatility of prices, rather than volatility of capital flows.) Most commonly—and this convention will be followed here—price volatility is defined as the standard deviation of changes in the log of asset prices.

Although there is no generally accepted definition of financial system instability or systemic risk, the following definition, which incorporates many of the elements in defini-

tions put forward by other authors, may be useful:¹

Periods of financial system instability entail severe market disruptions that—by impairing the system’s ability to provide payment services, to price and transfer risks, and/or to allocate credit and liquidity—have the potential to cause a reduction in real activity.

Financial system instability is often linked to concerns about key financial institutions becoming illiquid or failing, although concerns about the overall liquidity and infrastructure of financial markets can also play a role. Although financial instability has the potential to damage the real economy, it will not always lead to an actual reduction in economic activity. Policy reactions by the authorities, for instance, may avert economic problems.

Periods of financial instability are nearly always accompanied by greater market volatility. However, market volatility need not imply financial instability (see Schwartz, 1985; and Crockett, 1997a). Volatility will often have benign consequences and need not be a concern to authorities. In efficient markets, where prices embody all available information, asset price volatility will reflect the volatility of economic fundamentals and is an inherent part of a well-functioning financial system. Even relatively large short-term volatility can be the result of a rational reaction by market participants to rapidly changing events and increased uncertainty about future returns. It is only when volatility becomes extreme (often referred to as “tail events”), is a potential source of strains on key financial institutions or markets, or results in self-perpetuating contagious price falls, that it is associated with financial instability and should be a concern for the authorities.

The financial system is continually subject to shocks (related to news or events) that

cause participants to reevaluate the future value of, and the risks embodied in, assets or their perception of counterparty risks. There are generally two types of shocks: those that are broad or systematic, affecting large segments of the financial system, and those that are idiosyncratic, affecting the health of specific institutions or the price movements in specific markets. Broad shocks are often related to large changes in one or more countries’ prospective macroeconomic performance, while examples of idiosyncratic shocks are a sudden drop in the prices of certain key assets—sometimes stemming from a correction of an earlier asset price misalignment (or bubble)—or the failure of a financial institution.

The degree to which shocks to the financial system are amplified and propagated across markets or across institutions is a key element of financial system instability. Because idiosyncratic shocks originate in one part of the market and could spread to others, they can often prove particularly useful case studies of the vulnerability of the financial system. Broad shocks, on the other hand, tend to affect the financial system in several areas simultaneously, making it more difficult to isolate individual systemic weaknesses. The four case studies presented later in this chapter therefore look at idiosyncratic financial shocks.

Factors That Can Turn Volatility into Instability

Among the factors that can amplify price volatility and turn it into instability are the following:

Incentive Structures

Peer-group performance measures or index-tracking can encourage herding and short-termism among institutional investors, leading to amplified or self-perpetuating price

¹See Crockett (1997a and b), Davis (2002), and De Bandt and Hartmann (2000) and the references therein for various definitions of financial system stability and systemic risk.

movements. Pressures to meet short-term earnings targets, for instance, or structures that reward staff at intermediaries according to volume of business rather than risk-adjusted return can lead to underestimation of long-term risk and imprudent leveraging. Conflicts of interest at intermediaries can also lead to insufficient disclosure of risks to investors. Sudden changes in herd sentiment, amplified by any increase in leverage, could then create instability through contagious price falls and difficulty in repricing risks.

Lack of Robust Risk Management

Leverage increases the sensitivity of financial institutions and the system as a whole to economic downturns and to asset price declines more generally. Rare events and regime shifts that may not be factored into risk measurement models or stress tests may be sources of unappreciated risk. Currency mismatches can lead to systemic risks, especially under pegged exchange rate regimes where the possibility of a regime change may not be fully taken into account in risk management. Certain hedging strategies (delta hedging or “portfolio insurance”) may lead to feedback mechanisms that amplify price movements. The unwinding of a concentration of leveraged positions (relating perhaps to a popular “carry trade” or asset bubble) can similarly increase volatility. A combination of extreme price movements and sudden realization of previously unappreciated market and credit risks could lead to heavy losses at key institutions and disruptions to market pricing.

Lack of Transparency

Lack of disclosure by individual firms makes risk management by others under volatile conditions more difficult. Inadequate initial disclosure of the true scale of positions or financial condition can lead to sudden changes in market sentiment when the existence of large exposures or weaknesses becomes known and to extreme price reac-

tions as market participants try to discern the facts and assess the implications amid partial information and rumors. Market uncertainty over the solvency of individual firms, and concerns (whether justified or not) about others that share some of the same characteristics, can impair the allocation of credit and functioning of payment systems.

Market Infrastructure Weaknesses

Payment, clearing, or settlement systems may not be adequate to allow participants to cope with large margin calls, doubts over counterparty risk, or heavy volumes of business. This could cause illiquidity and payments difficulties to spread rapidly through the system.

The appropriate balance between market discipline and regulation needs to be found. Otherwise deregulation can lead to an excessive buildup of debt as new investors in the market underestimate the risks in the newly deregulated segment of a market, while new regulatory and supervisory systems may not have been sufficiently calibrated to withstand an economic downturn or a burst of negative news. Alternatively, regulations that tighten risk limits during times of market instability can have procyclical effects that amplify market volatility. Regulation could also be excessive, hampering market innovation. All these are challenges that authorities unavoidably face and therefore need to be prepared to address.

The potential sources of instability just mentioned are illustrated by the case studies discussed later.

Empirical Evidence on Volatility, Correlations Between Markets, and Macroeconomic Factors

The empirical work that follows assesses historical trends in financial market volatility and aims to separate episodes of high volatility that reflect macroeconomic factors from those that stem more from financial shocks. The

data examined relate to equity prices, foreign exchange rates, and bond returns in Germany, Japan, the United Kingdom, and the United States, representing the four major financial centers. Volatility is measured by the historical standard deviation of price changes, calculated as the moving average over a rolling sample.

Developments during the past 30 years suggest that equity volatility has recently picked up, while recent bond and foreign exchange volatility have remained within their typical historical bands (and indeed in a number of cases show less volatility than periods in, for example, the 1980s). The evidence also indicates that the major mature equity markets have become more integrated.

Econometric estimates suggest that, apart from in Germany, the connection between equity market volatility and domestic recessions is fairly close.² However, the periods of our four case studies are exceptions where volatility is elevated with little or no direct link to domestic recessions.

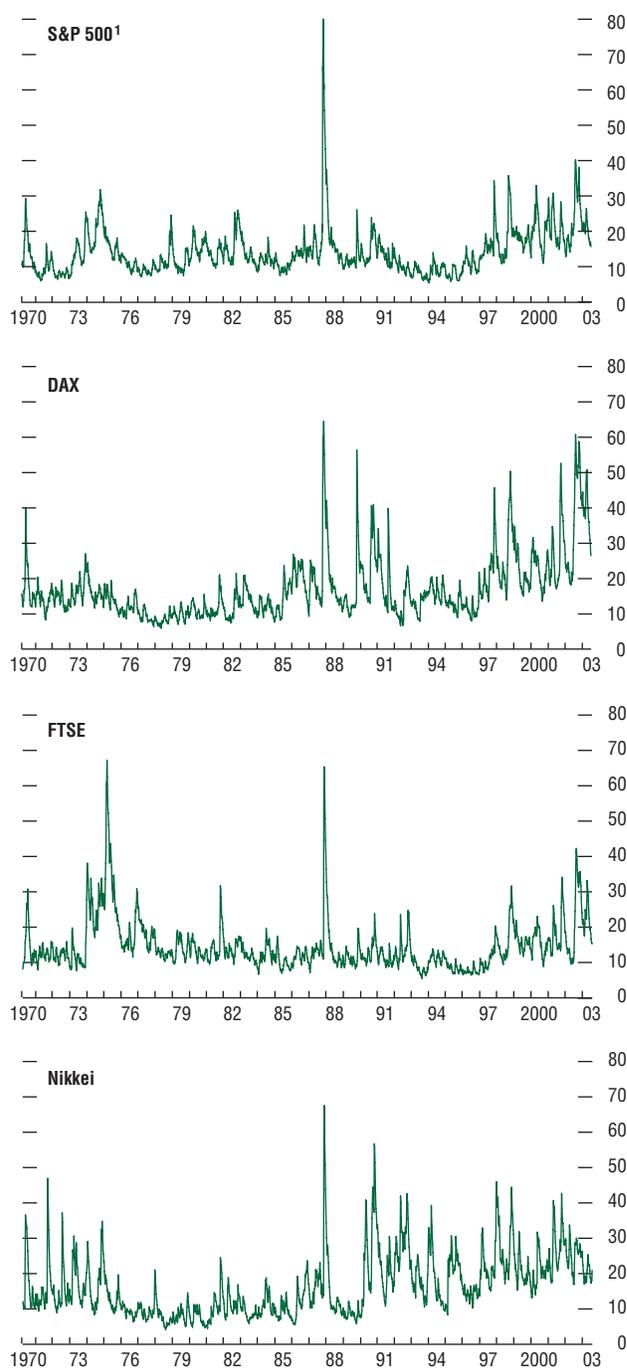
Historical Trends in Financial Market Volatility

Equity price volatility has trended up since the mid-1990s.³ Equity volatility has been particularly high since 2000, except in Japan, as the TMT bubble burst, followed by shocks such as the events of September 11, 2001, the Enron and WorldCom accounting scandals, and geopolitical uncertainty (Figure 3.1). This pattern is consistent with an asymmetric “feedback” or “leverage effect” generally observed: equity volatility tends to rise when asset prices fall (Campbell, Lo, and

²It is important to note that these estimates examine the correlation between volatility and recessions, but do not attempt to test the causality between them.

³Volatility is calculated as the annualized standard deviation of percentage returns over a rolling sample. The standard deviations are calculated from an exponentially weighted moving average of past squared returns, where the weights decay by a factor of 0.94 for daily returns and 0.92 in the case of monthly data.

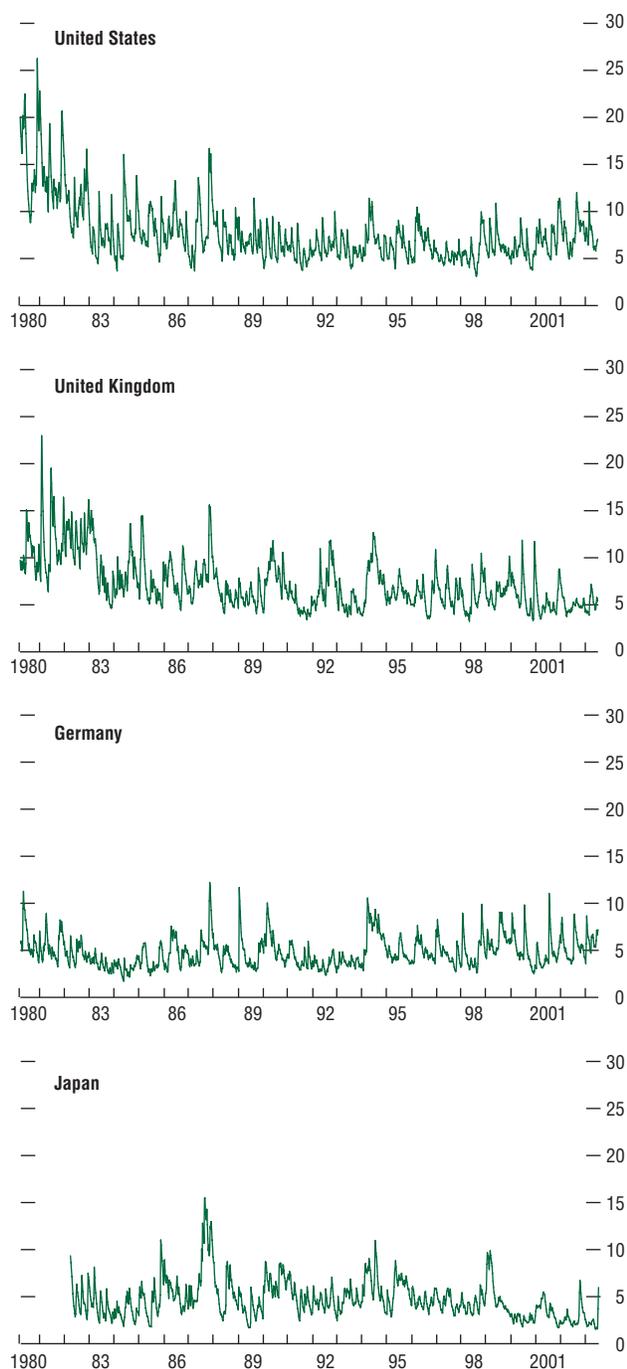
Figure 3.1. Equity Market Volatility
(In percent)



Sources: Datastream; and IMF staff estimates.

¹The following figures are outside the scale of this figure: 94 percent on October 5, 1987; and 91 percent on November 1, 1987.

Figure 3.2. Bond Market Volatility¹
(In percent)



Sources: Datastream; and IMF staff estimates.
¹Based on 7 to 10 year bond index returns.

MacKinlay, 1997, p. 497). All four equity markets analyzed exhibit brief intense spikes in volatility during periods of financial stress, such as the October 1987 crash and the LTCM crisis in 1998. Except for the 1987 crash, equity volatility in the United States and the United Kingdom until the mid-1990s had remained generally lower than during the oil crisis in the mid-1970s. Equity market volatility in Japan surged in the early 1990s following the bursting of the equity bubble, and in Germany volatility jumped at the time of reunification.

The volatility of returns on an index of 7 to 10 year government bonds in the United States, the United Kingdom, and Germany has moved in a relatively stable range since the 1987 crash (Figure 3.2), and for the United States and United Kingdom has remained considerably lower than during the high inflation of the early 1980s. Some simultaneous spikes in volatility can be identified in all four markets, including in 1994 when the U.S. Federal Reserve reversed its interest rate policy and the 1998 LTCM episode, but in general spikes are much less pronounced than for equities.

Like bonds, foreign exchange volatility does not show any rising trend (Figure 3.3). Foreign exchange volatility between the dollar, yen, pound, and euro has been high only at specific moments of policy uncertainty, most notably around the 1985 Plaza Agreement and the 1992 Exchange Rate Mechanism crisis. Since the early 1990s, the volatility of the dollar vis-à-vis the euro and pound has declined, with a peak in mid-2000 when the euro reversed its decline. The yen-dollar volatility jumped in the fall of 1998 when investors reduced their yen carry trades and associated hedging positions.

Extreme daily price changes (so-called tail events) have become more frequent for equity markets, while less frequent in bond markets and stayed close to average frequencies in foreign exchange markets (Table 3.1). Since October 1997, the percentage of days in

which equity prices moved more than 3 percent was two to three times higher than in the overall period since 1970. By contrast, the number of large daily movements declined sharply in bond markets while it remained at about normal in foreign exchange markets. The frequency of tail events is a useful measure of market instability because standard deviation measures of volatility are a form of averaging that may mask occasional large price movements that can impose strains on the system.

Large equity tail events—though recently more frequent than average—have not been unusually common compared with past episodes of financial stress.⁴ Monthly U.S. equity data that includes the Great Depression show how limited recent tail event counts have been by comparison with some other periods (Table 3.2).⁵ For example, the 1973–74 recession, oil shocks, and the end of the Bretton Woods regime created deep uncertainty and a period of much more frequent large price moves.⁶

Correlations between national markets have been rising for equities and in some cases for bonds. As financial markets and underlying economies become increasingly integrated and companies' operations become more multinational, correlations would be expected to rise.⁷ Indeed, correlations between national equity returns have risen substantially in several cases, generally

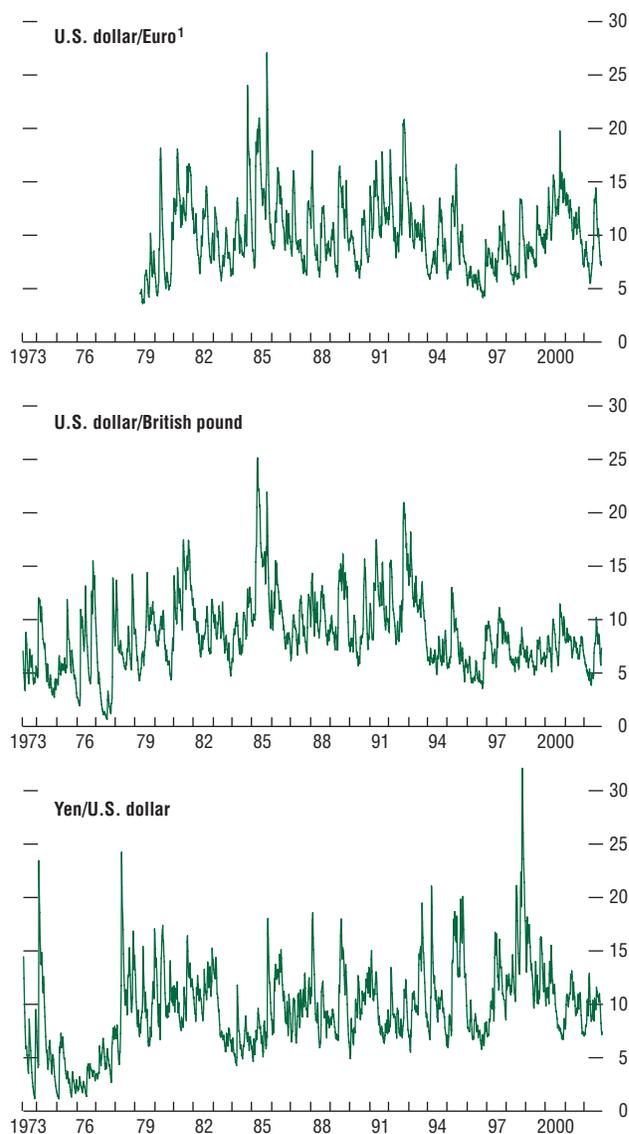
⁴Following the 1987 crash, U.S. stock markets introduced circuit breakers that cause trading to halt after an equity price decline reaches a certain threshold. However, these have been triggered only once and so have not directly significantly reduced the recent tail event count.

⁵Jorion (2002) comes to the same conclusion using similar data and technique.

⁶See Davis (2003), who compares the 1973–74 bear market in equities to the bear market that began in 2000.

⁷See Bordo, Eichengreen, and Irwin (1999), who show that, since the mid-1970s, globalization has led economies and financial markets to be more integrated.

Figure 3.3. Historical Foreign Exchange Volatility
(In percent)



Sources: Datastream; European Central Bank; and IMF staff estimates.

¹Prior to 1999, data refer to European Currency Unit.

Table 3.1. Frequency of Tail Events¹
(In percent)

Equity	2000s	1973–74	1970–Sep. 1997	Oct. 1997–2003	Full Sample	Sample Standard Deviation
S&P 500	5.7	1.9	0.6	3.4	1.1	1.0
DAX	16.7	0.7	1.7	10.2	2.7	1.3
FTSE	4.4	4.4	1.3	2.6	1.5	1.0
Nikkei	9.7	9.1 ²	2.2	5.9	2.9	1.2

Bond returns	2000s	1990–92	1994	Oct. 1997–2003	Full Sample	Sample Standard Deviation
United States	1.4	1.3	1.2	0.9	1.9	0.5
Germany	2.0	1.7	3.8	1.1	1.5	0.3
United Kingdom	1.4	1.5	1.5	0.9	1.8	0.5
Japan	0.9	2.9	3.4	0.5	1.9	0.3

Foreign exchange	2000s	1990–92	1973–Sep. 1997	Oct. 1997–2003	Full Sample	Sample Standard Deviation
Euro	0.1	0.4	0.2	0.1	0.2	0.6
Sterling	0.0	0.0	0.1	0.0	0.1	0.6
Yen	0.7	0.0	0.3	0.4	0.3	0.7

¹For equity and foreign exchange, the frequency is calculated as the number of trading sessions with 3 percent or greater returns as a percentage of the total number of trading sessions during the relevant period. For bonds the cut-off is calculated as 3 times the full sample standard deviation for each series of bond returns.

²Sample period is 1990 to 1992 for comparison purposes with the Japanese bursting bubble period.

involving a greater comovement with the S&P 500. An average of these correlations has varied substantially, but reached a new high in 2002 (Figure 3.4).⁸ Cross-country bond return correlations between the United States, United Kingdom, and Germany have become increasingly positive recently, in line with increasingly integrated fixed-income markets as well as the convergence in business cycles. Only Japanese bond returns exhibited slightly declining correlation with those abroad, reflecting an increasingly isolated domestic financial system (Figure 3.5). The correlation of bond and equity returns within the United States, the United

Kingdom, and Germany has generally, and perhaps ominously (see below), been declining (Figure 3.6).⁹

Macroeconomic Factors and Equity Market Volatility

While the *level* of asset prices is related to macroeconomic activity, the relationship between asset return *volatility* and macroeconomic conditions is not so straightforward. Although studies have found that stock market volatility rises during economic contractions,¹⁰ the explanations put forward for this empirical observation have

⁸Like the volatility measures, correlations are calculated using exponential weights with a decay factor of 0.94.

⁹One criticism of the correlation estimates used here is that they are biased upward during periods in which returns are more volatile (Forbes and Rigobon, 2001). However, Chakrabarti and Roll (2002) argue that correlations are not necessarily biased if the crisis is characterized by sharp asset price declines, which happen also to coincide with heightened volatility.

¹⁰Studies of U.S. equity market volatility and the business cycle date back to Officer (1973). Schwert (1989) shows that recessions are the single most important explanatory factor for volatility. Hamilton and Lin (1996) show that recessions account for about 60 percent of the variation in volatility, while Campbell and others (2001) find that volatility increases by a factor of two to three during recessions. There is also some limited empirical evidence that cross-country stock market correlations rise during recessions (see Erb, Harvey, and Viskanta, 1994).

Table 3.2. United States: Frequency of Monthly Equity Returns Greater Than 8 Percent

(In percent)

Periods	S&P 500
1871–1899	2.0
1900s	3.3
1910s	0.8
1920s	5.0
1930s	22.3
1940s	2.5
1950s	0.0
1960s	0.8
1970s	4.1
1980s	5.7
1990s	3.3
2000s	8.8
1871–2002	4.3

Periods	S&P 500
Oct. 1997–2002	6.6
Oct. 1997–Dec. 1999	3.7
1973–1974	10.8
1980–1982	10.8

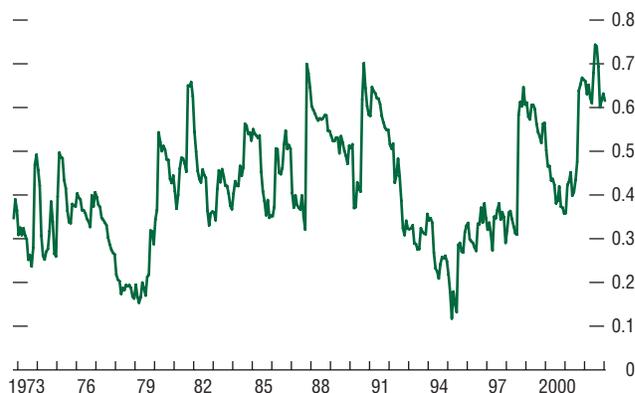
Data Source: Robert Shiller's website: <http://aida.econ.yale.edu/~shiller/data.htm>.

The frequency is calculated as the number of 8 percent or greater monthly returns as a percentage of the total number of months during the relevant period.

received only weak support.¹¹ Recent research, however, has shown that larger investor uncertainty about asset fundamentals tends to increase volatility (and correlations) of asset returns and that this investor uncertainty in principle rises during recessions. This could explain the positive correlation between equity volatility and recessions that has been observed. On the other hand, periods of high market volatility that are unrelated to economic recessions may tend to indicate increases in investor uncertainty related to instability in the financial system rather than to macroeconomic factors.

Asset price volatility could increase even if the fundamentals themselves do not become more volatile. This could happen if investors become more uncertain about underlying

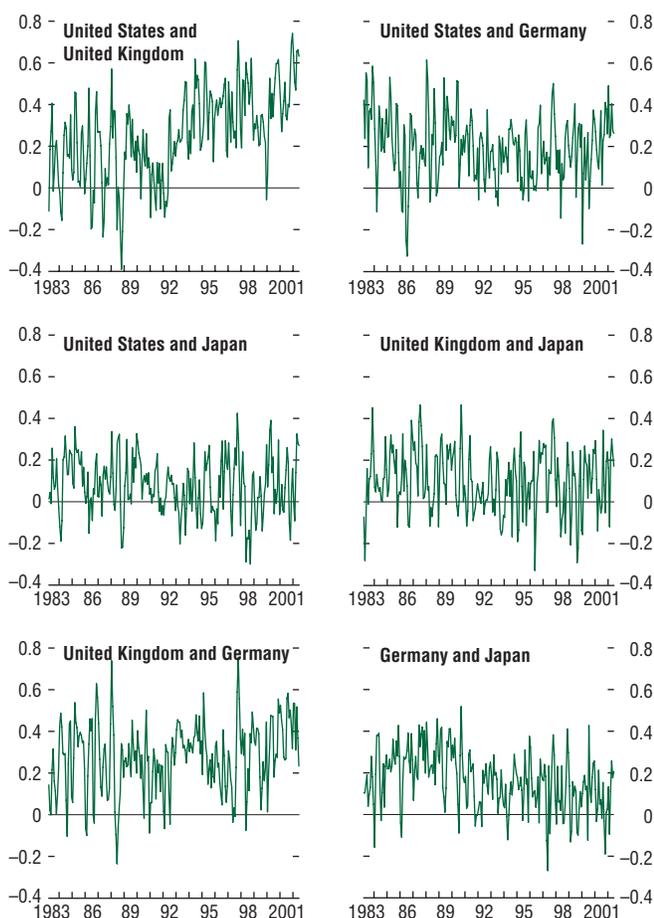
¹¹One explanation for this is that firms become riskier during recessions because they tend to be more financially levered and as a result their share prices fluctuate more. Yet Schwert (1989) finds that U.S. recessions still explain a substantial part of U.S. equity market volatility even after controlling for firm leverage.

Figure 3.4. Average Cross-Country Stock Market Correlations¹

Sources: Datastream; and IMF staff estimates.

¹Average of the bilateral correlations between S&P 500, FTSE, DAX, and Nikkei.

Figure 3.5. Bilateral Bond Market Correlations



Sources: Datastream; and IMF staff estimates.

Table 3.3. Correlations Between Historical Volatility and Recessions

Market	Own Recessions	U.S. Recessions
S&P 500	0.28 ¹	
FTSE	0.20 ¹	0.17 ¹
DAX	-0.27 ¹	0.00
Nikkei	0.24 ¹	-0.05

¹Indicates estimates that are significant at the 5 percent level.

long-term economic and financial growth rates and trends and therefore attach large significance to relatively small pieces of news. This may explain why the volatility of macroeconomic variables per se explains only a small amount of asset price volatility. (In the G-7 there has been a general decline in the volatility of many macroeconomic variables such as GDP growth or inflation during the 1990s, and yet there is no evidence that asset price volatility has declined concurrently.)

The behavior of return volatility in the various equity markets during business cycles suggests an interesting pattern (Table 3.3).¹² There is a fairly close positive correlation between equity market volatility and domestic recessions—except in Germany, where the correlation was negative. Meanwhile, the volatility in the FTSE was as almost as strongly correlated with U.S. recessions as with U.K. recessions.

High equity market volatility and domestic recessions were particularly closely synchronized in the United States and the United Kingdom (Table 3.4) when measured by a concordance statistic, which, unlike correlations, is not biased by a few large events. To

¹²To time recessions, for the United States, the National Bureau of Economic Research (NBER) recession dates are used. For the other countries, the recessions are dated based on the analysis presented in Chapter III of the April 2002 *World Economic Outlook* (IMF, 2002). There, business cycle turning points are identified based on peaks and troughs in real economic activity. Since the *World Economic Outlook* dates are at a quarterly frequency, while the analysis in this chapter is based on monthly data, we assume that the economy is in recession during all three months of a recession quarter.

Table 3.4. Concordance Statistics for High Equity Volatility Regimes and Recessions¹

High Volatility Regime	Own Recessions	U.S. Recessions	High U.S. Volatility Regimes
United States	0.87 ²		
United Kingdom	0.82 ²	0.83 ²	0.80 ²
Germany	0.53	0.62 ²	0.65 ²
Japan	0.48	0.41	0.50

¹The concordance statistic determines the number of periods, as a proportion of the number of periods in the sample, during which the two relevant variables are in the same state.

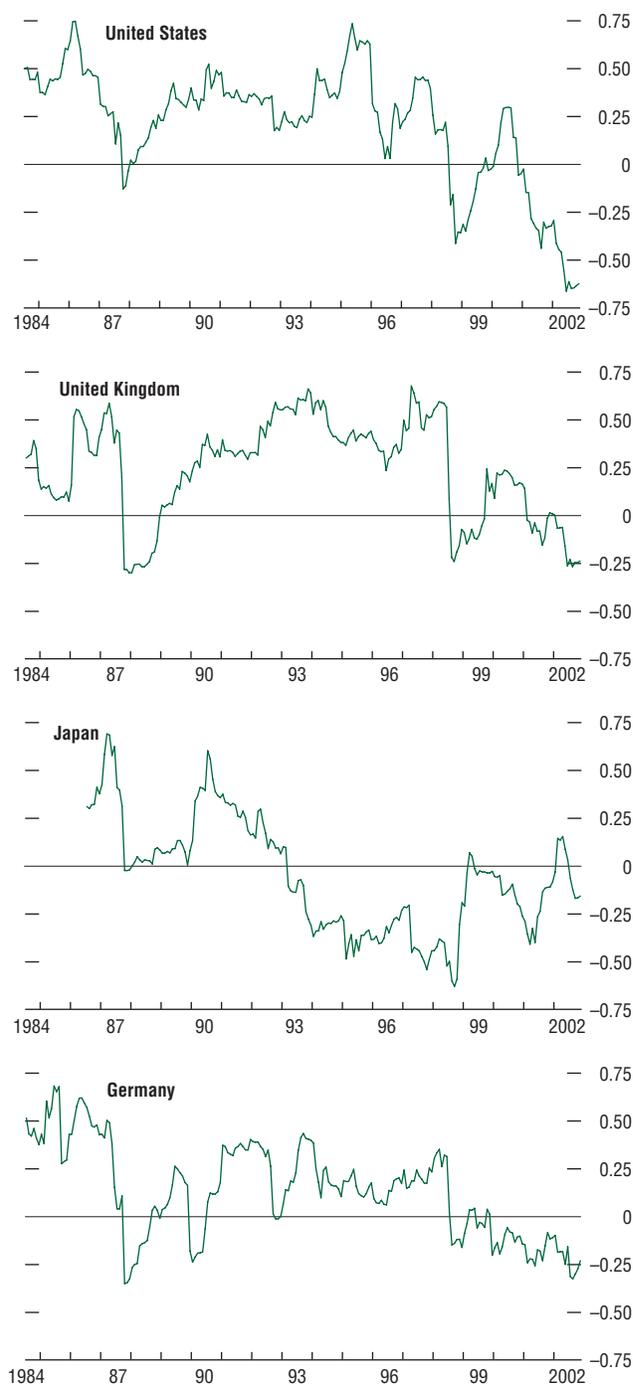
²Indicates estimates that are significant at the 5 percent level, implying that the respective regimes statistically coincide.

that end, an econometric model with two equity-volatility regimes—a high-volatility and a low-volatility regime—was used to estimate the probabilities that the observed equity returns fall into the high volatility regime (Figure 3.7).¹³ Using this measure, German and U.K. volatility appear even more closely synchronized with U.S. recessions than with recessions in their own countries. By contrast, equity market volatility in Japan is relatively detached from domestic and international economic cycles.

U.S. recessions overlap with all but three periods when the model suggests that U.S. equity markets were in the high-volatility regime. The three episodes unrelated to recessions coincided with the 1987 stock market crash, the autumn of 1998, and the second volatility spike in 2002, and were likely triggered by financial stability concerns rather than macroeconomic factors. Meanwhile, the sustained period of the high-volatility regime in Japan begins when the 1990 bubble bursts and precedes recession by several years. These are our four case studies (see the Appendix to this chapter for details).

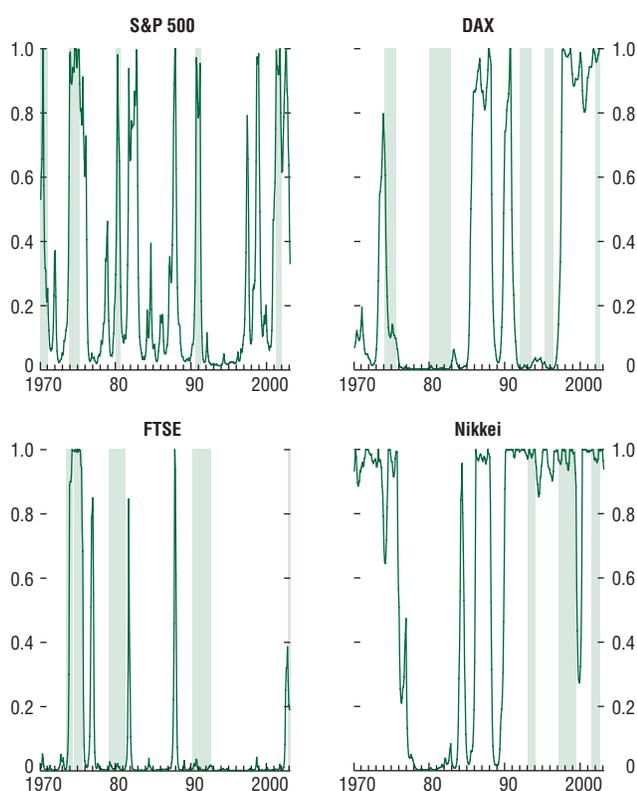
The correlations between equity markets rise during U.S. recessions (Table 3.5). These results suggest that global fundamental

¹³We use a Markov-switching regime econometric model, where recurring persistent regimes of heightened volatility are identified endogenously (see Hamilton, 1994, for details).

Figure 3.6. Correlations Between Stock and Bond Returns

Sources: Datastream; and IMF staff estimates.

Figure 3.7. Probability of High Equity Volatility State and Recession Dates¹



Sources: Datastream; and IMF staff estimates.
¹Shaded areas show recession periods for each country.

Table 3.5. Equity Market Correlations During U.S. Recessions and Expansions

	United States	Germany	United Kingdom	Japan
United States		0.51	0.55	0.34
Germany	0.64		0.44	0.30
United Kingdom	0.69	0.58		0.29
Japan	0.60	0.71	0.54	

Bottom part of matrix reports the estimated correlation coefficients during recession periods; top, during expansions.

uncertainty—proxied by U.S. recessionary periods—has not only an impact on the volatility of equity returns but also their correlation across countries.

U.S. recessions also overlap with all the periods when correlations between equity markets surged abruptly except the same three episodes identified above in the case of U.S. high-volatility regimes. These non-recession-related periods of heightened stock market volatility generally corresponded to times of greater systemic risk where flight-to-quality dynamics were prevalent, as described in the following section.

Episodes of Negative Correlation Between Bonds and Equities

While correlations between bond returns and equity returns in each country have typically been positive since the early 1980s, the correlations sometimes turn negative during periods of equity market volatility, suggesting flight-to-quality. The three episodes in this period coincide with the three U.S. high-volatility regimes identified above as not coinciding with recessions (Figure 3.8). As such, episodes of negative stock-bond correlations tend to coincide with, and can be a signal of, financial instability in mature markets, but generally do not arise in periods when high stock market volatility is related to economic recessions.

Negative correlations of equity and bond returns also tend to coincide with sharp increases in implied volatility in U.S. and

Table 3.6. Regime-Switching Model for Bond-Equity Correlations: Coefficient Estimates¹*(In percent)*

	United States	Germany
β_0	0.30	0.10
β_1	-0.10	-0.10
Correlation	0.53	0.64

The coefficient related to the negative (positive) regime is β_1 (β_0) for the U.S. and Germany. The negative values for β_1 imply a negative relationship between stock and bond returns when in this regime, and thus represent the flight-to-quality periods. The bottom row is the correlation estimate between estimated probability of being in the flight-to-quality regime and the implied volatility measures.

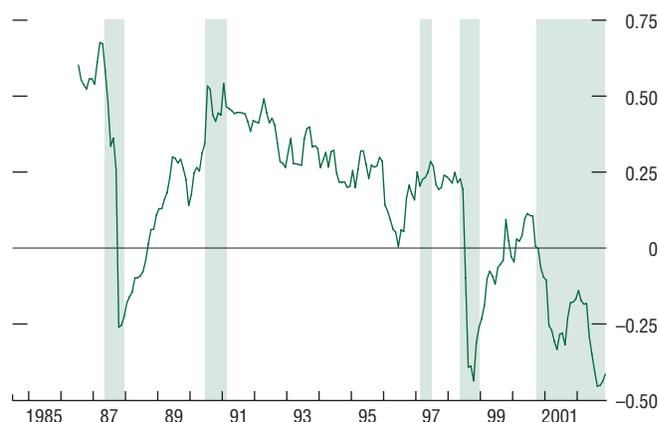
¹All estimates are significant at the 5 percent level.

German equity markets, as measured by the volatility indexes VIX and VDAX.¹⁴ Based on a regime-switching econometric model, the synchronization is measured by the correlation between periods of negative bond-equity correlations, on the one hand, and periods of high or low implied volatility, on the other hand (Table 3.6).¹⁵ The results suggest a close mapping between the “flight-to-quality” periods and high levels of the VIX or VDAX (Figure 3.9). The flight-to-quality regimes coincided in the United States with the 1987 crash, the 1998 LTCM crisis, and the period since mid-2000. For Germany, flight-to-quality dynamics have been observed more or less since 1998.

Overall, the flight-to-quality analysis supports the hypothesis that periods of high equity market volatility that are unrelated to economic recessions tend to coincide with heightened perception of risk by market participants in response to increases in global financial instability. The period since 2000—when negative bond-equity correlations over-

¹⁴In Whaley (2000) the VIX index is referred to as the “Investor Fear Gauge” because it tends to spike during times of market turmoil.

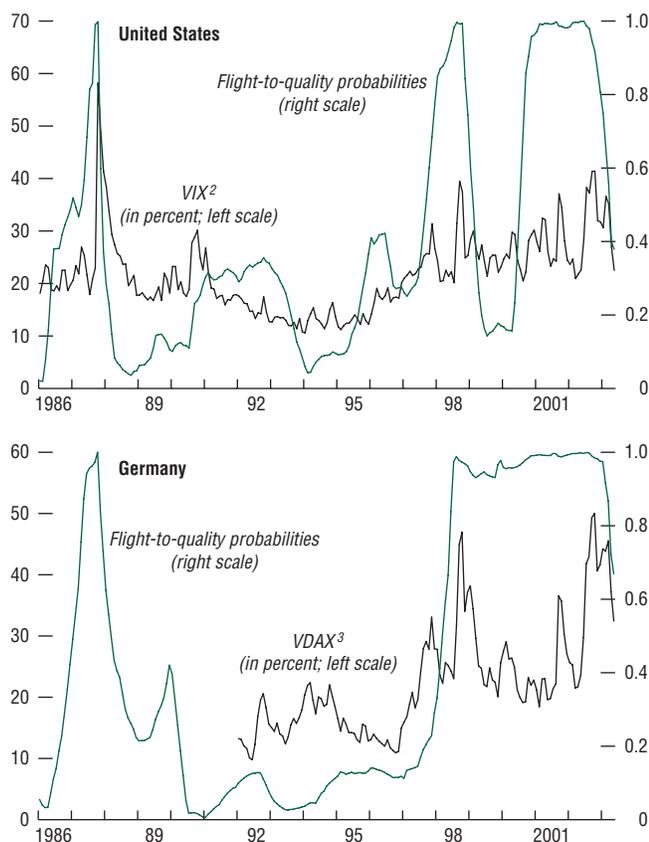
¹⁵Following Stivers, Sun, and Connolly (2002), an econometric Markov-switching model was estimated. Bond returns were regressed on stock returns (plus lagged bond returns and a regime-dependent constant), and the coefficient on the stock returns was allowed to take on one of two values—depending on the positive or negative correlation regime.

Figure 3.8. Bond and Stock Return Correlations¹

Sources: Datastream; and IMF staff estimates.

¹Average of the stock and bond correlations for each country. Shaded areas indicate high equity volatility dates for the United States.

Figure 3.9. “Flight-to-Quality” Probabilities and Implied Volatility¹



Sources: Datastream; and IMF staff estimates.

¹“Flight-to-quality” probability represents the probability of being in a period when bond and stock returns are negatively correlated, based on a regime-switching model.

²VIX is Chicago Board Options Exchange volatility index. This index is calculated by taking a weighted average of implied volatility for the eight S&P 100 calls and puts.

³VDAX represents the implied volatility of the DAX.

lapped with a mild recession and high equity volatility—is an exception, presenting a “hybrid” case where both recessionary and financial factors seem to have been at play.

Case Study Analysis of Periods of Recessionless Financial Stress

Although many spikes in financial asset price volatility are related to periods of stress in economic cycles, volatility can also spike at other times. For example, major market innovation, deregulation, or other structural changes can lead to financial bubbles that create volatility when they eventually burst. At the outset of the bubble, new business opportunities can prompt a sudden rise in risk appetite in financial markets, which is often accompanied by a buildup of leverage (whether explicitly, through direct borrowing, or implicitly, such as through use of derivatives). Unrealistic assumptions about long-term financial returns and beliefs in stable relationships in markets, combined with weak risk management, can encourage excessive risk-taking.

When market participants—in reaction to exogenous events—reevaluate underlying assumptions and curb their risk appetite, they start to unwind their financial positions. Those exogenous events may be the proximate causes of the bursting of the bubble, but are not necessarily the underlying causes, particularly if the market dynamics were unsustainable in the long run; if the particular events had not occurred, some other event in due course would likely have led to a similar reevaluation. Once the market decline begins, leverage heightens financial stability risks: it increases investors’ losses from the falling asset prices; it tends to raise counterparty exposures; and it can force them to liquidate positions quickly. These sorts of factors can amplify the price declines.

Four particular episodes that involved spikes in volatility provide some lessons for financial stability and are discussed as case studies in the Appendix at the end of this

chapter. These episodes were not accompanied by recessions, and so appear to have been less related to fundamental uncertainty about macroeconomic conditions. The four events, which all led to major concerns about financial instability, are:

- The Black Monday stock market crash of 1987;
- The bursting of the Japanese equity and real estate bubble in 1990;
- The LTCM crisis of 1998; and
- Market conditions following the collapse of the TMT equity bubble in 2000.¹⁶

A sharp reduction in risk appetite in a crisis, uncertainties over asset valuations, and the complex web of interlocking counterparty exposures may make it difficult for market participants to coordinate an orderly unwinding of positions without official intervention. These four financial instability cases suggest that financial authorities, particularly central banks, played a crucial role in restoring calm to the markets. The case studies focus less on the run-up to the crisis and more on the period of the crisis itself and its unwinding. Typically, asset price volatility is particularly high during and after the crisis, rather than in the run-up, and the factors that determine whether volatility leads to financial instability can often be seen most clearly at that point. In some ways, the periods of high volatility in the case studies are very different; some took place over days and others over years. Yet the lessons learned still show similarities.

Policy Implications

Is the Current Period of Market Volatility a Cause for Concern?

Although it is often stated that volatility has increased in recent years, within the mature

markets a rise in volatility of asset prices and returns has only been evident in equity markets and not in other markets such as bonds or foreign exchange.¹⁷ But in episodes of high equity market volatility, significant strains and flows have emerged in other markets as well. Although many of the details of the case studies have been specific to equity markets, the policy lessons are more widely applicable across the financial system.

The current period of high equity volatility, which includes the period following the collapse of the TMT equity bubble, is unusual for its length rather than its height. Most periods of volatility in recent decades have been short-lived spikes that corresponded to sharp share price falls followed by a steady return to stability. However, the current period of higher volatility has lasted much longer than previous episodes.

The unusual nature of the current period of volatility therefore makes it difficult to say whether it could evolve into financial instability. Previous crises have often arisen from periods of relatively modest volatility. Arguably, market participants became complacent about market risks, assuming for instance that existing exchange rate relationships would remain stable or that sustained asset price rallies would continue. An extended period of high volatility could, in fact, be less threatening to financial stability than one where volatility is low because a risk is not recognized by investors or because market mechanisms artificially dampen volatility. When volatility is in plain sight to market participants and to regulators, the awareness for risk management is sharpened, more likely guarding institutions and the system itself against potential financial instability.

Nevertheless, periods of high volatility always argue for enhanced caution. First, mar-

¹⁶Part of the period following the TMT bubble coincided with a U.S. recession, but the high volatility persisted after the recession ended.

¹⁷Although in recent months equity market volatility has fallen (see Chapter II), the average volatility over the last three years remains high.

kets may have adjusted to the risk arising from the existing level of volatility but may not be prepared for a further increase. Second, risk management systems may adequately protect intermediaries from solvency and liquidity problems, but perhaps at the cost of lower levels of financing for the economy than would be the case at lower volatility levels or of inefficient allocation of capital as intermediaries pursue profit opportunities arising from the volatility itself rather than from long-run investment. Third, the volatility may itself be an indicator of underlying market weaknesses, which can be harbingers of instability.

Policy measures should not aim at reducing asset price volatility for its own sake, but should instead attempt:

- to avoid conditions where excessive vulnerabilities to volatility build up (e.g., through excessive leverage or risk exposures); and
- to prevent volatility from triggering financial instability (if, for instance, there are market features that, during a crisis, would tend to artificially amplify volatility, put payments or settlement systems under strain, or induce the bankruptcy of a key intermediary).

The policy implications therefore often involve measures to reduce the weaknesses in behavior of institutions and systems that can lead to forced sales or otherwise amplify price volatility, rather than to directly control price volatility itself.

The case studies indicate policy lessons from past periods of financial stress aimed at limiting the *effects* of volatility by:

- breaking the cycle of amplifying volatility;
- strengthening risk management practices;
- aligning incentive structures;
- enhancing transparency;
- improving market infrastructure; and
- finding the balance between leaving risk control to market discipline and regulation.

These topics are discussed in turn below.

Breaking the Cycle of Amplifying Volatility

Most of the case studies showed that, once a crisis had begun, the provision of liquidity by central banks was a key factor in easing the funding constraints that were amplifying volatility. Liquidity injections allowed transactions to be settled smoothly and boosted the confidence of market participants that the authorities would proactively address the wider crisis. They also helped to improve the relative yield return of other assets compared with cash. Conversely, in Japan, even after the asset bubble had burst, high interest rates were maintained for wider policy reasons and monetary policy thus could not soften the impact of falling asset prices.

As another important step, officials and market participants can establish a forum for finding collective means to resolve short-term liquidity problems. The agreement brokered by the Federal Reserve Bank of New York, for example, permitted creditors to unwind LTCM's positions in an orderly fashion, without the official sector providing liquidity. In other cases, private sector groupings—such as stock exchanges, clearinghouses, or more informal crisis groups—may be able to reach similar agreements.

Features of the market structure can also aim to stop the market's fall. Following Black Monday, circuit breakers were devised to slow the transmission mechanisms between equity and futures markets once a market fall begins. If circuit breakers, however, are not well designed, they could themselves be a source of amplified volatility.

In principle, and if possible, policy measures to avoid the amplification of volatility should best be taken before a crisis happens, so as to address underlying causes rather than symptoms. The remaining policy lessons address aspects that are more preventive. However, finding the right balance is not always easy. In particular, the debate remains unresolved as to how to strike an appropriate balance between two important goals for controlling the effects of volatility:

- setting rigorous and consistent standards for limiting participants' exposures and disclosing information on mark-to-market positions, thereby avoiding the buildup of leverage and potentially unsustainable positions that amplify volatility; and
- preventing these standards from simply amplifying volatility in another way, for example, by forcing or encouraging asset sales into falling markets at fire-sale prices to control risks.

There are a number of areas, described below, where this policy dilemma exists.

Strengthening Risk Management

Striking this balance is particularly pertinent in risk management, both for regulators and for the market itself.

The degree of leverage is a crucial factor in the extent to which volatility turns into instability, as it can increase both market risk and counterparty risk. Even a small number of leveraged players can cause major problems for the market as a whole, as the portfolio insurers of Black Monday, the hedge funds and other arbitrageurs of the LTCM crisis, and the telecom and energy firms of the TMT equity bubble showed. Their leverage creates the potential for large margin calls and even for insolvency and can greatly accentuate the original price fall as they attempt to rapidly close out their large and sometimes highly risky positions. Continually more sophisticated measurement of leverage—including leverage embedded in off-balance-sheet exposures—is needed as new financial instruments and strategies evolve.

During Black Monday, the severe limitations of portfolio insurance in coping with tail events of extreme volatility were exposed. While this kind of formalized computer trading was better controlled afterwards, the risks associated with arbitrage were exposed again

during the LTCM crisis. The need to adjust exposures rapidly (such as on swap spreads and on options) exaggerated the breaking down of the normal price relationships between instruments, thus increasing losses and the need for participants to close positions at fire-sale prices. Strict Value-at-Risk exposure limits and simple stop-loss rules also tend to provoke sales in a price-insensitive manner, and this experience has led some risk managers to reassess the need for flexibility in the application of such rules (or at least in their timing).¹⁸

The control of counterparty exposures can exacerbate developments during a crisis. Black Monday focused attention on counterparty exposures in equity markets and exchange-traded futures contracts, as well as in bank clearing systems. It helped launch initiatives for wider use of collateral and netting. Meanwhile, in the LTCM crisis, counterparty exposure problems surfaced in a new range of markets, such as over-the-counter (OTC) derivatives and in transactions with hedge funds. This has led to tighter collateral and netting practices, such as larger haircuts, and greater emphasis on “know-your-customer” procedures. It is important not to use collateral as the only safeguard; in Japan, the widespread use of real estate and equity collateral, on the assumption that valuations were robust, gave false comfort.

Notwithstanding improvements in risk management, several questions are unresolved, carrying the potential to amplify volatilities during crises:

- Banks and other financial institutions (including particularly large and complex institutions) have greatly strengthened the measurement and management of consolidated counterparty and other credit exposures, including their monitoring of hedge funds. But the official sector needs to continue to identify remaining gaps (such as in

¹⁸For a dissenting view, see Jorion (2002).

consolidated supervision of banking and insurance operations), and vulnerabilities, some of which can result from differences or lack of coordination and information-sharing between national supervisory systems.

- The highly concentrated nature of the OTC derivatives business exposes the market to the risk of failure of a major dealer, although market participants contend that collateralization and netting agreements cover most of the risk. In the absence of public information about derivatives exposures, it is unclear how quickly exposures could grow in the event of a major market movement.
- In the current low-yield environment, historical volatilities of fixed-income returns have been relatively modest, and participants may have been tempted to move to riskier assets to improve yield. Market risk measurement, including through Value at Risk (VaR), has become much more sophisticated. But participants must not rely too heavily on historical relationships, such as volatilities and correlations, for risk management, because a sudden shift to a higher-yield environment is unlikely to follow historical statistical patterns. Appropriate stress tests should be conducted because, if VaR limits are rigidly applied, many participants using similar VaR techniques could simultaneously try to close their positions in a falling market.
- The focus on internal and external ratings in the Basel II proposals, while generally helpful, carries the risk of procyclical increases in lending during a boom and reductions in lending if the credit environment deteriorates. As with market risk measures, too abrupt an implementation of tighter limits risks increasing volatility during a downturn.
- While banks and securities firms have improved their risk management, including dispersing risks by selling them to others, there are potential questions about the

sophistication of risk management elsewhere in the system. Some have suggested that insurance companies have taken on credit risk from banks because, by using different risk methodologies, insurers estimate credit risks as being lower than banks do, and because their regulatory capital requirements for investment risks may be less demanding. A buildup of credit risk leverage in the insurance and other sectors could amplify volatility in the event of a rapid reevaluation of risks—these concerns are related to the debate about fair-value accounting (see below).

Aligning Incentive Structures

The bursting of the TMT equity bubble demonstrated the importance of aligning market participants' incentives with the goals of stable and efficient markets and avoiding short-termism. Compensation packages for corporate managers often encouraged short-termism, including bonuses and stock options tied to near-term performance. Practices are now changing (partly because of changes in accounting treatment). For instance, some companies have started instead to issue shares with long-term lock-up provisions to executives. Possible conflicts of interest by stock market analysts and other participants undoubtedly accentuated the bubble and the resulting crash and have contributed to the lingering uncertainty about underlying company performance that is helping to keep equity volatility high. The corporate governance issues this raised have started to be addressed. Index-tracking by institutional investors and the short-term focus on meeting quarterly earnings targets by corporate managers, analysts, and fund managers can lead to herd behavior, leading investors not to question the majority market view during a boom and thus heightening the risk of an abrupt change in market views.

Looking ahead, a number of issues still need to be addressed:

- More needs to be done to encourage longer-term incentive structures for corporate managers. For instance, greater use of executive compensation packages that are vested only after, say, a three-year performance record would help to reduce short-termism. But the underlying tendency for markets to focus excessively on quarterly earnings figures remains a difficulty.
- While corporate governance is being strengthened in the wake of the TMT equity bubble, the process of agreeing new standards both within countries and internationally will inevitably be complex (especially when relating to accounting) and will last a number of years. The sharper focus on underlying earnings, removing some of the distortions of profit-smoothing, and recognizing previously hidden factors such as stock options and pension fund valuation changes, will be helpful. However, a balance needs to be found between avoiding artificial smoothing and creating spurious volatility through rigid application of fair-value accounting.¹⁹
- The prevalence of index-tracking and benchmarking among portfolio managers could be seen as reducing the risk of amplifying sales into falling markets, by leading investors to continue to hold their positions during downturns. However, it could also amplify volatility. First, it could lead institutional investors not to conduct due diligence during market rallies (for instance, the sharp gains of TMT stocks forced index-trackers to hold heavy weightings in those sectors). Second, there could be a sudden shift away from pure index-tracking when the market turns down, for instance if investors simultaneously shift portfolios into cash, reinforced by fund managers trying to match asset allocations in their peer group. It remains unclear, however, whether there is much the official sector can (or should) do to address this.
- It is now better recognized that conflicts of interest within investment banks can amplify volatilities by encouraging investment booms and hampering full risk assessment. The public attention suggests that conflicts of interest will be dampened at least for a while, not only through regulation but through banks' desire to protect their reputations. But standards have by no means been raised uniformly and the risk that these conflicts could shift to less heavily regulated companies exists.

Enhancing Transparency

The need for transparency was a particular lesson from the 1998 crisis. Globally this was reflected in the new international financial architecture, and of particular importance to the mature markets were topics such as increased disclosure by hedge funds, at least to their counterparties. The other episodes also raised transparency issues. The Japanese and TMT equity bubbles highlighted the need for bank and corporate sector balance sheet transparency and accuracy, not just so that counterparties and analysts have meaningful information but also so that the reporting institutions themselves operate under the right economic incentives.

Transparency could be further strengthened in several areas:

- Measuring risk concentrations and leverage during normal market times reduces the danger that a sudden realization of the scale of positions during a crisis could lead to destructive simultaneous attempts to unwind exposures. While reporting and disclosure in OTC markets are being improved, more needs to be done to the market's ability to assess aggregate levels of exposures in the related areas of derivatives, offshore centers, Special Purpose Vehicles, and hedge funds.

¹⁹A Banque de France discussion paper (2001) suggested that full fair-value accounting, in particular of banking books, would further amplify credit cycles.

- More broadly, the process of making corporate balance sheets more transparent and meaningful involves complex issues. One area where difficult judgments need to be made is “fair-value” accounting, and particularly how it relates to longer-term investments by financial institutions such as insurance firms and pension funds. It is important to give the public a transparent measure of institutions’ financial situations in existing market conditions, while avoiding excessive focus on the balance sheet impact from short-term volatility. Moving to fair-value accounting for insurance companies could likely harden minimum capital requirements, for example, and could risk amplifying volatility.
- There may be scope for some middle ground in the fair-value accounting debate to achieve an appropriate level of transparency, while smoothing the more extreme effects of marking to market. This could avoid unwarranted market reactions from disclosures or premature supervisory requirements to sell assets during market downturns. Ways could be sought to make “fair values” more stable, help analysts interpret the sensitivity of the results to market values, or use appropriately gradual periods for adjusting holdings to stay within regulatory standards. For instance, market prices could be averaged over a relatively short period, supplemental accounting information could illustrate the dependence of headline data on the assumptions made—particularly on the liability side—or regulatory limits could use more stable valuation measures or appropriately long adjustment periods.

Improving Market Infrastructure

Lessons about financial infrastructure have tended to progress from formal, centralized, markets to less formal markets, such as over-the-counter transactions. The 1987 crash and Japanese bubble highlighted the importance of collateralization, netting, and other aspects

of payments and settlement systems in stock markets, exchange-traded derivatives markets, and banking systems. By 1998, similar issues were highlighted in the OTC international bond and derivative markets, resulting in tightening of practices and contractual standards. By contrast (or perhaps, rather, as a consequence) these topics were less of an issue in the aftermath of the TMT equity bubble. Currently work continues in such areas as derivatives documentation, refinement of payments and settlement systems, and central clearinghouses.

Finding the Balance Between Market Discipline and Regulation

In many respects markets functioned reasonably well during the case studies illustrated. Indeed it could be argued that the financial instability in mature markets in the 1987 stock market crash and the LTCM crisis was encouragingly short-lived. In the Japanese and TMT equity bubbles, it was perhaps not the speed but the size of the market fall that caused the main problems.

In considering the degree to which new policy efforts are needed, it is important to strike a balance between regulation and allowing market forces to work. The predisposition should perhaps be not to impose extra restrictions or requirements unless a solid case is made that there is a market failure to be addressed. But the markets will continue to innovate, and regulators need to innovate with them. Some innovations will be direct responses by participants seeking less regulated alternatives as regulators become more sophisticated in monitoring existing markets and controlling leverage and risk. The challenge for regulators is to reach the optimum trade-off between regulation and market discipline. Experience shows that in many areas, self-regulation is not enough. Participants are often too close to events and insufficiently independent to be able to see what is needed for the big picture of stability. At the same

time, regulators need to work with participants to think through the likely changes in market behavior that would result from new regulations.

Future Work

Of all the areas of debate described above, the question of “fair-value” accounting perhaps best crystallizes the need to balance the requirement for continuously updated risk measurement and control against not inducing price-insensitive sales of positions to stay within limits during a crisis. There are no easy answers, but policymakers and market participants should find a solution that considers the systemic need to avoid amplifying market volatility, while still keeping close and timely control of risks at individual institutions. It would be preferable to learn the lessons on finding this middle ground from past financial crises rather than from the next one.

Future editions of the GFSR will return to other aspects of volatility and the policy reform agenda. Potential topics for examination include:

- the volatility of flows in mature markets, to complement this analysis of price volatility;
- the balance between regulation and market discipline, and possible trade-offs between transparency of mark-to-market values and volatility; and
- the implications of these subjects for the current reform agenda, including potential procyclical effects associated with Basel II and with “fair-value” accounting for the insurance and pension fund industry.

Appendix: Case Studies

The “Black Monday” Stock Market Crash of 1987

Initial Macroeconomic and Business Conditions

A dollar stabilization policy set out by the Plaza Accord in 1985 and Louvre Accord in early 1987, combined with steady growth in

U.S. economic activity, led to increased confidence in U.S. financial assets, which fueled the stock market boom. Leveraged M&A activity led to stock retirements and takeover premiums, which strongly promoted the upsurge in stock prices. At the same time, however, the United States was running increasingly large trade and fiscal deficits. Financial deregulation in other countries, especially Japan, helped finance the U.S. trade deficit. In the first half of 1987, foreign institutions bought as large a volume of U.S. equities as domestic institutions. Many of these foreign investors had weak risk management capabilities and relied on U.S. institutions to manage their funds.

Crisis Trigger

In early October 1987 a disagreement between G-5 authorities on the appropriate stance of monetary policy unsettled markets and led to market speculation that the Louvre Accord was breaking down. On October 14, 1987, the announcement of the unexpectedly large August trade deficit depressed the dollar and sent U.S. bond yields up. Equities thus became less attractive to foreign investors and also less attractive relative to bonds. On the same day, legislation was filed in Congress to eliminate tax benefits from the financing of corporate takeovers. In response, arbitrage traders started to sell shares in takeover candidates, which had led the earlier market rally.

Market Price Reaction

In the seven days after October 14 the Dow Jones Industrial Average fell by 31 percent, including 23 percent on October 19, 1987, the largest one-day fall in its history. The correlation between U.S. bond and stock prices turned suddenly negative amid a flight to quality. Bid-ask spreads widened, and at times liquidity evaporated altogether. The equity price falls and overall volatility rapidly spread around the world, as correlations between national stock markets rose sharply.

Amplifying Factors

The use of *portfolio insurance* strategies by a number of major institutional investors amplified the speed of stock price falls. Portfolio insurance uses computer models to protect equity portfolio values in a falling market by selling stock index futures automatically. This selling drove stock index futures prices down and created price gaps between futures and the underlying stocks, which gave index arbitrageurs an opportunity to profit by simultaneously buying futures and selling stocks. This arbitrage transferred the selling pressure from the futures market back to the stock market. The ensuing stock price falls triggered further programmed selling of index futures, with additional pressure on spot equity prices. Only a handful of large market players were responsible for much of the selling pressure.

Foreign investors also amplified the market decline as the dollar's fall prompted them to close U.S. equity positions.

Complexity and fragmentation of clearing systems for stocks, futures, and options created delay and confusion over payments of margin calls triggered by stock price falls, raising concern over the solvency of securities brokers and the ability of exchange clearinghouses to make payments. Banks quickly restricted lending to brokers. The consequent illiquidity and worries that participants would make forced sales to meet margin payments further amplified the market price falls and increased the flight to quality.

Responses by the Market and by the Official Sector

In response to mounting fear of a systemic breakdown, the Federal Reserve announced that it was ready to provide ample liquidity to the U.S. financial system. The Fed's action helped restore banks' confidence and thus maintain the supply of funding to brokers and market makers and avoid payments failures. Banks, which had little direct exposure to equities and therefore remained strong,

worked as a conduit for the Fed to coordinate orderly securities clearings. As a result, market functions were recovered rapidly. Nevertheless, the "flight to quality" shift of investments from stocks to bonds persisted for some time after the crash. Authorities in other countries also supplied short-term liquidity in response to the spillover to their own financial systems, but in more limited fashion than in the United States. Continental European central banks, in particular, kept monetary policy on a more even keel.

Large investors moved away from computer-generated portfolio insurance as a hedging tool, as they learned of its limitations during large market movements.

The Fed improved payment systems and stocks, futures, and option clearing systems were integrated, introducing delivery versus payment and the use of collateral. Since then, market participants as well as official bodies have developed more extensive collateralization and netting systems throughout the financial markets that could reduce the need for large margin calls in the midst of market turbulence. The Fed was also empowered to lend directly to securities brokers in case of emergency.

The securities regulators introduced circuit breaker mechanisms such as price limits, position limits, volume limits, and trading halts.

Recommendations for greater disclosure focused on payment systems positions. Although portfolio insurance standing orders had been large and undisclosed, there was no real move to try to encourage extra disclosure of participants' positions.

Although market confidence was temporarily damaged, the steady recovery in equity prices after the crash (within two years the Dow Jones index was back above its pre-crash level) restored many institutional investors' belief that equities were the highest returning asset in the long run. Incentives, based on past performance, to weight long-term portfolios toward equities therefore remained in place, especially in the United

States, United Kingdom, and a number of other countries.

Bursting of Japan's Equity and Real Estate Bubble in 1990

Initial Macroeconomic and Business Conditions

In the aftermath of the Louvre Accord, the Bank of Japan kept interest rates down to support the value of the dollar and to boost Japan's domestic economy, stimulating demand for equities. Easy monetary conditions encouraged leveraged investment, aggressive equity financing, and excessive borrowing based on inflated land collateral. Restrictions on land sales limited the supply of land and drove up land prices, and banks took greater risks, mostly through real-estate-related lending. Rapid bank credit expansion, supported by bank equity issues that increased lending capacity and by unrealized gains from banks' stockholdings, further fueled the stock and real-estate market boom. Cross-shareholdings (i.e., double-gearing), historical cost accounting, and insufficient disclosure contributed to weakening market discipline in an atmosphere of widespread optimism. Starting in May 1989, concerns over inflation led the Bank of Japan to progressively increase the official discount rate.

Crisis Trigger

Excessive price-earnings ratios and the successive official discount rate rises during 1989 started to concern the equity market. As long-term interest rates spiked up in early 1990, and equity futures began to fall, arbitrage between cash stocks and futures transmitted the downward pressure to the stock market.

Market Price Reaction

From February 20 to April 5, 1990, the Nikkei index dropped 23 percent, even though the S&P and European indices rose, then fell further, this time in line with other markets. From December 31, 1989 to its low in October 1990, the index fell almost 50 per-

cent, and continued to drift down in the decade that followed. Neither bond yields nor any cross-market correlations responded immediately. Land prices continued to rise for a while, but reacted sharply to the lending limits on real-estate-related industries set by the Ministry of Finance in April 1990. By the fall of 1990, land prices were falling nationwide. Bond-equity correlations remained positive until 1993. Lack of liquidity and infrequent settlement cycles, as well as inflation concerns, inhibited the use of government bonds as a safe haven.

Amplifying Factors

The stock market falls were amplified by portfolio insurance products and by arbitrage activities between stock and futures markets—the same mechanism as in Black Monday—as well as by unwinding of margin trading.

Lending based on land and, to a lesser extent, equities as collateral amplified Japan's financial bubble and the subsequent burst. When equity prices began falling, initially investors shifted their funds out of the stock market into land investments and bank deposits, which boosted banks' lending against land collateral. The "land myth" that land prices would never fall and "bank myth" that banks would never fail created a widespread false belief that land and banks were a safe haven, even after the stock market collapse began.

Financial risks started to accumulate in banks' balance sheets. Due to long-term relationships, banks did not wind down stockholdings or, after land prices began falling, loans collateralized on land. Historical cost accounting and inadequate disclosure allowed banks to defer losses stemming from stock falls and recognition of nonperforming loans. Nevertheless, the continued slide in land and stock prices gradually eroded banks' economic capital. Ineffective unwinding of impaired assets aggravated the crisis by leading to credit contraction and contributing to recession and deflation.

Responses by the Market and by the Official Sector

Initially, the continued strong economic and monetary growth led the Bank of Japan to continue tightening monetary policy even though stock prices were collapsing. The Bank of Japan eventually began easing monetary policy in August 1991 but a substantial amount of funds flowed into the government bond market for safety. Continued land and stock price declines further weakened the balance sheets of the banks and corporations despite further monetary easing and fiscal expansion. Eventually in February 1999, to abate deflationary pressures, the Bank of Japan adopted the zero interest rate policy.

On the structural front, a series of deregulations was introduced to improve the efficiency of the financial system and the government promoted financial consolidation. Mark-to-market accounting was introduced and several agencies were established by the government to purchase nonperforming loans (NPLs) and shares held by banks.

But, amid weak capital and low profitability, low interest rates and deposit guarantees allowed banks to delay costly debt restructuring. Delays in debt restructuring created more NPLs than banks' operating profits can absorb. Cross-shareholdings also made it difficult for banks to sell devalued stocks, and thus left banks highly vulnerable to equity prices. Consequently, the financial system became more fragile to the point that some banks required injections of public capital.

Failure of LTCM in 1998²⁰

Initial Macroeconomic and Business Conditions

In the mid-to-late 1990s, most mature economies, especially the United States, grew steadily in a low inflationary environment. The belief that the U.S. economy had entered

a new age of high productivity growth, financial globalization and the successful process toward EMU, and continued flows of funds into the United States and other mature equity and bond markets supported a long-lasting appreciation of asset prices. However, weakening counterparty credit standards, complacent risk management, and lack of disclosure by hedge funds allowed firms such as LTCM to build up highly leveraged positions that were not appreciated by the market and that in some areas amplified the asset price appreciation. Instead of controlling the size of their positions with hedge funds, counterparties relied heavily on collateralization of mark-to-market exposures to control risks.

Crisis Trigger

In August 1998, Russia's unilateral debt restructuring triggered a global reversal of the excessive narrowing in credit spreads. Unwinding convergence plays put selling pressures on mature market securities that had been used as collateral in leveraged positions in GKO and other emerging market asset positions. By mid-September, the rapidly mounting margin requirements pushed LTCM to the brink of collapse.

Market Price Reaction

Market stories of LTCM's weakness contributed to the swap spread widening in the week of August 17 and equity option volatility increases in the week of August 24. Spreads between older ("off-the-run") and benchmark treasuries widened by up to 35 basis points as the sell-off of off-the-run issues caused their liquidity to evaporate, while there was a flight-to-quality into benchmark bonds. U.S. and other government yields dropped from September 29 to October 6. The principal equity markets sold off jointly and bond-equity correlations turned negative in the United

²⁰See IMF (1998) for more details.

States, United Kingdom, and Germany, reflecting further flight-to-quality. As margin calls spread to other hedge fund positions, the dollar dropped by 17 percent against the yen from October 6 to 8.

Amplifying Factors

The key amplifier in the LTCM episode was leverage. LTCM engaged in credit spread plays based on the leveraging of on- and off-balance-sheet positions (though reportedly later also took some directional positions, particularly on equity volatility). LTCM levered up its positions by short-selling lower-yielding high-quality assets and using the proceeds to take long positions in riskier assets (mortgage-backed securities, mature market junk bonds). It also repoed assets and invested the proceeds in other relatively high-yield assets, including derivative contracts. LTCM's balance sheet positions totaled about \$120 billion at the beginning of 1998, compared with a capital base of \$4.8 billion. At the same time, LTCM held \$1.3 trillion gross notional value of off-balance-sheet derivative positions.

Major counterparties, because of competitive pressures, did not require initial margins for derivative contracts and took no haircut on repo transactions, and this allowed LTCM to build up high leverage with relatively little capital. Lack of transparency about hedge fund activities and failure by many other market participants to adequately monitor counterparty and market risks further allowed LTCM and others to build up leverage.

Once the crisis began, LTCM's attempts to unwind its positions amplified the volatility. The Russian crisis, at first, widened credit spreads. LTCM responded to the resulting margin calls by liquidating some of its most liquid positions. However, the selling pressure pushed down the prices of underlying assets and widened credit spreads further. This spiral gradually forced LTCM to liquidate less liquid positions at losses. The unwinding process was also accentuated by the fact that many of

its counterparties, and other market participants, took on similar leveraged positions and also faced selling pressures.

Responses by the Market and by the Official Sector

Concerned that a forced liquidation of LTCM's complex positions could produce major market disruptions and possible counterparty failures among systemically important institutions, the Federal Reserve orchestrated a coordinated resolution of LTCM by its creditors. Fourteen major creditors and counterparties of LTCM agreed to take over its management and inject \$3.6 billion to manage its orderly unwinding. This coordinated effort prevented a chain reaction of distressed sales of positions and possible failures that could have further disrupted U.S. and international capital markets. The Fed did not contribute funds to LTCM's resolution, and instead provided liquidity to the wider money market to ensure orderly clearing of securities transactions and deter panic sales.

Learning from these lessons, financial supervisors in the United States and elsewhere put more emphasis on internal risk controls and risk assessment, and encouraged banks to intensify monitoring of their borrowers' financial status (see IMF, 1999). Many mature market supervisors have intensified market surveillance. Due to the global repercussions of the LTCM incident and related problems from the financial crisis, the G-7 established the Financial Stability Forum to improve cross-border and cross-market cooperation of official agencies in identifying incipient vulnerabilities. The Basel Committee on Bank Supervision published guidance on sound practice for banks' interaction with highly leveraged institutions (HLIs). Internationally active banks strengthened monitoring of HLIs and improved counterparty risk and collateral management. The growing understanding of the need to diversify credit risks also spurred the growth of new financial products, such as credit derivatives.

Market Conditions Following the TMT Equity Bubble Collapse

Macroeconomic and Business Conditions

The long period of global economic growth in the 1990s supported strong investment and consumption spending—financed to a large extent by debt—and the surge in equity prices. Information technology (IT) innovation led to euphoria about the “new economy,” strong sustained productivity gains, and exuberant expectations of long-term growth in demand and profits, especially in the TMT sector. Deregulated energy and communications markets created opportunities for rapid business growth. The dotcom boom was also fuelled by the prospect of lucrative initial public offerings or takeovers by established companies.

Crisis Trigger

A developing investment and inventory overhang and overcapacities, particularly in the fast-rising telecom and IT industries, gave rise to a reassessment of business models and of projections for long-term earnings. Against this background, a sharp drop in profits for companies in these sectors in early 2002 combined with increasing nervousness about valuation levels of stocks led TMT stocks to begin falling.

Market Price Reaction

A far slower process of risk aversion has emerged through the process of unwinding the TMT equity bubble. The NASDAQ fell 32 percent from its open on March 27 to its close on April 14, 2000, the start of a long slide that ultimately took this technology-related index down 78 percent from early 2000 to late 2002. Deepening and widening interactions included a decline in the broader U.S. and European indices starting in the second half of 2000. Successive equity lows created deeper uncertainty, culminating in the equity lows of mid-to-late 2002 (for the broader markets, the largest cumulative equity decline since the

mid-1970s) when equity volatilities peaked, and credit spreads reached highs not seen in over a decade. Bond-equity correlations in the United States and the United Kingdom turned negative and remained so from early in 2000, reflecting flight-to-quality. In Germany and Japan bond-equity correlations turned sharply negative in the fall.

Amplifying Factors

Leverage taken on, particularly by energy and telecommunications companies, amplified the TMT equity bubble. Many issuers in these newly deregulated sectors were able to remain highly rated and raise large amounts of debt. Meanwhile others were able to raise large amounts in the high-yield market.

Moreover, attempts were made by others in the corporate sector to match the apparent equity results of high-tech sectors by financial leverage, including venture capital investments in dotcom companies and telecom companies. Weak corporate governance and internal controls allowed many companies to reward their managers with stock options and other benefits, sometimes tempting managers to manipulate short-term earnings. Conflicts of interest and governance problems at investment banks led to abuses, such as misleadingly optimistic analyst reports and allocations of IPO stock to insiders.

During the boom, many insurance and pension fund investors tended to automatically purchase equity and debt in proportion to the market to remain close to index weightings. This helped to sustain the boom, although these investors were not highly leveraged and therefore did not come under pressure to sell quickly once the bubble burst.

Nevertheless, during the post-bubble period, gradual sales of equities by insurers to preserve their capital strength and meet regulatory requirements as their asset portfolio values fell contributed to equity market declines.

Bank lending began to decline, reflecting the shared assessment by syndicated lenders in late 2000 that some lending had been

excessive. The commercial paper market contracted sharply, cutting off new funding and requiring repayments in response to market rumors, starting in 2001. Subsequently, headline bankruptcies at Enron (2001) and WorldCom (2002) led to large investor losses and a loss of confidence in the accuracy of reported corporate results. During this later period lower corporate investment and GDP growth, combined with the events of September 11, 2001, and the uncertainties leading up to the Iraq war, kept the equity falls going.

Responses by the Market and by the Official Sector

The robust banking system worked as a conduit of liquidity to securities brokers. Although banks had facilitated corporate fund-raising, they had managed to control their risks, including by taking a cautious attitude toward equity investments, selling credit products on to other investors, or by otherwise reducing exposure through devices such as credit derivatives.

Businesses themselves, facing a cash squeeze, began aggressively improving their cash flow starting in early 2001. Investment spending dropped precipitously, liquidity cushions were built up, and the maturity of borrowing extended. Corporate bond markets were willing to fund companies based on case-by-case examination of the names, resulting in a surge in bond issues in 2001.

As longer-term policy responses, authorities in the United States and other financial centers took measures to strengthen corporate governance and accounting and auditing standards. The Sarbanes-Oxley Act of 2002 created the Public Company Accounting Oversight Board, required new rules dealing with analyst conflicts of interest, strengthened corporate governance and disclosure, and limited insider transactions and loans to executives. The New York Stock Exchange and NASDAQ are taking steps to tighten corporate governance standards and place more empha-

sis on independent directors. The U.S. financial supervisors now require financial conglomerates to separate research and investment banking.

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