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**COMMITTEE ON THE GLOBAL FINANCIAL SYSTEM**

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**October 1999**

**A REVIEW OF FINANCIAL MARKET EVENTS  
IN AUTUMN 1998**

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**BANK FOR INTERNATIONAL SETTLEMENTS  
Basel, Switzerland**

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# Chapter 1

## Introduction and summary

Following its March 1999 meeting, the Committee on the Global Financial System formed a working group, chaired by Karen Johnson of the Board of Governors of the Federal Reserve System, to examine the events surrounding the market stresses in many international financial markets in autumn 1998. The group was charged with putting these events in perspective, with special emphasis on understanding the suddenness of the deterioration in liquidity and elevation of risk spreads in a wide variety of markets, the proximate causes of the withdrawal from risk-taking, and the speed with which and extent to which markets subsequently recovered. The focus of the working group, therefore, was on developments across many markets in a relatively narrow time frame, as opposed to the more general investigation of market liquidity provided by an earlier report to the CGFS or the scrutiny of a narrow set of financial entities contained in the report of the US President's Working Group and the recommendations on industry practices of the Counterparty Risk Management Policy Group.<sup>1</sup>

The working group assembled a large dataset on key financial prices in major international markets and attempted to characterise the degree to which price movements in the autumn were outsized and evidenced different correlations from those observed in relatively more tranquil times. (These data and some of the broad regularities among them are described in Annex 2.) It also searched contemporaneous accounts of the events to establish a time line of significant influences on markets (included as Table 1). Group members interviewed market participants in a number of international financial centres in June 1999 to learn about their actions regarding risk exposure and credit risk management. The group as a whole met with a half dozen market participants in Basel in early July to further that dialogue. Annex 1 summarises the insights gained from the interviews.

This is the report of the Working Group. Chapter 2 provides background on the episode of market stress in autumn 1998. The first part of Chapter 2 summarises the events of the period of market turmoil since mid-1997, noting the differences between the period July 1997–July 1998 and the period July 1998–early 1999. The second part examines the process of recovery in markets, which occurred rapidly as participants were encouraged by official action and emboldened by the profit opportunities offered in wide price spreads. Chapter 3 provides an analytic interpretation of the events of July–October 1998 and identifies important mechanisms that appeared to spread disruption across financial centres and amplified price dynamics. Some of those factors – such as an inadequate assessment of counterparty risks that permitted the excessive use of leverage, the failure to incorporate in risk management potential feedback effects of market liquidity on price setting, and the lack of information on aggregate positions – have already been identified as weaknesses in market structure in prior analyses of the events of last autumn by both the private sector and official institutions and have triggered a variety of responses and recommendations for additional changes. Other mechanisms – including a shrinking number of key market participants, the widespread emulation of certain financing, trading and risk management strategies, and compensation schemes encouraging a short-term focus in decision-making – are more entrenched in the structure of the financial industry and may still pose risks going forward. A diagram at the end of Chapter 3 summarises in schematic form the cycle of deterioration in market functioning as understood by the Working Group.

Chapter 4 examines the lasting imprint of last year's events. Risk spreads and many indicators of market liquidity have not returned to their levels of the summer preceding the storm, and indeed some

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<sup>1</sup> See BIS, Committee on the Global Financial System (1999), *Market Liquidity: Research Results and Selected Policy Implications* (the Shirakawa Report), the President's Working Group on Financial Markets (1999) *Report on Hedge Funds and the Long-Term Capital Management Episode*, and Counterparty Risk Management Policy Group (1999), *Improving Counterparty Risk Management Practices* (the Corrigan-Thieke Report).

have returned to their crisis levels. This may suggest that, on balance, market-makers and arbitrageurs have scaled back their activities somewhat and investors are more wary about the income prospects associated with a broad range of securities. To the extent that such risk spreads had been bid down to extremely low levels by historical standards in the period before the market pressures erupted, the subsequent net increase in those spreads may have made them now more consistent with fundamentals. Moreover, market participants appear to be taking steps to reduce their exposures to the recurrence of a widespread flight to quality, such as by using rates on private sector rather than government obligations as the benchmarks for pricing. But the net effect of these changes – both the reduced amount of capital devoted to enforcing arbitrage strategies and the shifting of hedging strategies – may have contributed to the recent widening of interest rate spreads, particularly on swaps, in many industrial countries in recent months.

Chapter 4 also draws some tentative lessons for policymakers from this experience. Foremost is the realisation that the first line of defence at a time of market stress is sound risk management by market participants, which in turn requires a regulatory and monetary policy environment ensuring that market discipline effectively governs credit decisions and risk-taking. Policymakers should also appreciate that the fallout from last year's financial market strains was less pronounced on real activity in the industrial countries because a healthy commercial banking system was able to act as a substitute means of intermediating funds. This helps to explain why in this episode the availability of credit to non-banks proved to be relatively more resilient in financial systems, such as those in the continental European countries, where banks play an important role, compared with those systems more oriented towards market-based financial intermediation. Thus, keeping depository institutions safe and sound must remain a priority. While some financial institutions were under severe stress at times, the events of last autumn were initially more a matter of a drying-up of market liquidity than a general withdrawal of credit availability. The subsequent dynamics, though, were complicated as the initial deterioration in market functioning that made participants less confident about price setting also subsequently induced credit strains as collateral values eroded and concerns about counterparties mounted.

Chapter 5 concludes with an outline of work still to be done. The group's efforts to describe the large dataset it collected only scratched the surface of potential empirical work. In addition, more sophisticated financial theory may be able to define more rigorously indicators of market stress, while continued contacts with market participants may make it possible to understand better the management of credit and market risks.

Table 1

**Significant events in the second half of 1998**

(All financial-market price and volume figures are for the 1998 sample period.  
Price figures are based on daily closing values.)

<b>Date</b>	<b>Event</b>
6 July	Salomon Brothers bond arbitrage desk disbanded
14 July	IMF approves Russia loan package
20 July	First WSJ headline on LTCM losses
21 July	Greenspan's Humphrey-Hawkins' testimony
23 July	Japanese sovereign debt placed under review
7 August	World Bank approves Russia loan.
13 August	Fall in HK stock market index (down 8% from Aug 12)
14 August	First HKMA stock market intervention
17 August	Russian effective default and rouble devaluation
31 August	Largest daily fall in DJIA
1 September	Malaysia imposes capital controls Highest volume (number of shares) on NYSE
2 September	LTCM shareholder letter issued
4 September	Greenspan speech at U.C. Berkeley First WSJ headline on Lehman Brothers' losses
7 September	HKMA introduced a set of seven technical measures to strengthen the mechanism of the currency board system
9 September	Bank of Japan reduces overnight call rate
10 September	Largest daily fall in 10-year US Treasury yield Largest daily fall in 10-year JGB yield
11 September	Largest daily increase in 10-year £ swap spread
12 September	Largest daily increase in 10-year US\$ swap spread
23 September	LTCM recapitalisation
28 September	Goldman Sachs delays flotation
29 September	Federal Reserve interest rate cut
1 October	Greenspan-McDonough Congressional testimony on LTCM Largest daily fall in 10-year UK Gilt yield
4 October	G7 statement
7 October	Bank of Spain cuts interest rates
8 October	Bank of England cuts interest rates
7-8 October	Yen/\$ falls 9%
9 October	Central banks of Portugal and Ireland cut interest rates Largest daily rise in 10-year US Treasury yield Largest daily rise in 10-year UK Gilt yield Largest daily rise in 10-year German Bund yield
10-11 October	Ellington Capital Management auctioned \$1.5 billion of mortgage securities
12 October	Japanese Diet approves bank reform legislation
14 October	BankAmerica Corp. reports fall in earnings of 78%
15 October	Inter-meeting Federal Reserve Rate cut
20 October	First LTCM swap auction
2 November	Second LTCM swap auction
5 November	Second rate cut by Bank of England
13 November	Brazilian government formally requested the IMF program.

Table 1 – contd.

<b>Date</b>	<b>Event</b>
17 November	Third Federal Reserve rate cut Japan sovereign debt downgraded by Moody's Third LTCM swap auction
2 December	IMF Board approves the program for Brazil
3 December	Co-ordinated interest rate cut by European central banks
10 December	Third rate cut by Bank of England
10 January	Market disrupted after Chinese government refused to help foreign creditors of GITIC
13 January	Fears of debt crisis in China sweep through Hong Kong, Hang Seng index falls more than 4% Brazilian devaluation – wider band.

## Chapter 2

### Background to the episode of market stress

Most analysts date the onset of the recent period of turmoil in international financial markets to the devaluation of the Thai baht in July 1997. That is not to say in retrospect that early warning signals had not been evident sooner for some national markets or that other markets, notably in eastern Europe, had not already been hit hard by bouts of stress. From the summer of 1997 onwards, however, turmoil appeared quickly in other emerging markets in Asia where broadly similar vulnerabilities, such as fragile financial sectors, possibly overvalued exchange rates and substantial short-term foreign currency denominated liabilities relative to reserves, were seen to be present. While stresses seemed to subside in spring 1998, they re-emerged with force in crises in Russia and Brazil and in industrial country markets in autumn 1998. The period from July 1997 to the end of 1998 can be divided into two distinct episodes, the first beginning in July 1997 and the second beginning in August 1998. Establishing the important contrasts between these two episodes provides the rationale for concentrating on the events of autumn 1998.

The turmoil that began with the Thai crisis quickly precipitated similar stresses in the financial markets of South-East Asia, Korea, Hong Kong, Taiwan and, to some extent, Latin America. Asian equity prices fell irregularly by about 50% from August 1997 to September 1998, and then began a recovery (Chart 1).<sup>2</sup> Currencies generally depreciated by 50-100% from August 1997 to the end of the year, and then began a recovery that left an overall 50% depreciation by September 1998 (Chart 2). The exception was Indonesia, where the rupiah depreciated sixfold and subsequently recovered threefold.

While the turmoil in the Asian economies from June 1997 to August 1998 led to an increase in certain risk premia in the financial markets of the industrialised economies, on balance the effects appear to have been neutral or even supportive of a continued rally in those markets. Long-term government bond yields in industrial countries fell, beginning around July 1997, as shown in Chart 3. The movement was most pronounced in the US market, where rates peaked around April-May 1997, and then trended down to early 1998. A similar movement can be seen in the German and Japanese markets. These rate declines had some element of a “flight to quality,” as investors withdrew from emerging market securities into industrial country government debt. But market participants also apparently reasoned that the deterioration of economic activity in Asia, by weakening the exports of industrial countries and causing a drag on commodity and other import prices, would lessen worldwide inflationary pressures.

Equity markets in the United States and Europe remained strong, though that upward movement was interrupted briefly in late October 1997, after share prices in Hong Kong shed nearly 30%. After a sharp one-day decline, US and European markets reversed quickly and moved towards new highs in mid-1998. Japan’s equity markets remained weak, for reasons special to Japan. Thus, despite the turmoil in emerging markets, there appeared to be no substantial long-lasting disruption in industrial country equity markets. Similarly, the markets for corporate debt in industrial countries were apparently little affected. In the United States, as shown in Chart 4, for instance, spreads of corporate yields over those on comparable government securities widened only slightly through mid-1998. Moreover, the rise in spreads was smaller than the decline in government yields, implying that, on balance, most corporate borrowers enjoyed more favourable terms.

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<sup>2</sup> Charts 1-12 and Tables 2-6 can be found at the end of the report.

To an important extent, this flight to safety benefited US assets in particular. Besides the rise in bond and stock prices, the US dollar gained on foreign exchange markets against the currencies of both emerging and developed economies, and the US dollar appreciated towards a local peak in August 1998, with the yen/dollar rate reaching a high of ¥147. In contrast, enthusiasm for pending monetary union in Europe worked to offset this ongoing strength of dollar assets, holding the Deutsche mark/dollar exchange rate essentially flat.

Thus, financial markets in industrial countries seem, for the most part, to have avoided negative effects from the Asian crisis. To be sure, the downward movement in share prices in October 1997 showed that a shock to one national market could spread quickly. Moreover, the mechanisms mentioned by some analysts at the time for facilitating the spread of shocks across markets – including the extensive use of leverage and certain financing, trading and hedging techniques – remained in place. But it was not until August 1998 that the picture changed markedly. The effective default by Russia on some government debt obligations on 17 August and the devaluation of the rouble shortly thereafter resulted in sizable losses for some investors. Some of these positions were highly leveraged through collateralised financing arrangements, such as securities lending, repurchase agreements and margin accounts at futures exchanges, which required that positions be marked to market daily. The erosion of the value of collateralised obligations as market prices moved produced, in effect, a global “margin call.”

The Russian default probably increased the perception of risk in other emerging market economies, especially in Latin America, partly by reminding investors of the inherent riskiness of investments in these economies but also by inducing a re-examination of the ability and willingness of major countries and international organisations to support credit-strapped sovereigns. The currencies of many emerging economies came under substantial pressure, and the market value of the international debt obligations of some countries declined sharply. Investors around the world shared in the resulting losses, and economic growth and corporate profits were perceived to be vulnerable. In these circumstances, many investors appeared to reassess the credit quality of various counterparties. More fundamentally, investment decisions apparently reflected some combination of an upward revision to uncertainty surrounding the expected future prices of financial instruments more broadly – either because such risks were correctly viewed as more substantial or because an earlier misconception that risks were low was corrected – and a reduced tolerance for bearing risk. The precise mechanisms that spread this reaction and amplified market dynamics are discussed further in Chapter 3.

The resulting shift of demand towards safety and liquidity between mid-August and mid-September accentuated the downward trend in yields on the government debt of major industrial countries. Yields on higher-quality private securities fell much less, and those on issues of lower-rated firms increased sharply. As a result, and in contrast to the earlier period, spreads of private rates over government rates rose substantially, reaching levels not seen for many years, and issuance of corporate securities dropped sharply. The spreads of private over comparable government rates in many major financial centres rose to recent highs in August-October at both short (Table 2) and long (Table 3) maturities. In industrial countries, the increases in spreads posted from lows earlier in the year ranged from 40 to more than 300 basis points.

In equity markets, share prices in industrial countries fell markedly in August and September 1998. General doubts about the financial sectors of industrial countries also intensified, evident in the more pronounced drop in equity values of financial institutions relative to broader indices in the United States and Europe (Chart 5). The largest losses were posted by European banks, which were presumably thought by investors to have a greater direct exposure to Russia. But US financial institutions were also hit hard, and more so over time. Reflecting the comparatively minor direct exposures of Japanese banks to Russia and the fact that investors’ opinion of such institutions had soured much earlier, the equity prices of Japanese banks, on average, tracked the general market there. Similar evidence of doubts about depository institutions became evident in funding costs in the interbank market (Chart 6). Three-month deposit rate spreads over yields on government securities widened first and by most in the United States and Canada and ultimately rose in the United Kingdom and France as well (though as with corporate bonds these spreads also reflected lower government yields resulting from the flight to safety).



In addition, the movement of the dollar/yen exchange rate was reversed, with the dollar depreciating against the yen in sharp declines over several days. The reasons underlying these sudden and marked increases in the exchange value of the yen were not evidently related to macroeconomic developments at the time. While the secular imbalances of the trade positions of the United States and Japan could explain longer-term pressures on the yen/dollar exchange rate, no specific trigger to such concerns emerged in these days. Rather, in retrospect and as will be discussed below, the unwinding of leveraged positions underpinned by large yen borrowings seems to have played an important role.

The rise in spreads of the debt of emerging economies over US Treasury yields was not confined to Russia, where prices of government paper were slashed to a fraction of their original value. Many eastern European countries and some in Latin America saw the spread of the yields on their debt over those on Treasuries surpass 10 percentage points (Chart 7). Losses incurred in Russia and other emerging markets by leveraged investors – including banks, brokerage houses and hedge funds – raised the prospects for distress sales of other risky assets by such investors, weighing on market sentiment and depressing prices. Many of these entities reduced the scale of their operations and trimmed their risk exposures, responding to pressures from more cautious counterparties and their own need to preserve capital in an environment of heightened uncertainty and a lessened tolerance for bearing risk. As a result, liquidity in many markets declined sharply, with bid-ask spreads widening and large transactions becoming more difficult to complete.

In the market for government securities, the costs of transacting and the ability to do so in large volume deteriorated. For example, periodic surveys of bid-ask spreads for Treasury securities conducted among US primary dealers at the time indicated a marked increase in caution on their part relative to what was reported to be typical in the early summer. The spreads at which dealers stood willing to transact in on-the-run coupon securities rose from 1/64th of a price point to between 1/32nd and 5/32nd of a point. For many older issues, no quotes were available at all. In an environment where there was less assurance that large positions in government securities could be unwound quickly without a sizable price concession, investors showed an increased preference for the liquidity offered by the most recent issues at each maturity. The yields on these more actively traded “on-the-run” securities fell noticeably relative to those available on “off-the-run” issues, those which had been outstanding longer (Chart 8).

Demand for the most liquid benchmark securities was further increased by the need of certain market participants to provide top-quality collateral as well as by investors stepping in to benefit from the expected further decline in bond yields in the light of ongoing concern about global deflation. The strong demand for German benchmark bonds as opposed to other securities, for example, led to an appreciation of the bund futures contract and pushed bund rates further below yields on other bond classes and other EMU sovereigns. Signs of deterioration were evident in markets for private securities. Bid-ask spreads on corporate instruments also widened. In the United Kingdom, for instance, spreads on Baa securities more than doubled over the course of the fall (Chart 9). In many markets, corporate risk spreads widened as well.

Conditions in world financial markets deteriorated further following revelations in early September of the magnitude of losses at a major hedge fund, Long-Term Capital Management (LTCM). LTCM indicated that it sought high rates of return primarily by identifying small discrepancies in the prices of various instruments relative to historical norms and then taking highly leveraged positions in those instruments in the expectation that market prices would revert to such norms over time. In pursuing its strategy, LTCM took very large positions, some of which were in relatively small and illiquid markets. While primarily concentrated in debt instruments, the firm also put on large bets in the aggregate both that the volatility of equity prices in the United States would decline and that a few equity prices would revert to their more usual historical behaviour relative to one another. In aggregate, LTCM supported assets of about \$125 billion on a capital base of about \$4 billion at mid-summer.

In an effort to avoid the adverse market consequences of the precipitous unwinding of LTCM’s portfolio that might have followed the firm’s default, the Federal Reserve Bank of New York contacted the major creditors and counterparties of LTCM to see if an alternative to default could be found. Subsequent discussions among the creditors and counterparties led to an agreement by the

private sector parties to provide an additional \$3½ billion of capital to LTCM in return for a 90% equity stake in the firm.

The private sector agreement to recapitalise LTCM allowed its positions to be reduced in an orderly manner over time. Nonetheless, the actual and anticipated unwinding of LTCM's portfolio, as well as actual and anticipated sales by other similarly placed leveraged investors, are likely to have contributed materially to the tremendous volatility of financial markets in early October. Market expectations of asset price volatility going forward, as reflected in options prices, rose sharply (Charts 10 and 11), as bid-ask spreads and the premium for on-the-run securities widened further. Long-term US Treasury yields briefly dipped to their lowest levels in more than 30 years, in part because of large demand shifts resulting from concerns about the safety and liquidity of private and emerging market securities. Spreads of rates on corporate bonds over those on comparable Treasury securities rose considerably, and issuance of corporate bonds, especially by lower-rated firms, remained very low. The stressed capital positions of many leveraged market participants increased calls for collateral from creditors. However, one stress-reducing consequence of this process was that it induced some paring-back of speculative positions in Asia, narrowing risk spreads and lessening pressures in exchange markets there.

To some extent, commercial banks were able to cushion the constriction of market finance in industrial countries, especially in the United States and the United Kingdom, by satisfying drawdowns on outstanding loan commitments to business firms and by holding more securities in their portfolios. Overall, an increased share of business lending was probably extended on floating rather than fixed rate terms. Indicative of this substitution, swap spreads among private borrowers relative to government rates widened in major markets, reflecting a higher premium paid for exchanging floating rate for fixed rate obligations as well as, perhaps, a heightened assessment of credit risk (Chart 12).

In continental Europe, the impact of market stress on the availability of credit to corporate borrowers was limited, given the relatively limited significance of market financing by corporate borrowers and the greater focus on bank-based financial intermediation. The widening of credit and swap spreads in continental Europe remained below levels observed in those financial systems more oriented towards market-based intermediation and credit to corporate borrowers was less constricted.

However, in general, the willingness of financial institutions in industrial countries to take on risk, especially with respect to international interbank as well as international credit and securities market activities, diminished considerably during this phase of market stress. (See, for example, BIS, *International Banking and Financial Market Developments*, March 1999 and June 1999.)

Almost as suddenly as the storm broke, market conditions in industrial countries stopped deteriorating by mid-October. Liquidity began to improve somewhat in the days and weeks following the cut in the Federal Reserve's intended level for the federal funds rate on 15 October, a policy move that may have had an especially strong market impact because it was taken between regularly scheduled monetary policy meetings. Internationally coordinated efforts to help Brazil cope with its financial difficulties, culminating in the announcement of an IMF-led support package in mid-November, contributed to the easing of market strains. In the government securities markets of most industrial economies, bid-ask spreads narrowed somewhat and the premium for on-the-run issues declined. With the earlier flight to quality and liquidity unwinding, rates on government bonds of industrial countries backed up considerably. Corporate bond spreads reversed a part of their earlier rise, and investment-grade bond issuance rebounded sharply. In the high-yield bond market, investors appear to have remained more hesitant, especially for all but the best-known issuers. Though the volume of junk bond issuance picked up, it did so by less than in the investment-grade market.

By the beginning of 1999, some measures of market stress had eased considerably from their levels in the fall. Equity markets had recovered most, but not all, of their autumn losses. With market yields low in absolute terms, many corporate borrowers brought new issues to market. However, markets remained somewhat illiquid relative to historical norms and risk spreads on corporate bonds stayed quite elevated. Indeed, swap spreads again breached new highs in August 1999. While the widening in swap spreads themselves probably reflected some displacement in the normal seasonal pattern of corporate borrowing, as issuers attempted to move forward their expected sales to avoid an expected

increase in official rates in the United States and subdued activity around the century date change, this may be an example of the kind of price anomaly which prior to the autumn 1998 crisis would have been quickly eliminated by the activity of leveraged position-takers.

Just as it is difficult to point to a single event as triggering the stresses in financial markets to begin with, no one action appears responsible for commencing the healing process. In interviews with members of the working group, market participants offered four candidate explanations, which apparently accumulated in October and November to encourage a return to more normal risk-taking.

(1) ***Monetary policy easing***, especially the inter-meeting move on 15 October by the Federal Reserve, induced many to believe that monetary accommodation would be forthcoming as long as market pressures posed a risk to economic expansion. Such tendencies were reinforced by the easing of monetary policy by the Bank of England and by scheduled participants in European monetary union converging on a single interest rate. Effectively, policymakers' willingness to act trimmed the adverse tail to potential economic outcomes, in a sense underwriting a renewed confidence in taking on risk. Reflecting that change in sentiment, equity prices in most major economies rallied from mid-October onwards.

(2) ***The orderly continuation in the risk arbitrage business of the newly recapitalised LTCM*** led market participants to take out any "fire sale" discount that may have been embedded in asset prices across a wide variety of instruments used in relative value trades.

(3) ***As time elapsed and no other large firm showed signs of failing***, market participants came to feel that some of their fears might have been overblown.

(4) ***Wide spreads in a variety of markets induced investors with longer time horizons to return to markets***. In effect, the exit of investors and traders with a short-term focus left money on the table for those entities willing to ride out the episode of market stress. As those spreads persisted beyond levels that would have reflected historical norms and an appropriate assessment of risks, more of such mobile capital entered. To be sure, the provision of some of this substitute funding did not always come entirely at lenders' initiative. In particular, some large internationally active commercial banks were confronted with a heavy volume of requests to honour outstanding loan commitments. Some businesses, rather than risk tapping markets when they were tender, drew instead upon backup lines of credit. Because such banks were generally well capitalised, they were able to meet such contingent obligations and, in some cases, pick up new business as well. This availability of a substitute to market financing may have helped contain market stresses and work to limit the fallout from such stresses on real economic activity.

### **Indications of financial market stress in the second half of 1998**

- Following Russia's currency devaluation and default, yield spreads on corporate bonds widened sharply worldwide, particularly for instruments with lower credit standing. By mid-September, corporate junk bond spreads had risen 200-750 basis points from their mid-year levels, medium-quality BBB spreads were up 25-60 basis points, and even high-quality AA corporate spreads were 10-35 basis points higher. Swap spreads in most major currencies rose 25-50 basis points over this period.
- Between their mid-year peaks and early October, equities in industrial countries shed 15-35% of their market value, with financial-sector and small-capitalisation indices falling more than the overall market. Swiss bank stock prices dropped by more than half. Emerging market stock indices also fell hard, but had largely bottomed out by early September.
- Day-to-day changes in financial prices were unusually volatile. Measures of implied volatility, inferred from options prices, rose sharply, peaking in October for most industrial country markets, but earlier in Latin America and later in Switzerland.
- Quoted bid-ask spreads rose in a number of markets, reflecting reduced liquidity. The yield premium for "off-the-run" government bonds in major industrial countries also widened somewhat, suggesting that investors were deriving particular comfort from the more liquid "on-the-run" issues.
- An indicator of liquidity in primary capital markets, private sector securities issuance, fell precipitously and then rebounded dramatically near year-end, suggesting that many firms had to delay financing for several months. However, sources of intermediated funds apparently did not dry up, with international loan origination volume holding steady.

## Chapter 3

### **Mechanisms producing contagion and amplifying market dynamics**

The general impression drawn from the working group's analysis and discussions is that the events of autumn 1998 cannot be understood in isolation. Rather, financial markets had weathered a series of blows, beginning with the sharp devaluation of the Thai baht in July 1997 and continuing with crises in Indonesia, Malaysia and Korea and a short-lived equity price correction. However, while the immediately preceding period of turmoil was stressful in a variety of markets, there had been no lasting imprint on the debt and equity securities of major industrial countries. The Asian crisis had not led to wider concerns about the global banking sector to the same extent as, for example, the 1980s Latin American debt crisis. On the contrary, to the extent that turmoil in Asia had induced a flight to quality and provided a deflationary drag on the industrial world's economies, yields in major countries tended to fall, cushioning any adverse impact of a weaker profits outlook on equity prices.

Indeed, as the first half of 1998 played out, an important set of trading strategies reaped further rewards. "Relative value arbitrage" mostly involves convergence trades, in which approximately offsetting positions are taken in two securities that have similar, but not identical, characteristics and trade at different prices. The securities in question might be two government notes differing only by date of issue, equity shares of the same firm trading on different national markets, or private and public debt instruments. By selling short the expensive security, the trader receives sufficient proceeds to buy the cheaper one. If the assumption that the two prices will converge proves correct, capital gains will accrue on one, or perhaps both, legs of the transaction. A particularly attractive feature of this strategy is the property that general changes in interest rates, such as those associated with central bank action or other macroeconomic shocks, should have offsetting effects on the purchase and short sale. Thus, a convergence play should offer important diversification benefits to a portfolio otherwise exposed to various macroeconomic risks.

However, unlike the conventional definition of arbitrage – i.e. the trade in identical assets that does not put capital at risk – relative value arbitrage is risky, as it relies on an assumed relationship reasserting itself to make prices converge in sufficient time. Often, the assumed relationship is derived from the historical behaviour of rates of return. The increasing sophistication of finance theory in the late 1980s and 1990s and improvements in computing power that enabled large amounts of data to be collected and analysed rapidly have also made it possible to identify and to price the individual components of risk in a widening class of financial instruments. Relying on those models allowed some firms to bet on the convergence of the prices of those components of risk that were similar across financial instruments. Yet, however sophisticated its analysis, a firm that bets on a narrowing of credit spreads or liquidity spreads is, in effect, performing a credit or liquidity intermediation role in the economy and suffers when the market prices of credit or liquidity risk rise for any reason.

Over the latter half of the 1990s, such convergence trades apparently won more often than they lost, as the decline in inflation worldwide and the run-up to and eventual adoption of monetary union in Europe produced a marked compression of nominal yields in major industrial countries – with the notable exception of Japan. This tendency among government yields was reinforced for private securities by a robust economic expansion in the United States that lent assurance that credit risk was low. General gains in equity prices in the major industrial countries provided investors with sizable increments to their wealth, some of which was directed towards more esoteric instruments in the search for higher returns. Swap spreads declined gradually from the early 1990s to early 1997, as risk management technologies improved and the market for these instruments became deeper and more liquid.

The success of the relative value arbitrage trading strategies pioneered by Long-Term Capital Management, together with the high regard for its staff, bred emulators, both at other hedge funds and in the trading operations of investment and commercial banks. It also gave LTCM and some of its

brethren a market reputation that proved useful in gaining credit on advantageous terms. In retrospect, few counterparties seem to have had a complete understanding of the risk profile of such firms, and their credit decisions were heavily influenced by both reputation and strong past performance. In the aggregate, counterparties did not impose sufficiently tight limits on exposures, in part because they relied on collateral agreements requiring frequent marking to market to limit the risk of their exposures. Although these agreements generally provided for collateral with a value sufficient to cover current credit exposures, they did not deal adequately with the potential for future increases in exposures should market values change dramatically.

The resources provided to the risk-arbitrage business helped enforce arbitrage relationships across a broad variety of markets, narrowing spreads and reducing price volatility in a manner that reinforced general macroeconomic trends. Indeed, by early 1998, risk spreads and volatility in most major financial markets were on the low side of experience, despite the tumult in Asian emerging economies.

In this environment of thin risk spreads, low volatility and considerable resources devoted to relative value arbitrage, the first signs of some fraying became evident in the early summer. Table 1 provides a chronology of events that market participants deemed significant to understanding developments, beginning in the second half of the year. In the first listed event, the proprietary trading desk of Salomon Brothers specialising in relative value arbitrage was disbanded on 6 July, as part of the consolidation of Citicorp and Travelers. This both sent a signal to market participants that one large firm viewed the long-run potential of such trading to be adverse and impaired the pricing of some of the common relative value trades as the desk's positions were subsequently closed. In addition, and not entirely unrelated to the price swings associated with Salomon Brothers' action, LTCM posted two successive monthly losses in June and July, a first for that high-flying firm.

Russia's effective debt default triggered sharp market responses that were out of proportion to the relatively modest losses experienced by large financial intermediaries. Apparently, there was a reappraisal by market participants of economic fundamentals. The market participants we spoke to viewed the default as a catalytic event that led them to rethink the certainty of the official backstop that they had taken for granted when purchasing emerging market debt. When coupled with talk of capital controls, and the actual imposition of such controls by Malaysia two weeks later, institutional investors began to view the world as a more hostile and uncertain place.

Uncertainty also extended to concerns about the financial health of some US-based globally active market participants. As worries about credit mounted, counterparties began ratcheting up standards and terms and demanding more collateral, just as the value of many collateralised positions deteriorated. In their own risk management, financial firms attempted to scale back their exposures in many markets. This adjustment of exposures applied both to position-taking activities and to hedging activities. Often, though, concerns about liquidity induced them to adjust their positions first in what were considered to be the deepest markets, government bond cash and futures markets in particular. This in turn led to wider risk spreads between these "core" assets and related instruments such as corporate bonds, confounding the usual correlations among rates of return across many markets and reducing the reliability of standard hedging strategies.

In the light of this uncertainty, there was an evident withdrawal from markets both by market-makers and investors, reflecting capital losses on initial equity, a shift of remaining equity towards safer instruments, and deleveraging. To an important degree, these withdrawals were mutually reinforcing. Market-makers scaled back their participation in non-core instruments because of both the evident lack of appetite for such securities by investors and the increase in the volatility of prices. Investors, observing the general drying-up of liquidity for all but the largest markets and most secure instruments, intensified their flight to safety. Together, they produced a marked escalation in the volatilities of financial prices – both actual and expected. Table 4 provides some evidence on the observed change in market volatility in a broad assortment of financial markets over the course of 1998. The actual change in yields on debt instruments were 40-250% more variable in the autumn than in the first half of the year. In equity and foreign exchange markets, the step-up in the day-to-day change in prices was even more pronounced.

This situation was seriously worsened by LTCM's near collapse. Its announcement in early September of large losses and its search for a capital injection exacerbated market strains in four dimensions. First, the firm itself and many of the entities that copied its risk-arbitrage trading strategies were active in narrowing the differences in returns from instruments that were essentially similar. As LTCM and its emulators scaled back their activities – either voluntarily to preserve their capital or involuntarily as the value of their collateral fell relative to the volatility of prices and creditors exerted more discipline – previously narrow risk spreads on a wide variety of securities widened dramatically. Second, firms that were direct counterparties of the hedge fund began to adjust their own risk exposures to reflect the possibility of default. Third, market participants traded on the anticipation that LTCM – which actively pursued a broad variety of arbitrage trading strategies and had large open positions, some in thin markets – might be forced to close out. Fourth, many market participants, recognising that LTCM's trading strategies were widely copied, had serious doubts about the viability of some other firms. In this situation of great uncertainty, rumours were rife and often fed upon themselves.

In the event, the recapitalisation of LTCM on 23 September by a consortium of 17 financial firms from the United States and Europe that were all active counterparties did not quell these concerns. There were ongoing fears about how quickly the firm would unwind its positions, doubts about its continued viability, and some suspicions that other entities might be in similar circumstances. In that regard, some market participants interpreted official efforts on LTCM's behalf as bespeaking serious and ongoing systemic concerns and providing justification for their own decisions to withdraw from market activities.

The deterioration of liquidity and widening of risk spreads were abetted by various market mechanisms that transmitted these developments to additional markets and amplified market dynamics. (A general schematic depicting those forces at work is provided in Annex 1.) Some of those mechanisms represent failures that have been, or are in the process of being, addressed as a result of the general reappraisal of risk management in light of the near-failure of LTCM. These include:

(1) ***Inadequate counterparty credit assessments*** that allowed LTCM and other entities to use leverage excessively. Market confidence in the principals of LTCM, a consistent track record of earnings, and that firm's policy of spreading its business among a wide collection of counterparties to limit information disclosure garnered it favourable credit terms from many firms. Thus, counterparty restraint was not an effective check on the use of leverage.

While LTCM was exceptional in the extent of its leverage, it was certainly not alone in its reliance on borrowed funds and use of derivative instruments. In a particularly common strategy employed by many firms (although reportedly not by LTCM) leverage was undertaken in the currency of the major market with the cheapest lending terms – Japan – and used to acquire assets denominated in other currencies. This “yen carry” trade generally exposed the borrower not only to the risks inherent in the position being funded, but also to the risk that the foreign exchange value of its yen obligations would change relative to the market value of the acquired asset. When credit terms ratcheted higher in the general flight to safety, many entities had to scale back, elevating the volatility of market prices. The yen/dollar exchange rate was especially susceptible to large intraday changes that many observers linked to the waxing and waning of the yen carry trade. In particular, the sharp appreciation of the yen against the dollar in September and October was apparently related in part to the unwinding of this trade. As credit-strapped leveraged market participants first saw the value of their collateral erode and then began to shrink their balance sheets, they had to acquire yen in the foreign exchange market to repay their initial borrowings.

(2) ***The failure to appreciate the role of market liquidity in risk management.*** The large positions that leverage allowed some firms to amass proved difficult to wind down in the general rush to safety. Essentially, some firms' risk management planning neglected to envision the possibility that their own efforts to close out positions would worsen the terms they faced. This failure to appreciate that credit problems could exacerbate market risk was most evident at LTCM, which had outstanding positions in some instruments representing large multiples of typical daily trading volume. Such stresses were also apparent in a variety of niche markets, such as that for Danish mortgage-backed securities. More generally, almost all markets faced a widening of bid-ask spreads and, to some extent,

a partial pullback of market-makers. As liquidity dried up, hedging proved even more difficult, intensifying pressures in the few remaining liquid instruments.

(3) ***A lack of adequate information on aggregate exposures*** made the prior two failures more probable. Many market participants had an understanding neither of the extent of leverage employed nor of the concentration of risks among a few entities in some markets. Some, but by no means all, of the market participants we spoke to admitted that they had been surprised at the overall size of LTCM in particular and of the outstanding leveraged positions in general.

As a result, market participants in the main may have misestimated the amount of capital actually devoted to keeping spreads tight across a variety of markets, in that they mistook leveraged positions as representing “real money” investment decisions. As those leveraged positions were unwound when both the collateral and the underlying capital supporting them shrank, other investors re-evaluated the appropriateness of spreads in terms of their own risk tolerances, which were less aggressive. Indeed, the lower amount of capital resources devoted to relative-value arbitrage –because of both losses incurred and the withdrawal by some investors – and the general realisation of how slim that capital base really is may imply that market prices now reflect a more appropriate balance that is weighted more towards those who are risk averse rather than risk tolerant.

(4) ***An over-reliance on quantitative tools*** meant that risk management was oriented towards things that could be easily measured – namely historical rates of return and correlations among those returns. However, during the crisis period price and return movements suddenly deviated from many historical correlations, rendering the advice that could be derived from simple risk management rules problematic and significantly complicating the management of portfolio risk.

Some sense of the fragility of those correlations can be obtained from Table 5, which reports the systematic comovement among a variety of risk spreads on a daily basis over the first and second halves of 1998. Two points are clear: first, the relationships prevailing in the earlier period were quite loose, suggesting that they were weak reeds upon which to support complicated risk management techniques; and, second, these correlations tended to pick up across a wide front in the second half.

In the light of this structural instability, investors who believed that they were diversified across instruments or countries were surprised to learn that historical correlations no longer persisted. In that environment, traders found that hedges no longer had the same properties. One lesson learned from this, according to some market participants, was the need to rely more on scenario analysis in risk management, in which staff are asked to estimate changes in the value of trading positions and credit exposures resulting from a variety of market contingencies. Although they now may be recognising the value of scenario analysis, and applying it more actively to managing market risk, most firms have yet to merge such techniques meaningfully into their procedures for measuring and managing their credit risk exposures.

Some market mechanisms that fostered contagion and amplified price dynamics were more fundamental to the structure of market institutions. As a result, they may pose risks going forward. These include:

(5) ***Increasing concentration of activity*** among a few large global institutions that were active in many markets made the propagation of shocks across markets more immediate and dramatic. Because of the broad scope of their business dealings, decisions by some of these firms to reduce their exposure to risk – either because threats to their capital diminished their appetite for risk-taking or because doubt in the market about their viability made leverage more expensive – influenced the prices of many financial instruments.

(6) ***Many entities relied on collateralised positions that were marked to market daily.*** Firms that levered their capital by borrowing in repo markets, through securities lending, or by the use of margin accounts at futures exchanges were required to provide more collateral or close out their positions as prices turned against them. To the extent that they elected to trim their positions rapidly



rather than gradually, those entities' actions exacerbated adverse price dynamics. If, instead, other positions were closed to free up collateral, price shocks were transmitted to other markets.<sup>3</sup>

While the pace of consolidation in the financial industry has been intense in recent years, there still remains a large collection of different entities. However, counting the number of firms overstates the degree of independence among those firms, because of:

(7) ***Widespread emulation of certain trading strategies and risk management practices***, which has tended to reduce the effective diversity in the market. The clearest example was the emphasis on relative-value trading strategies, pioneered by LTCM, at other hedge funds and the proprietary trading desks of many investment banks. The highly public travails of LTCM cast doubt on those other firms as well and created an incentive for some traders to move prices in the expectation that serious market dislocations would follow.

By their nature, some of these market risk control tools have the potential to tighten links across markets and to alter price dynamics. As one example, the strategy termed proxy hedging led traders to use major national markets to offset positions in thin markets that might have been difficult to liquidate quickly. Complaints about such practices surfaced regarding asset prices in Australia and Hong Kong at the time that the Asia crisis broke in 1997. When considering the events of August and September 1998, market participants reported that as financial conditions in Russia deteriorated, short positions in both Hungarian and Brazilian debt, which offer relatively deep markets, were put in place to hedge against long positions in Russian securities.

Even mature markets were not immune. In European markets, a broad range of assets was hedged by the highly liquid bund futures contract, triggering market pressures when spreads between these securities and bunds widened. In general, our contacts believed that the liquidity of instruments traded on organised exchanges fared better than those traded over the counter, making the former more attractive proxy hedges. They reported both that the interposition of an organised exchange in settlement eased counterparty concerns and that the greater transparency afforded by listed trading might have made price discovery easier. Other analysts cited the depth of the futures market for Mexican peso instruments as important in explaining pressures on that currency during this episode. Proxy hedging, in general, tended to spread shocks felt on the periphery of international financial markets to the core rather quickly.

More specifically regarding risk management:

(8) ***An escalation of the locus of decision-making at many firms may have spread pressures across markets and altered price dynamics***. In particular, as decisions on exposure limits shifted toward senior managers as stresses mounted, losses in one market, because they reduced the overall amount of capital, then prompted withdrawals from other markets. In that sense, the events of last fall mimicked those of a traditional margin call, albeit on a worldwide scale, as positions in a variety of markets were unloaded as a result of losses originally concentrated in a few. Consolidation across business lines may also have complicated decision-making. According to one market participant we spoke with, institutions with both trading operations and significant reliance on retail and wholesale deposits may have been quick to reduce risk so as to limit losses and not arouse concerns from their core funding base. As another example of an unintended consequence of risk management strategies, the general tendency at the height of the crisis for risk committees to decide each evening, based on that day's results, the risk tolerance for the next day may have introduced autocorrelation in daily returns.

(9) ***Some compensation and accounting practices may have intensified the responses to the original shocks and delayed other market participants who were well capitalised from stepping in to replace arbitrageurs who faced credit constraints***. Some market participants reported that the fact that most financial institutions had been extremely profitable through the first half of 1998 may have made

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<sup>3</sup> These systemic risks were noted in BIS (1998), *OTC Derivatives: Settlement Procedures and Counterparty Risk Management* (the "Parkinson IV Report"), p. 6.

managers quicker to close out losing positions for fear of jeopardising shareholders' earnings and their own bonuses. Other discussions with market participants suggested that internal limits triggered by marking to market implied that the preservation of risk capital required closing out some positions even though there may have been the strong suspicion that prices had overshot only temporarily. In that regard, competitive pressures may have induced some firms to close out positions so as not to be seen by the public as lagging behind peers that had already disclosed losses and announced remedial action.

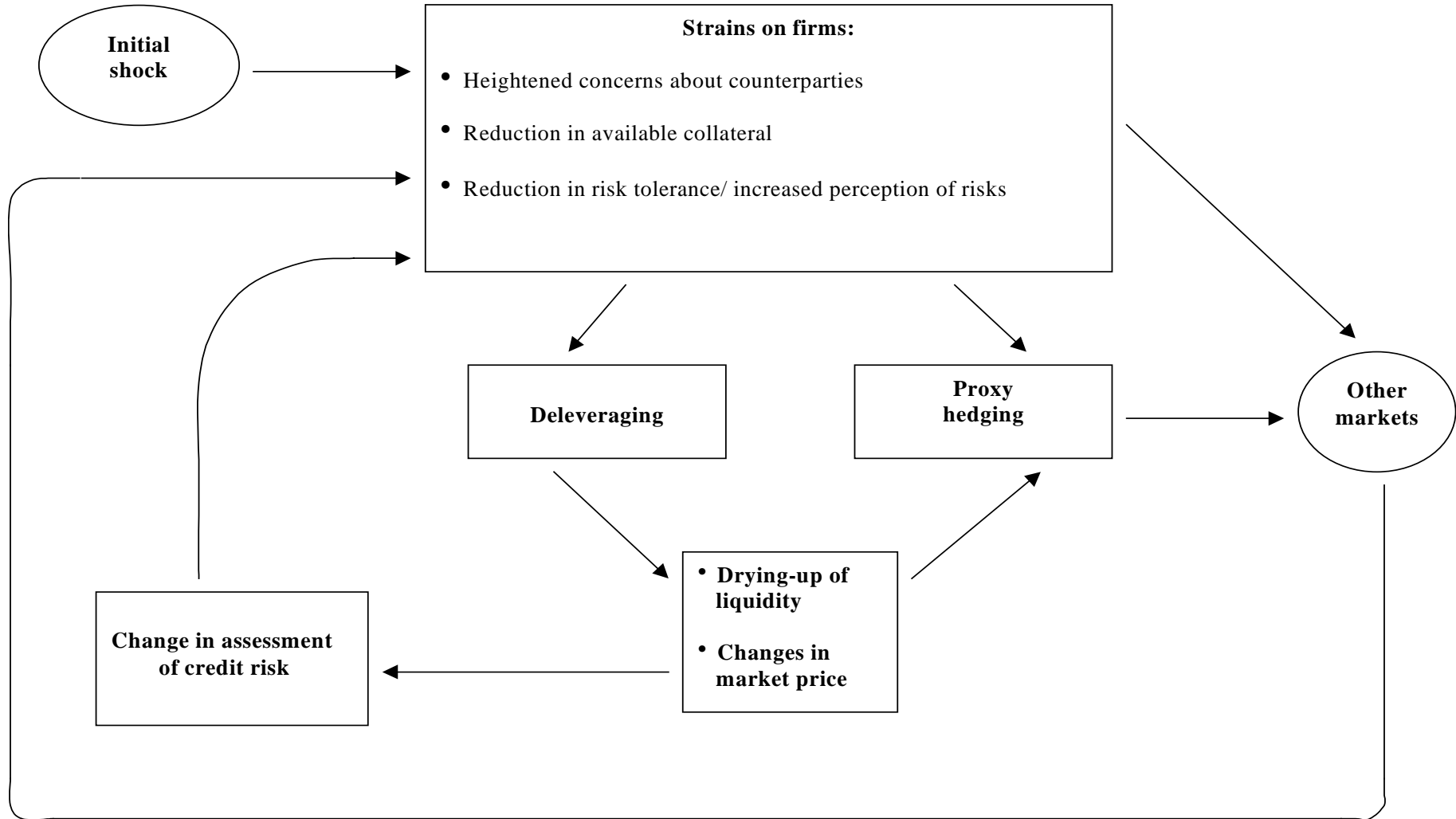
Finally, the tendency for portfolio managers to be compensated according to their performance relative to various market benchmarks made many unwilling to attempt to ride out the storm. Instead, they traded actively to track their peers because their compensation would be relatively secure if they were safely in the middle of the pack of fund managers.

It must be remembered, though, that while such practices are deeply ingrained in the industry, the events of last fall did trigger realignments in the upper echelons of management at many firms. To the extent that this episode induced a general reassessment of the importance of oversight of risk-taking activity by senior management and boards of directors, some longer-term benefits may well accrue.

The general lesson about market practices that emerges is an old one that could be put in either of two ways: in fall 1998, a number of large, active financial intermediaries either had too little capital relative to the risk they were undertaking, or exposed themselves to excessive risk in the pursuit of return. In some sense, the returns that relative value arbitrageurs earned in normal times could be thought of as compensation for performing liquidity intermediation – that is, taking on an illiquidity risk that the average investor was, properly, unwilling to bear. In normal times, this kind of intermediation is rewarded by positive returns, as compensation for the risk that on rare occasions market functioning might deteriorate, making relatively illiquid instruments especially unattractive to most potential holders. The events of last fall highlighted the fact that the seemingly abnormal returns earned by relative value arbitrage in normal times are not risk-free when viewed over a longer time span.

For all the financial sophistication of prominent market participants, the economic framework that may have applied was one of the oldest – the overshooting or “cobweb” model of economic dynamics. Relative value trading was profitable at first because the risk and human capital devoted to take advantage of the available opportunities was in scarce supply. Profits to that sector, naturally, attracted more risk and human capital over time, tending to erode those profits. Rather than reaching a stable equilibrium, however, the response to lower profits was to take on still larger positions and an excessive amount of risk. A benign macroeconomic background and the loosening of credit terms by counterparties cushioned the inevitable fall in returns in the industry at first, leading to yet more risk-taking, but at the cost of what was ultimately a more wrenching adjustment.

### The circle of deterioration in market functioning



## Chapter 4

### The remaining imprint and some tentative lessons

One year after the market strains emerged, most spreads have narrowed, but not back to the thin levels prevailing before the summer of 1998. Some spreads, such as those on interest rate swaps, are at or above autumn 1998 levels. While bid-ask spreads for on-the-run issues have mostly returned to their levels of before the crisis, off-the-run bid-ask spreads have not yet recovered.

By way of perspective, it is important to remember that there have been other episodes of major stresses in fixed income markets in the past decade. In 1989 and 1990, the criminal prosecution and subsequent bankruptcy of Drexel Burnham Lambert removed the dominant market-maker in a major market segment: high-yield securities. In 1994, the realisation that a substantial realignment of Federal Reserve policy was under way induced substantial strains in the debt markets of major industrial economies. The former produced a large deterioration in the prices of the high-yield securities that Drexel marketed and some systemic concerns related to clearance and settlement. The latter was associated with the failure of at least one large leveraged hedge fund that relied on sophisticated financial modelling, David Askin's Granite Capital, which adversely affected the niche market for collateralised mortgage obligations. In addition, the general contagion at the time evident in elevated interest rate volatility raised correlations among returns above historical norms, lessening the benefits from diversification and making investors skittish. As in the 1998 episode, some of the movements in interest rates across markets in 1994 were blamed on market mechanisms such as proxy hedging.

Autumn 1998 provided drama with elements drawn from both prior episodes. Macroeconomic events seemed closer to the root, and there was a much publicised example of the failure of sophisticated modelling, as in 1994. But the scale and scope of LTCM's activities in the business of relative value arbitrage was closer to – but by no means as dominant as – Drexel's presence in the high-yield market.<sup>4</sup>

At the time of writing, the events of 1998 appear to have lifted more quickly than did those of 1989–90 in the junk bond market but perhaps not so completely as those in 1994 one year later. To an important degree, that is good news: the risk spreads prevailing in the summer of 1998 were, by and large, unusually thin and counterparty assessments too generous. Nor is it obvious from the elevated level of equity prices in many industrial countries, especially the United States, that credit conditions are now restrictive.

Policymakers can draw five main lessons from the events of last autumn. Some of these lessons relate to failures of risk management and regulatory procedures that are the focus of remedial efforts by industry and the official sector, while others are more fundamental to the structure of financial institutions in an era of globalisation and rapid change.

(1) *Some of the mechanisms that tightened linkages across markets and amplified price dynamics can be addressed by carefully considered industry and government initiatives.* In some areas, this work is already under way. In particular, regulators and supervisors have provided additional guidance on lending to highly leveraged institutions. Industry efforts, spurred by the large losses that were experienced, are being devoted to managing market and credit risks more effectively. Meanwhile, national governments and international organisations are examining adapting existing reporting systems or mandating additional ones to foster greater transparency in markets.

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<sup>4</sup> It must be emphasised that at no point has the issue of criminal wrongdoing been associated with the activities of LTCM.

(2) ***Some of the mechanisms that are more basic to institutional structure are not easily changed by official statements or actions.*** Regulatory action or moral suasion is unlikely to be able to lengthen investors' time horizons, make traders less mindful of year-end bonuses, or render people in general less apt to copy success. The adverse consequences of consolidation on trading dynamics have to be weighed against economies of scale and scope in all the other businesses that financial institutions take part in. While the turnover in senior management at several global intermediaries over the past year may indicate that the industry is actually wrestling with these difficult issues in corporate governance, policymakers must appreciate that similar episodes of elevated volatility of financial prices may well take place again in the future. A goal of policymakers should be to create a regulatory and monetary policy environment that makes it less likely that this volatility creates systemic concerns.

(3) ***Monitoring markets and understanding trading and credit risk practices is important.*** Many of the most visible manifestations of market stresses occurred in markets not always directly followed by central banks. As long as financial institutions spread their activities into new markets and more risks become priced, central banks will have to continue to build up expertise to follow those developments.

(4) ***There is a tension between transparency of official action and reassuring market participants.*** To an important extent, market participants commit to trade in financial markets because they expect others to do so. If they think others will not, they will not, creating a self-fulfilling prophecy. Thus, even a modest reappraisal of risk-taking appetites, imposition of a small cost, or even public statements warning about certain behaviours could have large consequences for market activity. The public expression of concerns about market liquidity associated with the events surrounding the recapitalisation of LTCM could well have been interpreted by some as official concerns about other potential counterparties. When everyone fears this, everyone withdraws, justifying their fears. At the same time, expressing those concerns is important so that the public has an understanding of policy setting. This is a tension in policymaking that is likely to recur going forward.

## Chapter 5

### Work to be done

This report is intended to be read alongside the other efforts within the financial industry and by international groups to understand the events of last year. Unlike those other reports, we have tried to emphasise the consequences across a variety of financial markets of a confluence of factors. In that regard, this report can be taken to suggest that aspects of industry structure and market mechanisms, which are usually studied individually, interact in a way that can have broad consequences for pricing financial instruments. Much work remains to be done, which can be separated into two categories.

(1) *Initiatives related to improving the transparency of financial markets.* There is already some pressure to change aspects of industry structure that seem to have facilitated the spread of shocks and amplified their effects. As noted above, national governments and international organisations are examining either adapting existing reporting systems or mandating additional ones to foster greater transparency in markets. Without question, it is important to follow through on that programme, including some of the government initiatives included in the US President's Working Group Report (1999), the private sector recommendations in the Credit Risk Management Policy Group Report (1999), and the multilateral efforts coordinated by, among others, the Bank for International Settlements, the International Monetary Fund and the Basel Committee.

(2) *Initiatives related to monitoring and analysing financial markets.* If the explanation for what happened in last autumn relates to the interaction among many markets, then central banks may well have to increase the scope of their surveillance and analysis of market pricing and functioning. In terms of longer-term projects, it is clear that the in-depth empirical analysis of liquidity indicators will offer a deeper understanding of market functioning. The group's efforts to describe the large dataset it collected only scratched the surface of potential empirical work. The differing performance of organised and OTC markets during the crisis calls for a greater effort to understand the use of different trading platforms. But theory also may have a role to play. It is possible that more sophisticated financial modelling may be able to define more rigorously indicators of market stress. Some of the key tasks here include distinguishing between liquidity and credit risk premia, backing out default probabilities under different distributional assumptions, and studying how different margining practices affect leverage under different scenarios. Lastly, some of the most productive time spent by this working group was talking with market participants about their actions and reactions when markets were stressed. Continued contacts with market participants are necessary to understand better the continually evolving practices in the management of credit and market risks.

Table 2  
**Extremes in short-term interest rate spreads during 1998**  
(basis points)

		<b>Low</b>	<b>Date of Low</b>	<b>High</b>	<b>Date of High</b>	<b>High Less Low</b>
1	Japan 3-month interbank	- 22	6 Oct.	16	30 Oct.	38
2	Hong Kong 3-month interbank	19	23 Apr.	1294	28 Aug.	1275
3	Hong Kong 6-month interbank	100	23 Apr.	1198	28 Aug.	1098
4	Hong Kong 12-month interbank	169	23 Apr.	854	28 Aug.	685
5	Mexico 1-month interbank	86	27 Apr.	628	14 Sep.	542
6	US 3-month interbank	33	26 Feb.	144	16 Oct.	111
7	US 12-month interbank	40	24 Feb.	86	16 Oct.	46
8	US 1-month prime commercial paper	- 2	9 Sep.	54	16 Dec.	56
9	US 1-month second-tier commercial paper	14	26 Feb.	135	2 Dec.	121
10	Canada 3-month interbank	- 58	27 Aug.	67	7 Oct.	125
11	UK 3-month interbank versus repo rate	15	1 Jan.	58	23 Dec.	43
12	France 3-month interbank	- 12	15 Apr.	43	28 Dec.	55
13	France 12-month interbank	- 9	1 Apr.	34	29 Dec.	43
14	France 1-month commercial paper	- 19	30 Nov.	22	30 Dec.	41

Note: Inter-bank rate spreads are measured by using Euro-rates, except for Mexico and Hong Kong.

Table 3  
**Extremes in yield spreads during 1998**  
(basis points)

		<b>Low</b>	<b>Date of Low</b>	<b>High</b>	<b>Date of High</b>	<b>High Less Low</b>
1	Japan 5-year AA corporate bond	58	5 Jan.	92	20 Nov.	34
2	Japan 5-year BBB corporate bond	177	8 Jan.	227	22 Dec.	50
3	Japan 5-year bank bond	14	29 Jan.	77	10 Sep.	63
4	Japan 10-year yen Swap	58	5 Jan.	84	28 Aug.	26
5	Hong Kong 10-year government bond	222	23 Mar.	506	26 June	284
6	Hong Kong 3-year agency bond	1	6 Jan.	105	12 Oct.	104
7	Hong Kong 10-year HK\$ Swap	134	5 Jan.	199	9 Jan.	65
8	Latin America Brady bond	292	23 Mar.	985	10 Sep.	693
9	Mexico corporate Eurobond	313	26 Feb.	1253	11 Sep.	940
10	US 10-year AA corporate bond	70	23 Jan.	138	5 Oct.	68
11	US 10-year BBB corporate bond	114	23 Jan.	225	4 Nov.	111
12	US speculative-grade bond	307	30 Mar.	687	19 Oct.	380
13	US 10-year US\$ swap	44	11 Feb.	97	14 Oct.	53
14	Canada 10-year \$ swap	17	5 Feb.	48	14 Oct.	31
15	UK 5-year Aa corporate bond	48	13 Mar.	147	5 Oct.	99
16	UK 5-year Baa corporate bond	82	17 June	191	13 Oct.	109
17	UK four 5-year bank bonds	53	2 Jan.	154	5 Oct.	101
18	UK 10-year sterling swap	26	5 Jan.	116	5 Oct.	90
19	Netherlands two industrial bonds	25	19 Mar.	68	3 Dec.	43
20	Netherlands four 10-year bank bonds	24	21 Jan.	49	14 Oct.	25
21	Germany industrial bond	19	6 Mar.	114	11 Dec.	95
22	Germany 9-10 year mortgage bond	20	29 Apr.	57	21 Sep.	37
23	Germany 9-10 year bank bond	21	6 May	59	21 Sep.	38
24	Germany 10-year DM swap	18	1 May	69	25 Aug.	51
25	France A3 corporate bond	35	5 Mar.	66	30 Nov.	31
26	France average swap rate	19	18 May	36	4 Sep.	17
27	Swiss corporate bond	22	21 July	61	1 Oct.	39
28	Swiss 5-7 year SFr swap	39	1 June	89	31 Dec.	46

Note: Spreads are measured by using domestic rates.



Table 4  
**Ex post volatility during 1998**  
(1 January 1998 to 3 July 1998 = 100)

<b>Government Bond Yields</b>	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year	100	84	<b>188</b>	59	140
Hong Kong 3-year	100	47	<b>117</b>	98	37
Hong Kong 5-year	100	58	<b>144</b>	135	53
Hong Kong 10-year	100	55	<b>145</b>	143	47
US 2-year	100	50	<b>161</b>	185	181
US 5-year	100	53	<b>149</b>	210	143
US 10-year	100	51	132	<b>224</b>	122
US 30-year	100	52	154	<b>265</b>	151
US 10-year inflation-indexed	100	69	94	<b>193</b>	106
UK 10-year	100	99	149	<b>283</b>	122
Netherlands 10-year	100	57	<b>177</b>	264	104
Germany 10-year	100	63	<b>184</b>	283	103

<b>Stock Market</b>	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan	100	76	133	<b>206</b>	110
Japan bank	100	78	105	<b>173</b>	93
Hong Kong	100	91	<b>113</b>	113	75
Korea	100	87	70	<b>108</b>	90
Russia	100	<b>156</b>	172	140	79
Brazil	100	103	<b>302</b>	230	164
Mexico	100	99	<b>258</b>	215	109
US	100	138	<b>274</b>	235	122
US financial	100	139	<b>270</b>	289	143
Canada	100	157	<b>247</b>	257	117
UK	100	129	<b>219</b>	253	145
UK financial	100	131	189	<b>268</b>	138
Germany	100	104	<b>217</b>	250	144
France	100	112	<b>205</b>	254	124
France financial	100	142	<b>237</b>	311	153
Switzerland	100	132	<b>254</b>	341	139
Switzerland bank	100	160	<b>332</b>	449	188

Table 4 – cont.

Exchange Rate	1 Jan. to 3 July	6 July to 14 Aug.	17 Aug. to 22 Sep.	23 Sep. to 15 Oct.	16 Oct. to 31 Dec.
Hong Kong dollar/US dollar (12-month forward)	100	100	<b>154</b>	71	34
Yen/US dollar	100	72	<b>157</b>	219	112
Yen/Swiss franc	100	105	166	<b>289</b>	118
US dollar/Canadian dollar	100	95	<b>214</b>	262	142
US dollar/German mark	100	91	<b>131</b>	136	102
US dollar/Swiss franc	100	106	163	<b>234</b>	158

Notes: Volatility is measured as the square root of the mean daily squared change in the yield (essentially the standard deviation assuming a zero mean). Shading denotes the highest volatility and boldface denotes the largest increase.

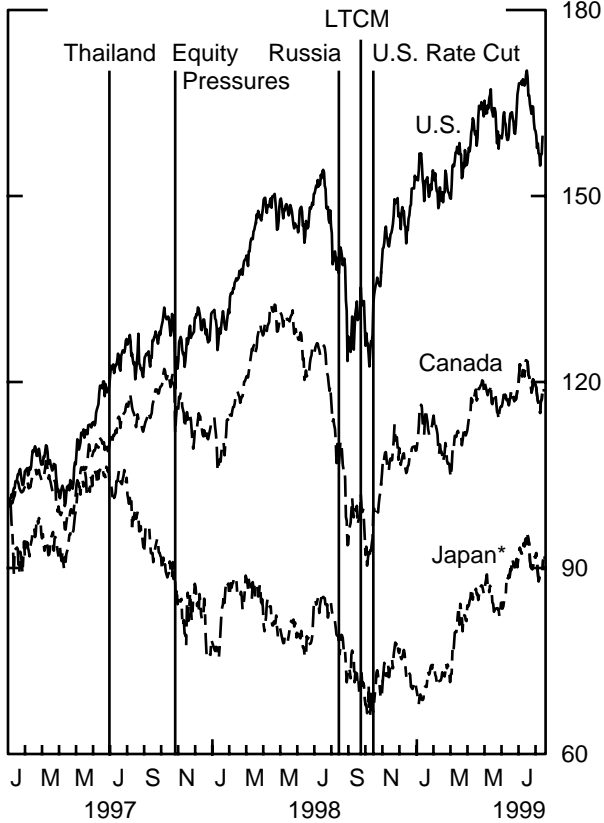
Table 5  
Correlations Among Yield Spreads (tenths)

	1/1/98 to 7/3/98												7/6/98 to 12/31/98											
	UK Aa	UK Baa	UK bnk	UK swa	Nth ind	Nth bnk	Ger ind	Ger mrt	Ger bnk	Ger swa	Swi crp	Swi swa	UK Aa	UK Baa	UK bnk	UK swa	Nth ind	Nth bnk	Ger ind	Ger mrt	Ger bnk	Ger swa	Swi crp	Swi swa
Japan 5-year AA corporate bond		+2	+1		+2	+1	+1		-1	-1	+1		+1			+2			-2	+2	+3	+1	+1	-1
Japan 5-year BBB corp. bond	+2	+3	+1	+1		+1	-1				+2	+1	+1	+1		+3	+2	+1	-1	+2	+2	+1	+2	-2
Japan 5-year bank bond	+1	+2	+2	+2		+1	-1	+3	+3			+1	+1	+1	+2	+2		+2	-2	+4	+3	+3		
Japan 10-year yen swap	+1	+3	+1	-2	+3	+1	+1	+1			-1	-1	-2	-3	-3			-2	-1	+1	+2	+1	-1	-1
HK 10-year government bond	+4	+3	+3	+3	+2	-1	+2	+2	+2	+2	-2	-1	-1	-2	-1	+2	-3	-1	+1	+3	+3	+3	-2	-1
HK 3-year agency bond	-1		+1	+1	+2	-1	-1	-2	-1	+2	+1	+2	+2	+2	+2	+3							+2	+1
HK 10-year HK\$ swap	+1		+2	-2	+1	+1	+1	+3	+1	-1	-1	-1	-1	-1	-1		+1		-1				-1	
Latin America Brady bond	+3	+2	+3	+2	+3		+1	+3	+3	+2	-2		+4	+3	+3	+5	+3	+4	+2	+5	+5	+5	+1	
Mexico corporate Eurobond	+1		+2	+2	+2	-1	+3	+4	+3	+2	-2		+4	+4	+4	+5	+2	+4	+2	+4	+5	+4	+2	
US 10-year AA corporate bond		-1	+1		+1	+1		+4	+4	-1	+1	+1	+4	+4	+5	+2		+2	+1	+1	+1	-1	+3	
US 10-year BBB corporate bond	-1	-1	+1		+1		+2	+4	+3	-1	+1	+1	+4	+4	+4	+1	+1	+2	+1	+1	+1	-1	+3	
US speculative-grade bond	+1	-1	+3	+1	+1		+4	+5	+3		-2	-1	+6	+6	+6	+4	+3	+4	+1	+2	+3	+2	+5	+1
US 2-year US\$ swap	+1	+1	+3	-1	+1	-1	+1	+1	+1	+1	-1		+5	+5	+3	+2	+3	+2	+1	+3	+3	+2	+2	+2
US 10-year US\$ swap		-2	+2	+1			+2	+3	+3	+1		+2	+6	+6	+5	+6	+2	+3	+2	+6	+6	+6	+3	+1
Canada 10-year C\$ swap		-1	+1	+2	-1	-1	+2	+2	+2	+1	+1	+1	+5	+5	+4	+4	+2	+2	+1	+3	+3	+3	+2	+2
UK 5-year AA corporate bond		+8	+7		+1	+3	-1	+1	+1		-2	-2		+10	+9	+7	+2	+5	+1	+4	+4	+3	+5	+1
UK 5-year Baa corporate bond			+7	-1	+2	+2	-2		+1	-1	-1	-2			+9	+5	+2	+4	+1	+3	+3	+2	+5	+1
UK four 5-year bank bonds				-1	+2	+1		+2	+2	-1	-1	-1				+7	+2	+5	+2	+3	+4	+3	+5	+1
UK 10-year sterling swap						-1	+1	+1	+1	+4		+2					+1	+5	+2	+6	+6	+6	+3	
Netherlands two industrial bonds						+2	-4			+1								+2	+1				+2	+1
Netherlands four 10-year bank bonds							-1	-1		-1									+2	+4	+4	+3	+2	+1
Germany industrial bond								+3				+1								+3	+4	+2		-2
Germany 9-10 year mortgage bond									+8	-1		+1									+10	+9		+1
Germany 9-10 year bank bond										+1		+1										+8		
Germany 10 year DM swap											+1	+1											+1	+1
Switzerland corporate bond												+8												+3
Switzerland 5-7 year SFr swap																								

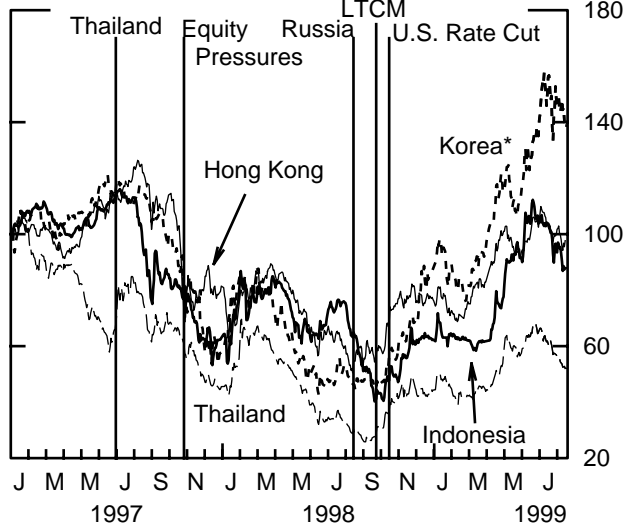
Notes: Statistics are based on 5-day changes in spreads, to allow for time-of-day differences. Correlation coefficients are rounded to nearest 10% and expressed in tenths, so that "+3" denotes 30%, for example. Shading ranges from white for zero or negative correlation to black for 100% (rounded) correlation. Each data label references both a row of the matrix and the column above its right-most extent.

# Equity Prices

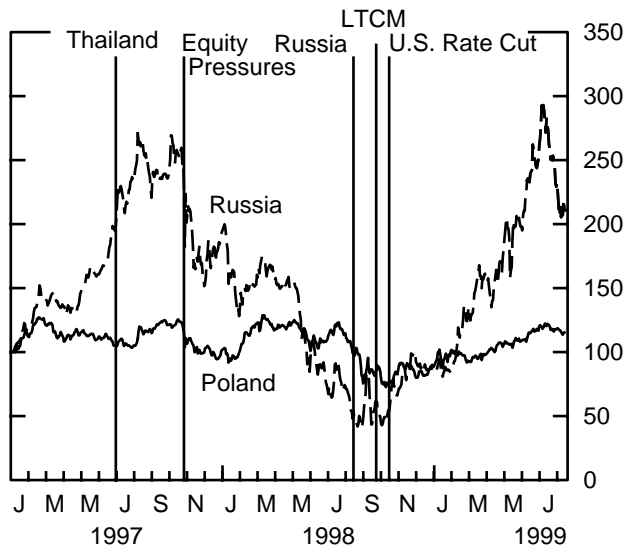
North America and Japan  
Index, January 2, 1997 = 100



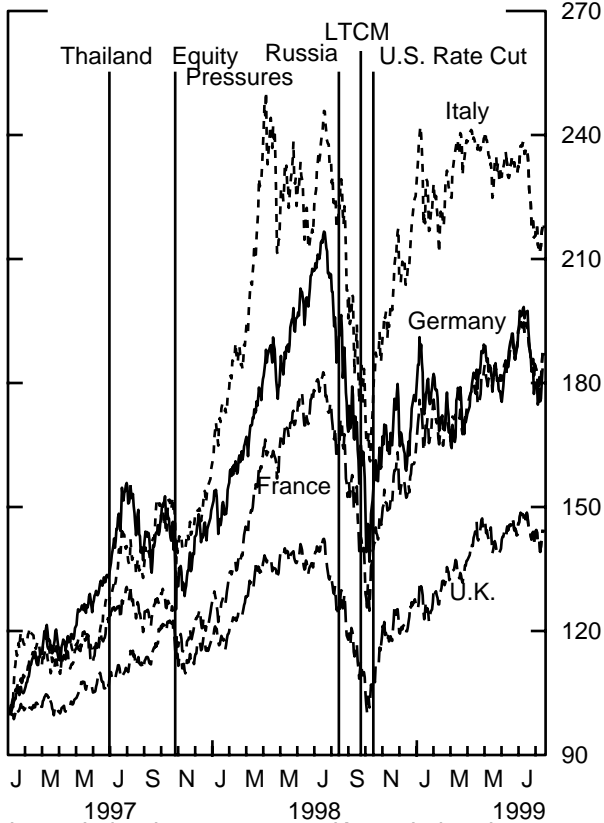
Asia  
Index, January 2, 1997



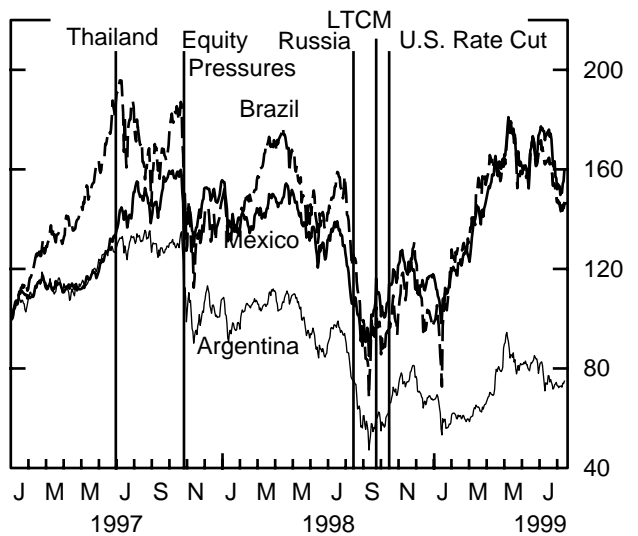
Eastern Europe



Europe



Latin America



\*Japan: Index, January 6, 1997; Korea: Index, January 3, 1997

# Nominal Currency Exchange Values

(Foreign currency prices of U.S. dollar)

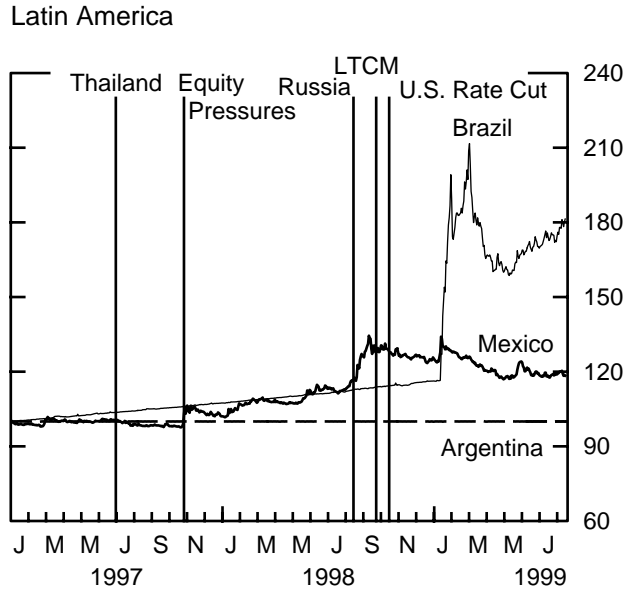
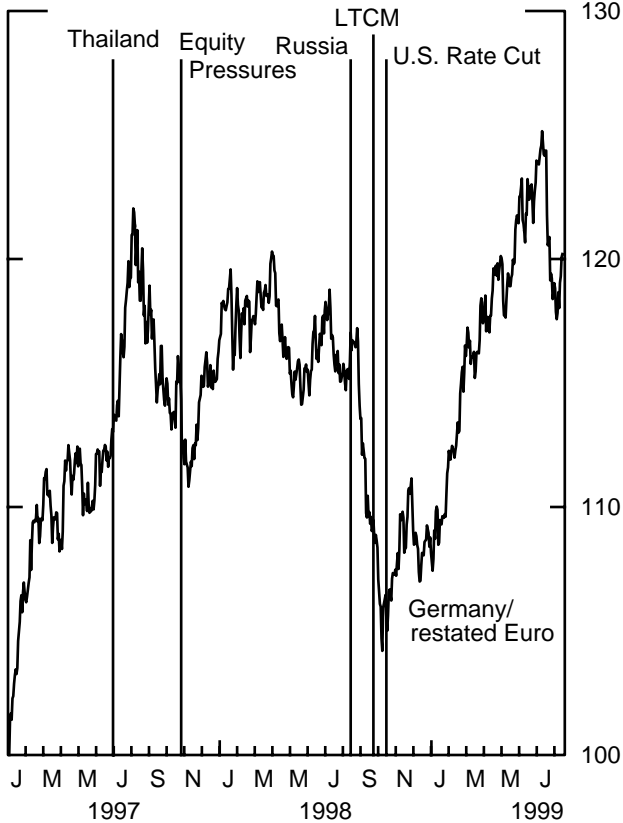
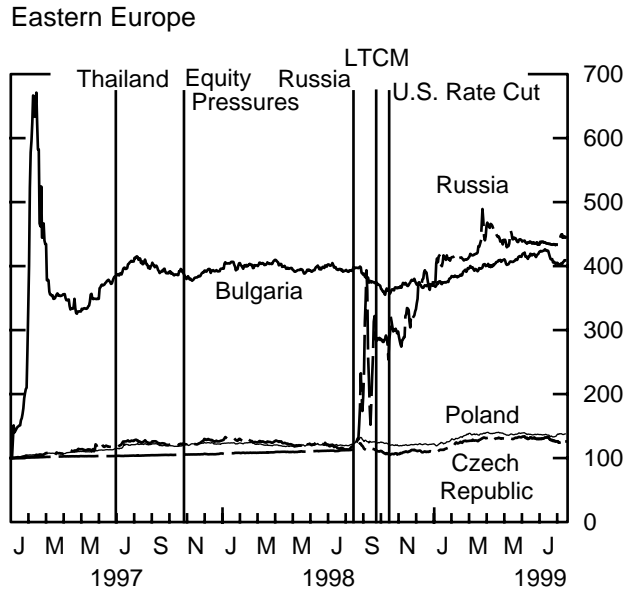
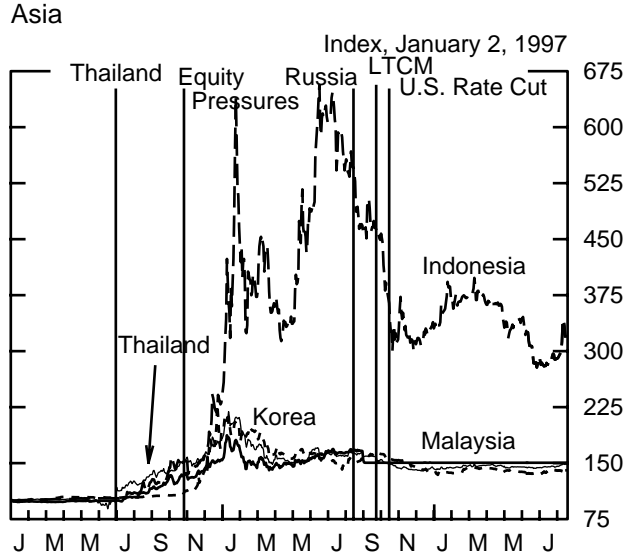
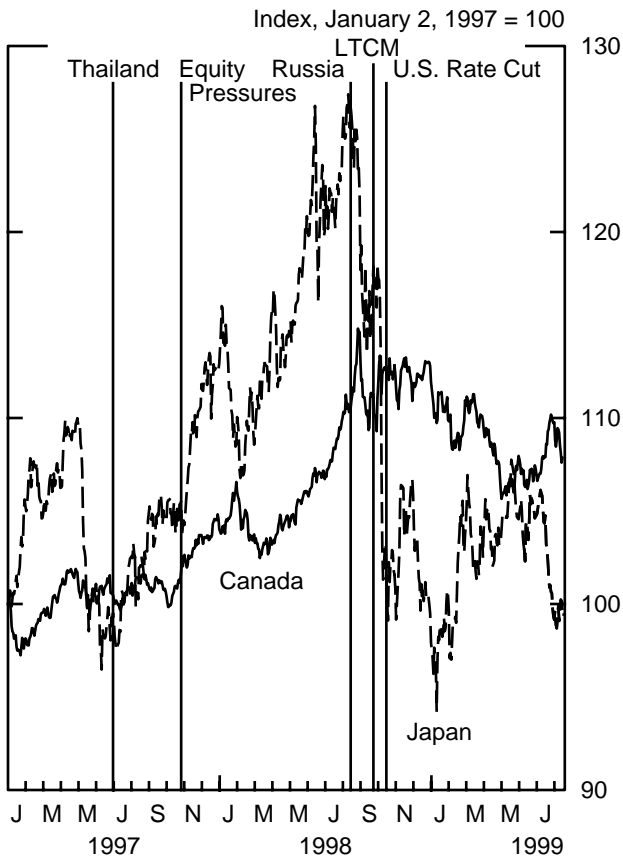
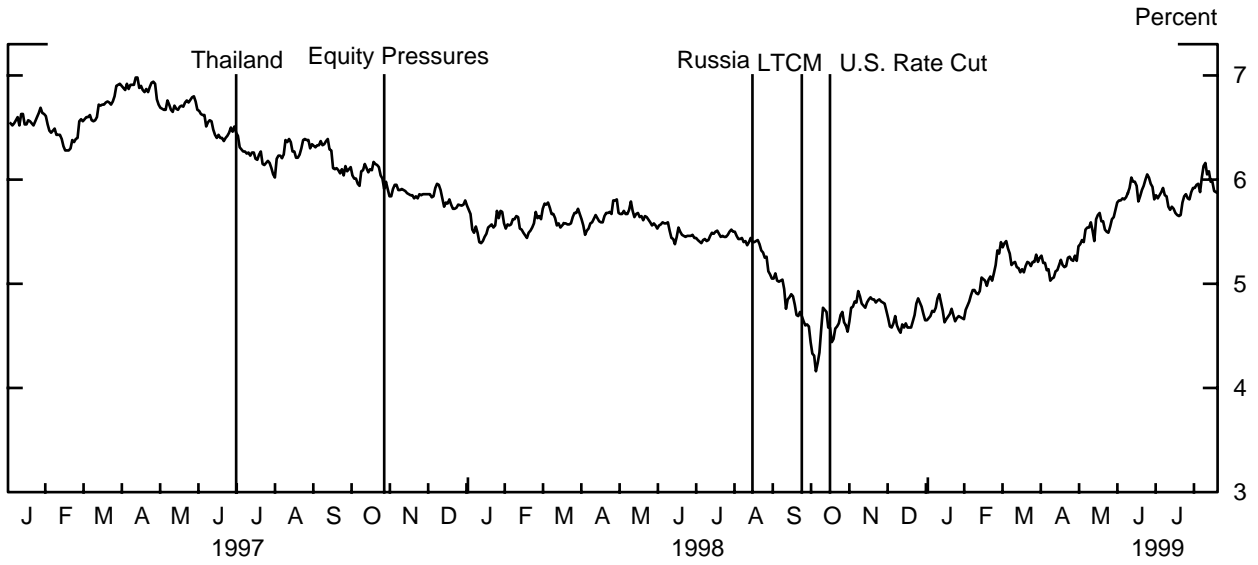


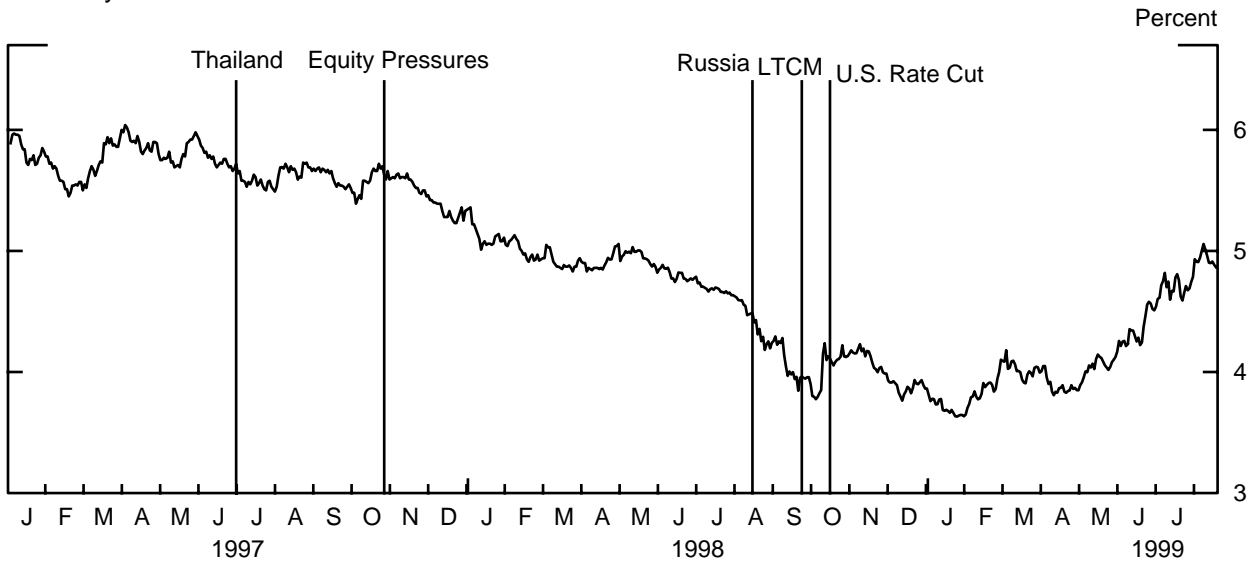
Chart 3

# Long-term Government Bond Yields

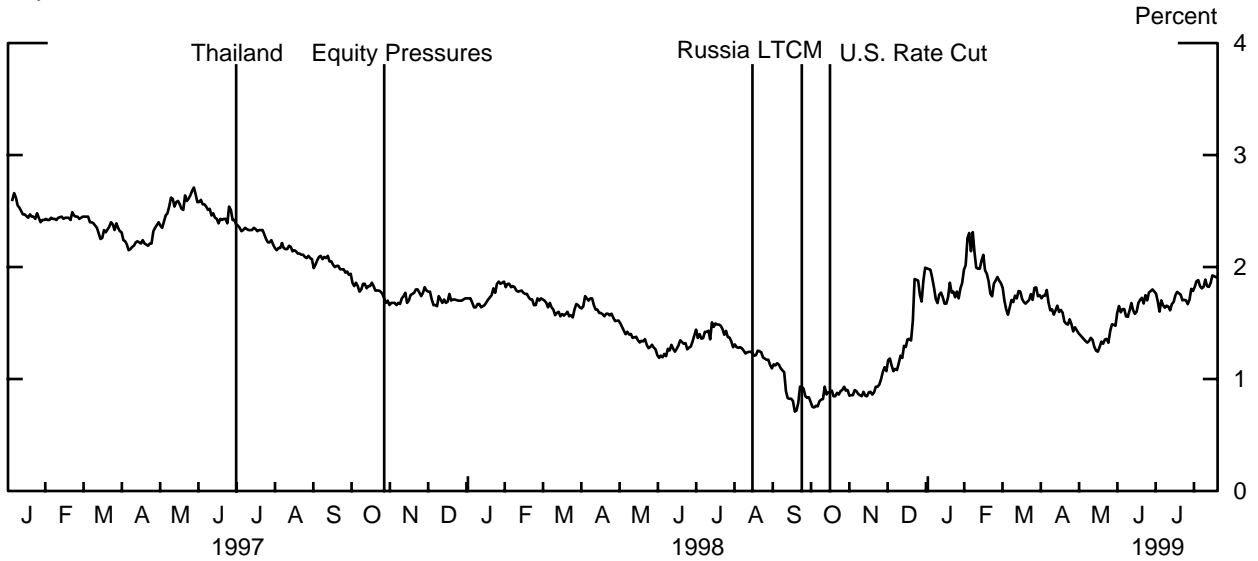
United States



Germany

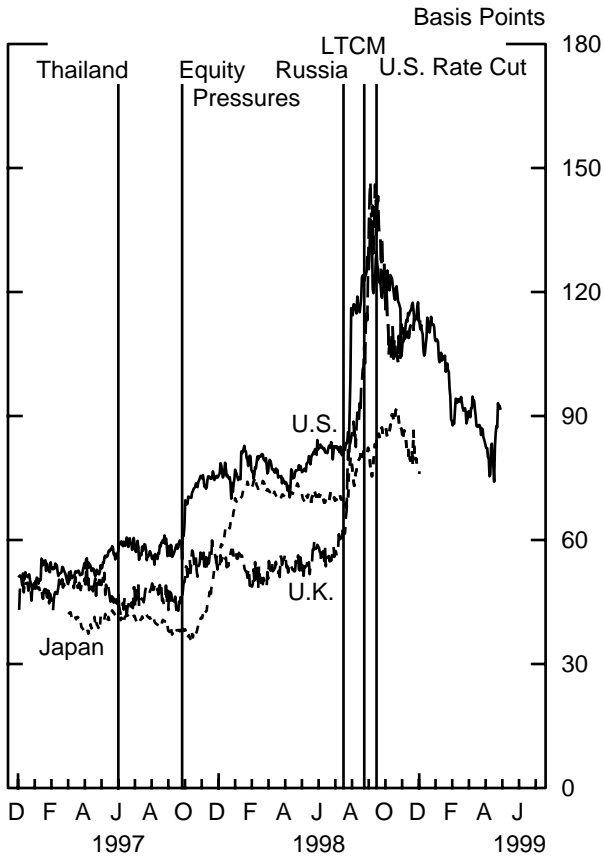


Japan

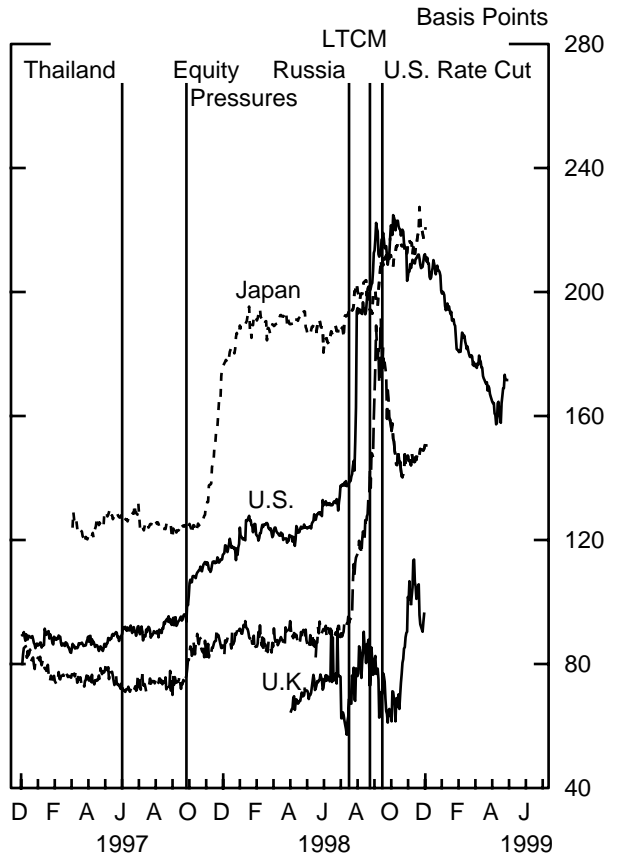


# Corporate Yield Spreads

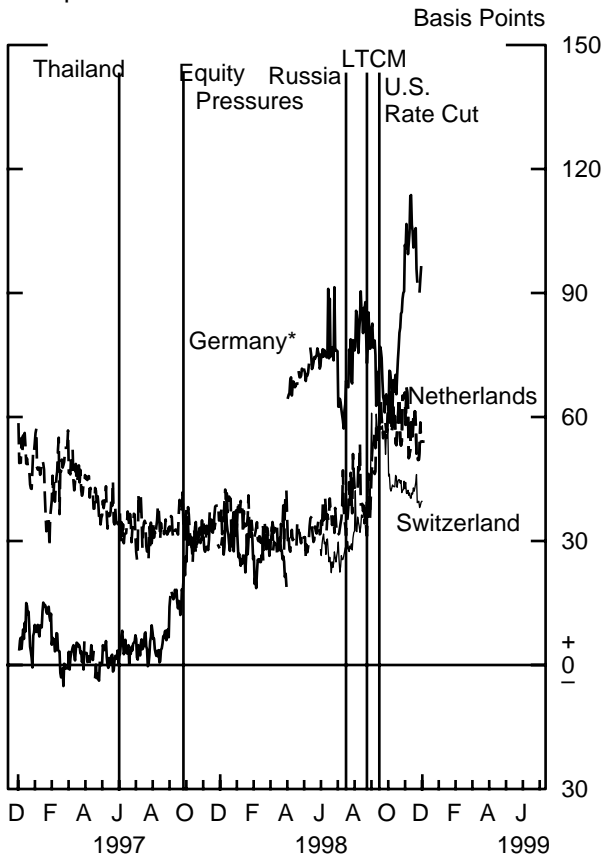
AA-Rated Bonds



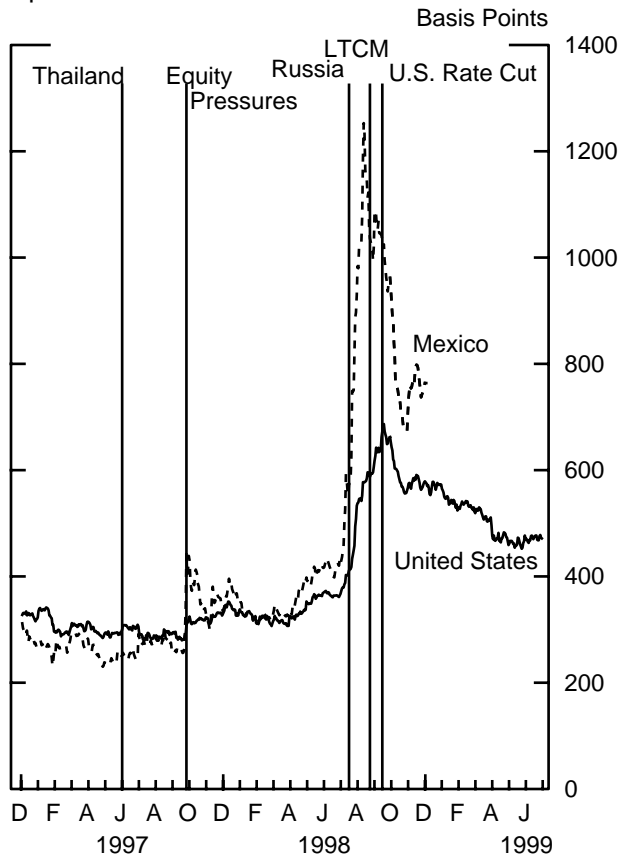
BBB-Rated Bonds



Europe



Speculative-Grade Bonds

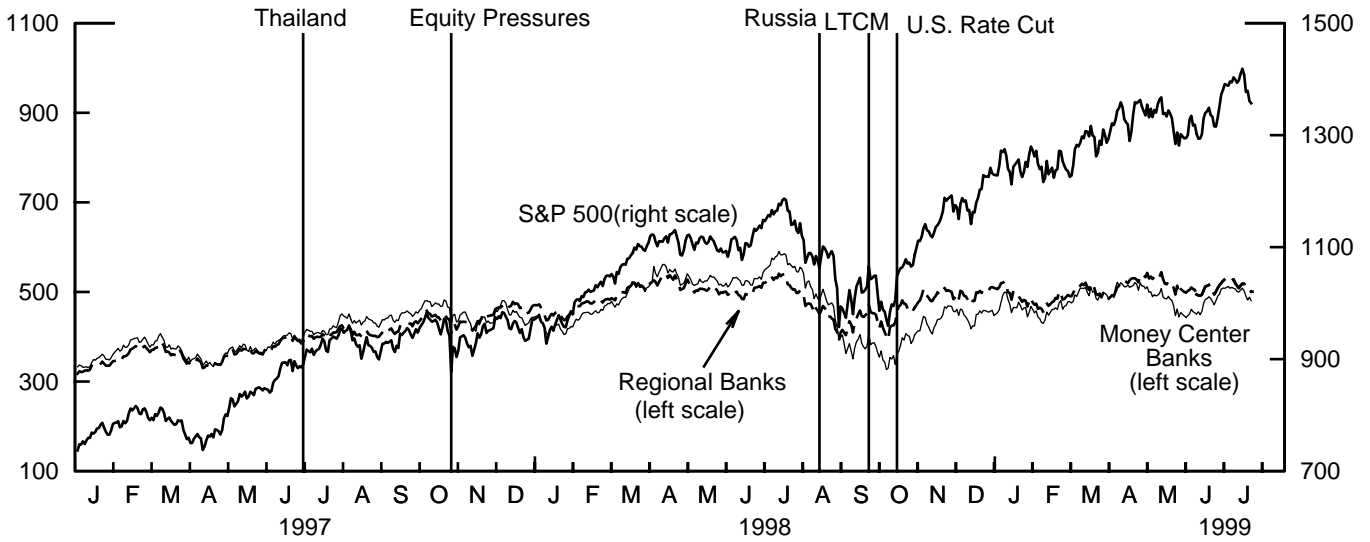


\*Break in German series

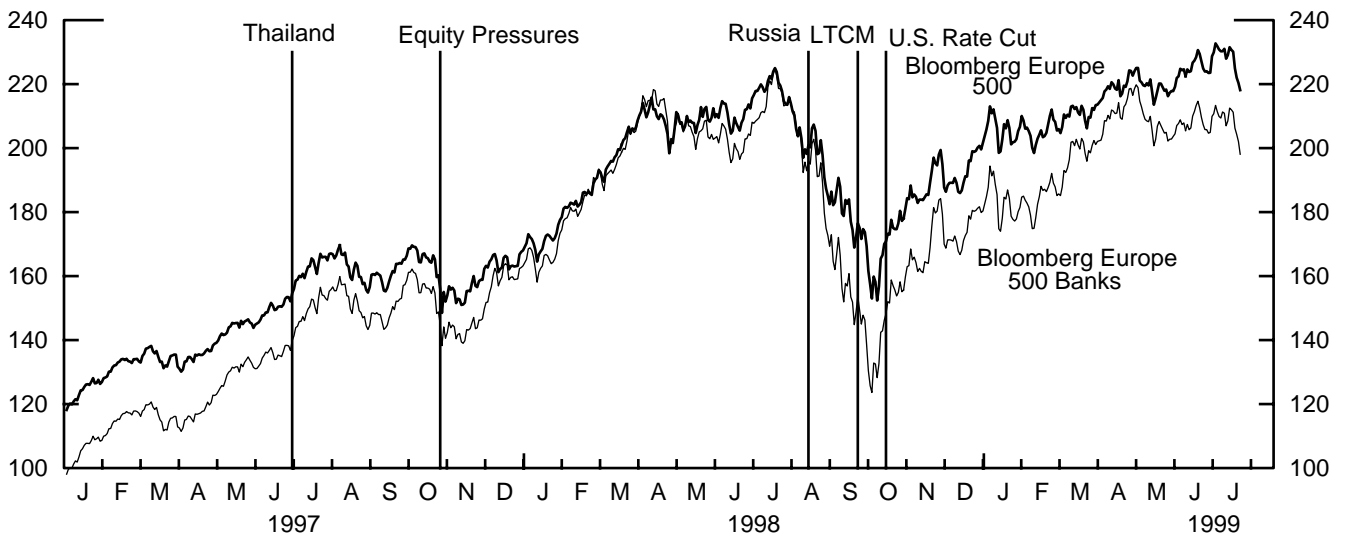
Chart 5

# Broad and Bank Stock Indexes

## United States



## Europe



## Japan

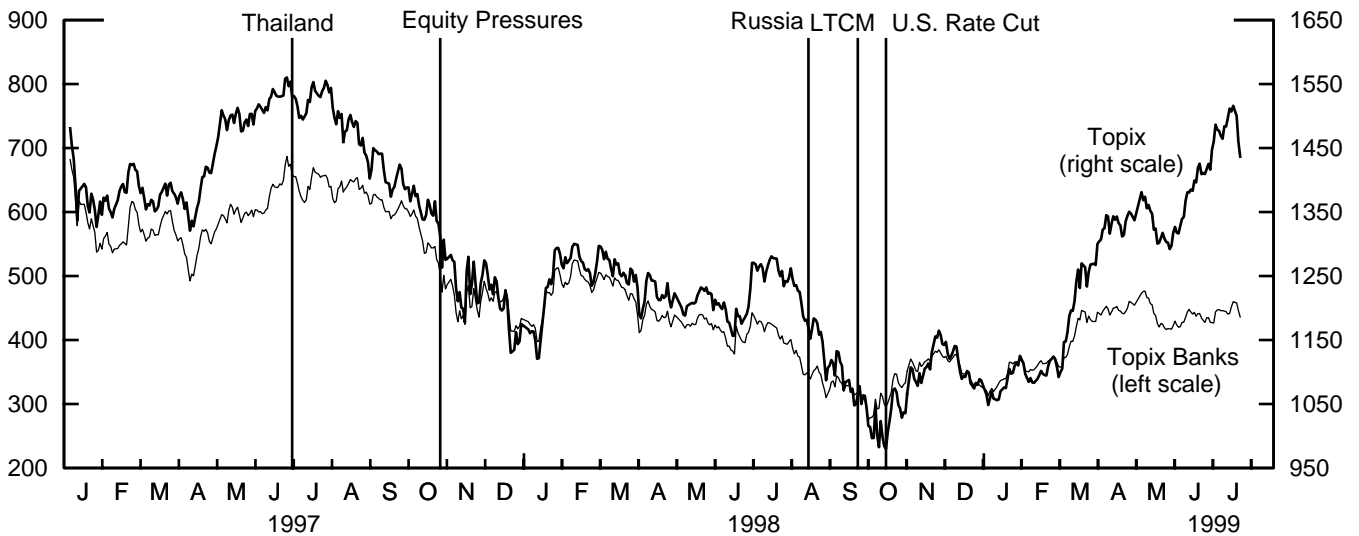
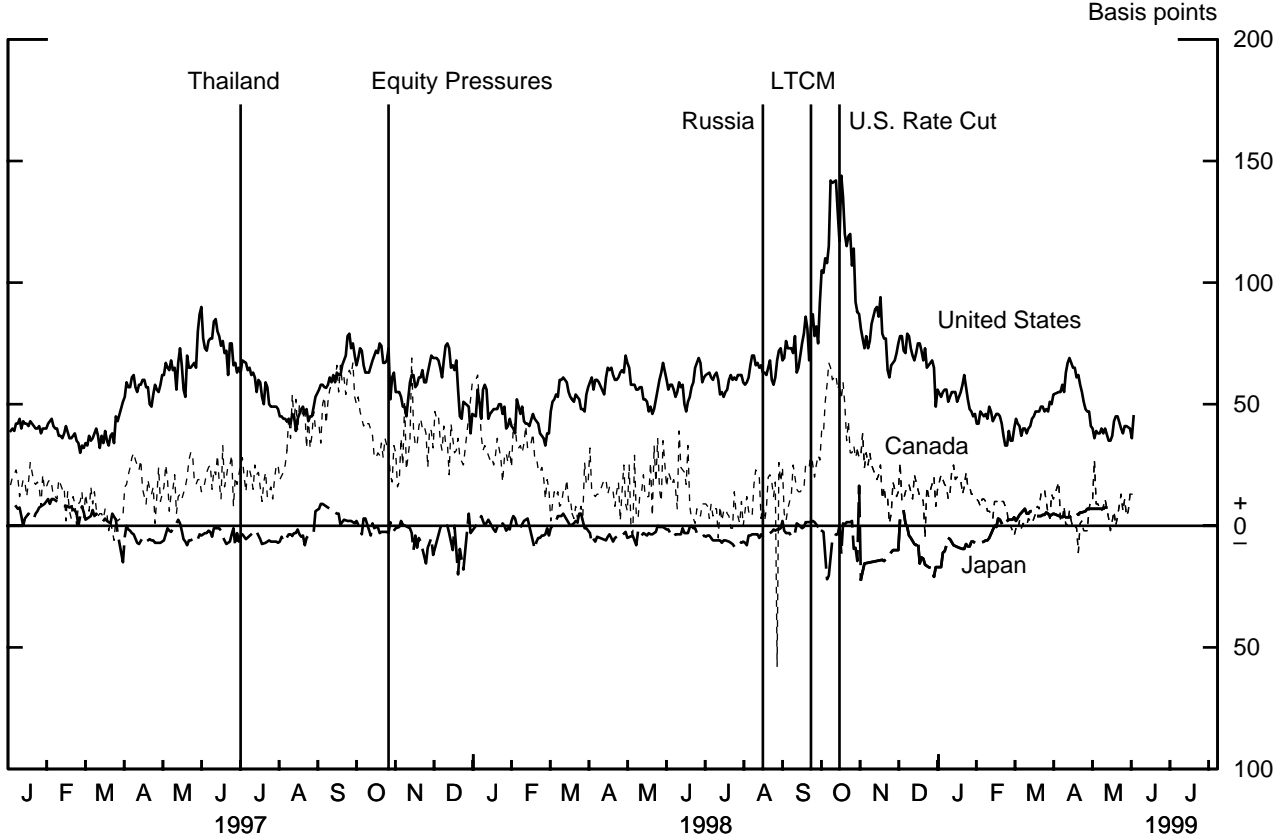




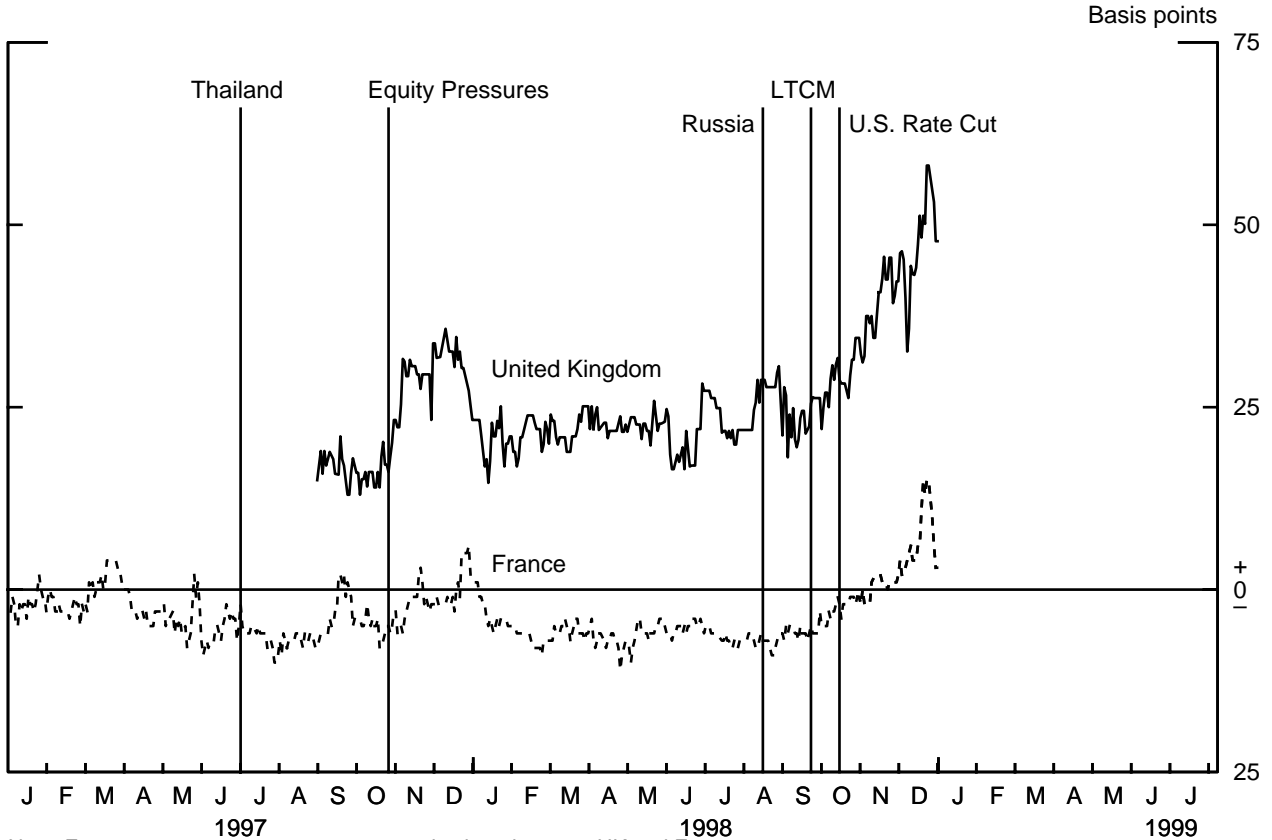
Chart 6

### 3-Month Interbank Rate Spreads

North America and Japan



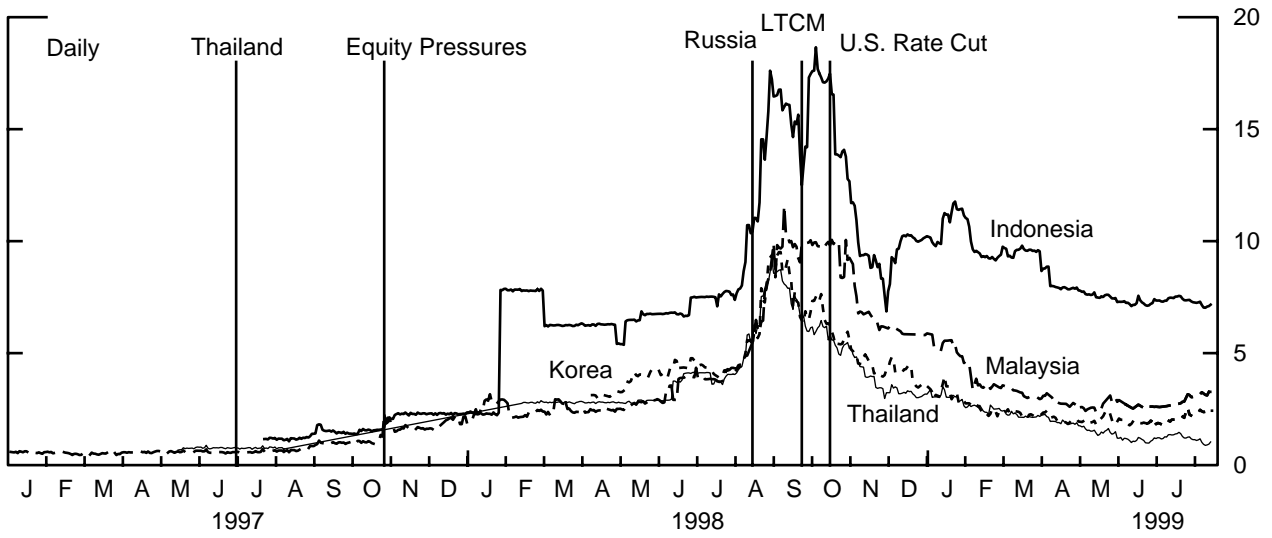
Europe



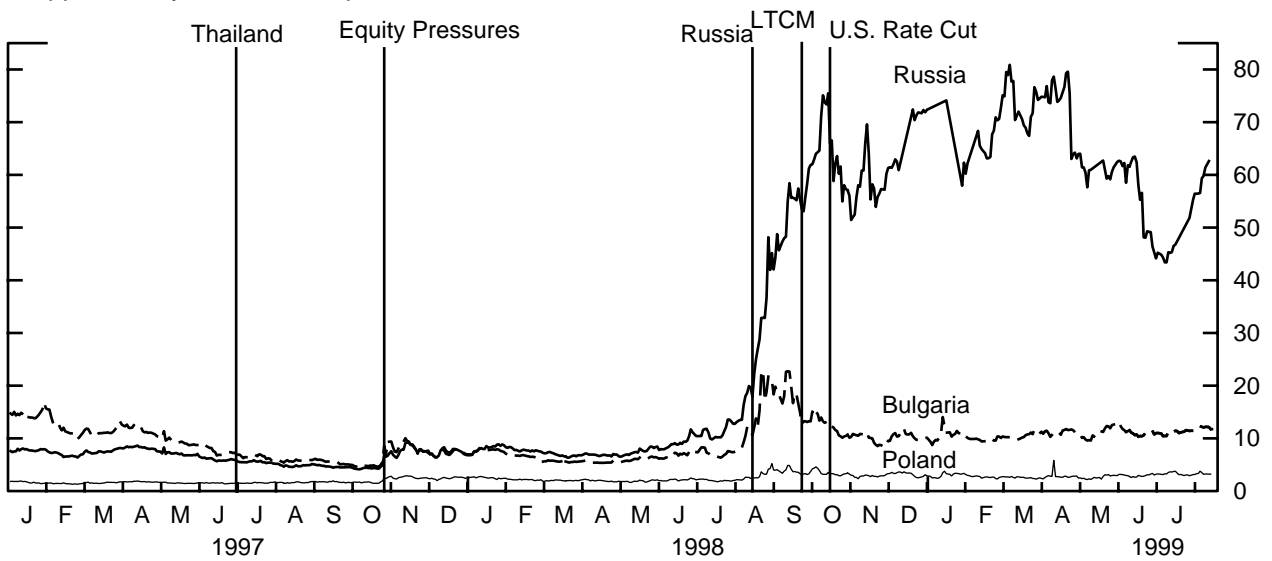
Note: Eurocurrency rate over treasury spreads plotted, except UK and France.  
For the UK, we calculated the eurosterling rate over the repo rate.  
For France, we calculated the domestic inter-bank(bid) rate over the treasury rate.

# Government Bond Yield Spreads

Offshore Bond Yield over U.S. Treasury



Stripped Brady Bond Yield Spreads over U.S. Treasuries



Stripped Brady Bond Yield Spreads over U.S. Treasuries

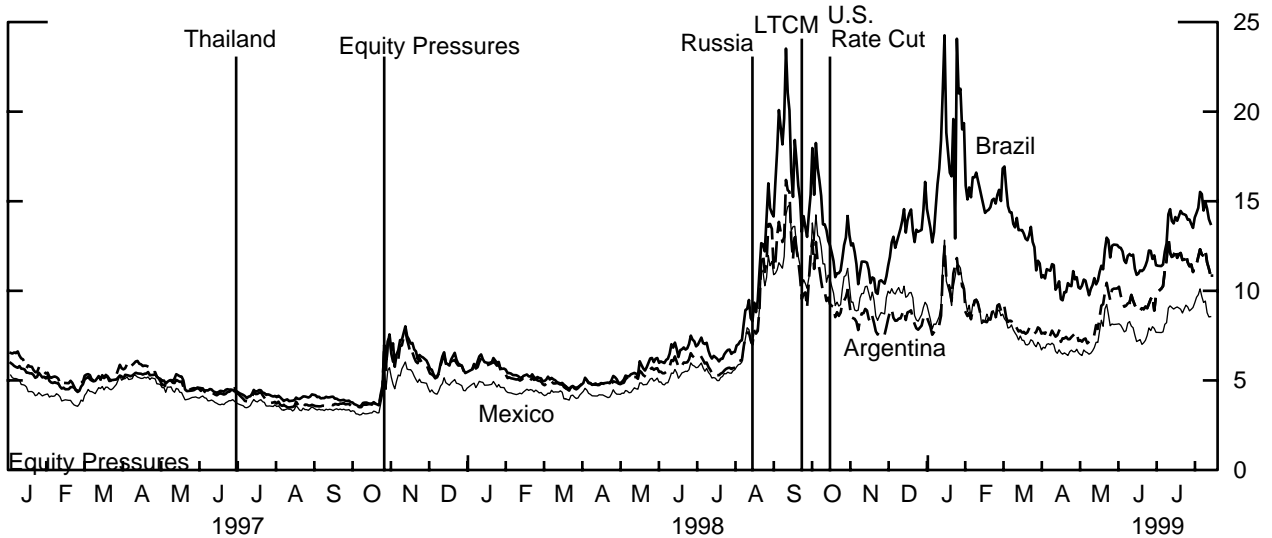
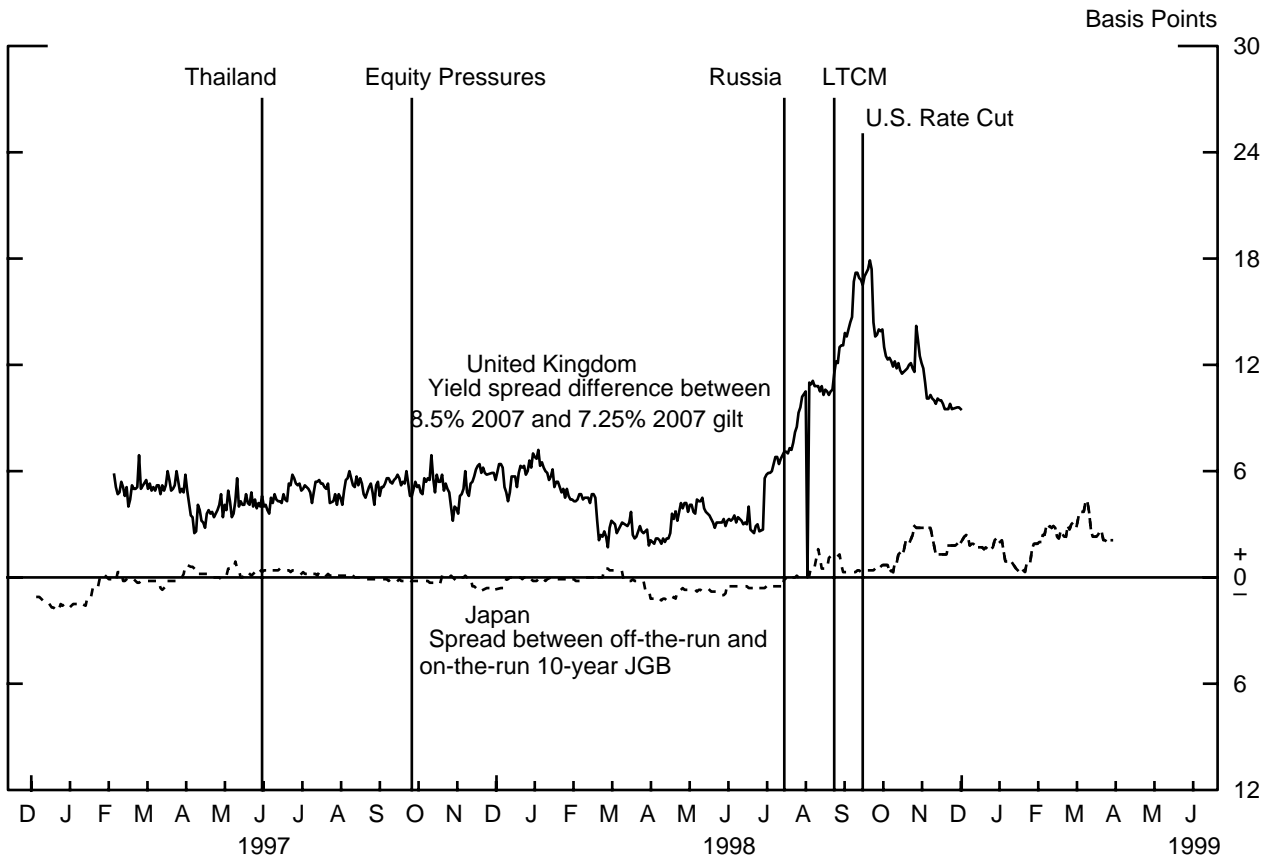


Chart 8

# Liquidity Spreads for 10-Year Government Bonds



Off-the-Run U.S. Treasury Spreads over On-the-Run

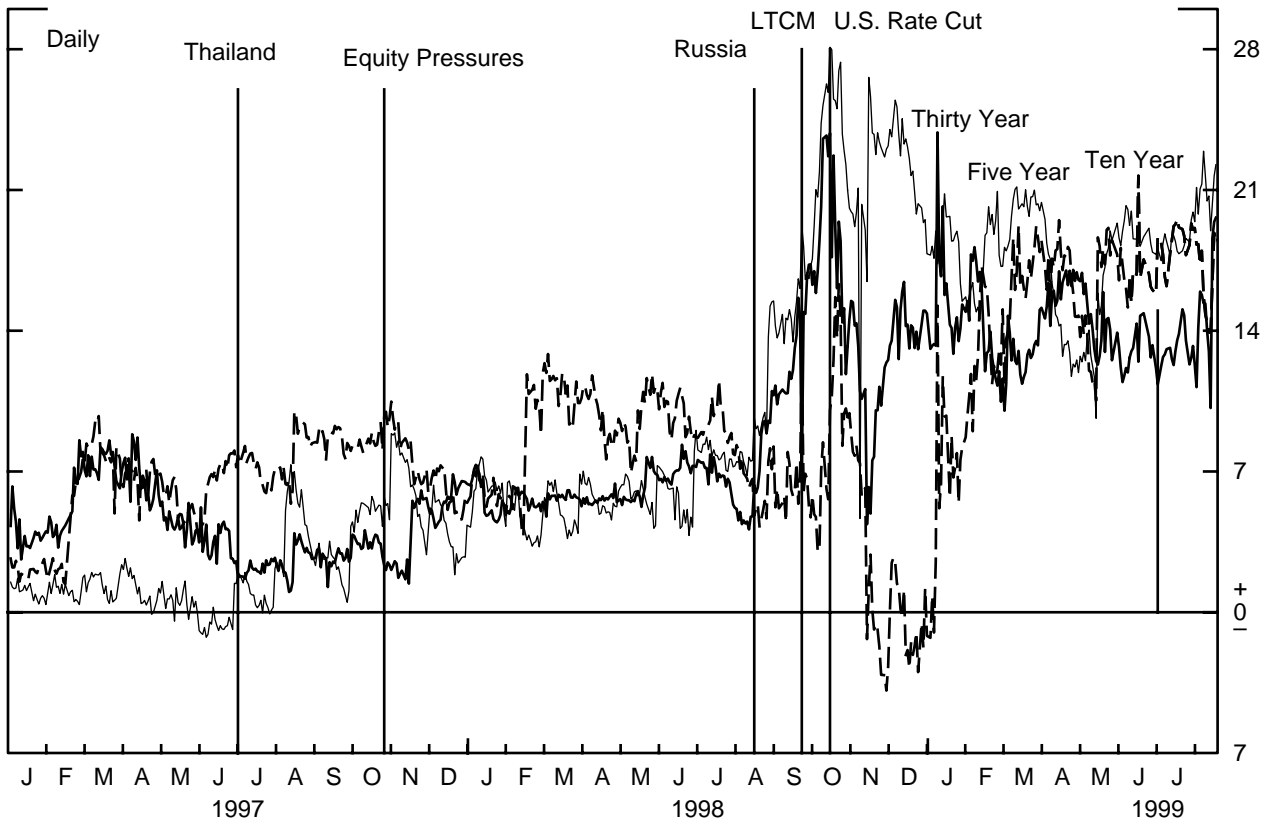
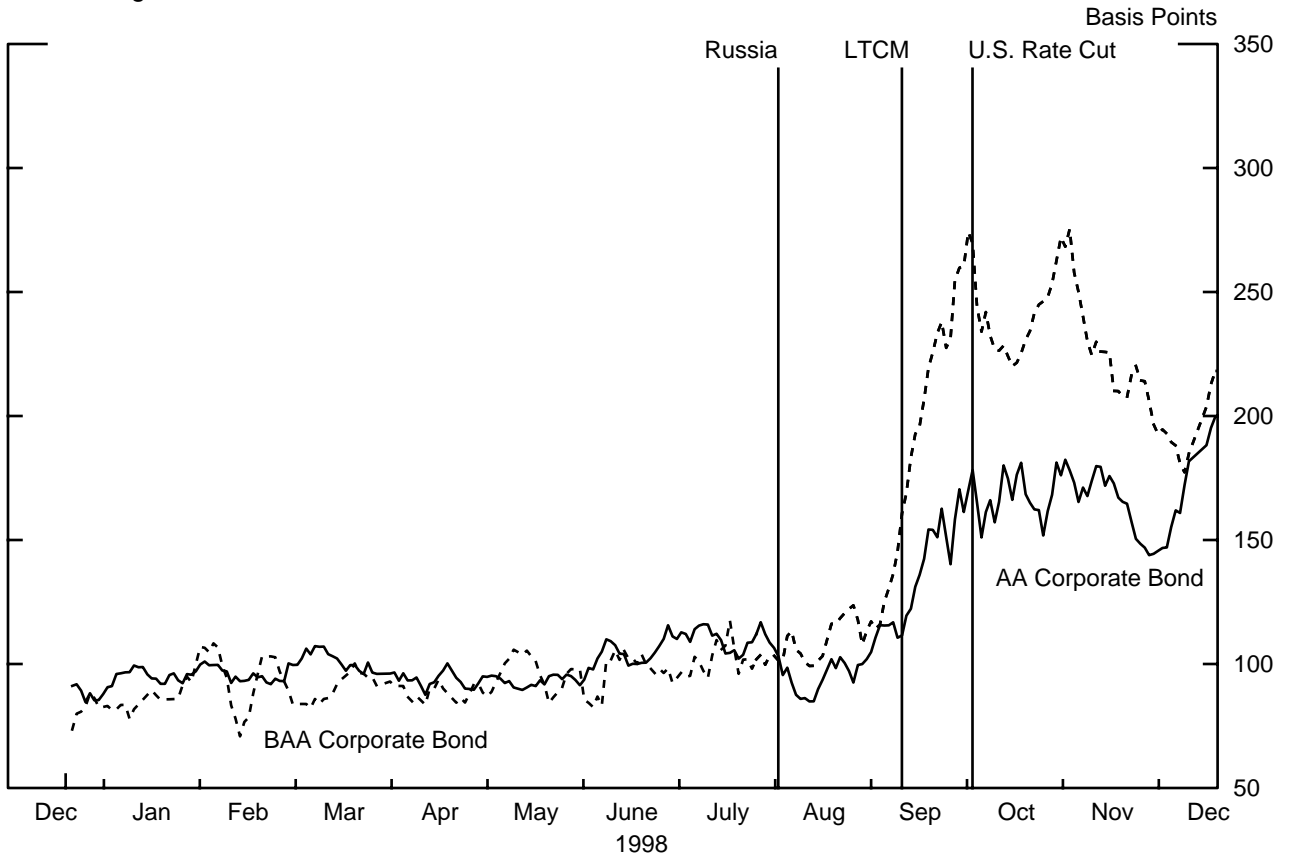


Chart 9

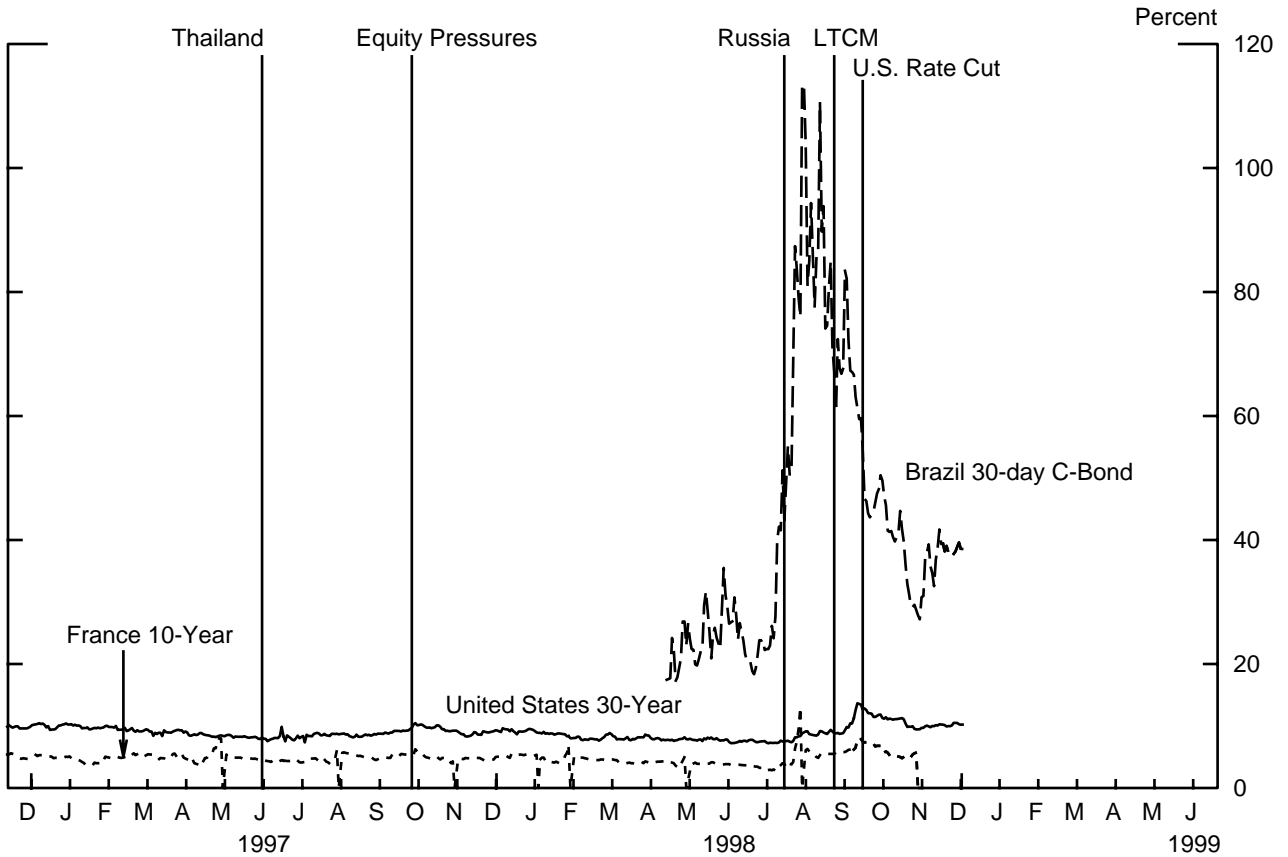
# Bid-Ask Spreads

United Kingdom



# Implied Volatility for Interest Rates

## Government Bond Yields



## 3-Month Interest Rates

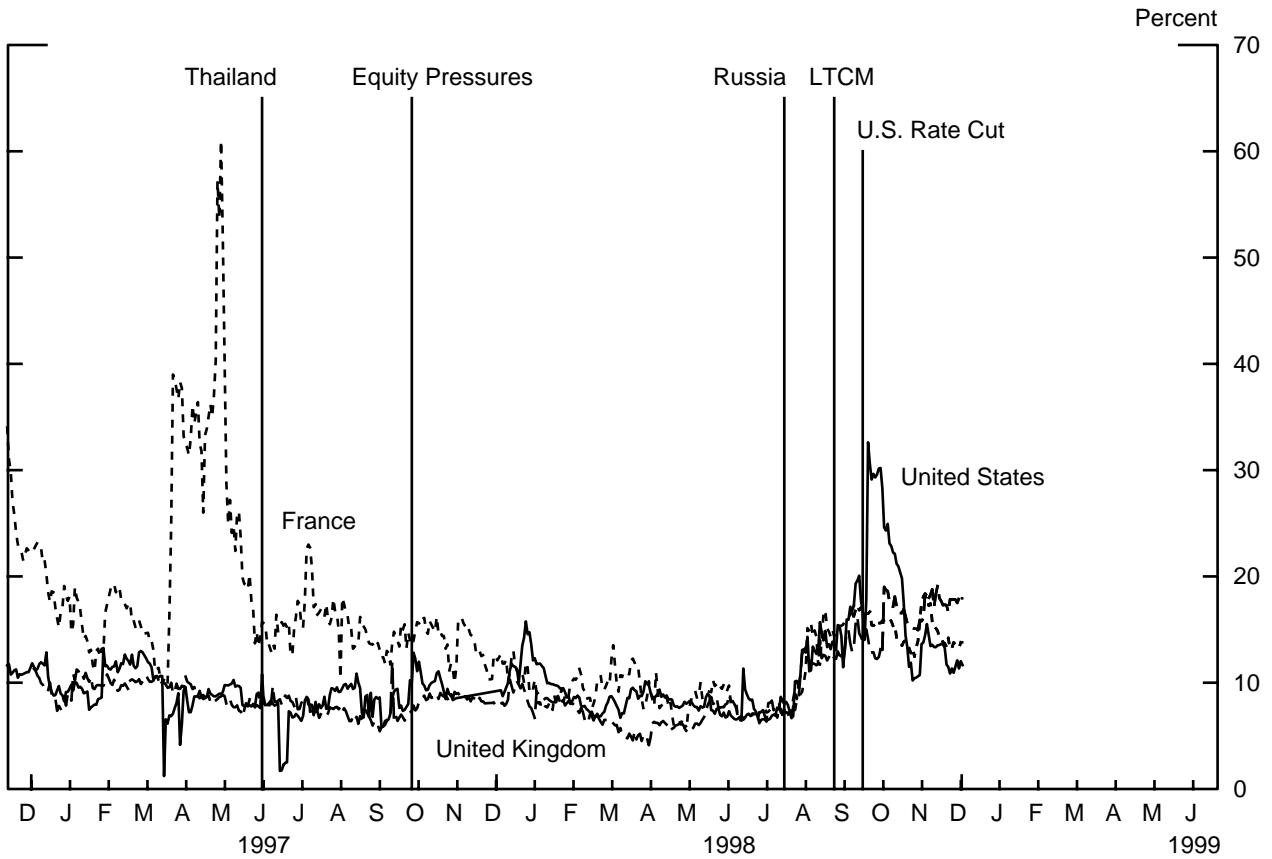
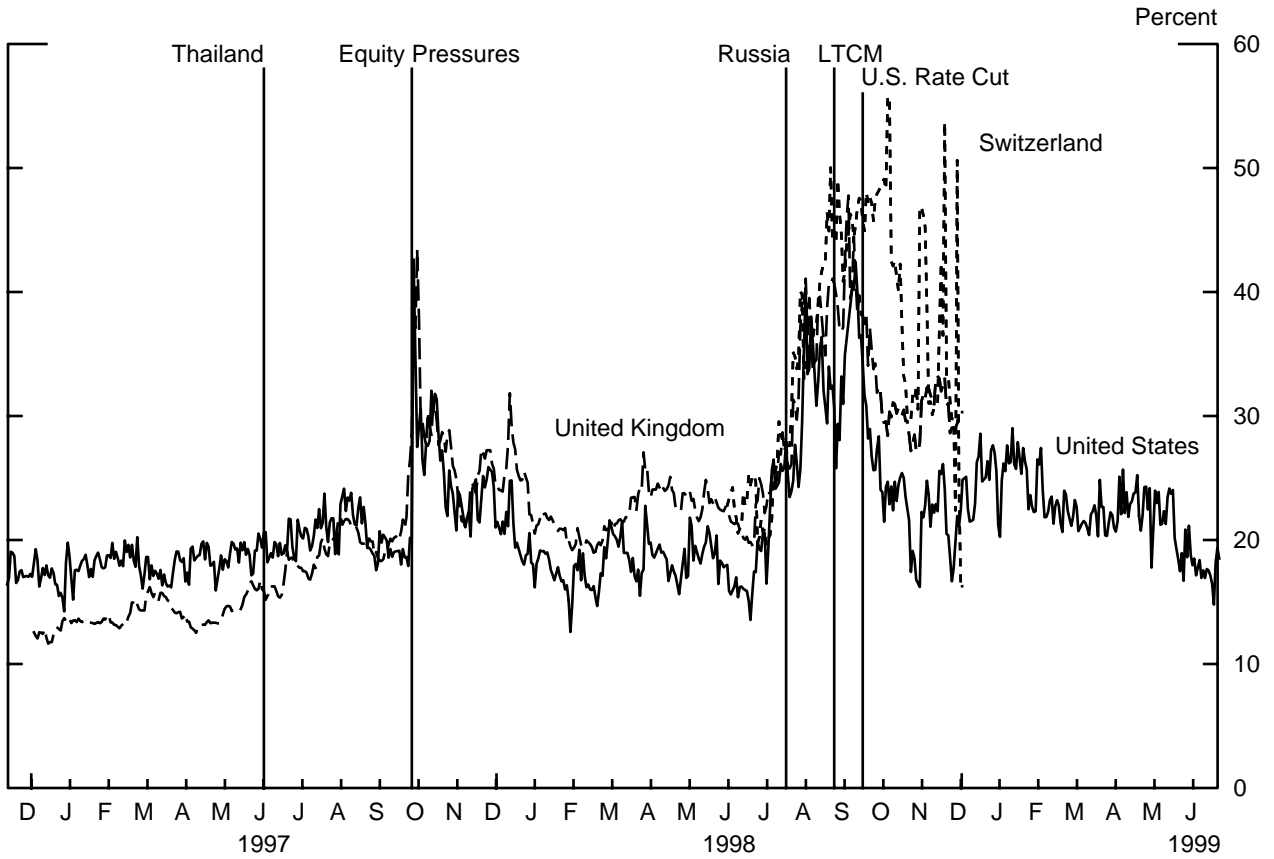


Chart 11

# Implied Volatility

## Stock Market Indices



## Dollar Exchange Rates

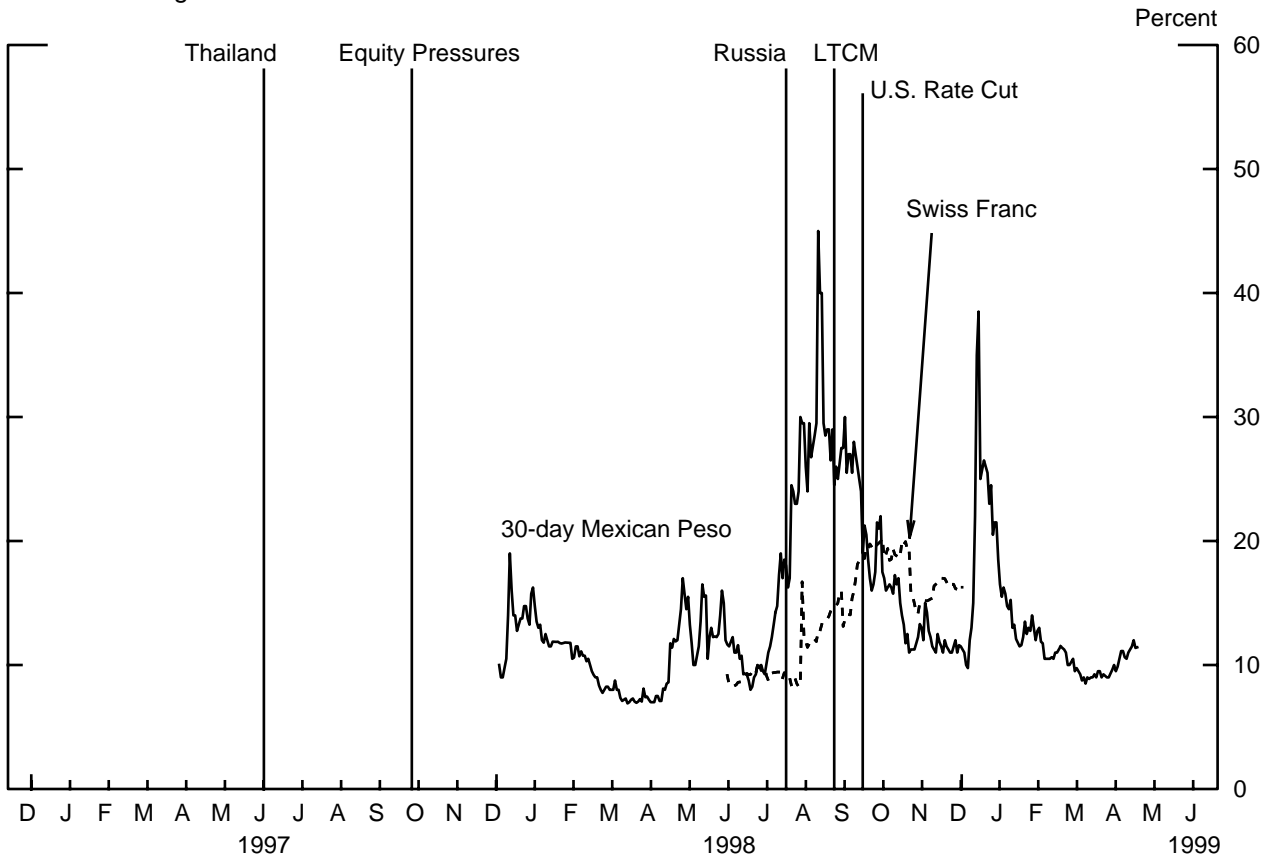
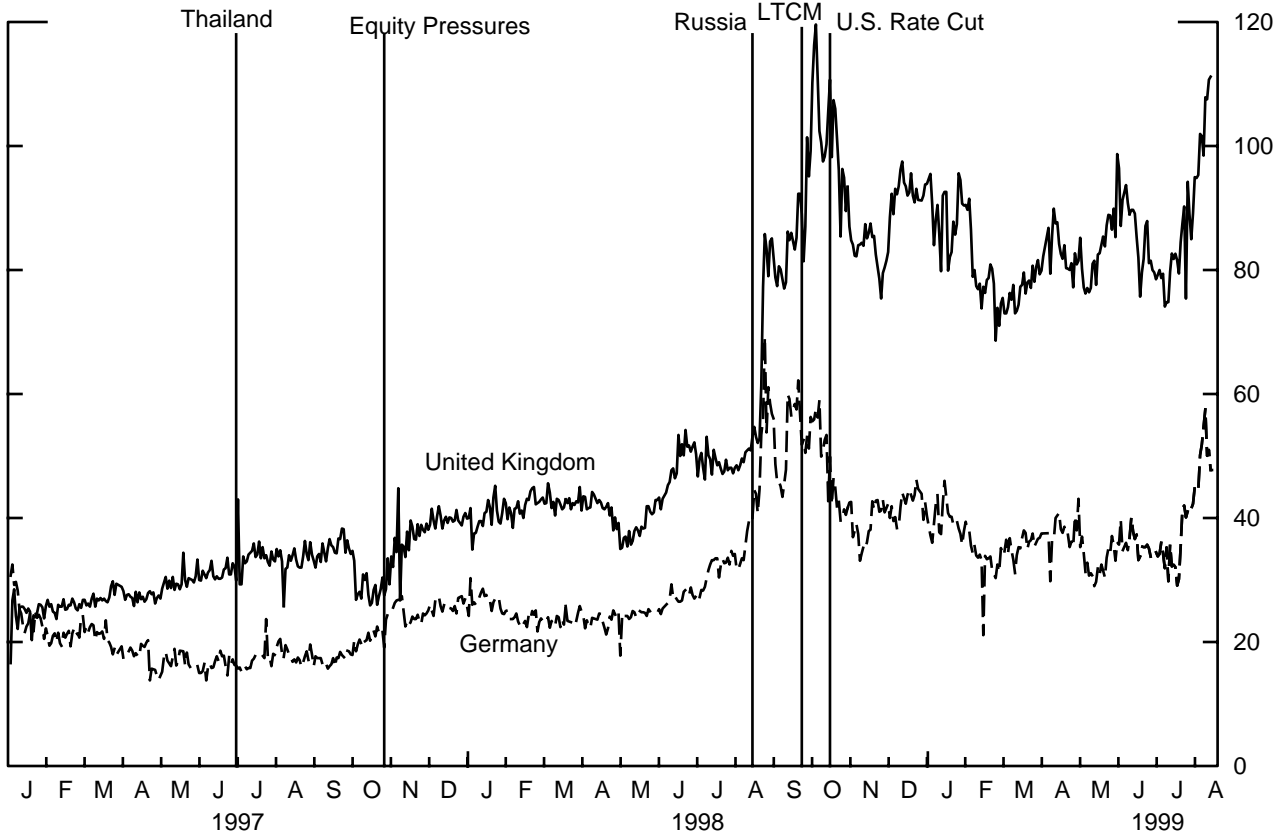
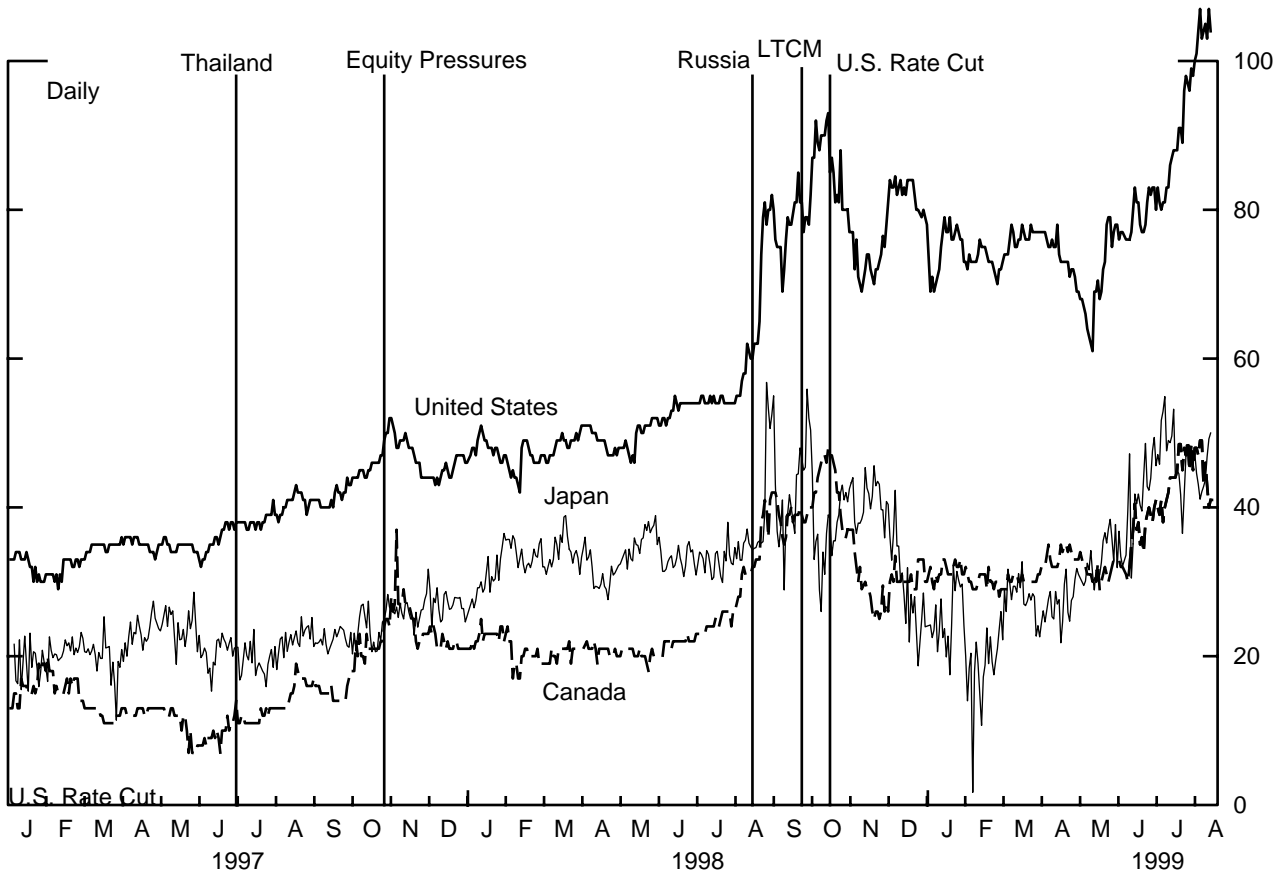


Chart 12

# Swap Spreads over Ten-Year Government Securities



# Annex 1

## Summary of interviews with market participants

This annex summarises the interviews with market participants on the market events of autumn 1998. The interviews were conducted by the central banks in each country represented in the Working Group, and by the Group itself during its 2 July meeting.

The questions focused on four main topics. Firstly, interviewees were asked to identify the major market events during autumn 1998. Secondly, they characterised the market conditions during the crisis. Thirdly, they reviewed their firm's activities from the specific standpoint of risk management activities during the crisis. Finally, they were invited to draw long-run lessons from the crisis.

This annex, based on national write-ups, reflects the consensus view that tended to emerge among market participants, citing divergent points of view when necessary.

The presentation follows the lines of the questions addressed to market participants. In the first section, the major market events during autumn 1998 are described as they were perceived by market participants: the triggering factors, the unfolding of the crisis and the beginning of relief in the financial markets. Secondly, market functioning during the crisis period is discussed, with a focus on the interaction of market, credit and liquidity risks. Finally, the legacy of the crisis is analysed in several respects: risk aversion behaviour, risk management techniques and the internal organisation of financial firms.

### 1. Major market events during autumn 1998 as perceived by market participants

This section focuses on the perception of events by market participants but does not describe the events themselves, which are summarised in Table 1 on page 3-4.

#### 1.1 *The triggering factors*

Both the *Russian crisis* (rouble devaluation and default) and *near-collapse of LTCM* were mentioned as the major events triggering the crisis. One interviewee noted that a major shock was caused to the market when the IMF signalled that its support of Russia was not unconditional. Another reason Russia's default may have caused so much turmoil was because it was a default on traded securities whereas the Asian problems in 1997 had been primarily in bank loans, which caused problems for banks affected but did not necessarily disrupt markets more broadly.

#### 1.2 *The unfolding of the crisis and the beginning of the recovery*

The unfolding of the crisis in developed markets, which was characterised by numerous risks (see section 2), was punctuated by both *events and rumours*. In Japan, however, the effects of the crisis were relatively limited, given the low exposure of Japanese banks to Russia, the focus on domestic developments, such as the government's banking reform policies, and the presence of a negative risk-averse mood since the collapse of financial firms.

The Hong Kong Monetary Authority stock market intervention in August, capital controls in Malaysia in September, rumours of difficulties at Lehman Brothers and other financial institutions, the dramatic fall in the yen/dollar exchange rate at the beginning of October, and reports of losses or lower earnings by large banks (such as BankAmerica Corp.) were mentioned by respondents as the most significant events.



According to several market participants, the first rate cut decided by the FOMC (23 September) fuelled concern among traders. That decision was perceived as a sign that markets were experiencing even more severe troubles than initially thought.

The *second monetary easing by the Federal Reserve* (15 October) signalled the beginning of the abatement of financial strains. At that time, traders clearly understood the commitment of the Federal Reserve to fix the problems. Even with the beginning of the recovery, market participants continued to avoid large exposures for the rest of 1998, because they did not want to further jeopardise the gains that they had booked in the first half of the year.

## 2. Market functioning during the crisis

Perhaps the most striking characteristic of the autumn 1998 crisis is the unfolding of multiple combined risks. For the sake of clarity, section 2.1 describes how market participants assessed these risks in isolation and section 2.2 is devoted to the dynamics of the crisis.

### 2.1 *The different strains on financial markets during autumn 1998*

Market participants identified several severe strains in financial markets during the crisis.

First of all, financial markets registered severe bouts of high volatility: there were increases both in *historical volatility*, reflecting the turbulence that markets had already experienced, and in *implied volatility*, measuring market risk expected in the future as discounted by market participants. The drying-up of liquidity hit financial markets, even the most active ones. Finally, the crisis led to a reappraisal of credit risk especially among financial intermediaries. This last feature was particularly stressed by the respondents.

#### 2.1.1 *The peaks in realised/expected market risks*

Market risk, as measured by the volatility of asset prices, was the best documented of the phenomena that occurred during the autumn 1998 crisis. Therefore, the interviewees did not analyse this feature in detail.

#### 2.1.2 *The drying-up of liquidity*

The drying-up of liquidity took several forms.

Market participants mentioned the *widening in bid-ask spreads*, to an unprecedented extent in several markets. This was particularly true of the foreign exchange market and more precisely the dollar/yen rate at the beginning of October. In extreme conditions, *markets became one-sided*. Simultaneously, investors looked for the most liquid government bond issues, e.g. on-the-run issues, in order to ensure the possibility of easily unwinding long positions. That reallocation raised the price of on-the-run issues relative to off-the-run issues, the spread between these two issues reflecting the liquidity premium.

Market participants diverged in their analysis of the functioning of government bond markets. Some respondents noted that even compulsory market-making was not sufficient to ensure the liquidity of a market: a number of market-makers withdrew from trading and did not ensure quotations. But according to others, the ability to transact for the desired amounts was maintained through the crisis. Even these respondents admitted, however, that this continued functioning was limited to on-the-run issues.

#### 2.1.3 *The reappraisal of credit risk*

In market participants' view, credit risk reappraisal was the most important phenomenon of the crisis. The consequences of this reappraisal for financial markets were manifold.

The events described above triggered *a search for the safest financial assets*. This search manifested itself in a flight to quality, benefiting US and European government bonds, and for a brutal but short-lived period a flight to cash episode benefiting the short end of these yield curves.

This reassessment also led to a *sharp widening in credit spreads*. The credit risk of financial intermediaries, which is reflected by the spread between swap rates and government bond rates, was revised upwards by investors. Likewise, spreads between corporate bonds and government bonds surged.

Several interviewees reported that the widening in credit spreads was further amplified by the drying-up of liquidity and by hedging activities. The search for the most liquid assets underpinned government bonds, thanks to the depth of these markets, to the detriment of financial assets issued by the private sector. Moreover, during the crisis, market-makers changed the way they hedged their corporate bond portfolios by switching to interest rate swaps instead of government bonds. This switch was motivated by the fact that swap spreads followed the same pattern as credit spreads. This new behaviour (which had already been adopted by some market-makers) in turn fuelled the widening in credit spreads. It is noteworthy that, according to some respondents, these two types of spreads reacted differently in the immediate aftermath of the crisis and therefore generated counterproductive hedges.

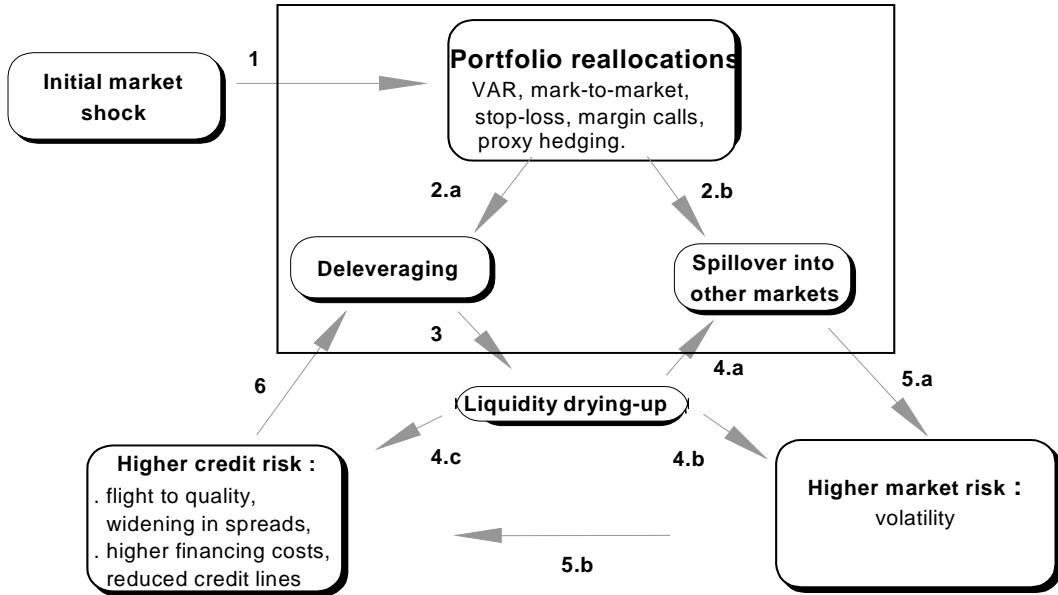
Simultaneously, credit risk reappraisal, especially with regard to financial intermediaries, took the form of *reductions in credit lines to other financial institutions*. Only a minority of market participants noted cuts in credit lines, however. Though sharply reduced, lending activity was not discontinued altogether.

**2.2 The interaction of risk**

Only a very small number of market participants declined to characterise the 1998 crisis as “exceptional”. Most interviewees mentioned that the events described, including the emergence and interaction of the three kinds of risk mentioned above, led to the worst crisis ever. In this respect, they stressed deficiencies in risk management techniques and the role they played in the contagion process.

**2.2.1 An explosive combination of risks**

The diagram below summarises the market participants’ view regarding the interaction of the three risks in the most comprehensive way. The sequencing of these six points is for the convenience of this report: the actual process was very swift.



1: The initial market shock, e.g. the Russian crisis and LTCM episode, triggered portfolio reallocations due to value-at-risk (VaR) models, mark-to-market techniques and stop-loss orders (see below for further details).

2.a: Portfolio reallocations led to a deleveraging process (see below for further details).

2.b: Portfolio reallocations, in reaction to the initial shock to one asset, needed to involve other classes of assets in order to reach a new equilibrium for the rebalanced portfolio. Moreover, in order to honour margin calls, investors had to sell other assets.

An important example of the spillover process had already been seen in the interactions among the different Asian and Pacific markets. Institutional investors who had long positions in less liquid Asian markets, such as Thailand, Indonesia and Malaysia, created short positions in more liquid Asian financial markets, such as Hong Kong, Singapore and Australia, as a proxy hedge to their long positions. That process engineered a sharp fall in these markets despite the fact that the economic conditions of these places were still relatively sound.

3: The deleveraging process that induced, for instance, a reduction in activity in repo markets and in arbitrage activities more broadly, caused liquidity to dry up in the markets where this process took place.

4.a: Traders were prevented from withdrawing from illiquid markets. Therefore, they unwound positions in related asset classes.

4.b: The evaporation of liquidity exacerbated market price volatility.

4.c: It also reduced the sources of financing for financial institutions that relied on the market for funding. Therefore, the credit risk assigned to these entities rose. Financial institutions that had already represented a relatively high credit risk faced financial difficulties: higher financing costs and reduced credit lines. Moreover, higher perceived credit risk led to a flight to quality and a widening in credit spreads.

5.a: The contagion process spread volatility to other markets.

5.b: In a high volatility environment, compliance with mark-to-market limits led to “distress sales”. High paper losses seemed briefly to endanger financial institutions.

6: Higher credit risk (higher financing costs and difficulties obtaining financing) compelled financial institutions to unwind their positions. This withdrawal magnified the drying-up of liquidity.

### 2.2.2 *The role played by risk management techniques in the contagion process*

**Value-at-risk models** measure market risk over a determined horizon and within a defined confidence level. In extreme market conditions, these models show some weaknesses.

There was a range of responses among the interviewees as to whether the magnitude of mature market turbulence was within or above their VaR limits. A large majority of interviewees admitted that last autumn’s events were in the “tails” of distribution and that therefore their VaR models were useless for measuring and monitoring market risk. On the other hand, other respondents (though a very small number) judged that their VaR models remained adequate.

Most of the interviewees also stressed that during autumn 1998 their estimated correlation matrices (which relied on historical data) and their assumption that liquidity would be available within a short-term horizon became unrealistic.

All in all, they shared the view that VaR models are not designed to measure/monitor market risk under extreme conditions: they are only supposed to provide reliable information on potential losses in a statistically defined percentage of occurrences. Instead, stress events have to be analysed by other tools, such as stress tests.

The deficiencies of the VaR methodology in conditions of contagion were unanimously emphasised by market participants. The surge in VaR levels above predefined limits during the crisis compelled market participants to unwind positions in the assets for which VaR limits were exceeded. Because of

the widespread use of similar models, similar behaviour was adopted by numerous investors. The resulting simultaneous pressure to unwind positions dried up the liquidity of markets and therefore exacerbated price volatility.

Moreover, illiquidity prevented investors from liquidating certain assets (i.e. those for which the VaR limits was exceeded) by as much as the VaR model would have suggested. Investors were forced to liquidate other, related assets. In this way, the contagion process was amplified.

In the view of market participants, the mark-to-market approach also played a major role in the contagion process. When stop-loss limits as measured by the mark-to-market technique were reached, sales were activated automatically and put additional pressure on markets. Furthermore, for leveraged instruments such as futures contracts or repo transactions margin calls, again relying on mark-to-market calculations, drove investors to sell assets.

### *2.2.3 Weaknesses of credit risk assessment*

Some market participants admitted that *time series data*, on emerging economy issuers especially, were neither consistent nor long enough to appraise credit risk in a reliable manner.

Moreover, interviewees mentioned that *competition* among financial institutions contributed to lower haircut levels and margin calls.

### *2.2.4 The weaknesses of a non-integrated risk management process*

Risk management techniques did not take into account the interplay between market risk and credit risk. These risks were measured in isolation. Most market participants mentioned that, in their own financial institutions, credit risk management and market risk management were conducted by separate teams with their own language. Finally, because of the assumption of a continuous liquid market, liquidity risk was not adequately appreciated.

## **3. The long-term impact of the crisis**

According to interviewees, the exceptional intensity of the autumn 1998 crisis probably led to a structural shift in risk aversion profiles in the financial industry. This structural evolution manifested itself in improvements in risk management techniques and improvements in the internal organisation of financial firms.

### *3.1 A likely structural change in risk appetite*

Most market participants reported that the emerging market crisis in 1997–98 and the mature market turbulence in autumn 1998 provoked a structural decrease in their level of risk appetite. On the other hand, a very small number of interviewees contended that persistently higher yield premia and higher expected market risk (measured by implied volatility) than before the crisis were the consequence of persistently greater risks.

The majority's point of view was supported by several lessons from the crisis. One legacy of the crisis is that financial institutions can suddenly lose their equity, especially when they have highly leveraged exposures. In other respects, traders know that liquidity on financial markets cannot be taken for granted any more.

This more cautious behaviour has led to a resilience in indicators of financial strains (implied volatilities, credit spreads), many of which have not yet returned to their pre-crisis levels. More prudence has also triggered a decline in the level of activity on financial markets – proprietary trading as well as activities on behalf of customers. After the sharp and forced deleveraging process during the crisis, market participants deliberately maintain lower leveraged positions than previously. A negative consequence of the reduction in proprietary trading activity may be that price anomalies are now more persistent than they used to be.

## 3.2 *The legacy for risk management techniques*

### 3.2.1 *Refinements in market risk management*

As mentioned above, in the view of market participants the VaR model is not designed to measure or monitor market risk under extreme conditions. Therefore, they do not reject the technique but are endeavouring to refine it. One example of these refinements concerns *the horizon over which VaR is calculated*. Specifically, it has been lengthened in order to take into account the difficulty in unwinding positions due to the drying-up of liquidity.

Interviewees emphasised the need for improvement in *stress testing* in order to estimate potential losses in extreme conditions (the “fat tails” of the distribution). Progress was acknowledged to be needed in defining these scenarios through a better analysis of disruptive price movements.

### 3.2.2 *Improvements in credit risk management*

With regard to the LTCM episode and the opacity of the firm’s positions and level of leverage, market participants underlined *the need to know their customers better*. They did not elaborate on the appropriate disclosure improvements, but they seemed to be less willing to lend to financial institutions that conduct business without transparency (e.g. financial institutions that do not want to disclose information that would help their counterparties to measure their positions and degree of leverage). They referred to more cautious policies regarding the quality of assets taken as collateral, the level of haircuts and margin calls. Market participants also suggested that netting agreements could be another way to improve credit risk management.

### 3.2.3 *Appraisal of liquidity risk and the interactions among risks*

Regarding liquidity risk, respondents say that they now calculate VaR with a longer horizon, i.e. a “liquidity-adjusted” VaR (see above). Some interviewees indicated that they are increasingly sensitive to the size of the market in which they want to take positions. Regarding the interactions among risks, market participants are studying ways to take account of correlations between credit risk and market risk. Some of them are studying a common measure for these two risks in order to calculate a single global VaR.

## 3.3 *The internal organisation of financial firms*

### 3.3.1 *The lessons for the organisation of trading activities*

Some market participants mentioned reorganisations in their front office activities. For instance, separate emerging market trading units were dissolved and integrated into regular global market trading units. Arbitrage activity, which in some financial firms formed a separate business line, has been integrated into other business lines.

### 3.3.2 *The lessons for the organisation of risk management*

Interviewees shared the view that the assessment of the interactions among risks calls for closer links between teams managing credit risk and market risk, and perhaps the merger of these separate staffs. They also foresee that the definition of stress scenarios (the identification of potential financial strains and estimation of their magnitude) could be developed by joint economic teams.

### 3.3.3 *The need to define and communicate strategic objectives for the firm*

The need to define strategic objectives for the firm is essential during crises. In the face of exceptional events, managers must make clear choices: whether to cut positions after experiencing substantial losses; whether to sue the issuer when there is a forced debt restructuring or to accept the restructuring in order to maintain good business relationships. Moreover, these strategic objectives have to be communicated and explained to traders, especially when these overall objectives may be in conflict with the goals of trading units.

## Annex 2

### Comparative data on liquidity and credit risk

The purpose of this annex is to empirically characterise the events in financial markets in the second half of 1998 with the help of an extensive customised dataset that has been compiled from the contributions of working group members. The analysis is particularly focused on the degree of comovement in asset prices, in addition to the extremity of price movements and market liquidity. In particular, we will be trying to address questions such as:

- How extreme were price movements, credit spreads, measures of implied and realised price volatility, and indicators of liquidity in comparison to normal periods? Although many of our data series are available for a relatively short period, we will also try to place 1998 in a somewhat longer-term context.
- Which markets were particularly impacted? Were there some markets that escaped unscathed?
- Were short-term comovements of asset prices markedly different from those seen in other periods?
- Were all markets affected most at about the same time or at different points during the period?
- What was the timing of the market turmoil with respect to major news events, such as the Russian default and the re-capitalisation of the Long-Term Capital Management (LTCM) hedge fund? How did subsamples (e.g. pre- and post- Russia and LTCM) differ?
- What evidence is there of reduced liquidity during the period and which markets were affected? We look at bid-ask spreads, trading volume, primary market activity, and liquidity premiums in asset prices.
- Particularly from a central bank perspective, a key implication of financial market turmoil is the risks and challenges it poses for financial institutions that must operate under those conditions. Thus we try to cast some of the analysis in terms of the consequences for risk exposures of trading firms and for the effectiveness of common hedging strategies.

Our principal findings are:

- During the second half of 1998 credit spreads widened, stock prices fell and volatility increased markedly in the majority of financial markets worldwide.
- Although the 17 August news of the Russian default seemed to serve as a trigger point for volatility and significant asset price declines, conditions worsened after the 23 September announcement of the LTCM recapitalisation agreement, and many market indicators hit bottom in the first half of October.
- However, the timing and severity differed somewhat across broad market categories. Hong Kong's experience was mild in comparison to what it saw in the first half of the year. Emerging markets more generally were hit particularly hard in August, but did not worsen significantly, and in many cases improved, from early September. Most short-maturity spreads and Japanese bond spreads only began to widen significantly towards the end of the year, as most other markets were recovering.
- Financial sector stock indices fell more than national market indices, but swap spreads and bank bond spreads widened by about the same amount as corporate bond yield spreads.

- Correlations between weekly changes in yield spreads were heightened somewhat in the second half of the year but, with the exception of closely related assets, typically reached levels of only around 20-50%. Thus “correlation risk” ought to have increased by large amounts only for relatively undiversified portfolios of credits. However, there was somewhat greater comovement in options prices, as reflected in measures of implied volatility. To the extent that they can be measured over a period so short, correlations appeared to be highest during the five-week period between the Russian default and the LTCM recapitalisation agreement. Individual correlation coefficients did not seem to be exceptionally unstable in the second half of 1998.
- Market participants hedging positions with futures or options would not have been insulated from the market turbulence.
- Quoted bid-ask spreads rose in some markets but not in some of the others for which data were available, such as European interbank markets. Overall turnover in exchange-traded instruments did not decline significantly, but OTC trading of emerging market bonds fell sharply in the fourth quarter, despite the recovery in prices.
- For some market indicators, particularly for stock market volatility, this was the most turbulent episode of the 1990s, but numerous other financial indicators – including most of our credit spread series – have reached more extreme levels within the past few years. Overall, the confluence of market movements since in late summer and autumn 1998 seems to fall into the category of a somewhat unusual but not extremely rare event.

The remainder of the discussion examines the evidence one piece at a time. A significant portion of the analysis is structured by separating 1998 into shorter intervals, the boundaries of which are marked by news events we considered to have potentially significant market implications, such as the Russian default and the LTCM news. Because there was some anecdotal evidence of significant deterioration prior to mid-August, we further divided the pre-Russia sample into two pieces, choosing the 6 July disbanding of Salomon Brothers’ storied bond arbitrage desk as the transition point. Finally, we selected the mid-October US rate cut as a possible trigger point for recovery. Accordingly, we found ourselves with five sub-periods:

1 January – 3 July

6 July – 14 August

17 August – 22 September

23 September – 15 October

16 October – 31 December

### **Credit spreads in 1998**

Table A1 shows average (yield and swap) spreads, relative to a government bond of the same maturity, for each of the sub-periods, listed geographically from Japan to Switzerland. A majority of these spreads, particularly in European and North American markets, reached their peak levels (the shaded cells) in the post-LTCM period, but most showed their largest increases (displayed in boldface) between the pre and post-Russia periods. Spreads that were initially wider tended to experience larger proportional increases, although the Japanese BBB bond spread barely budged. Yield spreads mostly declined after the US inter-meeting rate cut in mid-October, in a number of cases, as shown in Table A2, reaching their 1998 peaks just before the Federal Reserve’s surprise announcement.

Short-term markets (Table A3) show a more mixed pattern. Asian and emerging market spreads widened between mid-year and late September but then narrowed, particularly in Hong Kong, by year-end. The UK, US and Canadian spreads shown here rose mostly after 22 September. The US and Canadian interbank spreads came back down later in the year, but US commercial paper spreads widened further. The French short-term spreads shown here changed little over the whole period.

Short-term spreads often reached their peak levels (Table A4) at about the same time as longer-term spreads in the same country, but the UK interbank and US commercial paper spreads did not peak until December.

### **Bank spreads in 1998**

Figures A1 to A4 show bank bond yield spreads with corporate bond spreads and swap spreads for Japan, the Netherlands, the United Kingdom and Germany respectively. The patterns vary somewhat across the four countries, but in general bank bonds were not punished much more than other corporate bonds, and swap rates did not diverge sharply from bond yields. The comovement between swap spreads and bank bond spreads, which was particularly close in the United Kingdom and Germany, suggests that swap spreads were widening more on credit concerns than from any reluctance on the part of market participants to bear interest rate risk.

In Japan, however, swap spreads declined significantly in September and early October, while bank bond spreads lagged somewhat. Nevertheless, by year-end, Japanese bank bonds were trading once again at yield spreads distinctly narrower than AA-rated corporate bonds. Corporate bonds also underperformed in the Netherlands, with spreads widening relative to bank bonds.

### **Market indicators of liquidity**

Table A5 shows bid-ask spreads for a variety of markets. The table reflects sharply higher transaction costs for the Mexican peso exchange rate by late summer, and later increases for UK corporate bonds decreasing in credit quality. However, at least based on the data shown here, liquidity in Swiss and French swap and interbank markets appears to have been unimpaired, with quoted bid-ask spreads holding steady through the year. A caveat is that to the extent that these data represent indicative prices, rather than firm offers to trade in significant quantities, they may not reflect variation over time in the ability of these markets to absorb transaction flow.

Table A6 shows spreads between non-benchmark and benchmark 10-year government bonds for Japan, the United States and the United Kingdom, which are thought to reflect the greater liquidity of the more traded benchmark security. Also shown is the spread between Dutch and German sovereigns, which probably reflects greater liquidity for the German bunds, which serve as underlying instruments for exchange-traded derivatives, rather than considerations of relative default risk or devaluation risk. The two European spreads widened distinctly following the Russia and LTCM events.

### **Stock prices**

Table A7 shows the lowest levels reached in the five sub-periods for national stock market indices around the world. Most of the industrial country indices hit lows in early October that were 20-30% below their mid-year levels, with east Asian and Latin American markets bottoming somewhat earlier. Financial sector stocks fared somewhat worse than broader indices, with the Swiss bank index losing more than half of its value in just three months. Small-capitalisation stocks in the United States, which are less liquid and likely to be more affected by informational asymmetries, underperformed the broader market.

### **Implied and actual volatility**

Table A8 shows sub-period averages of implied volatility measures derived from options prices for a variety of underlying assets: stock indices, bonds, short rates and foreign exchange. Most of these rose sharply following the Russian default and increased further after the LTCM re-capitalisation, reaching levels 1½ to 2½ times their first-half averages. To the extent that the financial sector has an aggregate short position in options, which it sells in various forms to non-financial entities in return for implicit



or explicit fee income, the consequent increase in options prices would have led to losses, at least on a marked-to-market basis.

Actual volatility, at least within the brief sub-periods shown (Tables A9 and A10), often rose even more. For bond yields, exchange rates and stock market indices, volatility was usually highest for emerging markets (including Hong Kong) after the Russian default, and it was highest for G10 financial markets after the LTCM recapitalisation.

In addition, Table A11 shows realised volatility for the same list of yield spreads treated in Tables A1 and A2, which in many cases tripled or more from levels recorded in the first half of the year. For more than half of these spreads, volatility peaked in the post-Russia sub-period, but volatility increased subsequently for bond yield spreads in Hong Kong, Japan, the United Kingdom, and Switzerland.

Financial trading firms that use value-at-risk (VaR) measures for risk management typically use a backward-looking measure of historical volatility over a much longer sample period. In fact, the Basel Committee guidelines for the “internal models” approach to capital charges for market risk stipulate a minimum computation period of at least a year. Table A12 demonstrates that, when implied volatility measures were reaching their peak levels last year, such a historical measure of volatility over 250 trading days fell far short of the market expectations of future volatility that were implicit in options prices for most of these instruments. (In addition, Figure A5 depicts the substantial extent to which 250-day historical volatility lagged implied volatility for the UK stock index.) For this reason, conventional VaR measures, in addition to taking no account of illiquidity or counterparty credit risk, probably understated the amount of market risk in financial firms’ trading portfolios.

### **Flow measures of liquidity**

Table A13 shows average daily secondary market trading volume in a number of instruments for the five sub-periods. For most of these instruments, volume stayed close to normal levels through the Russia and LTCM news events, but then fell to its lowest level (the shaded cells) late in the year. Interestingly, Hong Kong trading volume in futures and bonds was actually higher after the Russian default than earlier in the summer.

Table A14 provides much more comprehensive volume information on exchange-traded derivatives, but only at a quarterly frequency. Volume was strong in the second half of 1998, although there was a decrease from the third to the fourth quarter. In contrast, trading in emerging market debt (which is dominated by Latin American issues) fell sharply in the third quarter and precipitously in the fourth, with almost no recovery in the first quarter of 1999.

The figures in Table A15 suggest that primary market volumes suffered more distinctly. Global net private issuance of bonds fell sharply in the fourth quarter, and money market issuance fell short of the quantity maturing. Monthly data for UK corporate bonds suggests that August and September activity was particularly weak. Syndicated loan origination (Table A16) declined less.

### **Correlations**

Table A17 (which stretches across three pages) compares correlations between five-day changes in yield spreads in the first and second halves of 1998, with the coefficients expressed in tenths to save space. Although some pairs of spreads are highly correlated, coefficients that are near zero or even negative are commonplace. On balance, correlations were somewhat higher in the second half, with the average coefficient (Table A18) increasing from 11% to 21%. Even in the most extreme sub-period – the five weeks after the Russian default – the average coefficient is only 37%. Also note that the average absolute change in correlations – compared to the previous six months – was only slightly higher for the second half of 1998 than for the first half. In other words, individual correlation coefficients did not seem to be exceptionally unstable in the second half of 1998.

The story is a little different for closely related yield spreads that were already significantly correlated in the first half of 1998. In particular (Tables A19 and A20), UK five-year bond spreads moved nearly in lockstep in the second half of the year, with average correlation reaching as high as 80%. (However, it is a fairly general statistical regularity that significantly correlated variables become more highly correlated in volatile periods – see Boyer, Gibson and Loretan (1997) for a discussion in the context of normally distributed variables.)

Correlations in implied volatility measures (Tables A21 and A22) essentially reflect comovements in options prices, net of the effect of changes in the value of the assets on which the options are based. These correlations increased in the second half of the year, particularly in the sub-period immediately following the Russian default. To the extent that financial firms tend, on net, to hold short positions in options, increased correlation may be problematic.

### **Hedging risk**

Another potential pitfall of changes in correlations is that hedging strategies will be undermined. Table A23 examines the effectiveness of a short futures position as a hedge for a long position in a government bond. In the upper panel, which shows the percentage reduction in risk exposure as a result of the hedge, a figure of 100 would denote a perfect hedge, with zero residual volatility in the hedged position. This type of hedge was least effective (comparing over the five sub-periods) for the Japanese bond and the Brazilian Brady bond following LTCM, but futures hedging for the US, UK and German government bonds during this period was about as effective as at any other time during 1998. However, residual volatility was still high, because volatility in the prices of the underlying bonds was higher. Thus, despite a reasonably effective hedge, hedgers would not have been insulated from the increase in volatility.

The last four lines in each panel show so-called cross-hedges, in which short German bund futures positions are offset against long positions in bonds issued by other national governments within the euro area. Interestingly, in each case, this hedge was unusually effective in the post-LTCM period. For the Dutch and French bonds, the residual volatility of the hedged position after 22 September was not only the lowest of the five sub-periods, but also less than for the hedge of the German bond.

One of the more striking features of these results is how ineffective most of these hedges were much of the time. The last panel shows how effective futures hedges were when held over the entire sub-period. Numbers closer to 100 % represent more effective hedges, with numbers greater than 100 % reflecting excess movement in the futures market. In addition to suggesting that futures hedging is more effective over longer periods, the figures imply that the futures and cash markets diverged most for most of these bonds after the LTCM recapitalisation announcement.

Table A24 shows analogous figures for hedges using interest rate swaps against 10-year government bond positions for Japan, the United States, the United Kingdom and Germany. For Japan and Germany, this was a uniformly ineffective hedge for a one-day holding period, with residual volatility exceeding that of the unhedged position in every sub-period. Over longer periods (the lower panel), however, swap hedging appears to be the most effective in Germany of the four countries examined. The US and UK hedges were relatively effective in the post-LTCM period, but residual volatility was still much higher than in the first half of the year.

### **Longer-term perspective**

A remaining question is how the turbulence in the second half of 1998 compares to other periods. Figure A6 shows several implied volatility measures since the early 1990s. All of these series reached comparable or higher levels in recent years. For example, French and US government bond yield volatility was higher for much of 1994.

Furthermore, most of the yield spreads in Table A25 and the short rate spreads in Table A26 reached higher levels in the 1990s than in 1998, in some cases by a substantial margin. For example, Mexican Brady bond spreads were about 400 basis points higher in early 1995, in the wake of the peso

devaluation, as were US speculative-grade bonds at the beginning of 1991, not long after the scandal involving Drexel Burnham Lambert. Hong Kong interbank spreads peaked in late 1997 during the so-called Asian financial crisis.

The 1998 stock market declines in Table A27 are 1990s records for most of the industrialised country indices, but at least in some cases, such as the United Kingdom's FT-SE 100 index, fall short of the declines generated by the crash of October 1987. The 1998 peak stock price volatility figures shown in Table A28 are also frequently the most extreme values for the 1990s for North American and European markets.

1998 peak volatility levels for bond yields (Table A29) and long-term and short-term spreads (Tables A30 and A31), however, tend to fall well short of the 1990s extremes, with Japan's three-month interbank rate spread the only exception. In many cases, the highest volatility occurred in 1994.

Surprisingly, 1998 (specifically October) contains the 1990s extreme for three of the five exchange rates shown in Table A32, although this is largely attributable to the sharp rise in the exchange value of the yen on 7 and 8 October. There was also a temporary blip in the Canadian dollar at the same time.

Table A1  
Average yield spreads during 1998  
(basis points)

	<i>Level</i>	<i>Change from previous period average</i>			
	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 5-year AA corporate bond	70	0	+ <b>6</b>	+ 4	+ 5
Japan 5-year BBB corporate bond	189	- 1	+ 11	+ 2	+ <b>14</b>
Japan 5-year bank bond	39	+ 12	+ <b>19</b>	- 3	- 21
Japan 10-year yen Swap	64	+ <b>3</b>	+ <b>3</b>	- 23	- 1
Hong Kong 10-year government bond	346	+ <b>115</b>	- 15	- 79	- 137
Hong Kong 3-year agency bond	43	+ <b>22</b>	+ 10	+ 10	- 10
Hong Kong 10-year HK\$ Swap	109	- 40	+ <b>6</b>	- 13	- 4
Latin America Brady bond	345	+ 79	+ <b>377</b>	- 41	- 97
Mexico corporate eurobond	355	+ 93	+ <b>502</b>	+ 94	- 240
US 10-year AA corporate bond	77	+ 5	+ <b>23</b>	+ 22	- 9
US 10-year BBB corporate bond	123	+ 11	+ <b>42</b>	+ 36	+ 2
US speculative-grade bond	332	+ 42	+ <b>146</b>	+ 104	- 24
US 2-year US\$ swap	37	+ 4	+ <b>11</b>	+ 9	- 5
US 10-year US\$ swap	51	+ 6	+ <b>20</b>	+ 11	- 8
Canada 10-year \$ swap	21	+ 6	+ <b>12</b>	+ 5	- 11
UK 5-year Aa corporate bond	54	+ 3	+ 26	+ <b>46</b>	- 16
UK 5-year Baa corporate bond	88	+ 2	+ 24	+ <b>53</b>	- 17
UK four 5-year bank bonds	59	+ 4	+ 28	+ <b>46</b>	- 16
UK 10-year sterling swap	33	+ 4	+ 30	+ <b>33</b>	- 11
Netherlands two industrial bonds	33	+ 3	+ 5	+ 6	+ <b>11</b>
Netherlands four 10-year bank bonds	28	+ 2	+ <b>8</b>	+ 7	- 2
Germany industrial bond (from May)	71	+ 1	+ 6	- 3	+ <b>8</b>
Germany 9-10 year mortgage bond	27	+ 0	+ <b>21</b>	+ 1	- 3
Germany 9-10 year bank bond	25	+ 2	+ <b>20</b>	+ 1	- 6
Germany 10-year DM swap	25	+ 9	+ <b>19</b>	+ 0	- 12
France A3 corporate bond	41	- 2	+ 10	+ <b>13</b>	+ 2
France average swap rate	20	+ 0	+ <b>12</b>	- 2	- 3
Swiss corporate bond	41	- 14	+ 6	+ <b>18</b>	- 6
Swiss 5-7 year SFr swap	52	+ <b>1</b>	+ 1	+ 6	- 5

Notes: Shading denotes highest average spread and boldface denotes the largest increase. Spreads generally are measured relative to a government bond of the same maturity and currency (US dollars for the Latin American and Mexican bonds). The Hong Kong government spread is measured relative to a US Treasury bond.

Table A2  
**High/low yield spreads during 1998**  
(basis points)

	<b>1998 low</b>	<b>Date of low</b>	<b>1998 high</b>	<b>Date of high</b>	<b>Increase from low</b>
Japan 5-year AA corporate bond	58	5 Jan.	92	20 Nov.	34
Japan 5-year BBB corporate bond	177	8 Jan.	227	22 Dec.	50
Japan 5-year bank bond	14	29 Jan.	77	10 Sep.	63
Japan 10-year yen Swap	58	5 Jan.	84	28 Aug.	26
Hong Kong 10-year government bond	222	23 March	506	26 June	284
Hong Kong 3-year agency bond	1	6 Jan.	105	12 Oct.	104
Hong Kong 10-year HK\$ Swap	134	5 Jan.	199	9 Jan.	65
Latin America Brady bond	292	23 March	985	10 Sep.	693
Mexico corporate eurobond	313	26 Feb.	1253	11 Sep.	940
US 10-year AA corporate bond	70	23 Jan.	138	5 Oct.	68
US 10-year BBB corporate bond	114	23 Jan.	225	4 Nov.	111
US speculative-grade bond	307	30 March	687	19 Oct.	380
US 2-year US\$ swap	30	24 Feb.	73	14 Oct.	43
US 10-year US\$ swap	44	11 Feb.	97	14 Oct.	53
Canada 10-year \$ swap	17	5 Feb.	48	14 Oct.	31
UK 5-year Aa corporate bond	48	13 March	147	5 Oct.	99
UK 5-year Baa corporate bond	82	17 June	191	13 Oct.	109
UK four 5-year bank bonds	53	2 Jan.	154	5 Oct.	101
UK 10-year sterling swap	26	5 Jan.	116	5 Oct.	90
Netherlands two industrial bonds	25	19 March	68	3 Dec.	43
Netherlands four 10-year bank bonds	24	21 Jan.	49	14 Oct.	25
Germany industrial bond (from May)	57	12 Aug.	114	11 Dec.	57
Germany 9-10 year mortgage bond	20	29 April	57	21 Sep.	37
Germany 9-10 year bank bond	21	6 May	59	21 Sep.	38
Germany 10-year DM swap	18	1 May	69	25 Aug.	51
France A3 corporate bond	35	5 March	66	30 Nov.	31
France average swap rate	19	18 May	36	4 Sep.	17
Swiss corporate bond	22	21 July	61	1 Oct.	39
Swiss 5-7 year SFr swap	39	1 June	89	31 Dec.	50

Notes: Spreads generally are measured relative to a government bond of the same maturity and currency (US dollars for the Latin American and Mexican bonds). The Hong Kong government spread is measured relative to a US Treasury bond.

Table A3  
**Average short-term interest rate spreads during 1998**  
(basis points)

	<i>Level</i>	<i>Change from previous period average</i>			
	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 3-month interbank euro-rate	- 2	- 4	+ <b>4</b>	- 3	- 2
Hong Kong 3-month domestic interbank	262	+ 100	+ <b>164</b>	- 310	- 157
Hong Kong 6-month domestic interbank	333	+ 100	+ <b>147</b>	- 291	- 157
Hong Kong 12-month domestic interbank	390	+ 75	+ <b>122</b>	- 228	- 142
Mexico 1-month domestic interbank	165	+ 8	+ <b>146</b>	+ 23	- 45
US 3-month interbank euro-rate	53	+ 8	+ 9	+ <b>37</b>	- 25
US 12-month interbank euro-rate	59	+ 2	+ <b>6</b>	+ 4	- 8
US 1-month prime commercial paper	7	+ 1	- 1	+ 5	+ <b>13</b>
US 1-month second-tier commercial paper	27	0	+ 1	+ 17	+ <b>38</b>
Canada 3-month interbank euro-rate	20	- 13	+ 6	+ <b>31</b>	- 23
UK 3-month interbank (euro-rate) versus repo	22	+ 1	+ 2	+ 2	+ <b>13</b>
France 3-month domestic interbank	- 6	- 1	+ 1	+ 2	+ <b>6</b>
France 12-month domestic interbank	- 1	- 1	0	- 2	+ <b>1</b>
France 1-month commercial paper	3	0	+ <b>1</b>	0	- 2

Notes: Shading denotes highest average spread and boldface denotes the largest increase. Spreads are measured relative to government treasury bills unless it is stated otherwise. Hong Kong interbank rates are midway between bid and ask. Other interbank rates are bid quotes.

Table A4  
**Peak short-term interest rate spreads during 1998**  
(basis points)

	<b>1998 low</b>	<b>Date of low</b>	<b>1998 high</b>	<b>Date of high</b>	<b>Increase from low</b>
Japan 3-month interbank euro-rate	– 22	6 Oct.	16	30 Oct.	38
Hong Kong 3-month domestic interbank	19	23 Apr.	1294	28 Aug.	1275
Hong Kong 6-month domestic interbank	100	23 Apr.	1198	28 Aug.	1098
Hong Kong 12-month domestic interbank	169	23 Apr.	854	28 Aug.	685
Mexico 1-month domestic interbank	86	27 Apr.	628	14 Sep.	542
US 3-month interbank euro-rate	33	26 Feb.	144	16 Oct.	111
US 12-month interbank euro-rate	40	24 Feb.	86	16 Oct.	46
US 1-month prime commercial paper	– 2	9 Sep.	54	16 Dec.	56
US 1-month second-tier commercial paper	14	26 Feb.	135	2 Dec.	121
Canada 3-month interbank euro-rate	– 58	27 Aug.	67	7 Oct.	125
UK 3-month interbank (euro-rate) versus repo	15	13 Jan.	58	23 Dec.	43
France 3-month domestic interbank	– 11	27 Apr.	15	21 Dec.	26
France 12-month domestic interbank	– 1	2 Jan.	5	9 Jan.	6
France 1-month commercial paper	– 19	30 Nov.	22	30 Dec.	41

Note: Spreads are measured relative to government treasury bills unless it is stated otherwise. Hong Kong interbank rates are midway between bid and ask. Other interbank rates are bid quotes.

Table A5

**Bid-Ask Spreads**

(1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Hong Kong 3-year agency bond	100	82	82	82	82
Mexico Peso/US Dollar exchange rate	100	82	<b>317</b>	222	105
Canada 3-month treasury bill	100	99	103	<b>177</b>	116
Canada 1-year treasury bill	100	93	86	<b>184</b>	117
UK Aa corporate bond	100	114	104	<b>154</b>	<b>174</b>
UK A corporate bond	100	115	137	<b>200</b>	<b>217</b>
UK Baa corporate bond	100	110	126	<b>245</b>	<b>246</b>
France 3-month interbank rate	100	100	100	100	100
France 3-month repo rate	100	94	94	<b>99</b>	93
France 1-year swap rate	100	100	100	100	100
France 10-year swap rate	100	58	<b>83</b>	85	85
Swiss 5-year swap rate	100	<b>101</b>	101	101	101

Note: Shading denotes highest average spread and boldface denotes the largest increase.

Table A6

**Average liquidity spreads for 10-year government bonds during 1998**

(basis points)

	<i>Level</i>	<i>Change from previous period average</i>			
	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan	- 0	- 0	+ 1	+ 0	<b>+ 1</b>
US	<b>9</b>	- 0	- 2	- 1	- 2
UK	4	+ 0	+ 5	<b>+ 5</b>	- 2
Netherlands (versus German yield curve)	3	<b>+ 6</b>	+ 6	<b>+ 2</b>	- 7

Notes: Shading denotes highest average spread and boldface denotes the largest increase. Spreads are measured relative to a benchmark or "on-the-run" bond yield unless it is stated otherwise.



Table A7  
**Lowest stock market index levels during 1998**  
(1 July 1998 = 100)

	1 Jan. to 3 July		6 July to 14 Aug.		17 Aug. to 22 Sep.		23 Sep. to 15 Oct.		16 Oct. to 31 Dec.	
	value	date	value	date	value	date	value	date	value	date
Japan	88	12 Jan.	92	14 Aug.	<b>82</b>	21 Sep.	77	15 Oct.	79	16 Oct.
Japan bank	85	17 June	78	12 Aug.	<b>70</b>	28 Aug.	<b>62</b>	1 Oct.	68	16 Oct.
Hong Kong	87	15 June	<b>78</b>	13 Aug.	83	1 Sep.	88	23 Sep.	112	19 Oct.
Korea	<b>89</b>	16 June	96	13 July	<b>92</b>	18 Aug.	93	23 Sep.	114	27 Oct.
Russia	99	2 July	69	13 Aug.	<b>33</b>	21 Sep.	26	5 Oct.	37	28 Oct.
Brazil	92	15 June	85	12 Aug.	<b>48</b>	10 Sep.	60	1 Oct.	66	29 Oct.
Mexico	92	15 June	81	12 Aug.	<b>65</b>	10 Sep.	76	7 Oct.	84	3 Dec.
US	<b>81</b>	9 Jan.	93	14 Aug.	<b>83</b>	31 Aug.	84	8 Oct.	92	16 Oct.
US financial	79	9 Jan.	88	14 Aug.	<b>73</b>	10 Sep.	69	8 Oct.	81	27 Oct.
US small-cap	89	12 Jan.	87	5 Aug.	<b>73</b>	31 Aug.	67	8 Oct.	75	16 Oct.
Canada	85	12 Jan.	85	14 Aug.	<b>75</b>	31 Aug.	72	5 Oct.	79	19 Oct.
UK	86	12 Jan.	91	13 Aug.	<b>84</b>	21 Sep.	79	5 Oct.	86	19 Oct.
UK financial	89	12 Jan.	89	13 Aug.	<b>80</b>	21 Sep.	<b>71</b>	5 Oct.	84	19 Oct.
Germany	69	12 Jan.	89	11 Aug.	<b>75</b>	21 Sep.	66	8 Oct.	75	23 Oct.
France	<b>67</b>	12 Jan.	90	11 Aug.	<b>78</b>	21 Sep.	69	8 Oct.	80	16 Oct.
France financial	69	12 Jan.	96	11 Aug.	<b>72</b>	21 Sep.	58	5 Oct.	73	23 Oct.
Switzerland	75	12 Jan.	93	11 Aug.	<b>75</b>	21 Sep.	64	5 Oct.	75	19 Oct.
Switzerland bank	65	12 Jan.	94	11 Aug.	<b>61</b>	21 Sep.	48	1 Oct.	58	19 Oct.

Note: Shading denotes lowest level and boldface denotes the largest drop from the previous-period low.

Table A8  
**Implied volatility measures during 1998**

	<i>Index: [1 Jan. to 3 July] = 100</i>				
	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec</b>
Mexico stock index	100	141	<b>261</b>	235	138
US 30-year government bond	100	85	<b>134</b>	180	199
US 3-month eurodollar	100	108	<b>168</b>	188	125
US stock market index (S&P 500)	100	90	104	<b>129</b>	128
UK stock market index (FTSE 100)	100	101	<b>156</b>	178	137
UK long government bond	100	86	<b>107</b>	165	139
UK 3-month interest rate	100	101	<b>152</b>	193	231
France 10-year government bond	100	75	<b>130</b>	146	132
France 3-month interest rate	100	76	<b>130</b>	171	159
Switzerland stock market index	100	109	<b>174</b>	211	182
Switzerland SFr/US\$ exchange rate	100	93	116	<b>158</b>	176

Note: Shading denotes peak implied volatility and bold-face denotes the largest increase.

Table A9  
**Government bond yield volatility during 1998**  
 (1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year	100	84	<b>188</b>	59	140
Hong Kong 3-year	100	47	<b>117</b>	98	37
Hong Kong 5-year	100	58	<b>144</b>	135	53
Hong Kong 10-year	100	55	<b>145</b>	143	47
US 2-year	100	50	<b>161</b>	185	181
US 5-year	100	53	<b>149</b>	210	143
US 10-year	100	51	132	<b>224</b>	122
US 30-year	100	52	154	<b>265</b>	151
US 10-year inflation-indexed	100	69	94	<b>193</b>	106
UK 10-year	100	99	149	<b>283</b>	122
Netherlands 10-year	100	57	<b>177</b>	264	104
Germany 10-year	100	63	<b>184</b>	283	103

**Exchange rate volatility during 1998**

(1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Hong Kong dollar/US dollar (12-month forward)	100	100	<b>154</b>	71	34
Yen/US dollar	100	72	<b>157</b>	219	112
Yen/Swiss franc	100	105	166	<b>289</b>	118
US dollar/Canadian dollar	100	95	<b>214</b>	262	142
US dollar/German mark	100	91	<b>131</b>	136	102
US dollar/Swiss franc	100	106	163	<b>234</b>	158

Notes: Volatility is measured as the square root of the mean daily squared change in the yield (essentially the standard deviation assuming a zero mean). Shading denotes the highest volatility and bold-face denotes the largest increase.

Table A10  
**Stock market volatility during 1998**  
(1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan	100	76	133	<b>206</b>	110
Japan bank	100	78	105	<b>173</b>	93
Hong Kong	100	91	<b>113</b>	113	75
Korea	100	87	70	<b>108</b>	90
Russia	100	<b>156</b>	172	140	79
Brazil	100	103	<b>302</b>	230	164
Mexico	100	99	<b>258</b>	215	109
US	100	138	<b>274</b>	235	122
US financial	100	139	<b>270</b>	289	143
US small-cap	100	163	<b>274</b>	278	127
Canada	100	157	<b>247</b>	257	117
UK	100	129	<b>219</b>	253	145
UK financial	100	131	189	<b>268</b>	138
Germany	100	104	<b>217</b>	250	144
France	100	112	<b>205</b>	254	124
France financial	100	142	<b>237</b>	311	153
Switzerland	100	127	<b>248</b>	313	133
Switzerland bank	100	133	<b>300</b>	367	159

Notes: Volatility is measured as the square root of the mean daily squared change in the natural log of the price (essentially the standard deviation assuming a zero mean). Shading denotes the highest volatility and bold-face denotes the largest increase.

Table A11  
**Yield spread volatility during 1998**  
(1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 5-year AA corporate bond	100	85	<b>243</b>	235	273
Japan 5-year BBB corporate bond	100	86	115	<b>160</b>	125
Japan 5-year bank bond	100	70	82	75	<b>100</b>
Japan 10-year yen Swap	100	91	<b>416</b>	408	371
Hong Kong 10-year government bond	100	51	<b>132</b>	167	67
Hong Kong 3-year agency bond	100	59	62	<b>120</b>	22
Hong Kong 10-year HK\$ Swap	100	77	<b>259</b>	58	59
Latin America Brady bond	100	212	<b>807</b>	415	243
Mexico corporate eurobond	100	283	<b>832</b>	365	285
US 10-year AA corporate bond	100	73	<b>305</b>	309	173
US 10-year BBB corporate bond	100	84	<b>464</b>	220	165
US speculative-grade bond	100	91	<b>278</b>	228	158
US 2-year US\$ swap	100	117	<b>355</b>	354	308
US 10-year US\$ swap	100	106	<b>346</b>	291	249
Canada 10-year \$ swap	100	91	<b>186</b>	106	178
UK 5-year Aa corporate bond	100	84	193	<b>409</b>	219
UK 5-year Baa corporate bond	100	69	157	<b>387</b>	158
UK four 5-year bank bonds	100	90	172	<b>278</b>	128
UK 10-year sterling swap	100	139	<b>277</b>	267	199
Netherlands two industrial bonds	100	114	<b>168</b>	150	147
Netherlands four 10-year bank bonds	100	50	<b>118</b>	109	110
Germany industrial bond (from May)	100	<b>417</b>	289	292	238
Germany 9-10 year mortgage bond	100	65	<b>246</b>	215	109
Germany 9-10 year bank bond	100	95	<b>267</b>	249	132
Germany 10-year DM swap	100	97	<b>387</b>	293	159
Swiss corporate bond	100	115	172	<b>297</b>	129
Swiss 5-7 year SFr swap	100	111	197	<b>413</b>	249

Notes: Volatility is measured as the square root of the mean daily squared change in the spread (essentially the standard deviation assuming a zero mean). Shading denotes the highest volatility and bold-face denotes the largest increase.

Table A12  
**Peaks in implied volatility measures during 1998**  
 (Percent Annual)

	<b>Peak in implied volatility</b>	<b>Date of peak</b>	<b>250-day historical volatility</b>	<b>Ratio: implied/historical</b>
Mexico stock index	84	15 Sep.	38	221%
US stock market index (S&P 500)	43	27 Oct.	20	215%
US 3-month eurodollar	33	19 Oct.	7	471%
US 30-year government bond	14	9 Oct.	13	108%
UK stock market index (FTSE 100)	48	5 Oct.	20	240%
UK long government bond	13	12 Oct.	15	87%
UK 3-month interest rate	19	14 Dec.	7	271%
France 10-year government bond	13	26 Aug.	4	325%
France 3-month interest rate	18	2 Dec.	12	150%
Switzerland stock market index	56	5 Nov.	27	207%
Switzerland SFr/US\$ exchange rate	20	30 Oct.	9	222%

Note: Historical volatility is the standard deviation of one-day changes in the natural log of the underlying, measured over the previous 250 weekdays and scaled to annual percent units.

Table A13  
**Average daily trading volume**  
(1 January 1998 to 3 July 1998 = 100)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Hong Kong government securities	100	<b>61</b>	102	97	84
Hong Kong private sector debt instruments	100	70	236	<b>89</b>	101
Hong Kong stock index futures	100	102	122	102	<b>79</b>
Hong Kong 3-month HIBOR futures	100	108	144	<b>90</b>	61
Mexico foreign exchange	100	114	<b>79</b>	69	61
Germany bonds	100	92	111	102	<b>88</b>
France 10-year bond futures	100	81	136	108	<b>55</b>
France 3-month bond futures	100	<b>50</b>	79	52	41
France 5-year PIBOR futures	100	<b>39</b>	70	36	24

Note: Shading denotes the period of lowest volume and bold-face denotes the largest decrease.

Table A14  
**Global trading volume**  
(Quarterly, 1998:1 = 100)

	<b>Futures</b>	<b>Options</b>	<b>Emerging market debt</b>
1997:1	85	103	
1997:2	95	109	
1997:3	93	100	108
1997:4	95	113	127
1998:1	100	100	100
1998:2	95	98	113
1998:3	108	144	84
1998:4	94	128	42
1999:1			43

Table A15  
**Private sector securities issuance**  
 (First Quarter of 1998 = 100)

	<b>Money Market (net global)</b>	<b>Bonds (net global)</b>	<b>UK corporate bonds (gross)</b>
1997:1Q	50	85	110
			75
			26
1997:2Q	42	88	64
			62
			71
1997:3Q	59	104	100
			47
			65
1997:4Q	– 25	75	122
			22
			21
1998:1Q	100	100	87
			78
			135
1998:2Q	10	132	35
			38
			52
1998:3Q	53	83	124
			43
			1
1998:4Q	– 46	47	25
			62
			63
1999:1Q	282	130	

Note: UK corporate bond issuance is stated monthly; net global issuance series are quarterly figures compiled by the Bank for International Settlements.



Table A16  
**Total international syndicated loan origination**  
 (billions of US dollars)

Year	Month	Announced loans
1997	1	44
1997	2	60
1997	3	99
1997	4	96
1997	5	133
1997	6	111
1997	7	99
1997	8	67
1997	9	97
1997	10	111
1997	11	81
1997	12	138
1998	1	37
1998	2	91
1998	3	102
1998	4	92
1998	5	77
1998	6	100
1998	7	80
1998	8	84
1998	9	70
1998	10	74
1998	11	65
1998	12	86
1999	1	30
1999	2	44
1999	3	82

Table A17

**Non-european yield spread correlations**

1 January 1998 to 3 July 1998 (tenths)

Japan 5-year AA corporate bond	+5		+5		+1			-1	+2	+3	-1	-3		-1
Japan 5-year BBB corporate bond			+2	+1	+1		+1	-1		+1	-3	-1	+1	-1
Japan 5-year bank bond				-1	-2			+1	+3	+2	+2	+1	+2	
Japan 10-year yen Swap				+1		+2	+2	+3	+1	+1	+1		+1	-1
Hong Kong 10-year government bond					-1	+1	+7	+7	+1	+2	+5	+3	+3	+3
Hong Kong 3-year agency bond						-1	+1	-2			-2	-2	-2	-2
Hong Kong 10-year HK\$ Swap							+2	+3	+2	+2	+4	+3	+1	
Latin America Brady bond								+8	+1	+1	+4	+2	+4	+3
Mexico corporate eurobond									+3	+3	+7	+4	+6	+4
US 10-year AA corporate bond										+9	+5	+2	+5	+1
US 10-year BBB corporate bond											+6	+2	+5	+2
US speculative-grade bond												+5	+6	+3
US 2-year US\$ swap													+5	+3
US 10-year US\$ swap														+5
Canada 10-year \$ swap														

6 July 1998 to 31 December 1998 (tenths)

Japan 5-year AA corporate bond	+6	+4	+6	+2		+1		+1	+2	+2	+3		+1	-1
Japan 5-year BBB corporate bond		+1	+4	-1	+1		+3	+3		+1	+3	+2	+2	+2
Japan 5-year bank bond			+3	+3	+1	+2	+4	+4	+2	+2	+3		+1	+2
Japan 10-year yen Swap				+3		+2	+2	+1	-1	-1				-1
Hong Kong 10-year government bond					+1	-1	+2	+2	+1				+2	
Hong Kong 3-year agency bond						-1	+1	+2	+2	+2	+2	+1	+1	+2
Hong Kong 10-year HK\$ Swap							+3	+2	-1	-1	-1		-1	-2
Latin America Brady bond								+8	+2	+2	+5	+4	+6	+3
Mexico corporate eurobond									+4	+4	+7	+4	+5	+5
US 10-year AA corporate bond										+9	+6	+1		+1
US 10-year BBB corporate bond											+7	+2	+1	+2
US speculative-grade bond												+4	+5	+5
US 2-year US\$ swap													+7	+7
US 10-year US\$ swap														+6
Canada 10-year \$ swap														

Table A17 (continued)  
**Correlations of non-european and european yield spreads**  
1 January 1998 to 3 July 1998 (tenths)

	<b>UK Aa</b>	<b>UK Baa</b>	<b>UK bnk</b>	<b>UK swa</b>	<b>Nth ind</b>	<b>Nth bnk</b>	<b>Ger mrt</b>	<b>Ger bnk</b>	<b>Ger swa</b>	<b>Swi crp</b>	<b>Swi swa</b>
Japan 5-year AA corporate bond		+2	+1		+2	+1		-1	-1	+1	
Japan 5-year BBB corp. bond	+2	+3	+1	+1		+1				+2	+1
Japan 5-year bank bond	+1	+2	+2	+2		+1	+3	+3			+1
Japan 10-year yen swap	+1	+3	+1	-2	+3	+1	+1			-1	-1
HK 10-year government bond	+4	+3	+3	+3	+2	-1	+2	+2	+2	-2	-1
HK 3-year agency bond	-1		+1	+1	+2	-1	-2	-1	+2	+1	+2
HK 10-year HK\$ swap	+1		+2	-2	+1	+1	+3	+1	-1	-1	-1
Latin America Brady bond	+3	+2	+3	+2	+3		+3	+3	+2	-2	
Mexico corporate eurobond	+1		+2	+2	+2	-1	+4	+3	+2	-2	
US 10-year AA corporate bond		-1	+1		+1	+1	+4	+4	-1	+1	+1
US 10-year BBB corporate bond	-1	-1	+1		+1		+4	+3	-1	+1	+1
US speculative-grade bond	+1	-1	+3	+1	+1		+5	+3		-2	-1
US 2-year US\$ swap	+1	+1	+3	-1	+1	-1	+1	+1	+1	-1	
US 10-year US\$ swap		-2	+2	+1			+3	+3	+1		+2
Canada 10-year C\$ swap		-1	+1	+2	-1	-1	+2	+2	+1	+1	+1

6 July 1998 to 31 December 1998 (tenths)

	<b>UK Aa</b>	<b>UK Baa</b>	<b>UK bnk</b>	<b>UK swa</b>	<b>Nth ind</b>	<b>Nth bnk</b>	<b>Ger mrt</b>	<b>Ger bnk</b>	<b>Ger swa</b>	<b>Swi crp</b>	<b>Swi swa</b>
Japan 5-year AA corporate bond	+1			+2			+2	+3	+1	+1	-1
Japan 5-year BBB corp. bond	+1	+1		+3	+2	+1	+2	+2	+1	+2	-2
Japan 5-year bank bond	+1	+1	+2	+2		+2	+4	+3	+3		
Japan 10-year yen swap	-2	-3	-3			-2	+1	+2	+1	-1	-1
HK 10-year government bond	-1	-2	-1	+2	-3	-1	+3	+3	+3	-2	-1
HK 3-year agency bond	+2	+2	+2	+3						+2	+1
HK 10-year HK\$ swap	-1	-1	-1		+1					-1	
Latin America Brady bond	+4	+3	+3	+5	+3	+4	+5	+5	+5	+1	
Mexico corporate eurobond	+4	+4	+4	+5	+2	+5	+4	+5	+4	+2	
US 10-year AA corporate bond	+4	+4	+5	+2		+2	+1	+1	-1	+3	
US 10-year BBB corporate bond	+4	+4	+4	+1	+1	+2	+1	+1	-1	+3	
US speculative-grade bond	+6	+6	+6	+4	+3	+4	+2	+3	+2	+5	+1
US 2-year US\$ swap	+5	+5	+3	+2	+3	+2	+3	+3	+2	+2	+2
US 10-year US\$ swap	+6	+6	+5	+6	+2	+3	+6	+6	+6	+3	+1
Canada 10-year C\$ swap	+5	+5	+4	+4	+2	+2	+3	+3	+3	+2	+2

Table A17 (continued)  
**European yield spread correlations**  
1 January 1998 to 3 July 1998 (tenths)

UK 5-year AA corporate bond	+8	+7		+1	+3	+1	+1		-2	-2
UK 5-year Baa corporate bond		+7	-1	+2	+2		+1	-1	-1	-2
UK four 5-year bank bonds			-1	+2	+1	+2	+2	-1	-1	-1
UK 10-year sterling swap					-1	+1	+1	+4		+2
Netherlands two industrial bonds					+2			+1		
Netherlands four 10-year bank bonds						-1		-1		
Germany 9-10 year mortgage bond							+8	-1		+1
Germany 9-10 year bank bond								+1		+1
Germany 10-year DM swap									+1	+1
Switzerland corporate bond										+8
Switzerland 5-7 year SFr swap										

6 July 1998 to 31 December 1998 (tenths)

UK 5-year AA corporate bond	+10	+9	+7	+2	+5	+4	+4	+3	+5	+1
UK 5-year Baa corporate bond		+9	+5	+2	+4	+3	+3	+2	+5	+1
UK four 5-year bank bonds			+7	+2	+5	+3	+4	+3	+5	+1
UK 10-year sterling swap				+1	+5	+6	+6	+6	+3	
Netherlands two industrial bonds					+2				+2	+1
Netherlands four 10-year bank bonds						+4	+4	+3	+2	+1
Germany 9-10 year mortgage bond							+10	+9		+1
Germany 9-10 year bank bond								+8		
Germany 10-year DM swap									+1	+1
Switzerland corporate bond										+3
Switzerland 5-7 year SFr swap										

Notes: Statistics are based on 5-day changes in spreads, to allow for time-of-day differences. Correlation coefficients are rounded to nearest 10% and expressed in *tenths*, so that “+3” denotes 30%, for example. Shading ranges from white for zero or negative correlation to black for 100% (rounded) correlation. Each data label references both a row of the matrix and the column above its right-most extent.

Table A18  
Average yield spread correlations (percent)

Period	Average correlation (for period)	Average correlation (previous 6 months)	Average   absolute   change
1 Jan. 1998 – 3 July 1998	11	14	17
6 July 1998 – 31 Dec. 1998	21	11	21
6 July 1998 – 14 Aug. 1998	17	11	27
17 Aug. 1998 – 22 Sep. 1998	37	13	31
23 Sep. 1998 – 15 Oct. 1998	17	27	37
16 Oct. 1998 – 31 Dec. 1998	12	23	26

Notes: Statistics are based on correlations of 5-day changes in spreads, as reported in Table A17.

Table A19  
UK Bond yield spread correlations

1 January 1998 to 3 July 1998 (tenths)

UK 5-year Aa corporate bond	+6	+8	+5	+7	+3	+6
UK 5-year A corporate bond	+6	+7	+3	+3	+3	+3
UK 5-year Baa corporate bond		+5	+6	+2	+5	
UK 5-year Barclays bank bond			+2		+2	
UK 5-year Lloyds bank bond				+3	+7	
UK 5-year NatWest bank bond					+2	
UK 5-year Royal Scotland bank bond						

6 July 1998 to 31 December 1998 (tenths)

UK 5-year Aa corporate bond	+9	+10	+7	+8	+8	+8
UK 5-year A corporate bond	+9	+9	+6	+7	+7	+7
UK 5-year Baa corporate bond		+6	+8	+8	+8	
UK 5-year Barclays bank bond			+4	+5	+6	
UK 5-year Lloyds bank bond				+7	+8	
UK 5-year NatWest bank bond					+7	
UK 5-year Royal Scotland bank bond						

Table A20  
Average UK Bond yield spread correlations (percent)

Period	Average correlation (for period)	Average correlation (previous 6 months)	Average   absolute   change
1 Jan. 1998 – 3 July 1998	44	56	23
6 July 1998 – 31 Dec. 1998	73	44	29
6 July 1998 – 14 Aug. 1998	45	44	10
17 Aug. 1998 – 22 Sep. 1998	82	45	37
23 Sep. 1998 – 15 Oct. 1998	79	68	16
16 Oct. 1998 – 31 Dec. 1998	63	75	12

Notes: Statistics are based on correlations of 5-day changes in spreads, as reported in Table A19.

Table A21  
**Correlations of implied volatility measures**  
1 January 1998 to 3 July 1998 (tenths)

Mexico stock index	+1		+3	+4	+2	+2	+1	+1	+1	-1
US stock market index (S&P 500)		+4	+4	+2	+1	-1	+1	-1		+3
US 30-year government bond			+3	+4	-1	+1	+2	+1	+1	+1
US 3-month eurodollar				+5	+2		+1	+1	+2	+4
UK stock market index (FTSE 100)					+2	+3	+1	+1	+2	
UK long government bond						+5	+1			+1
UK 3-month interest rate							+1	+1		-2
France 10-year government bond								+2	-3	-1
France 3-month interest rate									-2	-1
Switzerland stock market index										+4
Switzerland SFr/US\$ exchange rate										

6 July 1998 to 31 December 1998 (tenths)

Mexico stock index	-1		+1	+3	-1	+1		+2	+2	
US stock market index (S&P 500)		+2	+4	+3	+8	+3	+3	+2	+1	+4
US 30-year government bond			+1	+2			+1	+2	+3	+2
US 3-month eurodollar				+6	+4	+4	-1	+3	+1	+1
UK stock market index (FTSE 100)					+3	+3	+1	+3	+2	+2
UK long government bond						+1	+3	+2	+1	+4
UK 3-month interest rate							-1	+4	+1	+2
France 10-year government bond									+2	-1
France 3-month interest rate									+3	
Switzerland stock market index										+1
Switzerland SFr/US\$ exchange rate										

Notes: Statistics are based on 5-day changes in implied volatility, to allow for time-of-day differences. Correlation coefficients are rounded to nearest 10% and expressed in *tenths*, so that “+3” denotes 30%, for example. Shading ranges from white for zero or negative correlation to black for 100% (rounded) correlation. Each data label references both the row of the matrix it occupies and the column above its right-most extent.

Table A21 (continued)  
**Correlations of implied volatility measures**  
 17 August 1998 to 22 September 1998 (tenths)

Mexico stock index	+7	+8	+4	+6	+6	+7	+1	+5	+6	+4
US stock market index (S&P 500)	+9	+6	+9	+8	+8	+4	+3	+6	+5	
US 30-year government bond		+4	+7	+5	+7	+3	+2	+5	+3	
US 3-month eurodollar			+7	+6	+8	-2	+4	-1	+6	
UK stock market index (FTSE 100)				+9	+9	+1	+4	+5	+6	
UK long government bond					+7	+2	+5	+6	+6	
UK 3-month interest rate							+6	+4	+7	
France 10-year government bond								-1	+4	-4
France 3-month interest rate									+1	+3
Switzerland stock market index										+3
Switzerland SFr/US\$ exchange rate										

Notes: Statistics are based on 5-day changes in implied volatility, to allow for time-of-day differences. Correlation coefficients are rounded to nearest 10% and expressed in *tenths*, so that “+3” denotes 30%, for example. Shading ranges from white for zero or negative correlation to black for 100% (rounded) correlation. Each data label references both the row of the matrix it occupies and the column above its right-most extent.

Table A22  
**Average correlations of implied volatility measures (percent)**

Period	Average correlation (for period)	Average correlation (previous 6 months)	Average   absolute   change
1 Jan. 1998 – 3 July 1998	12	21	15
6 July 1998 – 31 Dec. 1998	19	13	18
6 July 1998 – 14 Aug. 1998	10	13	25
17 Aug. 1998 – 22 Sep. 1998	47	13	38
23 Sep. 1998 – 15 Oct. 1998	19	31	44
16 Oct. 1998 – 31 Dec. 1998	20	24	25

Note: Statistics are based on correlations of 5-day changes in spreads, as reported in Table A21.



Table A23

**Effectiveness of hedging a bond yield with a short futures position**

Reduction in volatility compared to unhedged position (percent)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year bond	16	27	56	- 2	54
Brazil 16-year Brady bond	50	56	71	27	35
US 30-year government bond	70	62	64	79	68
UK 10-year bond (using “long gilt” futures)	42	63	72	69	70
Germany 10-year bond	- 6	21	61	60	52
Netherlands 10-year bond (using German futures)	- 37	3	18	79	34
France 10-year bond (using German futures)	13	17	39	77	26
Italy 10-year bond (using German futures)	- 2	13	3	54	13
Spain 10-year bond (using German futures)	- 34	8	- 11	75	38

Residual volatility of hedged position (basis points, annualised)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year bond	54	32	35	57	47
Brazil 16-year Brady bond	8	14	27	29	16
US 30-year government bond	24	16	36	39	32
UK 10-year bond (using “long gilt” futures)	39	24	26	61	23
Germany 10-year bond	54	20	35	53	26
Netherlands 10-year bond (using German futures)	69	28	64	26	31
France 10-year bond (using German futures)	50	42	63	35	41
Italy 10-year bond (using German futures)	61	26	66	69	43
Spain 10-year bond (using German futures)	72	27	72	40	32

Note: These figures are based on notional hedges of changes in the yield. (except for the Brazil Brady bond future, where only one specific bond is eligible for delivery). Thus, when the futures price is based on the price of a notional bond, the price is converted to an implicit yield. A unit hedge ratio is used. (the true optimal hedge ratio may be affected by the identity of the cheapest-to-deliver underlying bond, which likely varies over time.) The numbers in parentheses are the change in the bond yield over the period, in basis points (except for the Brazil Brady Bond future, where they are percent changes in the bond price).

Table A23 (continued)  
**Effectiveness of hedging a bond yield with a short futures position**

Cumulative Effectiveness: Ratio of Change in Futures Yield to Change in Bond Yield (Percent)

	<b>1-Jan to 3-Jul</b>	<b>6-Jul to 14-Aug</b>	<b>17-Aug to 22-Sep</b>	<b>23-Sep to 15-Oct</b>	<b>16-Oct to 31-Dec</b>
Japan 10-year bond	78 (-32)	138 (-11)	65 (-51)	-110 (-5)	48 (118)
US 30-year government bond	90 (-25)	-580 (1)	83 (-69)	86 (-11)	87 (21)
UK long gilt bond	83 (-46)	63 (-21)	80 (-63)	121 (6)	55 (-70)
Germany 10-year bond	103 (-63)	87 (-24)	108 (-60)	185 (19)	193 (-27)
Netherlands 10-year bond (using German futures)	131 (-48)	116 (-21)	123 (-49)	231 (8)	150 (-18)
France 10-year bond (using German futures)	126 (-50)	118 (-21)	121 (-50)	134 (14)	83 (-18)
Italy 10-year bond (using German futures)	117 (-54)	124 (-20)	156 (-39)	153 (12)	49 (-56)
Spain 10-year bond (using German futures)	90 (-70)	116 (-21)	182 (-33)	132 (14)	50 (-54)

Notes: These figures are based on notional hedges of changes in the yield over the entirety of the sub-periods. Thus, when the futures price is based on the price of a notional bond, the price is converted to an implicit yield. The UK, France, and Italy bond yields are for benchmark bonds, and for other countries, the bond yield is from a yield curve estimation (generally taken from Bloomberg). The upper number in each cell is the ratio (in percent) of the change in the futures yield over the period to the change in the bond yield over the period. The number in parentheses below is the change in the bond yield over the period, expressed in basis points. For example, during the first period, the Japanese bond yield dropped 32 basis points, but the futures yield fell only 25 basis points – 78 percent as much. Period with effectiveness furthest from 100 percent is shaded.

Table A24

**Effectiveness of hedging a 10-year government bond yield with a swap**

Reduction in volatility compared to unhedged position (percent)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year bond	- 32	- 40	- 47	- 72	- 27
US 10-year bond	80	62	49	75	62
UK 10-year bond	44	- 3	1	49	27
Germany 10-year bond	- 5	- 35	- 36	- 29	- 15

Residual volatility of hedged position (percent, annualised)

	<b>1 Jan. to 3 July</b>	<b>6 July to 14 Aug.</b>	<b>17 Aug. to 22 Sep.</b>	<b>23 Sep. to 15 Oct.</b>	<b>16 Oct. to 31 Dec.</b>
Japan 10-year bond	84	62	117	96	130
US 10-year bond	16	16	51	48	38
UK 10-year bond	38	68	93	99	58
Germany 10-year bond	54	33	122	172	62

Notes: These figures are based on notional hedges of changes in the yield. A unit hedge ratio is used. ). Shading denotes the periods with the least effective hedges or most residual volatility.

**Cumulative Effectiveness: Ratio of Change in Swap Rate to Change in Bond Yield (Percent)**

	<b>1-Jan to 3-Jul</b>	<b>6-Jul to 14-Aug</b>	<b>17-Aug to 22-Sep</b>	<b>23-Sep to 15-Oct</b>	<b>16-Oct to 31-Dec</b>
Japan 10-year bond	41 (-32)	19 (-11)	-9 (-51)	310 (-5)	-30 (118)
US 10-year bond	72 (-25)	650 (1)	50 (-69)	45 (-11)	-5 (21)
UK 10-year bond	34 (-46)	198 (-21)	-1 (-63)	338 (6)	125 (-70)
Germany 10-year bond	88 (-61)	41 (-28)	69 (-56)	47 (1)	186 (-14)

Notes: These figures are based on notional hedges of changes in the yield over the entirety of the sub-periods. The UK bond yield is for a benchmark bond and for other countries, the bond yield is from a yield curve estimation (generally taken from Bloomberg). The upper number in each cell is the ratio (in percent) of the change in the swap rate over the period to the change in the bond yield over the period. The number in parentheses below is the change in the bond yield over the period, expressed in basis points. For example, during the first period, the Japanese bond yield dropped 32 basis points, but the swap rate fell only 13 basis points – 41 percent as much. Period with effectiveness furthest from 100 percent is shaded.

Table A25  
**Peak yield spreads: 1998 versus the rest of the 1990s**  
(basis points)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Date of peak</b>	<b>Ratio of peaks</b>
Mexico Brady bond	1992	468	847	16 Mar. 95	55%
US speculative-grade bond	1990	687	1059	3 Jan. 91	65%
Canada 10-year C\$ swap	1990	48	100	4 Jan. 90	48%
Netherlands government bond (vs. Germany)	1990	27	75	16 Jan. 90	36%
Netherlands two industrial bonds	1992	68	84	31 Dec. 93	81%
Netherlands two bank bonds	1992	47	67	29 Dec. 93	70%
Germany mortgage bond index	1990	110	122	14 Sep. 92	90%
Germany bank bond index	1990	22	53	14 Sep. 92	42%
Germany 10-year DM swap	1990	69	52	25 Feb. 94	133%
Swiss corporate bond	1992	61	70	24 Jan. 96	87%
Swiss 5-7 year SFr swap	1992	89	78	28 Feb. 96	114%

Table A26  
**Peak short rate spreads: 1998 versus the rest of the 1990s**  
(basis points)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Date of peak</b>	<b>Ratio of peaks</b>
Japan 3-month interbank	1992	22	21	22 Dec. 95	105%
Hong Kong 3-month interbank	1989	1294	1928	23 Oct. 97	67%
Hong Kong 6-month interbank	1989	1198	1417	23 Oct. 97	85%
Hong Kong 12-month interbank	1989	854	1404	23 Oct. 97	61%
US 3-month interbank	1989	144	166	27 Dec. 90	87%
US 12-month interbank	1989	86	220	22 Mar. 89	39%
Canada 3-month interbank	1989	67	69	13 Nov. 97	97%
France 3-month interbank	1989	43	362	30 Sep. 92	12%
France 12-month interbank	1989	34	93	13 Nov. 92	37%

Table A27

**Largest within-year stock price declines: 1998 versus the rest of the 1990s**  
(percent)

	<b>Data go back to:</b>	<b>1998 decline</b>	<b>Non-1998 decline</b>	<b>End-date of decline</b>	<b>Ratio of declines</b>
Japan	1989	– 25%	– 47%	1 Oct. 90	53%
Hong Kong	1989	– 44%	– 46%	28 Oct. 97	95%
Korea	1989	– 51%	– 56%	12 Dec. 97	92%
Brazil	1989	– 61%	– 69%	29 March 90	89%
Mexico	1992	– 45%	– 39%	27 Feb. 95	117%
US	1989	– 19%	– 20%	11 Oct. 90	97%
US financial	1989	– 35%	– 41%	29 Oct. 90	86%
US small-cap	1989	– 37%	– 30%	30 Oct. 90	121%
Canada	1989	– 32%	– 25%	16 Oct. 90	127%
UK	1989	– 25%	– 19%	28 Sep. 90	129%
UK financial	1989	– 39%	– 28%	24 Sep. 90	136%
Germany	1989	– 37%	– 32%	28 Sep. 90	115%
France	1992	– 33%	– 23%	25 Oct. 94	144%
France financial	1992	– 48%	– 34%	5 Oct. 94	143%
Switzerland (based on weekly data)	1992	– 39%	– 22%	6 July 94	179%
Switzerland bank (based on weekly data)	1992	– 55%	– 25%	7 Dec. 94	217%

Note: Measured as the largest percent decline between any two dates within a given year.

Table A28  
**Peak of within-month volatility of stock prices:  
1998 versus the rest of the 1990s**  
(June 1998 = 100)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Month of peak</b>	<b>Ratio of peaks</b>
Japan	1989	180	221	Nov. 97	81%
Hong Kong	1989	143	207	Oct. 97	69%
Korea	1989	132	146	Dec. 97	90%
Brazil	1989	235	422	Aug. 92	56%
Mexico	1992	211	176	Oct. 97	120%
US	1989	221	209	Oct. 97	106%
US financial	1989	278	190	Sep. 90	146%
US small-cap	1989	246	287	Dec. 90	86%
Canada	1989	242	165	Oct. 97	147%
UK	1989	213	164	Sep. 92	130%
UK financial	1989	230	183	Sep. 92	126%
Germany	1989	266	293	Oct. 89	91%
France	1992	226	177	Oct. 97	128%
France financial	1992	298	180	Sep. 92	166%
Switzerland	1992	271	199	Feb. 94	136%
Switzerland bank	1992	279	142	Feb. 94	196%

Note: Volatility is measured as the square root of the mean daily squared change in the yield or log stock price within the month.

Table A29  
**Peak of within-month volatility of government bond yields:  
1998 versus the rest of the 1990s**  
(June 1998 = 100)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Month of peak</b>	<b>Ratio of peaks</b>
Japan 10-year	1989	237	348	Feb. 90	68%
Hong Kong 3-year	1993	120	167	Oct. 97	72%
US 2-year	1989	283	363	June 95	78%
US 5-year	1989	269	347	April 94	77%
US 10-year	1989	270	323	April 94	84%
US 30-year	1989	205	277	April 94	74%
UK 10-year	1990	205	289	June 94	71%
Netherlands 10-year	1990	305	389	Feb. 90	78%
Germany 10-year	1990	290	414	Feb. 90	70%

Table A30  
**Peak of within-month volatility of yield spreads:  
 1998 versus the rest of the 1990s**

(June 1998 = 100)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non- 1998 peak</b>	<b>Month of peak</b>	<b>Ratio of peaks</b>
Mexico Brady bond	1992	390	1245	Jan. 95	31%
US speculative-grade bond	1990	260	371	April 90	70%
Canada 10-year C\$ swap	1990	339	638	Oct. 92	53%
Netherlands government bond (vs. Germany)	1990	173	348	June 94	50%
Netherlands two industrial bonds	1992	262	474	June 94	55%
Netherlands two bank bonds	1992	243	340	June 94	71%
Germany mortgage bond index	1990	589	785	Aug. 91	75%
Germany bank bond index	1990	181	600	March 94	30%
Germany 10-year DM swap	1990	576	695	June 94	83%

Note: Volatility is measured as the square root of the mean daily squared change in the spread within the month.

Table A31  
**Peak of within-month volatility of short rate spreads:  
 1998 versus the rest of the 1990s**

(June 1998 = 100)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Month of peak</b>	<b>Ratio of peaks</b>
Japan 3-month interbank	1992	853	787	Dec. 93	108%
Hong Kong 3-month interbank	1989	167	418	Oct. 97	40%
Hong Kong 6-month interbank	1989	194	400	Oct. 97	49%
Hong Kong 12-month interbank	1989	137	454	Oct. 97	30%
US 3-month interbank	1989	306	550	Dec. 90	56%
US 12-month interbank	1989	330	1037	March 89	32%
Canada 3-month interbank	1989	231	441	Sep. 92	52%
France 3-month interbank	1989	1134	8862	Sep. 92	13%
France 12-month interbank	1989	470	1897	July 93	25%

Note: Interbank rate spreads are measured by using euro-rates, except for Mexico and Hong Kong.

Table A32

**Peak of within-month volatility of exchange rates:  
1998 versus the rest of the 1990s**

(June 1998 = 100)

	<b>Data go back to:</b>	<b>1998 peak</b>	<b>Non-1998 peak</b>	<b>Month of peak</b>	<b>Ratio of peaks</b>
Yen/US dollar	1989	126	75	March 95	167%
Yen/Swiss franc	1992	204	160	Sep. 92	128%
US dollar/Canadian dollar	1989	326	262	Oct. 95	125%
US dollar/German mark	1989	137	296	Sep. 92	46%
US dollar/Swiss franc	1992	262	488	March 95	54%

Note: Volatility is measured as the square root of the mean daily squared change in the log exchange rate within the month.

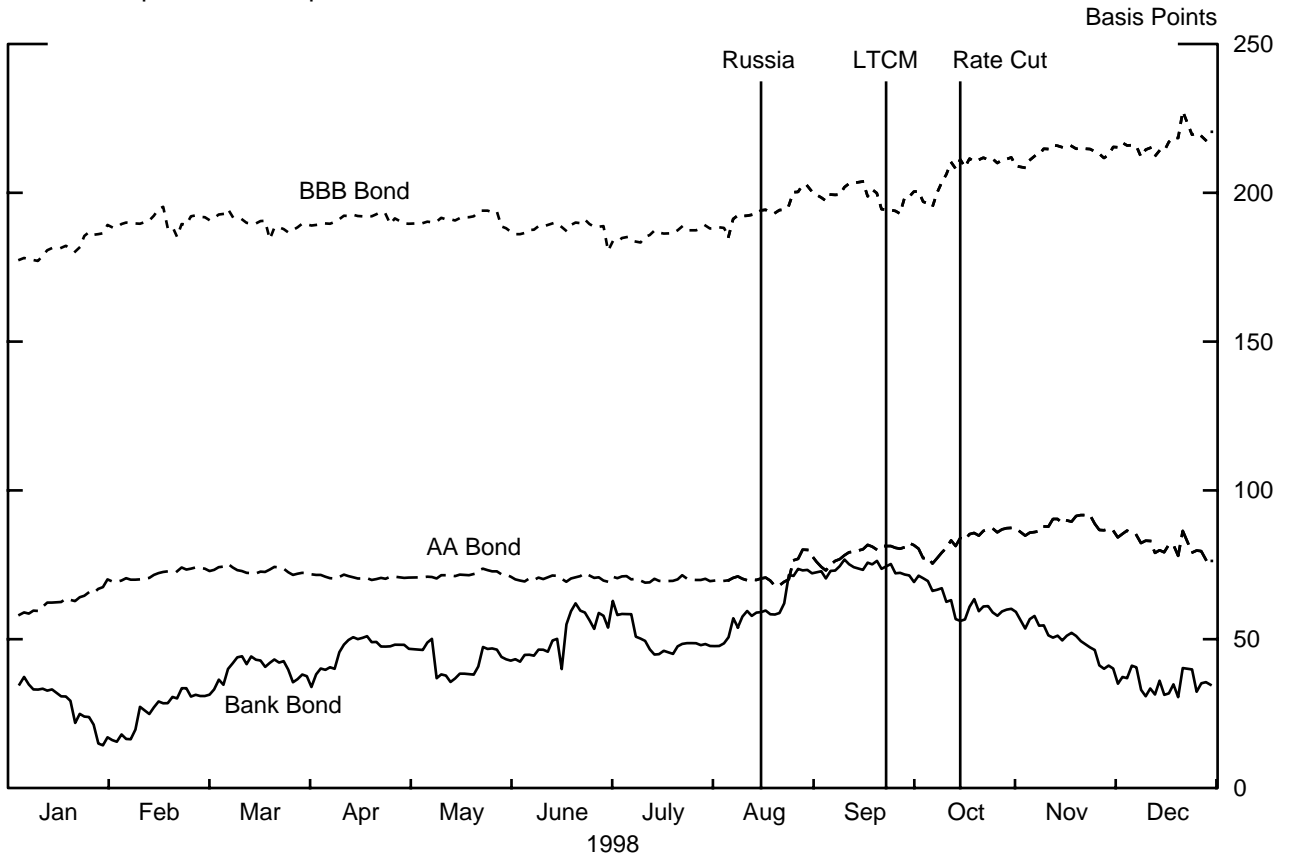


Figure A1

# Bank Bond Yield Spreads

Japan

Versus Corporate Yield Spread



Versus Swap Spread

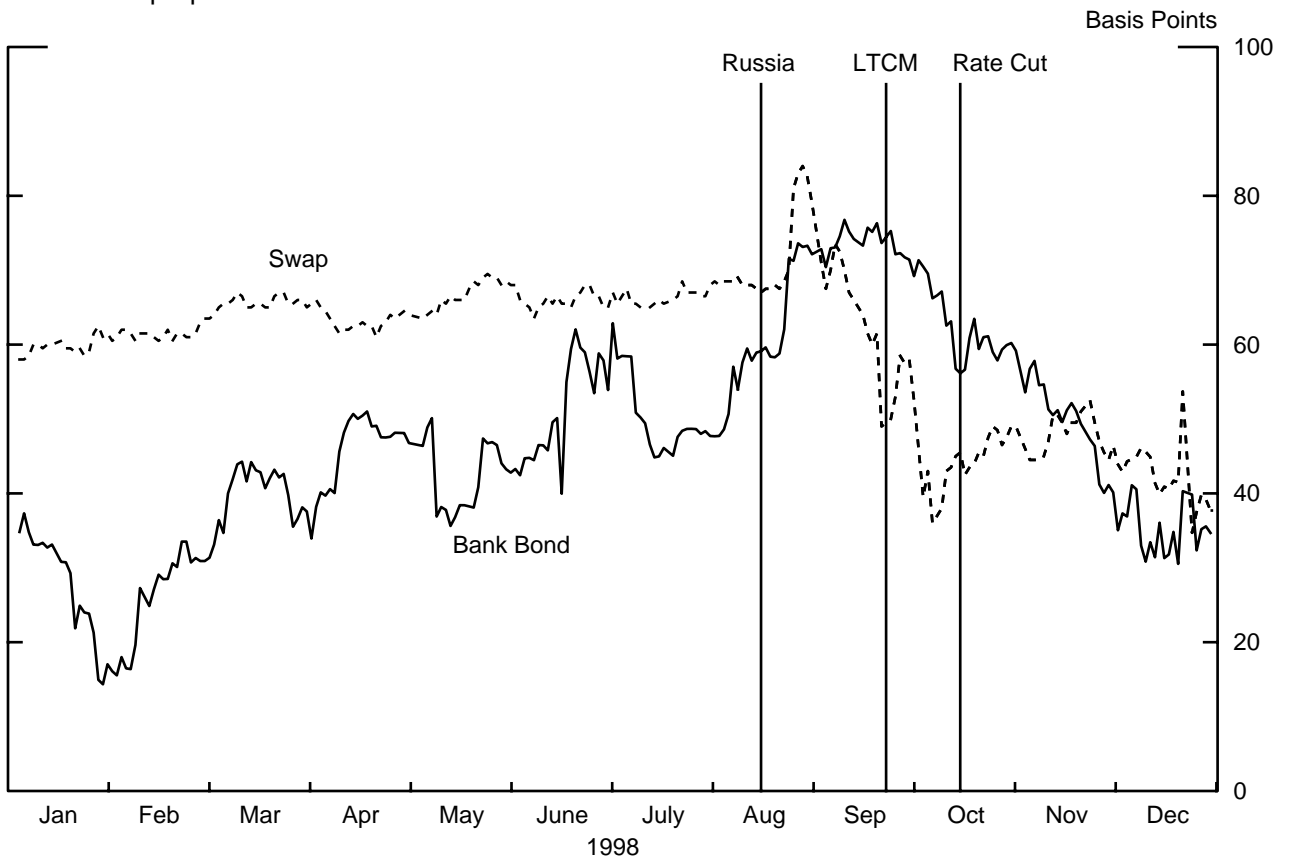
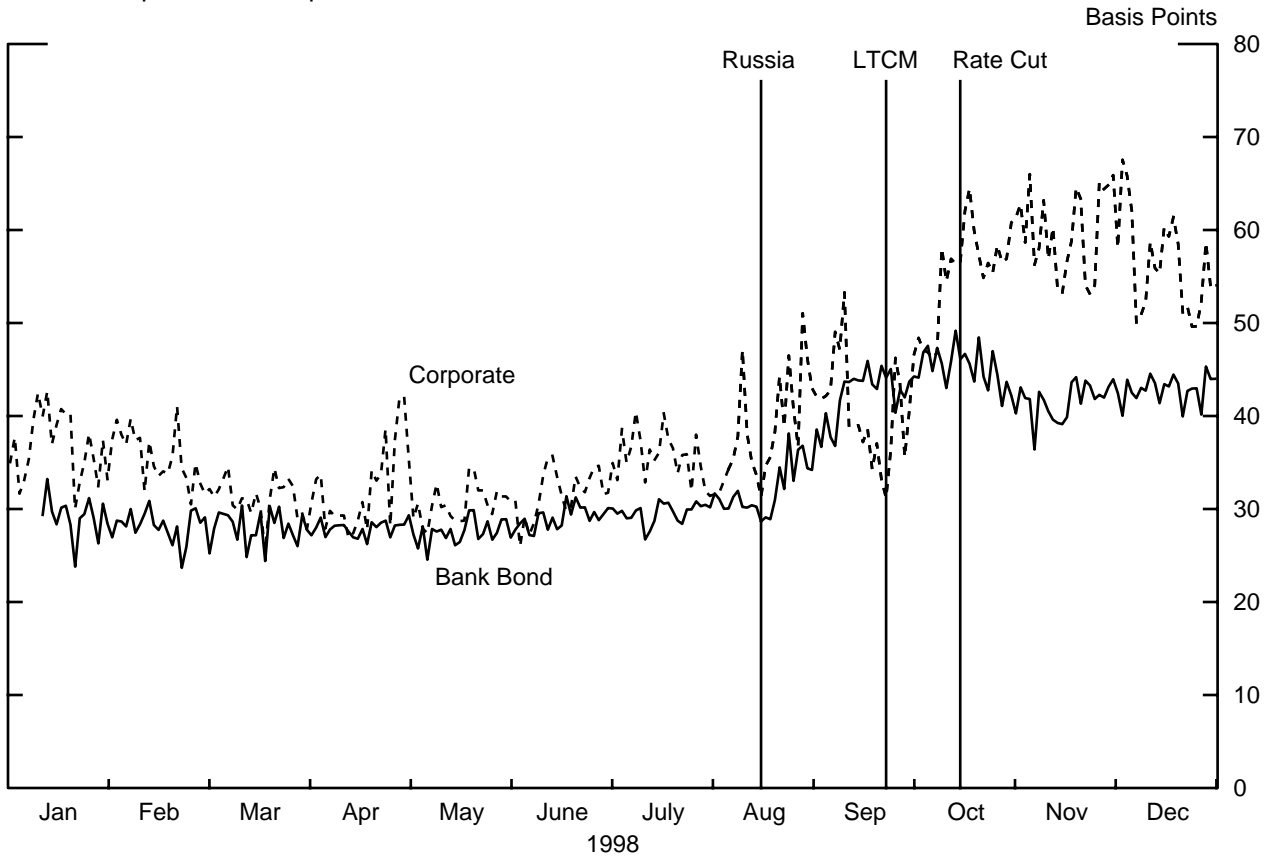


Figure A2

# Bank Bond Yield Spreads

Netherlands

Versus Corporate Yield Spread



Versus Swap Spread

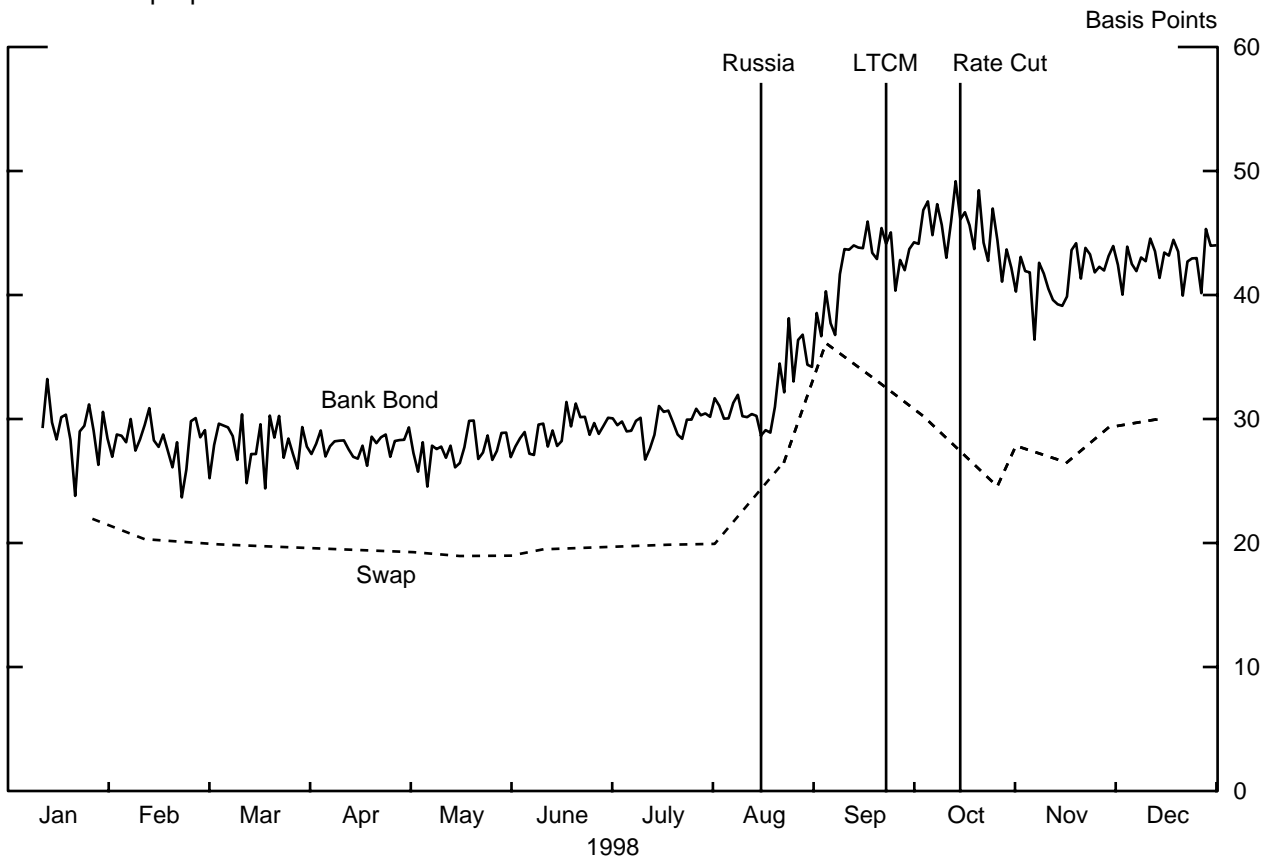
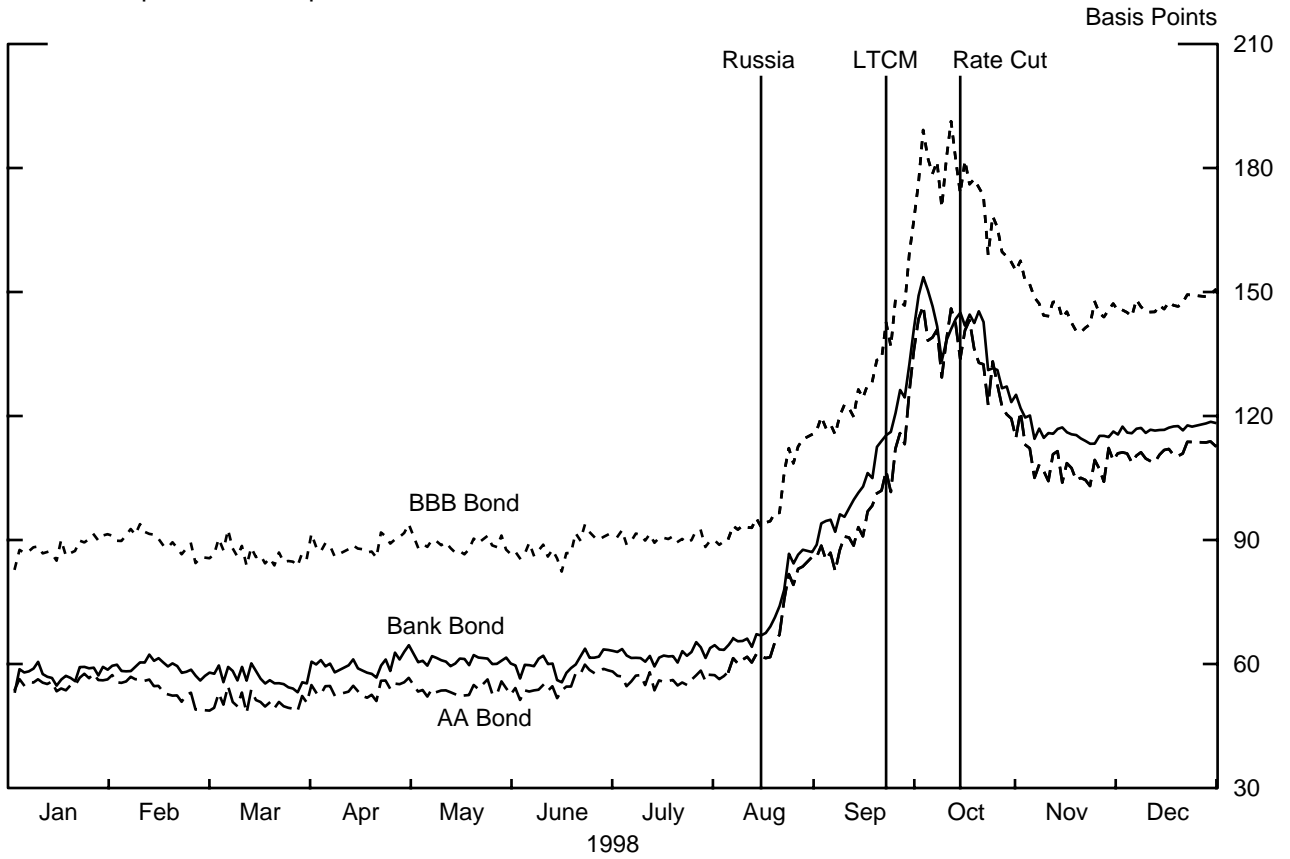


Figure A3

# Bank Bond Yield Spreads

United Kingdom

Versus Corporate Yield Spread



Versus Swap Spread

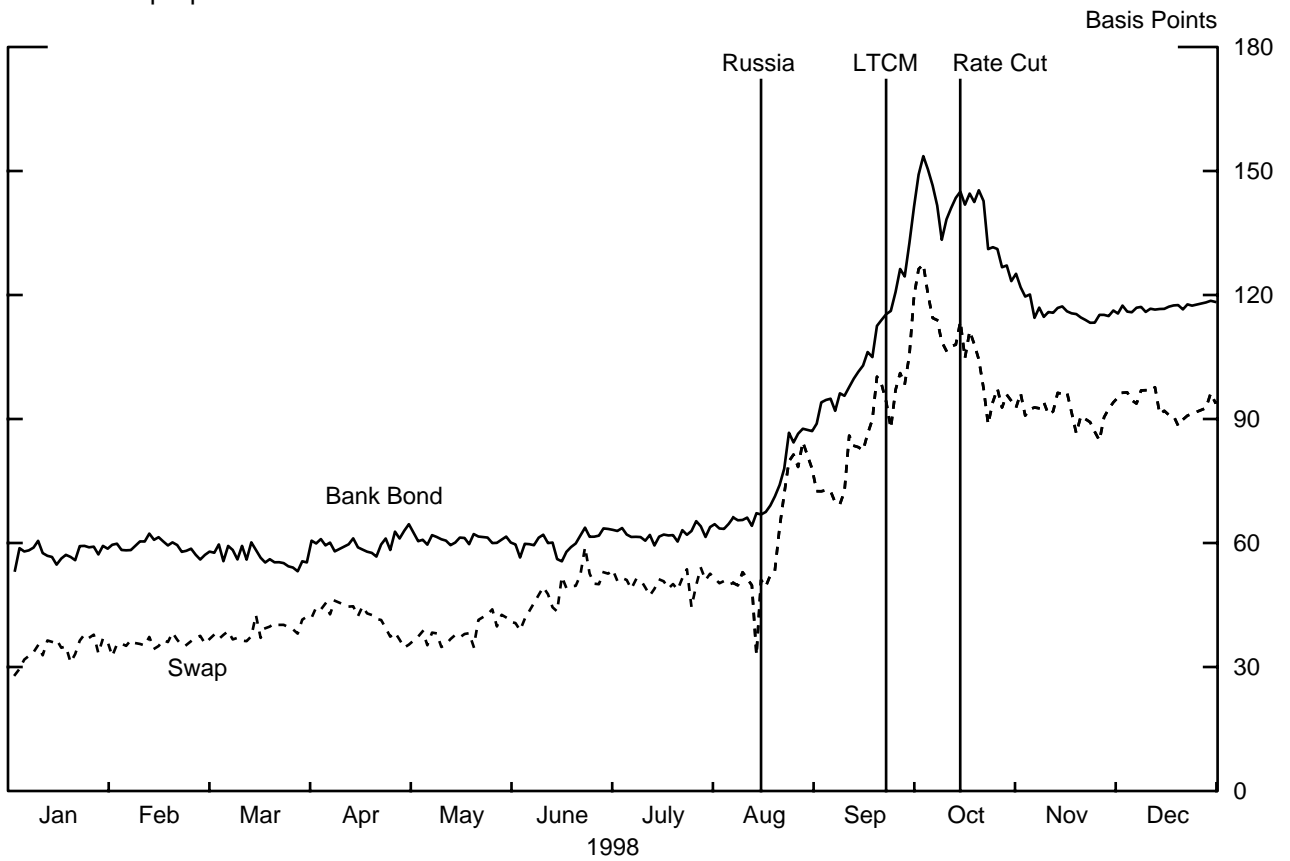
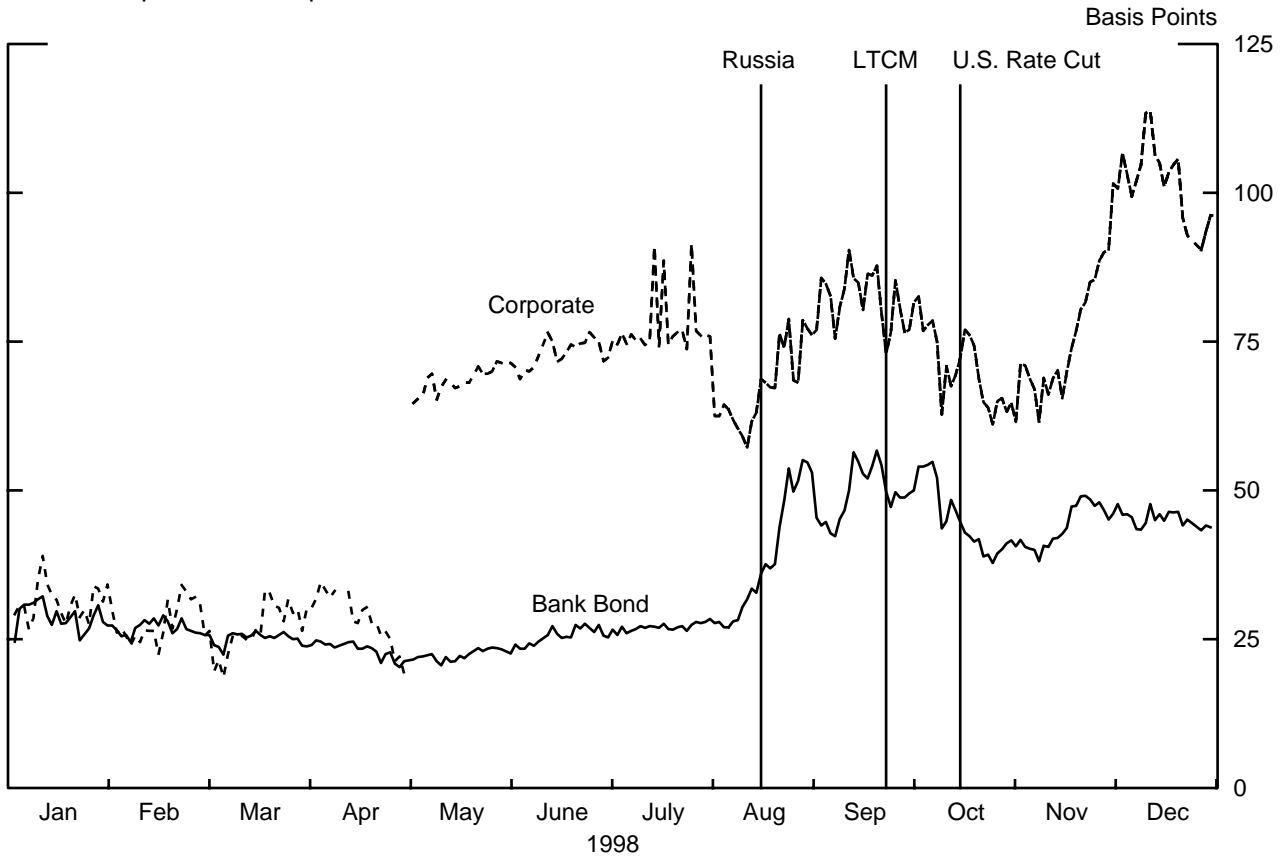


Figure A4

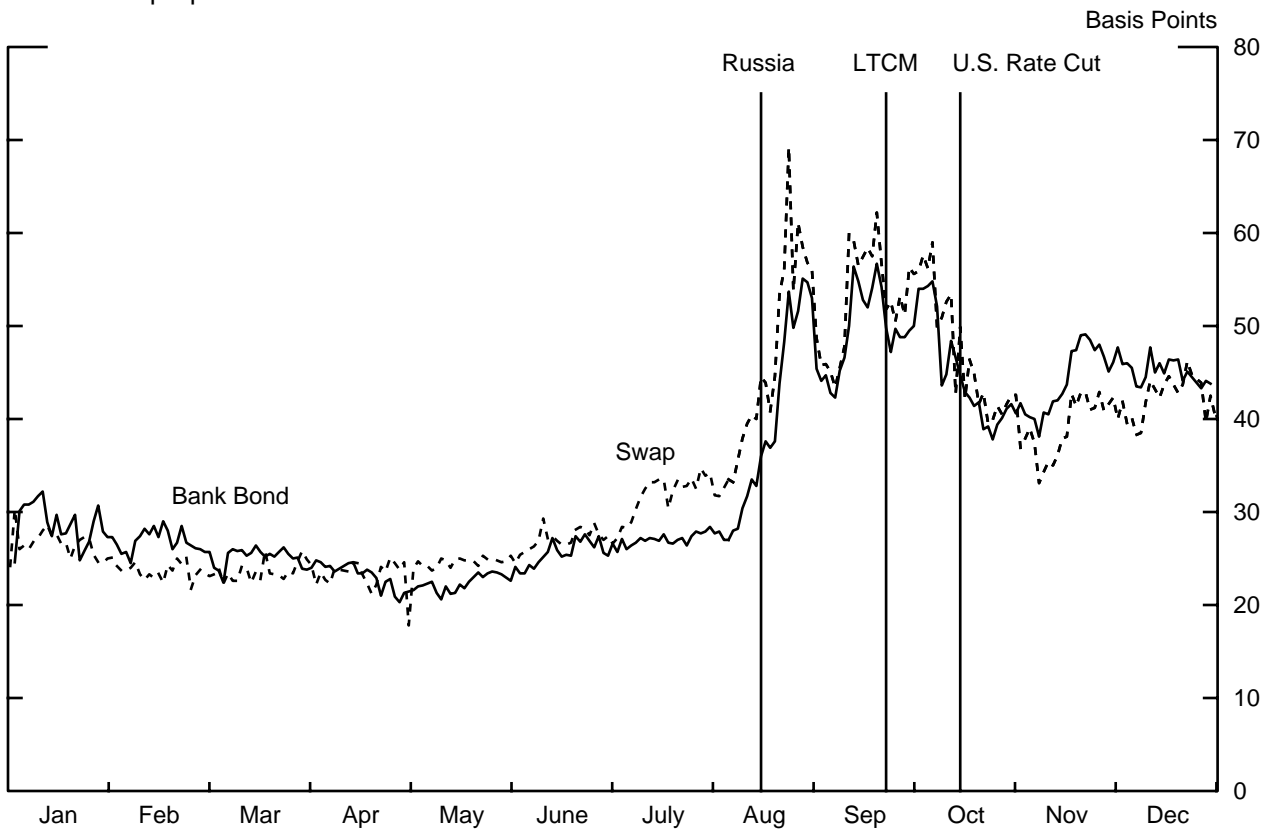
# Bank Bond Yield Spreads

Germany

Versus Corporate Yield Spread



Versus Swap Spread



Note: Spreads are measured by using domestic rates. 1998

Figure A5

# Implied and Historical Volatility

FTSE 100

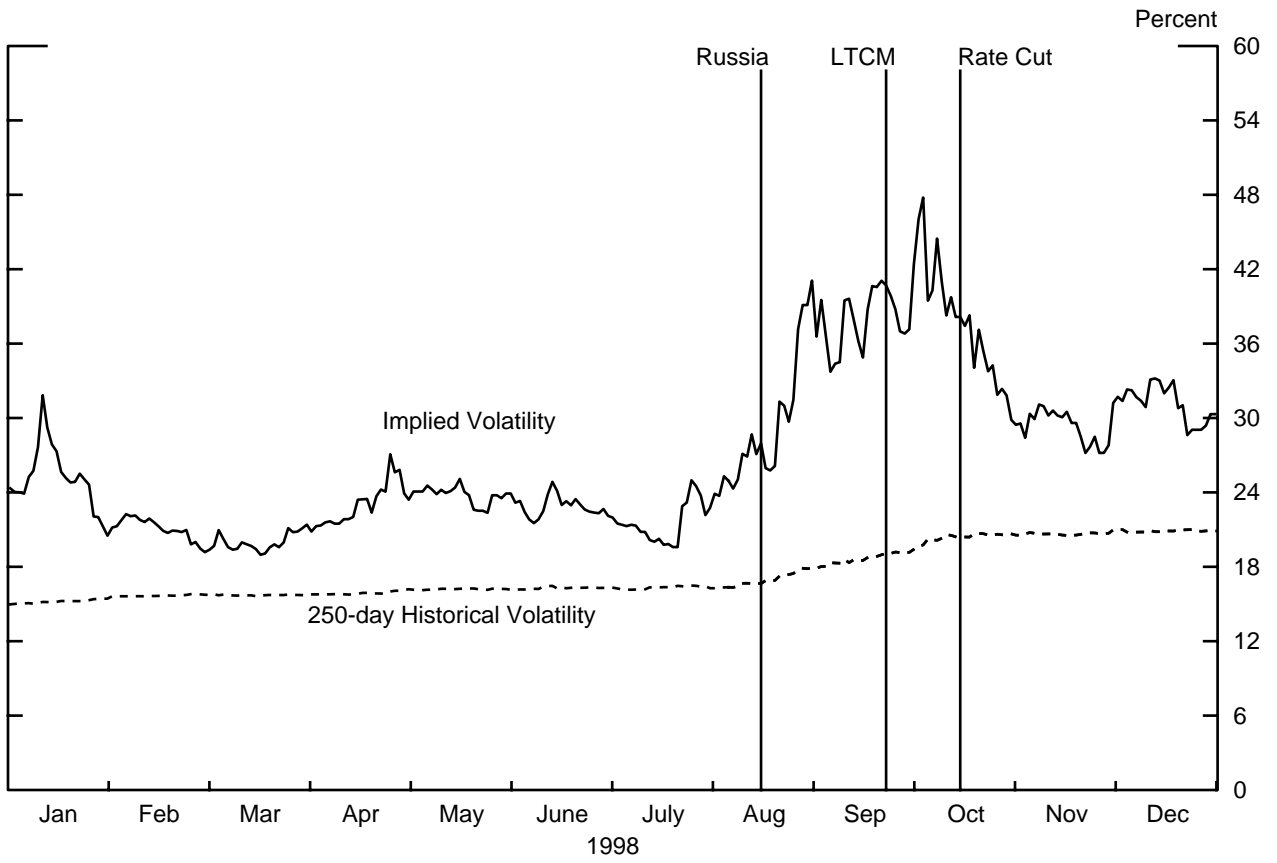
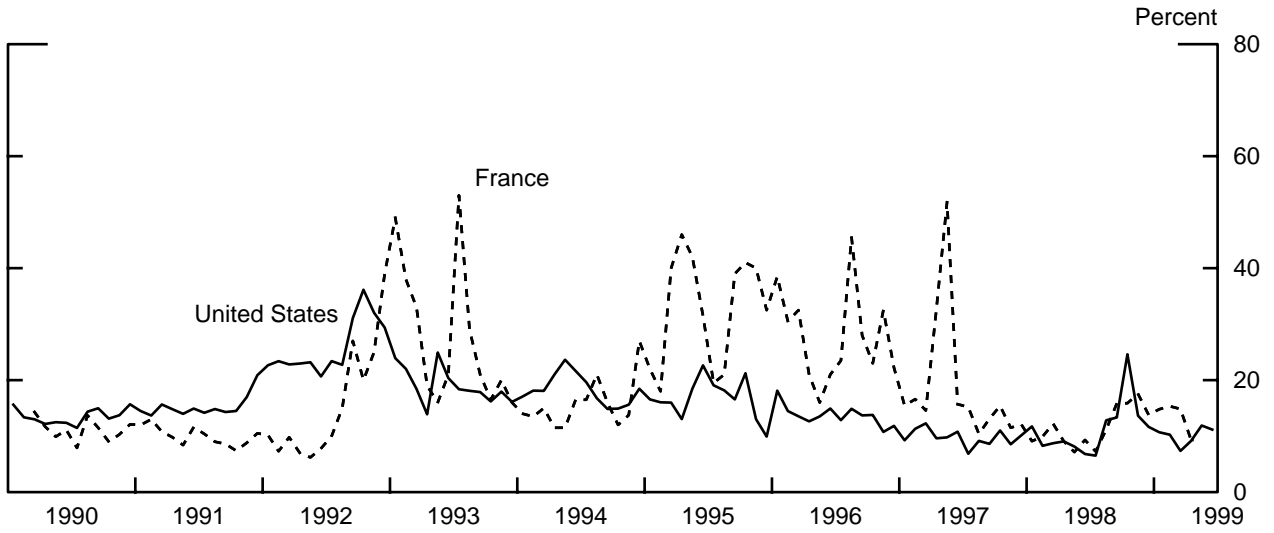


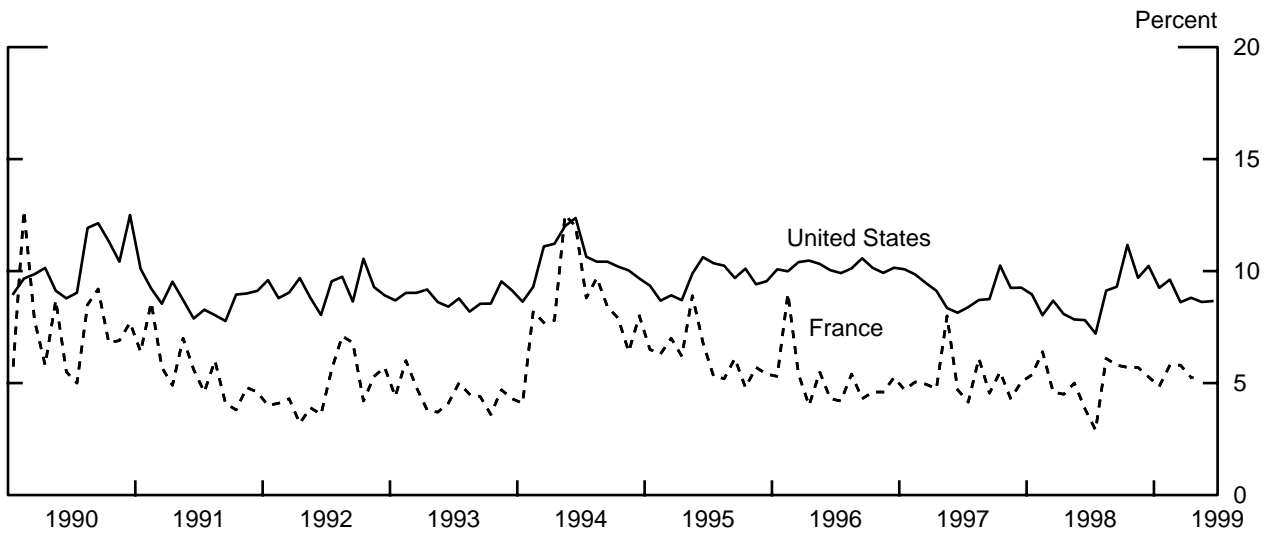
Figure A6

# Implied Volatility over the 1990s

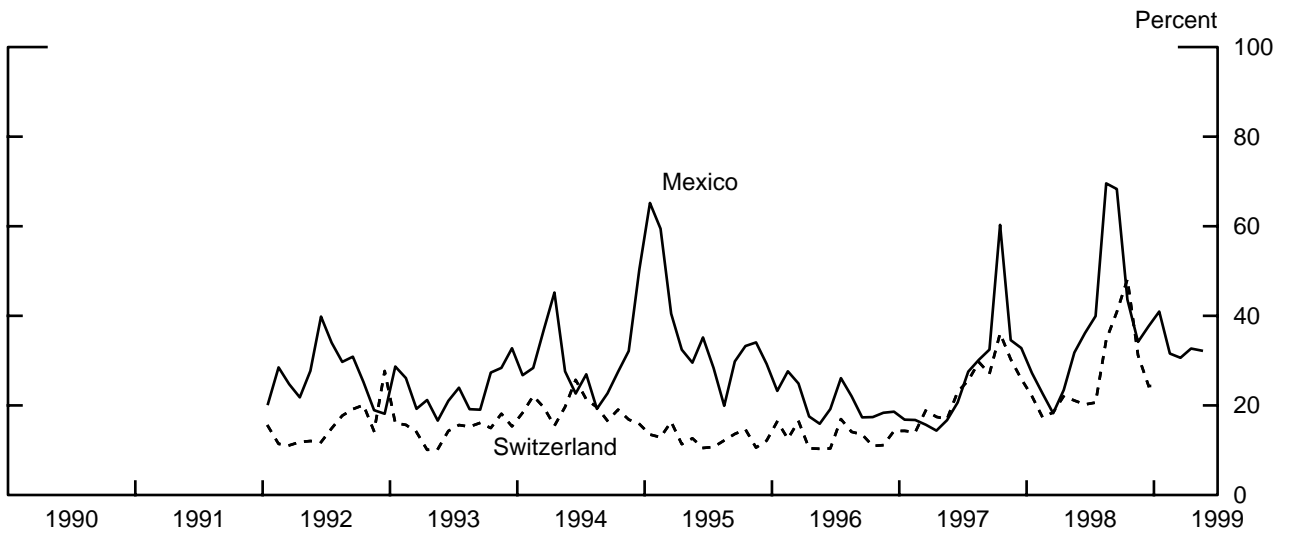
## 3-Month Interest Rates



## Government Bonds



## Stock Market Indices



## Sources and further details for data series used

Brazil 16-year Brady bond futures hedge: based on daily percent change in price of Brazil 2014 “C-Bond” and percent change in price of nearest-to-expiration Brazil C-Bond future trading on Chicago Mercantile Exchange (source: Bloomberg).

Brazil stock market index: Brazilian Bovespa Stock Index (source: Bloomberg).

Canada 3-month interbank: spread between 3-month euro currency bid rate for the Canadian dollar and treasury bill rate for Canada (source: BIS, Bank of Canada).

Canada 10-year \$ swap: swap spreads quoted relative to the on-the-run Canadian government bond (source: Bloomberg).

Canada stock market index: Toronto Stock Exchange 300 Composite Index (source: Bloomberg).

France 1-month commercial paper: spread between weighted weekly average rate at issue for 1-month maturity commercial paper Act/360 and daily 1-month euro currency bid rate for the French Franc (source: Banque de France, BIS).

France 1-year, 10-year swap rate: spread between bid and ask swap market rate quoted on simple interest basis, 360 days per year, with the same maturity (source: Banque de France).

France 3-month bond futures: 3-Month Pibor futures contract volume, in number of contracts (source: Banque de France).

France 3-month interbank: spread between 3-month interbank bid market rate quoted on simple interest basis and 3-month treasury bill rate for France (source: Banque de France).

France 3-month interbank rate: spread between 3-month bid and ask interbank market rate quoted on simple interest basis, 360 days per year (source: Banque de France).

France 3-month interest rate implied volatility: settlement volatility for the option on most traded 3-month future contract “Pibor” (source: MATIF SA).

France 3-month repo rate: spread between 3-month bid and ask repo market rate quoted on simple interest basis, 360 days per year (source: Banque de France).

France 5-year PIBOR futures: 5-Year PIBOR euro futures contract volume, in number of contracts (source: Banque de France).

France 10-year bond (using German futures) futures hedge: based on daily change in benchmark 10-year France government bond (source: Reuters) and daily change in price of nearest-to-expiration German 10-year bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (6% yield and 10-year maturity) (source: Bloomberg).

France 10-year bond futures: 10-year Notionnel futures contract volume, in number of contracts (source: Banque de France).

France 10-year government bond implied volatility: settlement volatility for the option on most traded 10-year future contract “Notionnel” (source: MATIF SA).

France A3 corporate bond: the sum of the average weighted spread between swap and credit curve for A3 issuers and the average weighted spread between swap and OAT curve. The spreads are weighted with the outstanding amount and the remaining maturity of each issue (source: CCF Charterhouse).

France average swap rate: the average spread between swap and OAT curve. The spread is weighted with the outstanding amount and the remaining maturity of each issue (source: CCF Charterhouse).

France financial stock market index: Financial services subindex of SBF120 French stock index (source: Bloomberg).

France stock market index: CAC 40 index of French stock prices (source: Bloomberg).

Germany 9-10 year mortgage bond, Germany 9-10 year bank bond: difference between yield on German mortgage (bank) bond over 9 to 10 years and yield on German listed Federal debt securities with residual maturities of over 9 to 10 years (source: Deutsche Bundesbank).

Germany 10-year bond futures hedge: based on daily change in estimated German Government Bund yield curve at 10 years (Source: Bloomberg) and daily change in price of nearest-to-expiration German 10-year bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (6% yield and 10-year maturity) (Source: Bloomberg).

Germany 10-year bond swap hedge: based on daily change in estimated Germany Bund yield curve at 10 years (source: Bloomberg) and daily change in yield of nearest-to-expiration Germany 10-year swap rate (source: Bloomberg, Datastream).

Germany 10-year DM swap: the difference between the German BGN benchmark bonds and the composite IRS rate (source: Bloomberg).

Germany 10-year government bond yield: bond yield generic 10-year German Bund (source: Datastream)

Germany bank bond index: spread between the German public bond yield and the German bank bond yield. Both series are weighted average yields for bearer bonds with remaining maturities over 3 years (source: Deutsche Bundesbank).

Germany bonds: stock market turnover (spot and OTC trading): All debt securities (source: Bundesbank).

Germany industrial bond (from May): difference between yield of German industrial bonds and yield on German listed Federal debt securities. Both series are weighted average yields for bearer bonds with remaining maturities over 3 years (source: Deutsche Bundesbank).

Germany mortgage bond index: the spread between the German public bond yield and the German mortgage bond yield. Both series are weighted average yields for bearer bonds with remaining maturities over 3 years (source: Deutsche Bundesbank).

Germany stock market index: Deutsche Aktien – DAX index (source: Reuters)

Hong Kong 3-month, 6-month, 12-month interbank: spread between the HIBOR and LIBOR of the respective maturity (source: Standard Chartered Bank, Reuters).

Hong Kong 3-month HIBOR futures: daily volume of 3-month HIBOR futures contract (source: Hong Kong Futures Exchange Limited).

Hong Kong 3-year agency bond: Spread between MTRC Note (or remaining maturity of 3 years) and its corresponding Exchange Fund Note (source: HKMA).

Hong Kong 3-year, 5-year, 10-year government bond yield: yield of Exchange Fund Note with the relative maturity (source: HKMA).

Hong Kong 10-year government bond: spread between 10-year Exchange Fund Notes and 10-year US Treasuries (source: HKMA and Reuters).

Hong Kong 10-year HK\$ Swap: spread between 10-year HK\$ interest rate swap and Exchange Fund Note (source: HKMA and various financial information service providers).

Hong Kong dollar/US dollar (12-month forward): sum of Hong Kong dollar/US dollar exchange rate and 1/10,000 of the 12-month Hong Kong dollar forward exchange rate (source: Census and Statistics Department, Hang Seng Bank Limited).

Hong Kong government securities: daily turnover of Exchange Fund Bills and Notes (source: HKMA).



Hong private sector debt instruments: daily turnover of HK\$ private sector debt instruments lodged with the Central Money Markets Unit, operated by the HKMA (source: HKMA).

Hong Kong stock market index: daily closing of the Hang Seng Index (source: CEIC).

Hong Kong stock market index futures: total daily volume of Hang Seng Index futures contracts (source: Hong Kong Futures Exchange Limited).

Italy 10-year bond (using German futures) futures hedge: based on daily change in benchmark Italian bond (source: Reuters) and daily change in price of nearest-to-expiration German 10-year bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (6% yield and 10-year maturity) (source: Bloomberg).

Japan 3-month interbank: difference between 3-month euro-rate for the yen and the 3-month Treasury bill rate in the Tokyo market (source: BIS, Japan Securities Dealers Association).

Japan 5-year AA corporate bond, Japan 5-year BBB corporate bond: spread between corporate bond quote rate and JGB with the same maturity (source: Japan Securities Dealers Association, via Tokyo-Mitsubishi Securities).

Japan 5-year bank bond: spread between 5-year bank debentures yield rate and JGB with same maturity (source: Japan Securities Dealers Association, via Tokyo-Mitsubishi Securities).

Japan 10-year bond futures hedge: based on daily change in estimated Japanese Government Bond yield curve at 10 years (source: Bloomberg) and daily change in price of nearest-to-expiration Japanese 10-year bond futures traded on Tokyo Stock Exchange (TSE) (source: Bloomberg).

Japan 10-year bond swap hedge: based on daily change in estimated Japanese Government Bond yield curve at 10 years (source: Bloomberg) and daily change in yield of nearest-to-expiration Japanese 10-year swap rate (source: Reuters, Tokyo Stock Exchange, Bank of Tokyo-Mitsubishi, Reuters).

Japan 10-year government bond yield: 10 year Benchmark yield of Japanese Government Bond (source: Tokyo Stock Exchange, Bank of Tokyo-Mitsubishi).

Japan 10-year liquidity spread: spread between off-the-run and on-the-run 10-year Japanese Government Bond (source: Tokyo Stock Exchange, Bank of Tokyo-Mitsubishi).

Japan 10-year yen Swap: spread between 10-year Japanese interest rate swaps and JGB benchmark (source: Telerate (or Reuters)).

Japan bank stock market index: TOPIX Banking Sector Subindex (source: Tokyo Stock Exchange).

Japan stock market index: Tokyo Stock Exchange TOPIX Index (source: Tokyo Stock Index).

Korea stock market index: Korean composite index (source: Bloomberg).

Latin America Brady bond: JP Morgan Emerging Markets Bond Index Latin America spread over Treasury bonds (source: JP Morgan).

Mexico 1-month inter-bank: difference in the equilibrium interbank interest rate and the Prebon Index. The Prebon Index was calculated using several Cetes 28d contracts in the secondary market (source: Banco de México, Prebon).

Mexico Brady bond: JP Morgan Emerging Market Bond Index Mexico spread (source: JP Morgan).

Mexico corporate Eurobond: JP Morgan Latin Eurobond Index Mexico Corporate spread over Treasury bonds (source: JP Morgan).

Mexico foreign exchange: Mexican foreign exchange market volume (source: Banco de México).

Mexico Peso/US Dollar exchange rate: spread between the closing bid and ask price of the Peso-US Dollar (source: Banco de México).

Mexico stock market index: Mexican Bolsa Index (source: Bloomberg).

Mexico stock index implied volatility: 30 day implied volatility of ATM peso options (source: Prebon Yamane).

Netherlands 10-year bond (using German futures) futures hedge: based on daily change in benchmark 10-year Netherlands bond (source: Bloomberg) and daily change in price of nearest-to-expiration German 10-year bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (6% yield and 10-year maturity) (Source: Bloomberg).

Netherlands 10-year government bond yield: yield for generic 10-year Netherlands government bond (source: ask Central Bank of Netherlands??).

Netherlands 10-year liquidity spread (versus German yield curve): yield spread between 10-year Netherlands and German government bond yield curves (source: Datastream).

Netherlands four 10-year bank bonds: average of yield spreads of ABN Amro 8.25% 4/07 bond, Bank Nederlandse Gemeenten 5.5% 1/08 bond, ING 5.5% 1/08 bond, and Nederlandse Waterschapsbank 5.5% 1/08 bond over Netherlands government bonds of similar maturities (source: Datastream).

Netherlands two bank bonds: average of yield spreads of Bank Nederlandse Gemeenten 7.625% 12/02 bond and ING 10% 3/01 bond over Netherlands government bonds of similar maturities (source: Datastream).

Netherlands two industrial bonds: average of yield spreads between Akzo Nobel NV 8% 12/02 bond and Unilever NV 9% 7/00 bond over Netherlands government bonds of similar maturities (source: Datastream).

Russia stock market index: Russian Trading System Index (source: Reuters).

Spain 10-year bond (using German futures) futures hedge: based on daily change in benchmark 10-year Spain government bond (source: Reuters) and daily change in price of nearest-to-expiration German 10-year bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (6% yield and 10-year maturity) (source: Bloomberg).

Switzerland 5–7 year SFr swap: spreads for the Swiss Franc swap rate are calculated by applying the DBI convex combination on the spreads of 5 and 7 year swap rates over Government Bond yields (source: Bloomberg).

Switzerland 5-year swap rate: spread between 5-year bid and ask swap market rate (source: Bloomberg).

Switzerland bank stock index: Swiss Market Index (source: Datastream).

Switzerland corporate bond: with an average duration of approximately six years, the Swiss Domestic Bond Index (DBI) is comprised of first class domestic bonds and federal bonds. The spread is calculated over a linear combination of the 5 and 7 year benchmark Government Bonds matching the DBI duration. Weekly data was used from 1 January through 30 June. Afterwards, business daily data was used (source: Swiss Stock Exchange, Primark).

Switzerland SFr/US\$ exchange rate implied volatility: (source: Datastream).

Switzerland stock index: Swiss Banking Index (source: Datastream).

Switzerland stock market index implied volatility: implied volatility of the Swiss Market Index (source: Datastream).

UK 3-month interbank versus repo rate: sterling interbank rate over 3-month repo spread (source: Bank of England).

UK 3-month interest rate implied volatility: short sterling implied volatility (source: LIFFE).

UK 5-year Aa, A, Baa corporate bond: calculated from 5-year duration corporate bonds, spread over duration matched Gilts (source: Bank of England).

UK 5-year Barclays, Lloyds, NatWest, Royal Scotland bank bond: spread for 5-year bank bond over 5-year Gilts (source: Bank of England).

UK four 5-year bank bonds: average of 5-year Barclays Bank, Lloyds Bank, Natwest Bank, and Royal Bank of Scotland bank spread over duration-matched Gilts (source: Bank of England).

UK 10-year government bond yield: 10-year UK gilt benchmark bond yield (source: Reuters).

UK 10-year bond swap hedge: based on daily change in estimated UK long gilt bond yield curve at 10 years (source: Reuters) and daily change in yield of nearest-to-expiration 10-year sterling (zero) swap rate (source: Reuters, Bank of England).

UK 10-year liquidity spread: spread between yield spread of 8.50% 2007 gilt and the yield spread of 7.25% 2007 gilt (source: Bank of England).

UK 10-year sterling swap: using Svensson model for zero Gilt yields (source: Bank of England).

UK Aa, A, Baa corporate bond: average bid-ask spread of relative UK corporate bonds (source: Reuters).

UK financial stock market index: FTSE financial stock index (source: Datastream).

UK long gilt futures hedge: based on daily change in estimated UK gilt benchmark bond yield curve at 10 years (source: Reuters) and daily change in price of nearest-to-expiration UK 10-year long gilt bond futures traded on London International Financial Futures and Options Exchange (LIFFE) converted to a yield based on the characteristics of the underlying notional asset (7% yield and 15-year maturity) (source: Bloomberg).

UK long government bond implied volatility: long Gilt implied volatility (source: LIFFE).

UK stock market index: FTSE 100 stock index (source: Datastream).

UK stock market index implied volatility: FTSE 100 implied volatility (source: LIFFE).

US 1-month prime commercial paper: commercial paper AA rate over 1-month repo rate (source: Federal Reserve).

US 1-month second-tier commercial paper: 1-month commercial paper A2 rate over P2 rate (source: Federal Reserve).

US 2-year, 5-year, 10-year, 30-year government bond yield: US Treasury bond yield with the relative maturity (source: Federal Reserve).

US 2-year US\$ swap, US 10-year US\$ swap: swap spreads quoted relative to the on-the-run Treasury yield curve (source: Bloomberg).

US 3-month Eurodollar implied volatility: implied volatility for 3-month Eurodollar (source: Federal Reserve).

US 3-month, 12-month interbank: difference between the euro currency bid rate for the US dollar and US Treasury bill rate of the same maturity (source: BIS, Federal Reserve).

US 10-year AA corporate bond, US 10-year BBB corporate bond: spread between Merrill Lynch corporate bond quoted yields and 10-year Treasury bond with the same maturity (source: Merrill Lynch, Federal Reserve).

US 10-year bond swap hedge: based on daily change in estimated Treasury bond yield curve at 10 years (source: Bloomberg) and daily change in yield of nearest-to-expiration Treasury 10-year swap rate (source: Federal Reserve).

US 10-year inflation-indexed government bond yield: 10-year indexed note yield (source: Federal Reserve).

US 10-year liquidity spread: spread between 10-year off-the-run and on-the-run Treasury bill rate (source: Federal Reserve).

US 30-year government bond futures hedge: based on daily change in estimated Treasury bond yield curve at 30 years (source: Bloomberg) and daily change in price of nearest-to-expiration Treasury 30-year bond futures traded on Chicago Board of Trade (CBT) converted to a yield based on the characteristics of the underlying notional asset (8% yield and 20-year maturity) (source: Bloomberg).

US 30-year government bond implied volatility: implied volatility of 30-year government bonds (source: Federal Reserve).

US dollar/Canadian dollar: US\$/Canadian dollar spot exchange rate (source: Federal Reserve).

US dollar/German mark: US\$/Euro spot exchange rate, restated German mark before 1999 (source: Federal Reserve).

US dollar/Swiss franc: US\$/Swiss franc exchange rate (source: Datastream).

US financial stock market index: S&P Financial Stock Index (source: Bloomberg).

US small-cap stock market index: Russell 2000 Stock Index (source: Federal Reserve).

US speculative-grade bond: spread between Merrill Lynch High Yield bond yield and 7-year Treasury bond (source: Merrill Lynch, Federal Reserve).

US stock market index: S&P 500 Stock Index (source: Federal Reserve).

US stock market index (S&P 500) implied volatility: (source: Federal Reserve).

Yen/Swiss franc: Swiss franc – 100 Yen exchange rate (source: Datastream).

Yen/US dollar: Yen/\$US dollar spot exchange rate (source: Federal Reserve).

**Members of the Working Group on  
Financial Market Events in the Autumn of 1998**

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