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Norbert Funke and Andrea Goldstein*

Financial Market Volatility

The volatility of financial markets has attracted a lot of attention in recent years. However, while particular episodes, such as the bond market turbulence in 1994 and considerable exchange rate movements in 1995, may give the impression that markets have become more volatile, there appears to have been no systematic increase in volatility over the last 20 years in major industrialised countries.

The liberalisation of capital flows, the deregulation of financial markets, the development of computer-based trading techniques and a greater sensitivity of financial markets to news are widely thought to have made financial markets more volatile in recent years. A certain degree of financial market volatility is, however, inevitable and may be beneficial. As asset prices are driven by demand and supply factors and incorporate expectations about the underlying fundamental factors, they change continuously as news become available. But financial market volatility may have a negative impact on real economic activity and resource allocation, particularly if it exceeds the level that the development of the underlying economic fundamentals justifies. The economics literature identifies various channels whereby volatility in the price of financial assets may be costly for the economy:

- large exchange rate volatility may distort and reduce international trade and hamper international economic integration;
- extreme stock market volatility may negatively influence aggregate investment behaviour, especially in those financial systems in which companies rely heavily on equity as a source of external financing;
- large interest rate volatility may render monetary policy-making more difficult; and
- more generally, financial market volatility may disrupt investors' confidence and bring about a surge in risk premia.

Exchange rate volatility affects relative prices and could therefore alter the international competitiveness of an economy. However, empirical evidence on the consequences for trade and investment remains inconclusive and points, at best, to limited effects only.¹ Several channels may link the stock market with

the level of investment.² According to Tobin, firms' investment decisions are based on the market value of a firm divided by the replacement value of its capital stock, i.e. Tobin's q .³ Therefore, companies will increase investment when the share price rises relative to the replacement value of their capital stock. Stock prices may also be an important determinant of investment decisions in another respect. If managers take equity price stability as an indicator for the level of certainty surrounding future business prospects, and investment decisions are based on expectations about these prospects, stable equity prices may lead to a larger aggregate investment.

Monetary authorities use a set of indicators to determine the appropriate policy setting. Short and long-term interest rates, the yield curve and the exchange rate are among the key policy indicators. As volatility may make these variables less predictable, the information value of market rates may decrease correspondingly and their reliability as guidelines for policy action may be reduced. A weaker link between short and long-term interest rates may render it more difficult for monetary authorities to anticipate the effects of policy changes on long-term interest rates.⁴

Large general financial volatility may increase uncertainty about the economic environment, with long-lasting effects as investors demand a higher risk premium. In terms of macroeconomic equilibria, such consequences may be particularly costly for highly indebted countries, for which even minor increases in the level of interest rates result in an increase in the debt-servicing burden.

¹ See A. Côté: Exchange rate volatility and trade. A survey, in: Bank of Canada Working Paper, No. 94-5, 1994.

² See P. Kupiec: Stock market volatility in OECD countries: Recent trends, consequences for the real economy, and proposals for reform, in: OECD Economic Studies, 1991, No. 17.

³ J. Tobin: A general equilibrium approach to monetary theory, in: Journal of Money, Credit, and Banking, 1969, Vol. 1, No. 1.

⁴ See S. Gerlach: Monetary policy and the behaviour of interest rates: Are long rates excessively volatile?, in: Bank for International Settlements, 1995, mimeo.

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Some Measures of Volatility

Financial market volatility can be measured in a variety of ways. Traditional practice has been to define volatility as the (annualised) standard deviation of the percentage changes of asset prices. The main disadvantage of this measure is that it assigns equal weight to all observations. As market participants are likely to put a greater weight on more recent observations, it is more useful to calculate a weighted measure of historical volatility. This can be done by assigning exponentially decaying weights, for example over a 6 month period (T), to past asset price changes.⁵ Formally, volatility (V_t) is defined as

$$V_t = \left(\sum_{i=1}^T d_{t-i}^2 \cdot w_i \right)^{1/2}$$

with past daily changes $d_t = \ln x_t - \ln x_{t-1}$, the weights of w_i declining exponentially ($w_1 = 0.0348$, $w_2 = 0.0336$, $w_3 = 0.0324$, etc.) and

$$\sum_{i=1}^T w_i = 1.$$

Calculations are then annualised and expressed in per cent.

Previous analyses have already suggested that financial market volatility measured on a monthly basis has not increased over the last two decades.⁶ Our analysis complements and extends previous work by focusing on daily exchange rate, stock and bond prices. The following results emerge:

□ peaks in volatility have been highest in stock markets, followed by currency and bond markets. Although there have been periods of abnormal volatility (e.g. the 1987 stock market crash, the 1994 bond market turbulence and the exchange rate fluctuations in early 1995), volatility does not appear to have increased systematically during the last ten years (Figure 1);

□ compared with the late 1970s, average exchange rate volatility *vis-à-vis* the US dollar increased in all major countries up to the second half of the 1980s but declined slightly in the 1990s (Table 1);

⁵ See, for example, also J. P. Morgan's Riskmetrics. The results of this approach are similar to those of more sophisticated econometric analysis like GARCH (Generalised Autoregressive Conditional Heteroscedastic) models.

⁶ See, for example, OECD: Economic Outlook 57, June 1995; and M. Edey and K. Hviding: An assessment of financial reform in OECD countries; in: OECD Economics Department Working Papers, 1995, No. 154. See for an analysis of daily financial market volatility in Germany also Deutsche Bundesbank: Monthly Report, April 1996.

⁷ See M. Artis and M. Taylor: The stabilizing effect of the ERM on exchange rates and interest rates, in: IMF Staff Papers, 1994, Vol. 41, No. 1.

□ stock market volatility shows a mixed picture: in the United States and Canada it has remained lower in the 1990s than in the 1970s; in contrast, in Japan stock market volatility has almost doubled in the 1990s compared with the second half of the 1980s (Table 2);

□ when examined in a medium-term perspective, the 1994 bond market turbulence was not extraordinarily large (Figure 1).

To complement this picture, the number of large daily changes, defined as an absolute change larger than one per cent, were calculated (Table 3). This perspective tends to confirm the above results.

Some Possible Determinants of Volatility

This stylised overview suggests that there has been no systematic increase in volatility, although there have been recurring periods of high volatility. However, the causes of volatility are still open to debate. In the following, we focus on three particular motives, namely the institutional framework, macro-economic fundamentals, and spillover effects.

The institutional framework is an important constraint to the degree to which official assets prices may fluctuate. Explicit or implicit agreements may be particularly effective in reducing nominal exchange rate volatility. For example, the Bretton Woods system, as well as the Exchange Rate Mechanism (ERM) of the European Monetary System more recently, have kept (bilateral) exchange rate volatility low.⁷ Even for countries that do not participate in any

Table 1
Average Daily Exchange Rate Volatility *vis-à-vis* the US Dollar¹

	1974-79	1980-84	1985-89	1990-95
Japan	6.8	10.1	11.0	10.1
Germany	7.9	11.0	12.0	12.0
France	8.0	11.4	12.3	11.1
Italy	6.5	10.3	13.7	11.4
United Kingdom	9.0	9.8	11.6	10.5
Canada	4.1	4.0	6.6	5.3

¹ Annualised, in per cent.

Sources: Datastream and OECD; authors' calculations.

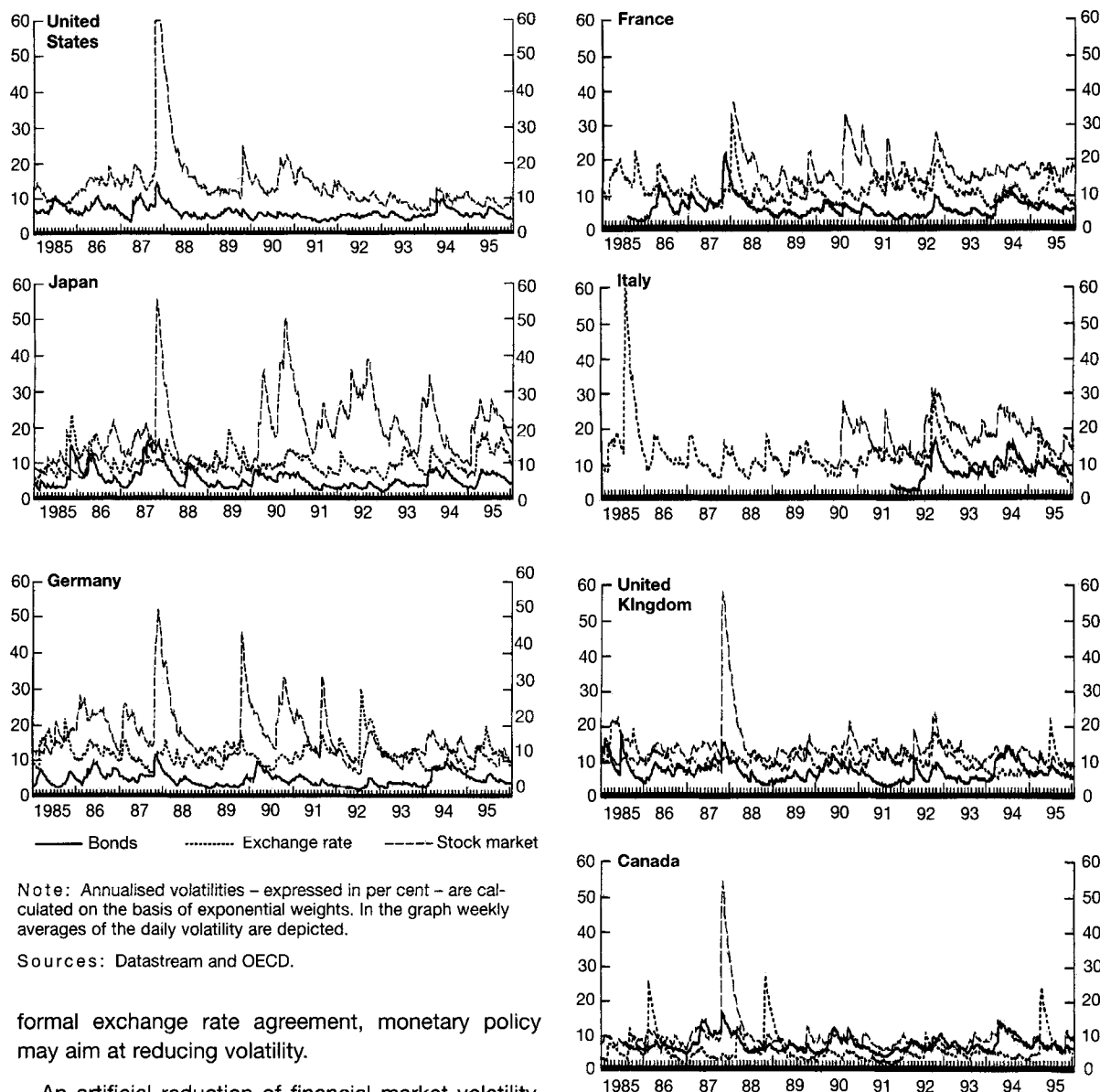
Table 2
Average Stock Market Volatility¹

	1974-79	1980-84	1985-89	1990-95
United States	14.5	14.5	17.0	11.3
Japan	n.a.	n.a.	13.4	22.5
Germany	10.9	11.6	19.3	14.9
Canada	10.3	14.3	11.0	8.4
Switzerland	11.8	9.2	13.7	11.9

¹ Annualised, in per cent.

Sources: Datastream and OECD; authors' calculations.

Figure 1
Volatilities Across Markets



formal exchange rate agreement, monetary policy may aim at reducing volatility.

An artificial reduction of financial market volatility, however, may not necessarily translate into an enhancement of social welfare. On the one hand, institutional agreements limiting volatility in one market may be reflected in increased volatility in a different financial market segment. But for policy-makers, the most important issue is whether the impact of less volatile financial markets may be felt on the real economy. Given inflexible labour markets, an exogenous change in the exchange rate regime will, for example, render adjustment processes more difficult. As long as it is not accompanied by structural changes in labour markets, an artificial reduction in exchange rate volatility may lead to larger fluctuations in unemployment rates and ultimately to a higher level

of unemployment. Though empirically difficult to judge, the evidence is mixed. For closely integrated economies, such as Austria and Germany, the former's credible monetary policy of holding the Austrian schilling stable *vis-à-vis* the D-Mark appears to have had positive effects, reducing the potentially negative effects of exchange rate volatility on business investment and risk premia, without having a negative impact on labour markets. In contrast, for countries that have not achieved sufficient convergence with their anchor country, the loss of flexibility entailed in the pegging may increase problems elsewhere.

Table 3
Volatility in Financial Markets: Average Yearly Number of Large Daily Changes

	Foreign exchange			Bonds			Equity		
	1981-85	1986-90	1991-95	1980-85	1986-90	1991-95	1980-85	1986-90	1991-95
United States	9.0	10.4	4.4	57.4	68.0	30.0
Japan	26.4	35.6	26.8	9.5	9.0	4.0	30.0	65.4	93.0
Germany	43.6	39.4	43.8	3.4	6.6	2.4	44.8	97.4	49.0
France	45.0	32.2	37.8	n.a.	10.6	7.2	n.a.	79.0	85.2
Italy	35.8	32.8	39.8	n.a.	n.a.	21.5	n.a.	63.0	95.8
United Kingdom	39.2	28.4	30.8	20.0	15.0	11.2	43.0	66.0	44.4
Canada	2.6	4.8	2.6	5.0	17.0	12.0	45.0	27.6	17.8

Notes: Large daily changes are defined as those exceeding one per cent in absolute value. Ten-year government bonds data available for the United States since 1983, for Japan since 1984, for France since 1986, for Italy since 1992 and for Canada since 1985; stock exchange data available for France since 1988, for Italy since 1990 and for the United Kingdom

Sources: Datastream and OECD; authors' calculations.

Microeconomic changes in the institutional framework may also affect the average level of volatility. The on-going process of financial deregulation is a case in point, with its consequences on volatility being a matter of continuing debate. On the one hand, financial market deregulation may have been associated with the emergence of general asset price bubbles. Financial reforms have been accompanied by a sharp increase in credit growth. Higher credit growth can contribute to inflationary pressures and increase the correlation between asset price cycles and the development of credit aggregates. The experience of developing countries has shown that deregulation may increase volatility when the size of the market is still small, trading is thin and the institutional framework remains underdeveloped.⁸ On the other hand, deregulation has allowed financial activity to grow substantially, both in scale and scope.⁹ Market liquidity has augmented and investors have been presented with greater opportunities to hedge financial risks. In more liquid markets, investors are better placed to resist the pressures of exogenous shocks, and the effects of noise traders are less likely to provoke major turmoil in financial markets.¹⁰ But others have suggested that systems where banks have a greater importance than markets in channelling

financial resources and where companies are requested to provide very little information to the public may suppress noise and therefore reduce excess volatility.¹¹

Fundamentals and Spillovers

While the institutional framework determines the degree to which financial markets may fluctuate, the evolution of macroeconomic fundamentals is a key determinant of the medium-term development of financial market volatility. In a stable economic environment large changes in private agents' expectations would be less likely and hence financial market volatility should be lower. In contrast, an unstable environment may prompt agents to revise their expectations frequently and cause asset prices to be more volatile.

Out of the set of key macroeconomic variables, inflation performance appears to be a crucial determinant of average financial market volatility.¹² Countries with higher average inflation rates – which also tend to experience higher inflation uncertainties and a larger ex post inflation volatility – record larger financial market fluctuations. Italy, the United Kingdom and Sweden, with the largest ex-post inflation volatility among the G-10 countries, have also experienced above-average volatility in the effective exchange rate, equity prices and long-term interest rates since 1973. Moreover, as shown by the particularly high volatility of Italian bond prices in 1994, macroeconomic performance not only influences the average level of volatility, but also its relative size in turbulent periods.

Studies of specific events have suggested that the development of fundamentals may, however, not fully explain periods in which volatility has gone up dramatically and very quickly. In periods of financial market turbulence, the positive correlation of volatility

⁸ See Inter-American Development Bank: Economic and social progress in Latin America, Johns Hopkins University Press 1995.

⁹ See M. Edey and K. Hviding, *op. cit.*

¹⁰ For an analysis of the information processing behaviour of markets, see L. Ederington and J. Lee: How markets process information: News releases and volatility, in: *Journal of Finance*, 1993, Vol. 48, No. 4.

¹¹ See F. Allen and D. Gale: A welfare comparison of intermediaries and financial markets in Germany and the US, in: *European Economic Review*, 1995, Vol. 39, No. 2.

¹² See C. Borio and R. McCauley: The anatomy of the bond market turbulence of 1994, in: *Bank for International Settlements*, 1995, mimeo.

Table 4
Correlation of Volatilities Across Markets

Markets		Average 1985-95	Stock market crash 1987Q1-3 1987Q4		Bond market turmoil 1994Q1 1994Q2-4	
United States	Bond-Stock market	0.51	0.52	0.95	0.32	0.56
Japan	Bond-Stock market	0.21	0.70	0.61	0.88	0.44
	Exchange-Bond market	0.44	0.70	0.10	0.83	0.56
	Exchange-Stock market	-0.02	0.49	0.60	0.79	0.12
Germany	Bond-Stock market	0.40	-0.50	0.85	0.13	0.69
	Exchange-Bond market	-0.17	-0.46	0.70	0.47	-0.21
	Exchange-Stock market	0.05	0.83	0.95	-0.31	-0.61
United Kingdom	Bond-Stock market	0.46	0.40	0.89	0.07	0.98
	Exchange-Bond market	-0.05	-0.47	0.82	-0.08	-0.78
	Exchange-Stock market	0.01	-0.07	0.89	0.08	-0.78

Note: Correlations refer to weekly averages of daily volatilities. Exchange rate volatility refers to the US dollar rate.

Sources: Datastream and OECD; authors' calculations.

across all countries increases considerably and factors not related to fundamental changes appear to be at work (Table 4).

The 1987 stock market crash provides some evidence for an increase in financial market turbulence that could not be solely associated with the development of fundamentals. In the United States, the major stock market indices had roughly doubled in the four years prior to the crash (1982 to 1986), while bond yields had declined during the same period from 13 per cent to 9 per cent. Some of the fundamentals had started to deteriorate. Nonetheless, the drop of the Dow Jones index of about 20 per cent on 19 October, and the nearly simultaneous decline in all the other major equities markets, cannot be explained solely by deteriorating fundamentals. More detailed analyses have failed to identify a global shock that could account for this parallel behaviour. It is rather that the dramatic fall in the Dow Jones led to significant spillover effects, with the correlation coefficient between weekly volatilities increasing to almost unity.

Doubts also exist on whether the increase in bond price volatility in 1994 can be fully explained by fundamentals. Volatility started to rise in Japan in January, with the effect spreading quickly to Germany and the United Kingdom. In February, the Federal Reserve raised its target federal funds rate (the overnight interbank rate on reserve deposits), following a fairly prolonged period in which US monetary authorities had repeatedly and gradually lowered short-term interest rates. This move was further reaffirmed in the following few months, driving up this key rate by 125 basis points in the four months to May 1994. As a result of the tightening of monetary policy in the United States, correlations across bond

markets remained generally higher than usual for most of 1994 (Figure 2). More detailed analyses suggest that the measurable uncertainty regarding fundamental macroeconomic and financial factors may not account for the extent of the fluctuations. The above examples show that the correlation of volatility does not lend itself easily to generalisations. Nonetheless, correlation tends to increase during periods of high volatility, and when there is considerable volatility in the market for one instrument, turbulence spreads to other asset markets.

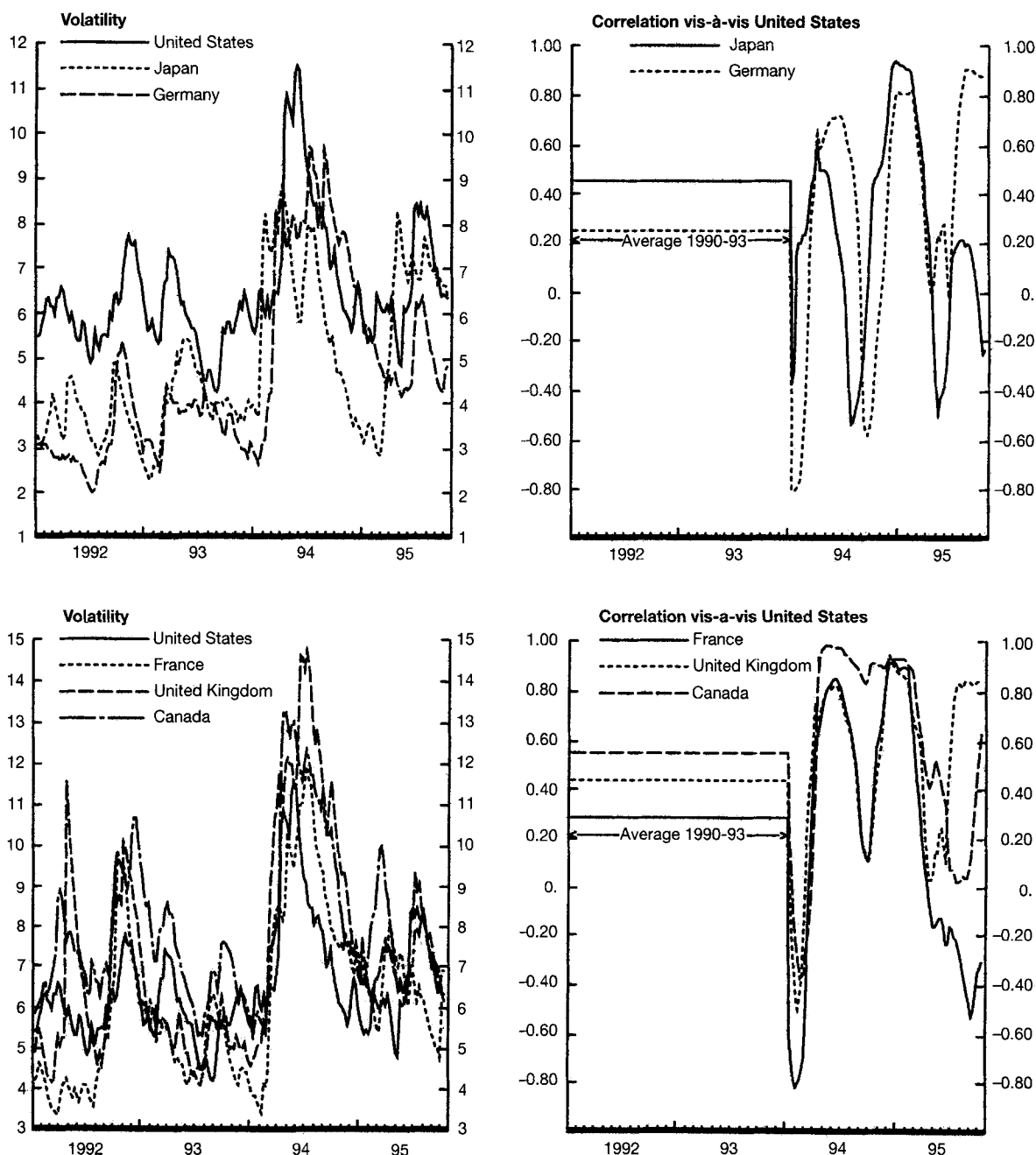
Conclusions

At least since the late 1970s, daily financial market volatility has not gone up in any systematic fashion. Compared to the whole of the 1970s, the results are mixed. While bilateral dollar rates have been more volatile in the last 15 years than in the 1970s, no clear trend is evident regarding stock market volatility. Recent periods of high volatility, such as the bond market turbulence in 1994, and the exchange rate turbulence in 1995, have not been extraordinarily high in a historical perspective. These results contradict the often expressed opinion that financial market volatility has recently increased.

The results refer, however, to traditional financial market instruments that have been actively traded for quite some time. With deregulation and technological innovation, a number of new financial instruments (e.g. high-yield bonds and derivatives) have been introduced, and their share of the market has increased substantially. It may be that they have proved more volatile than traditional instruments, although this also should have shown up in the behaviour of the underlying instruments.

Although the institutional framework and macro-

Figure 2
Bond Markets in the 1990's



Note: The correlation coefficient between weekly averages of daily volatilities is calculated over a 26-week sliding window.

economic fundamentals set the background for the average level of volatility, some evidence exists that factors unrelated to fundamentals also matter. Such factors seem to become more important in periods of abnormal volatility. Nonetheless, empirical analyses suggest that the real costs of periods of "excessive" financial market volatility, such as the stock market crisis in 1987, were less than expected at that time.

Still, volatile markets may render policy-making more difficult, in as far as the information content of assets prices is reduced. This supports once more the need for macroeconomic policies that are conducive to financial stability. Enhancing the flexibility of labour and product markets may also be necessary, in order to prevent rigidities in these markets from causing excessive volatility in financial markets.