Box 5

## STOCK MARKET VOLATILITY IN THE LIGHT OF THE FINANCIAL MARKET TURMOIL

After an extended period of generally tranquil equity market conditions, stock price volatility levels increased again across the globe with the outbreak of the financial turmoil in the summer of 2007 and have remained relatively high since then. Pronounced spikes in realised and expected stock market volatility are typical of periods of market turmoil,[1] with investors generally becoming very uncertain about future stock price developments and, accordingly, requiring a higher risk premium for holding equities. This is why periods of increased stock market volatility tend to coincide with stock price falls and certain indicators of expected stock market volatility have become known as "investor fear gauges".[2] This box looks at recent developments in stock market volatility from a longer-term perspective and uses an econometric model to explore the characteristics of the current period of high volatility.

The VSTOXX index is a measure of anticipated stock market volatility for the euro area (see Charts A and B, which use a long and a short data sample respectively). It is calculated on the basis of option prices and could, as a rough approximation, be interpreted as investors' expectations for the volatility of daily returns on the Dow Jones EURO STOXX 50 index over the next 30 calendar days.[3] The charts show that the VSTOXX index started to increase in late July and

1 In fact, comparable measures of realised and expected stock price volatility mirror each other closely. See the box entitled "Recent trends in implied stock market volatility" in the November 2004 issue of the Monthly Bulletin.
2 See R. E. Whaley (2000), "The investor fear gauge", Journal of Portfolio Management, pp. 12-17.
3 Like the VIX index – which is based on the Standard & Poor's 500 index in the United States – the VSTOXX index is calculated on the basis of a set of option prices rather than option-implied volatilities. The calculation can be interpreted as the approximate replication of a "variance swap rate". The square of any volatility index calculated in such a way can thus be regarded – taking into account an approximation error and a variance risk premium – as an indication of investors' expectations regarding the variance of daily stock returns over a given horizon. See P. Carr and L. Wu (2006), "A tale of two indices", Journal of Derivatives, pp. 13-29.

Chart A Stock market volatility in the euro area

(percentages per annum; daily data)


Source: STOXX.
Notes: The VSTOXX index is based on option prices. It can be interpreted as an approximation of investors' expectations for the volatility of daily returns on the Dow Jones EURO STOXX 50 index over the next 30 days.

Chart B Stock market volatility in the euro area for different horizons

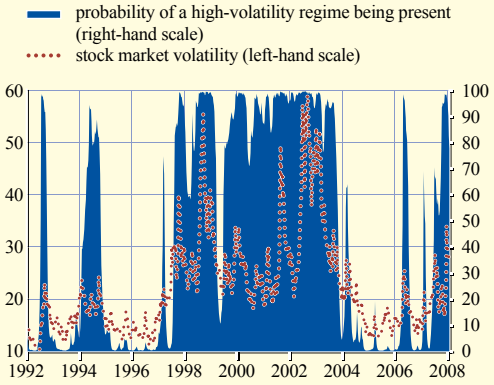
(percentages per annum; daily data)


Source: STOXX.
Note: On the basis of option prices, the VSTOXX sub-indices measure the expected annualised volatility of the Dow Jones EURO STOXX 50 index over different horizons.

peaked in mid-August at a level not seen since May 2003, while remaining well below earlier peaks in 2001 and 2002. The increasing stock market turbulence observed as of August 2007 reflected initial heightened concerns among market participants regarding the wider impact that the tensions in the US sub-prime mortgage market would have on financial conditions in global markets. Following a temporary moderation, stock market volatility spiked again in late January 2008, when investors' fears were amplified by increasing concerns regarding the outlook for economic activity, particularly in the United States, in the context of the ongoing financial turmoil.

**Chart C Implied stock market volatility and the probability of a high-volatility regime being present in the euro area stock market**

(percentages per annum; percentages)




Sources: Thomson Financial Datastream and ECB calculations.
Notes: The estimated probability of a high-volatility regime being present is based on a Markov-switching ARCH model using weekly euro area stock market data from February 1973 to February 2008. The volatility index used is the VDAX index, which reflects the expected volatility over a horizon of 30 days.

The dotted and dashed lines in Chart B denote expected volatility for the Dow Jones EURO STOXX 50 index over 12 and 24-month horizons respectively. Both series increased markedly in the course of the turmoil. Current levels indicate that investors expect stock market volatility to remain at elevated levels in the medium term.

Such expectations of a return to a higher-volatility environment of the sort that prevailed during most of the period between 1997 and 2003 appear to be consistent with the findings of an econometric model that identifies periods of high and low volatility in the euro area stock market on the basis of realised short-term stock returns.[4] Chart C displays weekly data indicating the estimated probability of being in a high-volatility state, together with the VDAX index (which reflects investors' expectations regarding the volatility of the German DAX index).[5] The model tends to distinguish clearly between the two regimes, as indicated by the fact that the probability of being in a high-volatility regime is generally either close to one or close to zero. For the full sample, starting in 1973, the model suggests that the stock market has been in a high-volatility state around 30% of the time. However, the last decade can be characterised as more turbulent, with a high-volatility regime present around two-thirds of the time. Against this background, after more than three and a half years of relatively low levels of volatility, the financial turmoil seems to have triggered a return to higher volatility in early August 2007. This notwithstanding, there was only fairly moderate empirical support for the presence of a high-volatility regime in the first few months of the turmoil, with the corresponding probability standing only slightly above 50% at that time. The likelihood of a high-volatility regime being present did not cross the 80% threshold until November 2007 and has largely remained well above that level since then. As the estimated probability of moving from a high-volatility regime to a low-volatility regime

4 The model is based on weekly returns for the Datastream total market price index for the euro area for the period from February 1973 to February 2008. It is specified as a Markov-switching ARCH model which allows for two volatility regimes and for asymmetry effects (i.e. positive and negative return shocks affect the conditional variance processes in different ways). See D. Domanski and M. Kremer (2000), "The dynamics of international asset price linkages and their effects on German stock and bond markets", Bank for International Settlements, Conference Paper No 8, pp. 134-158.

5 The VDAX index (more precisely, the VDAX-NEW index) and the VSTOXX index are conceptually identical and in practice exhibit very close comovement. While the VDAX index has been calculated backwards until January 1992, the VSTOXX index is not available before January 1999.

is relatively low, a high-volatility regime is likely to prevail for a while once that state has been reached. However, as suggested by the results for the full sample starting in 1973, the actual length of a high-volatility phase varies between shorter episodes, such as the two-month period starting in late May 2006, and more lengthy phases, with the drawn-out period starting in mid-1999 representing an extreme example. Hence, while the model suggests that the current period of high volatility is likely to persist for some time, its ultimate duration is subject to considerable uncertainty.

Finally, all else being equal, an extended period of high stock market volatility implies tighter financing conditions in the economy on account of higher equity risk premia, by comparison with the unusually low premia observed in the years preceding the financial market turmoil.[6]

6 In addition, stock market volatility is often also associated with similar developments in corporate bond spreads. See the box entitled "The recent repricing of credit risk" in the October 2007 issue of the Monthly Bulletin.