

## Box 13

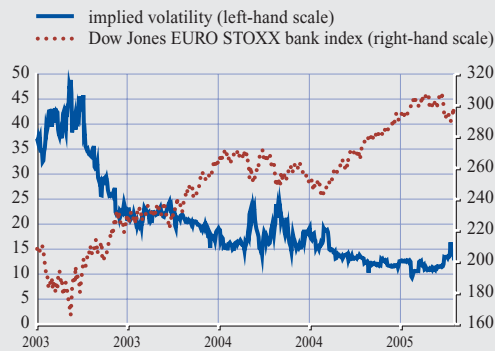
## OPTIONS-BASED INDICATORS OF FUTURE RISKS IN EURO AREA BANK STOCK PRICES

In assessing financial stability, central banks use a wide range of tools to monitor the risks of financial institutions. Timely indicators – such as expected default frequencies (EDFs) and distances to default (DDs) – can be extracted from the prices of financial assets. Bank stock prices in particular reflect market participants' views on the future earnings prospects of banks by discounting future dividends. EDFs and DDs in turn provide an assessment of the probability of banks experiencing financial distress (see Box 14). Compared to these indicators, option prices convey complementary information about the uncertainty perceived by market participants.<sup>1</sup> By incorporating the market's assessment of the expected future volatility of the asset price over the lifetime of the option, the observed prices of options provide additional information that goes beyond the expected average value contained in the stock price. This Box describes how information on uncertainty about future banking sector performance can be gauged from option prices.

Options are derivatives contracts that provide investors with the right but not the obligation to buy or sell the underlying asset at a predetermined price (the strike price) at a predetermined future date (the option's maturity date). From an option quote, it is possible to infer the

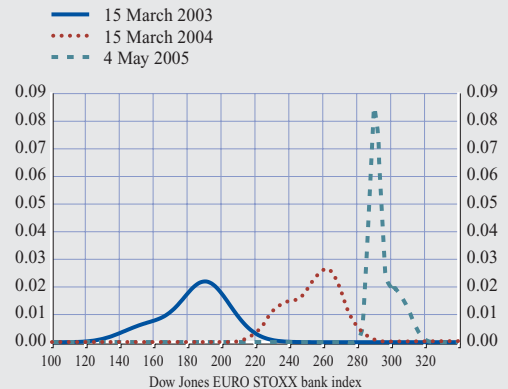
<sup>1</sup> Although EDFs and DDs are conceptually based on option theory, these indicators do not incorporate any information on traded options.

**Chart B13.1 Dow Jones EURO STOXX bank index and its implied volatility**



Source: Bloomberg.

**Chart B13.2 Risk-neutral probability density function of the future euro area bank stock index**



Sources: Bloomberg and ECB calculations.

expected volatility, or implied volatility, by inverting the Black and Scholes pricing formula.<sup>2</sup> Chart B13.1 plots the Dow Jones EURO STOXX banking sector index against its implied volatility.<sup>3</sup> After the recovery of the euro area stock markets started in March 2003, the market's perception about the future evolution of the Dow Jones EURO STOXX banking index changed significantly. Moreover, the upturn of the bank stock price index was accompanied by a continuous decline in implied volatility. A possible interpretation is that investors became less concerned about the risks of future sharp fluctuations in the index as the value of the stock index recovered.

The forward-looking perspective of risks in the euro area banking sector may also be broadened by analysing the risk-neutral probability density functions (PDFs) of the future value of the Dow Jones EURO STOXX banking index. This options-based indicator conveys information about both the future values of the stock index expected by market participants – revealed by the range of strike prices – and the probability attached to this expected value. Therefore, the PDF can concisely illustrate different scenarios priced in by financial markets.<sup>4</sup> In particular, it facilitates analysis of whether risks are viewed as symmetric or concentrated in a specific direction, i.e. towards an increase or a decrease in the stock price over the option's time to maturity. For example, less market uncertainty as captured by lower implied volatility tends to be reflected in a narrowing of the probability density distribution. A change in the market's assessment of the future directional risks of the stock price would, in turn, result in a change in skewness of the distribution function, with a higher risk of near-term gain (loss) in the stock index translating into rightward (leftward) skewness on the function. Given these

2 See F. Black and M. Scholes (1973), "The Pricing of Options and Corporate Liabilities", *Journal of Political Economy*, Vol. 81, No 3, pp. 637-54.

3 The chart plots the implied volatility of at-the-money options on the Dow Jones EURO STOXX banking index. This is the average volatility of call and put options, the strike price of which is equal to the value of the futures contract price for the first month maturity. Due to the greater liquidity of the options market for the narrower index comprising 48 banks, the broader index including 69 banks was not considered for this analysis.

4 The technique used here assumes an *a priori* shape for the PDF – a mixture of two lognormal distributions – which is sufficiently flexible to account for the distribution of the future asset prices implicit in option prices. The estimation consists in recovering the empirical PDF that produces option prices as close as possible to the observed market option prices. See W. R. Melick and C. P. Thomas (1997), "Recovering an Asset's Implied PDF from Option Prices: An application to Crude Oil during the Gulf Crisis", *Journal of Financial and Quantitative Analysis*, Vol. 32, No 1, pp. 91-115.

considerations, the PDF can be particularly valuable in identifying the risks, as perceived by market participants, of large changes in the outlook for the euro area banking sector over a given horizon.

Chart B13.2 plots PDFs for the Dow Jones EURO STOXX banking index on three dates, beginning with March 2003, when risks in the banking sector were considered to be rather high. The reduction in implied volatility throughout the sample period is reflected by a compression of the PDFs over time. The perceived direction of risks also changed over the period. In March 2003 the risk of a large decrease in the stock index was assigned a much higher probability than the risk of an increase of the same magnitude, as reflected by a relatively thicker left-hand tail of the curve. One year later, stock prices had risen and the asymmetry of risks had decreased significantly; and by May 2005 the PDF displayed a higher probability of positive variations in the stock index than of negative variations. The overall reduction in left-hand skewness, together with the compression of the PDF, suggest that participants in the options market have become increasingly confident of a benign outlook for the euro area banking sector, in line with the recovery in their share prices and improved financial results reported by many banks in 2004.

Overall, therefore, measures based on option prices to gauge risks in the banking sector can provide useful complimentary information. Recent developments in these indicators tend to suggest that, by early May 2005, the outlook for euro area banks had improved considerably when compared with March 2003. However, since the methodologies for estimating these indicators are subject to several caveats, the results should be interpreted with caution.