Box 16

ASYMMETRY AND FAT TAILS OF THE DENSITY OF THE EURO AREA INSURANCE AND BANKING STOCK INDICES

The risk-neutral density (RND) extracted from financial options prices facilitates direct insights into the entire distribution of market expectations regarding the future price of an underlying asset at a given point in time. In the monitoring of the euro area insurance and banking sector, high-frequency indicators can be useful as part of the ongoing assessment of perceived risks. This Box aims at analysing two indicators that can be extracted from options market prices and which provide information on the degree of asymmetry and the fatness of the tails of the RND. These indicators are commonly known as risk-reversals and strangles respectively in foreign exchange markets.

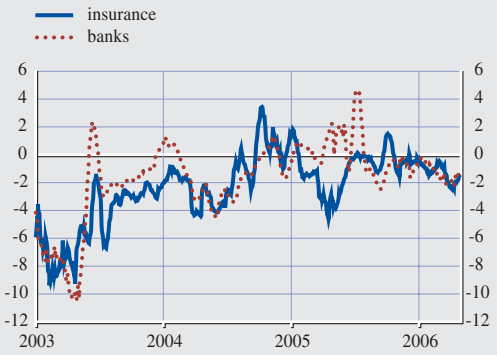
When investors perceive a downside risk for a certain stock index, then options betting on a sharp decline in the index will become more expensive than options betting on an increase in the index of the same size. The price of out-of-the-money (OTM) call options – options whose strike price is higher than the current value of the stock index – reflects information on the upper tail of the RND, the upside risk. The price of OTM put options – options whose strike price is lower than the value of the stock index – reveals information about the lower tail of the density, i.e. the downside risk. Hence, the difference in the prices of OTM calls and puts with strike prices symmetrically spaced around the mean can provide a measure of the skewness of the distribution.[1] Risk-reversal quotes measure precisely this difference in options prices, with the options values expressed in terms of implied volatility.[2] By convention, the risk-reversal is calculated as the difference between the implied volatility of an OTM call and that of an OTM put, with both options having the same so-called delta of either 10 or 25.[3] It can thus be used to ascertain whether the risk regarding future movements of an index lies on the upside or on the downside. However, it does not provide a particular prediction regarding the future direction of the stock price; it simply reflects the distribution of the future price as expected by market participants, which may prove wrong. Chart B16.1 displays a time series of this risk reversal indicator, which conveys information about both the direction and the magnitude of expected changes in the euro area insurance and banking stock indices. Negative values point to the fact that market participants assess the risk of a sharp fall of the stock indices as being more likely than a rise of the same magnitude.

It is worth noting that this interpretation of the directional views as perceived by market participants is only valid conditional on large stock index fluctuations. Indeed, for small variations when risk reversals are negative, the more likely event perceived is an increase in the stock index. Let us consider a situation where the probability of a large decline is much higher than the probability of a large increase in the stock index of the same size: there will be a fatter tail on the left hand side of the density than that on the right hand side (see Chart B16.2). For small changes in the index around the mean (vertical line with a value of 172), the more

1 Although in-the-money options could theoretically also be used to gauge the asymmetry in the density, these options are too thinly traded to reveal representative information about market expectations.
2 The options value can be expressed either in prices or in implied volatility, using the Black and Scholes (B&S) formula as a way to convert one into the other – which is different as using the B&S formula as a pricing tool.
3 The delta is a measure of the moneyness of an option. The lower the delta, the lower the probability that the option may be exercised at maturity. Options with 25 delta have been used to calculate the skewness and kurtosis indicators, given that the liquidity of these options is greater than that with 10 delta.

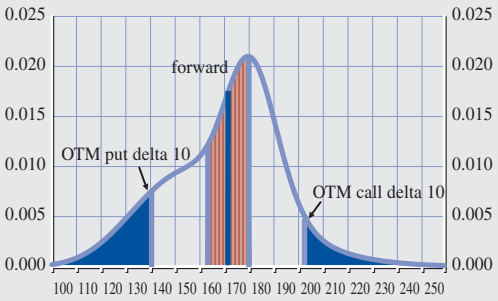
Chart B16.1 Risk reversals of the Dow Jones EURO STOXX insurance and banking stock indices (skewness indicator of the RND)

(implied volatility, %, 20-day moving average)



Sources: Bloomberg and ECB calculations.
Note: The risk-reversal indicator is calculated as the difference between the implied volatility of an OTM call with 25 delta and the implied volatility of a OTM put with 25 delta.

Chart B16.2 Negatively skewed RND: difference in probability attached to small versus large variations in underlying price

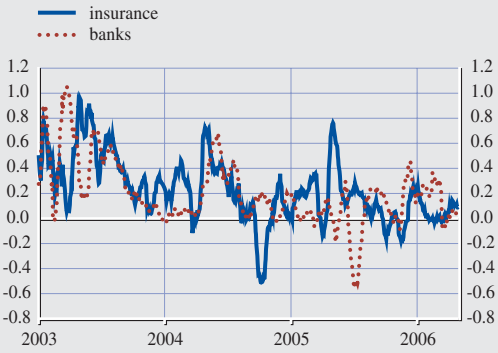


Sources: Bloomberg and ECB calculations.
Note: OTM European calls reflect conditions in the upper tail of the risk-neutral density, while OTM put reflects conditions in the lower tail.

probable scenario expected by market participants is one of a rise in the index: for a small upward variation of the index from the forward rate, the area on the right-hand side of the mean is greater than the area corresponding to a small downward change. This arises because in any negative skewed distribution with a fat tail on the left, the forward, i.e. the mean of the distribution, is always lower than the median and the mode. Conversely, if the risk reversal is positive, reflecting a perception that the probability of a large rise is greater than that of a large fall of the same size, the most probable event is a limited decline in the stock index.[4]

Chart B16.3 Strangles of the Dow Jones EURO STOXX insurance and banking stock indices (indicator of the fatness of the RND tails)

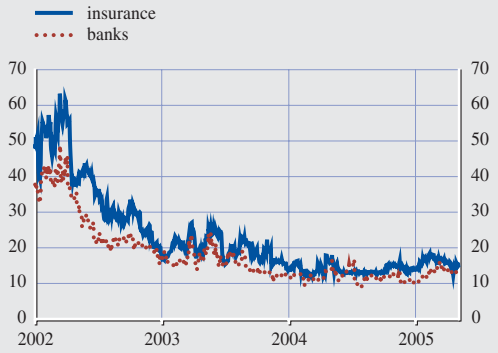
(implied volatility, %, 20-day moving average)



Sources: Bloomberg and ECB calculation.
Note: The strangle is calculated as the difference between the average implied volatility of OTM calls and puts, both with 25 delta, and the average at-the-money volatility of calls and puts, with 50 delta.

Chart B16.4 Implied volatility of the Dow Jones EURO STOXX insurance and banking stock indices

(implied volatility, %)



Source: Bloomberg.
Note: The implied volatility is calculated as the average of at-the-money calls and puts, with 50 delta.

4 As a risk reversal is measured as the difference in options prices, it reflects not only the conditional probability of the option being exercised at maturity, but also its expected payoff. Theoretically, it may happen that the probability of the call expiring in-the-money exceeds the probability of the put expiring in-the-money at maturity, although the risk reversal is negative. This is because a higher expected payoff of the put than that of the call may offset the difference in probability.

Chart B16.3 displays a time series of the kurtosis indicator that measures the thickness of the tails of the distribution. It is calculated as strangle quotes, e.g. as the difference between the average implied volatility of an OTM call and an OTM put with 25 delta, and the average volatility of an at-the-money call and put. A strangle quote would be zero for a normal distribution. A positive value indicates a more peaked density with fatter tails, which implies a higher probability of extreme variations, whether upside or downside, compared to a normal distribution. The information conveyed therefore differs from that in implied volatility of at-the-money options, which pertains to the expected variability of asset prices.

The expected variability of the insurance and banking stock index appears to be driven by some common systematic factors, as the two series have more or less moved in parallel since early 2003 (see Chart B16.4). The higher implied volatility for insurance equities would tend to suggest that market participants consider the insurance sector as being somewhat riskier than the banking sector. The skewness and kurtosis indicators for the two sectors also seem to have been driven by some common factors until September 2004. Since then, idiosyncratic factors seem to have been more relevant in accounting for the rather different short-term dynamics of the two industries.