Box 12

MEASURING THE INTEREST RATE RISK OF EURO AREA BANKS USING AN ASSET PRICING MODEL

Banks are exposed to interest rate risk through a number of channels, some of which are offsetting. For instance, an increase in interest rates can have a direct and positive effect on banks' expected net interest income whereas it can adversely affect the value of their fixed income holdings. In addition, by influencing the broad economic environment, changes in interest rates can also have indirect effects on banks. On one hand, higher interest rates can have a negative impact on banks' credit quality and non-interest income. On the other hand, higher rates can also signal expectations of an economic upswing with positive future implications for the banking sector. This Box assesses changes in the interest rate risk of a selection of euro area banks by means of a method which makes use of the fact that banks' equity prices contain information about their long-term outlook for profitability.

The standard Capital Asset Pricing Model (CAPM) model – a model which facilitates the decomposition of stock returns according to different risk factors – can be augmented with interest rate variables.[1] Although this approach is not a substitute for position or duration analysis (which allow for higher precision in the estimation of direct interest rate risks faced by banks) earlier studies using the CAPM approach have found that overall banks' stock returns tend to be negatively related to changes in interest rates. This suggests that higher interest rates have a predominantly unfavourable effect on the expected future profitability of banks. However, some analyses suggest that this relationship could be time-varying; in particular, there are indications that banks' interest rate sensitivity could have declined after the mid-1990s.[2]

For the current analysis, an aggregated measure of interest rate risk was constructed by applying a simple empirical model based on these insights to the weekly stock returns of a panel of 40 large banks located in the euro area.[3] The standard estimation method adopted in the literature consists of two steps. The first step is to generate a measure of unanticipated interest rate changes.[4] Since market interest rates and stock market returns tend to be correlated (multicollinearity), the second step is to estimate this correlation. Following this, a decomposition can be achieved which separates the total sensitivity of banks' stock returns to unexpected changes in interest rates that are due to direct effects (the direct relationship between the bank's stock return and interest rate variables) from changes caused by indirect effects (i.e. those that come through the market index return, which is a proxy for the broad economic environment).

1 For one of the first descriptions of this framework, see W. F. Sharpe (1964), "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance,* Vol. 19, No 3, pp. 425-42.

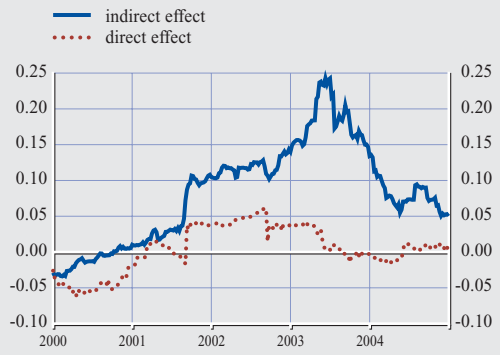
2 Among others, see M. J. Flannery and C. M. James (1984), "Market Evidence on the Effective Maturity of Bank Assets and Liabilities", *Journal of Money, Credit and Banking,* Vol. 16. No 4, pp. 435-45; E. Dinenis and S. K. Staikouras (1998), "Interest Rate Changes and Common Stock Returns of Financial Institutions: Evidence from the UK", *European Journal of Finance,* Vol. 4, No 2, pp. 113-27. The time variance of the relationship has been analysed for instance by W. Bessler and H. Opfer (2004), "Multi-Factor-Asset Pricing Models for German Stocks: An Empirical Analysis of Time Varying Parameters", Center for Finance and Banking, Justus-Liebig-University, Giessen.

3 The following equation was estimated: $R_b - r_f = \beta_0 + \beta_m * R_m + \beta_i * \Delta(I) + \eta$, where R_b = weekly banks' stock returns, r_f = the short term money market rate, R_m = weekly return of Dow Jones EURO STOXX 500 and $\Delta(I)$ = the weekly change of the interest rate variable.

4 While there are many ways to do this, the standard approach in the literature is to base interest rate expectations on a simple auto-regression model, which is the approach taken here.

Chart B12.1 52 week rolling coefficients measuring sensitivity of banks' stock returns to one-year yields

(%)



Source: ECB calculations.

The term spread (for measuring changes in the market yield curve slope), the one-year zero coupon yield (for measuring shifts in the yield curve) as well as ten-year zero coupon yields were all individually considered as the interest rate variable in the estimations. As an example, Chart B12.1 shows estimates, computed on a rolling 52 week basis, of the direct and indirect sensitivity of equally-weighted aggregate bank stock returns to changes in one-year (euro) zero coupon yields.

Table B12.1 shows the estimation results for a sequence of short samples (one year) together with findings for the whole sample period (January 1999 to December 2004). The coefficients represent the sensitivity of weekly returns to a 1 percentage point increase in the three different interest rate variables.

The estimated coefficients reveal that the indirect effect, measured by the product of the market beta – the correlation between the return of the market index and the return of the bank index – and the market return sensitivity on interest rate changes, is dominant in explaining euro area banks' stock returns. One possible explanation for this finding is that the proportion of banks' net income that is sensitive to economic cycles (e.g. non-interest income) has increased over the sample period. Indeed, in the sample considered here, those banks with a higher share of non-interest income in total income exhibited higher indirect coefficients. The signs of the indirect coefficients are positive for most of the estimation period, suggesting that higher interest rates were interpreted positively for future banking sector profitablity.

Apart from some of the sub-periods, the coefficients measuring the impact of direct effects of interest rate changes remained close to zero.[5] There are at least two potential explanations for why the direct effects appear negligible. First, this could have reflected a growing use of interest rate derivatives designed to limit banks' exposures to interest rate risk. Second, due to low earnings from maturity transformation (resulting from narrow spreads between long-term

5 This low level of sensitivity to direct effects could also lend some support to previous studies that have analysed the degree of time variation.

Table B12.1 Direct and indirect sensitivity of banks' stock returns on interest rates for different samples

(%)

sample period	Δ (10y-1y)		Δ (1y)		Δ (10y)	
	direct	indirect	direct	indirect	direct	indirect
Jan. 1999 - Dec. 2004	-0.024	-0.008	0.018	0.075	-0.009	0.055
Jan. 1999 - Dec. 1999	-0.007	-0.044	-0.024	-0.031	-0.014	-0.035
Jan. 2000 - Dec. 2000	0.024	-0.007	-0.022	0.005	0.007	0.003
Jan. 2001 - Dec. 2001	-0.061	-0.061	0.037	0.108	-0.048	0.071
Jan. 2002 - Dec. 2002	-0.035	0.063	0.036	0.143	0.001	0.205
Jan. 2003 - Dec. 2003	-0.013	0.138	-0.003	0.147	-0.010	0.122
Jan. 2004 - Dec. 2004	-0.016	0.033	0.006	0.052	-0.004	0.048

Source: ECB calculations.

and short-term interest rates), banks may have attempted to minimise maturity mismatches in their banking books.

Overall, considering the period between 1999 and 2004, interest rates seem to have played an important, albeit time-varying, role in explaining banks' stock returns. While the direct effects were moderate, the coefficients for the indirect effects tend to be more important, highlighting the sensitivity of banks' expected income to the general economic outlook. The relatively low level of direct sensitivity of banks' stock returns to changes in interest rates may have reflected improvements in the ability of banks to mitigate their open positions by using off-balance sheet instruments or on-balance sheet hedging (via demand deposits). Looking ahead, should the share of demand deposits in banks' funding decline further, banks' direct exposures to interest rate risk may increase; this would provide additional incentives for the use of derivatives.