# The Exposure of Swiss Banks to Macroeconomic Shocks – an Empirical Investigation

Hansjörg Lehmann and Michael Manz

Swiss National Bank Working Papers
2006-4
SCHWEIZERISCHE NATIONALBANK
BANQUE NATIONALE SUISSE
BANCA NAZIONALE SVIZZERA
BANCA NAZIUNALA SVIZRA
SWISS NATIONAL BANK

ISSN 1660-7716

# The Exposure of Swiss Banks to Macroeconomic Shocks - an Empirical Investigation

Hansjörg Lehmann and Michael Manz*

Swiss National Bank

October 2004

Revised Version: April 2006

**Abstract**

Assessing financial stability is an issue of rapidly growing importance to central banks and banking authorities. This paper explores an extensive panel data set of Swiss banks to identify macroeconomic influencing factors on bank profitability and to quantify their impact on bank capitalization. We find evidence of a significant effect of various macroeconomic variables as e.g. real growth or interest rate shocks on bank earnings. However, our results suggest that the Swiss banking system is quite robust against macroeconomic shocks. Only a joint occurrence of a recession, rising interest rates and falling stock prices would lead to substantial losses in the Swiss banking industry.

*Keywords:* banking, macroeconomic shocks, stress tests, credit risk, interest rate risk, Switzerland

*JEL-Classifications:* G21, E44, C33

---

*E-mail: hansjoerg.lehmann@snb.ch and michael.manz@snb.ch. Without implicating, we thank Bertrand Rime, Robert Bichsel and an anonymous referee for their helpful comments. The opinions expressed herein are those of the authors and need not necessarily reflect the views of the Swiss National Bank.

# 1 Introduction

The real economy and the financial sector are closely interrelated. On the one hand, financial stability, which encompasses a stable banking system, plays a pivotal role in ensuring an efficient allocation of funds and in fostering economic growth. On the other hand, the macroeconomic environment affects the stability of the banking sector. In this paper, our focus is on the latter relation. The aim of our study is (i) to identify macroeconomic factors which affect the profitability of the banking sector; (ii) to quantify the impact of those macroeconomic variables; and (iii) to simulate the present and future profitability of banks on the basis of these variables. We hence provide an additional instrument to assess the resilience of the Swiss banking system.

Assessing the impact of the macroeconomic environment on the banking system has become an increasingly important issue on the research agenda, in particular within central banks. Macroeconomic stress tests have also been included in the International Monetary Fund's Financial Sector Assessment Program (FSAP).[1] Good surveys on financial stress testing are provided by Sorge (2004) and also by Jones, Hilbers and Slack (2004). Stress tests can be divided into two major categories: In a bottom up approach, banks themselves carry out individual stress tests for given scenarios and report them to regulators or central banks for aggregation. By contrast, in a top down approach the analysis is carried out at a centralized level and relies on data available to regulators or central banks.

In this paper, we adopt the latter approach. To analyze the influence of macroeconomic events on bank profitability, we run panel regressions of various bank earning components on a host of selected macroeconomic variables and some individual bank characteristics as control variables. We focus on three major components of bank earnings: the net income from the interest-differential business, provisions and write-offs, and earnings from the trading and commission business. Our data set includes individual bank data covering the entire Swiss banking sector between 1987

[1] See Blaschke et al. (2001) for a detailed discussion of FSAP issues.

and 2004. In a second step, drawing on the results of the regression analysis, we estimate the impact of different economic scenarios on bank profits. Our findings suggest that there is a statistically significant effect of various economic variables on bank profitability. This impact, however, is rather modest in economic terms.

Our contribution is closely related to the literature on macroeconomic stress tests in other countries. Most existing studies restrict attention to credit risk and loan losses, which can be assessed in different ways. One approach, taken e.g. by Virolainen (2004) and Boss (2002), is to postulate corporate defaults as a function of macroeconomic influencing factors, modelled as a probit or logit process. Alternatively, Drehmann (2005) uses equity data and a Merton model to derive default probabilities of firms. Based on predicted corporate sector default rates, this approach typically proceeds to assess the impact of selected scenarios on bank credit portfolios. Unfortunately, it is not straightforward to link corporate sector default rates to individual bank credit portfolios, in particular if detailed data on individual bank credit portfolios are lacking. Therefore, a second approach, which we follow in this paper, is to estimate the impact of macroeconomic events on banks directly. A number of studies explore loan loss provisions, non-performing loans or profitability measures as a function of macroeconomic variables. Examples in an aggregate time series context include Hoggarth, Sorensen and Zicchino (2005), Kalirai and Scheicher (2002) and Delgado and Saurina (2004). There exist also a few panel studies for individual countries as e.g. Salas and Saurina (2002), Pesola (2001) and Pain (2003). In a related paper, Elsinger, Lehar and Summer (2002) explore the role of mutual credit exposures in the Austrian banking system, which may reinforce the impact of an initial shock. The authors conclude that interbank linkages play a minor role. Likewise, Müller (2006) finds that second round effects due to interbank credit exposures are relatively unlikely in the Swiss banking system. In the present paper, we do not further investigate this issue.

The approach taken in this paper is perhaps most closely related to the panel study of Pain (2003), though we use a much larger data set which includes large in-

ternational banks, but also many regional, private and other banks. A key advantage of using individual bank data is the possibility to control for individual bank characteristics affecting profitability. For example, as an innovation to previous studies, we introduce a variable to detect and to control for profit smoothing behaviour on the level of individual banks. Also, we take into consideration the varying exposure across banks to different shocks, e.g. by including interaction terms between macroeconomic variables and bank characteristics or bank group dummies. In addition, unlike the contributions mentioned above, we consider not only credit risk but also interest rate and market risks. With regard to Switzerland, our paper provides the first comprehensive attempt to assess the impact of macroeconomic shocks on bank earnings.

The paper is structured as follows. Section 2 contains the results from the regression analysis for various bank income components. Based on these results, we proceed in Section 3 to simulate the banking sector's profitability for some selected macroeconomic scenarios. Section 4 concludes.

# 2 Regression Results

## 2.1 Data and Methodology

Our data set consists of individual bank accounting data from the year-end banking statistics collected by the Swiss National Bank, which cover all banks located in Switzerland from 1987 to 2004. Since there are no quarterly data available on the profit and loss account for most banks, we use annual data. After removing some outliers, our unbalanced panel contains 5250 observations. The maximal (average) number of periods is 18 (15) years. The average number of banks in the sample is 350. The sample can be divided into the four groups of big banks, cantonal and regional banks, private banks and foreign banks. An overview on the various sources of bank earnings is provided in Table 1. While the focus of cantonal and regional banks is on retail banking and thus on net interest income, the big banks

are universal banks. The remaining groups of private and foreign banks are rather heterogeneous and mainly active in private and investment banking. Table 1 also shows that net interest income, commission and trading income, and provisions are indeed the most relevant parts of bank earnings except for administrative expenses. Our data also include a number of macroeconomic variables that range from 1987 to 2004, covering roughly two entire business cycles in Switzerland.

TABLE 1: EARNINGS AND PROFITS OF SWISS BANKS, 1987-2004*

| | Regional and Cantonal Banks | Large Banks | Private Banks | Foreign Banks |
|---|---|---|---|---|
| Net interest income | 32.2 | 2515.4 | 10.2 | 14.4 |
| Commission income | 7.4 | 2250.5 | 38.8 | 24.2 |
| Net trading income | 2.2 | 974.2 | 9.3 | 5.3 |
| Other ordinary income | 3.3 | 652.5 | 3.0 | 4.1 |
| Administrative expenses | -23.3 | - 3618.8 | -34.0 | -26.6 |
| Provisions and write-offs | -12.5 | -1275.1 | -6.5 | -8.8 |
| Net extraordinary income | 2.2 | 100.8 | -1.2 | 0.3 |
| Taxes | -1.2 | - 225.9 | - 6.0 | -2.8 |
| Annual profit | 6.0 | 1172.1 | 15.9 | 9.5 |

* Income components per bank in million Swiss francs, average from 1987 - 2004.

Turning to methodological issues, we estimate panel regressions of the most important bank earning components on a set of macroeconomic variables and individual bank characteristics. As already mentioned above, the cross-sectional component allows to control for individual bank and bank group characteristics that also affect profits and to capture varying exposures to different shocks across banks. While our choice of explanatory variables is guided by economic priors, we estimate a reduced form rather than a structural model.

Though in our sample the number of banks exceeds by large the number of years, the time dimension is of particular interest because our focus is mainly on the impact

of macroeconomic variables over time. As has to be expected in this context, tests for serial correlation in the error terms of a linear panel-data model as proposed by Wooldridge (2002) indicate that autocorrelation is a serious issue in almost all of our regressions considered below. In the following, we therefore consider two different approaches to deal with time dependence.

On the one hand, we posit a panel model with first order serial correlation in the error terms, i.e.

$$y_{it} = \mathbf{x}_t'\boldsymbol{\beta} + \mathbf{z}_{it}'\boldsymbol{\gamma} + u_i + \varepsilon_{it}, \tag{1}$$

where

$$\varepsilon_{it} = \rho\varepsilon_{i,t-1} + v_{it}, \tag{2}$$

and $i = 1..N$, $t = 1..T_i$ and $|\rho| < 1$. In the above specification, $\mathbf{x}_t' = (x_{1t}, ..., x_{pt})$ is a vector of exogenous covariates which depend only on time, $\mathbf{z}_{it}' = (z_{1it}, ..., z_{qit})$ is a vector of exogenous covariates that vary both across banks and over time, $u_i$ is a bank-specific and time-invariant intercept, and $v_{it}$ is an independently and identically distributed error term with $E(v_{it}) = 0$, $E(v_{it}^2) = \sigma_v^2$ and $E(v_{it}v_{is}) = 0$ for all $t \neq s$. To estimate the above model, we apply the (feasible) Generalized Least Squares estimator for unbalanced panels with AR(1) disturbances developed by Baltagi and Wu (1999), where $u_i$ is treated as a fixed effect.

On the other hand, we also estimate a model with a lagged endogenous variable,

$$y_{it} = y_{i,t-1}\phi + \mathbf{x}_t'\boldsymbol{\beta} + \mathbf{z}_{it}'\boldsymbol{\gamma} + u_i + \varepsilon_{it}, \tag{3}$$

where $\mathbf{x}_t$ and $\mathbf{z}_{it}$ are again vectors of covariates, which, depending on the context, we assume to be either strictly exogenous or predetermined. Furthermore, we assume $|\phi| < 1$, $E(\varepsilon_{it}) = E(\varepsilon_{it}\varepsilon_{is}) = 0$ for all $s \neq t$ and $E(\varepsilon_{it}^2) = \sigma_\varepsilon^2$. Due to the correlation between the endogenous variable and the error term $(u_i + \varepsilon_{it})$, usual OLS estimation procedures are no longer consistent in the presence of a lagged endogenous variable. Therefore, we apply the general method of moments estimator proposed by Arellano and Bond (1991), which exploits the moment conditions

$$E[(\Delta y_{it} - \phi\Delta y_{i,t-1} - \Delta\mathbf{x}_t'\boldsymbol{\beta} - \Delta\mathbf{z}_{it}'\boldsymbol{\gamma})y_{i,t-j}] = 0 \quad j = 2, ..., t-1; \quad t = 3, ..., T \tag{4}$$

taking lags of the dependent variables as instruments to estimate the model in first differences. In addition, if $\mathbf{x}_t$ (or $\mathbf{z}_{it}$) is strictly exogenous, additional moment conditions $E[\Delta\varepsilon_{it}\mathbf{x}_s] = 0$ (or $E[\Delta\varepsilon_{it}\mathbf{z}_{is}] = 0$) become available for $t = 3, ..., T$ and $s = 1, ..., T$, and the whole time series $\mathbf{x}$ (or $\mathbf{z}_i$) are valid instrumental variables in the first differenced equation. The results presented in the following sections are based on the one-step estimator which is recommended for inference by Arellano and Bond (1991). For condition (4) to hold and thus for consistency of the GMM estimator, it is crucial that there is no serial correlation in the error terms, which implies that there is no second order autocorrelation in the first-differenced error terms. In the subsequent regression output, we therefore also present the Arellano-Bond test for second order serial correlation in the first differenced residuals. We cannot reject the null hypothesis that there is no autocorrelation for any of the regressions considered. Thus the inclusion of one lag of the dependent variable is sufficient to eliminate serial correlation.

The two estimation approaches differ substantially. Since the GLS estimator with serially correlated residuals treats autocorrelation as a nuisance that needs to be controlled for, while the lagged variable approach deals with the dynamics up front, we refer to equation (1) as the *static model* and to equation (3) as the *dynamic model*. Since we are not estimating a structural model, there is no obvious reason for why either setting should necessarily be preferred. In the subsequent sections, we present estimation results for both specifications.

## 2.2 Interest-Differential Business

The traditional interest-differential business of banks, which relies on their ability to earn higher interest rates on their assets than they have to pay on their liabilities, is likely to depend on the evolution of interest rates. Under the classical assumption that banks issue short term liabilities (e.g. demand deposits) to finance long term assets (e.g. loans), rising short term interest tend to reduce the net interest margin, since such an increase is typically accompanied by a less than proportional increase

in long term interest rates. This reflects interest rate risk inherent in the banking book. Indeed, most existing studies based on stock market data as e.g. Fraser et al. (2002) find a negative relation between bank stock returns and changes in interest rates. Historically, interest rate risk played an essential role in the secondary banking crises in the United Kingdom in the 1970s and in the US savings and loan crisis in the 1980s.[2] However, more recent studies on the interest rate margin as e.g. English (2002) are less conclusive about the impact of rising interest rates.

To investigate the impact of interest rate changes on the interest margin, we regress net interest income divided by the total of outstanding loans ($im_{it}$) on the change in the 3 month interest rate ($\Delta ir_t$), the spread between 10 year and 3 month interest rates ($spread_t$) and some controls. Among the bank specific variables we looked at, only the ratio of savings deposits to assets ($sav_{it}$) turned out to be relevant. Moreover, we allowed different bank groups to react differently to interest rate changes.

The regression output for both models specified in (1) and (3) is presented in Table 2. Since $\Delta \text{ir}_t$ and $\text{spread}_t$ both measure to some extent the impact of the interest rate structure on the interest margin, it is not surprising that they are not jointly significant. The coefficient of the interest rate turns out to be negative and statistically significant at a 95% confidence level in the static model, whereas it is not significant in the dynamic specification. On the other hand, the sign of the spread is positive and significant in the dynamic specification, but not significant in the static model. Unlike in the following analysis of provisions and trading income, the static and dynamic model imply somewhat different results, which suggests that there is no particularly robust relation between interest rates and interest margin.

Furthermore, in the static specification, the groups of private and foreign banks showed a stronger negative reaction on short term interest rate changes, and in both specifications, net interest income of private and foreign banks reacts more negatively to a higher term spread than other banks. The remaining bank groups

[2] See e.g. Remolona et al. (1990) and Hester (2002), respectively, for a discussion of these cases.

showed no evidence of significantly different factor loadings, and hence those bank group dummies are omitted from the regressions. Moreover, a higher ratio of savings to assets seems to increase net interest income, but this effect is significant only in the static setup.

TABLE 2: REGRESSION RESULTS FOR INTEREST RATE MARGIN

| dependent var.: $im_{it}$ | STATIC MODEL | | DYNAMIC MODEL | |
|---|---|---|---|---|
| | Coefficients | P-values | Coefficients | P-values |
| $\text{im}_{it-1}$ | - | - | +0.4404 | 0.001 |
| $\Delta\text{ir}_t$ | -0.0004 | 0.047 | -0.0001 | 0.996 |
| $\text{spread}_t$ | -0.0006 | 0.068 | +0.0021 | 0.027 |
| $\text{sav}_{it}$ | +0.0190 | 0.018 | +0.0317 | 0.208 |
| private*$\Delta\text{ir}_t$ | -0.0013 | 0.000 | -0.0021 | 0.376 |
| foreign*$\Delta\text{ir}_t$ | -0.0026 | 0.000 | -0.0013 | 0.312 |
| private*$\text{spread}_t$ | -0.0082 | 0.000 | -0.0181 | 0.000 |
| foreign*$\text{spread}_t$ | -0.0039 | 0.000 | -0.0100 | 0.001 |
| cons | +0.0334 | 0.000 | -0.0017 | 0.000 |
| number of obs (number of id) | 3690 (258) | | 3711 (258) | |
| Wald test of joint coeff: Prob > F | 0.0000 | | - | |
| Arellano-Bond test of AR(2) (H0: no autocorrelation): Prob > z | - | | 0.9558 | |

Note: The static model involves feasible GLS estimation of a model as specified in equations (1) and (2), while the dynamic model refers to the Arellano-Bond GMM estimation of the model in (3), where variables in $\mathbf{x}_t$ and $\mathbf{z}_{it}$ are assumed to be exogenous. A complete list of the variables used in the regressions is found in the appendix.

In economic terms, the impact of an interest rate change is rather small. Table 3 illustrates the effect of an interest rate increase by 100 basis points on net interest earnings, measured in percent of current bank profits. The figures reported represent weighted averages per bank group.[3] The results clearly suggest that the effect of an

[3]The estimates are based on the significant coefficient from the static model. For simplicity, we

increase in interest rates on the interest-differential business is of a minor magnitude. For example, a 100 basis point interest rate increase lowers net interest income and thereby profits of an average bank by 3.5% of current profits. The group of large international banks is even less sensitive to direct interest rate risk, because profits of those banks depend less heavily on the interest rate differential business.

TABLE 3: MARGINAL EFFECTS ON NET INTEREST INCOME IN % OF PROFITS*

| | all banks | cantonal and regional banks | big banks | private banks | foreign banks |
|---|---|---|---|---|---|
| $\Delta$ir: +100bp | -3.5% | -6.4% | -1.9% | -5.1% | -6.3% |

*Weighted average per bank group, where the weight of the impact on bank $i$ is given by its share of profits within the relevant group.

In light of the fact that recent studies provide rather mixed results on the impact of interest rate changes on net interest income, our modest results are not particularly surprising.[4] They imply that the maturity mismatch between assets and liabilities matters less than traditionally suggested, which may also reflect the increasing use of interest rate swaps and other instruments to hedge interest rate risk. Hence, direct interest rate risk does not seem to be a major threat for the Swiss banking industry. Still, this conclusion need not necessarily hold for *indirect interest rate risk* showing up in the amount of loan loss provisions, to which we now turn.

## 2.3 Provisions

Credit risk is considered to be a key contributor to fluctuations in bank earnings which is likely to depend on the macroeconomic environment. Due to data limitations, we rely on provisions showing up in the banks' income statements as a proxy

only present the marginal effects from the static model in the following tables.

[4]English (2002) finds that in 5 out of 10 countries considered, there is no statistically significant reaction of net interest income to interest rate changes.

for realized loan losses. Even though it is known that provisions and accounting data in general tend to be smoothed, in our view provisions are the best proxy currently available in Switzerland to assess loan losses for a substantial number of both banks and years.

In the following regressions, we normalize and detrend new provisions by dividing them by the total of outstanding loans at the end of year $t$. We then use the logit transformed provision ratio ($prov_{it}$) as a dependent variable.[5] The set of explanatory variables includes GDP growth ($\Delta gdp_t$), the unemployment rate ($ur_t$), the level of the 3 month interest rate ($ir_t$), and the spread of corporate over government bond yields ($bondspread_t$). It seems natural to expect that lower economic growth, higher unemployment, higher interest rates and higher corporate bond spreads contribute to higher provisions. Again, we include interaction terms between bank group dummies and macroeconomic variables where these proved to be relevant. In addition, the share of highly ranked mortgage loans ($rank_{it}$) serves as bank variable to control for risk taking behavior. In Switzerland, mortgage loans with a high rank are low loan-to-value (LTV) loans and are thus more secure. One should therefore expect that a higher share of well ranked mortgage loans reduces provisions and write-offs. Finally, an important issue is that bank managers may prefer to report higher provisions in good times and lower provisions in bad times, and accounting rules to some extent allow them to do so. However, our panel approach allows to control for a such "anti-cyclical" pattern in provision ratios. In particular, we do so by incorporating profits before provisions and write-offs ($pbpt_{it}$) into the regression. If provisions are used as a means to smooth profits, we expect a positive sign on this variable.

[5] The logit transformation logit(x)=ln(x/(1-x)), which maps the provision ratio on the real line, implies a non-linear relationship. Since we deal with provision ratios far below 0.5, the marginal impact of a deterioration in any explanatory variable is stronger the worse this variable is, i.e. the higher provisions are. This seems quite plausible and improves the fit of the regressions in most cases considered.

TABLE 4: REGRESSION RESULTS FOR PROVISIONS

| dependent var.: $prov_{it}$ | STATIC MODEL | | DYNAMIC MODEL | |
|---|---|---|---|---|
| | Coefficients | P-values | Coefficients | P-values |
| $\text{prov}_{it-1}$ | - | - | +0.210 | 0.000 |
| $\Delta\text{gdp}_t$ | -0.0318 | 0.000 | -0.0291 | 0.013 |
| $\text{ir}_t$ | +0.0779 | 0.000 | +0.0612 | 0.000 |
| $\text{bondspread}_t$ | +0.4051 | 0.000 | +0.3703 | 0.000 |
| $\text{ur}_t$ | +0.0627 | 0.000 | +0.0534 | 0.004 |
| $\text{pbpt}_{it}$ | +10.608 | 0.000 | +10.327 | 0.005 |
| $\text{rank}_{it}$ | -0.1602 | 0.021 | -0.7967 | 0.064 |
| foreign*$\text{ir}_t$ | +0.0301 | 0.015 | +0.0892 | 0.034 |
| foreign*$\text{bondspread}_t$ | -0.4447 | 0.000 | -0.5461 | 0.025 |
| cons | -5.2631 | 0.000 | -0.0139 | 0.104 |
| number of obs (number of id) | 4435 (288) | | 4191 (288) | |
| Wald test of joint coeff: Prob > F | 0.0000 | | - | |
| Arellano-Bond test of AR(2) (H0: no autocorrelation): Prob > z | - | | 0.3127 | |

Note: The static model involves feasible GLS estimation of a model as specified in equations (1) and (2), while the dynamic model refers to the Arellano-Bond GMM estimation of the model in (3), where variables in $\mathbf{x}_t$ and $\mathbf{z}_{it}$ are assumed to be exogenous. A complete list of the variables used in the regressions is found in the appendix.

Both the static and dynamic estimation results can be found in Table 4. The coefficients on economic growth, the unemployment rate, the interest rate and the corporate bond spread have the expected sign: a lower economic growth, higher unemployment, higher interest rates and higher corporate bond spreads tend to increase provisions. In addition, the coefficients are statistically highly significant and of a similar size in both the static and the dynamic specification. Looking at the differences between bank groups, only the group of foreign banks shows a statistically different reaction to some macroeconomic influencing factors. Other macroeconomic factors like real exchange rates, foreign GDP growth or stock price

changes did not seem to have a significant impact on the provision ratio. Likewise, including lags of various macroeconomic variables did not seem to provide significant additional explanatory power.

Interestingly, the positive and highly significant coefficient of $pbpt_{it}$ corroborates the hypothesis of a "smoothing behavior" in the provisioning process. It also suggests that we have effectively controlled for this behaviour. The share of $rank_{it}$ of well ranked mortgage loans has the expected negative coefficient, even though it is no longer statistically significant once we incorporate lagged provisions into the regression model. Finally, the highly significant and positive coefficient of lagged provisions points to a high degree of persistence in bank provisioning.

TABLE 5: MARGINAL EFFECTS ON PROFITS IN % *

| | all banks | cantonal and regional banks | big banks | private banks | foreign banks |
|---|---|---|---|---|---|
| $\Delta$gdp: -1% | -1.4% | -2.2% | -1.2% | -0.9% | -1.9% |
| ir: +100bp | -3.6% | -5.5% | -3.1% | -2.1% | -4.8% |
| bondspread: +25bp | -4.7% | -7.2% | -4.0% | -2.8% | -6.3% |
| ur: +1% | -2.9% | -4.4% | -2.4% | -1.7% | -3.8% |

*Weighted average per bank group, where the weight of the impact on bank $i$ is given by its share of total provisions within the relevant group.

Economically, the impact of the variables considered is somewhat less significant. A decline in real economic growth by one percentage point, for example, implies that profits of an average bank fall only by 1.4%. Table 5 summarizes the marginal effects of an increase in each relevant macroeconomic variable on the amount of new provisions in percent.

## 2.4 Trading and Commission Fee Income

Another source of bank profit variation is the income from trading and commissions, which consists of trading income ($trade_{it}$) and net earnings from commission fees

and services ($comm_{it}$). As can be seen from Table 1 in Section 2.1, the income from commission fees is more important than net trading income for all bank groups, but the latter is nonetheless a non-neglectable part of bank earnings. In this part of the paper, our focus is on the evolution and volatility of stock prices which are most likely to have a key impact on the trading and commission fee income. In case of net trading income, the impact of the evolution of stock prices seems rather obvious, but market conditions may also likely have an indirect impact on the commission fee income. We therefore run two separate regressions for the trading income and the commission fee income.

**a)** *Trading Income*

In the following regressions, we normalize trading income by dividing it by the trading portfolio (mainly stocks and bonds, without participations) of individual banks. The macroeconomic explanatory variables we look at are the percentage change ($\Delta spi_t$) and the volatility ($vola_t$) of the Swiss Stock Market index[6], the change of the 3 month interest rate ($\Delta ir_t$) and the change in the spread of corporate over government bond yields ($\Delta bondspread_t$).

Not surprisingly, the regression results imply that higher stock returns increase trading income of the period considered. Conversely, we find a negative impact of stock price volatility. Increases in interest rates and corporate bond spreads are expected to reduce the value of the banks bond portfolio and hence trading income, which is confirmed by the regression results. Again, the only bank group which differs substantially in its reaction is the group of foreign banks. In particular, their trading income rises more strongly with an increase in stock prices and a decrease in corporate bond spread or interest rates. Conversely, volatility seems to have a positive impact on trading income for foreign banks.

[6]Volatility is computed as the annualized unconditional standard deviation based on daily returns of the SPI index.

TABLE 6: REGRESSION RESULTS FOR TRADING INCOME

| dependent var.: $trade_{it}$ | STATIC MODEL | | DYNAMIC MODEL | |
|---|---|---|---|---|
| | Coefficients | P-values | Coefficients | P-values |
| $\text{trade}_{it-1}$ | - | - | +0.29196 | 0.004 |
| $\Delta\text{spi}_t$ | +0.00022 | 0.001 | +0.00026 | 0.050 |
| $\text{vola}_t$ | -0.00053 | 0.071 | -0.00115 | 0.007 |
| $\Delta\text{ir}_t$ | -0.00192 | 0.067 | -0.00935 | 0.044 |
| $\Delta\text{bondspread}_t$ | -0.01356 | 0.027 | -0.02766 | 0.142 |
| foreign*$\Delta\text{spi}_t$ | +0.00046 | 0.002 | +0.00103 | 0.068 |
| foreign*$\text{vola}_t$ | +0.00167 | 0.001 | +0.00011 | 0.935 |
| foreign*$\Delta\text{ir}_t$ | -0.02315 | 0.043 | -0.00928 | 0.145 |
| foreign*$\text{bondspread}_t$ | -0.00637 | 0.001 | +0.02279 | 0.637 |
| cons | +0.07457 | 0.000 | -0.00326 | 0.197 |
| number of obs (number of id) | 3675 (253) | | 3450 (253) | |
| Wald test of joint coeff: Prob > F | 0.0000 | | - | |
| Arellano-Bond test of AR(2) (H0: no autocorrelation): Prob > z | - | | 0.2240 | |

Note: The static model involves feasible GLS estimation of a model as specified in equations (1) and (2), while the dynamic model refers to the Arellano-Bond GMM estimation of the model in (3), where variables in $\mathbf{x}_t$ and $\mathbf{z}_{it}$ are assumed to be exogenous. A complete list of the variables used in the regressions is found in the appendix.

**b)** *Commission Fee Income*

In a next step, we run similar regressions for the income from commission fees and services, which we normalize by dividing it by the value of securities in custody accounts. The explanatory variables include the volatility ($vola_t$) and the percentage change of the Swiss Stock Market index ($\Delta spi_t$). The regression results are shown in Table 7.

TABLE 7: REGRESSION RESULTS FOR COMMISSION INCOME

| dependent var.: $comm_{it}$ | STATIC MODEL | | DYNAMIC MODEL | |
|---|---|---|---|---|
| | Coefficients | P-values | Coefficients | P-values |
| $\text{comm}_{it-1}$ | - | - | +0.53936 | 0.000 |
| $\Delta\text{spi}_t$ | +0.00005 | 0.000 | +0.00004 | 0.000 |
| $\text{vola}_t$ | -0.00001 | 0.820 | -0.00006 | 0.054 |
| foreign*$\Delta\text{spi}_t$ | +0.00005 | 0.001 | -0.00002 | 0.678 |
| foreign*$\text{vola}_t$ | -0.00018 | 0.001 | -0.00042 | 0.000 |
| cons | +0.01172 | 0.000 | -0.00036 | 0.022 |
| number of obs (number of id) | 3759 (282) | | 3513 (282) | |
| Wald test of joint coeff: Prob > F | 0.0000 | | - | |
| Arellano-Bond test of AR(2) (H0: no autocorrelation): Prob > z | - | | 0.2028 | |

Note: The static model involves feasible GLS estimation of a model as specified in equations (1) and (2), while the dynamic model refers to the Arellano-Bond GMM estimation of the model in (3), where variables in $x_t$ and $z_{it}$ are assumed to be exogenous. A complete list of the variables used in the regressions is found in the appendix.

Our main findings imply that stock returns have a positive and highly statistically significant impact on the profits from the commission business.[7] By contrast, the coefficient of stock volatility is not significant in the static and even negative in the dynamic specification. As in previous regressions, the sensitivity of foreign banks differs significantly from other banks. For these banks, stock price volatility has a significantly negative impact on commission fee income in both the static and the dynamic regression model. It is interesting to notice that foreign banks behave differently in almost all regressions considered. Foreign banks are special insofar as unlike other banks in the sample, they are subsidiaries of dominant parent companies

[7]According to our further analysis, the performance of foreign stock market indices, which are highly correlated with the SPI, does not provide additional explanatory power. We refrain from reporting these results.

abroad. However, we do not have an obvious explanation for the differences in their reaction to stock price changes or other shocks. Generally, foreign banks are rather heterogeneous and mainly active in private and investment banking.

The quantitative relevance of a stock market decline is illustrated in Table 8, where we add up the impact on both trading and commission fee income. The figures suggest that if the SPI drops by 10%, profits of an average bank decrease by 16.9%. Although foreign banks' profits decrease even by 30%, the impact of a moderate SPI shock seems to be far from threatening the stability of the banking system. Moreover, the effect of an increase in volatility, interest rates or corporate bond spreads on the trading and commission income is of a minor magnitude.

TABLE 8: MARGINAL EFFECTS ON PROFITS IN % *

| | all banks | cantonal and regional banks | big banks | private banks | foreign banks |
|---|---|---|---|---|---|
| $\Delta$spi: -10% | -16.9% | -10.5% | -16.4% | -4.7% | -30.0% |
| $\Delta$vola: +20% | -2.4% | -1.2% | -3.6% | -0.8% | +6.7% |
| $\Delta$bondspread: +25bp | -10.0% | -3.9% | -10.9% | -3.6% | -22.2% |
| $\Delta$ir: +100bp | -6.1% | -2.2% | -6.1% | -2.0% | -20.4% |

*Weighted average per bank group, where the weight of the impact on bank $i$ is given by its share of total trading and commission income within the relevant group.

# 3 Scenario Analysis

In this section, we consider various macroeconomic events to illustrate the quantitative conclusions from the above regression results. We assess the overall impact of a change in macroeconomic variables by adding up the impact on individual earning components as the interest rate margin, trading and commission income, and provisions.[8] In order to check the robustness of the results, we compare the estimated

[8]In order to obtain a full picture of the profit and loss account, we also run panel regressions of other operating income and administrative expenses on various macroeconomic explanatory

effects on bank profits of an interest rate increase, a GDP decrease and a SPI decline for both the static and the dynamic specification used in the previous sections (see Table 9). The resulting change in bank profits is put in relation to the current excess capital of the individual banks, which is computed as the difference between eligible and required regulatory bank capital. If excess capital decreases by more than 100%, a bank is undercapitalized from a regulatory (and probably also from a market) point of view. Moreover, note that the marginal effects in Table 9 refer to the weighted average of all Swiss banks considered, so for some individual banks the result can be considerably worse. As can be seen from Table 9, the results of the static and dynamic model are pretty similar.

TABLE 9: MARGINAL EFFECTS ON BANK PROFITS IN % OF EXCESS CAPITAL*

| | static model | dynamic model |
|---|---|---|
| $\Delta$ir: +100bp | -8% | -10% |
| $\Delta$gdp: -1% | -2% | -1% |
| $\Delta$spi: -10% | -6% | -3% |

*Weighted average per bank group, where the weight of the impact on bank $i$ is given by its share of total excess capital within the relevant group.

To simulate the banking sector's profitability under different macroeconomic circumstances, we look at the following scenarios: a sharp interest rate increase ($\Delta$ir shock), an economic downturn in Switzerland ($\Delta$gdp shock), and a severe stock market decline ($\Delta$spi shock). We assume that a contemporaneous shock to the conditioning variable (e.g. $\Delta$ir) has an impact on bank profits in that year. The size of the assumed changes in GDP, short term interest rates or the Swiss stock market index, respectively, is set to 1.645 standard deviations, which corresponds to 5th or 95th percentiles under the assumption of normality. We also take into account correlation among macroeconomic variables. Macroeconomic variables covary statically

variables. Since these regression results are of no particular interest in themselves, we refrain from presenting these results in the paper.

in the sense that they react in the same year, and these changes also affect bank profits in that year. More specifically, in the first scenario, the change in the remaining variables is set to the average of 10'000 draws from their joint distribution conditional on an adverse GDP shock of 1.645 standard deviations. Under the assumption that all innovations considered are jointly normally distributed, the distribution of remaining variables conditional on a given GDP shock is also normal. The required means, standard deviations and covariance matrices are computed from quarterly data on annual changes in macroeconomic variables from 1980 to 2004. The remaining scenarios are then computed analogously for adverse interest rate and stock price changes. We also construct a fourth scenario which combines the adverse shocks of the former three scenarios. This latter scenario, which is not in line with historically observed correlations, is of course rather unlikely, but we nonetheless include it as a worst case. In addition, we relate all scenarios to a baseline scenario which roughly corresponds to the status quo. For each scenario, Table 10 summarizes the assumptions on the changes in the three key variables (GDP, interest rates and stock prices). We then predict hypothetical bank profits for each scenario by computing bank profits as above, except that actual macroeconomic factors are replaced by the values assumed for each scenario. All bank specific characteristics are assumed to be constant, that is they are set to the values of the most recent observation. In the following, we only present results for the static model.

Before turning to discuss the results, it is important to recognize that any scenario analysis is subject to a number of limitations. On the one hand, in case of an extreme event, correlation among variables and the impact of macroeconomic shocks may deviate from the pattern we observed in the past. Since Switzerland never experienced very extreme (combinations of) adverse shocks in the period used for estimation, one might therefore argue that the model underestimates the effects of extreme scenarios. On the other hand, a scenario analysis typically assumes that banks cannot adjust their exposure before they are hit by a severe shock. If they could react quickly enough, the damage resulting from adverse events might

be smaller than suggested.

TABLE 10: MACROECONOMIC SCENARIOS

| | Basis Scenario | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|---|
| | | Interest rate increase | Recession | Stock market decline | Worst Case (1-3) |
| $\Delta$gdp | 1.7% | 3.7% | -1.2% | 1.7% | -1.2% |
| $\Delta$ir | 0 | +345bp | -40bp | 0 | +345bp |
| $\Delta$spi | +10% | +10% | +10% | -24.4% | -24.4% |

Table 11 presents the estimated impact of each scenario on bank profits in relation to their reported excess capital as of end 2004. Again, the results refer to the average effects per bank group. First of all, our results suggest that the effect of the interest rate increase scenario on bank profits is rather modest. This is mainly because the rise in interest rates comes along with a high GDP growth, which basically offsets the adverse impact of rising interest rates on the interest rate margin and on provisions. Table 11 also shows that while a recession reduces bank earnings compared to the benchmark scenario, the impact is still rather limited. By contrast, the consequences of a substantial negative SPI shock are more pronounced. It is interesting to notice that compared to the baseline scenario, the group of big banks shows the strongest reaction in all scenarios considered. However, this result is mainly explained by the fact that excess capital of big banks is considerably lower than in the other bank groups.

TABLE 11: PREDICTED BANK PROFITS IN % OF EXCESS CAPITAL*

(IN BRACKETS: DIFFERENCE TO BASELINE SCENARIO)

| Scenario | all banks | cantonal and regional banks | big banks | private banks | foreign banks |
|---|---|---|---|---|---|
| Basis scenario | 38% | 20% | 85% | 30% | 26% |
| 1. $\Delta$ir (boom) | 25% (-13%) | 12% (-8%) | 39% (-46%) | 30% (+0%) | 25% (-1%) |
| 2. Recession | 31% (-7%) | 16% (-4%) | 66% (-19%) | 27% (-3%) | 12% (-14%) |
| 3. $\Delta$spi | 17% (-21%) | 16% (-4%) | 30% (-55%) | 8% (-22%) | 12% (-14%) |
| 4. 1+2+3 | -22% (-60%) | -6% (-26%) | -73% (-158%) | -7% (-37%) | -7% (-33%) |

* Weighted average per bank group, where the weight of the impact on bank $i$ is given by its share of total excess capital within the relevant group.

Nonetheless, what may be most striking about the above findings is the relatively modest impact of the macroeconomic scenarios on average bank profits. Only in the unlikely scenario which combines a recession with a stock market decline and rising interest rates, banks suffer from a considerable loss of 22% of excess capital on average. However, when interpreting these results, one should also keep in mind that various recessions and interest rate increases in the past did in fact not trigger a major crisis in the Swiss banking system. In addition, our results are in line with empirical studies for other OECD countries.[9]

# 4 Conclusions

The findings in this paper provide evidence of statistically significant relationships between various macroeconomic variables and the profitability of the banking industry. In particular, bank earnings seem to be positively related with real economic

[9]For example, Hoggarth, Sorensen and Zicchino (2005) and Delgado and Saurina (2004) find that banking systems in the UK and Spain, respectively, are unlikely to be threatened by plausible adverse events in the macroeconomic environment.

growth and changes in stock prices, and negatively correlated with increases in interest rates. That said, the analysis also suggests that the impact of macroeconomic shocks on banks is rather modest in terms of excess capital. Put differently, the current level of excess capital suggests that the Swiss banking sector is quite resilient and well capitalized to absorb macroeconomic shocks. According to our simulations, only a joint occurrence of a recession, rising interest rates and falling stock prices would imply considerable losses in the banking industry.

While our analysis provides fairly plausible and, from a financial stability point of view, reassuring results on the resilience of the Swiss banking industry, there may be some reservations which suggest that the findings should be taken with a grain of salt. In particular, the lack of extreme observations on the macroeconomic variables considered limits the potential to reliably estimate the impact of extreme scenarios. Despite these reservations, in our view the chosen approach, using extensive panel data and addressing market and interest rate risk as well as credit risk, is a useful tool to assess the overall resilience of a banking system. It provides the first comprehensive assessment of the relation between the cyclical performance of the economy and bank profitability in Switzerland. Our conclusion that the Swiss banking industry is currently well prepared to absorb reasonable macroeconomic shocks appears to be quite robust.

# References


Arellano, M. and S. Bond 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *The Review of Economic Studies*, 58: 277-297.

Baltagi, B. H. and P. X. Wu 1999. Unequally spaced panel data regressions with AR(1) disturbances, *Econometric Theory*, 15: 814-823.

Blaschke, W., Jones, M.T., Majnoni G. and M.P. Soledad 2001. Stress Testing of Financial Systems: An Overview of Issues, Methodologies and FSAP Experience, IMF Working Paper 01/88.

Boss M. 2002. Ein makroökonomisches Kreditrisikomodell zur Durchführung von krisentests für das österreichische Kreditportfolio, Finanzmarktstabilitätsbericht 4, Oesterreichische Nationalbank.

Delgado J. and J. Saurina 2004. Credit risk and loan loss provisions: an analysis with macroeconomic variables, Working Paper, Banco de Espana.

Drehmann (2005). A Market Based Macro Stress Test for the Corporate Credit Exposures of UK Banks, Working Paper, Bank of England.

Elsinger H., A. Lehar and M. Summer 2002. A New Approach to Assessing the Risk of Interbank Loans, Financial Stability Review 3, Oesterreichische Nationalbank.

English, W.B. 2002. Interest Rate Risk and Bank Net Interest Margins, *BIS Quarterly Review*, 12/02: 67-82.

Fraser D., J. Madura and R. Weigand 2002. Sources of Bank Interest Rate Risk, *The Financial Review* (37): 351-368.

Freixas X. and J.-C. Rochet 2002. *Microeconomics of Banking*, 3rd edition, Cambridge and London: MIT Press.

Hester D. 2002. U.S. Banking in the Last Fifty Years: Growth and Adaptation, SSRI Working Paper 2002_19, University of Wisconsin - Madison.

Hoggarth, G., S. Sorensen and L. Zicchino 2005. Stress tests of UK banks using a VAR approach, Working Paper No 282, Bank of England.

Im, K., H. Pesaran and Y. Shin 2003. Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics*, 115: 53-74.

Hilbers, P., M. Jones and G. Slack 2004. Stress Testing Financial Systems: What to Do When the Governor Calls, IMF Working Paper 04/127.

Kalirai, H. and M. Scheicher 2002. Macroeconomic Stress Testing: Preliminary Evidence for Austria. Financial Stability Report 3, Österreichische Nationalbank.

Müller, J. 2006. Interbank Credit Lines as a Channel of Contagion, *Journal of Financial Services Research*, 28(3): forthcoming.

Pain D. 2003. The provisioning experience of the major UK banks: a small panel investigation, Working Paper No.177, Bank of England.

Pesola J. 2001. The role of macroeconomic shocks in banking crises, Bank of Finland Discussion Paper 6/2001.

Remolona E., R. Cantor, M. Gaske, L. Hargraves, L. Schwartz and V. Stein 1990. How safety nets work, *Central Banking*, No. 2 (Autumn 1990): 52 - 63.

Salas V. and J. Saurina 2002. Credit risks in to institutional regimes: Spanish commercial and savings banks, *Journal of Financial Services Research*, 22(3): 203-224.

Sorge M. 2004. Stress testing financial systems: an overview of current methodologies, *BIS Working papers* No. 165.

Virolainen K. 2004. Macro Stress Testing with a Macroeconomic Credit Risk Model for Finland, *Bank of Finland Discussion Papers*, 18.

Wooldridge, J. M. 2002. Econometric Analysis of Cross Section and Panel Data, Cambridge, MA: MIT Press.Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA: MIT Press.

**Swiss National Bank Working Papers published since 2004:**

2004-1 Samuel Reynard: Financial Market Participation and the Apparent Instability of Money Demand

2004-2 Urs W. Birchler and Diana Hancock: What Does the Yield on Subordinated Bank Debt Measure?

2005-1 Hasan Bakhshi, Hashmat Khan and Barbara Rudolf: The Phillips curve under state-dependent pricing

2005-2 Andreas M. Fischer: On the Inadequacy of Newswire Reports for Empirical Research on Foreign Exchange Interventions

2006-1 Andreas M. Fischer: Measuring Income Elasticity for Swiss Money Demand: What do the Cantons say about Financial Innovation?

2006-2 Charlotte Christiansen and Angelo Ranaldo: Realized Bond-Stock Correlation: Macroeconomic Announcement Effects

2006-3 Martin Brown and Christian Zehnder: Credit Reporting, Relationship Banking, and Loan Repayment

2006-4 Hansjörg Lehmann and Michael Manz: The Exposure of Swiss Banks to Macroeconomic Shocks – an Empirical Investigation

Swiss National Bank Working Papers are also available at www.snb.ch, section Publications/Research
Subscriptions or individual issues can be ordered at Swiss National Bank, Fraumünsterstrasse 8, CH-8022 Zurich, fax +41 44 631 81 14, E-mail library@snb.ch