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Stress testing banks' profitability: the case of French banks[1]

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Résumé

Cet article propose d'évaluer la sensibilité de la rentabilité bancaire aux chocs macroéconomiques sévères mais plausibles. En particulier, à partir de données de superviseur couvrant la période 1993-2009, nous testons la résistance des banques françaises. D'abord, nous identifions les déterminants macroéconomiques et financiers (croissance du PIB, courbe des taux, volatilité du marché boursier) et les déterminants individuels (total du bilan, ratio des fonds propres et revenus hors intérêts par rapport au total bilan) de la rentabilité des banques. Ensuite, dans le cadre des exercices de macro-stress tests, nous montrons que la rentabilité des banques françaises est peu affectée par les scenarios macroéconomiques adverses. Ainsi, selon notre modèle, le système bancaire français dans son ensemble resterait rentable même dans un scénario de récession sévère.

Mots-clés: rentabilité bancaire, estimation dynamique de panel, stress test

Code JEL : C23; G21; L2.

Abstract

We build a stress testing framework to evaluate the sensitivity of banks' profitability to plausible but severe adverse macroeconomic shocks. Specifically, we test the resilience of French banks using supervisory data over the period 1993-2009. First, we identify the macroeconomic and financial variables (GDP growth, interest rate maturity spread, stock market's volatility) and bank-specific variables (size, capital ratio, ratio of non interest income to assets) that significantly affect French banks' profitability. Second, our macroeconomic stress testing exercises based on a simulation of macroeconomic variables show that French banks' profitability is resilient to major adverse macroeconomic scenarios. Specifically, our findings highlight that even severe recessions would leave the French banking system profitable.

Keywords: bank profitability, dynamic panel estimation, stress test.

JEL classification: C23; G21; L2.

1. Introduction

Over the last decades, banking systems of developed countries have experienced major changes regarding their sources of revenue. The traditional interest revenue has been increasingly replaced by fees & commissions and trading incomes. According to some observers, this development could lead to a weaker resilience of banks' revenues to adverse shocks. Yet, several banking systems, among which the French one, went through the current financial crisis without any failure and their profitability remained strong in spite of a strong economic and financial downturn. As a matter of fact, the French banking system as a whole proved profitable even through 2008 and 2009.

From the supervisory point of view that aims to ensure the banking system's solvency, identifying the vulnerabilities of banks' profitability is crucial. *First*, profits prove to be a, if not the main, driver of bank capital (Gropp and Heider, 2009). Hence, any trouble regarding banks' profitability is likely to be transmitted to the solvency ratios, eventually threatening the banking system's strength. *Second*, in line with the "bank capital channel" literature (van den Heuvel, 2002), banks facing a slump in profits, together with difficulties to issue additional equity, are likely to ration credit in order to meet regulatory constraints, and finally to weigh on the economic growth. *Third*, profits are known to be reliable early-warning indicators of financial distress (Demirgüç-Kunt and Detragiache, 1999), though they are available, at best, at a, quarterly frequency. This low profitability data frequency, in addition to their backward-looking nature, makes it fundamental for regulators to identify the main determinants of profits in order to run accurate forecasts and make out vulnerabilities in a more forward-looking manner.

The early research dedicated to banks' earnings sources focuses on net interest margins (Ho and Saunders, 1981). In that respect, Allen (1988), Saunders and Schumacher (2000), and Demirgürc-Kunt and Huizinga (2000) highlight a robust relationship between interest margins and the business cycle.

Nevertheless, the growing importance of non-interest income (fees & commissions and trading incomes) progressively lessens the importance of net interest income. On average the share of

income generated by traditional interest activities has progressively fallen in the US and in Europe over the two last decades. Therefore, recent research has focused on the determinants of bank profitability accounting for both interest and non-interest activities. Alternatively, the literature on bank interest margins has considered the impact of non-interest activities on optimal loan price and margin setting (Carbo Valverde and Rodriguez Fernandez, 2007). In this paper, because we are concerned about the safety and soundness of the banking system and the ability of individual banks to generate income to prevent sharp equity changes, we focus on aggregate profit measures such as the return on equity (ROE) and the return on assets (ROA). Earlier work on bank profitability has focused on three types of determinants which are generally found as significant determinants of banks' profitability: *firm-specific* variables (the amount of capital, bank expenditures, the size of the bank proxied by its total assets, and the risk born by the financial institution) as stated by Goddard *et al.* (2004), Kosmidou *et al.* (2006), Athanasoglou *et al.* (2008), and Albertazzi and Gambacorta (2009); variables linked to the *market's structure* (the market power of the bank, the share of non-interest income), as established by Smirlock (1985), Berger (1995), Lepetit *et al.* (2008); and finally *macroeconomic and financial* variables (GDP growth, interest rate spread, inflation, stock market's return and volatility, loan growth), as established, among others, by Revell (1979), Molyneux and Thornton (1992), Demirguc-Kunt and Huizinga (2000), Beckmann (2007), Athanasoglou *et al.* (2008), and Albertazzi and Gambacorta (2009).

In order to assess the resilience of financial institutions to macroeconomic and financial shocks, we rely on the recent stress testing frameworks developed by supervisors and central banks over recent years. In contrast to the methods implemented by banks themselves, those implemented by supervisors focus on the resilience of the financial system as a whole. Jones *et al.* (2004), Sorge (2004) and Foglia (2009), among others, provide extensive literature reviews on those practices. The purpose of such methodologies is to test the capability of the financial system to survive severe but plausible scenarios. Hence, they appear as particularly relevant tools to assess the effects of adverse scenarios on banks' profitability, like our paper's objective, since they prove forward-looking and adapted to various unfavorable hypothetical scenarios.

In the present paper, we propose a framework to evaluate the resilience of banks' revenues to adverse macroeconomic shocks, and apply it to French supervisory data. For this purpose, we

first identify the main determinants of French banks' profitability – measured by their Return-on-Assets – by considering the most relevant macro and bank-specific factors used in the literature. Second, we develop an innovative stress testing framework to evaluate the resistance of French banks' Return-on-Assets to adverse macroeconomic shocks.

Our contribution to the existing literature is twofold. First, we build up an original and comprehensive (i.e. not restricted to sensitivity analysis) macro-econometric stress testing framework that allows us to test for the resilience of banking profitability in the current downturn context. Second, although Goyeau *et al.* (1998) and Goyeau *et al.* (2002) extend the model developed by Flannery (1981) to analyze the profitability of French banks their focus is on the sensitivity of bank profits to interest rate changes. To our knowledge, our paper is the first one that uses individual supervisory bank data to study the determinants of French banks' profits and their sensitivity to changes in the economic environment as a whole and therefore accounting for a large number of macro variables such as interest rates but also GDP growth, inflation, stock prices and exchange rates.

Our results show that banks' profitability significantly depends on macroeconomic and financial variables (GDP growth, interest rate spread, stock market's volatility) and bank-specific variables (size, capital ratio, ratio of non interest income to assets). However, simulating major macroeconomic shocks and looking at the magnitude of their effect on banks' profitability, we find that French banks' profitability is resilient to major adverse macroeconomic scenarios. These outcomes are likely to give quantitative grounds to the fact that, at the current juncture, one did not observe any disastrous loss among the French banking system.

The remainder of the paper is structured as follows. Section 2 discusses the data and the model we estimate as a first step to capture the determinants of bank profitability. Section 3 presents our main findings as well as robustness checks for this first stage procedure. Section 4 describes the stress testing framework and the subsequent results; section 5 concludes.

2. Data and empirical model

2.1 Data

In this paper, bank-specific variables come from the supervisory dataset BAFi consisting of a panel of individual French banks' consolidated data, on a relatively long period (1993-2009) on an annual basis. The dataset, called 'BAFi' which stands for 'Base des Agents Financiers' (Basis of financial agents), belong to the French banking supervisor ('Prudential Supervisory Authority'). Relying on such supervisory data allows us considering the whole French banking system on a consolidated basis in a comprehensive way. In particular, it turns out that the quality of data as regards non-interest and especially trading income appears much better than that of private data providers, especially at the very beginning of the sample. The panel is unbalanced, that is to say, some banks may appear or disappear from time to time, essentially because of mergers and acquisitions. Hence, we finally get an overall number of 370 different groups over the whole sample, about 170 on average each year.

2.2 Dependent variable

Our dependent variable is banks' profits. Alternative profitability measures could be considered for the purpose of this study, Return-on-Assets (ROA), defined as the ratio of the net income after taxes to total assets and Return-on-equity (ROE), defined as the ratio of the net income after taxes to total equity. Net Interest Margin, defined as the ratio of the net interest income after taxes to total assets could also be used as a proxy. However as net interest margin is solely based on interest activities, whose importance in terms of share of total income has experienced a continuous decrease over the recent years (Coffinet *et al.*, 2009) and does not constitute an aggregate measure of profitability, we do not consider it as a relevant endogenous variable for the purpose of this paper.

As regards ROE and ROA, the latter is more consistent with supervisory concerns than the former: first, it is directly related to the quality of loans, as opposed to ROE, which takes on the shareholder's perspective; second, ROA may be computed as the ratio of ROE to leverage, and thus integrates the latter explicitly, which is of special interest at the current juncture. However, there might be to some extent inconsistencies between the numerator and the denominator of the

ROA because the former is related to profits generated from all activities and the latter covers only the balance-sheet activities. Nevertheless, ROA reflects the ability of banks to generate profits from all activities related to their assets. It seems particularly relevant for banks with noteworthy intermediation activities, and especially most French banks. Hence, we focus on ROA as the key ratio for evaluating banks' profitability, consistently with our supervisory objective and following the recommendations of the International Monetary Fund (2002) and numerous studies like, for instance, Athanasoglou *et al*. (2008).

Chart 1 displays the evolution of banks' profitability during the period under consideration according to these three measures after removing outliers, defined as observations beyond the 95% percentile and below the 5% percentile.

[Chart 1: evolution of banks' profitability (1993-2009)]

From the outset, one notices that the overall French banking system's Return-on-Assets seems to move in accordance with the business cycle, with significant decreases in the years 1993-1994, 2001-2002 and 2007-2009, coincident with economic slowdowns or downturns. On the contrary, the periods from 1994 to 2000, and 2003 to 2006, corresponding to robust economic growth, exhibit an increase in the French banking system's Return-on-Assets.

Besides, chart 1 shows that ROA and ROE behave in a very similar manner over the whole sample period. The correlation between both series is very high (93%). Hence, we can infer from that figure that results obtained on the basis of ROA figures are robust to the choice of the profitability measure (ROA *vs.* ROE). On the contrary, as expected, NIM is less correlated to ROA and ROE, and behaves in an opposite manner (as shown by the negative sign of the correlation coefficients). This tends to show that the aggregate profitability of banks is, over the sample period, rather linked to non-intermediation activities than to traditional interest revenues.

Nonetheless, the French banking system is composed of institutions with different legal status, that is to say commercial banks, financial and investment firms, and mutual and cooperative banks. The sample (cf. Table 1) seems well balanced between different types of institutions with, for a total of 2896 bank-year observations, 920 for commercial banks, 1070 for mutual and

cooperative banks and 906 for financial and investment firms. The average ROA for the whole French banking system reaches 0.67%. It is homogenous across the three groups and ranges from 0.55% for commercial banks to 0.88% for financial and investment firms. Its standard deviation for financial and investment firms is more than two times higher than that of mutual and cooperative banks, indicating a higher heterogeneity in the former group than in the latter. Moreover, consistently with the empirical literature, we find that smaller banks generate higher ROA and in accordance with the too-big-to-fail hypothesis, that they are also more capitalized.

[Table 1: descriptive statistics of individual bank variables]

2.3 Independent variables

As regards the bank-specific determinants of banks' profitability, the related literature generally considers the amount of capital, the size of the bank, the risk born by the bank and the expenditures amount of the bank (Goddard et al., 2004; Kosmidou *et al.*, 2006; Athanasoglou *et al.*, 2008; Albertazzi and Gambacorta, 2009). The *amount of capital* is likely to positively impact profitability, as capital may be interpreted as the amount of own funds available to support the bank's business, and hence as a buffer against adverse developments. This relationship may be strengthened by the M&As that occurred in the late 90s. Finally, a high capital ratio may be viewed as a means for a bank to signal a high expected profitability. The *size* of the bank is a possible determinant of its profitability, as size can be considered as a proxy for capital adequacy since large banks raise capital at a lower cost. Nevertheless, the empirical evidence is mixed and sometimes points out a significantly *negative* relationship between size and profitability. An interpretation is that large banks could experiment negative effects due to bureaucratic reasons. Conversely, too-big-too-fail considerations may lead to a positive relationship. The *risk born by the bank* could act in the following way: an increase in exposure to credit risk would decrease bank's profitability. The risk proxy mostly used in the literature is the ratio of loan-loss provisions to total loans and is specific to credit risk which might not be relevant in the context of a growing share of non-interest income in total income. The relationship is in the literature generally unambiguously negative though sometimes not significant. The *expenditures* ratio of the banks (i.e. operating cost over assets) is expected to be negatively related to profitability, as improved management of those expenses may increase efficiency and raise profits. The *market*

power assumption suggests that firms with large market shares and differentiated products are able to use market power and enjoy a more secured income position. Another possible source of profitability is linked to the *source of revenues*: all other things kept equal, a higher share of revenue stemming from a more profitable business is likely to act positively on the overall profit. In that respect, the increase in non-interest income could have a positive effect on banks' profitability. Hence, in this paper, we also control for business differences.

All in all, we consider the following bank-specific variables:

- The 'capital' variable is defined, for each bank, as the ratio of equity to total assets;
- The ratio of non-interest income 'nnii' is the ratio of the sum of fees and commissions, trading income and dividends to total assets[4];
- The 'expenditures' ratio is defined as the ratio of total expenditures to total assets;
- The size of the bank variable is built as dummy variables: 'Large' for banks whose balance-sheet amount is in the upper quartile and 'Small' for those whose balance-sheet is in lower quartile;
- The 'risk' variable is the ratio of loan loss provisions to total loans;
- The 'market power' variable is the individual net operating income over the total net operating income of the banking industry.

The macroeconomic and financial determinants reflect the economic and financial environment which can also affect banks' performances. They are the same across banks and hence represent as many cross-sectional common factors. Six macroeconomic and financial variables are often considered: economic growth, inflation, interest rate spread (split or not between short-term and long-term), stock index return and volatility, and loan growth. There are several reasons why output *growth* may have a positive impact of bank profitability. First, higher growth may result in a higher loan distribution (increased demand) and indirectly higher revenues from financial markets, due to higher stock market returns. Second, with expectations of higher profits, provisions could decrease in economic upturns and hence capital may have a positive impact on profitability. Empirically, many studies find a significantly positive relationship between GDP growth and banking profitability. However, the effect of *inflation* on profitability is ambiguous

[4] Alternative measures could be the ratio of non-interest income to total income or the ratio of net non-interest income to total net operating income (DeYoung and Roland, 2001; Stiroh, 2004; Stiroh and Rumble, 2006; Lepetit *et al.*, 2008). However, these measures do not lead to robust results in the outcomes of our regressions, or make the other variables' significance less robust. Hence, we decided to rely on that 'nnii' measure, yielding very robust specifications of the model, and already used by Smith *et al.* (2003) and DeYoung and Rice (2004).

and essentially depends on whether bank's expenses grow faster than inflation i.e. whether inflation is accurately forecasted by the banks or not. A significantly positive effect of inflation of profitability is generally interpreted as a good monitoring of future inflation by banks, yielding an accurate adjustment of interest rates and thus resulting in revenues growing faster than costs. In most recent papers, the effect of inflation on profitability is found significantly positive. The effect of *interest rate spread* relies on the traditional maturity transformation activity of banks, yielding revenues essentially related to loans: banks are assumed to receive and remunerate short-term deposits and grant long-term loans, from which they receive an interest rate. Hence, a higher interest rate spread is likely to impact positively on banking profitability. This effect is to be more significant when tested on the NIM subcomponent of revenues. *Loan growth* is linked to the traditional source of revenue for the banks that is the one stemming from credit distribution. Among the different revenue sources, it is likely to impact positively not only on net interest income, but also on a part of fees related to credit. *Stock market returns* are directly linked to the revenue's subcomponent stemming from trading income. However, it often appears strongly correlated with GDP growth, which makes its study as a determinant of the overall banking profitability difficult, all the more than GDP growth is jointly considered. On the contrary, stock market volatility, which may increase banks' trading opportunities, yields higher non interest income and profitability, or increase provisions because of higher uncertainty and thus leads to smaller profits.

We use the following explanatory variables for our regressions on ROA:

- 'GDP growth' is defined as the year-on-year change in the real French GDP in volume, extracted from the OECD database. The choice of the *national* GDP growth is consistent with the choices made by Athanasoglou et al. (2008) and Albertazzi and Gambacorta (2009) among others. It assumes that, even on a consolidated database, profitability of French banks essentially depends on the French growth, irrespective of those of countries where international groups may own assets. Nevertheless, it seems reasonable, first as French GDP growth does not prove, on average, uncorrelated to that of countries where French banks might own assets, and second because the international merger and acquisitions of French banks took place only in the very recent years. Another more practical reason lies in that we can only observe the path of French GDP growth to perform stress tests and do not want to impend artificially on the effect of a recession on ROA (conservative assumption on stress tests, see section 4);

- The ‘inflation’ variable is defined as the year-on-year variation in the French consumer price index;
- The ‘yield curve’ variable is the difference between the 10-year French Treasury bond rate and the 3-month Euribor (Pibor before 1999) rate;
- The 'stock market index’s return’ (volatility) variable is measured as the year-on-year growth of the SBF250 index’ return (the annual historical volatility of the SBF250 index);
- The loan growth is the year-on-year relative change in the total credit volume in the French economy.

Chart 2 shows the developments in some of the main macroeconomic variables (GDP growth the yield curve) used in our model.

[Chart 2: evolution of GDP growth and yield curve (1993-2009)]

Table 2 provides summary information on the definition of the variables we use in this paper and outlines their expected signs. Table 3 shows some descriptive statistics of the macroeconomic variables

[Table 2: Expected signs of explanatory variables]

[Table 3: Macroeconomic and banking annual data (1993-2009)]

2.4 Model

Our objective is to identify the macroeconomic, financial and bank-specific determinant of banks’ profitability. For this purpose, as shown by Chart 2, bank profits seem to persist over time. Hence, following Berger *et al.* (2000), we allow for the existence of an autoregressive component of ROA. More specifically, we consider a dynamic model specification including a lagged endogenous variable, to account for persistence. The model is written, for each date *t*, as:

$$\pi_{i,t} = c + \phi_1 \pi_{i,t-1} + \sum_j \beta^j X_t^j + \sum_k \theta^k Z_{i,t}^k + \varepsilon_{i,t} \qquad (1)$$

where π is ROA and c a constant, i indicates the i-th bank of the sample, X^j indicates the j-th macroeconomic variable which is common to all banks, Z^k indicates k-th bank-specific variable and $\varepsilon_{i,t} = \nu_i + u_{i,t}$ is a residual terme composed of a bank-specific fixed effect ν_i and a normal residual $u_{i,t}$.

2.5 Econometric investigation

Our econometric investigation is performed in four steps. As a first step, we test for the stationarity of the panel, using unit root tests for unbalanced panels (the Levin, Lin and Chu test, complemented by a Fisher test). Results are presented in Table 4 and tend to confirm the stationarity of the panel.

[Table 4: results of the stationarity tests for the bank-specific variables]

The stationarity of the macroeconomic variables is also tested using a Dickey Fuller test but is not that relevant given the small number of observations (17 for each variable).

[Table 5: results of the stationarity tests for the macroeconomic and financial variables]

As a second step, we identify whether some explanatory variables might be endogenous. There are two good candidates: apart from the credit risk measure, which will not be retained in the end because of its insignificance, the capital ratio and the share of non-interest income in total assets. Following Athanasoglou *et al.* (2008), we run model (1) with these variables as strictly exogenous, strictly endogenous or one exogenous and the other endogenous. The Sargan tests, though they indicate that both could be considered as endogenous, appear in favour of considering nnii i.e. the share of income coming from non-interest activities as endogenous and capital as exogenous. This may seem surprising as the equity ratio, as a target variable, is generally considered endogenous in most papers (Athanasoglou et al., 2008).

A third question that may arise is the treatment of mergers and acquisitions (M&A). Following Athanasoglou *et al.* (2008) and Albertazzi and Gambacorta (2009), we chose to disregard any detailed treatment of mergers and acquisitions, and to estimate an unbalanced panel. There may be two reasons for this: first, including a dummy variable for each merger may limit dramatically the number of degrees of freedom of the system; second, as argued by Athanasoglou et al. (2008), the capital variable already accounts indirectly for potential M&A effects[5].

Fourth, as regards the estimation *stricto sensu*, we use the Arellano-Bond (Arellano and Bond, 1991) *two step* estimator for dynamic panel-data models and *robust* option to report standard error. We use two types of instruments for our difference equation: all exogenous variables (X and Z) as additional standard instruments except non interest income (*nnii*)[6] and lagged endogenous variables (π and *nnii*) as difference GMM-type instruments. The difference equation used in our model is:

$$\Delta\pi_{i,t} = \phi_1 \Delta\pi_{i,t-1} + \sum_j \beta^j \Delta X_t^j + \sum_k \theta^k \Delta Z_{i,t}^k + \Delta\varepsilon_{i,t} \qquad (2)$$

3. Results

3.1 Baseline equation

Our aim is to estimate the impact of economic and financial shocks on banks' profitability. We begin by considering the whole vector of possible variables, identified in the literature, that is to say: GDP growth, spread, inflation rate, stock market return, stock market volatility, loan growth, share of non-interest income, capital, expenditures, risk and the constant.

Firstly, we chose stock market index's return as the measure of market activities. However, the coefficient of this variable proves not significant in our regressions, especially when estimated

[5] To check for robustness, we re-run our regressions excluding observations corresponding to a yearly increase in assets by more than 20%. This leaves the results unchanged.

[6] Non interest income is directly linked with net income. By running several models, regression results show inherently that non interest income is better modelled as an endogenous variable.

with other macroeconomic variables. Then, we find that the positive coefficients of the yield curve and the market index return are not simultaneously significant. Besides, this variable is highly and negatively correlated to inflation, with a correlation coefficient of -0.60 during the studied period (cf. Table 6). For that reason, in the remainder of the paper, we only consider stock market volatility as a proxy for market risk.

[Table 6: coefficient of correlation between macroeconomic and financial variables]

Regarding the other macroeconomic variables, we find that the inflation rate is not significant when combined with GDP growth. This may result from the strong relationship between these two variables. Loan growth is never significant and dropped from the remaining equations. Furthermore, among the banking specific variables, we find that the variables 'risk' and 'expenditures' are not significant but keep the former in the remaining results to be consistent with the underlying theoretical models.

Finally, we get the final results which are presented in Table 7, which are those we will consider in the remainder of the paper as the main equation results.

[Tables 7: Results for the main equations]

The significant coefficient on the lagged endogenous variable confirms the dynamic specification. The coefficient of the lagged ROA, which equals to 0.171, indicates that profitability seems to be moderately persistent over time. According to Athanasoglou *et al.* (2008), a small value of that coefficient means that the banking industry is fairly competitive (high speed of adjustment) or that informational opacity is low (Berger et al., 2000).

The regression results confirm our guess that a higher GDP growth, steeper yield curve or higher inflation rate increase banks' profitability. The coefficient on GDP growth means that an increase in GDP growth by 1% increases the overall ROA of the whole French banking system by about 0.04%, which is quite important given the average ROA over the sample (0.67%). The same reasoning applies to the yield curve. Contrary to the market index return, market index volatility is negatively linked with banking profitability. An interpretation is that higher stock market

volatility is associated with higher uncertainty, leading to lower profits. To test whether the relationship is still relevant when the economic growth slows down, we re-run the main equation with a cross-variable which equals the economic growth times a time dummy for periods when economic growth is lower than 2%. The results remain unchanged.

As regards the effects of banking structure to banking global profitability, we observe that both the leverage ratio (the inverse of the capital-to-asset ratio included in our estimation) and the non-interest income have a positive effect on banking profitability. The fact that the intensity in the use of capital increases banks' profitability can be interpreted as a proxy for the "efficiency" of the capital, particularly important in banks' risky businesses. Besides, we find evidence that small banks have higher ROA than other banks, consistently with descriptive statistics and the empirical literature.

3.2 Back testing of the results

In order to analyse the quality of our model, the following standard tests for linear dynamic panel models are presented in the result table of each regression: the Wald-test indicates jointly significance of coefficients of explanatory variables; the Sargan-test shows no evidence of over-identifying restrictions; the negative statistic value for the first-order autocorrelation test on errors is expected in dynamic panel models; the second-order autocorrelation test on errors have been rejected so that there is no autocorrelation of order 2 of differenced errors.

In addition, the following table 8 and chart 3 give additional information on the quality of the model. Table 8 shows that first and second moments of actual and estimated ROA plea for the robustness of the regression over the whole sample (2292 observations). Chart 3 shows that the model is able to replicate the broad dynamics of the actual path of the aggregate ROA.

[Table 8: Results of back testing]

[Chart 3: path of average ROA]

3.3 Additional robustness checks

3.3.1 Baseline equation re-estimated with group-effects

As shown in Table 1, the panel used may exhibit slight differences in the behaviour of sub-samples of the panel. In this subsection, we re-estimate the main equation with specific effects linked to the legal status or to the size on the individuals.

Individual effects linked to banks' legal status

We estimate a further regression for ROA where the variable GDP growth has been substituted by GDP growth times indicators ($X^l I_q$), which are dummy variables on banks' legal status. The aim is to test the differentiated effects of banks' legal status in events of macroeconomic shocks.

$$\pi_{i,t} = \phi_1 \pi_{i,t-1} + \sum_l \beta^l X_t^l + \sum_k \theta^k Z_{i,t}^k + \sum_q \delta_q GDP_t \ \ I_q + \varepsilon_{i,t} \qquad (3)$$

I_q : q-th dummy variable; for example, I_{bmc} =1 for mutual and cooperative banks, 0 otherwise.

The table 9 presents the results for this alternative estimation .

Our main findings are that mutual and cooperative banks appear less impacted by GDP growth shocks than commercial banks, with a sensitivity of 0.01 against 0.052, which tends to prove that mutual banks' profits are poorly impacted by the business cycle.

[Table 9: Results for the equation with individual effects]

Individual effects linked to banks' balance-sheet size

We differentiate banks' size according to the size of their balance-sheet; banks that are in the 75%-100% percentile region of the largest balance-sheet are classified as large banks, and banks in the bottom 25% percentile region are classified as small banks.

Our main finding is that small banks seem to be more affected than other banks by shocks on GDP growth.

All in all, the results of the subsection 3.3.1 can be summarized in that we do not exhibit a clear homogeneity of the panel as regards the sensitivity of each category's ROA to GDP growth. Nevertheless, as our goal is to study the resilience of the *whole* French banking system to adverse macroeconomic scenarios, we will consider only the results of the main equation in the remainder of the paper.

3.3.2 Restricting the time-window

As a complementary robustness check, we propose to re-run the main equation on a narrower time-window that would cover the period 2000-2009. A reason for choosing this restricted period lies in that some authors find a different behaviour of ROA's reaction to macroeconomic variables after 1999 because of:

- the introduction of the euro;
- a different business model of banks;
- a growing influence of securitization, that would threaten the old model of profits through maturity transformation, and thus alter especially the sensitivity of ROA to spread fluctuations.

In addition, despite the gap is in general small, Chart 3 shows that the model as estimated over the whole period systematically overestimates the actual ROA from 1994 to 1999, as it is the opposite in the remaining period. Results of the main model re-estimated over the 2000-2009 sub-period presented in the last column of Table 9 clearly plea for the robustness of the model, as regards the magnitude of the coefficients, even if the significance of the coefficients is slightly altered. But for our stress testing purpose (section 4), only the magnitude of the various coefficients matters. In addition, re-drawing Chart 3 but with the coefficients re-estimated over the 2000-2009 sub-period leaves the gap between estimated and actual ROA unchanged (chart available upon request).

3.3.3 Orthogonalizing the macroeconomic variables

As our three variables of interest (GDP growth, interest rate spread, stock market volatility) prove somewhat correlated (cf. Table 6), we re-estimate the main model after orthogonalization of those variables For this purpose, we keep our GDP growth variable unchanged. We regress the spread on the GDP growth and a constant term and define the orthogonalized spread* as the residuals of this equation. Moreover, we regress the volatility of the stock market on the GDP growth, the spread and a constant term and define the residuals of that equation as the new stock market volatility. We re-run all the equations above using those new variables. Results presented in Tables 10 and 11 show that, on the whole, our main results are robust.

[Tables 10: Robustness tests: Results with orthogonalized macroeconomic variables]

[Table 11: Robustness tests: Results with orthogonalized macroeconomic variables]

3.3.4 Using an alternative measure of product diversification

As our measure of product diversification 'nnii' is by construction an element of the ROA and might appear very specific to financial and investment firms (for which it exhibits the highest values), we estimate an alternative model which relies on another measure of product diversification, that is to say the ratio of loans to the total assets, as proxy for the loan activity of banks. When we re-run the Sargan test, we find that our new variable loans/assets has to be specified as an exogenous variable, whereas the ratio of capital now appears endogenous and is specified as such in the regression. Results presented in Table 12 are fully consistent with the main results of Table 7.

[Table 12: Results with alternative measure of product diversification]

4. Macroeconomic stress-tests of French banks' profitability

Stress-tests focused on banking profitability seek to identify the most important economic and financial channels of contagion of an initial shock that may affect the stability of the banking sector. Indeed, as the previous section showed, the economic and financial market environment may affect banks' profitability. The aim of stress test exercises is to study the effects of some macroeconomic or financial variables paths derived from various scenarios – a forecast and some adverse variants - on relevant banking variables, such as profitability.

4.1 The stress testing framework

The approaches by Lehmann and Manz (2006) and Rouabah (2006), focusing on Swiss and Luxemburg respectively, conclude that the impact of macroeconomic and financial shocks on banks' profits is relatively modest, showing that the two banking sectors are resilient. But the analysis carried out in these papers, albeit interesting, is limited to sensitivity analysis and does not consider the effect of a comprehensive adverse scenario on banking variables, especially profitability.

Here, it is very important to notice that our aim is not to only study the impact of one shock of one specific explanatory variable on the income subcomponents, regardless of the impact of such a shock on the other variables. On the contrary, the impact of stress scenarios on the relevant risk factors is consistently determined with the Banque de France's (Baghli et al., 2005) forecast models (*Mascotte* and *Nigem*). This means that we simulate the effects of various exogenous shocks (in our stress test exercise, demand shocks yielding recession scenarios, a yield curve flattening and an exchange rate shock), conditionally on these models, on the “stressed” output variables of the macroeconomic model (that prove to be our “stressed” explanatory variables for the banking model), which are then used as “stressed” inputs in our revenue model. Hence, we get “stressed” profitability, which is compared to the value obtained without any stress (i.e. in line with the basis line of the forecast). The advantage of using such a macroeconomic model is that it offers a lot of flexibility in the design of the scenario and that it ensures the consistency of the forecasted and stressed paths of the various macroeconomic variables.

A limitation to this approach lies in the feature of traditional macroeconometric models. Even though it provides an integrated and consistent framework to link the different effects of

exogenous shocks on key macro variables such as GDP growth, loans or interest rates, the model is not clearly devoted to analyse financial relationships and how different agents in the system may be financially constrained. Hence, in such models, there is no limit to credit demand from households. Another limitation is related to the fact that our model does not aim at taking into account "second round" effects, as it only captures the effect of macroeconomic shocks on banking variables and not directly that of banking variables on macroeconomic and financial ones. In addition, our stress test exercises are carried out all other things being equal: in particular, we do not model any portfolio reallocation, leading to a shift from interest income to trading income, in case of, for instance, a negative shock on the spread, leading to a decrease of net interest revenues. For these reasons, it seems much more relevant to restrict our stress test exercise to the first year of shock, given that it is likely to avoid any unreliable result.

4.2 Results of the stress test

The macroeconomic baseline scenario stems from the Broad Macroeconomic Projection Exercise for France, which is produced by the DG Economics of the Banque de France. Stressed scenarios are defined as severe but plausible in comparison with the baseline scenario. At the juncture of April 2009, we designed and tested five hypothetical stress scenarios which were all found at that time consistent with the definition of stress test scenarios (severe but plausible) though their probability of occurence is from a statistical and historical point of view likely different. At that point, it is indeed important to understand that the design of stress scenarios strongly rely on expert judgement. Conversely, it should be very clear at that point that our goal is not to compare quantitatively the magnitude of the effects of each adverse scenario with respect to the others. We are much more interested in i) the qualitative comparison of different outputs of various scenarios; ii) the absolute magnitude of the effects of scenarios over a certain threshold, for instance a negative profitability of banks. Hence, the five scenarios that were worth simulating were as follows:

- Internal demand shocks: - 1% GDP growth, - 2% GDP growth, - 3% GDP growth;
- Financial shocks: a 25% depreciation of the dollar against the euro; a flattening of the yield curve (- 200 bp Euribor 3-month and – 400 bp OAT (government bonds)10-year).

[Table 13: design of scenarios]

As the question of whether the recession shocks tested, though they appear 'severe' enough, are plausible, we study the distribution of GDP growth in France from 1875 to 2008 excluded the war years in order to calibrate the probability of recession (cf. chart 4). It is clear from the results of non autocorrelation tests (cf. table 14) that the GDP growth is a White Noise process. Moreover, the GDP growth does not follow a Normal distribution according to the normality tests (cf. table 15). Thanks to the distribution of GDP growth, we simulate the probability of the three recession scenarios defined previously. According to this distribution, the average value of GDP growth is 2.7% and the cumulative probability associated is about 58%. Hence, the probability that the GDP growth is greater than the average value is equal to 42%. We get that the probability of GDP growth to be smaller than -1% is 14%, 2% is 8% and -3% is 5% (cf. Table 16).

[Table 14: White Noise test for GDP growth]

[Table 15: Normality test]

[Table 16: Calculation of expected ROA]

As earlier said, the impacts of the stress scenarios on the relevant macro risk factors (GDP, loan growth, interest rates) for the years 2009-2010 are determined by using the Banque de France Mascotte model (Baghli *et al.*, 2005) and NIGEM, the latter being provided by the NIESR (National Institute of Economic and Social Research) and used to introduce international interactions.

Table 13 presents the effects of these scenarios on the variables used as inputs in our profitability models. Table 14 presents the results of stress tests using the baseline model presented in table 7.

[Table 17: results of stress tests using the baseline model]

First, our results show that the French banking system would be somewhat resilient to the set of comprehensive adverse scenarios tested. Only the severe recession scenarios (-2% growth and -3% growth) would generate negative profits. On the contrary, other scenarios (flattening of the yield curve, exchange rate shock, moderate recession) would yield positive profits. In comparison with the actual figures for the French banking system recorded in 2009, those results stemming from the stress test scenarios are consistent with the reporting of banks. Indeed, as the GDP growth forecast for 2009 is likely to be in the range [-2.4%;-2%] (see for instance recent OECD's and IMF's outlooks), our -2% stress scenario constitutes a good benchmark. The annual ROA of -0.01% forecasted by the model is not that far from the actual figure, which equals 0.02% for the French banking industry in aggregated consolidated data. This means that the diagnosis of relatively good results recorded by the French banking system in the context of the current crisis could have been rather accurately forecasted by the model, especially relatively to the mean of ROA over the sample (0.67%). This reveals the robustness of our model as a backtesting check. In addition, the first actual figure obtained for French banks' ROA, 0.063%, is close to that obtained by simulating our model using the actual path for explanatory variables, providing, again, grounds to the robustness of our model.

In order to answer the question of why French banks and the French banking system as a whole prove that resistant to strong economic shocks, an alternative would be to go in deeper details in the analysis of income subcomponents (e.g. Coffinet et al., 2009) and is left for future research. Nevertheless, the interpretation of main equation's results can provide some intuition. Indeed, one of the three main macroeconomic drivers – the interest rate maturity spread – is clearly linked to the traditional maturity transformation activity of banks. Conversely, the GDP growth could be associated to that income subcomponent as stronger economic growth could enhance the credit demand and hence support the loan activity and profitability of banks. Another significant driver of overall banks' profitability – stock market volatility – is clearly specific to trading revenues (and indirectly GDP growth). As a result, a conclusion that can be drawn from these results is that the French model of universal banking –that is to say the diversification of products and revenues by banks – could lead to opposite developments in income subcomponents in depressed situations, the higher risk and lower profits generated by trading activities and economic downturn being compensated by a more profitable traditional credit activity, driven by a widening of the yield curve in downturns – e.g. due to interest rate cuts by the central bank.

That can also be due to the fact that the provision of services, commission and fee, trading might suddenly stop which is not the case of traditional intermediation activities which generate interest in the long run. Therefore, our results can be viewed as a support for the model of universal banking as a source of resilience.

5. Conclusion

Our results provide evidence of statistically significant relationships between the macro environment and the profitability of the banking industry. In particular, we provide strong evidence that the overall French banking system's profitability positively depends on the French GDP growth, the stock market return and the interest rate maturity spread, the share of non-interest income and the capital owned by banks, and negatively on bank size and credit risk. These results are consistent with those obtained in the banking literature.

Our stress testing analysis suggests that the impact of economic shocks may be relatively modest in terms of profitability, the French banking system being quite resilient and well capitalized to absorb extreme macroeconomic and financial variations. In particular, the model would have performed in a good manner to forecast the good results of the French banks in spite of the current depressed environment. These results can be interpreted as a plea for the model of universal banking, though further work should be carried out to definitely conclude on that point.

However, a lot of work remains to be done, as other risk channels may affect banks' profits but are not simulated in our framework, such as the sudden illiquidity in specific banking activities observed in August 2007 at the beginning of the subprime crisis (illiquid structured products, tensions in the money market...). Moreover, the model may be refined in terms of econometrics, as it fails to explicitly account for non-linearities that may arise in extreme events. Since we are especially interested in the extreme losses arising from stressed scenarios, it would be of particular interest to implement quantile regressions.

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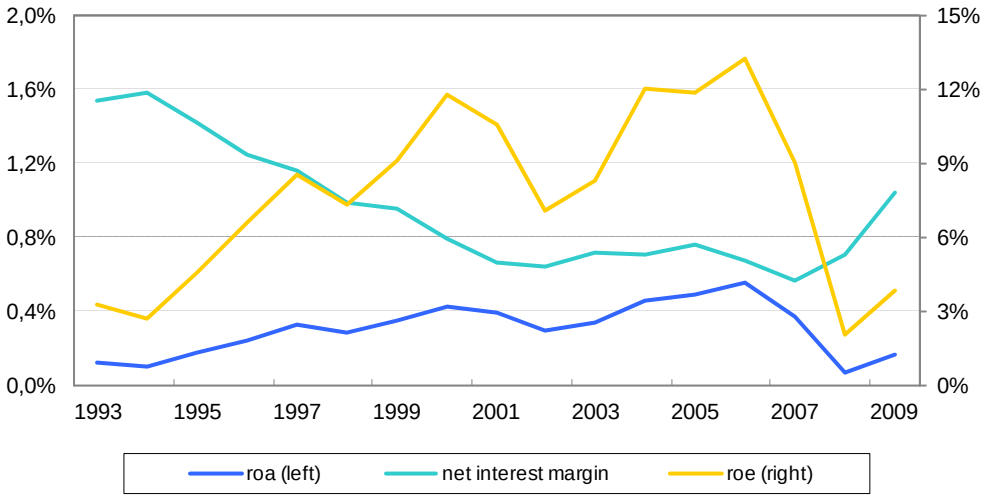
Chart 1: evolution of banks' profitability (1993-2009)



Coefficient of correlation	ROA	Net interest margin	ROE
ROA	1		
Net interest margin	-0,60	1	
ROE	0,93	-0,59	1

Chart 2: evolution of banks' profitability and GDP growth (1993-2009)

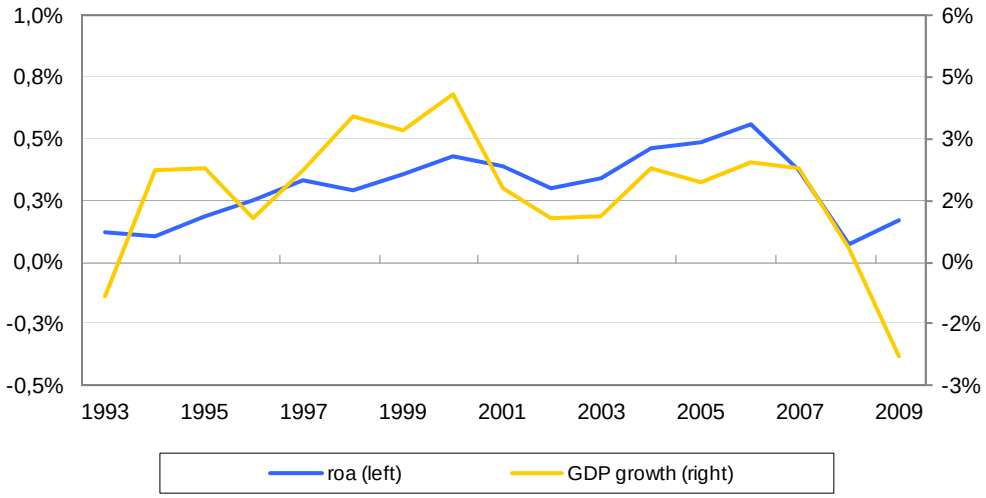


Chart 3: path of individual mean ROA

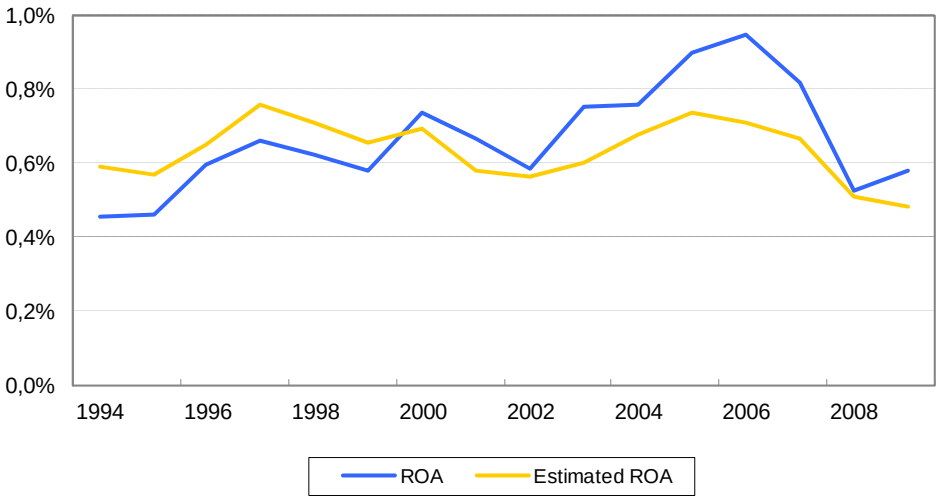


Chart 4: Distribution of GDP growth

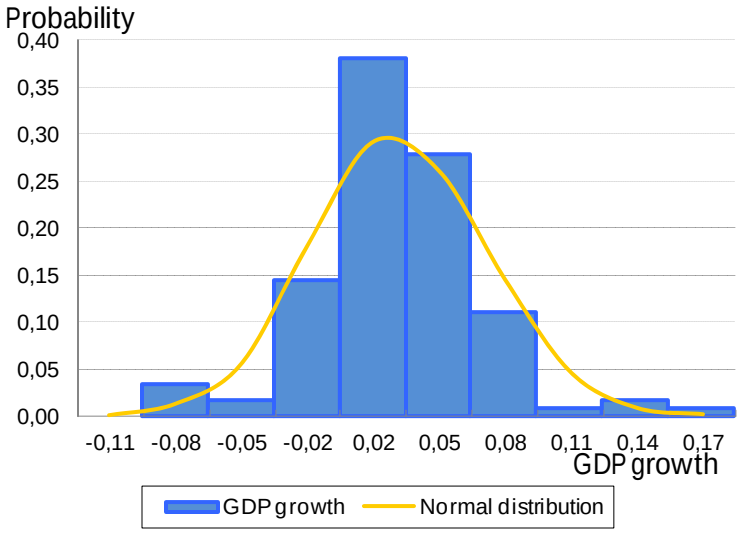


Table 1: descriptive statistics of ROA

1993-2009	all banks	Commercial banks	Mutual and cooperative banks	Financial and investment firms	Large banks	Average banks	Small banks
ROA							
Average	0,7%	0,5%	0,6%	0,9%	0,4%	0,7%	0,9%
Std.	0,7%	0,7%	0,3%	1,0%	0,4%	0,7%	1,0%
Min	-1,6%	-1,6%	-0,7%	-1,5%	-1,5%	-1,6%	-1,6%
Max	4,1%	4,1%	3,2%	4,1%	3,0%	4,1%	4,1%
Obs.	2896	920	1070	906	724	1448	724
Capital / assets							
Average	10%	8%	8%	14%	6%	9%	17%
Std.	12%	13%	4%	15%	4%	7%	19%
Min	-3%	0%	-3%	0%	0%	-3%	0%
Max	100%	100%	31%	97%	23%	81%	100%
Non interest income /assets							
Average	3%	2%	2%	4%	1%	2%	5%
Std.	9%	4%	1%	15%	1%	3%	16%
Min	-16%	-16%	0%	-3%	0%	-16%	-3%
Max	210%	33%	7%	210%	7%	68%	210%
expenditures / assets							
Average	3%	3%	2%	5%	2%	3%	6%
Std.	8%	3%	1%	14%	1%	2%	15%
Min	0%	0%	0%	0%	0%	0%	0%
Max	195%	30%	6%	195%	6%	59%	195%
Individual net operating income /total operating income							
Average	0,6%	1,1%	0,4%	0,2%	2%	0,2%	0,0%
Std.	1,9%	3,1%	1,1%	0,8%	4%	0,1%	0,0%
Min	0%	0%	0%	0%	0%	-0,2%	0,0%
Max	23%	23%	11%	12%	23%	1,3%	0,4%
Loans / assets							
Average	74%	72%	84%	66%	73%	77%	72%
Std.	24%	21%	9%	32%	16%	23%	29%
Min	0%	4%	40%	0%	3%	0%	0%
Max	100%	99%	96%	100%	98%	99%	100%
Loan loss provisions / loans							
Average	3%	3%	1%	5%	1%	2%	7%
Std.	10%	12%	5%	12%	2%	8%	16%
Min	0%	0%	0%	0%	0%	0%	0%
Max	100%	100%	96%	99%	21%	99%	100%
Ln(Assets)							
Average	15	15	16	14	17.5	15	12
Std.	2	2	1.1	2.1	1.3	0.7	0.9

Min	7	10	12	7	16	14	7
Max	22	22	21	21	22	16	14
Subsample ROA<0							
Ln(Assets)							
Average	14						
Std.	2						
Capital / assets							
Average	0.11						
Std.	0.17						
Subsample ROA>0							
Ln(Assets)							
Average	15						
Std.	2						
Capital / assets							
Average	0.10						
Std.	0.11						

Table 2: Expected signs of explanatory variables

Variable	**Specifications**	**Notation**	**Exp. Sign**
Dependent variable			
Profitability	Net profits after taxes / assets	ROA	
explanatory variables			
Output	GDP annual growth	GDP	+
Inflation	Annual inflation rate	Cpi	+/-
Loan	Annual growth rate of aggregated loans	Loan	+
Yield curve	Difference between OAT10y and Euribor 3m	Spread	+
Financial market return	SBF 250 index's annual return	Sbf	+
Financial market volatility	Volatility of the SBF 250 index's annual return	Volsbf	-
Large banks	Dummy variable for large banks	Large	-
Small banks	Dummy variable for small banks	Small	+
Capital	Capital over assets	Capital	+
Credit risk	Loan loss provisions / loans	Risk	-
Market power	Individual net operating income / total net operating income of the banking industry	P_Noi	+
Non interest income	Non interest income / total assets	NNII	+

Table 3: Macroeconomic and banking annual data (1993-2009)

Macroeconomic data (1993-2009)				
	Average	CV	Min	Max
GDP growth	1.68%	0.93	-2.29%	4.08%
Spread	0.93%	1.16	-1.82%	2.37%
Loans	4.55%	0.91	-1.27%	11.75%
Inflation	1.6%	0.41	0.09%	2.81%
SBF250 return	8.2%	2.96	-41.61%	49.5%
SBF250 volatility	18.7%	0.41	9.62%	38.3%

Table 4: results of the stationarity tests for the bank-specific variables

	Levin, Lin & chu		Fisher test	
Variable	W-stat	p-stat	χ^2	p-stat
ROA	-13	0.00	448	0.00
Capital	-167	0.00	487	0.00
Risk	-593	0.00	690	0.00
NNII	-19	0.00	494	0.00

Table 5: results of the stationarity tests for the macroeconomic and financial variables

Variables	Dickey-Fuller ERS		
	T-stat	1% critical value	10% critical value
GDP growth	-1.21	-2.73	-1.60
Spread	-1.81	-2.73	-1.60
Loan growth	-1.39	-2.73	-1.60
Inflation	-1.82	-2.73	-1.60
SBF return	-3.22	-2.73	-1.60
SBF volatility	-1.62	-2.73	-1.60

Table 6: coefficient of correlation between macroeconomic, financial and banking variables

	roa	L.roa	gdp growth	spread	loan	cpi	sbf	volsbf	L.volsbf	capital	risk	nnii	large	small	expenditure
L.roa	0,69	1,00													
gdp growth	0,04	-0,02	1,00												
spread	-0,01	-0,12	0,13	1,00											
loan	0,14	0,16	0,41	-0,15	1										
cpi	0,03	0,07	-0,03	-0,41	0,11	1									
sbf	0,01	-0,06	0,06	0,22	-0,14	-0,56	1								
volsbf	0,00	0,05	-0,22	-0,09	0,14	0,08	-0,59	1,00							
L.volsbf	-0,03	-0,03	-0,55	0,37	-0,19	-0,37	0,09	0,42	1						
capital	0,32	0,28	-0,04	0,01	0,01	0,00	0,01	-0,03	-0,002	1					
risk	0,08	0,02	0,02	0,05	-0,07	-0,01	0,03	0,00	-0,01	0,20	1				
nnii	0,24	0,15	-0,04	0,003	0,03	0,03	-0,01	0,03	0,01	0,28	0,14	1			
large	-0,18	-0,17	-0,14	-0,07	0,15	0,04	-0,08	0,01	0,08	-0,20	-0,14	-0,10	1		
small	0,14	0,07	0,07	0,08	-0,17	-0,05	0,08	-0,06	-0,10	0,34	0,25	0,19	-0,33	1	
expenditure	0,20	0,13	-0,03	0,01	0,01	0,03	-0,01	0,03	-0,01	0,27	0,14	0,98	-0,12	0,19	1,00
p_noi	-0,10	-0,11	-0,03	-0,04	0,01	0,03	-0,02	0,00	-0,01	-0,14	-0,07	-0,04	0,40	-0,17	-0,05

Tables 7: Results for the main equations

Arellano-Bond dynamic panel data estimation (t= 1993 - 2009) Number of Obs. = 2292 Number of groups = 370						
ROA	coef.	p	coef.	p	coef.	p
Lag1 (Roa)	0.171**	0.034	0.173**	0.035	0.171**	0.041
GDP growth	0.039***	0.001	0.043***	0.000	0.041***	0.000
CPI	-0.015	0.334				
Spread	0.047***	0.002	0.057***	0.000	0.056***	0.000
L1. SBF volatility	-0.00004**	0.044	-0.00003*	0.064	-0.00004*	0.058
Small	0.002	0.182				
Large	-0.001*	0.084				
Capital	0.013***	0.003	0.013***	0.003	0.013***	0.003
NNII	0.065**	0.019	0.065**	0.020	0.065**	0.020
Risk	-0.002	0.311				
Market power	0.031	0.617				
Low-growth* GDP					-0.002	0.849
Wald test	chi2(11)=74	p>chi2 = 0.00	chi2(6)=51	p>chi2 = 0.00	chi2(7)=64	p>chi2 = 0.00
Sargan test of over-identifying inst.	chi2(238)=225	p>chi2 = 0.71	chi2(238)=223	p>chi2 = 0.70	chi2(238)=226	p>chi2 = 0.70
Autocorrelation test AR(1)	z=-3.02	p>z=0.00	z=-3.02	p>z=0.00	z=-3.01	p>z=0.00
Autocorrelation test AR(2)	z=0.26	p>z=0.80	z=0.24	p>z=0.81	z=0.24	p>z=0.81
Overall R^2	45%		39%		38%	
Between R^2	61%		52%		51%	
Within R^2	18%		17%		16%	

Table 8: Results of back testing

Variable	obs	Mean	Std. Dev.	Min	Max
ROA	2291	0.66%	0.65%	-1.58%	4.06%
estimated ROA	2291	0.63%	0.44%	-0.63%	9.69%

Table 9: Results for the equations with individual effects

Arellano-Bond dynamic panel data estimation						
(t= 1993 - 2009) Number of Obs. = 2292 Number of groups = 370					(t= 2000 - 2009) Number of Obs. = 1358 Number of groups =246	
ROA	coef.	p	coef.	p	coef.	p
Lag1 (L.Roa)	0.169**	0.021	0.176**	0.015	0.120*	0.075
GDP growth					0.035**	0.021
Spread	0.066***	0.000	0.060***	0.000	0.082***	0.000
L1. SBF volatility	-0.00005***	0.008	-0.00004**	0.043	-0.00007***	0.002
Capital	0.013***	0.002	0.013***	0.002	0.012***	0.005
NNII	0.066**	0.024	0.066**	0.026	0.061**	0.024
Bank*GDP	0.052***	0.010				
Cm*GDP	0.010	0.318				
IF*GDP	0.104***	0.000				
Large*GDP			0.034**	0.014		
Average*GDP			0.037***	0.006		
Small*GDP			0.087**	0.024		
Wald test	chi2(8)=58	p>chi2 = 0.00	chi2(8)=59	p>chi2 = 0.00	chi2(6)=64	p>chi2 = 0.00
Sargan test of over-identifying inst.	chi2(238)=235	p>chi2 = 0.54	chi2(238)=223	p>chi2 = 0.74	chi2(208)=193	p>chi2 = 0.74
Autocorrelation test AR(1)	z=-3.10	p>z=0.00	z=-3.08	p>z=0.00	z=-3.35	p>z=0.00
Autocorrelation test AR(2)	z=0.26	p>z=0.80	z=0.26	p>z=0.80	z=-0.68	p>z=0.49
Overall R^2	44%		43%		32%	
Between R^2	58%		57%		42%	
Within R^2	19%		18%		14%	

Tables 10: Robustness tests: Results with orthogonalized macroeconomic variables

Arellano-Bond dynamic panel data estimation (t= 1993 - 2009) Number of Obs. = 2292 Number of groups = 370						
ROA	coef.	p	coef.	p	coef.	p
Lag1 (Roa)	0.174**	0.012	0.173***	0.035	0.173**	0.037
GDP growth	0.051***	0.000	0.055***	0.000	0.054***	0.000
CPI	-0.016	0.322				
Spread*	0.035**	0.028	0.045***	0.002	0.044***	0.004
L1. SBF volatility*	-0.004*	0.054	-0.003*	0.070	-0.004*	0.059
Small	0.002	0.148				
Large	-0.001*	0.082				
Capital	0.013***	0.003	0.013***	0.003	0.013***	0.003
NNII	0.066**	0.022	0.066**	0.022	0.066**	0.022
Risk	0.031	0.557				
Market power	-0.002	0.21				
Recession-year* GDP					-0.005	0.726
Wald test	chi2(11)=78	p>chi2 = 0.00	chi2(6)=51	p>chi2 = 0.00	chi2(7)=64	p>chi2 = 0.00
Sargan test of over-identifying inst.	chi2(238)=223	p>chi2 = 0.74	chi2(238)=223	p>chi2 = 0.69	chi2(238)=226	p>chi2 = 0.70
Autocorrelation test AR(1)	z=-3.02	p>z=0.00	z=-3.02	p>z=0.00	z=-3.01	p>z=0.00
Autocorrelation test AR(2)	z=0.26	p>z=0.80	z=0.24	p>z=0.81	z=0.24	p>z=0.81
Overall R^2	46%		40%		36%	
Between R^2	62%		48%		47%	
Within R^2	19%		24%		18%	

Table 11: Robustness tests: Results with orthogonalized macroeconomic variables

Arellano-Bond dynamic panel data estimation						
(t= 1993 - 2009) Number of Obs. = 2292 Number of groups = 370					(t= 2000 - 2009) Number of Obs. = 1358 Number of groups =246	
ROA	coef.	p	coef.	p	coef.	p
Lag1 (L.Roa)	0.168**	0.021	0.176**	0.031	0.117*	0.075
GDP growth					0.059***	0.000
Spread*	0.051***	0.000	0.047***	0.002	0.060***	0.000
L1. SBF volatility*	-0.005**	0.014	-0.004**	0.043	-0.007**	0.026
Capital	0.013***	0.002	0.013***	0.002	0.012***	0.006
NNII	0.066**	0.026	0.067**	0.024	0.061**	0.028
Bank*GDP	0.067***	0.001				
Cm*GDP	0.029***	0.005				
IF*GDP	0.117***	0.000				
Large*GDP			0.049***	0.000		
Average*GDP			0.051***	0.000		
Small*GDP			0.099**	0.011		
Wald test	chi2(8)=58	p>chi2 = 0.00	chi2(8)=69	p>chi2 = 0.00	chi2(6)=64	p>chi2 = 0.00
Sargan test of over-identifying inst.	chi2(238)=235	p>chi2 = 0.54	chi2(238)=223	p>chi2 = 0.74	chi2(208)=193	p>chi2 = 0.68
Autocorrelation test AR(1)	z=-3.10	p>z=0.00	z=-3.08	p>z=0.00	z=-3.35	p>z=0.00
Autocorrelation test AR(2)	z=0.26	p>z=0.80	z=0.25	p>z=0.80	z=-0.71	p>z=0.48

Table 12: Results with alternative measure of product diversification

ROA	coef.	p
Lag1 (Roa)	0,101	0,132
GDP growth	0,039***	0,000
CPI	-0,022	0,175
Spread	0,047***	0,002
L1. SBF volatility	-0,00006***	0,002
Small	0,004***	0,002
Large	-0,001	0,144
Capital	0,014**	0,017
Loans	0,000	0,847
Risk	0,000	0,845
Market power	0,025	0,569
Wald test	chi2(11)=80	p>chi2 = 0,00
Sargan test of over-identifying inst.	chi2(238)=239	p>chi2 = 0,46
Autocorrelation test AR(1)	z=-3,03	p>z=0,00
Autocorrelation test AR(2)	z=0,24	p>z=0,81

Table 13: design of scenarios

	In deviation from the basis line	GDP growth	
		T+1	T+2
1	- 1% GDP growth	-0.8	-2.1
2	- 2% GDP growth	-2.1	-3.0
3	- 3% GDP growth	-2.7	-4.0
4	- 25% depreciation of USD/EUR	-0.6	0.0
5	Flattening of the yield curve	0.0	0.4

Table 14: White Noise test for GDP growth

Autocorrelation check for White Noise			
To lag	Chi-square	DF	Pr>Khi 2
6	9.65	6	0.14
12	10.85	12	0.55
18	19.12	18	0.39
24	26.33	24	0.34
30	27.83	30	0.58

Table 15: Normality test

Normality tests		
Test	Statistique	p value
Shapiro-Wilk	W= 0.96	Pr > W=0.001
Kolmogorov-Smirnov	D= 0.09	Pr> D=0.03

Table 16: Calculation of expected ROA

GDP growth	Prob.	GDP growth	Prob.	St prob.	ROA (N+1)	ST ROA
> 2.7%	42%					
>-0.3%	80%	>-0.3%	80%	42%	>0.07%	0.07%
>-1%	86%	[-1%, -0.3% [	6%	6%	[0.04%, 0.07% [	0.04%
>-2%	92%	[-2%, -1% [	6%	6%	[-0.01%, 0.04% [	-0.01%
>-3%	95%	[-2%, -3% [	3%	3%	[-0.03%, -0.01% [	-0.03%
Average						0.030%

Table 17: results of stress tests using the main equation results

	ROA	-1% GDP growth	-2% GDP growth	-3% GDP growth	-25% depreciation of USD/EUR	Flattening of the yield curve (-200bp ST, -400bp LT)
Aggeregated data	T+1	0.04%	-0.01%	-0.03%	0.05%	0.07%
	T+2	0.01%	-0.03%	-0.07%	0.10%	0.11%
Cooperative banks	T+1	0.09%	0.08%	0.08%	0.10%	0.10%
	T+2	0.07%	0.06%	0.05%	0.09%	0.09%
Commercial banks	T+1	0.05%	-0.01%	-0.04%	0.06%	0.09%
	T+2	0.03%	-0.03%	-0.08%	0.14%	0.16%
Financial firms	T+1	0.00%	-0.13%	-0.19%	0.02%	0.08%
	T+2	-0.03%	-0.14%	-0.25%	0.19%	0.23%

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