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Banks' management of the net interest margin: evidence from Germany

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Abstract

We decompose the change in banks' net interest margin into a change in market-wide bank rates and a change in the balance-sheet composition. Our empirical findings from a detailed data set on German banks' balance-sheet positions, broken down into different maturities, creditors and borrowers and degrees of liquidity are as follows: (i) Changes in bank rates have a much greater impact on and explain more of the variation in net interest margins than do changes in balance-sheet compositions. (ii) Changes in bank rates and changes in balance-sheet compositions affect the change in the net interest margin less strongly for derivative users than for non-users. On average, banks employ interest rate derivatives to reduce on-balance risk. (iii) When risk-taking becomes more lucrative, banks tend to increase their on-balance exposure. This effect is more pronounced for derivative users than for non-users.

Keywords: Net Interest Margin, Banking, Balance-Sheet Composition

JEL classification: G21

Non-technical summary

Banks collect deposits and channel these funds to firms for financing their investment projects. Thereby, banks transform the cash flows in several ways. Short-term deposits are used to grant long-term loans (term and liquidity transformation), and the risky returns from these loans are transformed into risk-free payments to customer deposits (credit risk transformation). Banks are remunerated for the risk that is accompanied with the transformations. This remuneration is part of the banks' net interest income.

We investigate how the banks manage their net interest margin, i.e. the net interest income divided by the bank's total assets. To do so, we break down the timely change in the net interest margin into three components, namely the component that is due to changes in the premiums for the different transformation functions, the component that results from changes in the balance-sheet composition and the bank-specific residual component. For our empirical investigation, we use a data set that is broken down in detail into maturities, creditors and debtors and degrees of liquidity. The study covers all universal banks in Germany from 1999 to 2010. We derive the following empirical results:

- Changes in the risk premiums have a much stronger impact on the net interest margin than changes in the composition of the balance sheet.

- Banks apply derivatives to reduce on-balance interest rate risk. Thereby, however, their total risk does not decrease as they increase their exposure to other risks accordingly.

- When risk premiums increase, banks tend to increase their on-balance exposure. This behavior is more pronounced for banks using derivatives than for banks which do not.

Nichttechnische Zusammenfassung

Banken sammeln die Gelder der Einleger ein und reichen sie an die Unternehmer für deren Investitionen weiter, wobei sie als Mittler die Zahlungsströme transformieren. So werden kurzfristig fällige Kundengelder als langfristige Kredite vergeben (Fristen- und Liquiditätstransformation), und die unsicheren Rückflüsse aus diesen Krediten werden in Zahlungen für sichere Kundeneinlagen umgewandelt (Risikotransformation). Für das Risiko, das mit diesen Transformationen einhergeht, werden die Banken entlohnt, was sich im Zinsüberschuss der Banken niederschlägt.

In diesem Papier wird untersucht, wie die Banken ihre Nettozinsmarge, d.h. den Zinsüberschuss bezogen auf die Bilanzsumme, steuern. Dazu wird die zeitliche Änderung der Nettozinsmarge einer jeden Bank in drei Teile aufgespalten, nämlich in einen Teil, der auf Änderungen in den Prämien für die einzelnen Transformationensfunktionen zurückgeht, in einen Teil, der sich aus den Änderungen in der Bilanzzusammensetzung ergibt, und in einen bankindividuellen Restteil. Wir verwenden für diese empirische Unterschung einen Datensatz, bei dem die Bilanzen der Banken detailliert nach Laufzeiten, Schuldern und Gläubigern sowie dem Grad der Liquidität aufgegliedert sind. Die Studie erstreckt sich über alle Universalbanken in Deutschland und den Zeitraum von 1999 bis 2010. Es ergeben sich folgende empirische Ergebnisse:

- Änderungen in den Risikoprämien haben einen viel stärkeren Effekt auf die Nettozinsmarge als Änderungen in der Zusammensetzung der Bankenbilanz.
- Banken nutzen Derivate dazu, die Zinsänderungsrisiken in der Bilanz abzusichern. Dadurch sinkt aber nicht das Gesamtrisiko der Banken, weil sie die übrigen Risikopositionen entsprechend erhöhen.
- Steigen die Risikoprämien, dann weiten die Banken tendenziell ihre Risikopositionen aus. Dieses Verhalten ist bei Banken, die Derivate einsetzen, stärker ausgeprägt als bei Banken, die keine Derivate einsetzen.

Contents

Banks' management of the net interest margin: Evidence from Germany[1]

1 Introduction

Banks provide three main transformation functions with which they generate income, namely term, liquidity and risk transformations. With these transformation functions, banks fulfill an important role for economic prosperity; the income generated with these transformation functions, or more precisely banks' net interest margin, determines the social costs of financial intermediation (Maudos and de Guevara (2004)). Research on banks' interest margins, defined as the difference between interest revenues and expenses per unit of assets, has a long tradition and has identified key determinants explaining differences in the level of interest margins (Ho and Saunders (1981), Angbazo (1997), Wong (1997), Saunders and Schumacher (2000), Maudos and de Guevara (2004), Kasman et al. (2010)).

While research has so far focused on explaining the *level* of banks' interest margin, we put forward a decomposition of the *change* in the net interest margin that allows us to investigate banks' management of the net interest margin. We decompose the change in the net interest margin into three components: The first component, which we call *price change*, captures how changes in market-wide bank rates for various assets and liabilities contribute to the change in the net interest margin. These price changes include all changes in premiums for banks' transformation functions, i.e. market-wide changes in the premiums for term, liquidity and risk transformation that give compensation to banks for interest rate, liquidity and credit risk. The second component, which we call *weight change*, captures how changes in the banks' balance-sheet structure, i.e. the changes in the on-balance risk exposure, contribute to the overall change in the net interest margin. The third component is the idiosyncratic change in a bank's net interest margin and captures bank-specific deviations from the market-wide bank rates.

In the short run, a bank's management can influence the net interest margin by adjusting the balance-sheet weights. In this sense, weight changes are endogenous. By contrast,

[1]The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Deutsche Bundesbank. We thank the participants of the Bundesbank Research Seminar for their helpful comments.

changes in the net interest margin that are due to market-wide changes in bank rates are exogenous, at least in the short run. In the long run, however, the management decides on the bank's exposure to the different types of risk. In other words, the component due to price changes reflects the management's strategic attitude towards risk-taking whereas the component due to weight changes is about tactical decisions.

In our empirical study, we use annual data from all German universal banks from 1999 to 2010 and estimate 18 market-wide bank rates (8 related to assets and 10 related to liabilities) to capture rates on various maturities, different types of borrowers and creditors, and different degrees of liquidity. We use the estimated market-wide bank rates to calculate price and weight changes. Then, we investigate the relevance of these price and weight changes for the changes in net interest margins. We find that price changes, i.e. the strategic component, have a far stronger impact on and explain a greater deal of the variation in net interest margins than weight changes, which represent the tactical component.

Derivatives are an important instrument of managing risk. Several decades ago, the interest rate, liquidity and credit risks were closely associated with the asset-liability structure of the banks' balance sheet. Therefore, the main way in which banks limited their exposure to interest rate, liquidity and credit risk was by constraining their asset-liability structure which created a strong dependence between investment (granting loans) and financing decisions (collecting deposits or issuing additional equity). Nowadays, however, risk-transfer instruments, such as interest rate and currency swaps, allow banks to separate their on-balance sheet asset-liability structure from the risk exposure implied by it (e.g. Smith and Stulz (1985), Froot et al. (1993)). Therefore, we investigate differences between derivative users and non-users and find that price and weight changes affect the change in the net interest margin less strongly when banks apply derivatives than when they do not. This evidence indicates that banks use derivatives to reduce the on-balance interest rate risk exposure.

We also investigate banks' weight changes, which summarize – for each bank and each year – all changes in the balance-sheet structure into a single number. Here we investigate the correlation between weight changes and price changes and discuss whether this correlation differs between banks using derivatives and those which do not. Our empirical findings indicate that weight changes of banks using derivatives depend more strongly on price changes than the ones of non-users. Banks using derivatives increase their on-balance exposure to those risk factors whose remuneration increases more strongly than banks not using derivatives.

Analyzing weight and price changes is a promising and innovative alternative to measures used so far in the literature. One strand of the literature has analyzed maturity gaps defined as the difference between assets and liabilities that mature or are repriced within a particular time frame, such as one year (Ahmed et al. (1997), Purnanandam (2007)). By contrast, our measure takes into account different dimensions of on-balance risk-taking, including maturity and liquidity mismatches, and exposure to credit risk. Moreover, our approach is advantageous since we distinguish between prices for risks and quantities of risks. For instance, the interest margin does not only depend on the degree of term transformation but also on the price a bank earns per unit of term transformation. Another strand of the literature has measured asset-liability dependencies with various correlation techniques (DeYoung and Yom (2008), Memmel and Schertler (2011)). For instance, using canonical correlation analyses on data from U.S. commercial banks, DeYoung and Yom (2008) find evidence that risk-transfer instruments have allowed banks to reduce their on-balance sheet asset-liability dependencies. While correlation measures do not deliver insights into the asset-liability structure of single banks, our measure has the strong advantage that it offers weight and price changes for each single bank in each single year.

The remainder of the paper is organized as follows. Section 2 presents the decomposition of the change in the net interest margin into price and weight changes and puts forward testable statements about its management. Section 3 describes the data, delivers estimates for 18 market-wide bank rates for different asset and liability positions, and summarizes price and weight changes for the German banking industry. Section 4 presents our findings on how changes in the net interest margin and the sensitivity between weight and price changes differ between banks using derivatives and those which do not. Section 5 concludes.

2 Managing the net interest margin

We decompose the change in the net interest margin of a bank not using derivatives into a price change, which is beyond the control of bank managers, and a weight change, which captures managers' tactical adjustments of the balance sheet. Then, we discuss the differences between derivative users and non-users.

2.1 Price and weight changes without derivatives

The net interest income NM (in euro) of a bank not using derivatives is the difference of the interest revenues and expenses of its asset and liability positions $W_{i,j}$ (in euro):

$$NM_i = \sum_{j=1}^{J_1} W_{i,j} r_{i,j} - \sum_{j=J_1+1}^{J} W_{i,j} r_{i,j} \tag{1}$$

where $r_{i,j}$ is the rate that bank i charges in case of an asset position ($j = 1, ..., J_1$) or pays in case of a liability position ($j = J_1 + 1, ..., J$). Setting $r_{i,j} = r_j + (r_{i,j} - r_j)$ and normalizing the euro-amount variables to the bank's total assets (i.e. $nm_i := NM_i/TA_i$ and $w_{i,j} := W_{i,j}/TA_i$), we obtain

$$nm_i = \sum_{j=1}^{J} w_{i,j} r_j \left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right) + \sum_{j=1}^{J} w_{i,j} \left(r_{i,j} - r_j\right) \left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right). \tag{2}$$

The term $\left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right)$ is equal to 1 for the asset positions $1, ..., J_1$ and equal to -1 for the liability positions $J_1 + 1, ..., J$. Replacing the weighted sum of the bank-individual deviations from the average interest rates of the various balance-sheet positions by the term η_i, the net interest margin in year t can be written as:

$$nm_{i,t} = \sum_{j=1}^{J} w_{i,j,t} r_{j,t} \left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right) + \eta_i. \tag{3}$$

We use Equation (3) to decompose the change in the bank's net interest margin as follows:

$$\Delta nm_{i,t} = nm_{i,t} - nm_{i,t-1} \equiv PCH_{i,t} + WCH_{i,t} + \Delta\eta_{i,t} \tag{4}$$

with

$$PCH_{i,t} = \sum_{j=1}^{J} w_{i,j,t-1} \Delta r_{j,t} \left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right) \tag{5}$$

and

$$WCH_{i,t} = \sum_{j=1}^{J} \Delta w_{i,j,t} r_{j,t} \left(1 - 2 \cdot \mathbf{1}_{\{j>J_1\}}\right) \tag{6}$$

PCH is the difference between the margin today and last year under the assumption that the last year's balance-sheet structure prevails and that the bank's idiosyncratic effect is unchanged. Thus, *PCH* gives the change in a bank's net interest margin due to changes in market-wide bank rates. An increase in the premiums for term, liquidity and credit risk transformation due to a change in average rates $r_{j,t}$, which we capture by a price change *PCH*, increases banks' net interest margins. Hence, we look at the combination of different exposures, namely interest rate, liquidity and credit risk exposure. The price change is, to a very large extent, beyond the bank management's influence, since it refers to changes in market prices. For example, when the slope of the term structure increases (which is exogenous from the bank management's perspective), the net interest margin goes up even if the management decides *not* to take on additional interest rate risk. Having said this, the bank management took the strategic decision in the past to be exposed to interest rate risk, or alternatively stated the bank's business model relies on the return from term transformation.

Correspondingly, *WCH* is the difference between the margin today and last year under the assumption that the bank rates are fixed to the ones today and that the bank's idiosyncratic effect is unchanged. Thus, *WCH* shows the effects in a bank's net interest margin due to changes in the balance-sheet structure. Bank managers influence their net interest margins by tactically changing their balance-sheet structure, captured by a weight change *WCH*. An increase in the exposure increases a bank's net interest margin, even if the average rates remain constant.

Per construction, these two variables are correlated with the change in the net interest margin. However, whether price or weight changes have a higher relevance in explaining changes in the net interest margin is an empirical question. To gain insight into the relative importance of price and weight changes, we compare the coefficient of determination (R^2) of different specifications of the following equation:

$$\Delta nm_{i,t} = \beta_0 + \beta_1 \cdot PCH_{i,t} + \beta_2 \cdot WCH_{i,t} + \varepsilon_{i,t} \tag{7}$$

This equation can be interpreted as the empirical equivalent to (4).

2.2 Usage of derivatives

Recent literature has put forward several explanations as to why and when hedging is worth considering, such as risk aversion of managers (Stulz (1984)), tax considerations (Smith and Stulz (1985)), and capital market imperfections leading to costs of financial distress and inefficient investment decisions (e.g. Stulz (1990), Froot et al. (1993)). We do not investigate different explanations for using derivatives. Rather, we build our argument on the flexibility implied by the use of derivatives: The use of derivatives, namely interest rate swaps, allows banks to separate the exposure to different sources of risk. For instance, assume that there is demand for long-term loans and the bank wants to hold the credit risk but notes the interest rate risk. A bank using derivatives can grant this loan and can offset the interest rate risk with an interest rate swap. By contrast, a bank not using derivatives has to renounce to grant this loan. If not, it has to bear the unwanted interest rate risk associated with the long-term loan, or it has to offset the interest rate risk via appropriate interbank positions. Irrespective of the action chosen, the bank not using derivatives cannot achieve the outcome of the bank using derivatives. However, because the use of derivatives comes at a cost, mainly fix costs, it is not profit-maximizing for all banks.

As traditional banking business (granting long-term loans and collecting short-term deposits) is much associated with term transformation, hedging interest rate risk would make additional on-balance business possible. If derivatives are mainly applied to reduce on-balance interest rate risk, the change in derivative users' net interest margin reacts less strongly to changes in prices and weights than the one of non-users. We empirically check this with the following regression:

$$\Delta nm_{i,t} = \beta_0+\beta_1 \cdot PCH_{i,t}+\beta_2 \cdot PCH_{i,t} \cdot DER_{i,t}+\beta_3 \cdot WCH_{i,t}+\beta_4 \cdot WCH_{i,t} \cdot DER_{i,t}+\varepsilon_{i,t}. \quad (8)$$

where DER denotes a dummy variable that takes on the value 1 in case of a bank using derivatives, and 0 otherwise. If derivatives are used to hedge, the coefficients β_2 and β_4 should be negative.

An increase in the remuneration for risk-taking gives the bank management incentives to increase the intensity of term, liquidity and credit risk transformation. For instance, when the term structure of interest rates becomes steeper, i.e. term transformation is better remunerated, banks tend to increase their interest rate risk exposure. In qualitative terms, it is the same profit-maximizing behavior that makes a firm in the real sector expand its production when the product price increases. Therefore, we expect a positive correlation between risk remuneration captured by price changes (PCH) and exposure captured by weight changes (WCH). Thus, changes in the net interest margin due to price changes are associated with changes in the net interest margin due to changes in the balance-sheet composition (with prices remaining constant).

The use of derivative is likely to influence the correlation between price changes and weight changes. On the one hand, one may argue that banks using interest rate derivatives adjust their interest rate exposure with derivatives so that they do no or little on-balance sheet adjustment after changes in the steepness of the term structure. Then, the correlation between price and weight changes should be less pronounced for derivative users than for non-users. On the other hand, banks with derivatives may react more strongly to changes in premiums, because using derivatives allows them to assume the exact exposure they want separately for each type of risk. For instance, assume that the premium for credit risk goes up and the term structure becomes less steep. A bank without derivatives, is likely to leave the positions unchanged or to do very little adjustment because the two developments tend to cancel each other out. By contrast, a bank using derivatives can increase its exposure to credit risk and – at the same time – decrease its exposure to interest rate risk by employing derivatives. Then, the correlation between price and weight changes should be more pronounced for derivative users than for non-users.

We investigate whether the correlation between price and weight changes differs between derivative users and non-users by running the following regression:

$$WCH_{i,t} = \beta_0 + \beta_1 \cdot DER_{i,t} + \beta_2 \cdot PCH_{i,t} + \beta_3 \cdot DER_{i,t} \cdot PCH_{i,t} + \varepsilon_{i,t} \tag{9}$$

3 Data

3.1 Descriptive statistics

Our sample comprises German universal banks, i.e. private commercial banks, savings banks and cooperative banks. The period under consideration covers 12 years, from 1999 to 2010. The number of banks in our sample varies between 2,577 in 1999 and 1,395 in 2010 mainly due to mergers and acquisitions. In total, our sample has 22,239 bank-year observations (see Table 1). We start our analyses in 1999 because there was a major change in the reporting forms, when the euro was introduced, especially concerning the maturity brackets.

To distinguish between banks using derivatives and those which do not we rely on notional amounts of derivatives stated in the monthly balance-sheet statistics. We specify that a bank uses derivatives if the notional amount is strictly positive; a bank does not use derivatives if the notional amount is zero in a given year. These derivatives include interest rate swaps, currency swaps, and combined interest rate and currency swaps, where pure interest rate swaps account by far for most of the notional volume.

Table 1 gives the percentage of banks using derivatives, which has substantially and steadily increased during the period from 1999 to 2010. In 1999, less than 29% of the German banks used interest rate derivatives, while in 2010 this percentage increased to nearly 48%. Moreover, we observe a distinct size effect: On average, less than 10% of the banks in the lowest size quartile use interest rate derivatives, whereas more than 65% of the banks in the highest size quartile make use of these instruments.

To obtain the banks' balance-sheet structure, we use data from the Deutsche Bundesbank's monthly balance-sheet statistics (see, Memmel and Stein (2008)). Table 2 shows how the balance sheet is broken down into different types of borrowers and creditors (e.g. banks versus non-banks), into different maturities (e.g. short-term versus long-term) and different degrees of liquidity (e.g. customer deposits versus issued bonds). In total, we distinguish 8 asset and 10 liability positions. Note that the reporting forms are much more detailed. However, to avoid a large number of banks having positions with zero weights, we do not use the maximal disaggregation, but merge positions where necessary and appropriate. Asset positions not considered in our analyses are, for instance, real estate, shareholdings in associated companies and other equity instruments since they do not yield any interest revenues. On the liability side, we exclude the banks' capital and provisions since they do not lead to interest expenses.

Table 3 displays descriptive statistics for selected asset and liability positions that are most relevant in terms of total assets for banks with and without derivatives.[2] The balance-sheet structure indicates the dominance of commercial banking activities. This is not surprising since savings and cooperative banks, which dominate the number of banks in our sample, are strongly engaged in traditional commercial banking. Loans to customers

[2]Except for the year 1999, for which we use year-end balance-sheet weights, we apply the average of the current and previous year-end balance-sheet weights to have an estimate for the average annual balance-sheet weight. This procedure is especially important for positions with short maturity because their book values change substantially from one year to the next. Positions with medium or long maturity do not change substantially from one year to the next.

account for more than 61% of total assets of the median bank. Also, customer deposits (more than 37%) and savings accounts (31% and 34% for median banks with and without derivatives) are the most important liability positions. For the median bank, both the 8 asset positions and the 10 liability positions account for around 90% of the total assets. Derivative users' balance-sheet structures do not differ substantially from the one of non-users. We merely observe that derivative users' savings accounts are less important, while their issued bonds are more important than those of non-users.

Banks using derivatives have lower interest margins (Table 4), but they have higher annual changes in the net interest margin than non-users. Banks using derivatives have lower interest revenues, but similar expenses, on average, than banks not using derivatives. The timely fluctuation of the net interest margin for derivative users is slightly higher than the one of non-users (0.49% vs. 0.46%), while the standard deviation of changes in the net interest margin is almost the same for derivative users and non-users (0.21% vs. 0.22%). Noteworthy, in our sample, the usage of derivatives does not imply that a bank's on-balance risk exposure goes down.

The sample we use in our empirical analyses is controlled for mergers and acquisitions and outliers. Since the recent years have been characterized by a large number of mergers and acquisitions, especially among savings and cooperative banks, we assign a new identifier to banks after a merger or acquisition. We apply a moderate correction of outliers. We drop those balance-sheet weights which are more than five standard deviations above the mean. In addition, we cut off the 1st and 99th percentile of the margin of interest revenues and interest expenses, respectively.

3.2 Bank rates

We determine market-wide bank rates for the various asset and liability positions by estimating the empirical equivalent of Equation (3) for interest revenues and expenses separately, because it was revealed that this would make the estimated rates considerably more reliable. In the estimations, we only include observations of banks not using derivatives. The expectation of η_i in Equation (3) need not be zero even if the interest rates r_j correspond to the cross-sectional expectations, i.e. $r_j = \mathrm{E}(r_{i,j})$. Due to possible correlations between a balance-sheet weight $w_{i,j}$ and the bank-individual interest rate $r_{i,j}$, the term $w_{i,j}\,(r_{i,j} - r_j)$ may have an expectation which is not equal to zero. Therefore, we include a constant and bank-specific fixed effects and estimate the interest rates for each year and each asset and liability position in fixed effects regressions.

The estimation results for the various market-wide bank rates are displayed in Table 5. Since we estimate 12 interest rates for the 8 asset positions (a total of 96 coefficients), and 12 interest rates for the 10 liability positions (a total of 120 coefficients), we report the time-series averages of the 8 asset and 10 liability positions. Accordingly, we report the average standard errors of the estimated coefficients. The precision of our interest rate estimates differs across the positions. For instance, the average standard deviation of the rate on interbank liabilities with an initial maturity of one to two years is 1.13%, whereas the precision of the rate on long-term loans to non-banks is more than ten times higher with the average standard deviation being 0.09%.

In Figure 1, we compare our rate estimates for savings accounts with the respective rates from the German part of the EWU interest rate statistics available from 2003 to 2010 to gain insights into the reliability of our market-wide bank rate estimates. Although the level is different – the German part of EWU interest rate statistics shows higher values – the qualitative course in time is quite similar. When the former Bundesbank interest rate statistics was adapted to the EWU interest rate statistics in 2003, the same observation was made: During a transition period of six month (during which data was reported according to the old and new method), it was observed that the level differed but that the timely movements were qualitatively the same (see Deutsche Bundesbank (2004)).

We use the interest rate estimates $\hat{r}_{1,t}, ..., \hat{r}_{J,t}$ to calculate changes due to prices and weights according to Equations (5) and (6) and present descriptive statistics in Table 6. The average price change (PCH) is negative, whereas the average weight change (WCH) is positive. This means that during the period from 1999 to 2010 the weighted premium for interest rate, liquidity and credit risk has decreased, while the exposure of the banks has increased. The standard deviation of the net interest margin changes due to prices changes is larger for derivative users than for non-users, indicating that the on-balance exposure of banks using derivatives is larger than that of non-users. When we look at different size quartiles, we find that this is especially true for large banks. We do not observe this pattern in the standard deviation of changes in the net interest margin due to weight changes.

4 Results

4.1 Relative importance of price and weight changes

We estimate Equation (7) to determine the relative importance of price changes (PCH) and weight changes (WCH) for changes in the net interest margin. In Table 7 we display the results of ordinary least square (OLS) regressions. In column 1, we include the changes in prices and weights. The coefficients on price changes (0.836) and weight changes (0.475) are highly significantly positive, but considerably below 1, which is the theoretical value laid down in Equation (4). This holds especially for the coefficient on weight changes. Part of this may be due to the usage of derivatives, which we will deal with below, other causes may be that the (assumed) exogenous variables and the error term are correlated. For instance, when a bank increases its exposure to, let's say, customer loans, then it has to offer lower rates to the customers to attract more business, i.e. the increase in business volume goes at the expense of the margin. Such a negative correlation between the explanatory variable and the error term leads to a downward biased coefficient.

Noteworthy of the price and weight changes is that they account for 41.8% of the variation in the changes of the net interest margin (see column 1). The rest of the variation is due to idiosyncratic changes in the bank rates and due to (little) model errors. For instance, the balance-sheet weights are calculated as the average of the previous year-end and the current year-end weights, which may be an imprecise estimate for overnight interbank assets and liabilities. The high coefficient of determination R^2 in our model indicates that information about the balance-sheet structure is worth analyzing and suitable for predicting interest income. In fact, the explained variance of 41.8% in our model compares with 28.4% in a recent study using a different approach for German savings and cooperative banks (Memmel (2008)). In columns 2 and 3, we separately report the effect of price and weight changes, respectively. We find that price changes alone explain roughly one third of the variation in the data, while weight changes explain almost 10% of the variation. In Section 2, we associate the price changes with the strategic component and the weight changes with the tactical component. It turns out that the strategic component is about three times as relevant as the tactical component when it comes to changes in the net interest margin.

4.2 Usage of derivatives

To check whether derivatives (here: mostly interest rate swaps) are applied to reduce on-balance interest rate exposure, we include interaction terms of a dummy variable equal to one when the bank uses derivatives, on the one hand, and price and weight changes on the other. We report results in Table 8. In column 1, the results suggest that derivatives users' change in the net interest margins responds differently to price and weight changes than that of non-users. An increase of 100 basis points due to price changes (weight changes) translates into an actual margin increase of 89 (51) basis points for banks not using interest derivatives and of only 76 (42) basis points for derivative users, and these differences are highly significant. These findings indicate that derivative positions partly offset the on-balance exposure. Remember, however, that the usage of derivatives does not imply that a bank's overall on-balance risk exposure goes down (see Table 4). Thus, banks using derivatives reduce the on-balance exposure to interest rate risk and – simultaneously – increase the on-balance exposure to other risk factors so that the overall risk (measured by the standard deviation of the net interest margin) remains unchanged. The finding that banks use derivatives for hedging purposes is in line with the recent literature. For instance, from a sample of 55 US banks Ahmed et al. (1997) find that after accounting for their derivatives 33 of them (60%) have a lower interest rate exposure than before. For U.S. banks, Brewer et al. (2011) show that the loan growth of derivative users is less restricted by internal funds (core deposits growth) than that of non-users.

Recent literature has shown that bank size and derivatives usage are highly correlated (e.g. Purnanandam (2007), and this is confirmed in our data as displayed in Table 1); one reason for this might be the costs for starting the use of derivatives in the form of trained employees and effective control mechanisms (e.g. Carter and Sinkey (1998)). We therefore split our sample into four size quartiles and estimate for each quartile how price and weight changes shape changes in the net interest margin. We display the results in columns 2 to 5 of Table 8. The coefficients on the price change are significant and of similar magnitude for all four size quartiles. Derivatives usage decreases the sensitivity of the net interest margin to price changes only for larger banks (in the 3rd and 4th size quartile), but not for smaller banks (in the 1st and 2nd size quartile). The coefficients on the weight change are significant for all size quartiles; their magnitudes are only similar for the first three size quartiles. Derivatives usage decreases the sensitivity of the net interest margin to weight changes especially for small banks (1st size quartile), which cannot be found in the case of large banks (in the 4th size quartile). These findings might indicate that larger banks, but not smaller ones, use derivatives as a strategic instrument to reduce on-balance interest rate exposure. By contrast, the net interest margin of small derivative users is as much exposed to price changes as the one of small non-users, while the net interest margin of small users is much less exposed to weight changes than that of small non-users. It seems as if small banks use derivatives to hedge quickly built up on-balance sheet positions. For instance, when a small bank grants a large loan to a firm, it may use derivatives to hedge this loan's interest rate risk.

We also employ the notional amount of derivatives relative to total assets to capture the extent of derivatives use. We run the model presented in column 1 of Table 7 for five subsamples according to the extent of derivatives use and present results in Table 9. We find that the coefficients on price and weight changes decline the larger the extent of derivatives usage. For non-users, an increase of 100 basis points due to price changes (weight changes) translates into an actual margin increase of 89 (51) basis points. For users in the highest derivative quartile, however, an increase of 100 basis points due to price changes (weight changes) translates into an actual margin increase of only 63 (33) basis points. Thus, extensive use of derivatives allows banks to reduce the effect of on-balance price (weight) changes by 29% (35%). In addition, the extensive use of derivatives weakens the link between the (theoretical) on-balance net interest margin and the actual margin of the profits & losses statement, observable at diminishing coefficients of determination in Table 9.

We carry out three robustness tests for the model displayed in column 1 of Table 8, which are available upon request. First, we estimated the model for the different banking groups since the groups differ with respect to ownership structures and business objectives (Memmel and Schertler (2011)). For savings and cooperative banks we see our findings confirmed. Savings banks' changes in the net interest margin respond to price changes more strongly than the one of cooperative banks. Also, the changes in the net interest margin of savings banks using derivatives respond to price changes less strongly than that of cooperative banks using derivatives. Second, we performed subsample regressions for each year in order to investigate whether the relation between price and weight changes, on the one hand, and the change in the net interest margin, on the other, changed over time. Price and weight changes have positive and significant coefficients each year; the interaction terms of price (weight) changes and derivatives usage are significantly negative in 8 (7) out of the 11 years. Thus, our findings have not been fully confirmed in these few years. Third, banks' decision on whether or not to use derivatives may depend on the (change) in the net interest margin (e.g. Carter and Sinkey (1998), Ashraf et al. (2011)). Therefore, we instrument the derivative dummy variable with log assets and non-performing loans. The coefficients on the interaction terms are also significant and of similar magnitude when these instruments are used.

4.3 Changes in on-balance exposure

Next, we investigate whether banks' behavior is procyclical and whether the procyclicality is more pronounced for banks using derivatives. Therefore, we investigate the correlation between weight changes, the banks' tactical adjustments, and price changes, the change in market-wide bank rates. We estimate Equation (9) and also include a dummy variable HEK, which is 1 when a bank's regulatory capital ratio is above the median capital ratio in a given year, and 0 otherwise. We do this to take into account that weight changes are likely to depend on other banks' characteristics which are also used in studies analyzing the impact of derivatives use on lending, risky assets and maturity gaps (e.g. Brewer et al. (2001), Brewer et al. (2000), Brewer et al. (2011), Delis and Kouretas (2011), Purnanandam (2007), Ahmed et al. (1997)).

We display the results in Table 10. Indeed, we find that banks react procyclically, i.e. that an increase in the remuneration for risk-taking is followed by an extension of the exposure. When the net interest margin goes up by 100 basis points due to price changes, the exposure increases so that the margin goes up by an additional 4 basis points. This result is line with Memmel (2011) who finds that a bank's exposure to interest rate risk is positively related to the steepness of the term structure. Interestingly, banks using derivatives react more strongly to price changes than non-users (9 basis points vs. 4 basis points). This finding suggests that banks using derivatives are more flexible and, thereby, just increase the exposure to the risk whose remuneration has gone up, whereas non-users have to attract new businesses whose interest rate, liquidity, and credit risk matches their desired risk profile. The subsample estimations for size quartiles presented in columns 2 to 5 show that this effect is caused by large banks. For an increase of 100 basis points due to a price change, large users increase their weights so that the margin goes up by 14.3

basis points, while large non-users' margin goes only up by 5.2 basis points. In line with the findings in the literature on lending, the exposure increases when the bank belongs to the better capitalized half of banks.[3]

As in the last subsection, we also investigate the extent of derivatives use and carry out robustness checks (available upon request). We split derivative users in 4 subsamples and run the model depicted in column 1 in Table 10 without the derivative dummy. We find that the sensitivity between weight changes and price changes increases the greater the extent of derivatives usage. Moreover, we estimate the model presented in column 1 of Table 10 for the different banking groups. We find most of our findings confirmed for savings and cooperative banks. The only exception is the dummy variable for derivative users for cooperative banks, which is insignificant.

So far, we only tested whether banks using derivatives differ from non-users with respect to the sensitivity between weight and price changes. In the following, we focus on derivative users only and investigate whether they adjust their balance-sheet structure and their nominal amounts of derivatives at the same time. Therefore, we use a 2-equation system to model weight changes and derivatives changes simultaneously. Weight changes are defined as before; derivatives changes denote annual changes in the notional amount of derivatives relative to total assets. As exogenous variables we include price changes, *HEK*, and non-performing loans (*NPL*). As identifying variables we use assets growth and the logarithm of total assets. We depict the results in Table 11.

In column 1 we include all banks using derivatives irrespective of their size. Changes in the derivatives positively influence weight changes, and weight changes positively influence derivatives changes. This indicates that both changes are simultaneously determined. Price changes affect weight changes positively, and derivatives changes negatively. Thus, when the renumeration of risk increases, banks reduce their notional amount of derivatives usage. This behavior is in line with the aim to protect cash flows from dropping. *HEK* is not related to weight changes indicating that the positive effect of *HEK* in Table 10 is due to the inclusion of both banks with and without derivatives. Belonging to the group of banks with high capitalization comes along with lower derivatives changes. Non-performing loans influence weight changes negatively, and derivatives changes positively.

[3]Note that the explained fraction of variation in weight change regressions is very low.

This finding may indicate that banks aim at reducing their overall risk exposure when non-performing loans, i.e. credit risk, increase.

In columns 2 to 4 we report results for size quartiles based on our previous size classification. Since the number of observations in the 1st quartile is very low, we combine these observations with the ones from the 2nd quartile. Once we distinguish between derivative users of different sizes, the derivatives changes do not longer influence weight changes, while weight changes influence derivatives changes in a significantly positive manner. These findings suggest that changes in the notional amount of derivatives follow weight changes, but not the other way around. Price changes are significantly related to weight changes exclusively in the case of large banks and they are related to derivatives changes in a significantly negative way for the larger banks in the 3rd and 4th quartiles.

The results presented in Table 11 are, however, subject to at least two limitations. (i) The annual change in notional amounts may incorrectly reflect hedging intensities applied by banks. The reason for this is that some of the derivatives may offset other derivatives of a bank and this is not captured by the notional amounts. (ii) The frequency of our data, which is annual, may be of too poor a quality to investigate whether changes in derivatives follow or lead changes in the balance-sheet compositions. When interpreting the results presented in Table 11 these two limitations have to be kept in mind.

5 Conclusion

We decompose changes in the net interest margin into price and weight changes. Price changes are the sum of annual changes in market-wide bank rates on different assets and liabilities weighted with the respective asset and liability positions in the previous year. In the short run, these price changes cannot be influenced by the management and are interpreted as the bank managers' strategic decision. Weight changes are the sum of the current market-wide bank rates on the different assets and liabilities weighted with the annual changes in the banks' balance sheet positions. These weight changes reflect bank managers' tactical decisions. We distinguish and estimate market-wide bank rates for 8 asset and 10 liability positions which differ with respect to the type of borrowers and lenders, maturities and degrees of liquidity. Therefore, price changes cover all margin-relevant market-wide changes, such as premium changes due to term structure changes, liquidity changes, and credit quality changes.

Our main findings from a data set of German banks (including private commercial banks, savings banks, and cooperative banks) for the period from 1999 to 2010 can be summarized as follows: The price and weight changes explain more than 40% of the variation in banks' changes in the net interest margin, where price changes are far more relevant than weight changes. Changes in the net interest margin of banks using derivatives depend on weight and price changes less strongly than the ones of non-users. This finding is in line with the argument that interest rate derivatives are mainly used to reduce the risk of on-balance exposure, or alternatively to give flexibility to increase on-balance risk exposure. Finally, banks behave procyclical, i.e. weight and price changes are positively correlated; the correlation between weight and price changes is stronger for banks using derivatives than for banks not using derivatives.

Our research also indicates avenues for future research. Our approach makes it possible to investigate the banks' management of the net interest margin by using detailed information on a bank's balance-sheet composition, thereby taking into account the different market-wide bank rates which depend on different creditors and borrowers, maturities and various degrees of liquidity. This approach may be useful for top-down stress-test exercises when the net interest income needs to be calculated in different scenarios.

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Figures and Tables

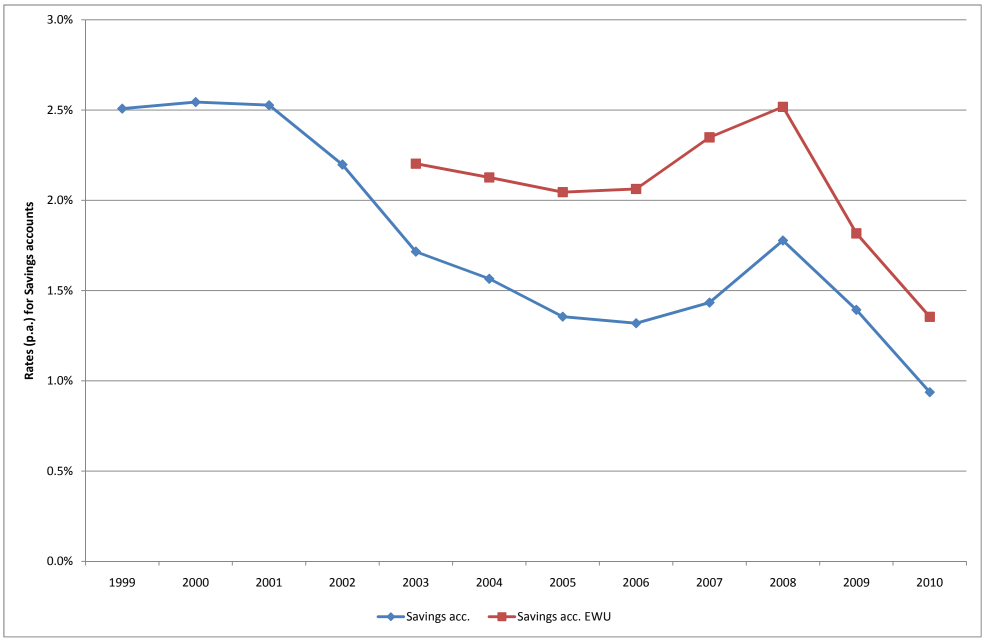

Figure 1: Rate comparison

Note: This figure compares our rate estimates for savings accounts (line with small squares) with the rates from the EWU interest rate statistics, German contribution, (line with big squares), available for 2003-2010.

	No of bank-year obs.	Derivative users	Size quartiles			
			1st	2nd	3rd	4th
1999	2,577	28.8%	8.5%	22.4%	35.4%	48.9%
2000	2,317	30.6%	8.1%	23.5%	40.1%	50.8%
2001	2,138	31.2%	6.5%	24.2%	41.9%	52.4%
2002	1,992	32.2%	8.2%	23.5%	40.2%	56.8%
2003	1,876	33.2%	7.9%	25.8%	40.5%	58.4%
2004	1,807	35.3%	9.3%	28.3%	42.0%	61.4%
2005	1,735	36.5%	9.2%	29.0%	40.6%	67.2%
2006	1,688	41.9%	10.2%	36.5%	49.1%	71.8%
2007	1,659	44.8%	11.1%	38.1%	54.2%	75.8%
2008	1,619	45.2%	10.6%	38.5%	55.1%	76.5%
2009	1,436	44.8%	12.0%	34.3%	53.5%	79.7%
2010	1,395	47.8%	17.5%	37.5%	56.2%	80.2%
Total	22,239	36.6%	9.1%	28.4%	43.8%	65.1%

Table 1: Usage of derivatives

Note: The percentage of banks using derivatives is shown for our sample period 1999-2010. Derivatives are interest rate swaps, currency swaps, and combined interest rate and currency swaps. Size quartiles are with respect to total assets in the respective year.

	Maturity bracket			
	1	2	3	4
Loans to banks	Daily	Up to 1 y	1 y to 5 y	More than 5 y
Loans to non-banks	–	Up to 1 y	1 y to 5 y	More than 5 y
Bonds	No breakdown			
Loans from banks	Daily	Up to 1 y	1 y to 2 y	More than 2 y
Customer deposits	Daily	Up to 1 y	1 y to 2 y	More than 2 y
Savings accounts	No breakdown			
Issued bonds	No breakdown			

Table 2: Breakdown of the balance sheet

Note: The balance sheet is broken down according to the type of borrower and creditor, maturity and degree of liquidity. Maturity refers to initial maturities.

	Banks w/o derivatives			Banks with derivatives		
	25th	50th	75th	25th	50th	75th
	Percentile			Percentile		
Loans to banks	6.4%	10.6%	16.0%	5.9%	9.7%	14.3%
Loans to non-banks	53.6%	61.7%	68.2%	53.4%	61.1%	67.6%
Bonds	11.5%	16.9%	23.7%	11.5%	16.6%	23.0%
Assets included	88.7%	92.1%	93.9%	85.6%	89.9%	92.5%
Loans from banks	9.3%	13.8%	19.2%	10.5%	14.6%	19.8%
Customer deposits	31.0%	37.2%	44.3%	32.1%	37.9%	44.5%
Savings accounts	28.2%	34.4%	40.4%	24.6%	30.8%	36.9%
Issued bonds	0.0%	0.0%	2.8%	0.4%	3.1%	6.3%
Liabilities included	88.2%	89.8%	91.2%	88.3%	89.6%	90.9%

Table 3: Selected balance-sheet positions

Note: The most relevant balance-sheet positions in terms of total assets are shown for banks with and without derivatives. Overall, we distinguish 8 asset and 10 liability positions (see Table 2). *Assets included* and *Liabilities included* refer to the sum of these positions. All German universal banks are included from 1999 to 2010.

	Banks w/o derivatives		Banks with derivatives	
	Mean	Std dev	Mean	Std dev
Interest revenues	4.96%	0.64%	4.72%	0.65%
Interest expenses	2.50%	0.55%	2.54%	0.55%
Net interest margin	2.46%	0.46%	2.18%	0.49%
Change in net margin income	-0.03%	0.22%	-0.02%	0.21%

Table 4: Interest margin

Note: Interest revenues, interest expenses, and the net interest margin are depicted as a percentage of total assets. All German universal banks are included from 1999 to 2010.

		Interest revenue		Interest expenses	
Position	Bracket	Mean	Std dev	Mean	Std dev
Loans to/from banks	1	2.21%	0.19%	1.37%	0.55%
	2	2.43%	0.16%	0.99%	0.30%
	3	3.30%	0.19%	2.34%	1.15%
	4	4.30%	0.28%	3.33%	0.15%
Loans to/from non-banks	1			0.37%	0.16%
	2	5.88%	0.24%	1.24%	0.17%
	3	5.05%	0.23%	1.00%	0.34%
	4	5.12%	0.10%	2.42%	0.20%
Savings accounts				1.77%	0.15%
Bonds		4.10%	0.09%	2.76%	0.25%
Const.		0.61%		0.88%	
No of obs		13,644		13,644	
No of banks		2,672		2,672	
R-sq Within		89.8%		90.4%	
R-sq Between		78.5%		75.7%	
R-sq Overall		81.5%		80.8%	

Table 5: Estimated market-wide bank rates

Note: This table delivers results on the interest rates $r_{1,t},...,r_{J,t}$ for different types of borrowers and creditors, maturities and degrees of liquidity, where the interest revenue (IR) and expenses (IE) are the dependent variables in the following fixed effects estimations:
$IR_{i,t} = \beta_0^A + \sum_{t=1999}^{2010} \beta_{1,t} \cdot w_{i,1,t} + ... + \sum_{t=1999}^{2010} \beta_{J_1,t} \cdot w_{i,J_1,t} + \varepsilon_{i,t}^A$ and
$IE_{i,t} = \beta_0^L + \sum_{t=1999}^{2010} \beta_{J_1,t} \cdot w_{i,J_1,t} + ... + \sum_{t=1999}^{2010} \beta_{J,t} \cdot w_{i,J,t} + \varepsilon_{i,t}^L$.
The coefficients $\beta_{1,t}$ to $\beta_{J,t}$ are equal to the respective average interest rates $r_{1,t}$ to $r_{J,t}$. $\varepsilon_{i,t}^A$ and $\varepsilon_{i,t}^L$ capture the banks' idiosyncratic deviations and the bank-specific fixed effects, and $w_{i,j}$ denotes the break down of the assets and liabilities. We report the time-series averages of estimated bank rates for the 8 asset and 10 liability positions and the average standard errors of the estimated coefficients. Only banks not using derivatives in a given year are included in the estimations.

	Banks w/o derivatives		Banks with derivatives	
	Mean	Std dev	Mean	Std dev
		Price changes (PCH)		
All banks	-0.041%	0.141%	-0.042%	0.158%
1st size quartile	-0.044%	0.143%	-0.039%	0.150%
2nd size quartile	-0.036%	0.143%	-0.049%	0.149%
3rd size quartile	-0.036%	0.139%	-0.040%	0.159%
4th size quartile	-0.049%	0.132%	-0.040%	0.162%
		Weight changes (WCH)		
All banks	0.017%	0.126%	0.024%	0.121%
1st size quartile	0.018%	0.136%	0.012%	0.118%
2nd size quartile	0.012%	0.121%	0.011%	0.129%
3rd size quartile	0.013%	0.124%	0.017%	0.124%
4th size quartile	0.029%	0.115%	0.035%	0.116%

Table 6: Decomposition of the net interest margin

Note: This table delivers descriptive statistics of changes in the net interest margin due to prices and weights. Price and weight changes are calculated according to Equations (5) and (6) with the rate estimates from Table 5. Size quartiles are based on total assets.

	Δnm	Δnm	Δnm
PCH	0.836***	0.866***	
	(0.010)	(0.010)	
WCH	0.475***		0.549***
	(0.013)		(0.015)
Const	0.000	0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
No of obs	18,728	18,728	18,728
R-sq	41.8%	34.5%	9.9%

Table 7: Impact of price and weight changes on the change in the margin

Note: This table delivers results on how changes in prices and weights impact on changes in net interest income. The underlying model in column 1 looks like: $\Delta nm_{i,t} = \beta_0 + \beta_1 \cdot PCH_{i,t} + \beta_2 \cdot WCH_{i,t} + \varepsilon_{i,t}$. Robust standard errors in brackets according to White (1980). *** denotes significance at the 1% level.

	All	Size quartiles			
		1st	2nd	3rd	4th
PCH	0.891***	0.886***	0.885***	0.899***	0.921***
	(0.012)	(0.021)	(0.023)	(0.023)	(0.029)
PCH*DER	-0.125***	0.085	-0.028	-0.108***	-0.223***
	(0.018)	(0.061)	(0.035)	(0.034)	(0.036)
WCH	0.509***	0.519***	0.527***	0.548***	0.357***
	(0.016)	(0.024)	(0.035)	(0.032)	(0.043)
WCH*DER	-0.091***	-0.197***	0.010	-0.085*	-0.002
	(0.026)	(0.086)	(0.054)	(0.049)	(0.052)
Const	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No of obs	18,728	4,564	4,660	4,697	4,807
R-sq	42.1%	42.5%	43.8%	43.8%	39.1%

Table 8: Derivatives use and the change in the margin

Note: This table delivers results on how changes in prices and weights impact on changes in net interest income. The underlying model looks like: $\Delta nm_{i,t} = \beta_0 + \beta_1 \cdot PCH_{i,t} + \beta_2 \cdot PCH_{i,t} \cdot DER_{i,t} + \beta_3 \cdot WCH_{i,t} + \beta_4 \cdot WCH_{i,t} \cdot DER_{i,t} + \varepsilon_{i,t}$. Robust standard errors in brackets according to White (1980). *** and * denote significance at the 1% and the 10% level, respectively.

		Derivative quartiles			
	Non-users	1st	2nd	3rd	4th
PCH	0.894***	0.856***	0.852***	0.770***	0.633***
	(0.012)	(0.044)	(0.029)	(0.027)	(0.028)
WCH	0.507***	0.492***	0.501***	0.429***	0.328***
	(0.016)	(0.039)	(0.042)	(0.037)	(0.044)
Const	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No of obs	11,809	1,652	1,668	1,744	1,855
R-sq	43.0%	46.7%	45.2%	43.3%	32.3%

Table 9: Extent of derivatives use and change in the margin

Note: This table provides results on how changes in prices and weights impact on changes in net interest income. The following model is estimated for five subsamples classified on the extent of derivatives use: $\Delta nm_{i,t} = \beta_0 + \beta_1 \cdot PCH_{i,t} + \beta_2 \cdot WCH_{i,t} + \varepsilon_{i,t}$. Robust standard errors in brackets according to White (1980). *** denotes significance at the 1% level.

		Size quartiles			
	All	1st	2nd	3rd	4th
PCH	0.038***	0.029*	0.051***	0.035***	0.052***
	(0.009)	(0.015)	(0.016)	(0.017)	(0.021)
PCH*DER	0.059***	0.001	-0.024	0.036	0.091***
	(0.013)	(0.044)	(0.031)	(0.025)	(0.025)
DER	0.001***	0.000	0.000	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HEK	0.001***	0.001	0.002***	0.002***	0.002***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
No of obs	18707	4560	4660	4695	4792
R-sq	0.90%	0.25%	0.45%	0.67%	3.10%

Table 10: On-balance sheet weight changes

Note: This table displays results on how changes in prices (PCH) correlate with changes in weights (WCH). The underlying model looks like: $WCH_{i,t} = \beta_0 + \beta_1 \cdot DER_{i,t} + \beta_2 \cdot PCH_{i,t} + \beta_3 \cdot DER_{i,t} \cdot PCH_{i,t} + \beta_4 \cdot HEK_{i,t} + \varepsilon_{i,t}$. Robust standard errors in brackets according to White (1980). *** and * denote significance at the 1% and the 10% level, respectively.

	All	Size quartiles		
		1st, 2nd	3rd	4th
	Weight change (WCH)			
$\Delta DERIVATIVE$	0.004***	0.000	0.055	0.000
	(0.001)	(0.010)	(0.252)	(0.001)
PCH	0.099***	0.039	0.279	0.143***
	(0.013)	(0.029)	(1.098)	(0.020)
HEK	0.001	-0.001	0.029	0.001
	(0.001)	(0.004)	(0.139)	(0.001)
NPL	-0.014***	-0.017***	0.049	-0.022***
	(0.003)	(0.006)	(0.311)	(0.005)
GROWTH	-0.003***	-0.006	0.033	-0.007***
	(0.001)	(0.007)	(0.186)	(0.001)
	Derivatives change ($\Delta DERIVATIVE$)			
WCH	122.4***	113.9***	97.6***	105.1***
	(12.4)	(25.5)	(20.2)	(17.5)
PCH	-15.542***	-5.813	-8.683**	-25.839***
	(2.43)	(4.68)	(4.30)	(4.36)
HEK	-0.309***	-0.230	-0.442*	-0.329*
	(0.118)	(0.229)	(0.252)	(0.191)
NPL	1.360***	2.188**	0.537	0.524
	(0.492)	(0.907)	(1.101)	(0.932)
log(SIZE)	0.010***	0.008	-0.019	0.023***
	(0.003)	(0.013)	(0.023)	(0.006)
No of obs	4,775	1,074	1,207	2,092

Table 11: Simultaneous changes in weights and derivatives

Note: This table delivers results on weight and derivatives changes using 3SLS estimations for derivative users only.
The model looks like:
$WCH_{i,t} = \beta_0 + \beta_1 \cdot \Delta DERIVATIVE_{i,t} + \beta_2 \cdot PCH_{i,t} + \beta_3 \cdot HEK_{i,t} + \beta_4 \cdot NPL_{i,t} + \beta_5 \cdot GROWTH_{i,t} + \varepsilon_{i,t}$
$\Delta DERIVATIVE_{i,t} = \alpha_0 + \alpha_1 \cdot WHC_{i,t} + \alpha_2 \cdot PCH_{i,t} + \alpha_3 \cdot HEK_{i,t} + \alpha_4 \cdot NPL_{i,t} + \alpha_5 \cdot log(SIZE_{i,t}) + \delta_{i,t}$
***,** and * denote significance at the 1%, 5% and 10% level, respectively.

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