NBER WORKING PAPER SERIES

BANKS EXPOSURE TO INTEREST RATE RISK AND THE TRANSMISSION OF MONETARY POLICY

Augustin Landier
David Sraer
David Thesmar

Working Paper 18857
http://www.nber.org/papers/w18857

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 2013

For their inputs at early stages of this paper, we thank participants to the “Finance and the Real Economy” conference, as well as Nittai Bergman, Martin Brown, Jakub Jurek, Steven Ongena, Thomas Philippon, Rodney Ramcharan, and Jean-Charles Rochet. Charles Boissel provided excellent research assistance. David Thesmar thanks the HEC Foundation for financial support. Augustin Landier is grateful for financial support from Scor Chair at Fondation Jean-Jacques Laffont. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Banks Exposure to Interest Rate Risk and The Transmission of Monetary Policy
Augustin Landier, David Sraer, and David Thesmar
NBER Working Paper No. 18857
February 2013
JEL No. E51,E52,G2,G21,G3

ABSTRACT

We show empirically that banks' exposure to interest rate risk, or income gap, plays a crucial role in monetary policy transmission. In a first step, we show that banks typically retain a large exposure to interest rates that can be predicted with income gap. Secondly, we show that income gap also predicts the sensitivity of bank lending to interest rates. Quantitatively, a 100 basis point increase in the Fed funds rate leads a bank at the 75th percentile of the income gap distribution to increase lending by about 1.6 percentage points annually relative to a bank at the 25th percentile.

Augustin Landier
the Toulouse School of Economics
21 Allée de Brienne
31000 Toulouse, FRANCE
augustin.landier@tse-fr.eu

David Sraer
Princeton University
Bendheim Center for Finance
26 Prospect Avenue
Princeton, NJ 08540
and NBER
dsraer@princeton.edu

David Thesmar
HEC Paris
1 rue de la libération
78351 Jouy-en-Josas cedex
France
thesmar@hec.fr

1. Introduction

This paper explores a novel channel of monetary policy transmission. When a bank borrows short term, but lends long term at fixed rates, any increase in the short rate reduces its cash flows; Leverage thus tends to increase. Since issuing equity is expensive, the bank has to reduce lending in order to prevent leverage from rising. This channel rests on three elements, that have been documented in the literature. First, commercial banks tend to operate with constant leverage targets (Adrian and Shin (2010)). Second, banks are exposed to interest rate risk (Flannery and James (1984); Begeneau et al. (2012)). Third, there is a failure of the Modigliani-Miller proposition, which prevents banks from issuing equity easily in the short-run (see, for instance, Kashyap and Stein (1995)). In this paper, we provide robust evidence that this monetary policy channel operates in a large panel of US banks. In doing so, we make three contributions to the literature.

We first document, empirically, the exposure of banks to interest rate risk. Using bank holding company (BHC) data – available quarterly from 1986 to 2011 – we measure the "income gap" of each bank, as the difference between the dollar amount of the banks assets that re-price or mature within a year and the dollar amount of liabilities that re-price or mature within a year, normalized by total assets. To focus on significant entities, we restrict the sample to banks with more than \$1bn of total assets. In this context, we document substantial variations in income gap, both in the time-series and in the cross-section. Banks typically have positive income gap, which means that their assets are more sensitive to interest rates than their liabilities. However, in the cross-section, some banks appear to have a much larger exposure to interest rate risk than others: Income gap is zero at the 25^{th} percentile, while it is 25 percent of total assets at the 75^{th} percentile. There is also substantial variation in the time-series: The average income gap of banks goes from 5% in 2009 to as much as 22% in 1993.

Second, we show that banks do not fully hedge their interest rate exposure. Banks with non-zero income gaps could use interest rate derivatives – off-balance sheet instruments – so as to offset their on-balance sheet exposure. While this may be the case to a certain extent, we find strong evidence that banks maintain some interest rate exposure. In our data, income gap strongly predicts the sensitivity of profits to interest rates. Quantitatively, a 100 basis point increase in the Fed funds rate induces a bank at the 75^{th} percentile of the income gap distribution to increase its quarterly earnings by about .02% of total assets, relative to a bank at the 25^{th} percentile. This is to be compared to a quarterly return on assets (earnings divided by assets) of 0.20% in our sample. This result is strongly statistically significant, and resists various robustness checks. It echoes earlier work by Flannery and James (1984), who document that the income gap explains how stock returns of S&Ls react to changes in interest rates. While we replicate a similar result on listed bank holding companies, our focus in this paper is on income gap, bank cash flows and lending. Our results, as well as Flannery and James', thus confirm that banks only imperfectly hedge interest rate exposure, if they do so at all. This result is actually confirmed by recent findings by Begeneau et al. (2012): In the four largest US banks, net derivative positions tend to amplify, not offset, balance sheet exposure to interest rate risk.

Our third contribution is to show that the income gap strongly predicts how bank-level lending reacts to interest rate movements. Since interest rate risk exposure affects bank cash-flows, it may affect their ability to lend if external funding is costly. Quantitatively, we find that a 100 basis point increase in the Fed funds rate leads a bank at the 75^{th} percentile of the income gap distribution to increase its lending by about .4 ppt more than a bank at the 25^{th} percentile. This is to be compared to quarterly loan growth in our data, which equals 1.8%: Hence, the estimated effect is large in spite of potential measurement errors in our income gap measure. Moreover, this estimate is robust to various consistency checks that we perform. First, we find that it is unchanged when we control for factors previously identified in the literature as determining the sensitivity of lending to interest rates: leverage, bank size and asset liquidity. In the cross-section of banks, our effect is larger for smaller banks, consistent with the idea that smaller banks are more financially constrained. Similarly, the effect is more pronounced for banks that report no hedging on their balance sheet. Finally, we seek to address a potential endogeneity concern: When short rates are expected to increase, well-managed banks may increase their income gap, while being able to sustain robust lending in the future environment. We find, however, that our effect is unaffected by controlling for different measures of "expected short rates". All in all, acknowledging that income gap is not randomly allocated across banks, we reduce as much as possible the potential concerns for endogeneity: We use lags of income gap, find that income gap affects lending after controlling for bank observables, and show that it operates via realized, not expected, short rates. Overall, our results suggest that the income gap significantly affects the lending channel, and therefore establish the importance of this mode of transmission of monetary policy.

Our paper is mainly related to the literature on the bank lending channel of transmission of monetary policy. This literature seeks to find evidence that monetary policy affects the economy via credit supply. The bank lending channel is based on a failure of the Modigliani-Miller proposition for banks. Consistent with this argument, monetary tightening has been shown to reduce lending by banks that are smaller (Kashyap and Stein (1995)), unrelated to a large banking group (Campello (2002)), hold less liquid assets (Stein and Kashyap (2000)) or have higher leverage (Kishan and Opiela (2000), Gambacorta and Mistrulli (2004)). We find that the "income gap" effect we document is essentially orthogonal to these effects, and extremely robust across specifications. This effect does not disappear for very large banks. In addition, via its focus on interest risk exposure, our paper also relates to the emerging literature on interest rate risk in banking and corporate finance (Flannery and James (1984), Chava and Purnanandam (2007), Purnanandam (2007), and Begeneau et al. (2012), Vickery (2008)). These papers are mostly concerned with the analysis of risk-management behavior of banks and its implications for stock returns. Our focus – the effect of interest rate risk exposure on investment (corporate finance) or lending (banking) – thus complements the existing contributions in this literature.

The rest of the paper is organized as follows. Section 2 presents the data. Section 3 shows the relationship between banks income gap and the sensitivity of their profits to variations in interest rates. Section 4 analyzes the role of the income gap on the elasticity of banks lending policy to interest rates. Section 6 concludes.

2. Data and Descriptive statistics

2.1. Data construction

2.1.1. Bank-level data

We use quarterly Consolidated Financial Statements for Bank Holding Companies (BHC) available from WRDS (form FR Y-9C). These reports have to be filed with the FED by all US bank holding companies with total consolidated assets of $500 million or more. Our data covers the period going from 1986:1 to 2011:4. We restrict our analysis to all BHCs with more than $1bn of assets. The advantage of BHC-level consolidated statements is that they report measures of the bank's income gap continuously from 1986 to 2011 (see Section 2.2.1). Commercial bank-level data that have been used in the literature (Kashyap and Stein, 2000; Campello, 2002) do not have a consistent measure of income gap over such a long period.

For each of these BHCs, we use the data to construct a set of dependent and control variables. We will describe the "income gap" measure in Section 2.2.1 in further detail. The construction of these variables is precisely described in Appendix A. All ratios are trimmed by removing observations that are more than five interquartile ranges away from the median.[1] We report summary statistics for these variables in Table 1.

There are two sets of dependent variables. First are income-related variables that we expect should be affected by movements in interest rates: net interest income and net profits. We also take non-interest income as a placebo variable, on which interest rates should in principle have no impact. We normalize all these variables by total assets. Second, we

[1] Our results are qualitatively similar when trimming at the 5th or the 1st percentile of the distribution.

look at two variables measuring credit growth: the first one is the quarterly change in log commercial and industrial loans, while the second one is the quarterly change in log total loans.

As shown in Table 1, the quarterly change in interest income is small compared to total assets (sample s.d. is 0.001). This is due to the fact that interest rates do not change very much from quarter to quarter: On average, quarterly net interest income accounts for about 0.9% of total assets, while the bottomline (earnings) is less than 0.2%. Notice also that non-interest income is as large as interest income on average (1% of assets compared to 0.9%), but much more variable (s.d. of 0.023 vs 0.003).

Control variables are the determinants of the sensitivity of bank lending to interest rates that have been discussed in the literature. In line with Stein and Kashyap (2000), we use equity normalized by total assets, size (log of total assets) and the share of liquid securities. The share of liquid securities variable differs somewhat from Kashyap and Stein's definition (fed funds sold + AFS securities) due to differences between BHC consolidated data and call reports. First in our data, available-for-sale securities are only available after 1993; second, Fed Funds sold are only available after 2001. To construct our measure of liquid securities, we thus deviate from Kashyap and Stein's definition and take all AFS securities normalized by total assets. Even after this modification, our liquidity measure remains available for the 1994-2011 sub-period only.

Our control variables, obtained from accounts consolidated at the BHC-level, have orders of magnitudes that are similar to existing studies on commercial bank-level data: Average equity-to-asset ratio is 8.7% in our data, compared to 9.5% in Campello (2002)'s sample (which covers the 1981-1997 period); The share of liquid assets is 27% in our sample, compared to 32% in his sample. The differences naturally emanate from different sample periods (1994-2011 vs. 1981-1997) and different measures for liquidity.[2] Given these discrepancies, the fact that both variables have similar order of magnitude is reassuring.

[2]Due to data availability constraints, we do not include the Fed Fund sold in our measure of liquidity.

2.1.2. Interest Rates

We use three time-series of interest rates. In most of our regressions, we use the fed funds rate as our measure of short-term interest rate, available monthly from the Federal Reserve's website. To each quarter, we assign the value of the last month of that quarter. Second, in Table 8, we also use a measure of long-term interest rates. We take the spread on the 10-year treasury bond, also available from the Fed's website. Last, we construct a measure of expected short interest rates using the citetfama87 series of zero coupon bond prices. For each quarter t, we use as our measure of expected short rate the forward 1-year rate as of $t-8$ (two years before). This forward is calculated using the zero coupon bond prices according to the formula $p_{2,t-8}/p_{3,t-8}-1$, where $p_{j,s}$ is the price of the discount bond of maturity j at date s.

2.2. Exposure to Interest Rate Risk

2.2.1. Income Gap: Definition and Measurement

The income gap of a financial institution is defined as (see Mishkin & Eakins, 2009, chapters 17 and 23):

$$\text{Income Gap} = \text{RSA} - \text{RSL} \tag{1}$$

where RSA are all the assets that either reprice, or mature, within one year, and RSL are all the liabilities that mature or reprice within a year. RSA (RSL) is the number of dollars of assets (liability) that will pay (cost) variable interest rate. Hence, income gap measures the extent to which a bank's net interest income are sensitive to interest rates changes. Because the income gap is a measure of exposure to interest rate risk, Mishkin and Eakins (2009) propose to assess the impact of a potential change in short rates Δr on bank income by calculating: Income Gap $\times \Delta r$.

This relation has no reason to hold exactly, however. Income gap is a reasonable approximation of a bank's exposure to interest rate risk, but it is a noisy one. First, the cost of debt rollover may differ from the short rate. New short-term lending/borrowing will also be connected to the improving/worsening position of the bank on financial markets (for liabilities) and on the lending market (for assets). This introduces some noise. Second, depending on their repricing frequency, assets or liabilities that reprice may do so at moments where short rates are not moving. This will weakens the correlation between change in interest income and Income Gap $\times \Delta r$. To see this, imagine that a bank holds a \$100 loan, financed with fixed rate debt, that reprices every year on June 1. This bank has an income gap of \$100 (RSA=100, RSL=0). Now, assume that the short rate increases by 100bp on February 20. Then, in the first quarter of the year, bank interest income is not changing at all, while the bank has a \$100 income gap and interest rates have risen by 100bp. During the second quarter, the short rate is flat, but bank interest income is now increasing by $\$1 = 1\% \times \$100$. For these two consecutive quarters, the correlation between gap-weighted rate changes and interest income is in fact negative. Third, banks might be hedging some of their interest rate exposure, which would weaken the link between cash flows and Income Gap $\times \Delta r$. Overall, while we expect that the income gap is connected with interest rate exposure, the relationship can be quite noisy due to heterogeneity in repricing dates and repricing frequencies, and their interaction with interest rate dynamics. The income gap is a gross approximation of interest rate exposure; Its main advantage is that it is simple and readily available from form FR Y-9C.

Concretely, we construct the income gap using variables from the schedule HC-H of the form FR Y-9C, which is specifically dedicated to the interest sensitivity of the balance sheet. RSA is directly provided (item bhck3197). RSL is decomposed into four elements: Long-term debt that reprices within one year (item bhck3298); Long-term debt that matures within one year (bhck3409); Variable-rate preferred stock (bhck3408); and Interest-bearing deposit liabilities that reprice or mature within one year (bhck3296), such as certificates of deposits. Empirically, the latter is by far the most important determinant of the liability-side sensitivity to interest rates. All these items are continuously available from 1986 to 2011. This availability is the reason why we chose to work with consolidated accounts (BHC data instead of "Call" reports).

We scale all these variables by bank assets, and report summary statistics in Table 2. The average income gap is 13.4% of total assets. This means that, for the average bank, an increase in the short rate by 100bp will raise bank revenues by 0.134 percentage points of assets. There is significant cross-sectional dispersion in income gap across banks, which is crucial for our identification. About 78% of the observations correspond to banks with a *positive* income gap: For these banks, an increase in interest rates yields an *increase* in cash flows. A second salient feature of Table 2 is that RSL (interest rate-sensitive liabilities) mostly consists of variable rate deposits, that either mature or reprice within a year. Long term debt typically has a fixed rate.

2.2.2. Direct evidence on Interest Rate Risk Hedging

In this Section, we ask whether banks use derivatives to neutralize their "natural" exposure to interest rate risk. We can check this directly in the data. The schedule HC-L of the form FR Y-9C reports, starting in 2005, the notional amounts in interest derivatives contracted by banks. Five kinds of derivative contracts are separately reported: Futures (bhck8693), Forwards (bhck8697), Written options that are exchange traded (bhck8701), Purchased options that are exchange traded (bhck8705), Written options traded over the counter (bhck8709), Purchased options traded over the counter (bhck8713), and Swaps (bhck3450).

We scale all these variables by assets, and report summary statistics in Table 3. Swaps turn out to be the most prevalent form of hedge used by banks. For the average bank, they account for about 18% of total assets. This number, however, conceals the presence of large outliers: a handful of banks –between 10 and 20 depending on the year– have total notional amount of swaps greater than their assets. These banks are presumably dealers. Taking out these outliers, the average notional amount is only 4% of total assets, a smaller number than the average income gap. 40% of the observations are banks with no derivative exposure.

The data unfortunately provides us only with notional exposures. Notional amounts may conceal offsetting positions so that the total interest rate risk exposure is minimal. To deal with this issue, we directly look at the sensitivity of each bank's revenue to interest rate movement and check whether it is related to the income gap. We do this in the next Section and find that banks revenue indeed depend on Income gap $\times \Delta r$: This confirms the direct evidence from Table 3 that banks do not hedge out entirely their interest rate risk.

3. Interest Risk and Cash-Flows

In this Section, we check that the sensitivity of profits to interest rate movements depends on our measure of income gap. This Section serves as a validation of our measure of income gap, but also shows that hedging, although present in the data, is limited.

By definition (1), we know that banks profits should be directly related to Income gap $\times$ Δr. We thus follow the specification typically used in the literature (Kashyap and Stein (1995), Stein and Kashyap (2000); Campello (2002) for instance), and estimate the following linear model for bank i in quarter t:

$$\begin{aligned}\Delta Y_{it} = &\sum_{k=0}^{k=4} \alpha_k.(\text{gap}_{it-1} \times \Delta\text{fed funds}_{t-k}) + \sum_{k=0}^{k=4} \gamma_k(\text{size}_{it-1} \times \Delta\text{fed funds}_{t-k}) \\ &+ \sum_{k=0}^{k=4} \lambda_k(\text{equity}_{it-1} \times \Delta\text{fed funds}_{t-k}) + \sum_{k=0}^{k=4} \theta_k(\text{liquidity}_{it-1} \times \Delta\text{fed funds}_{t-k}) \\ &+ \sum_{k=0}^{k=4} \eta_k \Delta Y_{it-1-k} + \text{gap}_{it-1} + \text{size}_{it-1} + \text{equity}_{it-1} + \text{liquidity}_{it-1} + \text{date dummies} + \epsilon_{it}\end{aligned} \tag{2}$$

where all variables are scaled by total assets. Y_{it} is a measure of banks cash flows and value: interest income, non-interest income, earnings and market value of equity (see Appendix A for formal definitions). $\sum_{k=0}^{k=4} \alpha_k$ is the cumulative effect of interest rate changes, given the income gap of bank i. This sum is the coefficient of interest. If the income gap variable contains information on bank interest rate exposure and if banks do not fully hedge this risk, we expect $\sum_{k=0}^{k=4} \alpha_k > 0$.

Consistent with the literature, we control for existing determinants of the sensitivity of bank behavior to interest rates: bank size (as measured through log assets) and bank equity (equity to assets). Because of data limitation, we include bank liquidity (securities available for sale divided by total assets) as a control only in one specification. In all regressions, the controls are included directly and interacted with current and four lags of interest rate changes. These controls have been shown to explain how bank lending reacts to changes in interest rates. Their economic justification in a profit equation is less clear, but since our ultimate goal is to explain the cross-section of bank lending, we include these controls in the profit equations for the sake of consistency. As it turns out, their presence, or absence, does not affect our estimates of $\sum_{k=0}^{k=4} \alpha_k$ in equation (2).

The first set of results directly looks at net interest income, which is the difference between interest income and interest expenses. This item should be most sensitive to variations in interests paid or received. We report the results in Table 4. Columns 1-5 use (quarterly) changes in interest income normalized by lagged assets, as the dependent variable. Column 1 reports regression results on the whole sample. The bottom panel reports the cumulative impact of an interest rate increase, $\sum_{k=0}^{k=4} \alpha_k$, and the p-value of the F-test of statistical significance. For interest income, the effect of income gap weighted changes in interest rates is strongly significant. A \$1 increase in $Gap_{it-1} \times \Delta FedFunds_t$, after 5 consecutive quarters, raises interest income by about 0.05 dollars. This suggests that the income gap captures some dimension of interest rate exposure, albeit imperfectly so.

This effect applies across bank size and seems unaffected by hedging. Columns 2-3 split the sample into large and small banks. “Large banks” are defined as the 50 largest BHCs each quarter in terms of total assets. Both large and small banks appear to have similar exposure to interest rate: the overall impact of interest rate changes on income ($\sum_{k=0}^{k=4} \alpha_k$) is not statistically different across the two groups (p value = 0.83). Columns 4-5 split the sample into banks that have some notional exposure on interest rate derivatives and banks that report zero notional exposure. This sample split reduces the period of estimation to 1995-2011, as notional amounts of interest rate derivatives are not available in the data before 1995. We find strong and statistically significant effects for both categories of banks. While the income of banks with some derivative exposure respond slightly less to changes in interest rate than the income of banks with no exposure, the difference is not statistically significant (p value = .19). In non-reported regressions, we further restrict the sample to BHCs whose notional interest rate derivative exposure exceeds 10% of total assets (some 4,000 observations): even on this smaller sample, the income gap effect remains strongly significant and has the same order of magnitude. Overall, our results indicate that interest rate hedging is a minor force for most banks, and even most large banks. This is consistent with the findings reported in Begeneau et al. (2012) that the four largest US banks *amplify* their balance sheet exposure with derivatives, instead of offsetting them, even partially. Their evidence, along with ours, suggests that banks keep most interest rate risk exposure related to lending, perhaps because hedging is too costly. This is also in line with Vickery (2008), who shows that financial institutions alter the types of originations they do (fixed rate vs. variable rate) depending on their ex-ante exposure to interest risk. At a broader level, this is also consistent with Guay and Kothari (2003), who document that the impact of derivatives on the cash-flows of non-financials is small, even in the presence of shocks to the underlying assets.

To further validate the income gap measure, we run a "placebo test" in columns 6-10. In these columns, we use non-interest income as a dependent variable, which includes: servicing fees, securitization fees, management fees or trading revenue. While non-interest income may be sensitive to interest rate fluctuations, there is no reason why this sensitivity should be related to the income gap. Thus, with non-interest income as a dependent variable, we expect $\sum_{k=0}^{k=4} \alpha_k = 0$ in equation (2). Columns 6-10 of Table 4 report regression estimates of equation 2 for all banks, small banks, large banks, unhedged banks and banks with some interest rate derivative notional. In all these samples, the coefficient on income gap $\times$ Δr is small and statistically insignificant.

A natural next step is to look at the impact of the income gap on the sensitivity of overall earnings and market value to changes in interest rate. We report these results in Table 5. Columns 1-5 report the effect on earnings (of which interest income is a component), while columns 6-10 report the effect on market value of equity. Both are normalized by total assets. $\sum_{k=0}^{k=4} \alpha_k$ is positive and statistically significant at the 5% level in all our specifications. In other words, the income gap has a significant predictive power on how banks earnings and market value react to changes in interest rate. In column 1, the estimates show that a \$1 increase in $Gap_{it-1} \times \Delta FedFunds_t$ after 5 consecutive quarters raises earnings by about \$0.07. This order of magnitude is similar to the effect on interest income from Table 4. This is not surprising since we know from Table 4, columns 6-10 that the income gap has no effect on non-interest income. This effect remains unchanged across size groups and is not affected by the presence of interest rate derivatives on the bank's balance sheet (columns 2-5).

The sensitivity of banks market value to changes in interest rate also depends positively and significantly on the income gap. The effect that we report in column 6 of Table 5 is of a similar order of magnitude than the one obtained for earnings: A \$1 increase in $Gap_{it-1} \times \Delta FedFunds_t$ raises banks market value of equity by about \$1.8. Given the same shock raises earnings by \$0.07, this implies an earnings multiple of approximately 25, which is large but not unreasonable. As for earnings, the difference in the estimated effect across size or hedging status is insignificant, even though hedged banks tend again to react less to $Gap_{it-1} \times \Delta FedFunds_t$ than banks with no interest rate derivatives.

In Appendix B, we replicate the estimation performed in Table 4 and Table 5 using an alternative procedure also present in the literature. This alternative technique proceeds in two steps. First, each quarter, we estimate the cross-sectional sensitivity of the dependent variable (changes in interest income and earnings) to the income gap using linear regression. In a second step, we regress the time series of these coefficients on changes in interests rate as well as four lags of changes in interest rate. If the income gap matters, banks profits should depend more on the income gap in the cross-section as interest rates increase. Table B.1 shows this is the case and that estimates of $\sum_{k=0}^{k=4} \alpha_k$ are similar to those obtained with our main approach. The cumulative effect of a \$1 increase in $Gap_{it-1} \times \Delta FedFunds_t$ yields a 5 cents increase in interest income and a 7 cents increase in overall earnings.

We conclude this section by emphasizing that our regressions should in principle understate banks exposure to interest rate risk. This is because the income gap measure we use only gives a rough estimate of the true sensitivity of banks income to short interest movements. In the absence of the full distribution of repricing dates, the one year repricing items fail to capture important dimensions of interest rate sensitivity. Despite this caveat, the main lessons from this Section's analysis are that (1) our income gap measure still explains a significant fraction of the sensitivity of bank profits to interest rate movements and (2) this holds true even for large banks or banks with large notional amounts of interest rate derivatives.

4. Interest Risk and Lending

4.1. Main Result

We have established that interest rate changes affect banks cash flows when the income gap is larger. If banks are to some extent financially constrained, these cash flow shocks should affect lending. We follow Stein and Kashyap (2000) and run the following regression:

$$
\begin{aligned}
\Delta \log(\text{credit}_{it}) = & \sum_{k=0}^{k=4} \alpha_k.(\text{gap}_{it-1} \times \Delta \text{fed funds}_{t-k}) + \sum_{k=0}^{k=4} \gamma_k (\text{size}_{it-1} \times \Delta \text{fed funds}_{t-k}) \\
& + \sum_{k=0}^{k=4} \lambda_k (\text{equity}_{it-1} \times \Delta \text{fed funds}_{t-k}) + \sum_{k=0}^{k=4} \theta_k (\text{liquidity}_{it-1} \times \Delta \text{fed funds}_{t-k}) \\
& + \sum_{k=0}^{k=4} \eta_k \Delta \log(\text{credit}_{it-1-k}) + \text{gap}_{it-1} + \text{size}_{it-1} + \text{equity}_{it-1} + \text{liquidity}_{it-1} \\
& + \text{date dummies} + \epsilon_{it}
\end{aligned} \tag{3}
$$

which is identical to equation (2) except that change in log credit is now the dependent variable (this is the variable used in most of the extant literature). As in our cash flow regressions, all other variables are normalized by lagged assets (see Appendix A for exact definitions). $\sum_{k=0}^{k=4} \alpha_k$ is the cumulative effect of interest rate changes on lending growth for a given income gap. This is our coefficient of interest. If the income gap variable contains information on banks interest rate exposure and if banks do not fully hedge this risk, we expect $\sum_{k=0}^{k=4} \alpha_k$ to be strictly positive.

As in the existing literature, we control for potential determinants of the sensitivity of lending to interest rates: bank size, bank equity and asset liquidity (see Appendix A for definitions). In all regressions, we include these controls directly as well as interacted with current and four lags of interest rate changes. These interaction terms help to measure the sensitivity of lending to interest rates. For instance, we expect high equity banks and large banks to be less sensitive to interest rate fluctuations (Kashyap and Stein (1995)). This is because changes in the cost of funding affect cash flows which reduces lending by financially constrained banks. We also expect banks with liquid assets to lend relatively more when rates increase (Stein and Kashyap (2000)). This happens because in such environments, banks lose reserves: In order to meet their requirements, they have to either sell liquid assets, issue costly debt, or reduce lending. Banks that have little debt capacity (i.e. are financially constrained) and no liquid assets have no other solution than scaling down lending.

We first run regressions without the control for asset liquidity, as this variable is not available before 1993. We report the results in Table 6: separately for C&I loan growth (columns 1-5) and for total lending growth (columns 6-10). As before, we run regressions on the whole sample (columns 1 and 6), split the sample into large and small banks (column 2, 3, 7 and 8) and into banks with some interest rate derivatives and banks without (column 4, 5, 9 an 10). Focusing on total lending growth, we find results that are statistically significant at the 1% level, except for large banks. The effects are also economically significant. If we compare a bank at the 25^{th} percentile of the income gap distribution (approximately 0) and a bank at the 75^{th} percentile (approximately 0.25), and if the economy experiences an 100 basis point increase in the fed funds rate, total loans in the latter bank will grow by about .4 percentage points more than in the former. This has to be compared with a sample average quarterly loan growth of about 1.8%. Note also that notional holdings of interest rate derivatives do not significantly explain cross-sectional differences in banks sensitivity of lending growth to changes in interest rate. While the estimates of $\sum_{k=0}^{k=4} \alpha_k$ drops from 1.9 to 1.5 when we move from the sample of banks with no notional exposure to interest rate derivates to the sample of banks with a strictly positive exposure, this difference is not statistically significant (p value = 0.62). This is consistent with the idea that banks with notional exposure do not necessarily seek to hedge their banking book (Begeneau et al. (2012)). We also find that the sensitivity of large banks lending growth to interest rate changes does not depend significantly on their income gap (column 4 and 8). However, the point estimates have the same order of magnitude for large and small banks (1.7 versus 1.4 for total lending) and the difference between small and large banks is not statistically significant (p value = 0.85). Finally, our results are mostly similar when using C&I loans or total loans as dependent variables. The only difference is that the sensitivity of C&I lending growth to changes in interest rate for banks with no notional exposure to interest rate derivatives does not depend significantly on their income gap (column 5) while it is positive and statistically significant when looking at total lending growth (column 10).

Overall, the other control variables we use to explain the sensitivity of lending growth to changes in interest rates in a much less consistent way than our income gap measure. In rows 4 to 6 of the bottom panel of Table 6, we report the sum of the coefficients on interaction terms with size. Large banks decrease their lending less when the fed funds rates increase (i.e. the coefficient is positive). On C&I loans, the estimated effect is statistically significant (Kashyap and Stein (1995) report a similar result on commercial banks data over the 1976-1993 period); but on total loans we find no significant impact and the coefficient is nearly zero. The impact of size on the sensitivity of lending growth to changes in monetary policy has the same order of magnitude as the impact of the income gap. If we compare banks at the 25^{th} and 75^{th} percentile of the size distribution (log of assets equal to 14.2 vs 15.9) and consider a 100bp increase in fed funds rates, the smaller bank will reduce its C&I lending by .3 percentage points more (compared to .4 with the income gap). Thus, the income gap explains similar variations of C&I lending in response to monetary policy shocks than bank size, but it explains significant variations in total lending while size does not. Turning to the role of capitalization, rows 7 to 9 in the bottom panel of Table 6 report the sum of the coefficients on $\frac{equity_{it-1}}{assets_{it-1}}.\Delta fedfunds_{t-k}$. Estimates are in most cases insignificant and have the "wrong" economic sign: better capitalized banks tend to reduce their lending *more* when interest rates increase. This counterintuitive result does not come from the fact that equity is correlated with size (negatively) or with income gap (positively): in unreported regressions, we have tried specifications including the interactions term with equity only, and the coefficients remained negative.

In Table 7, we include the asset liquidity control, which restricts the sample to 1993-2011. Despite the smaller sample size, our results resist well. For C&I lending growth, they remain statistically significant at the 5% level for all banks, small banks, and banks without derivative exposure. For total lending growth, estimates are statistically significant at 1% for all specification but large banks. For total lending growth, the point estimate for large banks is similar to the estimate for small banks, but it is much less precise – a possible consequence of smaller sample size. For both credit growth measures, the difference between large and small banks is insignificant.

Asset liquidity does not, however, come in significant in these regressions, and it also has the "wrong" economic sign: banks with more liquid assets tend to reduce their lending more when interest rates increase, but the effect is not precisely estimated. The discrepancy with Kashyap and Stein's results comes from the fact that we are using BHC data, instead of commercial bank data. BHC data report a consistent measure of income gap, while commercial bank data fail to do so. Our use of BHC data has two consequences: First, we work at a different level of aggregation; Most importantly, our regressions with liquidity controls go from 1993 to 2011, while Kashyap and Stein's sample goes from 1977 to 1993. It is possible that reserves requirement have become less binding over the past 20 years.

In sum, we find that the income gap has significant explanatory power over the cross-section of bank lending sensitivities to changes in interest rates. This relationship is significant and holds more consistently across specifications than the effect of size, leverage or liquid assets. The income gap seems to matter less for larger banks, in particular when looking at C&I credit, consistent with the idea that larger banks are less credit constrained. Interest derivative exposure does not appear to reduce the effect of income gap in a significant way.

5. Discussion

5.1. Credit Multiplier

This Section uses interest rate shocks to identify the credit multiplier of banks in our sample. To do this, we reestimate a version of equation (3) where the dependent variable is defined as quarterly *increase* in \$ loans normalized by lagged assets. It thus differs slightly from the measure we have been using in the previous Section (quarterly change in log loans), which is commonly used in the literature. The advantage of this new variable is that it allows to directly interpret the sum of the interacted coefficients $\sum_{k=0}^{k=4} \alpha_k$ as the \$ impact on lending of a \$1 increase in the interest-sensitive income, gap $\times \Delta r$. We can then directly compare the \$ impact on lending to the \$ impact on cash-flows as estimated in Table 4. The ratio is a measure of the credit multiplier.

We obtain a credit multiplier of about 11, i.e. a \$1 increase in cash flows leads to an increase in lending by \$11. Using the change in \$ lent normalized by total assets as the depend variable, we find a cumulative effect of .81 (p-value = .002). This effect is strong and statistically significant, which is not a surprise given the results of Table 6 –only the scaling variable changes. This estimate means that a \$1 increase in gap $\times \Delta r$ leads to an increase of lending by \$.81. At the same time, we know from Table 4 that the same \$1 increase generates an increase in total earnings of about \$0.07. Hence, assuming that the sensitivity of lending to interest rate comes only through this cash flow shock, this yields a multiplier of 0.81/0.07=11.5. This is slightly lower than bank leverage, since the average asset-to-equity ratio is 13.1 in our sample. Given that cash-flows are also additional reserves, the credit multiplier we get is consistent with existing reserve requirements in the US which are around 10 for large banks. These estimates do, however, need to be taken with caution since lending may be affected by gap $\times \Delta r$ through channels other than cash flows, as we discuss in the next section.

5.2. Short vs long rates: Cash flow vs Collateral Channel

A potential interpretation of our results is that the income gap is a noisy measure of the duration gap. The duration gap measures the difference of interest rate sensitivity between the *value* of assets and the *value* of liabilities (Mishkin and Eakins (2009)). Changes in interest rates may therefore affect the value of a bank's equity. Changes in the value of equity may in turn have an impact on how much future income a bank can pledge to its investors. For a bank with a positive duration gap, an increase in interest rates raises the value of equity and therefore its debt capacity: it can lend more. This alternative channel also relies on a failure of the Modigliani-Miller theorem for banks, but it does not go through cash flows; it goes through bank value. This is akin to a balance sheet channel, à la Bernanke and Gertler (1989), but for banks.

Directly measuring the duration gap is difficult and would rely on strong assumptions about the duration of assets and liabilities. Instead, to distinguish income effects and balance sheet effects, we rely on the fact that the impact of interest rates on bank value partly comes from long-term rates. To see this, notice that the present value at t of a safe cash-flow C at time $t+T$ is $\frac{C}{(1+r_{t,T})^T}$, where $r_{t,T}$ is the risk-free yield between t and $t+T$. Thus, as long as there are shocks to long-term yields that are not proportional to shocks to short-term yields, we can identify a balance sheet channel separately from an income channel. Consider for instance an increase in long-term rates, keeping short-term rates constant. If our income gap measure affects lending through shocks to asset values, we should observe empirically that firms with lower income gap lend relatively less following this long-term interest rates increase. By contrast, if our income gap measure affects lending only through contemporaneous or short-term changes in income, such long-term rate shock should not impact differently the lending of high vs. low income gap banks.

We implement this test for the presence of a balance-sheet channel in Table 8. In this table, we simply add to our benchmark equation (3) interaction terms between the income gap – as a proxy for the duration gap – and five lags of changes in long term interest rates, measured as the yield on 10 years treasuries. The coefficients on these interaction terms are reported in the lower part of the top panel. In the bottom panel, we report the sum of these coefficients (the cumulative impact of interest rates) as well as their p-value. In this Table, we report results for interest income, market value of equity, and the two measures of lending growth. The sample contains all banks.

We find no evidence that long term interest rates affect bank cash flows, value or lending. If anything, the cumulative effect goes in the opposite direction to what would be expected if the income gap was a proxy for the duration gap. Estimates of the income gap effect are unaffected by the inclusion of the long rate interaction terms. This test seems to suggest that monetary policy affects bank lending via income gap induced cash flows shocks much more than through shocks to the relative value of banks' assets and liabilities. However, it is important to emphasize that the power of test is limited by the fact that we do not directly measure the duration gap.

5.3. Expected vs Unexpected Movements in Interest Rates

In this Section, we focus on unexpected changes in short interest rates. A possible explanation for our results is that banks adapt their income gap in anticipation of short rate movements. Well-managed banks, who anticipate a rate increase, increase their income gap before monetary policy tightens. Then, their earnings increase mechanically with an increase in interest rates; At the same time, their lending is less affected by the increased interest rate, not because their earnings increase with the interest rate, but simply because they are better managed in the first place. However, if the increase in interest rate is unexpected, this possible explanation is less likely to hold. We thus break down variations in interest rates into an expected and an unexpected component and perform our main regression analysis using these two separate components.

To measure expected rate changes, we use forward short rates obtained from the Fama-Bliss data. For the short rate in t, we take as a measure of expected rate the forward interest rate demanded by the market at $t-2$, in order to lend between t and $t+1$. We then add to our main equation (3) interaction terms between the income gap and 5 lags of changes in expected short rates. We report regression results in Table 9 for two measures of cash-flows and two measures of credit growth. The sample contains all banks.

Our results are mostly driven by the unexpected component of the short rate. When controlling for the income gap interacted with expected change in the short rate, our estimate is unchanged. The cumulative impact of the short rate change, $\sum_{k=0}^{k=4} \alpha_k$, reported in the first line of the bottom panel of Table 9, remains statistically significant and similar in magnitude to our previous estimations. The cumulative impact of the *expected* rate change, reported in the third line of the bottom panel, is much smaller in magnitude and never statistically significant (the minimum p-value being .67).

This is unsurprising given the well documented failure of the expectation hypothesis (Fama and Bliss (1987)): even though they are the best forecast of future short rates, forward rates have very little predictive content. In line with the existing literature, the in-sample correlation between forward and effective short rates is .3 in levels (short rates are persistent), but only -0.01 in quarterly changes. If banks do not have superior information than the market, they will not be able to forecast future changes in the short rate and adapt their income gap consequently. Results from Table 9 are consistent with this interpretation.

6. Conclusion

This paper shows that banks retain significant exposure to interest rate risk. Our sample consists of quarterly data on US bank holding companies from 1986 to 2011. We measure interest-sensitivity of profit through the income gap, defined as the difference between assets and liabilities that mature in less than one year. The average income gap in our sample is 13.5% of total assets, but it exhibits significant cross-sectional variation. The income gap strongly predicts how bank profits will react to future movements in interest rates.

We also find that banks exposure to interest rate risk has implications for the transmission of monetary policy. When the Federal Reserve increases short rates, this affects bank cash flows and hence their lending policy. In other words, the income gap has a strong explanatory power on the sensitivity of lending to changes in interest rates. This variable has a stronger, more consistent impact than previously identified factors, such as leverage, bank size or even asset liquidity. Finally, we report evidence consistent with the hypothesis that our main channel is a cash-flow effect, as opposed to a collateral channel: Interest rates affect lending because they affect cash flows, not because they affect the market value of equity.

Our results suggest that the allocation of interest rate exposure across agents (banks, households, firms, government) may explain how an economy responds to monetary policy. In particular, the distribution of interest rate risk across agents is crucial to understand the redistributive effects of monetary policy and thus to trace the roots of the transmission of monetary policy.

References

Adrian, Tobias and Hyun Song Shin, "Liquidity and leverage," *Journal of Financial Intermediation*, July 2010, *19* (3), 418–437.

Begeneau, Juliane, Monika Piazzesi, and Martin Schneider, "The Allocation of Interest Rate Risk in the Financial Sector," Working Paper, Stanford University 2012.

Bernanke, Ben and Mark Gertler, "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, March 1989, *79* (1), 14–31.

Campello, Murillo, "Internal Capital Markets in Financial Conglomerates: Evidence from Small Bank Responses to Monetary Policy," *Journal of Finance*, December 2002, *57* (6), 2773–2805.

Chava, Sudheer and Amiyatosh Purnanandam, "Determinants of the floating-to-fixed rate debt structure of firms," *Journal of Financial Economics*, September 2007, *85* (3), 755–786.

Fama, Eugene F and Robert R Bliss, "The Information in Long-Maturity Forward Rates," *American Economic Review*, September 1987, *77* (4), 680–92.

Flannery, Mark J and Christopher M James, "The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions," *Journal of Finance*, September 1984, *39* (4), 1141–53.

Gambacorta, Leonardo and Paolo Emilio Mistrulli, "Does bank capital affect lending behavior?," *Journal of Financial Intermediation*, October 2004, *13* (4), 436–457.

Guay, Wayne and S. P Kothari, "How much do firms hedge with derivatives?," *Journal of Financial Economics*, December 2003, *70* (3), 423–461.

Kashyap, Anil K. and Jeremy C. Stein, "The impact of monetary policy on bank balance sheets," *Carnegie-Rochester Conference Series on Public Policy*, June 1995, *42* (1), 151–195.

Kishan, Ruby P and Timothy P Opiela, "Bank Size, Bank Capital, and the Bank Lending Channel," *Journal of Money, Credit and Banking*, February 2000, *32* (1), 121–41.

Mishkin, Frederic and Stanly Eakins, *Financial Markets and Institutions*, 6 ed., Pearson Prentice Hall, 2009.

Purnanandam, Amiyatosh, "Interest rate derivatives at commercial banks: An empirical investigation," *Journal of Monetary Economics*, September 2007, *54* (6), 1769–1808.

Stein, Jeremy C. and Anil K. Kashyap, "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?," *American Economic Review*, June 2000, *90* (3), 407–428.

Vickery, James, "How do financial frictions shape the product market? evidence from mortgage originations," Technical Report, Federal Reserve Bank of New York 2008.

Tables

Table 1: Summary Statistics: Dependent and Control Variables

	mean	sd	p25	p75	count
Net interest income / assets	0.009	0.003	0.008	0.010	35799
Non interest income / assets	0.010	0.023	0.004	0.011	35829
Earnings / assets	0.002	0.005	0.002	0.003	35829
Market value of equity / assets	0.155	0.183	0.093	0.190	18390
Δ Interest	0.000	0.001	-0.000	0.000	33201
Δ Non-interest	0.002	0.005	0.001	0.004	31583
Δ Earnings	0.000	0.001	-0.000	0.000	32175
Δ Market Value	0.004	0.024	-0.008	0.016	17453
Δ log(C&I loans)	0.015	0.089	-0.028	0.054	33624
Δ log(total loans)	0.018	0.047	-0.006	0.038	33964
Log of assets	15.273	1.367	14.224	15.936	35829
Equity to assets ratio	0.087	0.042	0.069	0.097	35829
Fraction Liquid assets	0.224	0.124	0.139	0.284	26443

Note: Summary statistics are based on the quarterly Consolidated Financial Statements (Files FR Y-9C) between 1986 and 2010 restricted to US bank holding companies with total consolidated assets of $1Bil or more. All variables are quarterly.

Table 2: Income Gap and Its Components

	mean	sd	p25	p75	count
Income Gap =	0.134	0.186	0.016	0.252	35545
Assets maturing/resetting < 1 year	0.437	0.149	0.343	0.532	35827
- Liabilities maturing/resetting < 1 year =	0.302	0.150	0.201	0.383	35545
Short Term Liabilities	0.291	0.151	0.189	0.371	35823
+ Variable Rate Long Term Debt	0.010	0.025	0.000	0.009	35698
+ Short Maturity Long Term Debt	0.001	0.006	0.000	0.000	35673
+ Prefered Stock	0.000	0.002	0.000	0.000	35561

Note: Summary statistics are based on the quarterly Consolidated Financial Statements (Files FR Y-9C) between 1986 and 2010 restricted to US bank holding companies with total consolidated assets of $1Bil or more. The variables are all scaled by total consolidated assets (bhck2170) and are defined as follows: Interest Sensitive Liabilities =(bhck3296+bhck3298+bhck3409+bhck3408)/bhck2170; Interest Sensitive Assets=(bhck3197)/bhck2170; Short Term Liabilities=bhck3296/bhck2170; Variable Rate Long Term Debt=bhck3298/bhck2170; Short Maturity Long Term Debt=bhck3409/bhck2170; Prefered Stock=bhck3408/bhck2170

Table 3: Summary Statistics: Derivatives Hedges of Interest Rate Risk

	mean	sd	p25	p75	count
Futures	0.027	0.172	0.000	0.000	24783
Forward Contracts	0.038	0.258	0.000	0.002	24799
Written Options (Exchange Traded)	0.010	0.080	0.000	0.000	24767
Purchased Options (Exchange Traded)	0.015	0.133	0.000	0.000	24765
Written Options (OTC)	0.030	0.187	0.000	0.002	24793
Purchased Options (OTC)	0.032	0.180	0.000	0.000	24818
Swaps	0.184	1.393	0.000	0.048	35351
At least some I.R. hedging	0.607	0.489	0.000	1.000	24762

Note: Summary statistics are based on Schedule HC-L of the quarterly Consolidated Financial Statements (Files FR Y-9C) between 2005 and 2010 restricted to US bank holding companies with total consolidated assets of $1Bil or more. Schedule HC-L is not available prior to 2005. The variables report notional amounts in each kind of derivatives at the bank holding-quarter level and are all scaled by total consolidated assets (bhck2170). Variables are defined as follows: Futures contracts = bhck8693/bhck2170; Forward contracts = bhck8697/bhck2170; Written options (exchange traded) = bhck8701/bhck2170; Purchased options (exchange traded) = bhck8705/bhck2170; written options (OTC) = bhck8709/bhck2170; Purchased options (OTC) = bhck8713/bhck2170; Swaps=bhck3450/bhck2170. HEDGED is a dummy equal to one if a bank has a positive notional amount in any of the seven types of interest hedging derivatives in a given quarter.

Table 4: Interest Rate Shocks and Interest Income

	ΔInterest$_{it}$					ΔNon Interest Income$_{it}$				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$Gap_{it-1} \times \Delta FedFunds_t$	.018***	.018***	.016	.035***	.014	-.0083	-.0077	-.036	-.029	.013
	(3)	(2.9)	(.77)	(3.3)	(1.6)	(-.54)	(-.51)	(-.47)	(-1.4)	(.45)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.039***	.039***	.027*	.031***	.047***	.04**	.042**	.11	.071***	.0066
	(6.3)	(5.9)	(1.7)	(3.1)	(4.9)	(2.4)	(2.5)	(1.5)	(3.1)	(.2)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	.0035	.0033	.02	.0077	-.00023	.0033	.0012	-.037	-.00013	.00046
	(.76)	(.67)	(1.5)	(.96)	(-.034)	(.24)	(.09)	(-.44)	(-.0062)	(.017)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	.0078	.005	.022	-.0057	.013*	-.013	-.02	.013	-.039	.028
	(1.6)	(1)	(1.5)	(-.64)	(1.9)	(-.99)	(-1.5)	(.23)	(-1.5)	(1.3)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	-.0083*	-.0075	-.023	.0032	-.021***	-.031**	-.018	-.087	-.0028	-.075**
	(-1.8)	(-1.6)	(-1.5)	(.43)	(-3.2)	(-2)	(-1.3)	(-1.1)	(-.16)	(-2.3)
N	28588	24931	3657	8237	12770	22671	20993	1678	7704	8699
r2	.11	.11	.12	.13	.094	.91	.91	.91	.9	.89
Sum of gap coefficients	.05	.05	.06	.07	.05	0	0	-.03	0	-.02
p-value of gap coefficients	0	0	0	0	0	.58	.85	.69	.96	.32
p-value of equality test		.83		.19			.71		.44	
Sum of size coefficients	0	0	0	0	0	0	0	-.02	0	0
p-value of size coefficients	0	0	.23	.63	0	.25	.66	.17	.61	.22
Sum of equity coefficients	0	-.01	.02	0	.05	.14	.07	.48	-.04	.4
p-value of equity coefficients	.88	.83	.88	.92	.09	.2	.5	.2	.76	.05

Note: All variables are defined in the text. All items are normalized by total assets laggedt by 1 quarter. Columns (1)-(5) use, as a dependent variable, the quarterly change in interest income divided by lagged total assets (Interest$_{it}$-Interest$_{it-1}$)/(Assets$_{it-1}$). Columns (6)-(10) use change in *non* interest income normalized by lagged assets. Columns(1) and (6) report estimates for the entire sample; columns (2-3) and (6-7) break down the sample into small and big banks. Columns (4-5) and (9-10) break down the sample into banks for which gross interest rate derivative position are positive, or equal to zero. All regressions is the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter), contemporaneous change in Fed fund rate, as well as four lags of interest rate change. We report these five coefficient in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), as well as their interaction with contemporaneous and four lags for change in interest rates. Error terms are clustered at the bank level. The bottom panel reports the sum of coefficients for rate changes interacted with: bank size and bank equity. These should be interpreted as the differential cumulative effect of interest rates. Below each of these sums, we report the p-value of a test of significance. Below these tests, we report a test of equality of these sums across subsamples (big vs small banks, hedged vs unhedged banks. These equality tests use the SURE procedure to nest the two equations in a single model.

Table 5: Earnings and Market Value

	$\Delta Earnings_{it}$					$\Delta MarketValue_{it}$				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$Gap_{it-1} \times \Delta FedFunds_t$	.031***	.031***	.071*	.041***	.038**	.68**	.76**	.57	1.4***	.78*
	(3.6)	(3.5)	(1.7)	(2.8)	(2.4)	(2.1)	(2.2)	(.57)	(2.6)	(1.8)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.032***	.035***	-.015	.051***	.028*	.46	.41	1	.71	.74*
	(3.2)	(3.4)	(-.41)	(2.7)	(1.8)	(1.5)	(1.2)	(1.1)	(1.1)	(1.7)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	.0022	.0042	-.029	-.018	.019	.18	.18	-.23	.65	-.062
	(.25)	(.45)	(-1.1)	(-1.1)	(1.4)	(.59)	(.55)	(-.28)	(1.1)	(-.14)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	.011	.0079	.045	.017	.0093	.16	.094	.27	-.9*	.9**
	(1.3)	(.91)	(1.4)	(.97)	(.67)	(.56)	(.32)	(.24)	(-1.7)	(2.5)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	.0017	.0014	.019	.013	-.012	.27	.31	.18	.82*	-.33
	(.21)	(.16)	(.61)	(.83)	(-.87)	(1.3)	(1.4)	(.2)	(1.8)	(-.97)
N	26992	23453	3539	7856	11975	15556	13372	2184	4684	7931
r2	.21	.22	.25	.24	.22	.33	.33	.43	.34	.35
Sum of gap coefficients	.07	.07	.09	.1	.08	1.8	1.8	1.8	2.6	2
p-value of gap coefficients	0	0	.01	0	0	0	0	.04	0	0
p-value of equality test		.74		.36			.94		.37	
Sum of size coefficients	0	0	0	0	0	.04	-.03	.03	0	.08
p-value of size coefficients	0	0	.94	.48	.05	.12	.53	.72	.94	.02
Sum of equity coefficients	.15	.17	.16	-.03	.27	3.8	4	4	4.8	4.4
p-value of equity coefficients	.17	.13	.57	.75	.18	.17	.2	.51	.38	.15

Note: All variables are defined in the text. All items are normalized by total assets laggedt by 1 quarter. Columns (1)-(5) use, as a dependent variable, the quarterly change in Earnings divided by lagged total assets (Earnings$_{it}$-Earnings$_{it-1}$)/(Assets$_{it-1}$). Columns (6)-(10) use change in market value of equity normalised by lagged assets. Columns(1) and (6) report estimates for the entire sample; columns (2-3) and (6-7) break down the sample into small and big banks. Columns (4-5) and (9-10) break down the sample into banks for which gross interest rate derivative position are positive, or equal to zero. All regressions is the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter), contemporaneous change in Fed fund rate, as well as four lags of interest rate change. We report these five coefficient in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), as well as their interaction with contemporaneous and four lags for change in interest rates. Error terms are clustered at the bank level. The bottom panel reports the sum of coefficients for rate changes interacted with: bank size and bank equity. These should be interpreted as the differential cumulative effect of interest rates. Below each of these sums, we report the p-value of a test of significance. Below these tests, we report a test of equality of these sums across subsamples (big vs small banks, hedged vs unhedged banks. These equality tests use the SURE procedure to nest the two equations in a single model.

Table 6: Interest Rate Shocks and Lending: Size and equity ratio interacted control

	Δlog(C&I)					Δlog(Total Loans)				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$Gap_{it-1} \times \Delta FedFunds_{t}$	.013	.18	-2	.036	-.58	-.42	-.5	1.2	-.34	-.05
	(.02)	(.25)	(-.99)	(.03)	(-.56)	(-1.2)	(-1.4)	(.67)	(-.61)	(-.095)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.82	.72	2.6*	.7	1.1	.67**	.82**	-.45	1.4**	.24
	(1.2)	(.96)	(1.7)	(.55)	(1)	(2)	(2.4)	(-.3)	(2.6)	(.45)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	1.1	1.1	.92	.2	.66	.6*	.74**	-1.4	.41	.17
	(1.6)	(1.4)	(.53)	(.14)	(.7)	(1.8)	(2.1)	(-1.1)	(.89)	(.29)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	1.4**	1.3*	1.5	3.3**	1.9**	.61*	.72**	-.3	1.2**	.81
	(2)	(1.7)	(.73)	(2)	(2.2)	(1.9)	(2.3)	(-.16)	(2.4)	(1.5)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	-1.3**	-1.2*	-1.6	-1.7	-2.4***	-.023	-.36	2.6*	-.73	.36
	(-2.1)	(-1.8)	(-.77)	(-1.2)	(-2.6)	(-.073)	(-1.1)	(1.7)	(-1.5)	(.74)
N	29614	25577	4037	8440	12994	29274	25505	3769	8364	12706
r2	.097	.095	.17	.081	.12	.2	.22	.14	.23	.2
Sum of gap coefficients	2	2	1.4	2.6	.72	1.4	1.4	1.7	1.9	1.5
p-value of gap coefficients	0	0	.58	.03	.5	0	0	.23	0	0
p-value of equality test		.79		.25			.85		.62	
Sum of size coefficients	.23	.19	.96	.15	.29	0	.02	.36	-.18	.07
p-value of size coefficients	0	.2	0	.74	.01	.95	.76	.09	.34	.23
Sum of equity coefficients	-12	-12	-12	2.6	-22	-4.7	-4.9	-1.4	-4.3	-9.1
p-value of equity coefficients	.05	.07	.52	.76	0	.23	.24	.88	.09	.04

Note: All variables are defined in the text. Columns (1)-(5) use, as a dependent variable, the quarterly change in log commercial & industrial loans. Columns (6)-(10) use change in log total loans. Columns(1) and (6) report estimates for the entire sample; columns (2-3) and (6-7) break down the sample into small and big banks. Columns (4-5) and (9-10) break down the sample into banks for which gross interest rate derivative position are positive, or equal to zero. All regressions is the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter), contemporaneous change in Fed fund rate, as well as four lags of interest rate change. We report these five coefficient in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), as well as their interaction with contemporaneous and four lags for change in interest rates. Error terms are clustered at the bank level. The bottom panel reports the sum of coefficients for rate changes interacted with: bank size and bank equity. These should be interpreted as the differential cumulative effect of interest rates. Below each of these sums, we report the p-value of a test of significance. Below these tests, we report a test of equality of these sums across subsamples (big vs small banks, hedged vs unhedged banks. These equality tests use the SURE procedure to nest the two equations in a single model.

Table 7: Robustness: Controlling for Liquidity

	Δlog(C&I)					Δlog(Total Loans)				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$Gap_{it-1} \times \Delta FedFunds_t$	.063	.43	-5.2**	.79	-.89	-.052	-.19	2.4	.1	.071
	(.083)	(.53)	(-2)	(.64)	(-.85)	(-.13)	(-.5)	(.99)	(.18)	(.13)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.58	.39	3.8*	.023	1.3	.37	.57	-.74	1.1**	.3
	(.73)	(.46)	(1.7)	(.019)	(1.2)	(.97)	(1.4)	(-.43)	(2)	(.56)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	.7	.63	2.5	.44	.35	.52	.68*	-1.8	.32	.1
	(.87)	(.74)	(1.1)	(.32)	(.35)	(1.4)	(1.7)	(-1.1)	(.7)	(.18)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	2.6***	2.4***	2.7	2.8*	1.9**	.67*	.78**	-1.4	.89*	.6
	(3.2)	(2.8)	(1.4)	(1.7)	(2.3)	(1.8)	(2.1)	(-.67)	(1.7)	(1.2)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	-2.2***	-2.1**	-3.8	-1.6	-2.5***	-.029	-.46	4.1*	-.47	.37
	(-2.9)	(-2.5)	(-1.4)	(-1.1)	(-2.7)	(-.084)	(-1.4)	(1.9)	(-.95)	(.79)
N	22784	19966	2818	8440	12991	22423	19794	2629	8364	12703
r2	.094	.091	.19	.082	.12	.2	.22	.14	.23	.2
Sum of gap coefficients	1.7	1.8	.05	2.5	.25	1.5	1.4	2.5	1.9	1.4
p-value of gap coefficients	.03	.03	.98	.05	.82	0	0	.17	0	0
p-value of equality test			.6		.19			.55		.56
Sum of size coefficients	.39	.36	1.2	.14	.26	.04	.04	.49	-.19	.06
p-value of size coefficients	0	.03	0	.75	.02	.44	.58	.04	.3	.29
Sum of equity coefficients	-12	-10	-21	3	-22	-3.1	-2.8	-2.8	-4	-8.7
p-value of equity coefficients	.1	.16	.27	.73	0	.4	.49	.7	.11	.04
Sum of liquidity coefficients	-2.1	-1.6	-3.7	-.34	-4.4	-.75	-.9	.01	-.15	-.78
p-value of liquidity coefficients	.15	.29	.34	.87	.03	.27	.21	.99	.88	.38

Note: All variables are defined in the text. Columns (1)-(5) use, as a dependent variable, the quarterly change in log commercial & industrial loans. Columns (6)-(10) use change in log of total loans. Columns(1) and (6) report estimates for the entire sample; columns (2-3) and (6-7) break down the sample into small and big banks. Columns (4-5) and (9-10) break down the sample into banks for which gross interest rate derivative position are positive, or equal to zero. All regressions is the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter), contemporaneous change in Fed fund rate, as well as four lags of interest rate change. We report these five coefficient in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), liquid assets$_{it-1}$)/assets$_{it-1}$) as well as their interaction with contemporaneous and four lags for change in interest rates. Error terms are clustered at the bank level. The bottom panel reports the sum of coefficients for rate changes interacted with: bank size, bank equity, and bank liquidity. These should be interpreted as the differential cumulative effect of interest rates. Below each of these sums, we report the p-value of a test of significance. Below these tests, we report a test of equality of these sums across subsamples (big vs small banks, hedged vs unhedged banks. These equality tests use the SURE procedure to nest the two equations in a single model.

Table 8: Short rate vs Long-Short Rates

	ΔInterest Income	ΔMarket Value	Δlog(C&I)	Δlog(Total Loans)
$Gap_{it-1} \times \Delta FedFunds_t$	.02***	.67*	.058	.09
	(2.9)	(1.8)	(.071)	(.22)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.037***	.59*	.54	.68*
	(5.8)	(1.7)	(.69)	(1.9)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	.0025	.42	.59	.67
	(.49)	(1.2)	(.72)	(1.6)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	.008	.29	1.6**	.44
	(1.4)	(.86)	(2.1)	(1.2)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	-.008*	.085	-1	-.11
	(-1.7)	(.34)	(-1.4)	(-.31)
$Gap_{it-1} \times \Delta 10years_t$	-.00046	.051	-.11	-.95***
	(-.1)	(.2)	(-.17)	(-2.8)
$Gap_{it-1} \times \Delta 10years_{t-1}$	-.0039	-.026	.34	-.53
	(-.79)	(-.094)	(.5)	(-1.3)
$Gap_{it-1} \times \Delta 10years_{t-2}$	.0042	-.32	.65	-.54
	(.96)	(-1.2)	(.97)	(-1.5)
$Gap_{it-1} \times \Delta 10years_{t-3}$	-.0026	-.48*	.64	-.28
	(-.58)	(-1.8)	(.95)	(-.77)
$Gap_{it-1} \times \Delta 10years_{t-4}$	.0023	-.32	-.3	.41
	(.5)	(-1.3)	(-.48)	(1.2)
N	28588	15556	29614	29274
r2	.11	.33	.098	.21
Sum of coefficients: Fed Funds	.05	2	1.8	1.8
p-value	0	0	.05	0
Sum of coefficients: long rate	0	-1.1	1.2	-1.9
p-value	.96	.14	.52	.08

Note: All variables are defined in the text. Dependent variables are: quarterly change in interest income normalized by total assets (column 1), quarterly change in market value of equity (column 2), quarterly change in log C&I loans (column 3), and quarterly change in log total loans (column 4). All regressions use the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter) and five lags of short rate change, and interactions between income gap and five lags of long rate (the spread on the 10 year treasury bond) changes. We report these $2 \times 5 = 10$ coefficients in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), as well as their interaction with the five lags of long and short rate changes. Error terms are clustered at the bank level. The bottom panel of the Table reports the sum of coefficients for interaction of gap with short (first line) and long rate (third line). p-values of significance tests for these sums are reported below their values.

Table 9: Realized vs Rates and Expected Rates

	ΔInterest Income	ΔEarnings	Δlog(C&I)	Δlog(Total Loans)
$Gap_{it-1} \times \Delta FedFunds_t$	.018***	.035***	.054	-.41
	(2.8)	(3.8)	(.08)	(-1.1)
$Gap_{it-1} \times \Delta FedFunds_{t-1}$	.038***	.03***	.66	.62*
	(6.2)	(3)	(.91)	(1.8)
$Gap_{it-1} \times \Delta FedFunds_{t-2}$	.003	.0025	1.1	.59*
	(.63)	(.28)	(1.6)	(1.8)
$Gap_{it-1} \times \Delta FedFunds_{t-3}$	.0074	.0096	1.3*	.53
	(1.5)	(1.1)	(1.8)	(1.6)
$Gap_{it-1} \times \Delta FedFunds_{t-4}$	-.0084*	.0014	-1.3*	-.017
	(-1.8)	(.17)	(-1.9)	(-.052)
$Gap_{it-1} \times \Delta ExpectedFF_t$	.00062	.0017	.4	.27
	(.21)	(.37)	(1)	(1.3)
$Gap_{it-1} \times \Delta ExpectedFF_{t-1}$	-.00048	-.00036	-.18	-.21
	(-.18)	(-.079)	(-.43)	(-1.1)
$Gap_{it-1} \times \Delta ExpectedFF_{t-2}$	-.0013	.011***	-.32	-.18
	(-.46)	(2.7)	(-.76)	(-.85)
$Gap_{it-1} \times \Delta ExpectedFF_{t-3}$	-.00088	-.007	-.52	-.12
	(-.33)	(-1.5)	(-1.3)	(-.6)
$Gap_{it-1} \times \Delta ExpectedFF_{t-4}$	-.0012	-.00098	.33	.092
	(-.41)	(-.21)	(.83)	(.43)
N	28588	26992	29614	29274
r2	.11	.22	.099	.21
Sum of coefficients: Fed Funds	.05	.07	1.8	1.3
p-value	0	0	.02	0
Sum of coefficients: forward rate	0	0	-.29	-.13
p-value	.68	.67	.79	.8

Note: All variables are defined in the text. Dependent variables are: quarterly change in interest income normalized by total assets (column 1), quarterly change in market value of equity (column 2), quarterly change in log C&I loans (column 3), and quarterly change in log total loans (column 4). All regressions use the same set of right-hand-side variables. The coefficients of interest are interaction terms between income gap (lagged by one quarter) and five lags of short rate change, and interactions between income gap and five lags of forward rate changes. The forward rate in quarter t is defined as the forward rate taken at $t-8$, for loans between t and $t+4$ and measures the expected 1 year rate in t, as predicted by the market 2 years before quarter t. We report these $2 \times 5 = 10$ coefficients in the Table. Following Stein and Kashyap (2000), we further include as controls: four lags of the dependent variable, calendar time dummies, as well as $gap_{it-1}\times$ trend, $log(assets_{it-1})$, book equity$_{it-1}$)/assets$_{it-1}$), as well as their interaction with the five lags of short and forward rate changes. Error terms are clustered at the bank level. The bottom panel of the Table reports the sum of coefficients for interaction of gap with short (first line) and past forward rate (third line). p-values of significance tests for these sums are reported below their values.

A. Variable Definitions

This Section describes the construction of all variables in detail. i is an index for the bank, t for the quarter.

A.1. Bank-level Variables

This Section gathers the variables constructed using the Consolidated Financial Statements of Bank Holding Comanies (form FR Y-9C). Note that flow variables (interest and non-interest income, earnings) are defined each quarter "year to date". Hence, each time we refer to a flow variable, we mean the *quarterly*, not year-to-date, flow. To transform a year-to-date variable into a quarterly one, we take the variable as it is for the first quarter of each year. For each quarter $q = 2, 3, 4$, we take the difference in the year-to-date variable between q and $q - 1$.

- Δ**Interest**$_{it}$: Change in interest income = [interest income (bhck4107) at t + interest expense (bhck4073) at $t - 1$ - interest income (bhck4107) at $t - 1$ - interest expense (bhck4073) at t] / (total assets (bhck2170) taken in $t - 1$]. Note that bhck4073 and bhck4107 have to be converted from year-to-date to quarterly as explained above.

- Δ**Non Interest**$_{it}$: Change in non interest income = [non interest income (bhck4079) at t - non interest income (bhck4079) at $t-1$] / (total assets (bhck2170) taken in $t-1$]. Note that bhck4079 has to be converted from year-to-date to quarterly as explained above.

- Δ**Earnings**$_{it}$: Change in earnings = [earnings (bhck4340) at t - earnings (bhck4340) at $t - 1$] / (total assets (bhck2170) taken in $t - 1$]. Note that bhck4340 has to be converted from year-to-date to quarterly as explained above.

- Δ**Value**$_{it}$: Change in interest income = [Equity market value at t - Equity market value at $t - 1$] / (total assets (bhck2170) taken in $t - 1$]. Equity market value is obtained for publicly listed banks after matching with stock prices from CRSP. It is equal to the number of shares outstanding (shrout) $\times$ the end-of-quarter closing price (absolute value of prc).

- **Δlog(C&I loans$_{it}$)**: commercial and industrial loan growth = log[C&I loans to US adressees (bhck1763) at t + C&I loans to foreign adressees (bhck1764) at t] - log[C&I loans to US adressees (bhck1763) at $t-1$ + C&I loans to foreign adressees (bhck1764) at $t-1$].

- **Δlog(Total loans$_{it}$)**: Total loan growth = log [Total loans (bhck2122) at t] - log[Total loans (bhck2122) at $t-1$].

- **ΔEarnings$_{it}$**: Change in earnings = [earnings (bhck4340) at t - earnings (bhck4340) at $t-1$] / (total assets (bhck2170) taken in $t-1$]. Note that bhck4340 has to be converted from year-to-date to quarterly as explained above.

- **Gap$_{it-1}$**: Income gap = [assets that reprice or mature within one year (bhck31970) - interest bearing deposits that reprice or mature whithin one year (bhck3296) - long term debt that reprices within one year (bhck3298) - long term debt that matures within one year (bhck3409) - variable rate preferred stock (bhck3408)] / total assets (bhck2170)

- **Equity$_{it-1}$**: Equity ratio = 1 - [total liabilities (bhck2948) / total assets (bhck2170)]

- **Size$_{it-1}$**: log (total assets (bhck2170))

- **Liquidity$_{it-1}$**: Liquidity ratio = [Available for sale securities (bhck1773)+ Held to Maturity Securities (bhck1754)] / total assets (bhck2170)

A.2. Times series Variables

This Section gathers different measures of interest rates used in the paper.

- Δ**Fed Funds**$_t$: First difference between "effective federal funds" rate at t and $t-1$. Fed funds rates are available monthly from the Federal Reserve's website: each quarter, we take the observation corresponding to the last month.

- Δ**10yrs**$_t$: First difference between yields of 10 year treasury securities at t and $t-1$, available from the Federal Reserve's website.

- Δ**Expected FF**$_t$: Change in past "expected" 1 year interest rate between $t-1$ and t. Expected 1 year rate at t is obtained from the forward rate taken at $t-8$ (two years ago), for a loan between t and $t+3$ (for the coming year). This forward rate is computed using the Fama-Bliss discount bond prices. At date $t-8$, we take the ratio of the price of the 2-year to the 3-year zero-coupon bond, minus 1.

B. Time-Series Regressions

We provide here estimates using an alternative specification also used in the literature (Stein and Kashyap (2000), Campello (2002)).

B.1. Methodology

We proceed in two steps. First, we run, *separately for each quarter*, the following regression:

$$X_{it} = \gamma_t gap_{it-1} + controls_{it} + \epsilon_{it} \tag{4}$$

where X_{it} is a cash flow or lending LHS variable.$controls_{it}$ include: $X_{it-1}, ..., X_{it-4}$, $log(assets_{it-1})$, $\frac{equity_{it-1}}{assets_{it-1}}$. From this first step, we obtain a time-series of X to gap sensitivity γ_t.

In our second step, we regress γ_t on change in fed funds rate and four lags of it, as well as four quarter dummies:

$$\gamma_t = \sum_{k=0}^{k=4} \alpha_k.\Delta fedfunds_{t-k} + quarterdummies_t + \epsilon_{it} \tag{5}$$

Again, we expect that $\sum_{k=0}^{k=4} \alpha_k > 0$: in periods where interest rates increase, high income gap firms tend to make more profits, or lend more.

We report the results using the new methodology in Tables B.1 and B.2. Results are a little bit weaker using this approach, but have the same order of magnitude. Results on profits and cash flows are still all significant at the 1% level of significance, and have the same order of magnitude. Results on lending, controlling for size and leverage, but not for liquidity, remain significant at the 1 or 5% level for total lending growth. They become a bit weaker, albeit still significant at the 5% level for the whole sample, for C&I loans. Controlling for liquidity reduces the sample to 1994-2011 (BHC data do not report liquidity holdings before 1994), so it reduces the sample size by a third. Significance weakens, but income gap effects on total lending remains statistically significant at the 5% level for the whole sample and small firms, as well as firms with some interest rate derivative exposure. This alternative estimation procedure provides estimates with very similar orders of magnitude.

B.2. Results

Table B.1: Time Series Approach: Profits

	$\Delta Interest_{it}$					$\Delta Earnings_{it}$				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$\Delta FedFunds_t$	.016**	.018**	.0026	.0069	.037***	.032***	.031***	.04*	.059***	.038**
	(2.3)	(2.3)	(.2)	(.77)	(3)	(3.4)	(3)	(2)	(4.2)	(2.3)
$\Delta fedfunds_{t-1}$	.029***	.025***	.044***	.037***	.012	.029***	.035***	.0043	.014	.048***
	(3.8)	(3)	(3.1)	(4)	(.86)	(2.8)	(3)	(.19)	(.96)	(2.7)
$\Delta fedfunds_{t-2}$	.0055	.0062	.0013	.0011	.014	-.017*	-.011	-.04*	.00013	-.03*
	(.74)	(.75)	(.097)	(.12)	(1)	(-1.7)	(-1)	(-1.8)	(.009)	(-1.8)
$\Delta fedfunds_{t-3}$	.0095	.0021	.023*	.011	-.012	.019**	.0094	.054***	.0083	.018
	(1.4)	(.27)	(1.8)	(1.2)	(-.92)	(2)	(.91)	(2.7)	(.57)	(1.1)
$\Delta fedfunds_{t-4}$	-.008	-.003	-.017	-.018**	.0027	.0086	.0062	.029	.011	.015
	(-1.3)	(-.43)	(-1.5)	(-2.1)	(.22)	(1)	(.66)	(1.6)	(.81)	(.93)
N	93	93	93	63	63	93	93	93	63	63
ar2										
Sum of coefficients	.05	.04	.05	.03	.05	.07	.07	.08	.09	.08
p-value	0	0	0	0	0	0	0	0	0	0

In columns 1-5, we use change in interest income (divided by assets) as the dependent variable. In columns 6-10, we focus on change in Net Income (divided by book equity). All results come from a two-step procedure. First, for each quarter from 1986 to 2011, we regress the depend variable on four lags of itself, $log(assets_{it-1})$ and the income gap gap_{it-1}. We obtain a time series of coefficients on gap_{it-1}, called $\gamma_{\Delta X}$ where ΔX is the relevant dependent variable. We then regress $\gamma_{\Delta X}$ on $\Delta fedfunds_{t-k}$ for all $k = 0, 1, 2, 3, 4$ and four quarter dummies.

Table B.2: Time Series Approach: Lending Growth with Size, Equity controls

	Δlog(C&I loans)					Δlog(Total loans)				
	All	Small	Big	No Hedge	Some Hedge	All	Small	Big	No Hedge	Some Hedge
$\Delta FedFunds_t$	.57	1.1	-1.6	-.25	1.8	-.06	-.3	.053	.23	.07
	(.61)	(1.1)	(-.94)	(-.23)	(.98)	(-.13)	(-.61)	(.053)	(.35)	(.085)
$\Delta fedfunds_{t-1}$	.76	.4	2.1	.18	.32	.18	.03	.84	.039	1.2
	(.72)	(.35)	(1.2)	(.16)	(.16)	(.34)	(.055)	(.74)	(.056)	(1.4)
$\Delta fedfunds_{t-2}$	.77	.53	-.54	.71	-.95	.69	1.3**	-.85	-.29	.65
	(.76)	(.49)	(-.3)	(.63)	(-.49)	(1.4)	(2.5)	(-.79)	(-.42)	(.75)
$\Delta fedfunds_{t-3}$	.94	.98	.56	2.3*	2.9	.37	.18	-.014	.6	.73
	(.98)	(.96)	(.33)	(2)	(1.5)	(.78)	(.36)	(-.014)	(.88)	(.86)
$\Delta fedfunds_{t-4}$	-1	-.51	-1.1	-2.5**	-1.3	.15	.083	1.1	.8	-.46
	(-1.2)	(-.56)	(-.73)	(-2.3)	(-.71)	(.34)	(.19)	(1.2)	(1.3)	(-.57)
N	93	93	93	63	63	93	93	93	63	63
ar2										
Sum of coefficients	2	2.5	-.5	.44	2.8	1.3	1.3	1.1	1.4	2.2
p-value	.04	.02	.77	.69	.15	0	.01	.3	.04	.01

In columns 1-5, we use growth of C&I loans as the dependent variable. In columns 6-10, we focus on total loans growth. All results come from a two-step procedure. First, for each quarter from 1986 to 2011, we regress the depend variable on four lags of itself, $log(assets_{it-1})$, $\frac{equity_{it-1}}{assets_{it-1}}$, and the income gap gap_{it-1}. We obtain a time series of coefficients on gap_{it-1}, called $\gamma_{\Delta X}$ where ΔX is the relevant dependent variable. We then regress $\gamma_{\Delta X}$ on $\Delta fedfunds_{t-k}$ for all $k = 0, 1, 2, 3, 4$ and four quarter dummies.