Why Have Negative Nominal Interest Rates Had Such a Small Effect on Bank Performance? Cross Country Evidence

Jose A. Lopez, Andrew K. Rose, and Mark M. Spiegel*

September 12, 2019

.**Abstract**

We explore the impact of negative policy rates on banks using data on 5,200 banks from 27 advanced European and Asian countries, 2010-2017. Our cross-country panel specification allows us to condition on global shocks and bank-specific fixed effects. Banks offset interest income losses under negative rates with lower deposit expenses and gains in non-interest income, including fees and capital gains. Small and low deposit-ratio banks drive most results. Banks respond to negative rates by increasing lending activity and raising their share of deposit funding. Overall, our results indicate benign implications of negative rates to date for bank profitability.

Keywords: zero, effective, lower, data, firm, empirical, regression, panel, deposit, size.

JEL Classification Numbers: E43, G21

*Lopez is Vice President, Financial Institutions Supervision, Federal Reserve Bank of San Francisco (jose.a.lopez@sf.frb.org); Rose is B.T. Rocca Jr. Professor, Haas School of Business, University of California, Berkeley, ABFER senior fellow, CEPR research fellow, and NBER research associate (arose@haas.berkeley.edu); Spiegel is Vice President, Economic Research, Federal Reserve Bank of San Francisco (mark.spiegel@SF.frb.org). Remy Beauregard, Rebecca Regan and Ben Shapiro provided research assistance. For comments, we thank the editor and two anonymous referees, Joshua Aizenman, Arindam Banik, Stijn Claessens, Leonardo Gambacorta, Priyank Gandhi, Isaiah Hull, Tor Jacobson, Jesper Lindé, Bob McCauley, Frank Packer, Yuri Sasaki, Erik von Schedvin, Hyun Song Shin, Yosuke Takeda, and seminar participants at the BIS, Riksbank, USC, and the Chicago Financial Institutions Conference. The views expressed below do not necessarily represent those of the Federal Reserve Bank of San Francisco or the Board of Governors of the Federal Reserve System.

1. Introduction

Low interest rates around the world due to accommodative monetary policy regimes have been a source of concern for the banking industry for some time. In the immediate wake of the global financial crisis of 2007-09, policy rates in several advanced economies fell to levels close to the so-called "zero lower bound." Many banks have argued that nominal deposit rates could not fall below zero without eroding their customer bases.[1] Since they have acted accordingly, low interest rates have been associated with narrowing interest rate margins, which present an obstacle to bank profitability [e.g. Jobst and Lin (2016), Altavilla, et al. (2018)].

The linkage between the level of nominal interest rates and bank income has been much examined in the literature; for example, Borio, et al. (2017) found that bank profitability is reduced at low rates of interest, and that the sensitivity of profitability to rate reductions is enhanced as interest rates fall. Moreover, Borio and Gambacorta (2017) found that bank lending becomes less responsive to reductions in policy rates as they approach zero, suggesting that the financial channel of the monetary transmission mechanism is weaker as interest rates approach zero.[2] Eventually, the burden on the banking sector can get large enough that further rate reductions are contractionary, rather than expansionary, Brunnermeier and Koby (2018).[3]

A zero lower bound for retail *deposits* clearly exists. Figure 1 displays average overnight deposit rates for the euro area, as well as a number of the larger countries in our sample whose policy rates go negative, including euro area countries France, Spain, Italy and Germany, and non-euro area Sweden, Denmark and Japan. It can be seen that deposit rates in these countries, all of which experienced policy rates that fell below zero by the end of our sample,

drift arbitrarily close to, but did not fall below zero. For example, by the end of our sample, Japanese banks pay one-tenth of one percent in interest.

Concerns about the implications of crossing zero for bank profitability have been voiced to argue both against crossing zero and in favor of taking steps (at higher levels of interest) to avoid approaching zero. The monetary transmission mechanism may be weak at *low positive* rates, due to the adverse implications for bank profitability; this argument should apply even more forcefully to *negative* nominal interest rates, as adjustments in deposit rates seem to hit a hard boundary at zero. In practice, banks have been generally unwilling to charge negative nominal interest rates on deposits, especially for smaller customers. Eggertson, et al. (2017) make this argument and provide a theoretical foundation for the special role of negative rates in disrupting the financial monetary transmission channel. They confirm their theory based on aggregate data from five countries and the euro area, as well as bank-level data from Sweden.[4] However, in spite of such concerns nominal interest rates in a substantial number of countries in fact, have broken through zero, and many now have negative policy rates.

Several studies, reviewed below, have examined the implications of negative interest rates for bank profitability and behavior; almost all use bank-level data for an individual country or currency. Most studies conclude that responses at the bank level have mitigated the adverse effect of negative rates on bank profitability and lending. Specifically, some banks have been adept at increasing non-interest income (such as through increased fees), while others have adjusted funding allocations to rely less on deposits. The nature of adjustments taken by any individual bank depends on both its business model and size, as both influence a bank's reliance on deposit funding as opposed to more market-based wholesale funding.

A challenge with any study that relies on the experience of a single economy is that the move to negative rates reflects prevailing economic conditions. This endogeneity makes it difficult to identify any change in bank profitability and/or behavior that stems solely from negative rates. In this paper, we move towards partially addressing this challenge by considering a panel of cross-country data. Since different economies move to negative rates at different times, this feature of the panel allows us to include fixed time effects to control for responses to global conditions. Many have argued that global financial shocks – particularly monetary policy shocks – have been particularly relevant during our sample period, e.g., Rey (2015). We are also careful to compare countries with negative nominal interest rates only to others with low positive rates; we deliberately drop observations where the prevailing policy rate exceeds 1.00%. Still, our techniques are non-structural and exploratory in nature; we seek primarily to establish stylized facts.

Further, since some countries in our panel never experience negative nominal rates, our work can be viewed as a difference-in-difference study; i.e., we compare banks in economies that experienced negative rates (as opposed to those that did not), after policy rates turned negative (as opposed to before). Local conditions are also likely to affect both bank profitability and monetary policy. We respond to this econometric challenge by instrumenting for negative policy rates with proxies for local conditions, using variables commonly associated with conventional monetary rules: unemployment, GDP growth, the output gap, and inflation. However, we have limited confidence in this approach; our value added lies in establishing stylized facts rather than testing structural hypotheses.

Our data set includes annual income statements for 5,273 banks from the European Union, Switzerland and Japan, between 2010 (before the advent of negative nominal rates) and 2017 (the most recent period available), and includes observations (with gaps) for fourteen different currencies, one of which is the 19-country Euro.[5] Our sample also allows us to examine countries that "go negative" at different times and for different reasons. Presumably, movements into negative rates are different in floating exchange rate countries as opposed to those with pegged exchange rates, since the latter respond more to foreign pressures that might undermine the peg. We exploit this difference below by examining our results across exchange rate regimes. More generally, our study differs from most of the existing literature in looking at bank performance in a large set of banks from a variety of different monetary regimes. To our knowledge, it is the first study that pools European and Japanese data on bank performances at negative rates, providing substantial variability in the data. Moreover, our sample includes a large number of banks, allowing us to analyze precisely the banks most exposed to adverse effects from negative interest rates. Given the exploratory nature of our investigation, we accordingly split our data into sub-samples along two interesting dimensions: bank size and reliance on deposits.

Our results suggest that bank profitability as a whole has, thus far, been unaffected by negative nominal interest rates. We find no substantive effect on overall net income from negative rates. These results are notable because relative to the existing literature, our sample includes a relatively large share of small banks and banks that are more reliant on deposit funding (i.e., high-deposit banks), both of which would be expected to be more exposed to losses under negative interest rates.

While banks have generally experienced only negligible income effects, we find that they suffer statistically significant losses in *net interest* income. More precisely, banks experience statistically significant losses both on lending income and "other" interest income.[6] These losses are mitigated somewhat by reductions in interest expenses, but not sufficiently to avoid overall interest income losses. Notably, banks do not substantially reduce deposit expenses, probably because most nominal deposit rates are sticky at zero. Large banks appear to be more capable of adjusting their funding costs, as they achieve statistically significant reduction in deposit expenses, while changes in small bank deposit expenses are insignificant.

To make up for losses on net interest income, banks have achieved significant gains in *net non-interest* income; we find statistically significant increases in both fees and (especially) other non-interest income, such as capital gains, gains on securities, and insurance income. Large banks also reduce other interest expenses more than their smaller counterparts.

Furthermore, we find that banks that rely relatively less on deposits (hereafter low-deposit or "LD") do better under negative interest rates than their high-deposit (HD) counterparts. HD banks are more vulnerable to losses attributable to a zero-lower bound on deposits than their LD counterparts. LD banks suffer bigger reductions in net interest income but also receive larger increases in net non-interest income under negative rates.

To see if our results depend on the monetary regime, we split our data into a variety of sub-samples composed of either large countries (Japan and German), or small countries with similar (fixed or floating) exchange rate regimes. Our results are heterogeneous; the effect of negative nominal interest rates on bank profitability varies with the monetary regime. Our key

result – that negative nominal interest rates only have a small overall effect on bank profitability, since losses in interest income are offset by gains in non-interest income – appears to stem primarily from banks in economies with floating exchange rates.

Finally, we extend our analysis on bank performance to review the effects of the negative rate environment on banking activities. Negative rates lead total bank lending to increase as a proportion of total assets, a result driven by small and HD banks. LD banks tend to lower their lending activities, a key reason why they also experience a larger decline in interest income. All banks decrease their holdings in safe assets (such as cash and central bank reserves) in response to negative nominal interest rates. Negative rates also induce banks to increase their deposit funding and their leverage.

2. Literature Review

Nominal interest rates in advanced economies have been low by historic standards since the global financial crisis of 2007-09; it is unsurprising that a literature has emerged which examines their impact on bank activity and performance.

2.1 Impact of low or negative rates on bank activity

Most studies of bank activity focus on the impact of low or negative rates on lending levels and portfolio risk. Borio and Gambacorta (2017) find that bank lending becomes less responsive to reductions in policy rates as these approach zero, while Delis and Kouretas (2011) find that bank risk tolerance increases at low interest rates. Aramonte, et al. (2015) examine syndicated loans and find that nonbank financial institutions increase their riskiness under low

rates, while conventional banks tend to originate riskier syndicated loans under low rates, but then divest.

A number of studies examine negative rates and banking activity using bank-level data. Heider, et al. (2017) examine lending activity by 46 Eurozone banks to a large number of individual firms between 2013 and 2015. Relative to similar rate cuts under *positive* rates, they find that the introduction of *negative* rates in the euro area in 2014 induced deposit-dependent banks to cut lending, and to reallocate loans towards more risky firms. They deal with the potential problem of monetary policy endogeneity by including industry-year and country-year fixed effects. Nucera, et al. (2017) examine 111 Eurozone banks and find that negative rates induced change in a bank's propensity to become undercapitalized in a financial crisis, a characteristic known as "SRisk"; smaller, more traditional banks exhibited a disproportionate increase in riskiness relative to large banks, in response to interest rate cuts below zero. Similarly, Bubeck, et al. (2019) examine securities holdings for 26 large euro area banking groups and find that banks more reliant on deposits for funding disproportionately increase the riskiness of their asset portfolios in response to a movement into negative rates. Amzallag, et al. (2018) examine the response of Italian banks to movements into negative policy rates. They find that negative rates are associated with higher mortgage rates from banks more reliant on retail deposits for funding.

Bottero, et al. (2019), examine loan growth for bank and firm pairs among 95 Italian banks. They find that liquidity, rather than deposit intensity, drives a move towards a riskier portfolio after the introduction of negative rates in the euro area. In particular, they find that

banks with more liquid assets are more likely to swap those assets into longer-term loans in an effort to increase yield.

Demiralp, et al. (2017) examine data for 205 Euro area banks and find the portfolio adjustments at negative rates differ by bank characteristics. Banks that rely heavily on deposit funding extend more loans when rates are negative; investment banks adjust by reducing excess liquidity; wholesale banks raise the share of government bonds in their portfolios. Demiralp, et al. note that identifying the impact of negative rates is difficult because of the confluence of other policies adopted by the ECB as it moved to negative rates. They respond by asserting that a bank's sensitivity to negative rates depend on its business model. They further claim that banks will be more sensitive to negative rates the higher their excess liquidity, as these assets particularly suffer from negative returns on excess reserves.

Basten and Mariathasan (2018) examine 68 Swiss banks, using the share of excess reserves as a proxy for exposure to negative rates. They find that banks with higher excess reserves adjusted their liabilities, primarily through reductions in bond issuance, thus increasing exposure to maturity mismatch.

For a large sample of German banks from 2003 through 2017, Urbschat (2018) finds that HD banks tend to experience lower net interest income and lower loan growth under negative rates, both of which erode bank profitability. We examine differences across bank types below, splitting banks by both size and reliance on deposit funding.

The elevated reliance on non-interest income by banks under low or negative rates [e.g. Borio and Gambacorta (2015)] has itself has been generally found to increase bank risk

exposure. Stiroh (2004) finds that U.S. banks' reliance on non-interest income during the 1990s increased their overall risk and had few diversification benefits. Lee, et al. (2014), examine data 967 banks in 22 Asian countries, and find that increased reliance on non-interest income across banks is associated with increased risk and reduced profitability. In contrast, however, Albertazzi and Gambacorta (2009) found that non-interest income was less correlated with the macroeconomic conditions for European banks over a similar time-period, and thus provided diversification benefits.

2.2 Impact of low or negative rates on bank profitability

Studies of profitability tend to focus on the abilities of banks to compensate for the adverse impacts of low and/or negative rates on their net interest income. Bikker and Vervliet (2017) examine a panel of American banks from 2001-2015 and find that bank profitability is reduced at low interest rates; the primary cause is reduced net interest margins. They also find that American banks can maintain overall profitability under low rates by adjusting on other margins, a result echoed below. They speculate that defaults drop under low rates, allowing banks to reduce provisioning for bad loans. However, they do not find evidence of increased risk exposure.

Borio, et al. (2017) find that bank profitability is reduced at low interest rates and that the sensitivity of profitability to rate reductions is enhanced as interest rates fall. Claessens, et al. (2018) obtain similar results for a large cross-section of banks, driven by reductions in interest rate margins. A recent study by the Committee on the Global Financial System [CGFS

(2018)] uses a large cross-country panel and finds that net interest margins fall with declines in 3-month rates.

Altavilla, et al. (2018), examine 288 Eurozone banks and find that short-term financial conditions, in the form of 3-month OIS rates, do not impact on bank profitability once one conditions for expected future macroeconomic conditions.[7] Consistent with our findings below, their results indicate that banks suffer losses under low rates on net interest margins, but compensate through gains in non-interest income.

A literature also examines bank behavior in economies that have experienced negative nominal interest rates. Bech and Malkhozov (2016) document that the movement into negative territory by four central banks in Europe since 2014 further squeezed bank net interest income margins precisely because banks were loath to charge negative *deposit* rates. Turk (2016) examines samples of Danish and Swedish banks and finds that bank margins were roughly stable across the zero threshold; reductions in wholesale funding costs and increased fees offset losses experienced in interest income. Arce, et al. (2018) find that banks with reduced net interest margins under negative rates are often poorly capitalized and take less risk.

Basten and Mariathasan (2018) examine 68 Swiss banks, using the share of excess reserves as a proxy for exposure to negative rates. They find that banks with higher excess reserves raised fees and interest income to compensate for negative liability margins. Banks also adjusted liabilities, primarily through reductions in bond issuance, thus increasing maturity mismatch.

Our analysis, which also focuses primarily on bank profitability, differs from earlier studies in both sample and model specification. On the sample side, we consider a disparate group of monetary regimes (14 different currencies, including the euro), which allows us to account for global conditions. More generally, our sample allows us to employ a difference-in-differences strategy as not all of the monetary regimes in our sample experienced negative rates, and those that do enter into negative territory do so at different points in time.

Our sample is also large and heterogeneous, including over 5,000 banks, many of which are small and/or dependent for their funding on retail deposits. Both characteristics would be expected to be conducive to losses under negative interest rates. Indeed, we confirm that this is the case, as is also suggested by bank balance sheet adjustments documented in Demiralp, et al. (2019).

Finally, as we focus on examining the implications of nominal policy rates on either side of zero, we restrict our base sample to include only episodes of negative or low positive rates, and examine a period with relatively low rates throughout, 2010-2017. This contrasts with the samples considered in the CFGS (2018) and Altavilla, et al. (2018) studies, who examine movements in 3-month rates. The latter measure reflects changes in financial conditions from any source, which could include external shocks, quantitative easing and other "unconventional policy" changes, or others. On the specification side, our paper explicitly considers the implications of crossing zero. This also contrasts with earlier studies, whose specifications hold bank sensitivity to interest rate changes constant throughout their samples.

In the end, though, our findings below that banks appear to at least temporarily manage movements into negative rates suggest that the same mechanisms identified for low rates in the existing literature are also employed when policy rates cross zero. As such, our work is complementary to these earlier studies.

3. The Data Set

Our data set consists of balance sheet and income statement variables for individual banks between 2010 through 2017, taken from the Fitch Global Banking database.[8] The observations come from 28 European countries and Japan, thus covering a variety of monetary regimes including monetary unions, exchange rate peggers, and inflation targeters.[9] Our data set begins two years before the onset of negative nominal interest rates and includes all countries that experienced negative nominal interest rates through the end of our observations in 2017.[10]

Our data set differs from the existing literature primarily in two dimensions. First, we include a variety of countries with different monetary regimes; these entered negative rates at different points in time, if at all. During our sample, five economies experienced negative nominal policy interest rates: Denmark, the EMU, Japan, Sweden, and Switzerland. Denmark first crossed into negative rates in July 2012, while Swiss interest rates have been most negative (with rates on sight deposits at -0.75%).[11] We also include similar countries that did not go negative: Bulgaria, Czech Republic, Hungary, and the UK.[12] We include time fixed effects to

account for global conditions, and, more generally, employ a difference-in-differences strategy; not all our economies experienced negative rates, and none for the entire sample.

The second difference from the literature is that, with over 5,200 banks and more than 35,000 observations, our data set is relatively large. The database allows us to examine closely the effects of negative rates on banks that differ along several dimensions, such as size and deposit-reliance. We identify a bank as large if its assets exceed $10 billion during the sample; about an eighth of our banks are large, though they hold around 93% of total bank assets. If a bank's deposits exceeded 75% of total funding at some point in the sample (as is true of four-fifths of our sample), it is defined as high-deposit.[13]

Our data set has a few complications. Banks report information using different (sometimes multiple) accounting methods.[14] While we used bank-level fixed effects throughout, we want as consistent a sample as possible. Therefore, when we have duplicate time series of banks reported in different accounting methods, we drop the less commonly-used method for that bank's country. We also drop banks that use unconventional accounting systems.[15] Finally, we generally choose unconsolidated observations, only reporting consolidated observations if unconsolidated are unavailable. We use annual observations, typically reported in the fourth quarter.[16]

Descriptive statistics are tabulated in Appendix Table A1. At the right, we present mean values for bank income (as a percentage of total assets), along with standard deviations, for nine different monetary regimes. We compare bank profitability under negative and low positive nominal interest rates, defining the latter as a policy rate that is within the [0, 1%) range.[17] Of the five economies that experienced negative nominal interest rates, net income

was, on average, higher under positive rates for the EMU, Japan, Sweden and Switzerland. However, the differences across positive and negative rate regimes were small, and Danish banks did slightly better with negative rates. This impression is corroborated by Figure 2, which scatters bank profitability against the policy rate. The regression line has no slope, suggesting little effect of interest rates on bank profitability.

4. Bank Profitability under Negative Nominal Interest Rates

Our empirical strategy is to use a plain-vanilla approach, relying on the richness of our data set rather than elaborate econometrics. Accordingly, we begin with a conventional panel regression specification:

$$Y_{ijt} = \beta NEGI_{jt} + \{\delta_i\} + \{\theta_t\} + \varepsilon_{ijt} \qquad (1)$$

where:

- Y_{ijt} is the dependent variable of interest for bank i in country j for year t,
- $NEGI_{jt}$ is a binary variable which is one if country j had a negative nominal policy interest rate during year t, and is zero if the nominal policy interest rate was low and positive, meaning either zero or below 1% (observations with higher nominal rates are dropped),
- $\{\delta_i\}$ and $\{\theta_t\}$ are comprehensive sets of bank- and time-specific fixed effects, and
- ε_{ijt} represents a residual, assumed to be well-behaved.

The coefficient of interest to us is β, the average effect of negative (as opposed to low positive) nominal interest rates on the dependent variable of interest. We use robust standard errors, clustered by bank. We are interested in a number of overall and disaggregated measures of bank performance, and we typically measure these as ratios of total assets.[18] Also, we drop outliers of our dependent variables, typically defining those as observations outside the (1, 99) percentiles of the univariate distribution.[19]

Benchmark Results

Our single most striking set of results can be seen in the top three cells at the left of Table 1. This presents estimates of β (multiplied by 100 for ease of presentation), for five different regressands estimated with equation (1). The top cell shows negative interest rates have had an economically small, positive, but statistically insignificant effect on bank net income, compared with low positive rates. The cells underneath reveal that while net *interest* income has fallen significantly by 7.8 basis points, this has been almost precisely compensated by gains in net *non-interest* income of 7.5 basis points. These offsetting results suggest banks are reluctant to charge their depositors negative rates and willing to endure losses from interest income, while offsetting these losses with gains from non-interest income.

These results are robust to a variety of perturbations to our methodology, as summarized in Appendix Table A2. In particular, we first raise the ceiling on the nominal interest rate from 1% to 2% and then 3%. Next, we drop banks included on the Basel Committee's list of Global Systematically Important Banks. Next, we drop the world's 100 largest banks, as compiled by Standard and Poors, and then all consolidated banks. Then we

drop: a) the first (2010) and last (2017) year of the sample, separately; b) banks from Germany and Japan, the two biggest countries in the sample; and c) banks with any missing years of data, in order to be left with a balanced panel. Next we: a) substitute country- for bank-specific fixed effects, b) drop time fixed effects altogether; and c) add a control for active quantitative easing. The penultimate row adds the same four macroeconomic variables to equation (1) as controls, while the final row adds in the Herfindahl index for gross loans (within a country-year) and the slope of the yield curve as further controls.[20] In all cases, the effect of negative nominal rates on net interest income remains negative and significant; similarly, the effect on net non-interest income stays positive and is significant. The effects of negative rates on aggregate net income is small, positive and typically insignificant, except for the unreliable estimator without time effects.[21]

A separate Appendix Table A3 compares our least squares results with instrumental variables. We use combinations of four macroeconomic variables commonly used as determinants of the "Taylor Rule" model of interest rate determination (output growth, the output gap, CPI inflation, and the unemployment rate) as instrumental variables for NEGI. We use all four variables together, and then drop them one by one. In all cases, Stock-Yogo tests (tabulated at the extreme right) indicate that our IVs are not weak. Further, none of the IV net income coefficients is significantly different from zero; all this is to the good. While all of the net interest income coefficients are negative, not all are significantly so; similarly, all of the non-interest income coefficients are positive but not all are significantly different from zero. While we do not wish to overclaim the strength of our IV results, we gain confidence from the fact

that all are consistent with our least squares results; they add moderately to our confidence in the benchmark results.

While the left-most column of Table 1 includes our entire sample of banks, the remaining columns disaggregate our sample by bank size and dependence on deposits. On average, banks experience increases in net income when rates are negative, however these are all insignificant. The reduction in net interest income and offsetting rise in non-interest income stems primarily from small and low-deposit banks. Net interest income for large banks is insignificantly affected by negative (as opposed to low positive) nominal interest rates; high-deposit banks do suffer statistically significant reductions in net interest income, but their gains in non-interest income are statistically insignificant. Consistent with the literature, the responses to negative rates differ by funding characteristics; Jobst and Lin (2016) argue that lending rates fall more quickly than deposit rates as rates move into negative territory.

The reduction in net interest income and offsetting rise in non-interest income stems primarily from small and LD banks. These firms are likely to have larger shares of market-based funding and correspondingly have a more varied business model that includes additional financial services business activities. These funding differences would likely contribute to notable differences in response to negative interest rates. For example, LD banks are likely to be more exposed to fluctuations in market rates due to their higher intensity of short-term funding outside of deposits, and are thus less negatively affected by negative interest rates. Moreover, LD banks are also likely to hold a higher share of securities as assets. As we show below, these correspond to gains in non-interest income, likely due to capital gains enjoyed as policy rates go negative.

The two rows in the middle of Table 1 examine overall performance in terms of two alternative measures of profitability. We examine both smoothed returns on assets (ROA, defined as net income divided by average rather than year-end total assets), and smoothed returns on equity (ROE, defined as net income divided by average common equity). The effect of negative rates on ROA for all banks has a coefficient similar to that for net income, but is now significantly positive, suggesting substantive noise in annual movements in total assets; the same is true of large banks. Still, the ROA results indicate an even more positive picture of bank fortunes under negative rates, especially for large banks. The effect of negative rates on ROE are insignificant, except when the sample is separated by deposit dependence. LD banks experienced marginally positive increases in total profitability, since they were able to increase non-interest income more than their interest income fell. This shows up strikingly in the ROE results, which are significant and large for LD banks, quite the opposite of HD banks. Our point estimates of these differences are substantial, with negative rates associated with a 77 basis point decline in smoothed ROE for HD banks, and a 237 basis point *increase* in smoothed ROE for LD banks.

The three rows at the bottom of Table 1 are analogous to those at the top in that they consider total net income and its two constituent parts, net interest and net non-interest income. They differ from the top rows in being expressed as ratios to earning rather than total assets. In practice, this makes little difference to our qualitative results, with one exception. In particular, while only LD banks can significantly raise net non-interest income when total assets are used as the denominator, both HD and LD banks can significantly raise non-interest income when earning assets are used.[22]

To summarize, the overall effect on bank profitability of moving from low positive nominal interest rates into negative territory seems negligible. However, this masks two underlying effects that offset each other; a decline in net interest income that is counterbalanced by an improvement in bank non-interest income. Further, these results stem from smaller banks and banks that depend comparatively less on deposits; large and high-deposit banks are less affected. To shed further light on the matter, we now explore further by decomposing the components of interest and non-interest income.

5. Decomposing Net Interest and Non-Interest Income

Interest Income and Expenses

We begin by examining the components of net interest income further. Our results are in Table 2. We first split net interest income into gross interest income and expenses. We then further decompose gross interest income into interest income on loans and "other" interest income, while splitting gross interest expense into spending on customer deposits and other interest expenses.[23]

When we examine the full sample of banks at the left of the table, both gross interest income and expense show economically significant and statistically significant declines, but the decline in expenses is smaller than that of income, resulting in the decline in net interest income reported in Table 1. Both loan income and other interest income exhibit statistically significant declines. However, the only part of gross interest expenses to rise significantly is attributable to customer deposits. This all matches conventional wisdom: banks suffer interest

income losses under negative rates on loans and are unable (or unwilling) to pass these losses fully on to their depositors; hence, bank net interest income declines with negative interest rates.

The columns to the right of Table 2 show that large banks seem more nimble than smaller banks. Large banks suffer smaller and statistically insignificant declines in gross interest income and contain their expenses better, enabling them to avoid the significant losses on net interest income experienced by small banks. LD banks suffer significantly greater losses in gross interest income, especially income from loans. To help offset this decline in interest income, LD banks lower their deposit expenses at statistically significant levels. LD banks are likely better able to lower other interest expenses more as they are better able to access other, market-based funding sources.[24]

Our results indicate that the response to negative nominal interest rates varies with bank characteristics, consistent with the literature. Demiralp, et al. (2019) find that deposit-intensive banks adjust their balance sheets in favor of increased lending activity; Heider, et al. (2018) find that high deposit banks respond to movements into negative rates by reducing their lending activity in favor of riskier assets; and Amzallag, et al. (2018) find that Italian banks more reliant on retail deposits raise mortgage rates more after a move into negative policy rates.

Non-Interest Income and Expenses

Our key result is that improvements in bank net non-interest income offset, on average, declines in net interest income. We analyze this further in Table 3, which is the analogue to Table 2 but covers key components of the *non*-interest part of the income statement.

Tabulated at the left of Table 3 are results for the entire sample of banks. The increase in net non-interest income stems from an increase in gross income rather than a decline in gross expenses; the latter are insignificantly different between negative and low positive interest rates. The driving results are on the income side, stemming primarily from improvements in "other non-interest income" and less so from fees. This includes "sustainable income related to core business activities" after excluding net fees; for example, net capital gains and gains on securities are included in this category.

A couple of previous studies, noted above, have found that net fees tend to increase under unconventional monetary policies. Our universally-positive coefficient estimates in the second row of Table 3 are consistent with these findings; the coefficients are similar across categories of banks but are small relative to other income components and typically statistically insignificant. Overall, our results suggest a more modest role for fees than that found in the literature.

There are few substantive differences between large and small banks in the components of non-interest income and expenses, though large banks experienced increases in non-interest expenses much more than small banks; as with the entire sample, these are associated with other non-interest expenses (likely depreciation and administrative expenses).

Of special interest are the differences between HD and LD banks for the effect of negative interest rates on gross non-interest income, which is an order of magnitude higher for LD banks. Much of this difference stems from "other non-interest income," which includes gains on securities; see Appendix A4. Such capital gains are interesting for two reasons. First, they do not appear to be experienced by traditional HD banks to nearly the same extent. Second, they may be associated with unanticipated movements into negative rates, suggesting that a monetary shock pushing rates into negative territory might be temporarily benign due to immediate capital gains on security holdings for LD banks. But if these gains are transitory, remaining under negative rates may not (continue to) be painless. Gains on securities from reductions in policy rates can only be enjoyed once.

We pursue this point a little further by adding linear and quadratic time trends for the duration of the negative nominal interest rate regime as a regressor; specifically, we estimate:

$$Y_{ijt} = \beta NEGI_{jt} + \gamma^{L} YRSNEGIjt + \gamma^{Q} YRSNEGI^{2}_{jt} + \{\delta_i\} + \{\theta_t\} + \varepsilon_{ijt} \qquad (2)$$

where:

- $YRSNEGI_{jt}$ is the number of whole years for which country j has had a negative nominal policy interest rate at the end of year t, and is zero if the nominal policy interest rate was low and positive.

Figure 3 graphs fitted values of ($\beta NEGI_{jt} + \gamma^{L} YRSNEGIjt + \gamma^{Q} YRSNEGI^{2}_{jt}$) for values of YRSNEGI ranging between 0 and 5 (its maximum value in the sample), for three different regressands:

total net bank income, net interest income, and net non-interest income (all measured relative to total assets). The panel to the left of Figure 3 portrays the fitted values from the linear model (with the constraint $\gamma^{Q}=0$) scattered against the number of years under negative nominal interest rates (YRSNEGI). The unconstrained values are presented in the right panel of Figure 3. Both specifications deliver similar results.

Figure 3 shows that the effect of negative nominal interest rates on total bank net income varies with the duration of negative rates; it hovers around zero and is trending negative by the five-year mark. The effects of negative rates on bank interest and non-interest income are opposite (as is to be expected from Table 1). However, the interest income trend is negative and is slightly larger than the positive non-interest effect. As a result, while banks appear to be capable of increasing their non-interest income under negative nominal rates, their losses on interest income grow at an even faster rate. The net result is increasing losses for banks as the duration of time under negative rates rises.

However, while these results are sensible, the regressions fit poorly with correspondingly wide confidence intervals. Accordingly, they are merely suggestive of the possibility of a negative effect of the duration of a negative rate regime, and we are careful not to over-interpret our results.

To summarize thus far, banks have largely been able to neutralize losses in interest income stemming from the move to negative nominal interest rates via offsetting gains in non-interest income. But much of the latter arises from other non-interest income, such as capital gains associated with the move below zero. As the negative interest rate episode endures, such

gains may prove insufficient to overcome the growing deterioration of interest income. Succinctly, the longer-term implications of negative rates may differ from those we have observed so far, especially for HD banks.

6. Differences Across Monetary Regimes

One of the strengths of our data set is that it includes countries with three different types of monetary regimes. A large number of countries were members of the European Economic and Monetary Union (EMU); indeed, three Baltic countries joined EMU during the sample. The EMU is the largest monetary regime to have experienced negative rates. Japan and several European countries maintained floating exchange rates (typically with inflation targeting) during the sample. Of these, Japan, Sweden and Switzerland (but not the Czech Republic, Hungary or the UK) experienced negative nominal interest rates. Finally, while Bulgaria and Denmark maintained fixed Euro exchange rates (as did Estonia, Latvia and Lithuania prior to their EMU entries), only Denmark experienced negative interest rates. In our analysis above, we have implicitly exploited this panel variation across time and monetary regimes. In this section, we explore it directly, asking how banks in different monetary regimes are affected by negative nominal interest rates.

We do this by estimating equation (1) for key measures of bank income statements variables but restricting the sample to observations from a particular monetary regime. We focus on seven different measures of bank performance, most importantly the three aggregate measures of net income, net interest and net non-interest income. To provide a little more

color into the movement of these aggregates, we also look at four sub-components that provide particular insights: gross interest income and income from loans, as well as gross non-interest income and expenses.

For each of measure of bank performance, we provide results for seven monetary regimes, represented as columns in Table 4. First, we tabulate results at the left for banks in the two biggest countries in our sample, Japan and Germany (the latter a critical part of EMU). In both cases, we are unable to control for time fixed effects, since these would be collinear with the key variable of interest (NEGI).[25] Excluding time effects means that all macroeconomic consequences for bank performance from, e.g., monetary policy, are simply ignored. This approach is likely to give a distorted impression, especially with respect to the precision of our estimates, so a strong note of caution is appropriate. We provide these results for two reasons: a) to demonstrate the advantage of using a cross-country panel; and b) as a comparison with the literature, which often uses banks from a single monetary regime.

We have more confidence in the results to the middle and right of Table 4, since these columns all exploit cross-country panel data, enabling us to include time fixed effects. We provide five different sets of results, for: a) banks from countries with exchange rates pegged to the Euro (Bulgaria, Denmark, and the three Baltics before they joined EMU); b) banks based in these peggers plus the Eurozone; c) banks in European countries that maintained flexible exchange rates vis-à-vis the EMU (Czech Republic, Hungary, Sweden, Switzerland and the UK, all of which target inflation); d) banks in these flexers plus the Eurozone; and e) banks in all economies with flexible exchange rates (essentially the prior category) with the addition of Japanese banks.

The most striking aspect of the results in Table 4 is the heterogeneity across monetary regimes. Consistent with the headline results of Table 1, none of the five panel estimates in the right-part of the top row of Table 4 are significantly different from zero (two are negative, and three are positive); that is, there is no substantive reliable effect of negative nominal interest rates on bank profitability. This is in stark contrast to the unreliable national results tabulated at the left, which indicate a significant decline in bank profits from negative nominal rates in both Japan and Germany. This is the first indication that it is important to use a cross-country panel approach to generate an estimate of the effect of negative nominal interest rates on bank performance that is both reliable and general.

More evidence of the importance of the panel approach is apparent elsewhere in Table 4. Where there is a significant effect of negative rates on net interest income, it is always negative; likewise, all significant coefficients for net non-interest income are positive. However, the magnitudes of such effects vary substantially across monetary regimes, and the effects of negative nominal rates on sub-components of bank performance vary even more. For instance, the two panel estimates of gross interest (and loan) income effects for peggers are big and positive, while the three for different sets of floating exchange rate countries are similar in absolute value and negative. Similarly, the effects of negative nominal rates on gross interest expenses differ substantively by monetary regime; they are large and positive for peggers, and the opposite for floats. One can only discern the differences across monetary regimes by using a panel which involves different countries.

To summarize, our key result – negative nominal interest rates only have a small overall effect on bank profitability, since losses in interest income are offset by gains in non-interest income – stems from economies with floating exchange rates.

7. Bank Activity Under Negative Nominal Interest Rates

In this section, we extend our analysis to bank lending and liquidity management under negative nominal interest rates; our results are in Table 5.

The most obvious effect of negative rates is probably that on loan activity, as one might expect banks to raise their lending in the wake of a policy rate move into negative territory. In fact, the literature to date reports mixed results. Demiralp, et al. (2019) find that lending increases more after a move into negative rates among banks more reliant on retail for funding and holding greater excess liquidity. The latter measure is increasing in the losses to banks associated with movements into negative policy rates. Similar results are found for easing in financial conditions by Altavilla, et al. (2018). However, Eggertson, et al. (2017) and Heider, et al. (2018) find that banks that are more reliant on retail deposits for funding reduce their lending under negative rates.[26]

The first row of Table 5 shows that total bank lending as a percentage of bank assets increases insignificantly under negative rates in our sample. Any increase is driven almost entirely by small banks and by HD banks, whose loan share rises by about 75 basis points. In contrast, LD banks display a relatively large (but insignificant) decline in lending, which likely contributes to their larger decline in interest income and larger increases in non-interest income (manifest in Table 3).[27]

Changes in lending activity are likely to lead to changes in the credit risk profile of the loan portfolio. Measuring the riskiness of loan portfolios is challenging since accrual (or "banking book") accounting rules provide a large degree of flexibility in recognizing when loans default. We therefore examine loan impairment charges and reserves for impaired and non-performing loans, and observe two notable effects. Loan impairment charges, expressed as a fraction of total assets, increase for all banks and for each sub-sample. This in keeping with much of the literature cited above.[28] Similarly, commercial bank reserves set aside to cover losses on impaired and non-performing loans (as a fraction of loans) also rose for all bank categories, particularly LD banks.[29]

We next examine changes in holdings of safe assets (cash) under negative interest rates. Clearly, in a negative rate environment the relative returns on holding these assets decline, and the banks in our sample unsurprisingly shift away from them in a statistically meaningful way. Cash holdings at all banks declined by over 2.8 percentage points and by slightly higher amounts at small banks and HD banks. The bottom row of Table 5 shows that while central bank reserves fall by almost 2.5 percentage points for all banks, small banks and HD banks drive this decline.[30]

In addition to changes on the asset side of bank balance sheets, the negative interest rate environment may also induce changes in bank liabilities (or funding). Deposit funding rose for all banks, but is only statistically significant for HD banks. This finding is in line with other research – such as Kashyap and Stein (2000) – that deposits increase under expansionary monetary policy. Some of this increase may be associated with unconventional monetary

policy, including quantitative easing, as funds used to purchase government securities find their way into bank deposits.

The leverage ratio (defined as the ratio of total bank debt to equity) similarly increases but insignificantly. The insignificance of negative interest rates on these liability variables suggests that banks have not adjusted their funding strategies much, even as they have shifted away from safe assets in their asset mix. Banks may not perceive a move into negative rates to be durable, and may therefore be reluctant to undertake costly adjustments that have to be reversed quickly.

8. Conclusion

We investigate the performance and activities of banks experiencing negative nominal interest rates, using a large recent cross-country data set of bank income statements. To our knowledge, this is the first study that examines the impact of negative nominal policy interest rates on a wide variety of banks in for different monetary regimes. Our investigation is exploratory in nature, intended to reveal stylized facts that can be used for more structural analysis by other researchers.

We find little overall impact of negative nominal rates on bank profitability, compared with low (<1.00%) positive rates. However, different components of income respond significantly; a decline in net interest income is largely offset by increases in non-interest income stemming from "other income" sources, such as capital gains on securities. The richness of our panel allows us to condition for global shocks and to dis-aggregate banks by both size and dependence on deposit-funding. Our key results are driven by countries with

floating exchange rates, and banks that are either small, have low deposit-dependence, or both.

Overall, our results suggest that banks fare reasonably well under negative nominal interest rates, compared to low positive rates. However, the considerable heterogeneity we find makes us cautious to conclude that the financial channel of the monetary transmission mechanism remains unchanged as policy rates cross zero. That is especially true since the positive returns in "other non-interest income" enjoyed by banks under negative rates may prove unsustainable if they are primarily attributable to capital gains stemming from negative interest rate surprises. Nevertheless, our results suggest that the standard monetary transmission mechanism continues to work, at least for small and high-deposit banks, as the move into negative policy rates induces these banks to shift their asset portfolios away from cash and increase lending activity.

These results also serve to alleviate any concerns about moving policy rates into negative territory. Since the income effects for banks in countries with negative rates have been small and lending activity has not diminished much, zero does not seem to be a serious lower bound for nominal interest rates, at least over concerns about the viability of the financial system. Moreover, if the cost of hitting zero is low, the argument to raise the inflation target in hopes of avoiding zero is accordingly weakened. However, we reiterate that there is no guarantee that the gains to non-interest bank income are sustainable over longer periods. Our analysis of the duration of negative rates suggests that the benign effects observed so far are likely to diminish, but the actual effects will only be revealed with time.

References

Albertazzi, U. and Gambacorta, L. (2009) "Bank Profitability and the Business Cycle" *Journal of Financial Stability*, 5, 393-409.

Altavilla, Carlo, Miguel Boucinha and Jose´-Luis Peydro, (2018), "Monetary policy and bank profitability in a low interest rate environment," *Economic Policy,* 33(96), 531-586.

Amzallag, Adrien, Alessandro Calza, Dimitris Georgarakos, and João Sousa, (2019), "Monetary policy transmission to mortgages in a negative interest rate environment," *ECB Working Paper Series*, No. 2243, February.

Aramonte, S., S. J. Lee, and V. Stebunov, (2015), "Risk Taking and Low Longer- Term Interest Rates: Evidence from the U.S. Syndicated Loan Market," *Finance and Economics Discussion Series* 2015-068, Washington: Board of Governors of the Federal Reserve System.

Arce, Oscar, Miguel Garcia-Posada, Sergio Mayordomo, and Steven Ongena (2018) "Adapting Lending Policies when negative interest rates hit banks' profits" mimeo, March.

Arteta, Carlos, M. Ayhan Kose, Marc Stocker, and Temel Taskin (2017) "Negative Interest Rate Policies: Sources and Implications" *Policy Research Paper* 7791, World Bank, Washington DC.

Basten, Christoph, and Mike Mariathasan (2018) "How Banks Respond to Negative Interest Rates: Evidence from the Swiss Exemption Threshold" *CESIFO Working Paper* 6901-2018, February.

Bech, M and A Malkhozov (2016) "How have central banks implemented negative policy rates?", *BIS Quarterly Review*, March, pp 31–44.

Bernanke, B. S., and M. Gertler (1995) "Inside the Black Box: The Credit Channel of Monetary Policy Transmission" *Journal of Economic Perspectives*, 9(4), pp 27-48.

Bikker, Jacob and Tobias Vervliet (2017) "Bank Profitability and Risk-Taking Under Low Interest Rates, *DNB Working paper* no. 560.

Borio, Claudio, and Leonardo Gambacorta (2017) "Monetary policy and bank lending in a low interest rate environment: diminishing effectiveness?" *Journal of Macroeconomics*, 54(B), 217-231.

Borio, Claudio, Leonardo Gambacorta, and Boris Hofmann (2017) "The influence of monetary policy on bank profitability" *International Finance*, 20, 48-63.

Bottero, Margherita, Camelia Minoiu, José-Luis Peydró, Andrea Polo, Andrea F. Presbitero, and Enrico Sette, (2019), "Negative Policy Rates and Bank Asset Allocation: Evidence from the Italian Credit and Security Registers," Universitat Pompeo Fabra Economics Working Paper Series Working Paper No. 1649, February.

Brunnermeier, Markus K., and Yann Koby, (2018), "The Reversal Interest Rate," *NBER Working Paper* 25406, December.

Bubeck, Johannes, Angela Maddaloni, and José-Luis Peydró, (2019), "Negative Monetary Policy Rates and Systemic Banks' Risk-Taking: Evidence from the Euro Area Securities Register," mimeo.

Buch, Claudia M., Matthieu Bussiere, Linda Goldberg, and Robert Hills (2018) "The International Transmission of Monetary Policy," *NBER Working Paper* No. 24,454.

Claessens, Stijn, Nicholas Coleman, and Michael Donnelly (2018) " 'Low–For-Long' interest rates and banks' interest margins and profitability: Cross-Country Evidence" *Journal of Financial Intermediation,* 35, 1-16.

Committee on the Global Financial System (2018) "Financial Stability Implications of a Prolonged Period of Low Interest Rates" CGFS Papers No. 61.

Delis, Manthos and Kouretas, Georgios (2011) "Interest rates and bank risk-taking," *Journal of Banking & Finance*, 35, 840-855.

Demiralp, Selva, Jens Eisenschmidt, and Thomas Vlassopoulos (2019) "Negative Interest Rates, Excess Liquidity, and Bank Business Models: Banks' Reaction to Unconventional Monetary Policy in the Euro Area," ECB Working Paper no 2283, May.

Eggertsson, Gauti, Ragnar E. Juelsrud (2017) "Are Negative Nominal Interest Rates Expansionary?" *NBER Working Paper* No. 24,039.

Heider, F., F. Saidi, and G. Schepens (2018). Life Below Zero: Bank Lending under Negative Rates. ECB Working Paper No 2173.Jiménez, G., S. Ongena, J.-L. Peydró and J. Saurina (2012) "Credit Supply and Monetary
Policy: Identifying the Bank Balance-Sheet Channel With Loan Applications" *American Economic Review*, 102, 2301–2326.

Jobst, Andreas, and Huidan Lin (2016) "Negative Interest Rate Policy (NIRP): Implications for Monetary Transmission and Bank Profitability in the Euro Area" *IMF Working Paper* WP/16/172.

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

Lee, C.C., Yanga, S.J., and Chang, C.H. (2014) “Non-Interest Income, Profitability, and Risk in the Banking Industry: A Cross-Country Analysis” *North American Journal of Economics and Finance*, 27, 48–67.

Nucera, Federico, Andre Lucas, Julia Schaumberg, and Bernd Schwaab (2017) “Do Negative Interest Rates Make Banks Less Safe?” *Tinbergen Institute Discussion Paper* TI 2017-041/IV,

Obstfeld, Maurice, Jay C. Shambaugh, and Alan M. Taylor (2005) “The Trilemma in History: Tradeoffs Among Exchange Rates, Monetary Policies, and Capital Mobility” *The Review of Economics and Statistics*, 87(3), 423-438.

Rostagno, M., U. Bindseil, A. Kamps, W. Lemke, T. Sugo and T. Vlassopoulos (2016) “Breaking through the zero line: the ECB’s negative interest rate policy”, Brookings Institution, Washington DC, June.

Stiroh, K.J. (2004) “Diversification in Banking: Is Noninterest Income the Answer?” *Journal of Money, Credit, and Banking,* 36, 853-882.

Turk, R. A. (2016) “Negative Interest Rates: How Big a Challenge for Large Danish and Swedish Banks?”, *IMF Working Paper* no 198.

Urbschat, F. (2018) “The Good, the Bad, and the Ugly: Impact of Negative Interest Rates and QE on the Profitability and Risk-Taking of 1,600 German Banks”, CESifo Working Paper #7358.

Table 1: Negative Nominal Interest Rates and Bank Profitability

	Denominator	**Sample of Banks** [Maximum Observations]				
Regressand	**Total Assets**	**All** [35,250]	**Large** [4,670]	**Small** [30,580]	**High-Deposit** [29,072]	**Low-Deposit** [6,057]
Net Income	**Total Assets**	.034 (.030)	.046 (.044)	.027 (.037)	.019 (.033)	.122 (.066)
Net Interest Income	**Total Assets**	-.078** (.021)	-.061 (.039)	-.074** (.026)	-.052* (.022)	-.258** (.063)
Net Non-Interest Income	**Total Assets**	.075** (.015)	.075** (.028)	.065** (.018)	.029 (.016)	.339** (.050)
Smoothed Return on Assets	**Average Assets**	.042** (.016)	.057* (.028)	.037 (.020)	.022 (.017)	.079 (.063)
Smoothed Return on Equity	**Equity**	-.256 (.217)	.253 (.494)	-.378 (.247)	-.768** (.228)	2.374** (.875)
Net Income	**Earning Assets**	-.015 (.047)	.040 (.049)	-.035 (.060)	.009 (.039)	.062 (.092)
Net Interest Income	**Earning Assets**	-.132** (.027)	-.106** (.039)	-.131** (.034)	-.111** (.029)	-.246** (.086)
Net Non-Interest Income	**Earning Assets**	.110** (.018)	.102** (.031)	.103** (.021)	.066** (.018)	.326** (.063)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in top row), including bank- and time- fixed effects. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017. Outliers removed (observations beyond 2/98 percentiles for net income, net non-interest income; beyond 1/99 percentiles for others). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

Table 2: Negative Nominal Interest Rates and Bank Interest Income and Expenses

	Sample of Banks [Maximum Observations]				
Regressand	**All** [34,815]	**Large** [4,617]	**Small** [30,198]	**High-Deposit** [28,738]	**Low-Deposit** [5,977]
Gross Interest Income	-.088** (.024)	-.048 (.043)	-.083** (.028)	-.048* (.023)	-.503** (.095)
Interest Income on Loans	-.055** (.021)	-.002 (.038)	-.054* (.025)	-.030 (.020)	-.378** (.095)
Other Interest Income	-.021** (.008)	.027 (.016)	-.033** (.009)	-.022** (.007)	-.103* (.047)
Gross Interest Expenses	-.037* (.015)	.008 (.026)	-.041* (.018)	-.026 (.015)	-.229** (.059)
Customer Dep. Expenses	.115** (.013)	.078** (.021)	.123** (.016)	.138** (.015)	-.033 (.023)
Other Interest Expenses	.006 (.009)	-.004 (.017)	.007 (.011)	.020* (.010)	-.102* (.045)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in top row), including bank- and time- fixed effects. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017. Outliers removed (observations beyond 1/99 percentiles). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

Table 3: Negative Nominal Interest Rates and Bank Non-Interest Income and Expenses

	Sample of Banks [Maximum Observations]				
Regressand	**All** [35,347]	**Large** [4,696]	**Small** [30,651]	**High-Deposit** [29,119]	**Low-Deposit** [6,086]
Gross Non-Interest Income	.078** (.017)	.064** (.021)	.072** (.021)	.040* (.018)	.311** (.056)
Net Fees	.010 (.008)	.027* (.011)	.005 (.010)	.009 (.008)	.029 (.030)
Other Non-Interest Income	.051** (.009)	.032* (.015)	.050** (.011)	.018* (.009)	.217** (.035)
Gross Non-Interest Expense	-.014 (.040)	.119 (.088)	-.056 (.045)	.013 (.039)	.001 (.069)
Personnel Expense	-.024* (.011)	.005 (.013)	-.033* (.014)	-.021 (.012)	-.062 (.035)
Tax Expense	-.011 (.007)	-.034* (.014)	-.003 (.008)	-.009 (.007)	-.025 (.027)
Other Non-Interest Expense	.011 (.010)	.034 (.020)	-.006 (.012)	.017 (.010)	-.004 (.052)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in top row), including bank- and time- fixed effects. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017. Outliers removed (observations beyond 1/99 percentiles). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

Table 4: Negative Nominal Interest Rates Effects Across Economies

Regressand	Japan. [4,680]	German [12,586]	Euro. Pegs [787]	EMU, Euro. Pegs [26,946]	Euro. Floats [3,721]	EMU, Euro. Floats [29,880]	No Pegs [34,560]
Net Income	-.115**	-.164**	.483	.161	-.075	-.051	.006
	(.007)	(.010)	(.320)	(.120)	(.069)	(.062)	(.026)
Net Interest Income	-.215**	-.256**	.385	.108	-.317**	-.334**	-.120**
	(.007)	(.007)	(.230)	(.076)	(.045)	(.045)	(.020)
Net Non-Interest Income	.104**	.095**	.157	-.018	.235**	.250**	.095**
	(.005)	(.005)	(.140)	(.051)	(.035)	(.032)	(.015)
Gross Interest Income	-.275**	-1.04**	.973**	.327**	-.311**	-.473**	-.187**
	(.007)	(.007)	(.162)	(.067)	(.049)	(.048)	(.021)
Interest Income on Loans	-.217**	-.784**	1.078**	.306**	-.360**	-.407**	-.143**
	(.006)	(.007)	(.139)	(.056)	(.049)	(.046)	(.019)
Gross Non-Interest Income	-.140**	-.124**	.181	-.004	-.136	-.114	-.020
	(.007)	(.015)	(.206)	(.080)	(.121)	(.110)	(.046)
Gross Interest Expenses	-.057**	-.784**	.638**	.151**	-.013	-.151**	-.086**
	(.002)	(.005)	(.095)	(.053)	(.031)	(.030)	(.012)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in top row), including bank- and time- fixed effects (bank effects only for Japan, Germany). Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data, 2010-2017. Outliers removed (observations beyond 2/98 percentiles for net income, net non-interest income; beyond 1/99 percentiles for others). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

Table 5: Negative Nominal Interest Rates and Bank Activity

	Sample of Banks [Maximum Observations]				
Regressand	**All** [35,321]	**Large** [4,709]	**Small** [30,616]	**High-Deposit** [29,180]	**Low-Deposit** [6,110]
Loans/ Total Assets	.391 (.301)	-1.066 (.804)	.788* (.0315)	.733* (.310)	-1.876 (1.184)
Loan Impair. Charges/ Total Assets	.191** (.029)	.143** (.031)	.198** (.038)	.168** (.031)	.282* (.115)
Impaired & NPL Comm'l Bank Reserves/Loans	.651** (.087)	1.063** (.144)	.513** (.104)	.338** (.088)	2.72** (.46)
Cash/ Total Assets	-2.877** (.327)	-2.034** (.525)	-2.992** (.406)	-3.04** (.35)	-1.526 (.967)
Deposits/ Total Funding	.613 (.315)	.675 (.782)	.622 (.348)	.787* (.34)	1.089 (1.130)
Leverage Ratio	.073 (.155)	-.154 (.353)	.007 (.179)	.048 (.17)	.14 (.40)
Central Bank Reserves/ Total Assets	-2.475** (.496)	-.517 (.718)	-3.22** (.63)	-2.81** (.56)	-.60 (.76)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in top row), including bank- and time- fixed effects. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100 except for leverage ratio. Annual data from 27 countries, 2010-2017. Outliers removed (observations beyond 1/99 percentiles), except for deposit/funding. Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

Figure 1: Overnight deposit rates in select countries

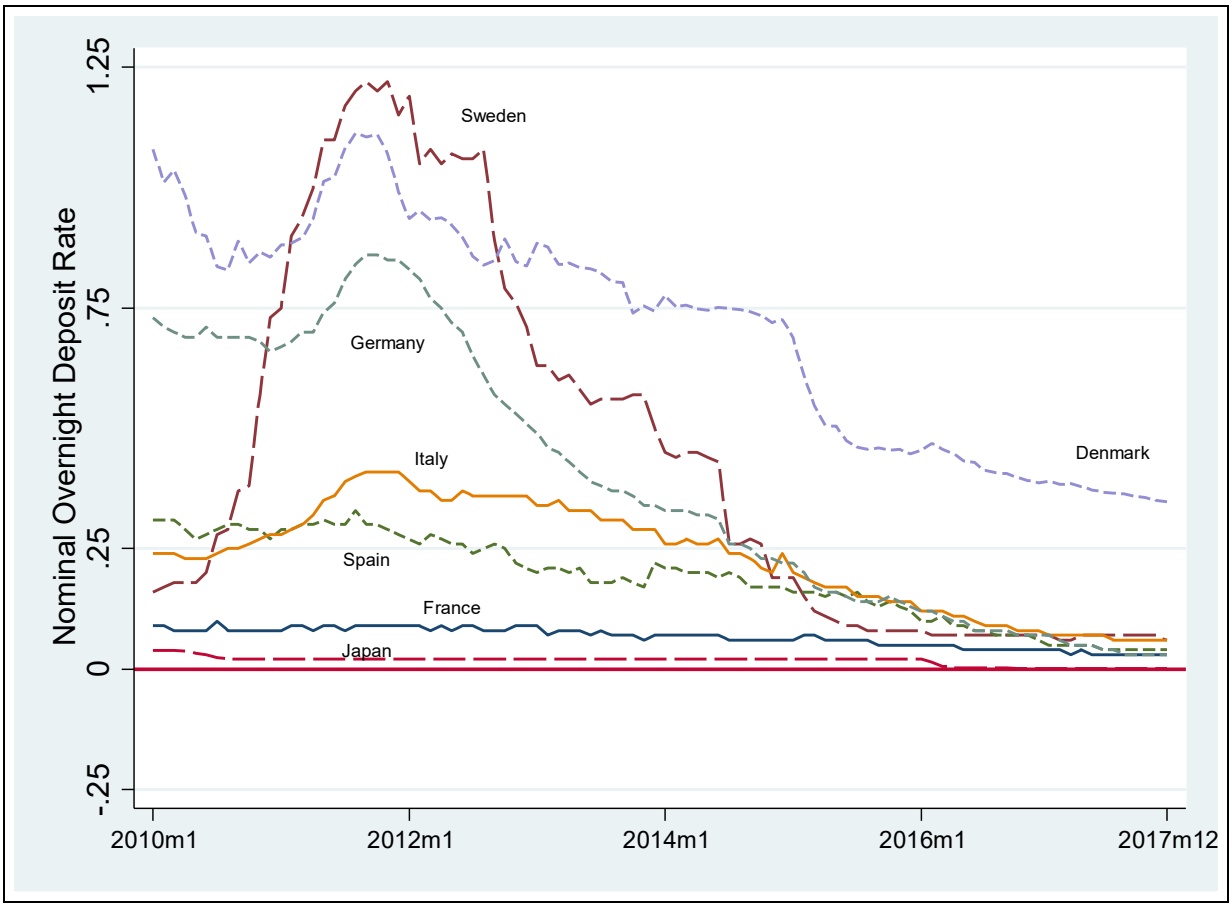


Figure 2: Bank profitability under negative and (low) positive nominal policy rates

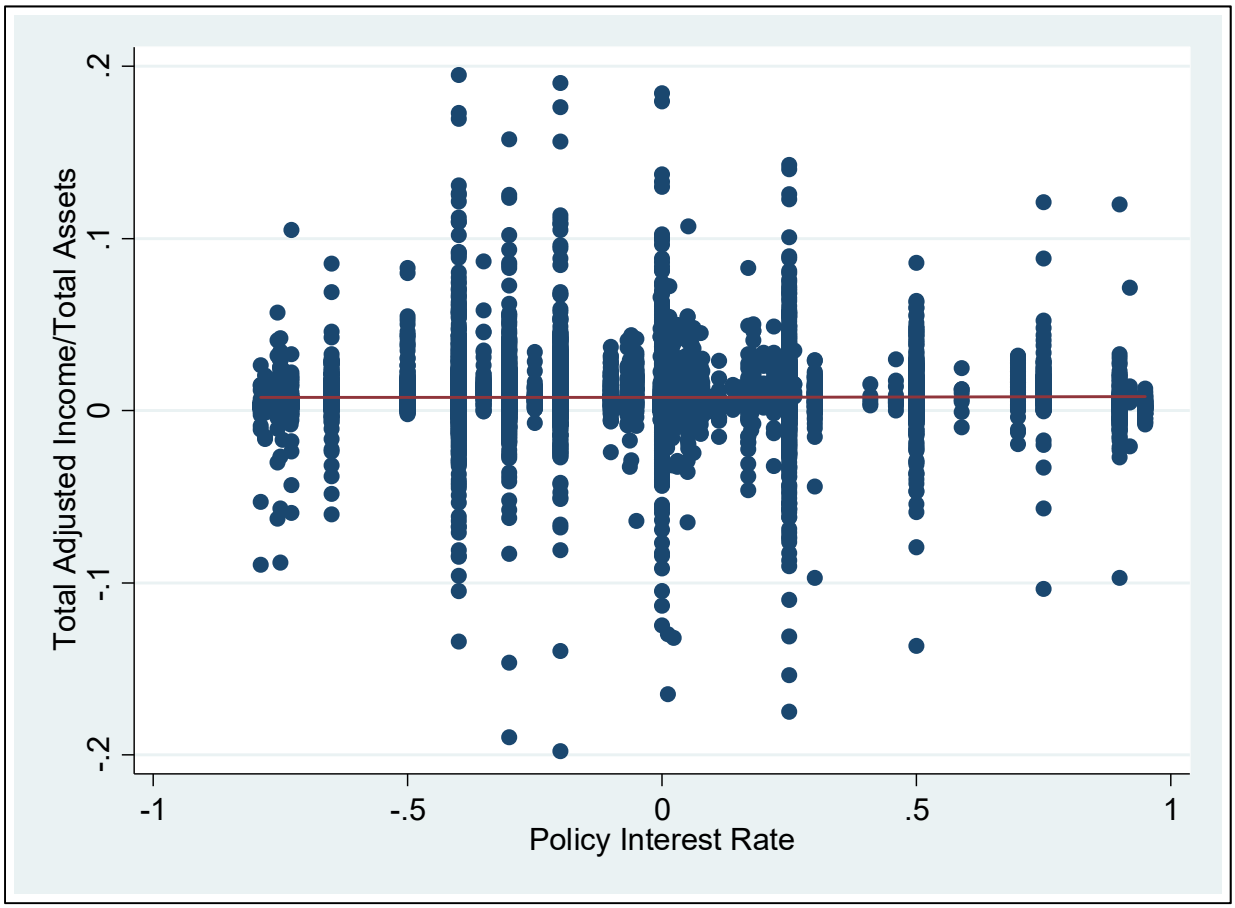
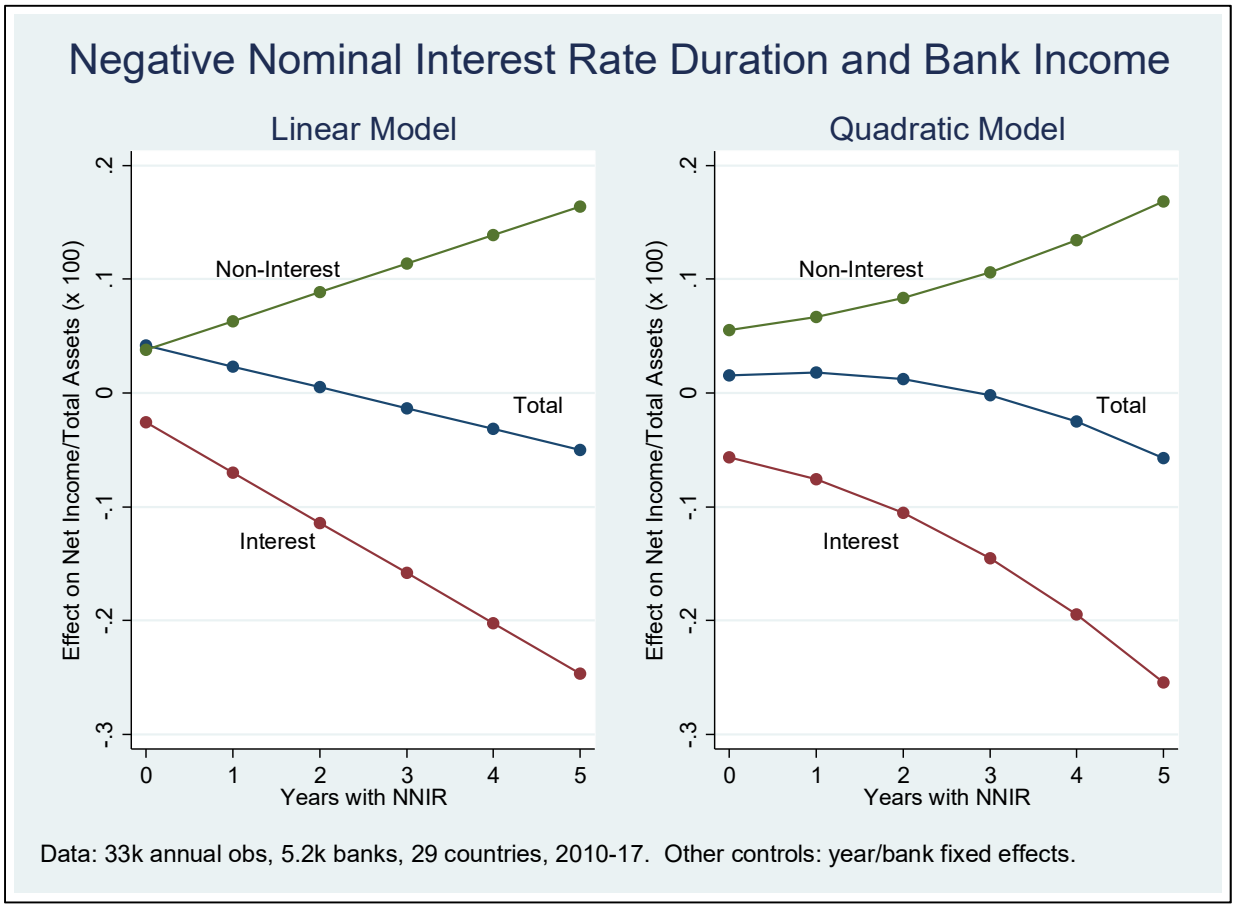


Figure 3: Bank profitability under negative nominal policy rates at different time horizons



Appendix Table A1: Descriptive Statistics

Economy (start of negative nominal interest rates)	Number of Banks			Net Income (% total assets)			
	Total	Large	High Deposit	Low Positive Rates		Negative Rates	
				Mean	Std. Dev.	Mean	Std. Dev.
All	5,273	685	4,265	.86	.98	.85	.99
Japan (2016)	600	185	584	.41	.40	.30	.42
Europe	4,673	500	3,681	.94	1.03	.91	1.02
EMU (2014)	3,900	415	3,048	.98	.94	.93	1.01
Denmark (2012)	102	7	87	.97	1.23	1.33	1.36
Other Pegs	51	2	45	1.60	1.70	n/a	n/a
Sweden (2015)	85	7	78	1.62	1.34	1.43	1.19
Switzerland (2014)	328	19	265	.50	.98	.49	.62
Other Floats	234	51	182	.65	1.52	n/a	n/a

Annual data, 27 countries, 2010-2017. Outliers removed (observations beyond 2/98 percentiles). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample. Other pegs include Bulgaria, and pre-EMU Estonia, Latvia, and Lithuania. Other floats include Czech Republic, Hungary, and UK.

Appendix Table A2: Sensitivity Analysis

	Net Income	Net Interest Income	Net Non-Interest Income
Whole Sample (Default)	.034	-.078**	.075**
	(.030)	(.021)	(.015)
Raise Nominal Interest Ceiling from 1% to 2%	.034	-.079**	.075**
	(.030)	(.021)	(.015)
Raise Nominal Interest Ceiling from 1% to 3%	.038	-.046*	.053**
	(.028)	(.020)	(.014)
Drop Systematically Important Banks	.045	-.070**	.108**
	(.031)	(.024)	(.026)
Drop Top-100 Banks	.045	-.069**	.107**
	(.031)	(.024)	(.027)
Drop Consolidated Banks	.020	-.064**	.057**
	(.031)	(.021)	(.014)
Drop 2010	.021	-.081**	.069**
	(.030)	(.021)	(.014)
Drop 2017	.043	-.076**	.078**
	(.028)	(.020)	(.014)
Drop Germany, Japan	.088	-.163**	.186**
	(.059)	(.042)	(.030)
Balanced sample	.032	-.064**	.061**
	(.028)	(.022)	(.022)
Substitute country- for bank- fixed effects	.018	-.081**	.075**
	(.036)	(.025)	(.019)
Drop time-fixed effects	-.065**	-.215**	.135**
	(.009)	(.005)	(.005)
Add control for quantitative easing	.034	-.079**	.074**
	(.031)	(.022)	(.016)
Control for output growth and gap, CPI inflation, unemployment rate	.046	-.099**	.111**
	(.035)	(.024)	(.019)
Control for 4 macro variables, Herfindahl index, yield curve slope	.048	-.097**	.110**
	(.034)	(.023)	(.019)

Each cell presents a coefficient from a separate regression of regressand (noted in top rows) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (noted in left column), including bank- and time- fixed effects unless noted. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017, unless noted. Outliers removed (observations beyond 2/98 percentiles for net income, net non-interest income; beyond 1/99 percentiles for others).

Appendix Table A3: Instrumental Variable Analysis

	Net Income	Net Interest Income	Net Non-Interest Income	P-value, Stock-Yogo first stage
Least Squares, Whole Sample	.034 (.030)	-.078** (.021)	.075** (.015)	.00
IV, using output growth and gap, CPI inflation, unemployment rate	.056 (.035)	-.032 (.023)	.034* (.017)	.00
IV, using output growth, CPI inflation, unemployment rate	-.058 (.030)	-.092** (.027)	.034 (.020)	.00
IV, using output growth and gap, unemployment rate	-.044 (.035)	-.128** (.033)	.084** (.026)	.00
IV, using output gap, CPI inflation, unemployment rate	.000 (.025)	-.015 (.022)	.015 (.019)	.00
IV, using output growth and gap, CPI inflation	-.013 (.026)	-.041 (.024)	.028 (.018)	.00

Each cell presents a coefficient from a separate regression of regressand (noted in top rows) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with instrumental variables except where marked (instrumental variables noted in left column), including bank- and time- fixed effects unless noted. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017, unless noted. Outliers removed (observations beyond 2/98 percentiles for net income, net non-interest income; beyond 1/99 percentiles for others).

Appendix A4: Components of Non-Interest Income

In the Fitch database, non-interest income is defined as the sum of six subcomponents:

- net fees and commissions that are typically earned on commercial banking, investment banking, custodial, and trust activities;
- net gains (or losses) on trading assets and derivatives activities;
- net gains (or losses) on assets booked at fair value through the income statement;
- net gains (or losses) on other securities revalued through the income statement;
- net insurance income; and
- the residual category of other operating income defined as other sustainable income related to core business activities that do not fall into any other category.

Ideally, we would like to understand the behavior of each component, and be able to compare its behavior under negative and low positive nominal interest rates, for different sets of banks. Unfortunately, many of these observations are missing in the Fitch data set. We have data for 98% and 82% respectively of all relevant observations for net fees and residual operating income, which explains why we include the first and last variables in Table 3. Note that the "other non-interest income" variable examined in Table 3 is the sum of the last five subcomponents listed. However, for the four remaining components of non-interest income, we have less than half of all observations, often far less. Given the possibility of serious selection bias, we have tabulated regression coefficients for these components in Appendix Table A4, along with the percentage of observations available. These are analogous to those in Table 3, but for more sparsely populated fields of non-interest income. Given the presence of

so many missing observations, we do not take these results seriously, and we urge the reader to approach them with appropriate caution.

Appendix Table A4: More Components of Non-Interest Income

	Sample of Banks [Maximum Observations]				
Regressand (% observations available)	**All** [16,459]	**Large** [3,537]	**Small** [12,922]	**High-Dep** [12,532]	**Low-Dep** [3,912]
Net Gain/Loss on Trading Securities, Derivatives (31%)	0.031* (0.016)	0.032 (0.023)	0.024 (0.024)	0.007 (0.016)	0.109** (0.037)
Net Gain/Loss on Assets at Fair Value (7%)	0.022 (0.024)	0.026 (0.023)	0.018 (0.040)	0.015 (0.037)	0.048 (0.030)
Net Gain/Loss on Other Revalued Securities (47%)	0.149** (0.011)	0.022 (0.016)	0.176** (0.013)	0.121** (0.013)	0.167** (0.024)
Net Insurance Income (1%)	0.040 (0.035)	0.004 (0.020)	0.218 (0.172)	0.121 (0.083)	-0.009 (0.023)

Each cell presents a coefficient from a separate regression of regressand (noted in left column) on binary variable, one for negative nominal policy interest rate, zero for zero/positive nominal interest rate below 1%. Regressions estimated with least squares on sample (maximum noted in top row), including bank- and time- fixed effects. Robust standard errors (clustered by banks) included parenthetically; coefficients significantly different from zero at .05(.01) significance level marked with one(two) asterisk(s). Coefficients and standard errors are multiplied by 100. Annual data from 27 countries, 2010-2017. Outliers removed (outliers for total non-interest operating income). Large banks have total assets >$10 billion dollars during sample; high-deposit banks have exceeded .75 deposit/total funding ratio during sample.

The only consistently significant category is that of net gains on other revalued securities. This is an opaque category, that includes returns on securities other than those listed elsewhere by Fitch; this opacity obviates further analysis. Still, it points towards capital gains/losses, consistent with the "other non-interest income" results reported in Table 3.

Endnotes

[1] For instance, Bloomberg in mid-August 2019 published "Depositors are Next as Nordic Banks Buckle under Negative Rates" (August 11, 2019) which begins "Ever since negative interest rates became a thing, banks have been too afraid to pass them on to retail depositors. That may be about to change. In Scandinavia, where sub-zero rates have been the norm longer than most other places, the finance industry has undergone several drastic adjustments to survive the regime. Banks have relied more on asset management and other services that generate fees, and less on the traditional business of lending and holding deposits. But with no end to negative rates in sight, those changes may not be enough. … So far banks haven't passed negative rates on to private customers for 'political reasons.' … Banks have so far balked at the idea. The first lender to charge depositors risks losing them, and any industry agreement to coordinate a move would expose banks to cartel charges. … " https://www.bloomberg.com/news/articles/2019-08-11/depositors-are-next-as-nordic-banks-buckle-under-negative-rates.

[2] Reductions in short-term interest rates have been shown to affect the characteristics of both borrowers [e.g. Bernanke and Gertler (1995)] and lenders [e.g. Kashyap and Stein (2000)], inducing increased lending activity [e.g. Bernanke and Blinder (1992) and Jiménez, et al. (2012)].

[3] Brunnermeier and Koby stress that the point at which further rate reductions become contractionary, a point they refer to as the "reversal interest rate," need not be at zero. However, their analysis does not speak to the possibility of a discrete reduction in the expansionary implications of interest rate reductions at zero.

[4] One exception is Rostagno, et al. (2016), who find that movements into negative rates may induce lending by making it costlier for banks to hoard cash.

[5] Not all these observations are used in practice; more on that below.

[6] Other interest income is defined as interest income generated from all non-loan assets such as debt securities, trading book items, short-term funds, and investment securities, excluding insurance-related interest.

[7] Altavilla, et al. (2018) consider a data set that extends into 2016, and so includes periods of negative European policy rates. However, their analysis pools across period of positive and negative euro area rates.

[8] Fitch sources its data through financial statements "… directly through web crawlers, alerts, by direct request and data feed." See https://app.fitchconnect.com/support for more detail. We remove a number of categories of non-banks from the original Fitch data set, including branches, bond banks, securities brokers, other brokerages, credit card banks, leasing subsidiaries, and factoring subsidiaries.

[9] We drop Croatian observations, since Croatia joined the EU partway through the sample. We restrict our analysis to comparing countries with negative or low positive nominal interest rates; since neither Poland nor Romania experienced nominal interest rates below 1%, we do not use their observations in our empirical work. Thus in practice we use observations for 25 EU countries (the EU-28 less Croatia, Poland and Romania), Switzerland and Japan, a total of 27 countries and 12 currencies.

[10] Data on policy rates are taken from central bank websites for: the official British bank rate, the Bulgarian base rate, the 2-week Czech repo rate, the Danish certificate of deposit rate, the ECB deposit facility rate, the Estonian Talibor rate, the 3-month Hungarian base rate, the Japanese uncollateralized overnight call rate, the Latvian refinancing rate, the Lithuanian Vilibor overnight rate, the Swedish repo rate, and the Swiss 3-month LIBOR.

[11] Sources: https://www.snb.ch/en/ifor/finmkt/operat/id/qas_gp_ums_2 and https://www.nationalbanken.dk/en/publications/Documents/2012/10/MON3Q_P1_2012_Negative%20Interest%20Rates.pdf .

[12] Poland and Romania do not enter our sample since their nominal policy rates never fell low enough; we also exclude Croatia since it only entered the EU in 2013.

[13] We have checked and our results do not seem to be particularly sensitive to the use of $10 billion and 75% deposit ratio as thresholds; $1 billion and 90% lead to similar conclusions.

[14] Fortunately, no bank changes its accounting method within our time-period.

[15] We define an accounting method as unconventional if it is used in less than 10% of a country's observations.

[16] Japanese banks report them in the first quarter, and we adjust accordingly. Note that we exclude a small number of U.K. banks reporting their annual figures in the first quarter. Since our data set has suspicious outliers, we typically truncate variables; more on this below.

[17] We refer to "positive" rather than "low positive" rates, for the sake of brevity. We use official policy rates to characterize nominal interest rates in this study, and these vary in term from overnight to three-months. In future research, we plan to repeat this study with a common-term market-based measure of prevailing interest rates.

[18] We have confirmed that our results are insensitive to the use of earning assets, defined as assets that are expected to earn an actual return and thus excluding accounting-related items.

[19] In the case of net income (fraction of total assets), we exclude values greater than 20% in absolute value.

[20] Inflation is measured as annual percent change by the IMF. Sources for the activity measures are unemployment from the IMF, output gap from the OECD, GDP from the IMF; Bloomberg provided end of year 10- and 2-year sovereign bond yields, and the slope is the difference between the two. While these instruments are unlikely to satisfy their exclusion restrictions (poor macroeconomic conditions are associated with both negative rates and low profitability on bank lending), the direction of endogeneity should act against our headline result of a surprisingly benign impact on bank profitability from negative rates.

[21] We have dropped subsidiaries and affiliates from our sample without substantively changing results. Also, non-parametric estimates of our key results provide no indication that our results are due to our assumption of linearity. Finally, weighting our results by either earning or total assets makes little substantive difference.

[22] We thanks a referee for forcefully making this point to us.

[23] Other interest income is defined as (gross interest and dividend income - interest income on loans), while other interest expense is defined as (total interest expense - interest expenses on customer deposits). As always, all components of Table 2 are normalized by total assets.

[24] For some types of banks, deposit income increases during the period of negative nominal interest rates; it is not entirely clear why. Figure 1 provides clear evidence that banks gradually lowered deposit rates towards zero during the regime of negative rates. It is possible that any increase in deposit income could be related to the volume of deposits that would increase during the related period of quantitative easing; indeed, the results on deposit funding in Table 5 support this intuition. We thank a referee for making this point.

[25] The same issue would be present if we included banks from Eurozone countries other than Germany.

[26] In addition to also conditioning for their excess liquidity, Demiralp, et al. (2019) note that the discrepancy between their results and those of Eggertson, et al. and Heider, et al. may stem from those studies' concentration on syndicated loans, which account for only 3% of euro area loans, while their coverage is much broader.

[27] Heider et al. (2016) also find that HD banks decrease their lending. The difference is likely attributable to their concentration on the syndicated lending market for corporations, whereas we examine total bank lending.

[28] Aramonte, et al. (2018), Bottero, et al. (2018), and Heider, et al. (2018) all find that retail deposit-intensive banks disproportionately increase the riskiness of their lending portfolios, attributing "reach for yield" as a response to lowered net interest margins at negative rates. However, more recently Bottero, et al. (2019) find for a sample of Italian banks that it is relative bank liquidity, which determines the costliness of shifting asset composition, rather than deposit intensity that determines shifts in bank portfolio riskiness.

[29] A comprehensive interpretation of these results requires further information. While the negative rate environment may have induced *riskier* lending requiring reserve increases, it is also possible that the reserve increases were a delayed response to non-performing loans underwritten earlier; in this case, it would be interpreted as risk-*reducing*. In addition, supervisory and regulatory changes in Europe during this period affected reserving decisions.

[30] The increased lending and reduced reserves by deposit-intensive banks are in keeping with the findings of Demiralp (2018), who identify deposit-intensive banks as a class of banks more highly affected by the negative interest rate policy.