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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Bank profitability and risk-taking under low interest rates*

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Abstract

The aim of this paper is to investigate the impact of the unusually low interest rate environment on the soundness of the US banking sector in terms of profitability and risk-taking. Using both dynamic and static modeling approaches and various estimation techniques, we find that the low interest rate environment indeed impairs bank performance and compresses net interest margins. Nonetheless, banks have been able to maintain their overall level of profits, due to lower provisioning, which in turn may endanger financial stability. Banks did not compensate for their lower interest income by expanding operations to include trading activities with a higher risk exposure.

Keywords: profitability, risk-taking, low interest rate environment, (dynamic) panel data models.
JEL classifications: G21.

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1. Introduction

Since the start of the financial crisis, concerns have arisen about the soundness of the financial sector. The current macroeconomic conditions and the unseen low interest rates present a challenging environment for financial institutions. Due to weak economic growth and lower expected real returns on investment, interest rates have been falling since the early 2000's all over the world. Moreover, as central banks attempt to meet their inflation target levels in order to ameliorate the economic conditions, an expansionary monetary policy has been exercised in the US, Europe and Japan, maintaining short-term policy rates at near zero levels. By means of large-scale asset purchases, the long-term interest rates have fallen to historically low levels too.

Studies on bank profitability and its relationship to the business cycle (see, e.g., Demirgüç-Kunt & Huizinga [1999], Bikker & Hu [2002]) regained considerable attention in the light of the most recent recession, see Athanasoglou et al (2008), Albertazzi & Gambacorta (2009), Bolt et al. (2012). Bank profitability is a predominant indicator of a sound and stable banking sector, but needs further attention in light of the low interest rate environment. Hitherto, any results on the link between interest rate levels and bank profitability is merely a by-product in the literature. Studies which specifically focus on the relationship between (low) interest rates and bank profitability are scarce, see Genay & Podjasek (2014), Alessandri & Nelson (2015) and English (2002). Borio et al. (2015) further stress the importance of understanding this relationship for the evaluation of monetary policy as this is suspected to have serious side effects.

Firstly, this paper aims to contribute to the literature by further exploring the relationship between bank profitability and the low interest rate environment. It is generally supposed that, in the long term, falling interest rates have a negative effect on bank profits. At first glance, banks might be able to compensate for lower lending rates by correspondingly lowering their funding rates. However, the funding rate is constrained to a zero lower bound, as customers are not expected to accept a negative deposit interest rate. Profit margins are squeezed along with the net interest margin, and as bank profits largely determine bank capital, lower profit margins could put pressure on the bank's capital position and thereby on its solvancy. This should also be seen in light of the increasing stringency of capital requirements under Basel 3.5.

Secondly, the issue of bank risk-taking will be addressed. Banks may have increased their risk appetite due to the low interest rate environment, yet the extent to which banks increase their risk exposure through risky investments in search for higher profits is hardly investigated. Thus far, this potential development has merely been suggested by, e.g., Weistroffer (2013) and Genay & Podjasek (2014). In the short run banks may benefit from lower loan loss provisions as a result of a reduced default probability on outstanding loans due to low interest rates for lenders. In the medium term, low interest rates might trigger banks to lower their lending standards which could cause a deterioration in the quality of the loan portfolio, raising credit risk.

This paper explores the impact of the low interest rate environment on both bank profitability and bank

risk-taking by analyzing a dynamic panel model which considers persistence effects, bank-specific and macroeconomic determinants, as well as the interest rate environment. In order to account for the dynamic structure and the potential endogeneity, a system GMM estimator is used. Alternatively, a static modeling approach is employed to expose relationships of interest.

The remainder of this paper is structured as follows: the next section provides an overview of the literature on determinants of bank profitability and on risk-taking behavior of banks. Section 3 presents the data and the relevant variables for the empirical study on the US banking sector. Also, the initial models are specified. Section 4 describes the methodology and the econometric techniques used to estimate these models in search for consistent and reliable estimates. Subsequently, the empirical results are presented, interpreted and discussed. Section 6 provides a conclusion.

2. Literature review

2.1. Bank profitability

Identifying the determinants of bank profitability is an important field of research. Demirgüç-Kunt & Huizinga (1999) were among the first to explain differences in bank profitability and net interest margins. Athanasoglou et al. (2008) made the popular, more parsimonious decomposition of determinants into bank-specific, industry-specific and macro economic categories. They adopted a dynamic model and found significant profit persistence. Many papers take this profit persistence into account in accordance with Berger et al. (2000), see e.g. Dietrich & Wanzenried (2011) for the Swiss bankings sector or Garca-Herrero et al. (2009) for the case of China, but also Alessandri & Nelson (2015).

Firstly, numerous bank-specific factors may affect the profits of a bank. Commonly used variables are size, bank capital, the level of (credit) risk, lending, revenue diversification, the business model or type of bank, efficiency and shares of publicly owned banks, see Athanasoglou et al. (2008). Based on the existing literature, this paper illustrates how these bank-specific factors affect bank profitability.

Size: Empirical evidence on the impact of bank size on profitability is inconclusive. Whereas Demirgüç-Kunt & Huizinga (1999), Goddard et al. (2004) and Borio et al. (2015) find a positive effect, ECB (2015) finds that bank size has a significantly negative effect on profitability, which is explained by the more complex and costly structure of larger banks. On the other hand, Athanasoglou et al. (2008) and Trujillo-Ponce (2013) find an insignificant effect and suggest a non-linear relationship such that profitability initially increases with size and then declines. Berger et al. (1994) remark on the consensus in the literature that the average cost curve in banking has a relatively flat U-shape with medium-sized banks being slightly more scale efficient than either large or small banks. Others such as Shehzad et al. (2013) find that larger banks are more profitable than small banks, but grow at a slower pace. Larger banks may benefit from economies of scale while smaller banks may try to grow faster at the expense of their profitability.

Capital: Bank capitalization, measured as the ratio of equity to assets, is another factor influencing

bank profitability. Relying on the effects of the Basel Accords which require banks to have a minimum level of capital as a percentage of risk-weighted assets (RWA), Iannotta et al. (2007) state that higher capital levels may denote banks with riskier assets. This at least holds for a given RWA leverage ratio, i.e. the ratio of capital to RWA. Through higher returns, higher capital ratios could yield higher profits. Athanasoglou et al. (2008) found a positive relationship as bank capital acts as a safety net in the case of adverse developments, so they can maintain their profitability in economically difficult times. Generally, empirical evidence suggests a positive relationship between capital and profitability, see also Demirgüç-Kunt & Huizinga (1999), Borio et al. (2015) and ECB (2015).

Credit risk: Bikker & Hu's (2002) finding that higher credit risk exposure via loans is associated with lower profit margins is widely validated in the literature. Higher credit risk directly affects profits as the amount of provisioning for expected loan losses is deducted from net profits. In the medium term, a lower quality of the loan portfolio also reduces profits as loan losses are actually incurred. Credit risk is found to be pro-cyclical (Bikker & Hu [2002]) and asymmetric (Marcucci & Quagliariello [2009]): during economic downturns, this cyclical effect is even more pronounced. Hence, credit risk and thus the higher level of provisioning has a negative impact on bank profitability, see Athanasoglou et al. (2008) and ECB (2015) as well.

Lending: The ratio of total loans over total assets represents a bank's relative lending size. A larger loan portfolio generates the vast majority of net interest income, obviously determining profit positively, but is also subject to higher credit risk which may, in turn, deteriorate profits. Based on empirical evidence, ECB (2015), Dietrich & Wanzenried (2011) and Trujillo-Ponce (2013) find that, on balance, lending positively affects profitability. Bikker & Hu (2002) find that lending is pro-cyclical and that banks with higher profits will lend more generously.

Diversification describes the ratio of non-interest income over total income. Non-interest income is generated via fee and commission income or trading activities. Stiroh (2004), Demirgüç-Kunt & Huizinga (1999) and ECB (2015) found that greater reliance on non-interest income is associated with weaker bank profitability. The converse has been found by Dietrich & Wanzenried (2011) in the case of Swiss banks and by Elsas et al. (2010) who argue that non-interest businesses yield higher margins and thus enhance profitability. Related to lending and diversification, Roengpitya et al. (2014) identify three different business models by classifying balance sheet compositions and find that profitability and efficiency vary markedly across business models and over time.

A second class of profitability determinants described by Athanasoglou et al. (2008) are those specific to the industry. Herewith, two factors are commonly considered.

Ownership, the shares of publicly-owned banks. Empirically, no clear relationship with profitability is found: Bourke (1989) and Molyneux & Thornton (1992) even claim that this variable is unimportant in explaining profitability.

Concentration, as measured by the Herfindahl-Hirschman index (HHI), is frequently studied by means

of two theoretical models. On the one hand, the structure-conduct-performance hypothesis states that highly concentrated markets positively impact bank profitability through greater market power and therewith the ability to charge relatively high rates for loans and low rates for deposits. Empirical evidence for the structure-conduct-profit hypothesis is found in Goddard et al. (2004) for Europe. On the other hand, the efficient-structure theory claims that greater market shares are gained from higher efficiency which increases profitability, see Berger (1995). Athanasoglou et al. (2008), Berger (1995) and Garca-Herrero et al. (2009) do not find a clear relationship between sector concentration and bank profitability, leaving room for the efficiency-structure hypothesis.

Thirdly, the macroeconomic environment is greatly determinative for bank profitability. The business cycle, as approximated by *real GDP growth*, has a significantly positively impact on profitability, see Demirgüç-Kunt & Huizinga (1999), Albertazzi & Gambacorta (2009) and Bikker & Hu (2002). This pro-cyclicality of bank profits is mainly explained by the influence of the business cycle on lending and provisioning, see Bikker & Hu (2002). In favorable economic conditions, the demand for credit by households and firms is higher, which improves the profitability of traditional interest practices. Bolt et al. (2012) also link bank profits and economic activity, detecting that the pro-cyclicality is stronger in deep recessions than under normal conditions. Furthermore, in economic booms the level of credit risk is estimated to be lower, and the quality of the lending portfolio is considered to be higher, which lowers credit loss provisions and directly boost profits. Marcucci & Quagliariello (2009) describes the asymmetric relationship of the business cycle and bank credit risk. Athanasoglou et al. (2008) also find an asymmetric effect: only in the upper phase of the business cycle this pro-cyclicality effect is found to be significant. They also note that net provisioning is a large source of the variability in profits.

Inflation also reflects aspects of the business cycle. Generally, empirical evidence asserts a positive inflation impact on profits, but this coefficient is difficult – if not impossible – to interpret. Demirgüç-Kunt & Huizinga (1999), for instance, find a positive relationship between inflation and net interest margin, giving the interpretation that high inflation translates into higher income from bank float. Besides, as policymakers only have the nominal interest rate in hand, inflation is determinative for the resulting real interest rates. In fact, inflation directly and indirectly affects profitability. Conflicting theories exist and for a full discussion Perry (1992) should be consulted.

2.2. Bank profitability and interest rates

The interest rate levels are also part of the macroeconomic environment. The short and long-term interest rate as well as the slope of the yield curve determine bank profitability. The existing bank profit literature mainly considers these factors as a by-product, such as Borio et al. (2015). The literature on monetary policy provides more detailed analyses on the impact of low interest rates, because the nominal interest rate is the main instrument central banks possess to stimulate the economy. So, it is important to take this field of research into consideration.

Borio et al. (2015) investigated the influence of monetary policy on bank profitability. They analyzed the effect of interest rates on the different profit components, i.e. net interest income, non-interest income and the level of provisions, as well as on overall profitability, as measured by return on assets. Firstly, net interest income increases with short-term interest rates (which act as proxy for all interest rates). Also, a positive relationship with the slope of the yield curve is found, which corresponds to the findings of Albertazzi & Gambacorta (2009). The relationship is found to be concave, both for interest rates a yield curve slope, so the effect is even more pronounced when interest rates are at low levels. Secondly, Borio et al. (2015) find that higher interest rates lower non-interest income. The short-term interest rate and the yield curve slope both have a positive effect on loan loss provisions. Again, Albertazzi & Gambacorta (2009) arrive at a similar result. Ultimately, the positive effects of interest rate and the slope of the yield curve on net interest income more than offsets the negative effects on non-interest income and provisions. Hence, the effect of higher interest rates on overall profitability is found to be positive and concave. This concave relationship is especially alarming as the present, almost zero interest rates and the flat yield curve have an amplified negative impact on overall profitability.

Bolt et al. (2012) is closely related to Borio et al. (2015). They also find that the effect of the short-term interest rate and the slope of the yield curve for loan loss provisions is positive. However, the other effects differ. They conclude that the short-term interest rate negatively affects net interest income (for long-term interest rate, however, they do find a positive effect). For the non-interest income an insignificant effect of short-term interest rate is found.

Alessandri & Nelson (2015) find evidence of a systematic effect of market interest rates on bank profitability. The net interest margin increases with the short-term interest rate. In response to higher interest rates, banks raise their lending rates and reduce their lending volume, potentially by strengthening their lending standards (this will be addressed in the following subsection), and *vice versa*. Regarding the yield curve, it is found that a steep yield curve boosts bank income margins, evidently as banks borrow short and lend long. An interesting point in Alessandri & Nelson (2015) is that banks in their UK sample take positions in interest rate derivatives. This follows from the finding that the level of interest rates and yield curve slope affect the net interest margin and trading income in opposite directions.

English (2002) addresses the issue of interest rate risk and net interest margins by inspecting interest rate volatility. He expects that a steeper term structure increases net interest margins and that interest rate volatility negatively affects net interest margins. A popular explanation is that maturity mismatch and repricing frictions are responsible for squeezed profits.

Since December 2008, the Federal Open Market Committee kept its short-term policy rate at nearly zero. This was combined by large-scale asset purchases aimed at lowering long-term interest rates and boosting economic activity. Genay & Podjasek (2014) examined the impact on bank profitability of this low interest rate environment, caused by expansionary monetary policy. In line with the previously mentioned papers as well as Demirgüç-Kunt & Huizinga (1999), a positive effect of short-term interest rates on the net

interest margin is found. This effect is stronger for smaller banks. Although their analysis suggest that low short-term interest rates and a flat term structure squeeze profits, they propose that the net effect of low interest rates on profits turns out to be positive because of the positive contribution to the business cycle. Apparently, the macroeconomic environment carries a higher weight in determining profitability. Additionally, Genay & Podjasek (2014) suggest that banks were able to compensate the negative low interest rates effect on profits by altering their business practices, potentially through higher fee income and lowering loan loss provisions.

2.3. Bank risk-taking

Altunbas et al. (2010) find that an unusually low interest rate environment over an extended period of time contributes to an increase in bank risk-taking. Presumably, banks are inclined to assume greater risk mainly via two channels. First, they may generate more income from non-interest activities, by raising fee and trading income, as formulated by Rajan (2005). Genay & Podjasek (2014) mention also lowering loan loss provisions. In Japan, the prime example of a long-lasting ultra-low interest rate environment, banks indeed tried to change their business models and developed new sources of income to maintain profitability. They expanded in areas outside their core markets, extended their range of services, shifted investment strategies and established new lines of business, see Weistroffer (2013). Roengpitya (2014) characterizes three different bank business models and found that after the financial crisis many banks adjusted their strategies in line with their business model's relative performance. However, they also find that a change in business model more often deteriorates profitability than enhances it. A possible explanation is that particularly those banks which were already in trouble were the ones that changed their strategies.

The 'search for yield' and increased risk appetite can also be explained by the finding of Manganelli & Wolswijk (2009) that during muted economic growth, lower interest rates may reflect less risk aversion. The existence of the risk-taking channel, i.e. the impact of changes in policy rates on either risk perceptions or risk tolerance, ascertained by Borio & Zhu (2008), is broadly accepted in the literature and by policymakers.

The second and predominant channel of risk-taking relates to credit risk. The low interest rate environment can affect the risk exposure in loan portfolios in two contrasting ways.[2] On the one hand, low interest rates might reduce the default probability on outstanding loans, and hence, reduce provisions for non-performing loans. On the other hand, banks might soften their lending standards lowering the loan portfolio quality, which in the medium run leads to higher credit losses. Jiménez et al. (2014) observes this for Spanish and Ioannidou et al. (2009) for Bolivian banks. Maddaloni & Peydró (2011) found that, in the case of Europe and the US, low short-term interest rates soften lending standards for both firms and households. Dell'Ariccia & Marquez (2006) find that low interest rates reduce adverse selection problems

[2] This has also been noted in Altunbas et al. (2010).

and thereby may decrease bank screening, increasing the probability of granting loans to more risky debtors. Delis & Kouretas (2011) complement the literature by considering the years 2001-2008 and note that low interest rates increased the riskiness of the loan portfolios.

A correlation in the above two channels of risk-taking can be considered, as Delis & Kouretas (2011) found that banks engaging in more non-traditional activities, i.e. higher risk exposure, also tend to take on higher risks in their traditional activities, i.e. higher level of credit risk.

3. Data and model

3.1. Data

We collect data on all US commercial and savings bank insured by the Federal Deposit Insurance Corporation (FDIC) from 2001 to 2015, stemming from the Call Reports.[3] This allows us to consider the years before and after the crisis, and fully capture the evolution of the low interest rate environment. The quality and completeness of these US data is better than what is available for other regions. The data on GDP growth, CPI inflation and long-term interest rates are acquired from the OECD Main Economic Indicators (MEI) database. The short-term interest rates are attained from Eurostat. Yearly averages are used for all variables. After omitting extreme values and undefined ratios from the sample, the resulting unbalanced sample contains 100,479 bank-year observations,[4] whereas the balanced sample, which is used in the empirical analyses, consists of 3,582 individual banks (see Table 1). In the empirical models, all level variables are divided by total assets in order to make them stationary and comparable. The following variables are adopted in the empirical analysis of this paper.

Table 1: Balanced versus unbalanced sample

	Number of observations	Number of individual bank	Average number of years under observation
Balanced sample	53,730	3,582	15.00
Unbalanced sample *	100,479	9,112	11.03

* Unbalanced sample consists of banks with at least three consecutive years under observation.

3.2. Dependent variables

Our first model investigates bank profitability (Model I) and the second model bank risk-taking (Model II). Several measures of profitability are used for Model I.

(a) *Net interest margin* (NIM), defined as the difference between interest income and interest expense, as ratio to total assets.

[3] See the website of FFIEC Central Data Repository's Public Data Distribution: https://cdr.ffiec.gov/public/.

[4] For consistency, the unbalanced sample is constructed by excluding all banks which have less than 3 years represented in the data.

(b) *Return on assets* (ROA), a commonly used performance measure, defined by the ratio of net income over total assets.
(c) *Return on equity* (ROE), the ratio of net income over total equity, is another performance indicator, reflecting the bank's return on shareholders' investments.
(d) *Profit* as reported on the bank's balance sheet is also investigated (as a ratio of total assets).

For Model II two different measures of risk are used in line with the two risk exposure channels described in Section 2.3.
(a) *Total capital ratio (TCR),* defined by the ratio of Total Risk-based Capital over Risk-weighted Assets. A higher risk exposure, resulting from more risky investments in a banks' search for yield, would translate into a lower ratio.
(b) *Credit loss provisions to total loans ratio* (*PCL)* describes the level of credit risk. A more risky loan portfolio, i.e. relatively larger share of NPLs, translates into higher credit risk and therefore more provisioning.

3.3. Explanatory variables

Taking the existing literature on the determinants of bank profitability into account as well as the particular interest of this paper concerning the low interest rate environment, the following variables are used. The set of explanatory variables barely differs between the two models. We provide an expected sign and, insofar as is lacking in Section 2, a rationale behind the usage of the variables provided.

Bank-specific variables

S*ize* is approximated by the logarithm of total assets. The effect on profitability is ambiguous as stated in Section 2. For risk-taking the expected effect is negative as larger banks may have a more developed risk management and more diversification benefits and thus a lower risk exposure. Alternatively, smaller banks may be inclined to take higher risks in order to grow. A priori, the effect of size on risk-taking is unclear.

Lending affects bank profitability via its effect on net interest margin and it affects riskiness via the quality of the loan portfolio. We do not have any a priori sign for its effect on risk-taking.

Capitalization, the ratio of total equity capital over total assets, represents a bank’s overall soundness and is expected to have a positive impact on both profitability and risk-taking.

Diversification, the ratio of total non-interest income over total income, expresses the bank's reliance on traditional intermediation practices. The effect on profits and risk-taking is ambiguous.

PCL and *TCR ratio* are explanatory variables in Model I but in turn dependent variables in Model II. *PCL*, the ratio of loan loss provisions to total loans, represents the quality of the loan portfolio and impairs profits directly. PCL may affect the TCR ratio as banks with a problematic loan portfolio might attempt to offset this by pursuing higher returns from trading, assuming more risk. A lower TCR reflects a higher risk exposure, and is expected to translate into higher returns.

Macroeconomic environment

The macroeconomic variables take account of the business cycle effect on bank profitability and bank risk-taking. *Real GDP growth* is expected to have positive coefficients. *CPI inflation* reflects that income margins are partly driven by inflation expectations through the income from bank float and has *a priori* a positive effect.

Interest rate environment

As *short-term interest rate* we take the 3-month money market rate. It is expected that lower interest rates impair the bank's profit margins (making the same assumption as in the literature that the short-term interest rate reflects the general interest rate level) and increase risk exposure. It is assumed that the interest rates' impact on the bank profitability and risk-taking are stronger where interest rates are already low. These concave relationships are studied by including a quadratic term of the short-term interest rate, which is thus expected to have a negative coefficient. As *long-term interest rate* we take the 10-year government bond yield. In this way, we can evaluate the *yield curve slope*, as approximated by the difference between long- and short-term rates. Analogous to Alessandri & Nelson (2015), we expect a positive effect on profit and a negative effect on risk exposure. The interest rate variables are considered in nominal terms, because these are under the control of central banks. Alessandri & Nelson (2015) provide a more detailed motivation.

Table A.1 in the appendix contains source information on the model variables and Table 2 provides the descriptive statistics, while the correlation matrix is presented in Table A.2. All variables our found to be stationary, using the Fisher panel unit root test, which conducts the augmented Dicky-Fuller unit root test on each panel, except *Size* and *Long-term interest rate*, see the last column of Table 2. Given that all dependent variables are stationary, the variable for *size* and *long-term interest rate* as independent variables are not excluded from the regressions,[5] especially because the exclusion of these variables does not severely affect the model's performance. The balanced sample is used for the estimation. In the unbalanced sample, bank observations are missing for some years due to mergers and acquisitions or bankrupty, which is referred to as the *attrition bias*. It could be argued that, for example, only the best performing and most profitable banks withstand bankruptcy and are thus present over the entire sample period. Accordingly, the balanced sample might be argued to give a biased impression, as it only contains the healthiest banks. However, this attrition bias is difficult to control for and probably negligible because of the large sample size. As a robustness check, however, one could compare the estimates from the balanced and unbalanced sample. If there are no considerable differences in the estimates, this bias can indeed be considered as negligible.

[5] Note that, according to theory, the long-term interest rate is stationary. In a world of growth and consolidation, size is, of course, not stationary.

Table 2: Descriptive statistics

	Mean	Standard deviation			Min	Max	Stationary	
		overall	*between*	*within*				*p-value*
NIM	3.56 %	0.65% /	0.51%	0.41%	0.24%	7.06%	Yes,	0.000
NII	8022	11022	10328	3852	152	282182	Yes,	0.000
Profit	14658	23092 21749 7769			-37665	449970	Yes,	0.000
ROA	0.96 %	0.66% 0.46% 0.47%			-6.50 %	4.39 %	Yes,	0.000
ROE	9.16 %	6.87% 4.69% 5.01%			-100.49 %	35.37 %	Yes,	0.000
TCR	17.91 %	9.71% 7.07% 6.66%			5%	1435.7 %	Yes	0.000
PCL	0.36 %	.56% 0.25% 0.50%			-0.84%	7.28%	Yes,	0.000
Size	11.72	1.01 0.96 0.31			8.70	15.83	No,	0.6661
Capitalization	10.82 %	3.11% 2.76% 1.44%			3.64%	53.75%	Yes	0.000
Diversification	11.90 %	7.07% 5.93% 3.85%			-7.75%	84.87%	Yes	0.000
Lending	61.59 %	15.03% 13.39% 6.84%			5.08%	98.46%	Yes	0.000
Real GDP growth	2.04	1.77 0 1.77			-3.02	4.62	Yes	0.000
Inflation	2.16	1.14 0 1.14			-0.36	3.84	Yes	0.000
Short-term rate	1.87	1.77 0 1.77			0.23	5.3	Yes	0.000
Long-term rate	3.56	1.02 0 1.02			1.80	5.02	No	1.000

Note: These descriptive statistics are based on the balanced sample. All variables, except from short and long-term interest rate, are made real. By means of winsorizing all extreme values and undefined ratios are excluded from the final sample. The variables NII and Profit are stationary only as ratio to total assets. For the Fisher panel unit-root test, the p-values are provided. A rejection of the null hypothesis implies stationarity.

3.4. Model specifications

Model 1 explains bank profitability from interest rates and other profit determinants:

$$\Pi_{it} = c + \alpha\Pi_{i,t-1} + \beta X_{it}^{BS} + \gamma X_{it}^{Macro} + \delta X_{it}^{IR} + \varepsilon_{it} \quad (1)$$

Π_{it} is the profitability measure for bank i in year t. Like in many other studies, a dynamic model is adopted, as bank profitability tends to persist over time, see Berger et al. (2000). The level of persistence is captured by the lagged dependent variable coefficient α. For a value of α between 0 an 1, profits show persistence but they will return to their normal level. For a value close to zero, persistence is low and the industry is quite competitive as the speed of adjustment is high. If α is close to 1, persistence is strong pointing to absence of competition, see Athanasoglou et al. (2008). The bank-specific determinants are captured by X_{it}^{BS}, the macro economy is represented in the X_{it}^{Macro} term and the interest rate environment is expressed by X_{it}^{IR}. The composite error is given by $\varepsilon_{it} = \eta_i + u_{it}$, where η_i is the unobserved bank-specific effect, which is time-invariant, and u_{it} the idiosyncratic error.

Model II describes bank risk-taking as a function of interest rates level and other determinants:

$$r_{it} = c + \alpha r_{i,t-1} + \beta X_{it}^{BS} + \gamma X_{it}^{Macro} + \delta X_{it}^{IR} + \varepsilon_{it} \quad (2)$$

r_{it} is the risk measure for bank i in year t. This model and its dynamic structure builds upon Delis & Kouretas (2011), who provide arguments for the dynamic nature of bank risk: it is a likely assumption that risk exposure, either from trading activities or from the quality of the loan portfolio, is carried onto the next period and therefore endures. The degree of risk persistence is captured by the coefficient α. The other regressors and the error term are similar to those in model I.

Considering the length of the period under study and the developments that have taken place, time effects might be present in the error component of both models. Therefore, year dummies are included in the estimation of the empirical models. In the theoretical models, a constant term is included, but this constant could of course not be identified in the fixed effects models.

4 Econometric Methodology

4.1 Dynamic modeling approach

The models proposed in the previous section consider the tendency of bank profitability and bank risk-taking to persist over time. The dynamic nature of these variables is broadly recognized in the existing empirical literature, see e.g. Athanasoglou et al. (2008) and Delis and Kouretas (2011) regarding the Greek banking sector, Dietrich and Wanzenried (2011) with respect to the Swiss, Trujillo-Ponce (2013) for the

Spanish and García-Herrero et al. (2009) for the Chinese. Moreover, aforecited papers such as Borio and Zhu (2008) and Alessandri and Nelson (2015) adopt related models. The dynamic models (1) and (2), therefore, constitute a legitimate starting point for the estimation of the relationships of interest.

Three precarious issues should be taken into account in the empirical estimation of these models. Firstly, some bank profitability and bank risk-taking determinants are, potentially, of endogenous character. This either follows from omitted variable bias or from a loop of causality between the independent and dependent variables. A clear example is provided by García-Herrero et al. (2009): more profitable banks may be able to increase their equity more easily by allocating part of their profit to reserves. They could also spend more on advertising and increase their size, which in turn might affect profitability. The causality could also be reversed as more profitable banks may employ more personnel, which could reduce their operational efficiency.

Additionally, it is presumable that there are some fixed effects specific to each individual bank that impact the bank's profitability or risk-taking which are not captured in the model. This is also known as unobserved heterogeneity. For instance, the bank's management or clientele, which could be argued to remain fairly constant over time, could affect the bank's performance or attitude towards risk. The results from the Hausman specification test confirm the presence of unobserved heterogeneity, as correlation exists between the fixed, bank-specific effects and the independent variables.

Finally, the dynamic structure of the models complicate the estimation. Least squares estimation methods such as the pooled OLS estimator, the first-difference estimator and the within estimator are proven to be inadequate in dynamic settings because the correlation between the lagged dependent variable and the error term, also known as the dynamic panel bias from Nickell (1981), causes inconsistent estimates. Standard results for omitted variables show that the pooled OLS estimate of the lagged dependent variable is biased upwards, whereas the within estimate is biased downwards, at least in large samples, see Bond (2002). These two estimators therefore provide a *credible range* in which the true estimate lies.

The system GMM estimator from Arellano and Bover (1995) and Blundell and Bond (1998), which builds on Arellano and Bond (1991), is developed for dynamic panel models in order to deal with the abovementioned issues. It uses lagged values of the dependent variable both in levels and in differences as instruments as well as lagged values of the other, potentially endogenous regressors. In this way the issue of endogeneity, unobserved heterogeneity as well as the persistence of the dependent variables is controlled for. It is proven that, if the moment conditions are satisfied, this estimator yields consistent and efficient estimators. Because of these desirable features, the system GMM estimator is widely adopted in the aforecited, related empirical studies on bank profitability and bank risk-taking. Hence, the bank-profitability and bank risk-taking models in this paper's analysis are estimated by means of the system GMM estimator. Analogous to related empirical literature, all bank-specific variables are treated as endogenous whereas the macro environment and interest rate variables are considered exogenously. Furthermore, time dummies are

included, so that the assumption of no correlation across individuals in the idiosyncratic error term is more likely to hold.

However, the assumptions of no serial correlation and the validity of instruments, on which the consistency of the system GMM estimator depends, are not satisfied. The presence of higher-order autocorrelation as well as the rejection of the Sargan-Hansen tests indicate that the instruments used are in fact endogenous. As a result, the estimation technique employed here may produce inconsistent estimates. This is in contrast with the related empirical studies on bank profitability and bank risk-taking which claim to find consistent estimates while adopting a similar modeling approach, estimation strategy and instrument set. In section 5, we find some degree of robustness as the estimates of the lagged dependent variable lie well inside the credible range for most models, as explained above.

4.2 Static modeling approach

As the lagged dependent variable in the previous modeling approach may cause inconsistency in the estimates, we chose to exclude this dynamic effect and continue to study the relationships of interest by means of a static model.

We start with the pooled OLS estimator. This specification not only omits the dynamics of bank profitability and bank risk-taking by assuming α in Eq. (1) is equal to zero, it also disregards the fixed, individual bank-specific effects by assuming with respect to the error term that $\eta_i = \eta$. From the Hausman specification test it could be concluded that such bank-specific effects are present and that the latter assumption is incorrect. The fixed-effects estimator is therefore preferred over the pooled OLS estimator.

In this static modeling approach the possible presence of endogeneity needs still to be solved. A common strategy to work around endogeneity is the use of instrumental variables. Analogous to the system GMM estimator in the dynamic modeling approach, the endogenous, bank-specific variables are instrumented by their own lagged values. This choice for the instrument set provides relevant instruments, as they are indeed correlated with the endogenous variables. As seen before, related empirical studies use a comparable set of instruments.

Whether these instruments are also valid, i.e. uncorrelated with the error term, remains a precarious issue. The Hansen J test of over-identifying restrictions is rejected for all models. It should therefore be concluded that instrumenting the bank-specific, endogenous variables by their own lagged values yield weak instruments. Potentially, a high persistence of the bank profit and risk-taking determinants and the lack of exogenous variation cause the violation of the exogeneity assumption. This is a similar conclusion to the one we have drawn from the dynamic modeling approach. Again, this casts some doubt on whether the research approaches in the literature effectively models bank profitability and bank risk-taking determinants.

5 Empirical Results

As we have failed to find appropriate instruments and therefore could not work around the endogeneity problems in the two modeling approaches, the within estimator without instrumental variables is considered in order to expose the (static) relationships of interest.

5.1 Bank profitability model

The first model exposes the impact of the low interest rate environment on bank profitability. To this end four different profitability measures of profit are examined. See Table 3 for the empirical results.

Table 3. Static bank profitability model estimated with fixed effects (without IV)

	NIM	**Profit**	**ROA**	**ROE**
Size	-0.000971 ***	0.00156	0.00366 ***	0.0346 ***
	(-4.93)	(1.26)	(14.80)	(14.42)
Capitalization	0.0644 ***	0.535 ***	0.0444 ***	-0.210 ***
	(17.42)	(18.83)	(12.67)	(-6.48)
Diversification	-0.00698 ***	0.00265	0.0160 ***	0.155 ***
	(-7.29)	(0.68)	(14.80)	(13.12)
Lending	0.0249 ***	-0.00298	0.00937 ***	0.0919 ***
	(48.95)	(-0.81)	(18.43)	(17.64)
Credit risk proxy	0.0242 ***	-0.133 ***	-0.511 ***	-5.605 ***
	(5.05)	(-6.72)	(-55.87)	(-42.30)
TCR	-0.00215 ***	0.00453	-0.00262 ***	-0.00261
	(-7.73)	(0.34)	(-5.61)	(-0.52)
Inflation	0.000218 ***	-0.00181 ***	0.000193 ***	0.00119 **
	(8.82)	(-15.51)	(6.23)	(3.11)
Real GDP growth	-0.0000926 ***	-0.000959 ***	0.0000504	0.000367
	(-4.08)	(-12.00)	(1.59)	(0.93)
Short IR	0.0151 ***	-0.0154 ***	0.0117 ***	0.106 ***
	(11.25)	(-3.31)	(7.20)	(5.53)
Short IR ^{2}	-0.0185 ***	-0.0127 **	-0.0123 ***	-0.121 ***
	(-12.60)	(-2.75)	(-6.70)	(-5.47)
Long IR	0.000302 ***	-0.00162 ***	0.0000304	-0.000792
	(3.65)	(-5.11)	(0.31)	(-0.72)
Constant	0.0250 ***	0.0140	-0.0438 ***	-0.329 ***
	(10.29)	(0.92)	(-14.42)	(-10.70)
Number of observations	53,730	53,730	53,730	53,730
Number of banks	3,582	3,582	3,582	3,582
Fraction of variance due to η_i	0.66	0.84	0.69	0.64
R^2 within	0.35	0.28	0.43	0.41
R^2 between	0.16	0.44	0.05	0.09
R^2 overall	0.22	0.40	0.16	0.20

Note: t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Net Interest Margin

In the first column the results for the net interest margin can be found. The short-term interest rate is significantly positive. A one percentage point increase in the level of short-term interest rate is associated with a 1.51 basis point increase in the net interest margin, ceteris paribus. This finding is in correspondence to the related literature of Alessandri & Nelson (2015), Genay & Podjasek (2014) and Demirgüç-Kant & Huizinga (1999). As the coefficient of the quadratic term of the short-term interest rate has a negative sign, the relationship is found to be concave, so the effect of a change in interest rates is even more pronounced when interest rates are already low. Also, for the long-term interest rate a small positive effect is found. From these results it can be concluded that the persistently low interest rate environment leads to a decline in the net interest margin, which is the bank's main source of profitability, see Fig. 1. This is in line with the presumption that as a consequence of the low interest rate environment banks struggle to generate profits from their traditional lending and funding practices.

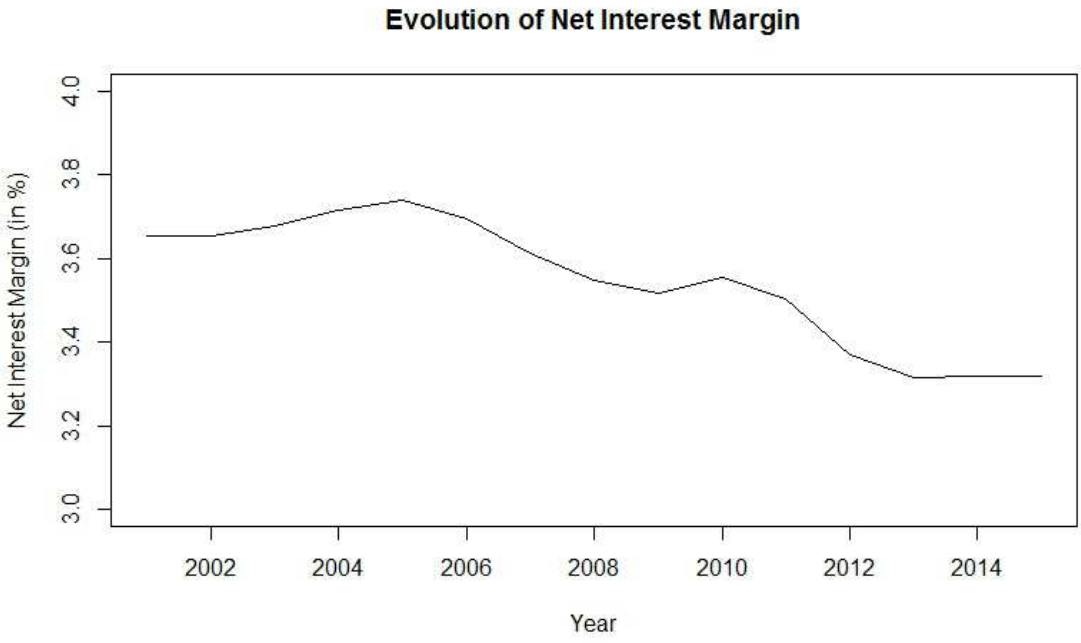

Fig. 1: The evolution of the net interest margin, on average

In line with Demirgüç-Kant & Huizinga (1999) and Dietrich & Wanzenried (2011), we find that larger banks are associated with lower margins as the coefficient of bank size is given by -0.00097. Better capitalized banks are associated with higher net interest margins, as supported by Demirgüç-Kant & Huizinga (1999). Furthermore, banks with greater reliance on non-interest income, i.e. higher diversification, have smaller net interest margins which is as expected and supported by related studies of Demirgüç-Kant & Huizinga (1999) and Dietrich & Wanzenried (2011). Besides, as the relative size of

lending increases by one percentage point, the NIM increases by 2.49 basis points. So banks could increase their revenue from interest income relative to their interest expenses by expanding their lending practices. We also found that as credit risk increases, the level of provisioning is raised which leads to a higher lending rate, which in turn boosts the NIM. This positive effect of provisioning is also found by Dietrich & Wanzenried (2011) for the Swiss banking sector. Moreover, a lower risk exposure is associated with smaller margins. Analogously, a capital ratio closer the minimum capital requirements, i.e. a higher risk exposure, leads to wider margins. This is in line with the risk-return relationship and could be seen in the light of the finding of Borio et al. (2015) that the net interest margin is positively related to the bank's asset volatility. In contrast with the empirical literature of e.g. Demirgüç-Kant & Huizinga (1999) we do not find a pro-cyclical effect of the NIM as the coefficient of real GDP growth is slightly negative.

Profit

For the effects on overall bank profits see the second column of Table 3. A one percentage point increase in the short-term interest rate is associated with a 1.54 basis point decrease in profits. The quadratic term has a negative sign indicating an asymmetric effect of the short-term interest rate on profits. The effect of the long-term interest rate is significantly negative as well. So, overall profits are not hurt as a results of the low interest rate environment. This outcome is somewhat surprising, but in line with the suggestions of Genay & Podjasek (2014). Apparently, banks are able to compensate for the decline in the NIM in such a way that the overall profits are not impaired, see Fig. 2. Whether or not banks did this by making more risky

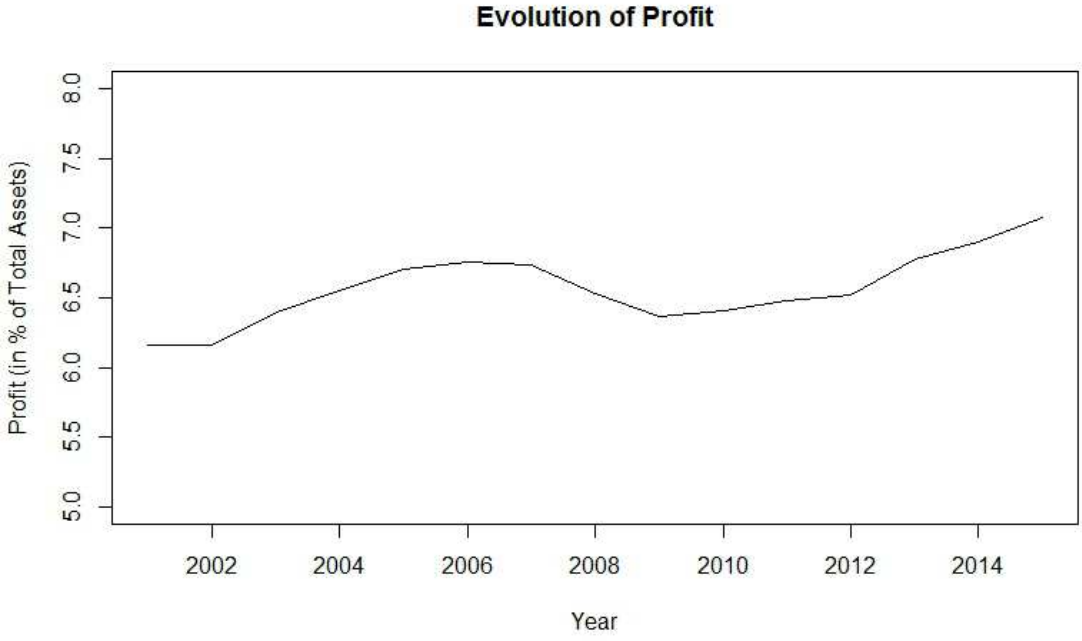

Fig. 2. The evolution of profits, on average

investments and thereby increasing their non-interest income, will be discussed in the succeeding section. Genay & Podjasek (2014) suggest that banks maintained their overall level of profits through higher fee income or through lowering provisions. This latter effect will also be addressed in the subsequent section. Furthermore, they state that, in the US, the net effect on profits might be positive as the low interest rate environment led to better economic outcomes via a lower unemployment rate, higher house prices and faster GDP growth.

The effect of bank size is found to be positive, but insignificant. The very strong positive effect of capitalization is mainly due to the definition of the variable profit as it comprises capital and reserves. Nevertheless, further evidence is provided that better capitalized banks are associated with higher profits. Furthermore, it is found that a one percentage point increase in the provisioning for credit losses is related to a 13.26 percentage point decrease in profits. This substantial negative effect follows from the fact that – in the accounting treatment of the bank – provisions are deducted directly from the net profits, see Bikker & Hu (2002) and Bolt et al. (2012). Again, the negative effect of real GDP growth and inflation are conflicting with the widely accepted pro-cyclicality of bank profitability. No clear relationships for diversification, lending and the capital ratio are found as these are insignificant.

Return on Assets

For the results of this commonly used profitability measure, see Column 3. The relationship to the short-term interest rate is positive which is in accordance with the existing literature. Corresponding to a one percentage point increase, the return on assets is found to be 1.17 basis points higher. This finding implies that the low interest rate environment weakens bank performance. The negative sign of the quadratic term implies that this relationship is concave and thus the impact on profitability is even more severe when interest rates are already at low levels. For the long-term interest rate an insignificant effect is found.

Also for this profitability measure a positive effect of bank size is found as well as the convincing positive effect of capitalization. Greater diversification is associated with a higher return on assets. Although this effect is not fully supported by the related literature, e.g. Athanasoglou et al. (2008) and Trujillo-Ponce (2013), it is similar to Dietrich & Wanzenried (2011). Together with the negative effect of the capital ratio, which suggests that higher risk exposure is associated with higher return on assets, the risk-return relationship is confirmed. Furthermore, the coefficient of lending reveals that a relatively large loan portfolio enhances bank profitability. In spite of that, greater credit risk causes a major worsening in the bank profitability as the coefficient -0.51 indicates. Moreover, from the insignificant effect of real GDP growth and the small positive effect of inflation, no clear evidence of pro-cyclicality is found. The results for *Return on Equity* (RoE) are similar to those of RoA.

5.2 Bank risk-taking model

Table 4 presents the results regarding the effects of the low interest rates on bank risk-taking.

Total capital ratio

The first column describes the bank's search-for-yield. It is found that the capital ratio is negatively related to the short-term interest rate: a one percentage point decrease in the short-term interest rate is associated with a 6.28 basis point increase in the capital ratio. This implies that banks have a relatively lower risk exposure at lower interest rate levels. This relationship cannot be concluded to be asymmetric as the quadratic term is insignificant. For the long-term interest rate, a significantly negative relationship is also found. Hence, no evidence is found that as a consequence of the persistently low interest rates banks expand their risky investments. Thus far, banks were able to maintain their overall level of profits without appealing to a search for yield.

Table 4. Static bank risk-taking model estimated with fixed effects (without IV)

	TCR ratio	**PCL**
Size	-0.0124 *	0.000419 *
	(-2.55)	(2.47)
Capitalization	1.538 ***	-0.0209 ***
	(9.22)	(-8.42)
Diversification	-0.0193 *	-0.00427 ***
	(-2.38)	(-3.92)
Lending	-0.179 ***	0.00239 ***
	(-26.66)	(5.19)
Credit risk proxy	0.210	
	(1.07)	
TCR		0.00123 ***
		(8.68)
Inflation	-0.00386 ***	0.0000676
	(-8.79)	(1.28)
Real GDP growth	-0.00238 ***	0.000231 ***
	(-8.31)	(4.66)
Short IR	-0.0628 **	0.0278 ***
	(-3.12)	(10.70)
Short IR ^{2}	-0.0150	-0.0231 ***
	(-1.12)	(-8.01)
Long IR	-0.00805 ***	0.00202 ***
	(-4.15)	(13.48)
Constant	0.354 ***	-0.00594 *
	(6.74)	(-2.36)
Number of observations	53,730	53,730
Number of banks	3,582	3,582
Fraction of variance due to η_i	0.23	0.21
R^2 within	0.16	0.13
R^2 between	0.77	0.02
R^2 overall	0.47	0.10

Note: t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

From the negative effect of bank size it could be inferred that larger banks are more risk-taking, as they may be engaged in more trading activities compared to smaller banks which typically are more traditional in their business practices. The results confirm that better capitalized banks are safer and have a lower risk exposure, see Delis & Kouretas (2011). This sizeable effect of capitalization can be explained from the definition of the capital ratio: for a given level of risk exposure, a higher level of capital directly increases this ratio. The negative effect of diversification is consistent with the expectation that more diversified banks will have more risky assets and thus a lower capital ratio. The higher risk related to a larger loan portfolio greatly impacts the overall risk exposure of the bank. The level of provisioning is positively related to the capital ratio through its effect on the bank's capital position. However, this is an indirect effect as it is found to be insignificant. A slightly pro-cyclical effect of the capital ratio is found. So, in more favorable economic conditions banks tend to increase their risk appetite, which is in line with Manganelli & Wolswijk (2009) who find lower risk aversion under such circumstances.

Provisions for Credit Losses

The second column describes the bank's attitude towards credit risk. It is found that a one percentage point decrease in the short-term interest rate is associated with a 2.78 basis point lower provisioning. This implies that banks expect lower loan losses in the low interest rate environment, potentially because of lower default probabilities on outstanding loans. Moreover, this relationship is found to be concave. These findings are analogous to Borio et al. (2015). Similarly, the effect of the long-term interest rate is significantly positive.

The finding that banks take on a smaller cushion against credit losses in a low interest rate environment could endanger the stability of the bank if credit losses prove to be higher than expected. In combination with the lower lending standards, as found by Maddaloni & Peydró (2011), and higher risk-taking on new loans through the risk-taking channels, see Borio & Zhu (2008), this might be a worrying development. On the other hand, by effectively lowering the provisioning, banks boosted their profits, at least in the short-run. Our analysis confirms the suggestion of Genay & Podjasek (2014) that banks were able to maintain their overall profits through lower levels of provisioning.

No significant impact of bank size is found. Moreover, better capitalized banks are associated with lower credit loss provisions as the negative coefficient indicates. Provisions represent the link between credit risk and capital as provisioning made to absorb (expected) loan losses directly lowers profits before they are allocated to capital and reserves, see Bikker & Hu (2002). So, well-capitalized banks already have a sufficient safety net to absorb credit losses. The diversification of income negatively affects provisioning (-0.0043). This is because in case of greater reliance on interest income, credit risk is a more predominant source of risk and thus more provisioning is needed to manage this. Analogously, the size of lending positively affects provisioning as a larger loan portfolio with potentially higher credit risk needs a higher level of provisioning. Whereas the level of provisioning had a negative impact on the capital ratio, the

opposite effect is positive. So, banks that take on lower risks in their lending practices, through a larger buffer for credit losses, also tend to have less risky assets. Furthermore, the effect of the business cycle on provisioning for credit losses is found to be slightly positive as both the effect of real GDP growth and inflation are significantly positive. This slight pro-cyclicality contrasts with Bikker & Hu (2002) and Marcucci & Quagliariello (2009), who find a counter-cyclical behavior of provisions.

5.3 Robustness of results

Dynamic estimation results

In Section 4.1 we discussed the dynamic modeling approach which is commonly used in the literature. The results from this system GMM estimator are presented in Table A.3 and A.4 of the appendix. As uncertainty exists about the consistency of these estimates, we use them as a robustness test. In comparison to the results of the pooled OLS and the Within estimator, which are shown in Table A.5-A.8, the estimates of the lagged dependent variable show a certain degree of robustness as they lie well inside the aforementioned *credible range* for most models (i.e. *NIM*, *ROA*, *ROE*, *PCL*). From this, one can conclude that the econometric estimation technique employed here indeed improves the estimates of the OLS-type estimators.

However, for some models we do not see an improvement in the estimation result. Firstly, according to our credibility range, the estimate of *Profit* is overestimated as the coefficient of the lagged dependent variable is higher than the estimate of the pooled OLS estimator. This coefficient of lagged *Profit* is very close to 1, which denotes a high level of persistence of overall profits. Probably, by means of adjustments in the level of provisioning or capital reserves the overall level of profits in the balance sheet is often kept fairly constant. In the literature profit measures such as *ROA* and *ROE* are more common, so that it is also possible that 'overall profit' is not a suitable bank profitability measure.

Secondly, the estimates for the *TCR* are underestimated as the coefficient of the lagged dependent variable lies below the estimate of the within estimator. A coefficient close to zero indicates absence of persistence.

All in all, the estimation results from our dynamic modeling approach could be considered as reasonably robust despite the possible lack of consistency of the estimators. Interestingly, the related empirical literature does not come across our estimation issues of invalid instruments, and thus inconsistent estimates. Most of the aforecited papers claim to find consistent estimates and clear persistence effects for both bank profitability and risk-taking, even where a corresponding set of explanatory variables, a similar estimation strategy and an analogous instrument set are used.

Static estimation results

In a second robustness test we use instruments in our static modeling approaches, in order to find consistent estimates (see Table A.9-A.12 in the appendix). Most estimates show a certain resemblance with the estimation results of the within estimator without instrumental variables as in Sections 5.1-5.2. However, some coefficients differ in sign, so we concluded that the issue of endogeneity seriously affects the estimation results. The lagged values of the endogenous, bank-specific variables, which generally comprise the instrument set of the related empirical literature, did not prove to serve as equally suitable instruments in this analysis.

With respect to model performance, the RMSE are well comparable across approaches whereas the R^2 is slightly lower in the models without instrumental variables. However, the static models have relatively low explanatory power compared to the dynamic models. Apparently, the lagged dependent variable implicitly captures some important effects which are not captured by the bank profitability and risk-taking determinants. So, the inclusion of this lagged dependent variable mitigates the problem of the omission of some other possibly, relevant variable(s). This casts doubts on whether the research approach in the literature effectively models all factors influencing bank profitability and bank risk-taking, as well as whether the related estimation issues are tackled adequately.

6 Conclusion

The aim of this paper is to investigate the impact of low interest rates on the profitability of banks as well as on the degree of risk-taking by banks. By means of a large panel data set consisting of macroeconomic indicators, interest rate variables and bank-specific balance sheet variables, these relationships are analyzed for the U.S. banking sector.

The presumption that the low interest rate environment deteriorates bank profitability is partly confirmed by this paper's analysis. It is found that bank performance is indeed impaired as a consequence of low interest rates. Moreover, the ability of banks to generate profits from their traditional lending and funding practices is reduced as the net interest margin is being compressed by persistently low interest rates. Nonetheless, the US banks were able to maintain their overall level of profits. This could have been achieved by effectively lowering their level of provisioning as the default probabilities on outstanding loans are smaller in a low interest rate environment.

With regard to the effects of the low interest rate environment on bank risk-taking, two risk-taking channels are considered. On the one hand, no clear evidence is found that banks increased their risk exposure in a search for yield. Until now, banks were able to maintain their overall level of profits and hence did not compensate for a reduced net interest income by making more risky investments through trading. Over time,

however, banks might alter their business models and expand their trading activities in order to be less dependent on their lending and funding practices. On the other hand, it is found that banks significantly lowered their level of credit loss provisioning in the low interest rate environment. Consequently, the buffer against unexpected credit losses has shrunk. Banks have thus maintained their overall level of profit at the expense of a smaller cushion against credit losses.

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Appendix

Table A.1. Sources of model variables

Variable (*Symbol*)	Definition	Source	Code
Net interest margin *(NIM)*	Difference between interest income and interest expense divided by total assets	Call Reports *	(RIAD4107 - RIAD4073) RCON2170
Net interest income *(NII)*	Difference between nterest income and interest expense	Call Reports	RIAD4074
Total Profit	Undivided profits and capital reserves	Call Reports	RCON3632
Return on Assets *(ROA)*	Ratio of Net income over total assets	Call Reports	RIAD4340 / RCON2170
Return on Equity *(ROE)*	Ratio of Net income over total equity capital	Call Reports	RIAD4340 / RCON3210
Total Capital Ratio *(TCR)*	Total Risk-based Capital to Risk-weighted Assets	Call Reports	RCON7205
Credit Risk proxy *(PCL)*	Provision for credit losses over total assets	Call Reports	RIAD4230 / RCON2170
Size	Logarithm of total assets	Call Reports	Log (RCON2170)
Capitalization	Total Equiy Capital over Total Assets	Call Reports	RCON3210 / RCON2170
Diversification	Total non-interest income divided by total income	Call Reports	RIAD4079
	(sum of total interest income and total non-interest income)	Call Reports	(RIAD4107 + RIAD4079)
Lending	Total loans over total assets	Call Reports	(RCON2122 + RCON2123) RCON2170
Real GDP growth	Average yearly GDP growth rate	OECD MEI	
Inflation	CPI Inflation	OECD MEI	
Short-term interest rate	3-month money market rate	Eurostat	
Long-term interest rate	10-year government bond	OECD MEI	

* These can be found on the website of FFIEC Central Data Repository's Public Data Distribution: https://cdr.ffiec.gov/public

Table A.2. Correlation matrix

	NIM	NII	Profit	ROA	ROE	TCR	PCL	Size	Capit-alizat-ion	Divers-ificat-ion	Len-ding	Real GDP growth	Inflat-ion	Short interest rate	Long interest rate
NIM	1.00														
NII	0.01	1.00													
Profit	-0.09*	0.82*	1.00												
ROA	0.35*	0.07*	0.09*	1.00											
ROE	0.30*	0.10*	0.06*	0.91*	1.00										
TCR	-0.14*	-0.14*	0.03*	0.016*	-0.15*	1.00									
PCL	0.09*	0.05*	-0.00	-0.44*	-0.44*	-0.07*	1.00								
Size	-0.15*	0.76*	0.65*	0.06*	0.10*	-0.18*	0.07*	1.00							
Capitalization	0.02*	-0.09*	0.09*	0.15*	-0.16*	0.62*	-0.07*	-0.16*	1.00						
Diversification	0.04*	0.22*	0.17*	0.07*	0.09*	-0.08*	0.03*	0.24*	-0.09*	1.00					
Lending	0.39*	0.17*	0.04*	0.03*	0.11*	-0.46*	0.07*	0.19*	-0.27*	-0.03*	1.00				
Real GDP growth	0.07*	-0.02*	-0.01*	0.16*	0.16*	0.02*	-0.19*	-0.05*	0.00	0.03*	-0.03*	1.00			
Inflation	0.11*	-0.05*	-0.06*	0.10*	0.12*	-0.01*	-0.09*	-0.10*	-0.02*	-0.10*	0.03*	0.38*	1.00		
Short interest rate	0.15*	-0.06*	-0.07*	0.12*	0.14*	-0.03*	-0.11*	-0.13*	-0.02*	-0.18*	0.10*	0.12*	0.61*	1.00	
Long interest rate	0.22*	-0.09*	-0.11*	0.13*	0.15*	-0.03*	-0.04*	-0.21*	-0.04*	-0.20*	0.085*	0.17*	0.49*	0.69*	1.00

Note: All correlation coefficients with a significance level of 5% or better are indicated with a star (*).

Table A.3. System GMM estimates of the bank profitability model

	NIM	Profit	ROA	ROE
NIM $_{t-1}$	0.668			
	(54.35)			
Profit $_{t-1}$		0.997		
		(62.24)		
ROA $_{t-1}$			0.530	
			(25.88)	
ROE $_{t-1}$				0.512
				(24.48)
Size	0.00100	0.00472	0.000711	0.00622
	(5.48)	(10.71)	(3.46)	(3.16)
Capitalization	0.0313	-0.0191	0.0321	-0.0442
	(4.87)	(-1.10)	(4.87)	(-0.70)
Diversification	-0.00249	-0.0144	-0.00874	-0.0679
	(-1.79)	(-4.90)	(-5.13)	(-4.05)
Lending	0.00218	-0.00685	-0.000879	-0.0139
	(2.34)	(-2.88)	(-0.85)	(-1.34)
Credit risk proxy	0.0299	-0.00442	-0.0470	-0.843
	(2.63)	(-0.11)	(-1.72)	(-3.15)
TCR	-0.0208	0.0119	-0.0147	-0.166
	(-5.88)	(1.02)	(-3.93)	(-4.87)
Inflation	-0.0000976	-0.000636	-0.0000601	-0.000275
	(-3.32)	(-8.67)	(-2.07)	(-0.95)
Real GDP	0.000147	0.000680	0.000558	0.00508
	(9.84)	(14.91)	(19.66)	(18.02)
Short IR	0.000943	0.0133	-0.000762	-0.00582
	(1.37)	(7.71)	(-5.58)	(-4.22)
Short IR ^{2}	-0.0000312	0.000342	0.000106	0.000426
	(-1.74)	(7.68)	(3.89)	(1.67)
Long IR	0.000132	-0.00957	-0.000256	0.00792
	(0.28)	(-8.17)	(-0.49)	(1.63)
Number of observations	50,148	50,148	50,148	50,148
Number of groups	3582	3582	3582	3582
Wald-test	$\chi^2(28) = 728418$	$\chi^2(28) = 534858$	$\chi^2(28) = 57578$	$\chi^2(28) = 50429$
Number of instruments	112	112	112	112
AR(1)	$z = -23.28$	$z = -14.99$	$z = -18.03$	$z = -15.43$
	p-value = 0.000	p-value = 0.000	p-value = 0.000	p-value = 0.000
AR(2)	$z = 1.44$	$z = -0.71$	$z = 5.28$	$z = 4.40$
	p-value = 0.149	p-value = 0.478	p-value = 0.000	p-value = 0.000
Hansen test of over-identifying restrictions	$\chi^2(83) = 702.00$ p-value = 0.000	$\chi^2(83) = 344.64$ p-value = 0.000	$\chi^2(83) = 501.20$ p-value = 0.000	$\chi^2(83) = 515.28$ p-value = 0.000

Note: z statistics in parentheses.

Table A.4. System GMM estimates of the bank risk-taking models

	TCR	PCL
TCR_{t-1}	0.00247	
	(2.03)	
PCL_{t-1}		0.405
		(33.59)
Size	-0.0164	0.000728
	(-10.41)	(3.84)
Capitalization	1.230	-0.0205
	(27.00)	(-3.53)
Diversification	-0.00184	-0.00505
	(-0.20)	(-4.17)
Credit risk proxy	-0.0211	
	(-0.32)	
TCR		0.00734
		(2.22)
Lending	-0.181	0.00670
	(-29.75)	(6.48)
Inflation	0.00217	0.000120
	(15.16)	(3.47)
Real GDP growth	-0.00152	-0.000713
	(-10.29)	(-22.66)
Short IR	-0.0923	-0.000878
	(-15.69)	(-5.87)
Short IR ^{2}	-0.00261	0.000151
	(-18.01)	(4.55)
Long IR	0.0708	-0.00128
	(17.43)	(-2.47)
Constant	0	0
	(.)	(.)
Number of observations	50,148	50,148
Number of groups	3,582	3,582
Wald-test	$\chi^2(28) = 88611.09$	$\chi^2(28) = 14029.92$
Number of instruments	112	112
AR(1)	$z = -5.83$	$z = -21.95$
	p-value = 0.000	p-value = 0.000
AR(2)	$z = -3.39$	$z = 5.23$
	p-value = 0.001	p-value = 0.000
Hansen test of over-identifying restrictions	$\chi^2(83) = 544.71$ p-value = 0.000	$\chi^2(83) = 395.62$ p-value = 0.000

Note: z statistics in parentheses.

Table A.5. Pooled OLS estimates of the bank profitability models

	NIM	Profit	ROA	ROE
NIM $_{t-1}$	0.780 ***			
	(317.67)			
Profit $_{t-1}$		0.943 ***		
		(729.39)		
ROA $_{t-1}$			0.656 ***	
			(237.67)	
ROE $_{t-1}$				0.627 ***
				(219.70)
Size	-0.000360 ***	0.000447 ***	0.000162 ***	0.00191 ***
	(-23.09)	(10.18)	(8.71)	(9.50)
Capitalization	0.0123 ***	0.0302 ***	0.0252 ***	-0.0410 ***
	(15.12)	(12.58)	(25.30)	(-3.85)
Diversification	0.000870 ***	0.000999	0.00549 ***	0.0570 ***
	(4.13)	(1.66)	(21.63)	(20.73)
Lending	0.00609 ***	0.00786 ***	0.000831 ***	0.0105 ***
	(45.19)	(20.97)	(5.25)	(6.13)
Credit risk proxy	0.0378 ***	-0.248 ***	-0.358 ***	-4.021 ***
	(14.40)	(-32.83)	(-110.17)	(-113.95)
TCR	-0.00252 ***	0.0222 ***	-0.00789 ***	-0.0522 ***
	(-6.23)	(18.69)	(-16.06)	(-9.80)
Inflation	-0.000171 ***	-0.000151 **	0.000142 ***	0.00144 ***
	(-9.36)	(-2.87)	(6.39)	(5.99)
Real GDP growth	0.000130 ***	0.000375 ***	0.000171 ***	0.00167 ***
	(13.98)	(14.01)	(15.15)	(13.61)
Short IR	0.0000995	-0.000812 ***	-0.00105 ***	-0.00825 ***
	(1.78)	(-5.04)	(-15.42)	(-11.15)
Short IR ^{2}	-0.0000540 ***	0.0000739 **	0.000101 ***	0.000635 ***
	(-6.63)	(3.15)	(10.18)	(5.91)
Long IR	0.000619 ***	0.000419 ***	0.000896 ***	0.00873 ***
	(19.85)	(4.67)	(23.65)	(21.25)
Constant	0.00507 ***	-0.0131 ***	-0.00240 ***	-0.000648
	(20.89)	(-19.96)	(-8.68)	(-0.22)
Observations	50,148	50,148	50,148	50,148
Adj. R ^{2}	0.76	0.95	0.66	0.63

Notes: t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$;

Table A.6. Pooled OLS estimates of the bank risk-taking models

	TCR	PCL
TCR $_{t-1}$	0.206 ***	
	(107.54)	
PCL $_{t-1}$		0.448 ***
		(115.20)
Size	-0.00173 ***	0.000166 *** **
	(-11.44)	(7.21)
Capitalization	1.285 ***	-0.00314 *
	(227.31)	(-2.57)
Diversification	-0.0397 ***	0.000339
	(-19.15)	(1.07)
Lending	-0.167 ***	0.00124 ***
	(-156.40)	(6.27)
Credit risk proxy	-0.126 ***	
	(-4.83)	
TCR		-0.00154 *
		(-2.53)
Inflation	-0.000533 **	0.000118 ***
	(-2.92)	(4.25)
Real GDP growth	0.000844 ***	-0.000645 ***
	(9.09)	(-46.77)
Short IR	0.000450	-0.000560 ***
	(0.80)	(-6.55)
Short IR ^{2}	-0.0000326	0.00000634
	(-0.40)	(0.51)
Long IR	-0.00107 ***	0.00102 ***
	(-3.43)	(21.58)
Constant	0.134 ***	-0.00170 ***
	(61.19)	(-4.94)
Observations	50,148	50,148
Adj. R ^{2}	0.82	0.27

Notes: t statistics in parentheses; *$p < 0.05$, ** $p < 0.01$, ***$p < 0.001$;

Table A.7. Within estimator estimates of the bank profitability models

	NIM	Profit	ROA	ROE
NIM	0.483 ***			
	(135.94)			
Profit $_{t-1}$		0.706 ***		
		(245.40)		
ROA $_{t-1}$			0.338 ***	
			(98.85)	
ROE $_{t-1}$				0.338 ***
				(97.04)
Size	-0.00112 ***	0.000465 *	0.00122 ***	0.0116 ***
	(-16.75)	(2.39)	(15.56)	(13.36)
Capitalization	0.0357 ***	0.113 ***	0.0313 ***	-0.196 ***
	(25.99)	(28.09)	(19.90)	(-11.32)
Diversification	-0.00653 ***	0.00467 ***	0.0133 ***	0.132 ***
	(-17.78)	(4.38)	(31.21)	(28.01)
Loan-to-Assets	0.0170 ***	0.0205 ***	0.00575 ***	0.0553 ***
	(69.43)	(29.57)	(20.75)	(18.01)
Credit risk proxy	0.0311 ***	-0.228 ***	-0.445 ***	-4.914 ***
	(11.59)	(-29.29)	(-141.86)	(-141.33)
TCR	0.000142	0.0751 ***	-0.00211 *	0.00254
	(0.20)	(35.82)	(-2.56)	(0.28)
Inflation	-0.0000228	-0.000180 ***	0.000114 ***	0.00123 ***
	(-1.37)	(-3.73)	(5.93)	(5.78)
Real GDP growth	0.000149 ***	0.000294 ***	0.000176 ***	0.00165 ***
	(17.32)	(11.77)	(17.71)	(14.92)
Short IR	-0.000154 **	-0.000442 **	-0.000440 ***	-0.00329 ***
	(-2.99)	(-2.95)	(-7.31)	(-4.95)
Short IR ^{2}	-0.0000329 ***	0.0000542 *	0.00000345	-0.000160
	(-4.33)	(2.46)	(0.39)	(-1.64)
Long IR	0.000769 ***	0.000142	0.00126 ***	0.0127 ***
	(24.01)	(1.53)	(34.01)	(30.97)
Constant	0.0153 ***	-0.0240 ***	-0.0188 ***	-0.131 ***
	(17.20)	(-9.38)	(-18.21)	(-11.49)
Number of observations	50,148	50,148	50,148	50,148
Number of banks	3,582	3,582	3,582	3,582
Fraction of variance due to η_i	0.46	0.53	0.47	0.41
R^2 within	0.54	0.70	0.52	0.50
R^2 between	0.73	0.97	0.57	0.59
R^2 overall	0.65	0.94	0.54	0.54

Notes: t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$;

Table A.8. Within estimator estimates of the bank risk-taking models

	TCR	PCL
TCR_{t-1}	0.0503 ***	
	(39.92)	
PCL_{t-1}		0.312 ***
		(72.15)
Size	-0.00514 ***	0.000635 ***
	(-12.04)	(5.77)
Capitalization	1.295 ***	-0.0214 ***
	(206.96)	(-9.63)
Diversification	-0.00483 *	-0.00471 ***
	(-2.06)	(-7.82)
Lending	-0.175 ***	0.00347 ***
	(-135.19)	(8.86)
Credit risk proxy	-0.0198	
	(-1.15)	
TCR		-0.000395
		(-0.34)
Inflation	-0.000889 ***	0.000252 ***
	(-8.38)	(9.16)
Real GDP growth	0.00110 ***	-0.000651 ***
	(20.05)	(-47.18)
Short IR	0.00133 ***	-0.00107 ***
	(4.03)	(-12.53)
Short IR ^{2}	-0.0000741	0.0000570 ***
	(-1.52)	(4.53)
Long IR	-0.00235 ***	0.00123 ***
	(-11.56)	(23.62)
Constant	0.204 ***	-0.00613 ***
	(36.76)	(-4.22)
Number of observations	50,148	50,148
Number of banks	3,582	3,582
Fraction of variance due to η_i	0.73	0.14
R^2 within	0.63	0.19
R^2 between	0.83	0.42
R^2 overall	0.80	0.23

Notes: t statistics in parentheses; *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$;

Table A.9. Pooled OLS estimates of the bank profitability models (with instrumental variables, exactly identified equation)

	NIM	Profit	ROA	ROE
Size	-0.00148 ***	0.00461 ***	0.000670 ***	0.00710 ***
	(-18.16)	(7.92)	(8.29)	(8.76)
Capitalization	0.0515 ***	0.539 ***	0.0683 ***	-0.106 *
	(9.82)	(9.58)	(11.24)	(-1.97)
Diversification	0.0136 ***	-0.0340 ***	0.00606 ***	0.0638 ***
	(8.30)	(-4.07)	(4.31)	(4.66)
Lending	0.0163 ***	0.00845	-0.000204	0.0121
	(20.32)	(1.25)	(-0.23)	(1.44)
Credit risk proxy	0.212 ***	-1.018 ***	-0.647 ***	-7.240 ***
	(9.69)	(-7.60)	(-25.45)	(-24.13)
TCR	-0.0167 ***	0.181 ***	-0.0230 ***	-0.160 ***
	(-5.74)	(5.86)	(-6.94)	(-5.33)
Inflation	0.000154 ***	-0.000641 ***	0.000283 ***	0.00342 ***
	(4.41)	(-3.80)	(7.65)	(8.37)
Real GDP growth	-0.000167 ***	-0.00246 ***	-0.000314 ***	-0.00394 ***
	(-3.63)	(-8.64)	(-5.26)	(-6.05)
	(-5.74)	(5.86)	(-6.94)	(-5.33)
Short IR	0.00682 ***	-0.00191	0.00849 ***	0.0925 ***
	(9.21)	(-0.49)	(9.99)	(9.72)
Short IR ^{2}	-0.00125 ***	0.000395	-0.00152 ***	-0.0165 ***
	(-8.93)	(0.54)	(-9.44)	(-9.17)
Long IR	0.00114 ***	0.000295	0.000505 ***	0.00519 **
	(8.86)	(0.49)	(3.45)	(3.12)
Constant	0.0321 ***	-0.0721 ***	-0.00455 ***	0.00842
	(26.24)	(-7.21)	(-3.47)	(0.62)
Observations	50,148	50,148	50,148	50,148
R^2	0.28	0.44	0.26	0.27
Test of endogeneity[#]	F(6,3581) = 128.278 p-value=0.000	F(6,3581) = 40.9283 p-value=0.000	F(6,3581) = 38.6813 p-value=0.000	F(6,3581) = 44.0818 p-value=0.000

Notes; t statistics in parentheses; $*p < 0.05$, $** p < 0.01$, $***p < 0.001$; [#]H_o: variables are exogenous

Table A.10. Pooled OLS estimates of the bank risk-taking models (with instrumental variables, exactly identified equation)

	TCR	PCL
Size	-0.00184 **	0.000280 ***
	(-3.02)	(6.25)
Capitalization	1.627 ***	0.00459
	(44.18)	(1.62)
Diversification	-0.0609 ***	0.00211 *
	(-7.04)	(2.10)
Lending	-0.207 ***	0.00242 ***
	(-37.26)	(5.82)
Credit risk proxy	-0.517 ***	
	(-4.72)	
TCR		-0.00483 ***
		(-3.42)
Inflation	-0.00156 ***	0.000442 ***
	(-5.50)	(9.71)
Real GDP growth	-0.00566 ***	-0.000454 ***
	(-17.77)	(-6.87)
Short IR	-0.0487 ***	0.0203 ***
	(-10.40)	(20.75)
Short IR ^{2}	0.00906 ***	-0.00387 ***
	(10.16)	(-20.63)
Long IR	-0.00595 ***	0.00242 ***
	(-7.05)	(12.56)
Constant	0.204 ***	-0.0131 ***
	(26.85)	(-13.57)
Observations	50148	50148
R^2	0.78	0.12
Test of endogeneity[#]	F(5,3581) = 43.949 p-value=0.000	F(5,3581) = 78.848 p-value=0.000

Notes: t statistics in parentheses; *$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; [#]H_o: variables are exogenous

Table A.11. Within estimator estimates of the bank profitability models (with instrumental variables, exactly identified equation)

	NIM	Profit	ROA	ROE
Size	0.000451 *	0.00660 ***	0.00358 ***	0.0318 ***
	(2.02)	(5.14)	(14.17)	(11.90)
Capitalization	0.0844 ***	0.489 ***	0.0369 **	-0.396 **
	(5.12)	(4.04)	(2.93)	(-3.23)
Diversification	-0.00577 ***	0.00291	0.00438 **	0.0406 *
	(-3.74)	(0.45)	(2.67)	(2.17)
Lending	0.0211 ***	0.0212	0.0111 ***	0.120 ***
	(9.65)	(1.33)	(6.61)	(7.13)
Credit risk proxy	0.129 ***	-0.632 ***	-0.696 ***	-7.933 ***
	(7.29)	(-9.16)	(-26.54)	(-23.21)
TCR	-0.0241 *	0.0965	-0.0132	-0.0861
	(-2.08)	(1.12)	(-1.55)	(-1.03)
Inflation	-0.0000735	-0.00262 ***	-0.000137	-0.00239 **
	(-0.97)	(-5.41)	(-1.78)	(-2.74)
Real GDP growth	-0.000919 ***	-0.00378 ***	-0.00100 ***	-0.0120 ***
	(-7.54)	(-5.12)	(-7.66)	(-8.30)
Short IR	-0.0264 ***	-0.154 ***	-0.0395 ***	-0.494 ***
	(-4.32)	(-4.58)	(-5.79)	(-6.35)
Short IR ^{2}	0.0562 ***	0.264 ***	0.0876 ***	1.066 ***
	(5.57)	(4.89)	(7.63)	(8.07)
Long IR	0.00180 ***	0.00602 ***	0.00253 ***	0.0302 ***
	(10.72)	(7.22)	(12.48)	(12.33)
Observations	50,148	50,148	50,148	50,148
Number of banks	3,582	3,582	3,582	3,582
Centered R ^{2}	0.33	0.28	0.38	0.35
Under identification				
Kleibergen-Paap rk LM statistics	$\chi^2(1)$=278.63, p-value=0.000	$\chi^2(1)$=278.63 p-value=0.000	$\chi^2(1)$=278.63 p-value=0.000	$\chi^2(1)$=278.63 p-value=0.000
Weak identification				
Cragg-Donald Wald F-statistic	274.77	274.77	274.77	274.77
Kleibergen-Paap Wald rk F statistic	0.20	0.20	0.20	0.20

Notes: t statistics in parentheses; $*p < 0.05$, $**\ p < 0.01$, $***\ p < 0.001$; First-stage, cluster robust F-statistics are given by F(6,3581)=3779.04 (Size), 1123.13 (Capitalization), 483.58 (Diversification), 4115.95 (Lending), 229.81 (Credit risk proxy), 490.94 (TCR).

Table A.12. Within estimator estimates of the bank risk-taking models (with instrumental variables, exactly identified equation)

	TCR	PCL
Size	-0.00485 ***	0.00202 ***
	(-4.02)	(8.12)
Capitalization	1.380 ***	-0.00471
	(47.42)	(-0.74)
Diversification	-0.0285 ***	-0.00740 ***
	(-3.93)	(-4.18)
Lending	-0.181 ***	0.00902 ***
	(-36.30)	(9.04)
Credit risk proxy	-0.0780	
	(-0.97)	
TCR		0.00180
		(0.47)
Inflation	-0.00506 ***	-0.000461 ***
	(-17.30)	(-5.06)
Real GDP growth	-0.00704 ***	-0.00145 ***
	(-11.51)	(-11.05)
Short IR	-0.294 ***	-0.0571 ***
	(-8.00)	(-6.71)
Short IR ^{2}	0.446 ***	0.134 ***
	(7.27)	(9.45)
Long IR	0.00469 ***	0.00531 ***
	(4.87)	(24.28)
Observations	50,148	50,148
Number of banks	3,582	3,582
Centered R ^{2}	0.63	0.13
Under identification		
Kleibergen-Paap rk LM statistics	$\chi^2(1)$=432.87	$\chi^2(1)$=276.11
	p-value=0.000	p-value=0.000
Weak identification		
Cragg-Donald Wald F-statistic	841.41	330.47
Kleibergen-Paap Wald rk F statistic	224.61	0.24

Notes; t statistics in parentheses; * $p < 0.05$, **< 0.01, *** $p < 0.001$; For the TCR model, the first-stage, cluster-robust F-tatistics are given by: F(5, 3581) = 4516.61 (Size), 1332.62; (Capitalization), 573.06 (Diversification), 4912.17 (Lending), 274.23 (Credit risk proxy). For the PCL model: F(5, 3581) = 4435.73 (Size), 1293.54 (Capitalization), 556.94 (Diversification), 4940.71 (Lending), 584.65 (TCR).

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