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Monetary Policy and Bank Profitability in a Low Interest Rate Environment

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Abstract
We analyse the impact of standard and non-standard monetary policy measures on bank profitability. For empirical identification, the analysis focuses on the euro area, thereby exploiting substantial bank and country heterogeneity within a monetary union where the central bank has implemented a broad range of unconventional policies, including quantitative easing and negative interest rates. We use both proprietary and commercial data on individual bank balance sheets and financial market prices. Our results show that monetary policy easing – a decrease in short-term interest rates and/or a flattening of the yield curve – is not associated with lower bank profits once we control for the endogeneity of the policy measures to expected macroeconomic and financial conditions. Importantly, our analysis indicates that the main components of bank profitability are asymmetrically affected by accommodative monetary conditions, with a positive impact on loan loss provisions and non-interest income largely offsetting the negative one on net interest income. We also find that a protracted period of low interest rates might have a negative effect on profits that, however, only materialises after a long period of time and tends to be counterbalanced by improved macroeconomic conditions. In addition, while more operationally efficient banks benefit more from monetary policy easing, banks engaging more extensively in maturity transformation experience a higher increase in profitability after a steepening of the yield curve. Finally, we assess the impact of unconventional monetary policies on market-based measures of expected bank profitability and credit risk, by employing an event study analysis using high frequency data, and find that accommodative monetary policies tend to increase bank stock returns and reduce credit risk.

Keywords: bank profitability, monetary policy, lower bound, quantitative easing, negative rates

JEL classification: E52, E43, G01, G21, G28.

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Table of contents

1 Introduction

Western Europe and the United States suffered a severe banking crisis in late 2000s followed by a deep and long-lasting economic recession, with substantial costs in terms of aggregate output and employment. A key channel through which the weakness in bank balance sheets affects the real economy works via the reduction in the supply of bank credit, including deleveraging and asset fire sales (Bernanke, 1983; Freixas, Laeven and Peydró, 2015). Historically, financial crises triggered persistent negative effects on the overall economy (Kindelberger, 1978; Reinhart and Rogoff, 2009). In the recent crisis, for example, the euro area only returned to its pre-crisis GDP levels in 2015, i.e. eight years after the crisis started. Central banks responded strongly to the banking and economic crisis, reducing their policy interest rates and implementing several unconventional monetary policies that have also influenced the slope of the yield curve; some commentators have even suggested that monetary policy was the only game in town to overcome the economic and financial problems (El-Erian, 2016).

Lower policy rates and accommodative unconventional monetary policies are in general crucial to address a weak macroeconomic environment also supporting the financial and banking system. This is because such measures provide abundant access to central bank liquidity and lower the cost of debt with positive consequences for bank funding and borrower creditworthiness respectively, thereby supporting bank capital and reducing non-performing loans and loan loss provisioning (Bernanke and Gertler, 1995; Praet, 2016; Bernanke, 2007; Diamond and Rajan, 2006; Freixas and Jorge, 2008; Gertler and Karadi, 2011, 2013; Kiyotaki and Moore, 2012; Freixas, Martin and Skeie, 2011; Allen, Carletti and Gale, 2009 and 2014). At the same time, there may also be some downsides associated with conventional and unconventional monetary policy easing (Rajan, 2005; Taylor, 2008; Allen and Rogoff, 2011; Stein, 2012 and 2014; Stiglitz, 2016), including a potential reduction in net interest income (Borio et al., 2017; Alessandri and Nelson, 2015) which could ultimately hamper the transmission of monetary policy (Brunnermeier and Koby, 2017). The net effect of monetary policy on bank profitability therefore remains an empirical question. Moreover, an important related question is whether a scenario of low (or even negative) rates protracted for an extended period of time alters the relationship between monetary policy easing and bank profitability.

These issues have crucial policy implications, as the ability of banks to generate adequate profits is relevant for the sustainability of the banking system and, as such, for its capacity to provide sufficient credit to the economy. Profitable banks are not only able to attract capital from market investors, but they can also generate capital internally through retained earnings. As such, bank profitability contributes to bank soundness and hence to financial stability (Admatti and Helwig, 2013; Freixas and Rochet, 2008).

In this paper, we analyse the impact of standard and non-standard monetary policy on bank profitability. For empirical identification, we focus on the euro area, which provides an interesting laboratory as it features substantial bank and country heterogeneity *within a monetary union* and the European Central Bank (ECB) has implemented a broad set of unconventional policies, including negative interest rates, credit and quantitative easing measures. We use proprietary ECB data on individual bank balance sheet also combining data from several commercial providers collected since the creation of the euro area. We study not only the average impact of monetary policy on bank profits but also its heterogeneous effects depending on banks' maturity transformation, and balance sheet characteristics. In addition, as there have been growing concerns over recent years that the net benefits of accommodative policies might be declining over time (Brunnermeier and Koby, 2017; Claessens, 2017), we examine whether a protracted period of low interest rates might impair bank profitability. The analysis also explores the main channels though which monetary policy actions influence bank profitability. At a micro level, bank-level data are used to analyse the impact of interest rate changes on the main components of bank profitability – i.e. net interest income, non-interest income and provisions. We complement this evidence by investigating the macroeconomic implications of changes in monetary conditions on the same components using a dynamic multivariate model.

Finally, we assess the impact of non-standard monetary policies on market-based expectations of future profitability, as measured by stock market returns of individual banks. As the vast majority of the stakeholders of a bank are debtholders we also investigate the impact of policy measures on market participants' perception of banks' credit risk, as proxied by banks' CDS spreads, thereby covering the impact for all the major stakeholders of a bank, ultimately including depositors and taxpayers. The dynamics of both bank stock prices and CDS are affected by a wide range of factors, making it particularly challenging to identify the effects of monetary policy due to endogeneity and simultaneity issues. Moreover, being forward-looking, financial market prices tend to react to information about policy changes only if these changes are unanticipated. Therefore, to correctly identify the impact of monetary policy, we use an event-study approach to isolate the unexpected component of the policy change by looking at the high-frequency movements in asset prices following monetary policy announcements (see, for example, Bernanke and Kuttner, 2005; Gürkaynak, Sack and Swanson, 2005b). The identifying assumption is that changes in financial assets occurring in a small window around a given policy announcement capture the (efficient) market reaction to the arrival of new information, thereby reflecting the causal impact of the policy.

This paper contributes to the literature on the impact of monetary policy actions on bank profitability. Early studies document the existence of a positive correlation between interest rates (usually expressed as level or slope of the term structure) and bank interest margins. This positive association is interpreted as a natural consequence of banks' maturity transformation activities (e.g.

Flannery, 1981; Hancock, 1985; Bourke, 1989; Saunders and Schumacher, 2000). Recent studies have also highlighted the possible trade-off between accommodative monetary policy and bank profitability. In general, the empirical evidence found in these studies suggests an adverse impact of monetary policy easing on net interest margins (Alessandri and Nelson, 2015; Borio et al., 2017), with amplification effects in low interest rate environments (Claessens et al., 2017).

Using a wide range of different data and econometric techniques we establish a set of robust results.

First, we contribute to the existing literature by finding that when evaluating the impact of monetary policy on bank profitability it is very important to consider the effects stemming from not only actual but also expected real economic activity. We are, to our knowledge, the first to use the expected (forecasted) macroeconomic developments and (forward-looking) credit risk among the possible set of controls. We find that low monetary policy rates and a reduced slope of the yield curve are associated with lower bank profits only if there are important variables omitted in the assessment. More specifically, according to economic theory and central bank practice (see, for example, Bernanke and Gertler, 1995), monetary policy reacts (is endogenous) to the current and expected overall economic and financial conditions.[1] If we control for overall expected aggregate economic and financial conditions, the association between monetary policy conditions and bank profitability breaks down. In other words, controlling for expected (in addition to current) economic and financial conditions is sufficient to eliminate the correlation between monetary policy and bank profitability. Bank balance sheet characteristics, such as bank capital, liquidity, non-performing loans and efficiency, are also important. This is not surprising, as weakness in bank balance sheets (and the associated impairment in the transmission mechanism) was an important motivation for monetary policy easing during the crisis (Praet, 2016).

Second, the main components of bank profitability are asymmetrically affected by accommodative monetary policies with the positive impact on loan loss provisions and non-interest income largely offsetting the negative one on net interest income, a robust result stemming from both micro and macro approaches.

Third, we find that heterogeneity of bank balance sheet characteristics matters for the transmission of monetary policy to bank profitability. Results suggest that an accommodative monetary policy is relatively more beneficial for banks with higher operational efficiency and banks with lower asset quality. Additionally, a steepening of the yield curve has a relatively more positive

[1] There is a large literature on the monetary policy transmission mechanism that explores the impact of monetary policy, and in general central bank policies, on the economy, via banks (Bernanke and Blinder, 1988 and 1992; Kaskyap and Stein, 2000; Diamond and Rajan, 2006; Gertler and Kiyotaki, 2010; Jiménez, Ongena, Peydró and Saurina, 2012, 2014, and 2017).

impact on profitability for banks that rely more heavily on maturity transformation activities (see also English et al., 2014).[2]

Fourth, while expansionary monetary policy does not compress bank profits, we find that being exposed to a low interest rate environment for a protracted period might exert downward pressure on bank profitability. However, the adverse effects are only significant after a long period of time and tend to be counterbalanced by the positive impact of low interest rates on real economic activity (and hence on banks).

Finally, the paper also contributes to the literature on the impact of monetary policy on expected profitability of firms as measured by stock market returns (Thorbecke, 1997; Bernanke and Kuttner, 2005; Rigobon and Sack, 2004; Ehrmann and Fratzscher, 2004; English, et al., 2014). In this context, we also highlight the importance of considering the effects of monetary policy actions on both debtholders' net wealth and credit risk; this is not only important for financial stability and systemic risk but also economically relevant as bank debt, including depositors, accounts for the vast majority of banks' value.[3] Evidence from financial markets provides striking results. After all major monetary policy easing announcements (including long-term liquidity provision, quantitative easing and negative policy rates), the vast majority of banks experience an increase in the market-based expected profitability – proxied by developments in bank stock prices – and a decrease in market perception of bank credit risk – proxied by bank CDS spreads. These two results also imply that softer monetary conditions do not hurt banks' main stakeholders (including debtholders and in general depositors and taxpayers). Overall, the evidence from financial markets supports the conclusions drawn from the analysis of bank balance sheets, namely that monetary policy easing does not impair bank profitability.

The remainder of the paper is organised as follows. Section 2 presents stylised facts on recent developments in bank balance sheet structure and profitability. In Section 3, the analysis focuses on the impact of monetary policy on bank profitability using accounting data for a cross-section of European banks. Section 4 complements the evidence based on bank-level data by investigating the macroeconomic implications of monetary policy shocks on profitability components using a dynamic multivariate model. Section 5 extends the assessment to the impact of monetary policy on banks' market valuations and credit risk as determined by stock market participants. Section 6 concludes.

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[2] Note that the maturity mismatch between bank assets and liabilities might be difficult to measure. For example, there are asset classes such as overdrafts that although short-term, do not have a specific maturity.

[3] Bank value is composed of the value of bank shares plus the value of bank debt. As discussed in the main text, given that banks are highly leveraged, even more so in Europe than the United States, most of the bank value stems from bank debt.

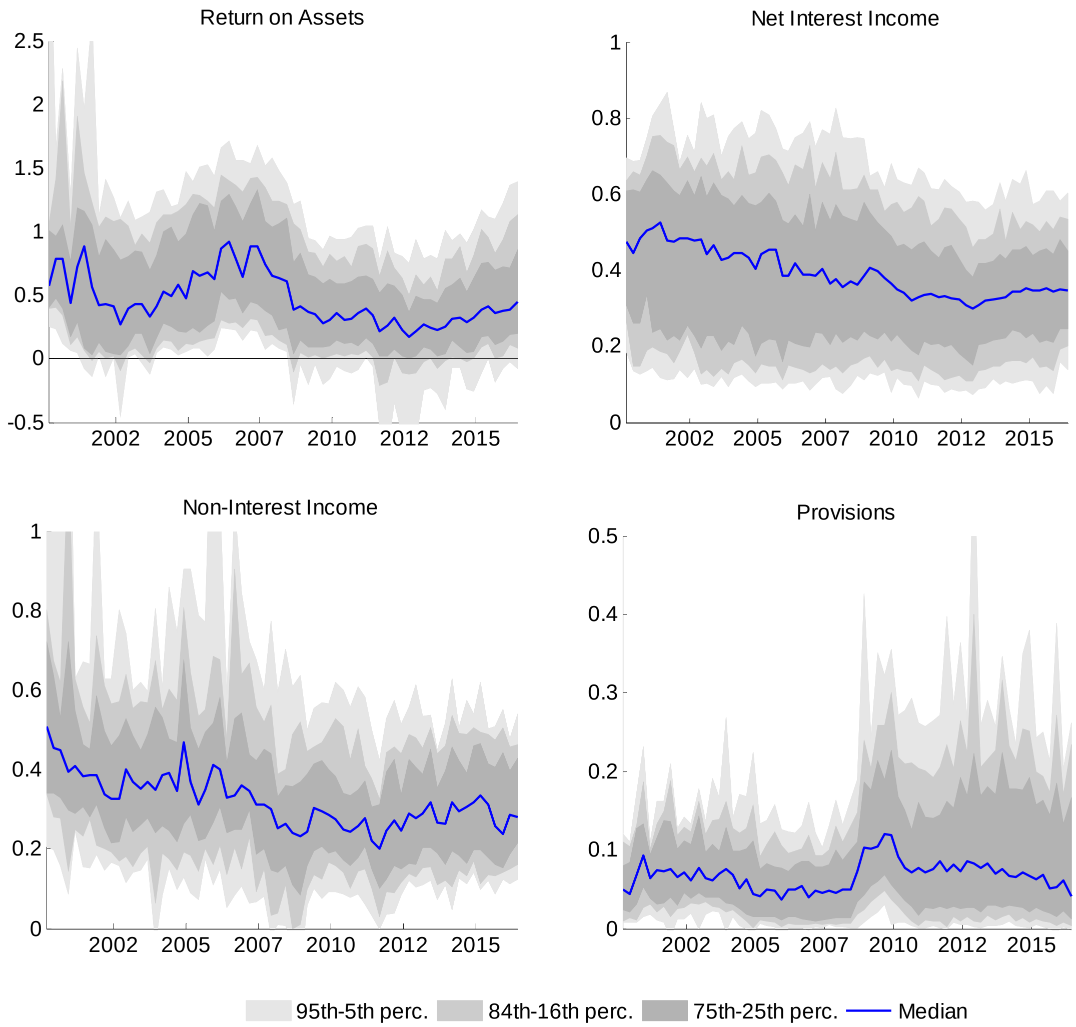
2 Stylised facts

In principle the impact of monetary policy actions on bank profitability might be ambiguous. This ambiguity is related to the fact that the effects on net interest margins driven by relative frictions in pricing assets and liabilities can be offset by general equilibrium effects associated with the reaction of credit quality and intermediation volumes to changes in interest rates. By aiming at compressing risk/term premia by altering the size of the central bank balance sheet, quantitative easing (QE) policies, for example, might produce two contrasting and possibly offsetting effects. On the one hand, the flattening of the yield curve typically associated with this type of policy may reduce the returns from maturity transformation activities and thus compress banks' net interest margins (e.g. Gambacorta, 2008; Alessandri and Nelson, 2015; Altavilla, Canova and Ciccarelli, 2016). On the other hand, QE may improve bank profitability by boosting demand for credit, as the policy is transmitted to the real economy. The effect of the policy on real economic activity might also improve the capacity of borrowers to honour their commitments, increasing the quality of the assets held in banks' portfolios and hence allowing for savings in costs associated with loan loss provisions.

How exactly bank profitability is affected by interest rate changes depends on the relative effects on its main components: net interest income, non-interest income, and provisions. Figure 1 illustrates the developments over time in bank profitability and its main components as well as their cross-sectional dispersion. Bank profitability showed an increasing trend in the run-up to the financial crisis, followed by a decline reflecting an abrupt increase in loan loss provisions. More recently, there has been a gradual recovery of bank profitability supported by increasing net interest income and declining provisions, reflecting higher credit quality thanks to the improved economic outlook. The resilience of net interest income in the recent low interest rate environment reflected savings in funding costs which more than offset lower interest income. In turn, interest income was supported by increasing intermediation volumes.

In order to understand the link between monetary policy and interest rates, it is important to have an overview of the main components of bank balance sheets in the euro area. Loans and advances are the main component of total assets. For the euro area as a whole, total loans comprise around 60% of total assets, whereas loans to the non-financial private sector account for close to 40%. Securities held represent 15-20% of the balance sheet, and about 2/3 of this item is comprised by sovereign debt, with equity instruments accounting for around 10% of securities held by euro area banks. Among the other assets, the main components are derivatives and cash and balances at central banks. The largest component of the liability side is deposits, at around 60% of total assets, of which about 60% are deposits from the non-financial private sector. Securities issued account for around 15% of total liabilities and capital accounts only for close to 6%. Other liabilities largely comprise derivatives.

Figure 1: profitability and its main components



Note: the figure illustrates the developments over time in the main components of bank profitability and their cross-sectional dispersion across the available sample of banks. The blue line represents (for each quarter) the median for the cross-section of banks. Similarly, the shaded areas comprise the interquartile range, the 50%, 68% and the 95% of the cross-sectional distribution of banks.

The different characteristics of bank assets and liabilities which are relevant for the link between the balance sheet structure and bank profitability can be summarised by the maturity gap. This indicator measures the difference between the (weighted average) repricing period of bank assets and liabilities.[4]

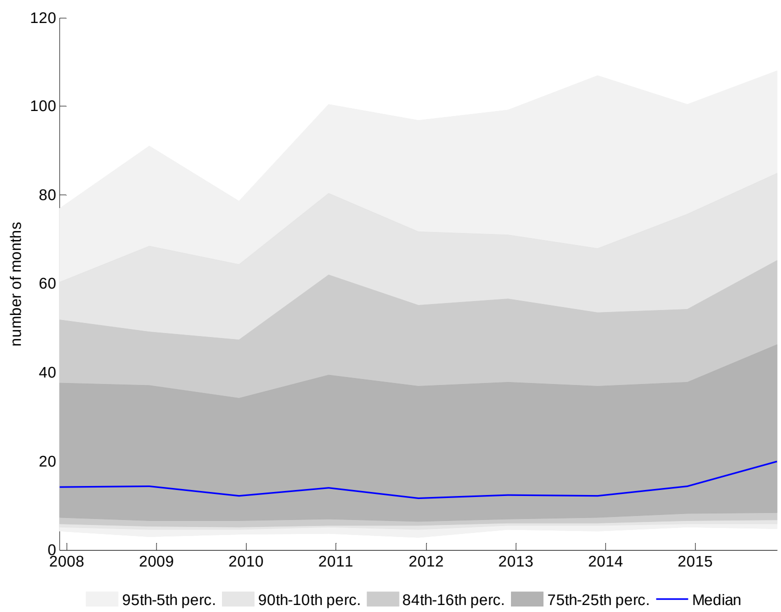
[4] Note that the maturity gap (see English et al., 2014) is similar to the "funding gap" introduced by Flannery (1983).

More formally, this indicator might be expressed as:

$$GAP_{i,j,t} = \sum_j \tau^j A^j - \sum_j \tau^j L^j \quad (1)$$

where τ^A denotes the weighted average repricing/maturity period (in months) of assets (A^j), which comprise loans to the non-financial private sector and debt securities held, whereas τ^L refers to the repricing time of the liabilities L^j, which in our case include deposits from the non-financial private sector and debt securities issued. Figure 2 illustrates the significant cross-sectional dispersion in maturity transformation, possibly reflecting different business models as well different loan-rate fixation periods.[5] The median maturity gap has recently increased to about 2 years, whereas its distribution ranges from 6 months to around 8 years. The link between the maturity gap and the impact of monetary policy on bank profitability is explored in the next section.

Figure 2: Maturity gap distribution across bank



Note: for each month, the chart reports the dispersion of the maturity gap across banks. The maturity gap considers loans to and deposits from the non-financial private sector based on new business volumes for each maturity bucket, relating to new loans plus loans whose rate is renegotiated. Weighted average rate fixation is calculated using the mid-point of each rate fixation bracket and 15 years for the bracket "over 10 years".

[5] See appendix 1 for stylised facts on loan-rate fixation periods across countries.

3 Exploiting the cross-section of banks

In this section, the analysis concentrates on the impact of monetary policy on bank profitability using accounting data for a cross-section of European banks. Return on assets is used as a measure of profitability and regression analysis is employed to explore its drivers. In general, we examine the role of monetary policy, the macroeconomic outlook and bank balance sheet characteristics. In doing so, we rely on different datasets with different degrees of confidentiality/granularity. More specifically, the analysis is carried out at quarterly frequency, matching different commercial datasets available since the establishment of the euro area with different confidential ECB proprietary datasets available at monthly and quarterly frequency over the period from June 2007 to January 2017. Therefore, data availability explains why there may be differences in some empirical specifications used in the analysis below.

3.1 Monetary policy and bank characteristics

In this subsection, we explore the link between monetary policy and bank profitability through the lens of bank balance sheet information. We also analyse whether bank characteristics influence the transmission of monetary policy actions to bank profitability.

The analysis focuses on the period from the start of 2000 to the end of 2016. We use quarterly data collected from different sources. More specifically, we use three sets of variables. Financial variables, such as the yield curve and the VIX, are taken from Datastream, while the country-specific measure of expected default frequency (EDF) for non-financial firms is taken from Moody's Analytics. Macroeconomic indicators are taken from Eurostat (real GDP and HICP inflation) and Consensus Economics (expected value of inflation and real GDP growth one year ahead).

Finally, bank balance sheet data are taken from different commercial datasets – namely Bankscope, SNL, Bloomberg and Capital IQ – with the aim of maximising the sample size. This also makes it possible to check the consistency of the information provided by the four datasets and hence minimise misreporting and outliers.

Descriptive statistics for the main variables used in the estimation are reported in Table 1.

For each variable, the table shows measures of central tendency and some selected percentiles describing the frequency distribution of data; the total number of observations available for each variable is given in the last column. The distribution across percentiles shows wide variation in the data over the sample. This variation is visible for all groups of variables in the table. For the regulatory capital ratio (i.e. the ratio of Tier 1 capital to risk-weighted assets), for example, the interquartile range goes from 11% to about 17%; the same range for the NPL ratio (i.e. the ratio of non-performing loans to total loans) goes from 2.4% to 8.5%.

Table 1: Descriptive statistics

	Mean	Std. Dev.	25th perc.	Median	75th perc.	# obs.
Financial variables						
Short-term rate	1.01	1.40	0.07	0.38	1.73	7,103
Slope	1.05	9.97	0.98	1.63	2.11	7,103
VIX	22.47	7.56	17.00	20.88	24.96	7,103
Expected default frequency	1.12	1.55	0.46	0.75	1.29	6,920
Macroeconomic variables						
Real GDP growth	0.69	2.78	-0.38	0.84	2.00	7,081
Expected real GDP growth	1.23	1.02	0.71	1.33	1.78	6,799
Expected inflation	1.60	0.52	1.24	1.61	1.88	6,799
Bank variables						
Return on Assets (in basis points)	41	76	12	36	71	7,103
Net interest income (in basis points)	36	23	22	35	48	5,843
Non interest income (in basis points)	36	47	17	28	42	2,583
Provisions (in basis points)	13	34	3	7	15	5,001
NPL ratio	6.79	7.41	2.44	4.12	8.52	3,765
Regulatory capital ratio	15.55	9.19	11.09	13.34	16.65	5,006
Cost-to-income Ratio	60.74	25.39	50.55	59.90	69.11	5,844

Note: Data are at quarterly frequency covering the period Q1 2000-Q4 2016. Variables are defined in percentage unless otherwise specified. Short-term rate is the three-month OIS, country-specific slope is the difference between ten- and two-year sovereign yields, euro area slope is the difference between ten- and two-year OIS and sovereign spread is the difference between ten-year sovereign yields and the ten-year OIS. Expected real GDP growth is the one-year-ahead expectation obtained from Consensus Economics.

We start with a simple specification to measure the effects of monetary policy on bank profitability:

$$ROA_{i,j,t} = \alpha_i + \beta_1 Level_t + \beta_2 Slope_{j,t} + \Omega X_{j,t} + \Phi Z_{i,j,t-1} + \varepsilon_{i,j,t} \qquad (2)$$

where ROA is the return on assets of a bank "*i*" operating in a country "*j*" at time "*t*"; α_i are bank fixed effects; β_1 and β_2 are the coefficients associated with the level of a short-term interest rate (the three-month OIS) and the country-specific slope of the term structure – calculated as the difference between the yields on government bonds with a residual maturity of ten years and two years. Positive values for these two coefficients would imply that an increase in interest rates or a steepening of the term structure tends to lead to an increase in bank profitability. The model also includes a set of country- and bank-specific controls, $X_{j,t}$ and $Z_{i,j,t-1}$, respectively. Country specific controls include current and expected GDP growth, expected inflation, a measure of stock market volatility (VIX), and a forward looking measure of borrower risk (the expected default frequency, EDF). Bank-specific controls include the non-performing loan ratio (gross non-performing loans as a proportion of total loans), the Tier 1 capital ratio, the cost-to-income ratio and the liquid asset ratio (liquid assets as a proportion of total assets). The vectors of coefficients Ω and Φ indicate the response of bank profitability to the controls used in the regression.

Important additional evidence might be obtained by interacting the level and the slope of the term structure with bank-specific variables.

The regression model then becomes the following:

$$ROA_{i,j,t} = \alpha_i + \beta_1 Level_t + \beta_2 Slope_{j,t} + \Omega X_{j,t} + \Phi Z_{i,j,t-1} + \Gamma_1 (Level_t \times Z_{i,j,t-1}) + \Gamma_2 (Slope_{j,t} \times Z_{i,j,t-1}) + \varepsilon_{i,j,t} \quad (3)$$

The expected sign of the elements of the $1 \times k$ coefficient vectors $\Gamma_1 = [\gamma_{11} \dots \gamma_{1k}]$ and $\Gamma_2 = [\gamma_{21} \dots \gamma_{2k}]$ depends on the balance sheet variable considered. For example, a positive sign on the interaction term between the level of short-term interest rate and the cost-to-income ratio would mean that the most efficient banks (with a lower cost-to-income ratio) are the ones that benefit more from lower rates. Similarly, a negative coefficient on the interaction term between the slope of the term structure and the non-performing loan ratio would mean that a flattening of the yield curve would tend to be especially beneficial for banks with a higher share of non-performing loans. The estimates of alternative specifications of equation (2) and (3) are reported in Table 2.[6] Standard errors are clustered at the bank level in all regressions.[7]

The first column of the table shows that, in the absence of additional controls, the impact of monetary policy action on bank profitability is statistically significant: a reduction in the short-term interest rate (more akin to conventional policy) or a flattening of the yield curve (more akin to unconventional policy) tends to reduce bank profitability. However, periods of low interest rates tend to coincide with poor macroeconomic conditions, and controlling for the current macroeconomic outlook indeed weakens this relationship (column 2). The relationship between interest rates and bank profitability also breaks down when variables that control for the expected macroeconomic outlook are taken into account (column 3). This illustrates the importance of the endogeneity of monetary policy to both current and expected economic and financial conditions. The role of expected macroeconomic developments is particularly relevant. A one standard

[6] Appendix 2 reports several robustness exercises. These include showing that using the same sample across the five specifications reported in Table 2 does not change the results and that results are also robust to the use of a euro area measure of the slope of the yield curve (based on OIS rates) in place of the country-specific term structures.

[7] Our preferred estimation method is OLS. In principle, this could result in inconsistent estimates, as the lagged dependent variable is correlated with the error term due to the presence of time invariant individual effects, as described by Nickell (1981). However, the time dimension of our dataset (the main sample covers 66 time periods) makes this effect negligible. Moreover, our results are robust to not including fixed effects and to the use of the GMM estimation, see Appendix 2.

deviation (i.e. one percentage point) increase in expected GDP growth increases ROA by about ten basis points.

Table 2: Monetary policy and balance sheet characteristics

	(1)	(2)	(3)	(4)	(5)
ROA_{t-1}	0.585***	0.556***	0.506***	0.413***	0.425***
	(0.0348)	(0.0330)	(0.0412)	(0.0584)	(0.121)
Short-term $rate_t$	0.0332***	0.0199***	-0.00209	0.00374	
	(0.00667)	(0.00671)	(0.00820)	(0.0148)	
$Slope_t$	0.00338***	0.00293**	0.000631	0.00161	
	(0.00128)	(0.00131)	(0.00136)	(0.00151)	
VIX_t		-0.00285***	0.00261**	0.00266	
		(0.000718)	(0.00108)	(0.00183)	
Real GDP $growth_t$		0.0238***	-0.00496	-0.000249	
		(0.00589)	(0.00487)	(0.0101)	
Expected real GDP $growth_t$			0.0823***	0.107***	
			(0.0108)	(0.0169)	
Expected $inflation_t$			0.0960***	0.112**	
			(0.0303)	(0.0494)	
Expected default $frequency_t$			-0.0568***	-0.0557**	
			(0.0211)	(0.0261)	
NPL $ratio_{t-1}$				-0.0108***	-0.000979*
				(0.00356)	(0.000440)
Regulatory capital $ratio_{t-1}$				0.00581	0.0218***
				(0.00385)	(0.00772)
Cost-to-income $ratio_{t-1}$				-0.00251**	0.000884*
				(0.00112)	(0.00049)
(Short-term $rate_t$) x (NPL $ratio_{t-1}$)					0.00634
					(0.00644)
($Slope_t$) x (NPL $ratio_{t-1}$)					-0.00233***
					(0.000395)
(Short-term $rate_t$) x (Cost-to-income $ratio_{t-1}$)					0.00204
					(0.00134)
($Slope_t$) x (Cost-to-income $ratio_{t-1}$)					0.000277***
					(0.0000768)
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*time FE	No	No	No	No	Yes
Number of observations	7,093	7,071	6,768	2974	2992
R^2	0.683	0.688	0.699	0.604	0.773

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

The logic behind this result is that a better expected macroeconomic outlook could increase current loan demand by stimulating investment which, in the euro area, is largely funded via bank intermediation. On the supply side, banks might be induced to increase their lending to the non-financial private sector as the improved economic outlook will translate into increased company and household income, and hence lower credit risk. Also, when including bank-specific variables, an average bank's profitability is not found to react to changes in the level or the slope of the yield curve – see column 4, our baseline specification. Important bank-specific control variables are the NPL ratio, the cost-to-income ratio and the regulatory capital ratio. Banks with a higher NPL ratio tend to demonstrate lower profitability: a one standard deviation (i.e. 7.4 percentage points) increase in the NPL ratio reduces ROA by 8 basis points. This result is intuitive as bad loans do not generate income and lead to costs associated with provisions for credit losses as well as operational costs associated with their management and resolution. In line with previous studies (e.g. Alexiou and Sofoklis, 2009; Athanasoglou et al., 2008; Dietrich and Wanzenried, 2011; García-Herrero et al., 2009; Pasiouras and Kosmidou, 2007), we find that cost efficiency has a positive and highly significant impact on profitability: a one standard deviation (i.e. 25 percentage point) increase in the cost-to-income ratio reduces ROA by 6 basis points. This relationship shows that operational efficiency is a major avenue to explore in order to improve bank profitability.

Finally, we test whether the effect of monetary policy on profitability depends on the cost efficiency or the credit quality of a bank's loan portfolio. We find a negative value for the interaction terms between the level and slope of the term structure and the NPL ratio, implying that the higher the NPL, the more positive the impact of monetary policy easing on profitability. There could be different reasons that explain this. First, NPL are non-income producing assets that still need to be funded. This means that lower interest rates, by decreasing funding costs, decrease the cost of holding NPL. Second, policy easing would decrease the cost of servicing debt, thereby exerting a positive influence on borrowers' ability to honour their commitments (and their probability of default).

We also find that the impact of monetary policy on bank profitability depends on the relative (operational) efficiency of a given bank. The coefficients on the interaction terms with the level and the slope of the term structure are both positive, suggesting that the effect of monetary policy easing on profitability is more positive in relative terms for banks with a lower cost-to-income ratio, i.e. with greater operational efficiency.

3.2 Keeping interest rates low for long

The results presented above indicate that changes in short-term rates or in the slope of the yield curve do not significantly influence bank profitability once macroeconomic and bank-specific controls are appropriately taken into account. Nonetheless, there might be adverse effects on bank profitability if rates remain low for a long period of time. Indeed, following a decrease in interest rates, net interest margins are at first shielded due to the typically faster repricing of the outstanding amount of liabilities as compared to assets. Since assets tend to be longer term, changes in the interest rates applied on new business take longer to be reflected in the outstanding amount of loans. A protracted low interest rate environment could therefore be expected to be more detrimental for banks.

This subsection presents a test for this hypothesis within the regression framework.

In principle, there are various methods to capture the heterogeneous effects of monetary policy in a protracted low interest rate environment. Claessens et al. (2017), for example, identify such an environment by constructing a variable that counts the number of periods in which a reference interest rate is lower than a fixed threshold (1.25% for the three-month rate, in their case). Along these lines, the duration of the low interest rate environment might be captured by a variable that counts the periods when the rate on marginal refinancing operations (MRO) or the interbank overnight rate (EONIA) has been below a fixed threshold. In these cases, however, the results will depend on the particular (arbitrary) value used for the threshold. In order to avoid the need to define an *ad hoc* threshold, we construct a variable, defined as the sum of consecutive quarters in which residuals from an estimated Taylor rule are negative. The Taylor rule uses the three-month overnight index swap (OIS) rate as proxy for the monetary policy instrument and includes expectations for future inflation and for GDP growth one year ahead. The identification of the low-for-long period based on Taylor residuals is therefore less arbitrary.

In practice, we add three variables measuring the low-for-long to our baseline specification and present the results in Table 3. Specifically, "Low for long $(D_{MRO\leq 1.5})$" and "Low for long$(D_{Eonia\leq 1.25})$" count the number of consecutive quarters in which the MRO and EONIA rates are below 1.5% and 1.25%, respectively (the associated results are in column 2 and 3); "Low for long (Taylor rule)" is a variable that counts the number of consecutive quarters in which residuals of the forward-looking Taylor rule are negative (results are in column 4).[8]

Comparing column 1 with columns 2 to 4 of the table shows that results concerning the impact on profitability of changes in yields, the macroeconomic environment and bank-specific characteristics are robust to the inclusion of the low-for-long variable in the model specification. Importantly, the coefficients for the low-for-long measures reported in columns 2 to 4 are all negative and statistically significant, suggesting that keeping rates low for an extend period of time might have negative consequences for bank profitability.

[8] Figure A1.4 in Appendix 1 displays the measures of low for long used in the estimations.

Table 3: The impact of low-for-long interest rates on bank profitability

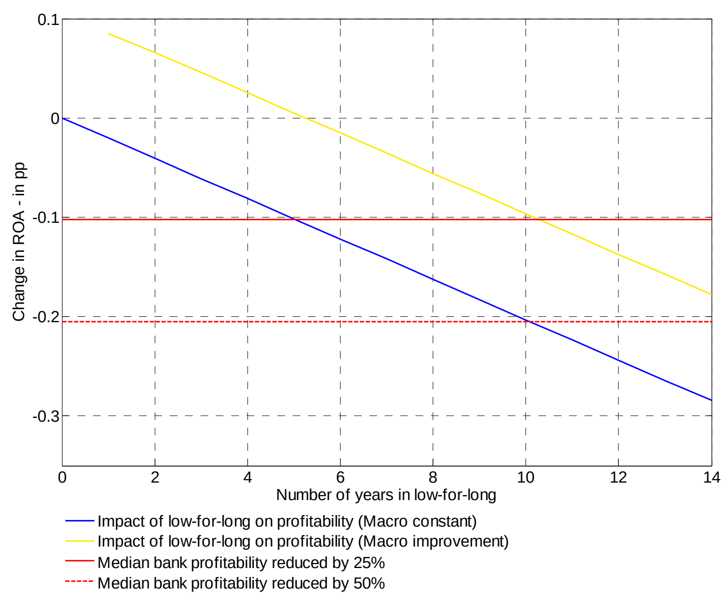
	(1)	(2)	(3)	(4)
ROA_{t-1}	0.413***	0.415***	0.415***	0.415***
	(0.0584)	(0.0594)	(0.0594)	(0.0592)
Short-term $rate_t$	0.00374	-0.0286	-0.0254	-0.0198
	(0.0148)	(0.0217)	(0.0210)	(0.0204)
$Slope_t$	0.00161	0.00142	0.00143	0.00131
	(0.00151)	(0.00149)	(0.00149)	(0.00148)
VIX_t	0.00266	0.000579	0.000687	0.00139
	(0.00183)	(0.00190)	(0.00190)	(0.00197)
Real GDP $growth_t$	-0.000249	0.00775	0.00740	0.00537
	(0.0101)	(0.0107)	(0.0107)	(0.0113)
Expected real GDP $growth_t$	0.107***	0.105***	0.105***	0.0978***
	(0.0169)	(0.0168)	(0.0168)	(0.0184)
Expected $inflation_t$	0.112**	0.0983**	0.0990**	0.104**
	(0.0494)	(0.0477)	(0.0478)	(0.0510)
Expected default $frequency_t$	-0.0557**	-0.0548**	-0.0548**	-0.0675***
	(0.0261)	(0.0254)	(0.0254)	(0.0255)
NPL $ratio_{t-1}$	-0.0108***	-0.00840**	-0.00848**	-0.00864**
	(0.00356)	(0.00378)	(0.00377)	(0.00368)
Regulatory capital $ratio_{t-1}$	0.00581	0.00687*	0.00677*	0.00629
	(0.00385)	(0.00401)	(0.00400)	(0.00413)
Cost-to-income $ratio_{t-1}$	-0.00251**	-0.00260**	-0.00259**	-0.00255**
	(0.00112)	(0.00114)	(0.00114)	(0.00114)
Low for long ($D_{MRO\leq1.5}$)		-0.00682***		
		(0.00251)		
Low for long ($D_{Eonia\leq1.25}$)			-0.00649***	
			(0.00246)	
Low for long (Taylor rule)				-0.00508**
				(0.00241)
Bank FE	Yes	Yes	Yes	Yes
Number of observations	2974	2900	2900	2885
R^2	0.604	0.607	0.607	0.604

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period 2000Q1–2016Q4. "Low for long ($D_{MRO\leq1.5}$)" and "Low for long ($D_{Eonia\leq1.25}$)" are variables that count the number of consecutive quarters in which the MRO and EONIA rates are below 1.5% and 1.25%, respectively; "Low for long (Taylor rule)" is a variable that counts the number of consecutive quarters in which residuals of a forward-looking Taylor rule are negative. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

These results are broadly in line with the evidence reported by Claessens et al. (2017) for a large cross-section of banks covering several countries. However, the relatively small size of the coefficients of the low-for-long variables indicates that it would take a relatively long period of time for a monetary policy easing to exert a significant adverse effect on bank profitability. In addition, the materialisation of the negative consequences for bank profitability would be offset by the impact of low rates on real economic activity.

The stylised evidence on the impact of a protracted period of low interest rate on bank profitability is illustrated in Figure 3. Results obtained using our preferred specification based on Taylor rule residuals (Table 3, column 4) indicates that each additional year of low interest rates decreases bank profitability by about two basis points. The blue line in Figure 3 shows the cumulative impact on bank profitability of an additional year in a low interest rate environment assuming that the macroeconomic outlook and bank provisions remain unchanged. The estimate from column 4 of Table 3 implies that, after five years of low rates, the ROA of a median bank (which is equal to 0.4%) is reduced by 25% (crossing the solid red line in the figure). The negative impact on profitability obtained with the other two low-for-long measures (i.e. using a threshold of 1.25% for the EONIA and 1.5% for the MRO) in columns 2 and 3 is of similar magnitude. This evidence is akin to the mechanism described in Brunnermeier and Koby (2017) where the temporary positive effects on the repricing of the securities held by banks are over time increasingly offset by the negative impact on net interest margins.

Figure 3: Low-for-long, bank profitability and macroeconomic outlook



Notes: the chart illustrates the results of the estimates in column 4 of Table 3. The solid blue line indicates the impact on ROA of being in low-for-long and is constructed at unchanged macroeconomic outlook. The yellow line shows the change in ROA when although being in low-for-long, the macro outlook improves.

The estimated impact can, however, be substantially different when the endogenous reaction of the macro variables associated with the low interest rate environment is taken into account. This is illustrated by the yellow line in Figure 3: a 1pp increase in the expected GDP (associated with an increase in bank profitability of about 10 basis points) would shift the blue line outward thereby contributing to a significant delay in the materialisation of the negative consequences for bank profitability associated with a low-for-long environment. For the first five years the change in expected GDP more than offsets the negative impact on profitability linked to the low-for-long; it would then take about ten years (twice as long as in the previous case) to reduce the profitability of the median bank by 25%. Overall, the adverse impact of a protracted period of low rates on profitability is likely to be offset by the respective impact on loan loss provisions and intermediation volumes, a mechanism not envisaged in Brunnermeier and Koby (2017) and further explored in the next subsection.

3.3 Components of bank profitability

In order to empirically document the channels through which monetary policy actions are transmitted to bank profitability, the analysis presented in this section singles out the impact of changes in interest rates on the main components of profitability.

The impact on *net interest income* works via a price channel, i.e. the components of the net interest margin, and via a quantity channel, which is more closely related to the positive impact of the low interest environment on aggregated demand. The second component is *non-interest income*, driven mainly by capital gains, fees and commissions. This component plays a special role when QE policies are implemented as the impact on asset values in financial markets might generate sizeable capital gains. The third component is *provisions*. This is related to the macro effects of the policies and the associated impact on borrowers' credit quality.

Regression results derived from a panel model specification similar to the one used in equation 2 are reported in Table 4. The first three columns of the table present the results for the main components of bank profitability: net interest income (NII); non-interest income (NNI); and provisions (PROV); the last column recalls results for overall return on assets (ROA) as shown in column 4 of Table 2 above. All components are expressed as annualised percentage ratios of total assets.

The level of short-term interest rates is found to be positively associated with banks' net interest margins. This result, which is found also in other studies (e.g. English et al 2014 and Claessens et al 2017), is robust to controlling for expected macroeconomic conditions and credit risk. All else equal, a 100 basis point increase in the short-term rate is associated with an increase in banks' net interest margins of around 1 basis point in the same quarter. Taking into account the persistence of net interest margins (the estimated autoregressive coefficient is about 0.5), the overall impact of such a shock would be 2.5 basis points, which corresponds to around 7% of the mean of the net interest margin. Net interest margins are also found to be positively associated with economic growth. Conversely, low asset quality and high cost to income ratios tend to compress net interest margins.

Table 4: Profitability components and monetary policy

	(1) NII	(2) NNI	(3) PROV	(4) ROA
Y_{t-1}	0.533**	0.0260	0.0665	0.413***
	(0.1851)	(0.0353)	(0.0568)	(0.0584)
Short-term rate$_t$	0.0089**	-0.00817	0.0104*	0.00374
	(0.00409)	(0.0112)	(0.00595)	(0.0148)
Slope$_t$	0.000269	-0.00101	0.000666*	0.00161
	(0.000225)	(0.00129)	(0.000336)	(0.00151)
VIX$_t$	0.000549	-0.00153*	0.00239***	0.00266
	(0.000373)	(0.000845)	(0.000788)	(0.00183)
Real GDP growth$_t$	0.00248**	0.00703	0.000505	-0.000249
	(0.00114)	(0.00591)	(0.00201)	(0.0101)
Expected real GDP growth$_t$	0.00203	0.0312***	-0.0476***	0.107***
	(0.00349)	(0.00919)	(0.0128)	(0.0169)
Expected inflation$_t$	0.00150	0.00734	-0.0526**	0.112**
	(0.00822)	(0.0141)	(0.0210)	(0.0494)
Expected default frequency$_t$	-0.00287	-0.0217*	0.0335***	-0.0557**
	(0.00389)	(0.0123)	(0.0108)	(0.0261)
NPL ratio$_{t-1}$	-0.00413***	0.00351	0.00871***	-0.0108***
	(0.00138)	(0.00279)	(0.00243)	(0.00356)
Regulatory capital ratio$_{t-1}$	0.00177	-0.00372	-0.00495***	0.00581
	(0.00111)	(0.00513)	(0.00161)	(0.00385)
Cost-to-income ratio$_{t-1}$	-0.000488***	-0.000207	0.000317	-0.00251**
	(0.000154)	(0.000406)	(0.000424)	(0.00112)
Bank FE	YES	YES	YES	YES
Number of observations	2794	1758	2754	2974
R2	0.740	0.317	0.399	0.604

Note: Dependent variables: NII = net interest income as a percent of assets; NNI = non-interest income as a percent of assets; PROV= provisions; ROA = return on assets. Y_{t-1} denote the lagged dependent variables. Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Results for non-interest income are less clear-cut: no significant relationship is found with the level or slope of interest rates. The main determinants of non-interest income are changes in the valuation of securities held and fee and commission income. The first determinant in particular, should in principle benefit from a decline in interest rates, as lower yields are reflected in higher asset prices. It is however, important to note that while changes in the valuation of securities held by banks affect their economic value, they are reflected in the profit and loss account only if the securities are accounted at market values or if the capital gain/loss is realised. Since the share of securities held at market values is relatively small (see LHS panel of Figure A1.3) it is not surprising that the estimated coefficient is not statistically significant.

Costs associated with loan loss provisions increase (decrease) following an upward (downward) shift or a steepening (flattening) of the yield curve. As discussed in Section 2 above, this is likely to reflect the fact that lower interest rates allow for a decrease in borrowers' probability of default and in the associated loss given default. Importantly, provisions are significantly affected by expected developments in economic growth and default frequencies. A one standard deviation (or 1.02 percentage point) increase in expected GDP leads to a reduction in provisions of 5 basis points, which corresponds to around one third of the provisions observed at the mean. An analogous decrease in the expected default frequency (1 standard deviation or 1.28%) leads to a similar impact on provisions.

3.4 The role of maturity transformation

In this subsection, we explore the role played by maturity transformation in the relationship between monetary policy and bank profitability. We do so by augmenting the regression model expressed in equation 3 with a bank-specific measure of the difference between the average maturity of its assets and liabilities: the maturity gap (as defined in equation 1). This variable could play an important role in the transmission of changes in interest rates to bank profitability. For example, a positive sign on the interaction term between the slope of the yield curve and the maturity gap would mean that banks engaging more heavily in maturity transformation tend to benefit more in relative terms from a steepening of the term structure.

In order to obtain information on the average maturity of the different balance sheet items, we use bank data on income and balance sheet characteristics retrieved by matching data from S&P Global Market Intelligence (formerly known as SNL Financial) with the iBSI (individual Balance Sheet Information), a proprietary dataset on bank balance sheet information available at a monthly frequency and maintained at the ECB. Given data limitations, the empirical analysis focuses on the period running from mid-2007 to end-2016. Importantly, the sample of banks covered by the dataset is chosen so as to be representative of the overall banking sector, thereby reflecting different business models, size and other bank characteristics. Table 5 contains summary statistics for the variables used in the estimation.

Table 5: Descriptive statistics for the restricted dataset

	Mean	Std. Dev.	25th perc.	Median	75th perc.	# obs.
Financial variables						
Short-term rate	0.60	1.15	-0.03	0.16	0.60	3,566
Country-specific slope	0.74	13.63	1.17	1.72	2.19	3,566
VIX	23.41	8.39	18.89	20.88	25.60	3,494
Macroeconomic variables						
Real GDP growth	0.04	2.37	-1.31	0.62	1.55	3,294
Expected real GDP growth	0.94	1.05	0.43	1.21	1.69	3,494
Expected inflation	1.55	0.51	1.21	1.56	1.87	3,494
Expected default frequency	1.09	1.28	0.51	0.77	1.20	3,494
Bank variables						
Return on Assets	0.25	0.55	0.07	0.27	0.51	3,566
Net interest income	0.39	0.17	0.25	0.36	0.53	2,102
Non-interest income	0.23	0.13	0.13	0.23	0.32	2,087
Provisions	0.15	0.14	0.05	0.10	0.21	2,092
NPL ratio	5.75	4.50	2.54	4.48	7.46	2,297
Tier1 capital ratio	10.81	3.34	8.42	10.57	12.36	2,806
Cost-to-Income Ratio	61.51	15.37	50.78	61.04	71.41	3,143
Liquid asset ratio	30.49	16.26	18.24	26.84	38.03	2,402
Maturity gap	25.05	25.47	7.51	13.28	33.08	2,958

Notes: Data are at quarterly frequency covering the period Q4 2007-Q4 2016. Short-term rate is the three-month OIS, country-specific slope is the difference ten- and two-year sovereign yields, euro area slope is the difference between ten- and two-year OIS and sovereign spread is the difference between ten-year sovereign yields and the ten-year OIS. Expected real GDP growth is the one-year-ahead expectation obtained from Consensus Forecast.

Estimation results are reported in Table 6. Similarly to Table 2, results show that, by influencing either the short-term rate or the slope of the term structure, monetary policy is found to have a significant impact on bank profitability if no additional controls are included in the specification (column 1). Also in line with previous results, current and future macroeconomic developments remain important drivers of bank profitability, and adding macroeconomic controls reduces the statistical significance of the coefficients for the short-term rate and the slope (column 2 and 3).

In this shorter sample, which is more focused on the crisis period, bank-specific variables prove to be more relevant in breaking the correlation between monetary policy and bank profitability (column 4). The impact on profitability of the cost-to-income ratio and the NPL ratio has similar sign and magnitude to the coefficients obtained using the longer sample: low cost efficiency and high non-performing loans tend to compress bank profitability.

Table 6: Monetary policy and maturity transformation

	(1)	(2)	(3)	(4)	(5)
ROA_{t-1}	0.180***	0.143***	0.106***	0.0110	0.0894**
	(0.0319)	(0.0326)	(0.0325)	(0.0448)	(0.0403)
Short-term $rate_t$	0.0642***	0.0531***	0.0259*	0.0146	
	(0.0138)	(0.0139)	(0.0150)	(0.0237)	
$Slope_t$	0.00453***	0.00404***	0.000865	0.000820	
	(0.00123)	(0.00124)	(0.00153)	(0.00152)	
VIX_t		-0.00629***	0.00153	-0.00287	
		(0.00153)	(0.00172)	(0.00232)	
Real GDP $growth_t$		0.0286***	-0.0136**	-0.00504	
		(0.00648)	(0.00683)	(0.00719)	
Expected real GDP $growth_t$			0.136***	0.126***	
			(0.0220)	(0.0250)	
Expected $inflation_t$			0.0992***	0.0228	
			(0.0296)	(0.0550)	
Expected default $frequency_t$			-0.0744***	-0.0766*	
			(0.0248)	(0.0413)	
NPL $ratio_{t-1}$				-0.0305***	-0.0264**
				(0.00971)	(0.0103)
Regulatory capital $ratio_{t-1}$				-0.0113	0.00568
				(0.00858)	(0.0120)
Cost-to-income $ratio_{t-1}$				-0.00219**	-0.000971*
				(0.00107)	(0.000451)
Liquid asset $ratio_{t-1}$				-0.00617	-0.00163
				(0.00600)	(0.00507)
Maturity gap_{t-1}				0.00427***	0.00418*
				(0.00150)	(0.00216)
(Short-term $rate_t$) x (Maturity gap_{t-1})					0.000107
					(0.00159)
($Slope_t$) x (Maturity gap_{t-1})					0.000696**
					(0.000273)
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*time FE	No	No	No	No	Yes
Number of observations	2,388	2,271	2,271	845	817
R^2	0.428	0.433	0.476	0.465	0.646

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 234 banks for the period Q12007–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

The positive coefficient on the maturity gap reflects the idea that, all other things being equal, increased maturity transformation translates into higher profitability (see English et al., 2014). An average bank will see its ROA increase by 11 basis points by increasing its maturity gap by one standard deviation (i.e. 25 months).

Moreover, we investigate whether the impact of changes in the level and the slope of the term structure depend on the maturity gap. The results in column 5 show that the profitability of banks that engage more heavily in maturity transformation has a more positive reaction to a steepening of the yield curve in relative terms. A bank with a maturity gap that is one standard deviation above the sample average sees its profitability increase by two basis points in response to a 100 basis point steepening of the yield curve.

In principle, the impact of monetary policy action on bank profitability through maturity transformation would be mitigated if banks used derivatives to hedge exposures to interest rate risk. Recent evidence by Begenau et al. (2015), however, suggests that the extent to which US banks use interest rate derivatives to hedge exposures to interest rate is limited. For the euro area, Hoffmann et al. (2017) find that banks use derivatives to reduce their banking book exposures to interest rate risk by 25%, on average. This suggests that not accounting explicitly for hedging activities should not lead to a significant bias in our estimates.

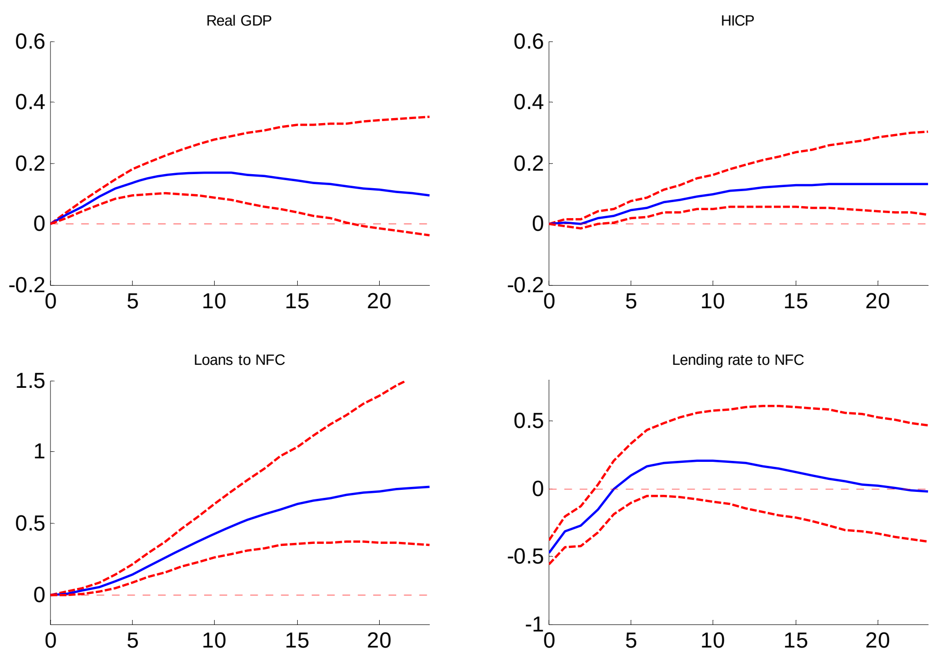
4 Evidence from a stylised macro model

This section focuses on the impact on bank profitability of a monetary policy easing through the lens of a dynamic model estimated at euro area level. The model is Bayesian vector-autoregression (BVAR) thought to capture the main channels through which monetary policy affect bank profitability. The variables included in the model are: return on assets (ROA), net interest income (NII), non-interest income (NNI), loan loss provisions (Provisions), lending rates to non-financial corporations (NFC), loan volumes to NFC, real GDP, HICP inflation, and interest rates with a remaining maturity of 1-day (i.e. the Eonia rate), 5-year, and 10-year. The variables enter the VAR in log-levels (or levels for variables already expressed in terms of rates) with 5 lags, for a sample period ranging from January 1999 to March 2017. For the estimation of the VAR, we address the curse of dimensionality problem by using Bayesian shrinkage, as suggested in De Mol et al. (2008). In more detail, we use Normal-Inverse Wishart prior distributions: we impose the so-called Minnesota prior, according to which each variable follows a random walk process, possibly with drift (Litterman, 1979). Moreover, we impose two sets of prior distributions on the sum of the coefficients of the VAR model: the "sum-of-coefficients" prior, originally proposed by Doan et al. (1984), and an additional prior that was introduced by Sims (1993), known as the "dummy-initial-observation" prior. The hyper-parameters controlling for the informativeness of the prior distributions are treated, as suggested in Giannone et al. (2015), as random variables and are drawn from their posterior distribution, so that we also account for the uncertainty surrounding the prior set-up in our evaluation.

In order to capture the impact of monetary policy in a low interest rate environment we simulate the response of the variables included in the model to a policy easing shock that resembles the effect of a quantitative easing (QE) policy on the term structure of interest rates, i.e. the effects are increasing in the remaining maturity of the underlying bonds (see Altavilla, Carboni, Motto, 2015). More precisely, the easing shock consists of a decrease in the 10-year yields of 100bps with a simultaneous smaller reduction on the 5-year and the Eonia amounting to 40 and 5 basis points, respectively. The shock is temporary and dies out over time with a decay that is assumed to be the same across maturities and fixed at 0.9.

Figure 4 shows the reaction of the macro variables to the policy shock.

Figure 4: Impact of a QE-type policy shock on macroeconomic outlook

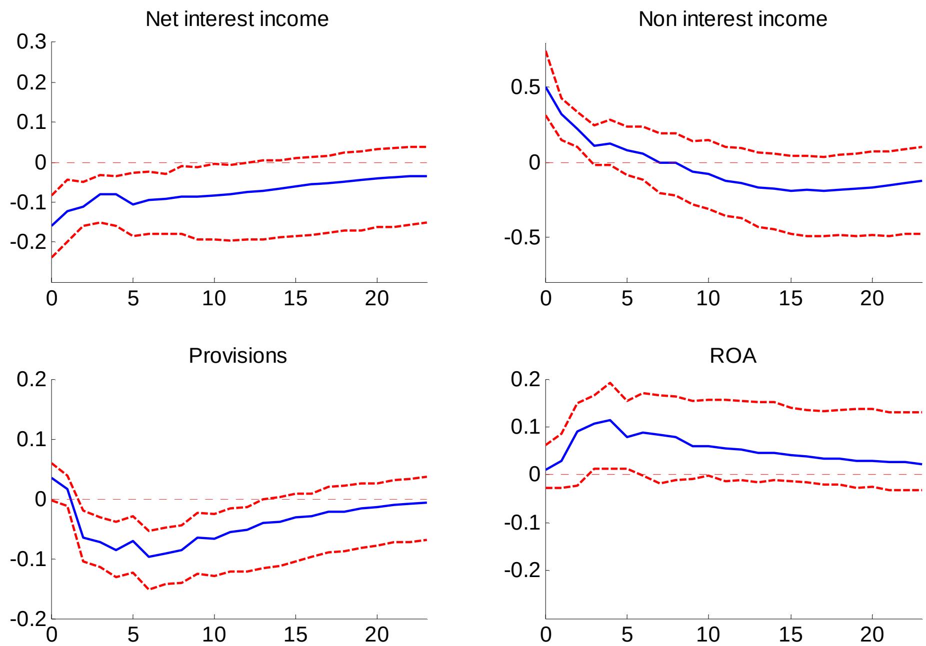


Notes: The horizontal axis refers to months after shock. The solid blue line represents the median response, while the dotted red lines refer, respectively, to the 16th – 84th percentile of the posterior distribution of the impulse-response functions.

Following an easing shock that flattens the term structure, real GDP, lending volumes and HICP inflation increases reflecting improved economic prospects associated with better financial conditions. The degree of accommodation is then pass-through to borrowing conditions thereby compressing lending rates to firms. These effects are all statistically significant.

Improvements in real economic activity as well as changes in the yield curve are transmitted to bank profitability and its components as illustrated in Figure 5. The reduction in interest rates on a large set of financial assets at different maturities is reflected in lower bank net interest income. A possible explanation for this reduction is that savings in funding costs do not fully offset lower interest income in the context of a flatter yield curve, as banks tend to fund longer-term assets with shorter-term liabilities, thereby engaging in maturity transformation. This is compounded by the fact that deposit rates tend to be particularly sticky at very low levels of interest rates. At the same time, non-interest income instead increases, possibly reflecting higher capital gains due to increases in the market value of sovereign bonds held by banks.

Figure 5: Impact of a QE-type policy shock on bank profitability



Notes: The horizontal axis refers to months after shock. The solid blue line represents the median response, while the dotted red lines refer, respectively, to the 16th – 84th percentile of the posterior distribution of the impulse-response functions.

In addition, the monetary policy shock has a delayed, significant, hump shaped effect on loan loss provisions. The estimated gradual decrease in provisions reaches the minimum after half a year indicating a lagged reaction of credit quality and intermediation volumes possibly linked to the feedback from improved economic outlook. In principle, this impact might be driven by two different channels. First, the pass-through to lending rates of the compression of yields on a large number of financial assets leads to a decrease in debt service costs for households and firms, in particular for variable-rate contracts. Second, improved borrower quality due to income and wealth effects following positive changes in the macro outlook reduce the probability of both firms and households defaulting on a loan (PD). At the same time, increased collateral values contribute a decrease in the losses incurred by banks when borrowers default on their loans (LGD). Finally, there is an effect that can work in the opposite direction. Compressed risk premia against the background of low interest rates imply that more projects become profitable. While this is an intended effect of the policy, if it is excessive, the increase in the risk inherent in new loans will lead to increased defaults in the medium to long run, especially for weaker banks (see Jimenez et al., 2007 – credit risk-taking channel). While we do not directly observe excessive risk taking by banks, the results suggest that overall this potential negative effect is, at worst, offset by the benefits described above.

Overall, the impact of monetary policy on bank profitability is found to be broadly neutral, and for most of the simulation horizon not statistically significant, reflecting the evidence that the effects on different components of bank profitability tend to largely offset each other.

5 Bank equity valuation and credit risk

In this section, the analysis moves from accounting measures of bank profitability to bank equity valuations that implicitly reflect market expectation of future profitability. Specifically, since bank equity prices reflect all the information currently available to stock market participants, they represent a forward-looking measure of profitability. The analysis provides empirical evidence on the reaction of bank-level stock returns to unexpected changes in the level and slope of the yield curve associated with the announcement of recent, non-standard monetary policy measures by the ECB. While equity prices are relevant for shareholders, bank equity in Europe has in general only accounted for around 5% of total assets, whereas the vast majority of bank activity if financed by debt. Therefore, in order to cover the impact of policies for major stakeholders of banks (including debtholders), the analysis also considers the reaction of the bank-credit risk (as summarised by the CDS) to these announcements. While stock returns and CDS tend to be highly correlated, the information they provide might differ substantially. Stock prices reflect the market value of banks, whereas CDS spreads measure market participants' perception of banks' credit risk. As such, the former is relevant for shareholders, while the latter is relevant for debtholders, ultimately including depositors.

We use high-frequency information at individual bank level on stock prices and CDS over the period from January 2007 to September 2016. The number of banks considered for each country and the representativeness of the sample are shown in Table 7.

Figure 6 depicts daily developments in bank stock prices (right panel) and CDS (left panel) over time for the cross-sectional distribution of banks available in the sample, as in a fan chart representation. The solid red line that goes through the areas is (for each day) the sample median.

The shaded areas comprise 95% of the cross-sectional distribution of banks around it: the interquartile range across banks is the darkest shade, and the next shade represents 68% of the distribution, and so on, until the 95% is covered. Three periods are clearly visible during the sample. The first one is related to the global financial crisis following the collapse of Lehman Brothers. After September 2007, CDS spreads started to widen and stock prices tumbled. The same dynamics, amplified even more, are observed during the sovereign debt crisis (2011-2012). Finally, there has been a further decline in stock prices and a slight deterioration in the market perception of bank risk over the 2015 and part of the 2016 that have significantly reverted in the last part of the sample.

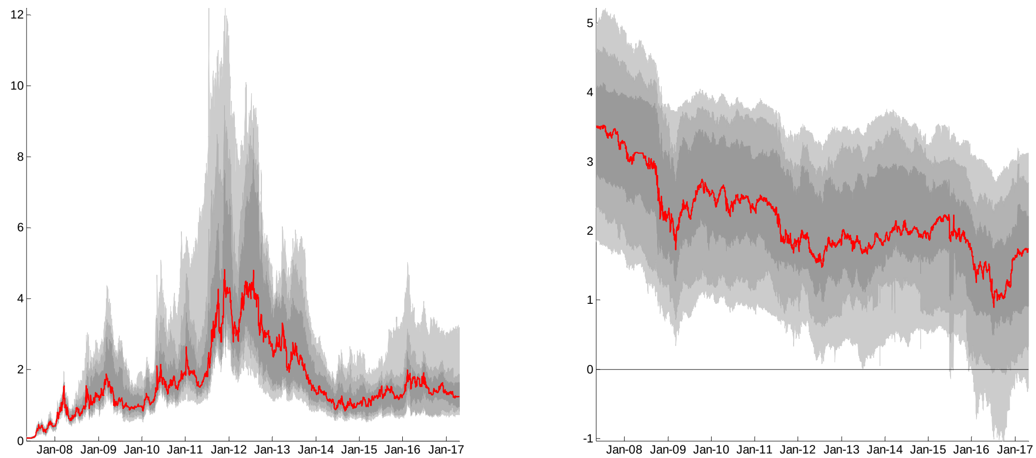
Table 7: Sample representativeness

Country	# banks		
	Stock	CDS	Stock & CDS
Austria	5	5	1
Belgium	2	3	2
Cyprus	2	0	0
Germany	6	9	2
Spain	8	8	6
Finland	1	0	0
France	4	7	4
Greece	4	4	4
Ireland	2	4	2
Italy	11	7	6
Luxembourg	0	1	0
Malta	2	0	0
Netherlands	4	5	4
Portugal	3	4	3
Total	54	57	34
Share of market cap (%)	96	93	93

Note: The table shows the number of bank by country for which we have information on stock prices (second column) and CDS (third column). The last column gives the number of banks for which we have information on both stock prices and CDS.

The observed developments make it particularly challenging to identify the effects of monetary policy due to endogeneity and simultaneity issues. Falling stock prices in response to lower interest rates (leading to a strong positive correlation between the two) could suggest that monetary easing compresses stock prices. The same reasoning applies to CDS. Of course, correlation is not causation, so movements in stock prices can only be interpreted as being due to policy action if monetary shocks are correctly identified. Being forward-looking, moreover, financial markets only tend to react to information about policy changes if these changes are unanticipated. Therefore, to correctly identify the impact of monetary policy, the unexpected component of the policy change must be isolated and confounding factors must be adequately controlled for.

Figure 6: Bank stock prices and CDS



Note: The chart shows the daily dispersion in bank stock prices (right panel) and CDS (left panel) for the sample of banks included in the analysis. The solid red line represents (for each day) the median of the cross-section of banks. Similarly, the shaded areas comprise the interquartile range, the 68% and the 95% of the cross-sectional distribution of banks.

For these reasons, we identify the effects of monetary policy announcements using high-frequency data in a conventional event study approach (see Bernanke and Kuttner, 2005). The idea is that changes in financial assets occurring in a small window around a given policy announcement capture the (efficient) market reaction to the arrival of new information, thereby reflecting the causal impact of the policy.[9] In our analysis, we concentrate on a one-day event window.[10] The regression model we estimate takes the following form:

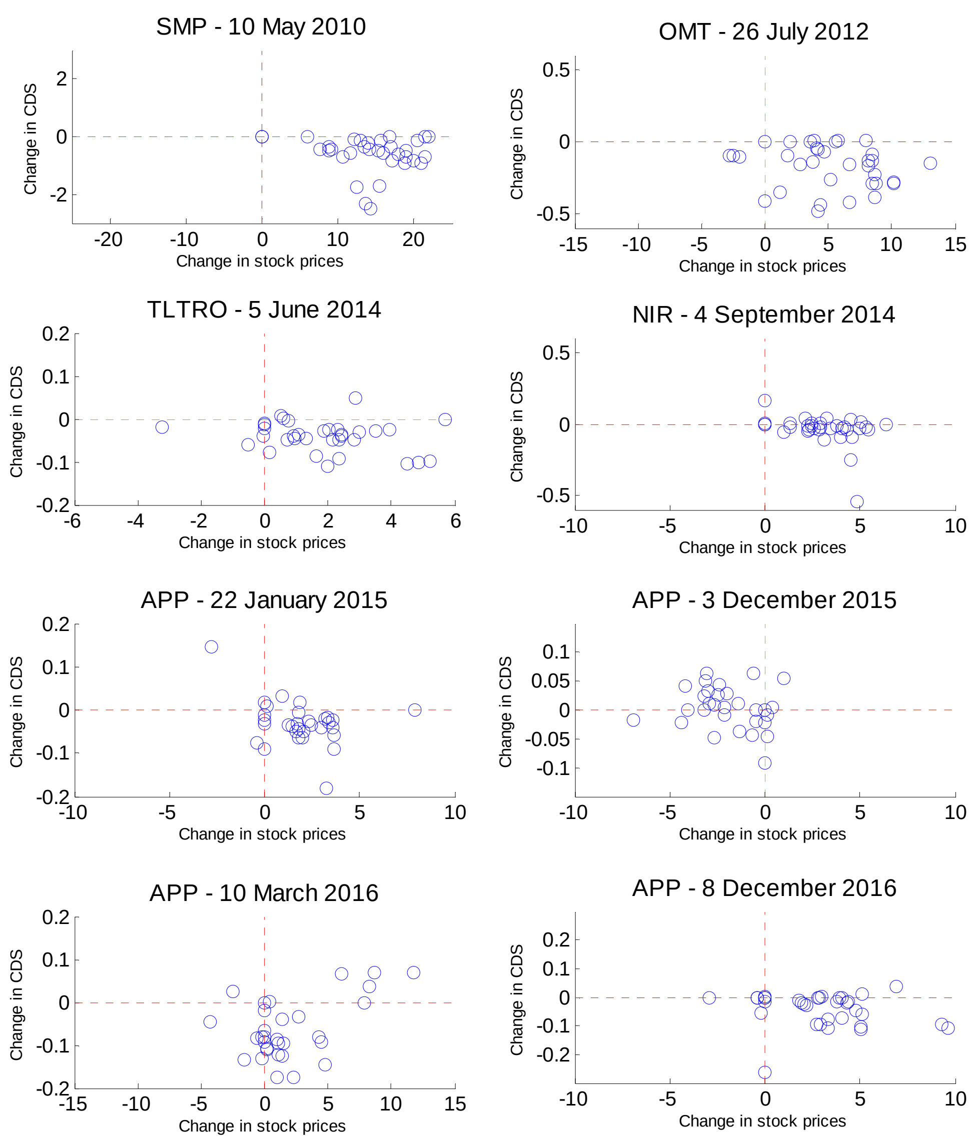
$$\Delta y_{i,t} = \sum_{j=1}^{k} \lambda_{i,j} D_{j,t} + \gamma_i News_t + \varepsilon_t \tag{4}$$

where t and i index days and individual banks, and the dependent variable ($\Delta y_{i,t}$) is the daily change in stock prices or CDS. $D_{j,t}$ denotes a set of event dummy variables, each taking the value 1 at the date of the policy announcement selected and 0 otherwise. The relevant set of events includes all calendar days when non-standard monetary policies were announced by the ECB.[11] $News_t$ is a vector including a set of (standardised) surprise components from releases of market-moving variables for both the euro area and the United States.[12]

[9] See Gürkaynak, Sack and Swanson (2005a), Altavilla and Giannone (2017) and Gürkaynak and Wright (2013).
[10] Expanding the event window to two days does not change the results.
[11] Appendix 3 lists the set of events selected.
[12] More specifically, the surprises are the difference between the data released during the event-window days and the consensus forecasts collected immediately beforehand. Data on the selected variables and the corresponding forecasts are from Bloomberg. See Altavilla and Giannone (2017) on the "controlled" event-study methodology.

The effect of the policy announcement for each event over a one-day window is measured by λ_j. Estimates are obtained by ordinary least squares, and statistical significance is assessed using heteroscedasticity-robust standard errors. The sample period is from the start of June 2007 to the end of September 2016. In order to highlight the impact of monetary policy announcements on both CDS and stock prices, we restrict the sample of banks considered in the analysis to those for which we have this information in both cases. The results are illustrated in Figure 7.

Figure 7: Change in stock price and CDS due to monetary policy



Note: Each figure corresponds to a monetary policy announcement. SMP is the Security Markets Programme; OMT is the Outright Monetary Transactions programme; VLTRO is the three-year, Very Long-Term Refinancing Operations; TLTRO is the Targeted Longer-Term Refinancing Operations; NIR is the Negative Interest Rate policy; APP is the Asset Purchase Programme.

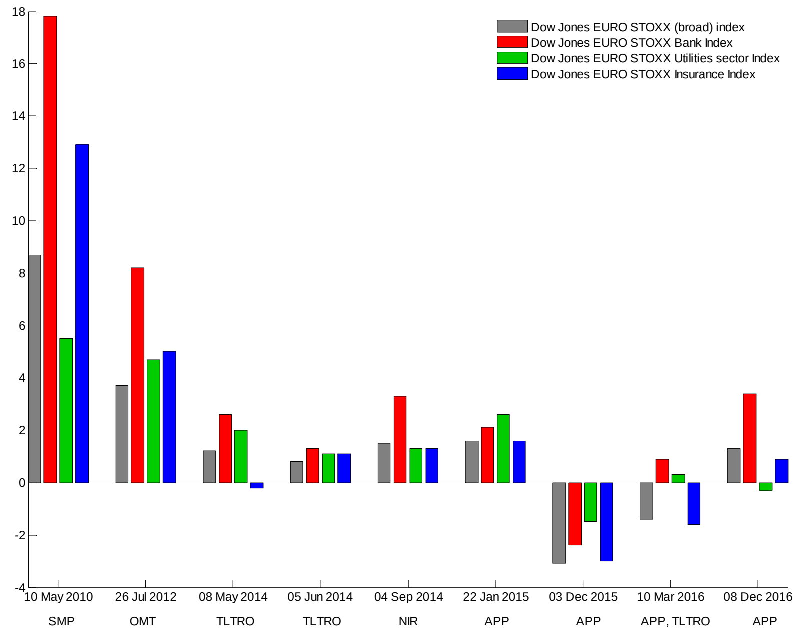
For each of the eight selected policy events and for each bank (denoted by a blue circle in the charts), the x-axis reports the change in stock prices while the y-axis reports the change in CDS spreads. The results are striking: for the vast majority of banks, stock prices increased and CDS spreads narrowed following all major monetary policy announcements.

This suggests that financial market participants reacted positively to the announcement of the new policies. The only exception is the announcement of the recalibration of the APP scheme in December 2015, which is associated with a fall in stock prices (second-to-last chart on the right of the figure). This is, however, easy to understand, as financial market participants interpreted the December policy decision as delivering lower-than-expected accommodation compared with what they had anticipated and factored into stock prices. The policy decision therefore elicited an opposite reaction in financial markets when announced. This announcement, however, is also characterised by a heterogeneous response of bank CDS.

In principle, there are different reasons why a monetary easing may lead to an increase in stock prices. First, financial markets might perceive that the looser policy may generate an increase in expected future dividends. Second, accommodative policy may be associated with a decline in the discount rate, being the future expected real interest rates used to discount the dividends. Third, the policy easing may compress the equity premium. In order to exclude the effect related to the discount factor, we repeat the same exercise for stock market indices of different industries. As the effect of the discount factor should affect all industries equally, the remaining differences should be attributed to changes in the equity premium associated with holding stocks or to the expected future dividends. Figure 8 shows that, although industry-based portfolios tend to react in a similar direction, the size of the response may vary substantially.

Overall, the index for the banking sector exhibits the largest response to most of the events. For utilities and insurance companies – which tend to be significantly less leveraged than banks – the effect of monetary policies is more muted. These results corroborate the previous evidence on the positive impact of non-standard measures on bank stock valuations (e.g. English et al., 2014).

Figure 8: Changes in stock price indices for different aggregates



Note: The figure shows the changes in selected stock price indices after non-standard monetary policy announcements.

Finally, we carry out an empirical analysis of the impact of recent announcements of non-standard measures on individual bank stock returns.[13] More specifically, we estimate the average reaction of bank stock returns to interest rate surprises using the following regression model:

$$\mathrm{r}_{i,j,t} = \phi_0 + \phi_1 Surprise_{Level,t} + \phi_2 Surprise_{Slope,j,t} + \Theta Controls_{i,j,\tau} + \eta_{i,j,t} \qquad (5)$$

where $\mathrm{r}_{i,j,t}$ denotes the one-day stock return of bank *i* operating in country *j* on the ECB Governing Council announcement date *t*; $Surprise_{Level,t}$ is the surprise component associated with the short-term interest rate (the 3-month OIS rate); while $Surprise_{Slope,j,t}$ is the slope surprise. The country-specific slope of the term structure corresponds to the difference between the sovereign yields with a remaining maturity of 10 and 2 years.

We also estimate a specification including a euro area slope (using the 10- and 2-year OIS yields) and each country sovereign spread relative to the 10-year OIS rate. In all cases, monetary policy surprises are derived from an event study using a 1-day window around policy announcements, also controlling for the surprise component of a large set of macroeconomic releases (as shown in equation 5). The vector $Controls_{i,j,t}$ comprises a set of indicators of bank balance sheet

[13] We concentrate on the policy announcements made since the onset of the financial crisis as listed in Table A.3.1.

characteristics as of the end of the year preceding each monetary policy announcement, indicated by τ.

Table 8: Bank stock returns and monetary policy surprises

	(1)	(2)	(3)	(4)
Short-term rate surprises	-13.40***		-15.93***	-15.64***
	(1.874)		(2.041)	(2.035)
Country-specific slope surprises		-2.458**	-3.807**	
		(1.164)	(1.526)	
Euro area slope surprises				4.761
				(3.178)
Sovereign spread surprises				-12.84***
				(1.802)
NPL ratio			-0.320***	-0.193***
			(0.0617)	(0.0610)
Regulatory capital ratio			0.0313	0.188*
			(0.0916)	(0.101)
Cost-to-income ratio			0.0161	0.00830
			(0.0163)	(0.0166)
Liquid asset ratio			-0.106	-0.0302
			(0.0695)	(0.0529)
Maturity gap			0.0998**	0.120***
			(0.0447)	(0.0428)
Bank FE	Yes	Yes	Yes	Yes
Number of observations	556	556	466	466
R^2	0.0672	0.0499	0.118	0.389

Note: Dependent variable in each regression is one-day bank stock return on the ECB Governing Council announcement date t. Surprises for short-term rates, country-specific slope, euro area slope, and sovereign spread are derived from an event study using a 1-day window around policy announcements, also controlling for the surprise component of a large set of macroeconomic releases. Bank-specific controls are measured as of the end of the year preceding each monetary policy announcement. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

The results reported in Table 8 indicate that monetary policy easing shocks, as measured by surprises on both the level (short-term rate) and (country-specific) slope of the yield curve, tend to have a positive impact on banks' market valuations. An unexpected decrease of ten basis points in the short-term rate – with no surprise change in the slope of the yield curve – causes the median bank's stock price to increase by about 1.5% (column 3); a shock to the country-specific slope of the yield curve of the same magnitude is estimated to increase the bank's stock price by about 0.4% (column 3).

Regarding the control variables, bank asset quality is negatively associated with bank stock return. A 1% increase in the NPL ratio translates into a 20-30 basis point decrease in bank stock returns on monetary policy announcement dates. Importantly, and in line with the analysis presented in the previous sections, stock returns are higher for banks engaging more in maturity transformation. An additional month of difference between the weighted average maturity of asset and liabilities increases the bank stock return by 0.1%.

6 Conclusions

In this paper, we have analysed the implications of alternative monetary policy actions on bank profitability and on market-based measures of bank shareholder value and bank risk. For empirical identification, we focus on the euro area, which provides an interesting case study as it includes substantial bank and country heterogeneity within a monetary union where a broad set of unconventional policies, including negative interest rates, credit and quantitative easing have been implemented. Moreover, we exploit proprietary ECB data on individual bank balance sheets since 2007, and data from commercial providers since the creation of the euro area. We have tackled our question by analysing different types of data – ranging from the daily frequency of the event study to the quarterly frequency of the bank balance sheet indicators – and over different sample periods. The results suggest some robust findings.

First, monetary policy easing, summarised as either a decrease in short-term interest rates or a flattening of the yield curve, is only associated with lower bank profits if there are no appropriate controls for the endogeneity of monetary policy to bank financial health – especially during the crisis period – as well as to current and expected aggregate economic and financial conditions.

Second, policy easing tends to be more beneficial in relative terms for more efficient banks and for banks with lower asset quality. At the same time, banks engaging more extensively in maturity transformation activities tend to have a more positive reaction to a steepening of the yield curve. Importantly, our analysis suggests that keeping interest rates low for long might have negative consequences for bank profitability. However, we find that it takes a long period of time for monetary policy to exert a substantial adverse effect on bank profitability as a result of looser policies. Furthermore, lower interest rates in general support real economic activity which, in turn, has a positive impact on bank profitability, thereby offsetting the adverse impact.

Third, evidence from both a panel data model that uses individual bank balance sheet data and a dynamic multivariate model that uses more aggregate data, suggest that following a monetary policy shock, the various components of bank profitability react asymmetrically. More specifically, since the impact on loan loss provisions largely offsets the one on net interest income, the overall effects of monetary policy on bank profitability are muted.

Finally, market-based expectations on future bank profitability are analysed looking at the high-frequency changes in bank stock returns around monetary policy announcement dates. Financial market evidence suggests that both bank debtholders and shareholders tend to be better off when the central bank announces new, accommodative monetary policy. This is important not only for financial stability and systemic risk but also for the possible distributional consequences that these policies may have on bank shareholders and debtholders, including depositors.

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Appendix 1 – Data

This appendix presents some additional data on bank balance sheets in greater detail.

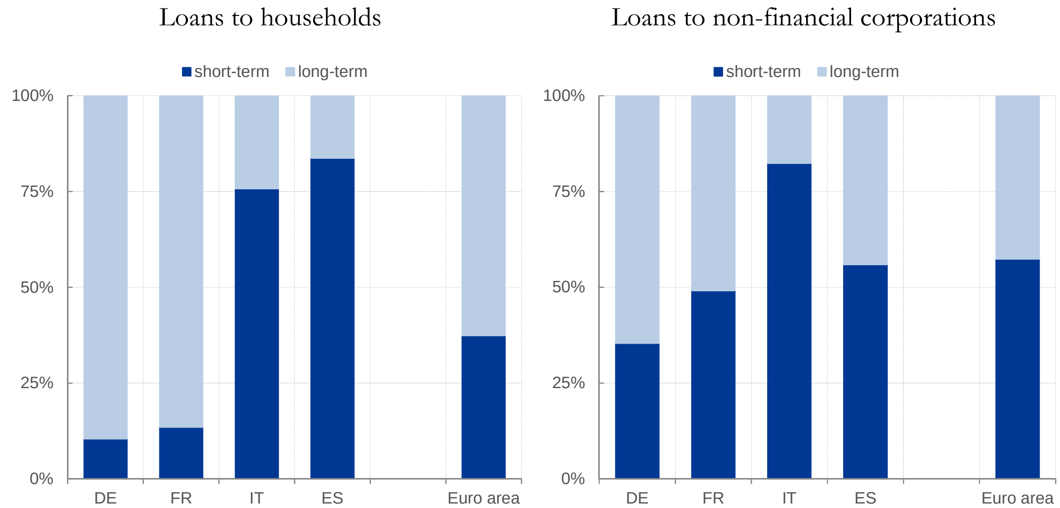
There is significant heterogeneity across countries in the loans that are set to reprice in the next 12 months. Short-term loans account for more than 75% of the total in Italy and Spain, and no more than 15% in Germany and France. For the euro area, the share of loans that are set to reprice in the next 12 months is lower, at just below 40%. For non-financial corporations, more than half of the stock of loans is set to reprice in the next 12 months, also reflecting the significant role of overdrafts. The share of short-term non-financial corporation loans is also relatively smaller in Germany and France than in Italy and Spain, even though the difference is less pronounced than for household loans (see Figure A1.1).

The importance of the impact of monetary policy action on bank profitability from capital gains depends on the structure of bank balance sheets. Monetary policy easing leads to an increase in the market value of debt securities and equity and, as holders of these securities, banks benefit from the associated capital gains. As shown in Figure A1.2, a significant share of euro area bank assets consists of securities and, in particular, government bonds.

The assessment of monetary policy-related capital gains depends not only on the class of security (i.e. equity/debt securities and corporate/government bonds) but also on the maturity and accounting portfolio of securities held by banks (see Figure A1.3). For the same change in yield, changes in valuation are higher the longer the maturity. Moreover, while changes in the valuation of securities carried at market value have a direct impact on the profit and loss account, securities included in the other accounting portfolios only generate capital gains if they are sold.

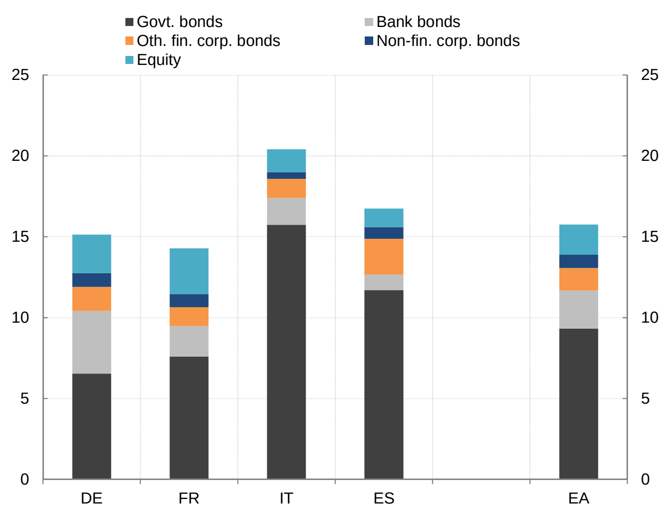
Figure A1.4 illustrates the measures of low-for-long used in Table 3. The left panel shows the distribution of the low-for-long measure obtained by counting the number of consecutive quarters in which residuals of a forward-looking Taylor rule are negative. The right panel reports two alternative measures of low-for-long obtained by counting the number of consecutive quarters in which the MRO and EONIA rates are below 1.5% and 1.25%, respectively.

Figure A1.1: Breakdown of loans by original maturity or time to interest rate reset (percentages)



Note: Breakdown as of December 2016. Based on outstanding amounts of loan volumes. Short-term refers to loans with original maturity up to one year and overdrafts plus loans with a remaining maturity over one year and interest rate reset within the next 12 months.

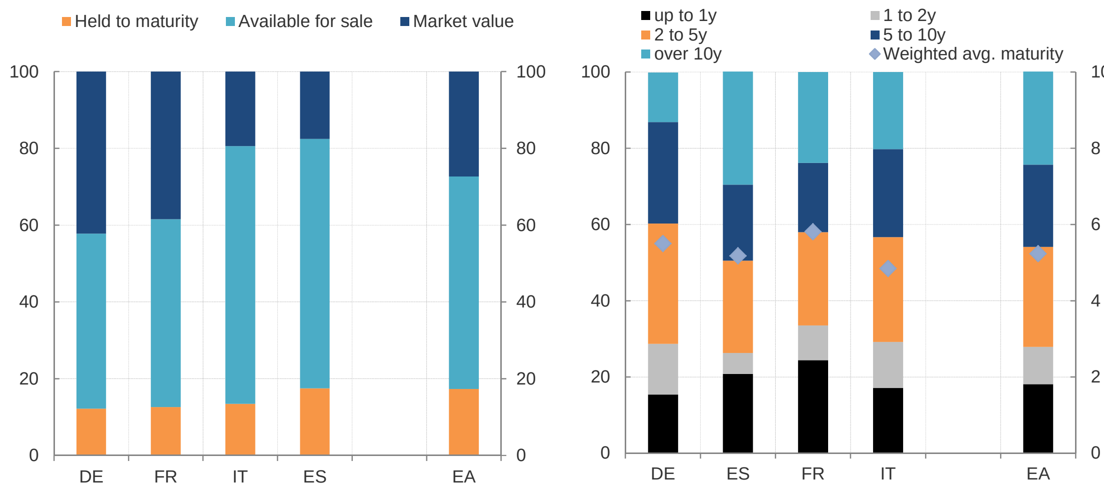
Figure A1.2: Breakdown of securities held, as a percentage of total assets



Note: Data on a consolidated basis for 339 euro area banking groups as of September 2016.

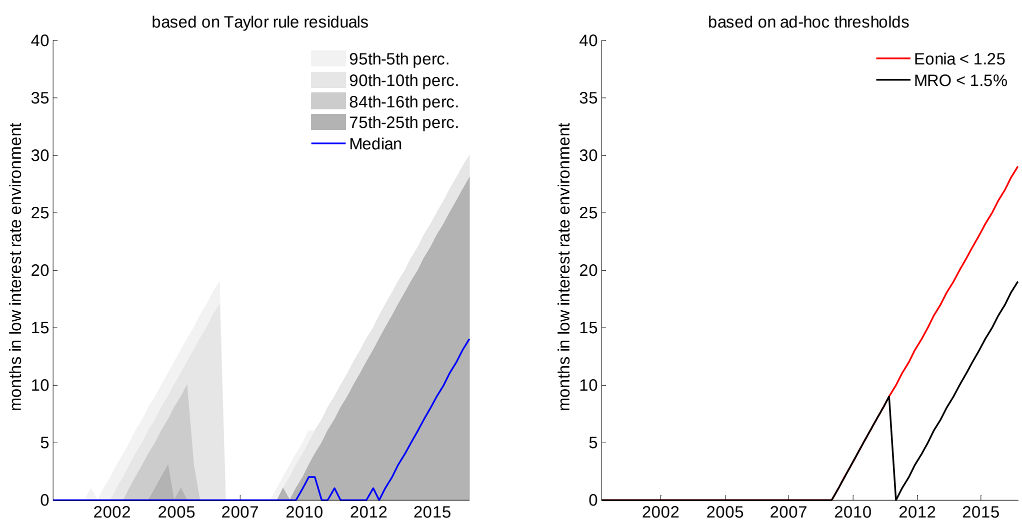
Figure A1.3: Characteristics of securities held by euro area banks, on a consolidated basis

Distribution by accounting portfolio — Distribution by residual maturity



Notes: Data on a consolidated basis for 339 euro area banking groups as of September 2016.

Figure A1.4: Measures of low for long



Note: the chart shows the measures of low-for-long used in Table 3. The left panel illustrated the distribution of the low-for-long measure obtained by counting the number of consecutive quarters in which residuals of a forward-looking Taylor rule are negative. The right panel reports two alternative measures of low-for-long obtained by counting the number of consecutive quarters in which the MRO and EONIA rates are below 1.5% and 1.25%, respectively.

Appendix 2 – Robustness

This appendix presents additional analysis carried out to check the robustness of the results presented in the main part of the paper.

Tables A2.1 and A2.2 replicate the results reported in Table 2 and Table 6, respectively, constraining the sample used in the estimation to be constant across all specifications. The results show that differences in the estimates across specifications are indeed driven by the additional information included in the model via controls variables and not by differences in the number of observations, which reflects differences in data availability across variables.

Table A2.3 shows that the results in Table 6 are robust to the use of the sample of banks defined in Table 2.

In the analysis presented in the main text, the slope of the yield curve is obtained by using the country-specific sovereign yield curve:, a bank faces a different yield curve constellation depending on the country where it operates. In order to test whether the results change when all the banks face a similar yield curve, we derive the slope of the term structure from the OIS rates (Table A2.4). Specifically, in order to test whether it is indeed the euro area yield curve that matters for bank profitability, we compare the results obtained from the baseline specification (column 1 in Table A2.4) with those obtained using the slope derived from the OIS curve (column 2, denoted with "euro area slope"). The coefficient is not significant. Finally, we check the importance of the sovereign spread (column 3) and find a negative and statistically significant coefficient: a reduction in the difference between the sovereign yields and the OIS rate at 10-year maturity is associated with an increase in profitability.

In addition, we show below that the results reported in the paper are robust to the omission of the fixed effects (Table A2.5) and to GMM estimation (Table A2.6).

Finally, Table A2.7 replicates the analysis on the profitability components reported in Table 4 for the shorter sample. Comparing the two tables indicates that when focusing on a shorter sample period the results obtained in the main text of the paper remain unchanged.

Table A2.1: Robustness – keeping a fixed number of observations

	(1)	(2)	(3)	(4)
ROA_{t-1}	0.520***	0.458***	0.413***	0.451***
	(0.0554)	(0.0571)	(0.0584)	(0.129)
Short-term $rate_t$	0.0575***	0.00430	0.00374	
	(0.0111)	(0.0134)	(0.0148)	
$Slope_t$	0.00463***	0.00130	0.00161	
	(0.00164)	(0.00129)	(0.00151)	
VIX_t		0.00291*	0.00266	
		(0.00166)	(0.00183)	
Real GDP $growth_t$		-0.00469	-0.000249	
		(0.00995)	(0.0101)	
Expected real GDP $growth_t$		0.104***	0.107***	
		(0.0173)	(0.0169)	
Expected $inflation_t$		0.138***	0.112**	
		(0.0446)	(0.0494)	
Expected default $frequency_t$		-0.0647**	-0.0557**	
		(0.0269)	(0.0261)	
NPL $ratio_{t-1}$			-0.0108***	0.00112
			(0.00356)	(0.0144)
Regulatory capital $ratio_{t-1}$			0.00581	0.0195**
			(0.00385)	(0.00791)
Cost-to-income $ratio_{t-1}$			-0.00251**	0.00104
			(0.00112)	(0.00292)
(Short-term $rate_t$) x (NPL $ratio_{t-1}$)				0.00559
				(0.00653)
($Slope_t$) x (NPL $ratio_{t-1}$)				-0.00232***
				(0.000385)
(Short-term $rate_t$) x (Cost-to-income $ratio_{t-1}$)				0.00233*
				(0.00133)
($Slope_t$) x (Cost-to-income $ratio_{t-1}$)				0.000266***
				(0.0000743)
Bank FE	Yes	Yes	Yes	Yes
Country*time FE	No	No	No	Yes
Number of observations	2974	2974	2974	2883
R^2	0.574	0.600	0.604	0.770

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.2: Robustness – keeping a fixed number of observations

	(1)	(2)	(3)	(4)	(5)
ROA_{t-1}	0.0934**	0.0876**	0.0680*	0.0110	0.0894**
	(0.0390)	(0.0388)	(0.0399)	(0.0448)	(0.0403)
Short-term $rate_t$	0.0667**	0.0688**	0.0546*	0.0146	
	(0.0310)	(0.0303)	(0.0325)	(0.0237)	
$Slope_t$	0.00430***	0.00415***	0.00119	0.000820	
	(0.00125)	(0.00126)	(0.00168)	(0.00152)	
VIX_t		-0.00382	0.00256	-0.00287	
		(0.00233)	(0.00227)	(0.00232)	
Real GDP $growth_t$		0.0170**	-0.0206***	-0.00504	
		(0.00707)	(0.00751)	(0.00719)	
Expected real GDP $growth_t$			0.125***	0.126***	
			(0.0262)	(0.0250)	
Expected $inflation_t$			0.0884	0.0228	
			(0.0589)	(0.0550)	
Expected default $frequency_t$			-0.0900**	-0.0766*	
			(0.0403)	(0.0413)	
NPL $ratio_{t-1}$				-0.0305***	-0.0264**
				(0.00971)	(0.0103)
Regulatory capital $ratio_{t-1}$				-0.0113	0.00568
				(0.00858)	(0.0120)
Cost-to-income $ratio_{t-1}$				-0.00219	-0.000971
				(0.00217)	(0.00181)
Liquid asset $ratio_{t-1}$				-0.00617	-0.00163
				(0.00600)	(0.00507)
Maturity gap_{t-1}				0.00427***	0.00418*
				(0.00150)	(0.00216)
(Short-term $rate_t$) x (Maturity gap_{t-1})					0.000107
					(0.00159)
($Slope_t$) x (Maturity gap_{t-1})					0.000296*
					(0.000173)
Bank FE	Yes	Yes	Yes	Yes	Yes
Country*time FE	No	No	No	No	Yes
Number of observations	845	845	845	845	817
R^2	0.398	0.405	0.441	0.465	0.646

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 234 banks for the period Q1 2007–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.3: Results since Q4 2007 using the larger sample

	(1)	(2)	(3)	(4)
ROA_{t-1}	0.533***	0.456***	0.389***	0.411***
	(0.0414)	(0.0502)	(0.0624)	(0.119)
Short-term $rate_t$	0.0146*	-0.0127	-0.00604	
	(0.00746)	(0.00990)	(0.0153)	
$Slope_t$	0.00286**	0.000676	0.00175	
	(0.00136)	(0.00142)	(0.00150)	
VIX_t		0.00503***	0.00434**	
		(0.00129)	(0.00203)	
Real GDP $growth_t$		-0.00677	-0.00122	
		(0.00618)	(0.0111)	
Expected real GDP $growth_t$		0.0868***	0.106***	
		(0.0140)	(0.0207)	
Expected $inflation_t$		0.0956***	0.110**	
		(0.0368)	(0.0520)	
Expected default $frequency_t$		-0.0575**	-0.0501*	
		(0.0253)	(0.0279)	
NPL $ratio_{t-1}$			-0.0102***	-0.0164
			(0.00376)	(0.0124)
Regulatory capital $ratio_{t-1}$			0.00670*	0.0202***
			(0.00402)	(0.00704)
Cost-to-income $ratio_{t-1}$			-0.00256**	0.000265
			(0.00115)	(0.00247)
(Short-term $rate_t$) x (NPL $ratio_{t-1}$)				-0.000113
				(0.00448)
($Slope_t$) x (NPL $ratio_{t-1}$)				-0.00245***
				(0.000398)
(Short-term $rate_t$) x (Cost-to-income $ratio_{t-1}$)				0.00184*
				(0.00103)
($Slope_t$) x (Cost-to-income $ratio_{t-1}$)				0.000293***
				(0.0000829)
Bank FE	Yes	Yes	Yes	Yes
Country*time FE	No	No	No	Yes
Number of observations	5769	5489	2779	2850
R^2	0.652	0.669	0.585	0.775

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2007–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.4: Country-specific and euro area slope

	(1)	(2)	(3)
ROA_{t-1}	0.420***	0.423***	0.407***
	(0.0593)	(0.0575)	(0.0609)
Short-term $rate_t$	0.00811	0.00655	0.0176
	(0.0150)	(0.0158)	(0.0139)
Country-specific $slope_t$	0.00135		
	(0.00152)		
Euro area $slope_t$		0.00841	0.0122
		(0.0258)	(0.0257)
Sovereign $spread_t$			-0.0547***
			(0.0179)
VIX_t	0.00297	0.00304	0.0000494
	(0.00186)	(0.00200)	(0.00151)
Real GDP $growth_t$	-0.000777	-0.000615	0.00185
	(0.0103)	(0.0108)	(0.0106)
Expected real GDP $growth_t$	0.0991***	0.0968***	0.0666***
	(0.0170)	(0.0179)	(0.0209)
Expected $inflation_t$	0.110**	0.115**	0.108**
	(0.0493)	(0.0501)	(0.0427)
Expected default $frequency_t$	-0.0572**	-0.0688**	0.00699
	(0.0286)	(0.0338)	(0.0215)
NPL $ratio_{t-1}$	-0.00797*	-0.00756*	-0.00771**
	(0.00411)	(0.00403)	(0.00381)
Regulatory capital $ratio_{t-1}$	0.00500	0.00490	0.00668*
	(0.00368)	(0.00380)	(0.00351)
Cost-to-income $ratio_{t-1}$	-0.00251**	-0.00248**	-0.00235**
	(0.00112)	(0.00110)	(0.00108)
Bank FE	Yes	Yes	Yes
Number of observations	2966	2966	2966
R^2	0.610	0.609	0.616

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.5: Results without bank fixed effects

	(1)	(2)	(3)	(4)
ROA_{t-1}	0.802***	0.785***	0.617***	0.619***
	(0.0268)	(0.0331)	(0.0496)	(0.142)
Short-term $rate_t$	0.00968**	-0.00830*	-0.0162	
	(0.00472)	(0.00498)	(0.0139)	
$Slope_t$	0.00171*	-0.000139	0.00174	
	(0.000897)	(0.00123)	(0.00130)	
VIX_t		0.000175	-0.000480	
		(0.000769)	(0.00129)	
Real GDP $growth_t$		-0.00436*	-0.00233	
		(0.00262)	(0.00628)	
Expected real GDP $growth_t$		0.0477***	0.0761***	
		(0.00955)	(0.0170)	
Expected $inflation_t$		0.0358	0.0835**	
		(0.0224)	(0.0369)	
Expected default $frequency_t$		-0.0266***	-0.0204	
		(0.0102)	(0.0129)	
NPL $ratio_{t-1}$			-0.00765***	-0.0484***
			(0.00199)	(0.0162)
Regulatory capital $ratio_{t-1}$			-0.0000854	0.00568*
			(0.00180)	(0.00308)
Cost-to-income $ratio_{t-1}$			-0.00290***	-0.00190
			(0.000847)	(0.00212)
(Short-term $rate_t$) x (NPL $ratio_{t-1}$)				-0.0198**
				(0.00837)
($Slope_t$) x (NPL $ratio_{t-1}$)				-0.00134***
				(0.000190)
(Short-term $rate_t$) x (Cost-to-income $ratio_{t-1}$)				0.000994
				(0.00105)
($Slope_t$) x (Cost-to-income $ratio_{t-1}$)				0.000122**
				(0.0000496)
Bank FE	No	No	No	No
Country*time FE	No	No	No	Yes
Number of observations	7,103	6,777	3,031	3,004
R^2	0.636	0.638	0.573	0.750

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. The constant is omitted in columns 1-3. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.6: Results of GMM estimation

	(1)	(2)	(3)	(4)
ROA_{t-1}	0.588***	0.573***	0.513***	0.461***
	(0.0625)	(0.0544)	(0.0619)	(0.0895)
Short-term $rate_t$	0.0289***	0.0169*	0.0127	0.0295
	(0.00846)	(0.00960)	(0.0102)	(0.0269)
$Slope_t$	0.00456**	0.00422**	0.00306	0.000443
	(0.00193)	(0.00200)	(0.00268)	(0.00129)
VIX_t		-0.00319***	0.00104	0.00415*
		(0.000834)	(0.00138)	(0.00229)
Real GDP $growth_t$		0.0211***	-0.00776	-0.00164
		(0.00735)	(0.00605)	(0.00965)
Expected real GDP $growth_t$			0.0738***	0.0501***
			(0.0162)	(0.0178)
Expected $inflation_t$			0.0374	0.0713
			(0.0355)	(0.0433)
Expected default $frequency_t$			-0.0288	-0.0530**
			(0.0222)	(0.0211)
NPL $ratio_{t-1}$				-0.0207**
				(0.0100)
Regulatory capital $ratio_{t-1}$				0.0215
				(0.0136)
Cost-to-income $ratio_{t-1}$				-0.0105**
				(0.00509)
Number of observations	7,103	6,777	3,031	3,004

Note: The dependent variable is the return on assets (ROA). Data are at quarterly frequency covering an unbalanced sample of 288 banks for the period Q1 2000–Q4 2016. The constant is omitted. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01.

Table A2.7: profitability components

	(1) NII	(2) NNI	(3) PROV	(4) ROA
Lagged dependent	0.669***	0.199***	0.0410	0.0110
	(0.0582)	(0.0543)	(0.0464)	(0.0448)
Short-term rate$_t$	0.00946***	0.000524	0.00945	0.0146
	(0.00323)	(0.00744)	(0.00602)	(0.0237)
Slope$_t$	-0.000117	0.000187	0.000753***	0.000820
	(0.0000827)	(0.000296)	(0.000281)	(0.00152)
VIX$_t$	-0.0000289	-0.00173**	-0.00181**	-0.00287
	(0.000238)	(0.000696)	(0.000764)	(0.00232)
Real GDP growth$_t$	0.00232***	-0.00185	-0.000782	-0.00504
	(0.000732)	(0.00185)	(0.00173)	(0.00719)
Expected real GDP growth$_t$	-0.00166	-0.00312	-0.0328***	0.126***
	(0.00210)	(0.00523)	(0.00545)	(0.0250)
Expected inflation$_t$	-0.0119***	-0.0250***	-0.0379***	0.0228
	(0.00310)	(0.00910)	(0.0141)	(0.0550)
Expected default frequency$_t$	0.000181	-0.00865	0.0261***	-0.0766*
	(0.00272)	(0.00977)	(0.00966)	(0.0413)
Maturity gap$_{t-1}$	0.000738**	0.000838*	0.000273	0.00427***
	(0.000284)	(0.000453)	(0.000304)	(0.00150)
NPL ratio$_{t-1}$	-0.00217***	0.00193	0.00635***	-0.0305***
	(0.000794)	(0.00226)	(0.00189)	(0.00971)
Regulatory capital ratio$_{t-1}$	-0.000973	-0.00343	-0.000506	-0.0113
	(0.00100)	(0.00212)	(0.00227)	(0.00858)
Cost-to-income ratio$_{t-1}$	-0.000296**	0.000456	-0.000795***	-0.00219
	(0.000128)	(0.000353)	(0.000285)	(0.00217)
Liquid asset ratio$_{t-1}$	-0.00111***	-0.00199**	-0.00235**	-0.00617
	(0.000383)	(0.000989)	(0.00106)	(0.00600)
Bank FE	YES	YES	YES	YES
Number of observations	757	751	758	845
R2	0.956	0.670	0.623	0.465

Note: Dependent variables: NII = net interest income as a percent of assets; NNI = non-interest income as a percent of assets; PROV= provisions; ROA = return on assets. Y_{t-1} denotes the lagged dependent variable.. Data are at quarterly frequency covering an unbalanced sample of 234 banks for the period Q12007–Q4 2016. Standard errors clustered at bank level in parentheses: * p<.1, ** p<.05, *** p<.01

Appendix 3 – Non-standard measures

Since the onset of the financial crisis, the European Central Bank has reacted by announcing and implementing a series of non-standard monetary policy measures. The table below presents the main announcements used in the analysis.

Table A.3.1 Non-standard monetary policies

Date	Type	Announcement
26/07/2012	OMT	"Whatever it takes" speech by ECB President Mario Draghi in London
02/08/2012	OMT	Outright Monetary Transactions programme (OMT)
06/09/2012	OMT	Technical features of OMT
08/05/2014	TLTRO	President of the ECB explicitly stated during the press conference that the Governing Council was willing to act in the following month
05/06/2014	TLTRO, NIR	Targeted longer-term refinancing operations (TLTROs); DFR=-10bps (10bps cut)
03/07/2014	TLTRO	Announcement of TLTROs
04/09/2014	ABSPP , CBPP3 , NIR, APP	Announcement of ABSPP, CBPP3; DFR=-20bps (10bps cut)
22/01/2015	APP	Announcement of APP1 (combined monthly purchases of €60 billion (CBPP, ABSPP, PSPP). Intended purchases: €1.14 trillion (The Governing Council also decided to modify the interest rate applicable to future TLTRO eliminating the 10bps spread over the MRO)
05/03/2015	APP	APP details
09/03/2015	APP	APP first operation
03/12/2015	APP, NIR	APP extended until March 2017, reinvestment of principal payments, inclusion of debt instruments issued by regional and local governments; DFR=-30bps (10bps cut, MRO and MLF unchanged)
04/12/2015	APP speech	Speech by ECB President Mario Draghi, Economic Club of New York, 4 December 2015
10/03/2016	APP, TLTRO, CSPP, NIR	APP (monthly purchases expanded to €80 billion), TLTRO2, CBPSPP investment-grade euro-denominated bonds issued by non-bank corporations); DFR=-40bps (10bps cut)
08/12/2016	APP	APP extended until December 2017; €60bn, DFR floor constraint dropped

Note: CBPP=Covered Bond Purchase Programme; OMT=Outright Monetary Transactions programme; TLTRO=Targeted Longer-Term Refinancing Operations; NIR=Negative Interest Rate policy; APP=Asset Purchase Programme. CSPP= Corporate Sector Purchase Programme.