Determinants of bank's interest margin in the aftermath of the crisis: the effect of interest rates and the yield curve slope*

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Abstract

This paper analyses the determinants of net interest margin, focusing on the impact of interest rates and the slope of the yield curve, using a broad panel of data from 32 countries over the period 2008-14, starting at the outbreak of the crisis. The results show that the expansionary monetary policy measures adopted by numerous central banks to combat the crisis have had a negative impact on net interest margins both via the reduction in interest rates and – less powerfully – the flattening of the yield curve. Given that the relationship between net interest income and interest rates/slope of the yield curve is concave, a potential normalisation of monetary policy would have highly beneficial effects on restoring margins. By the same token, further monetary policy interest rates cuts will erode banks' margins and, therefore, profitability.

Keywords: bank interest margin, yield curve, interest rates

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1. Introduction

In recent years, the effect of the extended period of low – or even negative – interest rates on banks' profitability has been a topic of discussion and a cause for concern. Indeed, both the International Monetary Fund (IMF), 2016a, in its *Global Financial Stability Report*, and the European Central Bank (ECB), 2016, in its *Annual Report*, have explored this issue, although their viewpoints diverge somewhat.

The IMF points to both the positive and negative effects of unconventional monetary policy on the banking sector. On the positive side, improved borrower solvency driven by economic growth reduces banks' default rates and so their need for provisions. It also produces capital gains through asset valuations when interest rates fall. Finally, the cost of financing initially falls faster than interest rates on loans, which improves financial margins.

However, on the negative side, as interest rates drop to zero and enter negative territory, financial margins narrow, and it becomes difficult to pass on the drop in interest rates to the interest on deposits. Moreover, the potential for capital gains on asset values becomes very small when there is little room for further cuts. Moreover, the bigger the proportion of variable interest rate loans, the bigger the negative impact on profitability, as the benchmark interest rate has fallen more than the banks' cost of funding. Similarly, a large share of funding from deposits has a negative impact on margins when rates are very low, as it is difficult to pass on the drop in interest rates to these deposits.

The IMF's position is that it is difficult to estimate the net impact of falling interest rates on bank profitability a priori and that it depends on factors such as banks' ability to pass on cuts in interest rates to both lending and borrowing rates, the relative importance of net interest margins in total revenues, and the potential to generate other forms of income. The IMF's estimates show significant differences between countries in terms of these factors. The negative impact is bigger the larger the volume of variable rate loans and the importance of deposits (particularly term deposits) as a source of funding. In the particular case of the Euro Area, the recent analysis of the IMF (2016b) shows that until now the reduction of interest rates has had an overall positive impact on bank profitability, supporting easier financial conditions and contributing to a modest expansion in credit. But looking ahead, further rates cuts will lower bank profitability.

The ECB highlights instead the positive effects of the recovery in credit. Although it mentions the negative impact of the flattening of the yield curve (a smaller difference between the interest rate on long-term assets and the rate at which short-term liabilities are issued) and the penalty of negative interest rates on the marginal lending facility (which has reached -0.4%), the ECB emphasizes the positive impact of better quality bank assets

(with the consequent reduced need for provisions), capital gains on these assets, and the reactivation of credit demand. The ECB justifies the net positive effect on the basis of the opinions of banks that stated that profitability increased in the months after the main non-conventional measures (such as the expanded debt purchase programme).

In this context, this paper focuses on one of the routes whereby changes in benchmark interest rates in money markets affect profitability, namely through the net interest margin. To do so, we take as our reference the models explaining this margin, and emphasise both interest rate levels and the effect of the yield curve on net interest margin.

To date, only a handful of papers have offered empirical evidence of the effect that an extended period of low interest rates and flattening of the yield curve (two consequences of expansionary monetary policy) can have on interest margins. Central banks adopted expansionary monetary policy to address the financial crisis that began in 2007, making this a subject of particular interest today in view of its effects on financial margins (and consequently on profitability). The latest papers by Alessandri and Nelson (2015), Borio et al. (2015), Entrop et al. (2015) and Claessens et al. (2016) incorporate data covering the post-2007 period and they obtain strong evidence of the negative impact of low interest rates and flattening of the yield curve on net interest margin and, in the case of Alessandri and Nelson (2015) and Borio et al. (2015), on profitability. Nevertheless, the emphasis of these papers is either on the effect of the yield curve or low interest rates, with evidence limited to just one country in some cases, as is the case of Entrop, Memmel, Ruprecht and Wilkens (2015) and Busch and Memmel (2015) for Germany, Alessandri and Nelson (2015) for United Kingdom or Genay and Podjasek (2014) for the USA.

Our work contributes with additional empirical evidence on a broad group of countries over the period 2008-2014, which are the years in which aggressive monetary policy measures were applied (including both conventional and unconventional measures), leading to a context of low or even negative interest rates in various geographical areas. The second novelty of the paper is that we focus on quantifying the impact on net interest margin of both the slope of the yield curve and the level of short-term interest rates, as these are two different variables that can operate on financial margin simultaneously, and in the same direction. Indeed, this is the case in the most recent years in which low interest rates have persisted and the yield curve has flattened. As well as margins being low due to the flat yield curve, interest rates at levels close to zero put further pressure on margins, as banks have difficulty passing on lower rates to depositors, and there is still some room left for rates to fall.

As well as the level of interest rates and their slope, this study considers the impact of other factors determining net interest margin that capture the characteristics of each bank (such as its market power, the influence of credit risk, operating costs, etc.) together with other

control variables (such as interest rate risk or the economic cycle), on trends in net interest margin. To do so, it takes as its reference various explanatory models of net interest margins when selecting its explanatory variables.

The results obtained make it possible to quantify the impact of falling interest rates and the flattened yield curve on net interest margin. In both cases the impact is non-linear, with a bigger impact from the decline in interest rates over the period studied than from the flattening of the yield curve. With this non-linear relationship, the normalisation of monetary policy would have a highly beneficial effect on the recovery in banking margins, given the current scenario of ultra-low and even negative interest rates. By the same token, if this low interest environment persists for an extended period, it could have negative effects on financial stability. It is therefore important for central banks to take into account the possible trade-off between economic growth and financial stability when evaluating the impact of their measures.

Following this introduction, the remainder of this paper is structured as follows. Section 2 reviews models analysing the determinants of net interest margins, focusing in particular on the effect of interest rates and the slope of the yield curve. Section 3 describes the sample used, the construction of the explanatory variables for net interest margins, and the methodology used to quantify the impact of the factors determining margins. Section 4 sets out the findings from empirical application. Finally, section 5 offers some conclusions and implications for economic policy.

2. The determinants of net interest margin: the effect of interest rates and the slope of the yield curve.

The literature analysing the factors determining net interest margin falls into four broad groups. The first takes the seminal model of Ho and Saunders (1981) as its starting point. This model considers banks as risk averse intermediaries between suppliers and demanders of lendable funds in a static framework over a single period. At the start of the period the bank receives loans and deposits randomly and has to decide the optimal margin to apply on both loan and deposit transactions. The original model has subsequently been broadened in order to incorporate other determinants of the intermediation margin. The extensions incorporate crossed elasticity of demand between banking products (Allen, 1988), the risk of default (Angbanzo, 1995), average operating costs (Maudos and Fernández de Guevara, 2004) and cost of maturity transformation (Entrop et al., 2015). With these extensions to the original model, the following variables are proposed as determinants of the net interest margin: the degree of competition, the risk (both credit risk and interest rate risk), operating costs, interest rate levels, and the yield curve.

The second group of papers includes Zarruck's first study (1989) analysing how banks' net interest margin varies in relation to conditions of uncertainty and risk aversion, subsequently expanded by Wong (1997) to include operating costs. These studies show that margins are positively correlated with banks' market power, operating costs, credit risk, and the interest rate. This group of papers sets the interest rate on loans and deposits simultaneously, while in the first group they are set independently.

The third group includes the recent contribution from Borio, Gambacorta and Hofmann (2015) which puts forward a modified version of the Monti-Klein model for the case where there is oligopolistic competition between *N* banks, incorporating the standard model with three new features: a cost of maturity transformation, a capital requirements coefficient, and an equation for provisions to cover loan losses. From this model, the empirical application includes the three-month inter-bank interest rate, the slope of the yield curve, the interest rate risk, macroeconomic indicators and variables approximating the characteristics of each bank (size, liquidity, efficiency, capitalisation) as determinants of net interest margin.

The fourth group develops and estimates a DSGE model with an imperfectly competitive banking sector, a key feature of which is an imperfect pass-through from policy rates to loan rates due to pricing frictions. This is the case of Gerali et al. (2010) and Alessandri and Nelson (2015), although in the latter a simple version of former model in partial equilibrium is considered. In these papers, authors postulate a linear relationship between the net interest margin and interest rates.

Looking more closely at the influence of monetary policy on bank’s interest margin, the theoretical model proposed by Borio et al. (2015) focuses on the effect of two variables: the short-term interest rate and the slope of the yield curve. The level of money market interest rates has an upward and non-linear (inverted U-shaped) relationship with the bank’s interest margins. This relationship depends on the curvature of the demand function (elasticity) for loans and deposits and on capital requirements. A maximum threshold exists above which the impact diminishes. This is more plausible when there is more market power in the market for deposits than in that for loans. In the case of the influence of the slope of the yield curve, the relationship with net interest margin is less clear cut, as it depends on the structural parameters of the model. The lesser the degree of competition, the greater the probability the relationship is positive.

In empirical applications, the results show a positive impact on net interest margin in terms of both interest rates and the slope of the yield curve. This was what Albertazzi and Gambacorta (2009) found for a sample of banking sectors in OECD countries, and Borio et al. (2015) for a panel of international banks from 14 developed countries, the effect being non-linear in this latter case. Alessandri and Nelson (2015) also find evidence of a

systematic effect of market interest rates and the slope of the yield curve on net interest margin and profitability using a panel data set on UK banks.

As the studies by Borio et al. (2015) and Classens et al. (2016) show, there are a number of reasons for the positive impact of short term interest rates and the slope of the yield curve on net interest margin. One of the most significant reasons for this inverted U-shaped relationship between money market interest rates and interest margins is the existence of a zero-percent interest rate floor for deposit (deposit rates tend to be downward sticky), explaining why a drop in the monetary policy rate narrows the margin more when rates are close to this floor than when they are further above it. In general, the impact of rates on the margin depends on the capacity for a reappraisal of assets and liabilities and on the maturity structure. The shorter the assets' maturity and more rapid the reappraisal, the bigger the effect of a cut in rates on net interest margins. By definition the slope of the yield curve has a positive effect on margins as it reflects the difference between long-term rates (at which the bank lends) and short term rates (at which it borrows).

The sensitivity of net interest margin to these two variables depends on the level of interest rates, with the impact being greater when rates are low. Behind this result is the argument that there is a floor under deposit interest rates (deposit rates tend to be downward sticky). Moreover, when the rates are low, this flattens the yield curve, reinforcing the negative impact on the interest margin.

3. Sample, variables and methodology

a) Sample and sources of information

The sample used in the empirical application includes banks from 32 countries around the world.[1] The period analysed is from 2008 to 2014, which starts with the outbreak of the financial crisis and covers the period in which many countries were implementing expansionary economic policy measures in response.

We include all banks included in BankScope (Bureau van Dijk) database for the aforementioned countries. However, banks for which there was no information on any of the explanatory variables for net interest margin were excluded from the sample.

[1] Austria, Australia, Belgium, Canada, Switzerland, Colombia, Czech Republic, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Iceland, Italy, Japan, Korea, Rep., Luxembourg, Latvia, Netherlands, Norway, New Zealand, Poland, Portugal, Russian Federation, Sweden, Slovenia, Slovak Republic, United States and South Africa. The reason that justifies the sample used is that they are the countries for which the OECD database provides information on interest rates in the short (money market) and long term (government debt) interest rates.

Additionally, those banks for which the prices of factors of production (needed to estimate the Lerner index of market power) were outside the range of 2.5 standard deviations on either side of the mean, calculated for each year, were also excluded. After filtering, the panel of data used comprised 26,149 observations corresponding to a number of banks ranging from a minimum of 3,386 in 2008 to a maximum of 4,027 in 2012.

Given that the interest margin depend on interest rates (short-term level and slope of the yield curve) it is important that there be a proper correspondence between the margin analysed and the interest rates. For this reason, non-consolidated variables are used such that there is a correspondence between domestic business in each country (and its corresponding margin) and both the domestic money market interest rate benchmark and the slope of the yield curve (which depends, in turn, on the countries' government debt interest rates) in the country in question.

b) Construction of the variables

To perform the empirical comparison, the following variables postulated by the theoretical models previously described are required. We combine the determinants of the Ho and Saunders (1981)'s models with the framework of Borio et al. (2015) which explicit the effect of the money market interest rate and of the slope of the yield curve on the net interest margin. All in all, we include the following determinants of the net interest margin: short-term interest rates, the slope of the yield curve, market power, money market volatility (interest rate risk), credit risk, the covariance between the two types of risk, banks' degree of risk aversion, the volume of credit, liquidity reserves, and average production costs. Each of these variables is approximated in the following way:

Interest rate level and the slope of the yield curve

The three-month interbank market interest rate is used as a proxy for short-term interest rates (*Short term interest rate*). As the theoretical models postulate, and according to the evidence from various studies, the expected sign of this variable is positive. The square of the variable is introduced in the estimates to capture a possible non-linear relationship.

On the other hand, the difference between the interest rate on a ten-year bond and the three-month interbank market interest rate is used as a proxy for the slope of the yield curve (*Slope of the yield curve*). The expected sign of this variable is positive, as an increase in the slope of the yield curve implies a bigger difference between the interest rate on loans and that on deposits.

To capture a possible non-linear relationship between the slope of the yield curve and the interest margin, the square of the slope of the yield curve is included as an explanatory variable.

The World Bank database is used to build the control variables (such as macroeconomic conditions). Money market and government debt interest rates were from the OECD database.

Market power

Although market concentration measures are frequently used as competition indicators, they suffer from two important drawbacks. Firstly, theory has shown that what is relevant when judging competition is not always the number of competitors (or the concentration) so much as the rivalry between them. And secondly, the concentration indicators do not show up variations between banks.

For these reasons, in our case we use the Lerner index of market power measured by the difference between price and marginal cost expressed as a percentage of price (*Lerner index*) estimated at individual bank level using the approach commonly used in other studies, such as Berg and Kim (1994) or Maudos and Fernandez de Guevara (2004). The price of banking output (approximated by total assets) is measured as the ratio between total income and total assets. The underlying assumption is that the flow of goods and services banks produce is proportional to their total assets, where this activity generates both financial (interest) and non-financial income.

The marginal cost of banking output is calculated based on the following translog cost function:

$$\ln C_i = \alpha_0 + lnTA_i + \frac{1}{2}\alpha_k(lnTA_i)^2 + \sum_{j=1}^{3}\beta_j \ln w_{ji} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3}\beta_{jk}\ln w_{ji}\ln w_{ki} + \frac{1}{2}\sum_{j=1}^{3}\gamma_j \ln TA_i \ln w_{ji} + \mu_1 \mathrm{Trend} + \mu_2 \frac{1}{2}\mathrm{Trend}^2 + \mu_3 \mathrm{Trend}\ln TA_i + \sum_{j=1}^{3}\delta_j \mathrm{Trend}\ln w_{ji} + \ln u_i$$

where *C* is the total costs (financial and operating costs), *TA* is total assets and *w* the price of the production factors, which are measured as follows:

w1: Price of labour = Staff costs / total assets.[2]

w2: Price of capital = operating costs (except staff costs) / fixed assets.

w3: Price of deposits = financial costs / deposits.[3]

Country specific cost functions are specified, to account for differences in the underlying banking technology. Fixed effects have also been introduced in the cost function estimate in order to capture the influence of variables specific to each bank. Lastly, a trend variable (*Trend*) has been included to reflect the effect of technological change, which translates into displacements of the cost function over time. As is common practice, the estimate was made imposing conditions of symmetry and grade one homogeneity in input prices. The expected sign of the Lerner index is positive, given that banks with more market power can establish a wider net interest margin.

Bank size

As a proxy for size, the estimate for the logarithm of loan volumes (*Log(loans)*) has been included. Although other studies (such as Borio et al., 2015) include total assets as a control variable (*Log(total assets)*), we consider the volume of loans to be a better proxy as, for a given credit risk, the potential losses will be directly proportional to the loan volume and therefore the risk premium applicable to the margin. Indeed, in the Ho and Saunders model (1981), the volume of loans is used as a determinant of the margin. For this reason, the expected sign of this variable is positive.[4]

Degree of risk aversion

Following the approach taken by McShane and Sharpe (1985) and others, banks' degree of risk aversion (*Risk aversion)* is approximated by the ratio equity/total assets. According to the theoretical model, a positive relationship is expected between this variable and the interest margin, as banks that are more risk averse will set higher margins.

Credit risk

The risk of non-payment or default on loans obliges banks demand an implicit risk premium in the interest rates they charge for these transactions. In the absence of a direct measure of

[2] As there are no data in BankScope about employee numbers for the entire sample, we have used the ratio of staff costs to total assets as a proxy for the cost of labour.

[3] Specifically, deposits correspond to the heading *customer and short term funding* in BankScope database.

[4] The empirical application analyses the robustness of the results using total assets as an indicator of size.

the variation in the return on the lending portfolio associated with the risk of non-payment or the default rate, credit risk is approximated by the ratio between provisions for insolvencies and the volume of credit granted (*Provisions/Loans*), as it is to be assumed that the higher the default rate, the larger the provisions banks set aside. Alternatively, the loans to total assets (*Loans/Total Assets*) ratio can be used, as done by Maudos and Fernández de Guevara (2004), on the assumption that banks face higher levels of risk the larger their lending. According to the theoretical models, the sign of these two variables is positive[5].

Interest rate risk

Money market uncertainty is usually captured through the volatility of a representative interest rate. Specifically, we proceed as in Ho and Saunders (1981), McShane and Sharpe (1985), Saunders, A., Schumacher, L. (2000), Maudos and Fernández de Guevara (2004), and Entrop et al. (2004), among others, using an indicator of the volatility of the money market rates. More precisely, we use the coefficient of variation calculated with monthly data on the three-month inter-bank rate (*Interest rate risk*). The expected sign is positive, as the increased volatility implies higher risk, and therefore, a bigger interest margin to offset that risk.

Interaction between credit risk and interest rate risk

Interaction between credit risk and market risk (*Risk covariance*) is proxied by the product of the measurement of credit risk and the interest rate risk.

Average cost of transactions

The average cost of transactions (*Average cost*) is defined as the ratio of total operating costs to total assets. The expected sign is positive, as net interest margin should at least cover operating costs and, therefore, the higher the costs, the higher the net interest margin needed.

Liquid reserves

Liquid reserves represent an opportunity cost as they mean forgoing income investment of these reserves in profitable assets. This variable (*Reserves*) is approximated by the ratio between liquid reserves (using the "cash and bank deposits" variable in the BankScope database) and total assets. According to the theoretical model, the expected sign is positive, as the bigger the volume of reserves the higher their opportunity cost, and hence the higher net interest margin needed to compensate.

[5] The empirical application tests for the robustness of the results using both provisions for insolvencies to the volume of credit granted and loans to total assets as an indicator of credit risk.

Net interest margin may be influenced by a number of additional variables as well as those proposed by the theoretical models. It is therefore common practice for studies to include other control variables. Specifically, implicit interest payments and a measure of management quality are usually included. Additionally, GDP growth has also been included as a control variable.

Implicit interest payments

As well as paying interest on deposits, banks may offer other services associated with them which sometimes involve implicit (paying a lower interest rate) rather than explicit remuneration (charging a fee for a service). Following Ho and Saunders (1981), Angbanzo (1997), Saunders and Schumacher (2000) and Entrop et al. (2015), among others, we have used the variable operating expenses net of non-interest revenues, expressed as a percentage of total assets as an approximation to these payments (*Implicit interest rates*). The expected sign of this variable is positive, as higher implicit payments imply higher operating costs, which need to be compensated for by a higher interest margin.

Management quality

Managing the banking business efficiently entails choosing the most profitable assets and lowest cost deposits (in terms of financial and operating costs). An approximation to this variable is the ratio of operating expenses to operating income (operating ratio, *Efficiency*). The higher this ratio, the greater the operating inefficiency, which translates into a smaller margin. The expected sign of this variable is therefore negative.

GDP Growth

In order to control for the possible influence of the economic cycle on net interest margin, the estimates include the annual rate of GDP growth (*GDP growth*).

Net interest margins

As regards the dependent variable, the net interest margin per unit of assets is used. This is defined as the difference between revenue and financial costs in relation to total assets (*NII*). This variable reflects the interest income and interest expenses associated to the outstanding amounts of loans and deposits. The theoretical approaches, particularly those that follow the Ho and Saunders (1981) methodology, modelise the spread of interest rates of new operations. The lagged net interest margin is included as an additional determinant to capture the inertia that the net interest margin may have. Table 1 contains the descriptive statistics on the variables used, and the number of observations per country.

>Insert Table 1<

c) Methodology

To analyse the impact of the determinants of net interest margin, we estimated a dynamic panel data model making it possible to capture the potential influence of specific features of each bank other than the variables included as regressors. This was done using the generalised method of moments (GMM) based on Arellano and Bond (1991) and Blundell and Bond (1998). As well as capturing the inertia in the trend in net interest margin (including its time lag as an explanatory variable), possible endogeneity problems were corrected by estimating the model in first differences and using the variables on levels time-lagged by a set number of periods. The estimation includes time effects to reflect the effects of specific variables in each year affecting the net interest margin.

The equation to estimate is therefore the following:

$$NII_t = f(NII_{t-1}, Short\ interest\ rate_t, Short\ interest\ rate_t^2, Slope\ of\ the\ yield\ curve_t,$$

$$Slope\ of\ the\ yield\ curve_t^2, Implicit\ interest\ payments_t, Efficiency_t, Lerner\ index_t,$$

$$Interest\ rate\ risk_t, Credit\ risk_t, Risk\ covariance_t, Size_t, Risk\ aversion_t, Average\ cost_t,$$

$$Reserves_t, GDP\ growth_t)$$

4. Results

Before discussing the results obtained from the estimation of the equation explaining net interest margins, it is worth examining how the core variables in our study, namely short-term interest rates and the slope of the yield curve, have changed over time. As Figure 1 shows, from 2008 to 2014, the three-month interest rate in the interbank market dropped sharply and remained low (at close to zero) until 2010, in a context of accommodative monetary policy by the main central banks. There was also a significant drop in long-term interest rates (approximated by the yield on ten-year bonds), declining to around 250 basis points in the United Stated, euro area and the United Kingdom, and 50 basis points in Japan. The difference between the long and short term rate rose sharply in 2009 (due to plummeting short-term rates) and then gradually came down.

>Insert Figure 1 <

As Figure 2 shows, there are significant differences in the level of net interest margins between countries/geographical regions and over time. In the former case, Japan's banking

sector had the lowest interest margins, followed by the United Kingdom and the euro area. Margins were much higher in the group classed as other countries and in the United States. Over the period analysed, net interest margins fell in Japan and the United States from 2010 onwards, remained stable in the euro area, and rose in the United Kingdom and the other countries group.

>Insert Figure 2 <

Table 2 shows the results of the estimation of the equation explaining net interest margin. The first column shows the results obtained when a linear relationship is assumed between the net interest margin and the short-term interest rate and the slope of the yield curve. The lagged dependent variable shows always a positive and significant coefficient, which confirms the fact of large inertia in the determinants of the NIM. Only the positive effect of the interest rate level is statistically significant. When the square of the two variables is introduced (column 2), a positive and statistically significant impact is obtained again for the sort-term interest rate, but in this case the relationship is quadratic (inverted U-shaped). Therefore, a change in the short-term interest rate has a bigger effect on the margin the lower the level of interest rates. As table 2 also show the maximum in the relationship between interest rates and margins is observed at 0.093 (9.3%), which is well above the interest rates observed in the sample.

Of the remainder of the determinants of net interest margin, the results show that banks with more market power (approximated by the Lerner index) set higher interest margin, as the theoretical models predict.

In the case of risk, the impact is positive and statistically significant in the case of credit risk (approximated by the ratio of provisions to total assets), such that banks exposed to higher risk charge the corresponding premium. In the case of interest rate risk (approximated by the volatility of short-term interest rates), the impact is positive but not statistically significant.

The bank's liquidity is also significant, and has a negative effect. The sign implies that banks that invest a larger proportion of their assets in liquid assets have smaller interest margin. This is logical bearing in mind the meagre (or even zero) financial income from these assets.

The results also show that better managed banks enjoy bigger margin, given the negative impact of the efficiency variable. This variable is inversely proportional to management efficiency and therefore to lower net interest margin. Finally, in all the estimates the effect of implicit payments is positive and statistically significant, as is predicted by the theoretical

models. The other explanatory variables (average costs, size, risk aversion, and GDP growth) are not statistically significant.

Column 3 shows the results when bank size is approximated by the logarithm of total assets, as a means of determining the robustness of the results. The parameter is not statistically significant, however, and the other results remain unchanged.

>Insert Table 2<

In column 4 credit risk is approximated by the ratio of loans to total assets and is not statistically significant. In this estimate, as well as the positive and concave relationship between net interest margin and the interest rate, the effect of the slope of the yield curve is also quadratic (also an inverted U-shaped relationship). The fact that on this occasion the square of the slope of the yield curve is significant may be due to a collinearity problem in the estimations shown in columns (1) to (3), making it difficult to capture the effect of each variable separately in them, although what is relevant is the joint effect of the two variables. Again, the results are unchanged when size is approximated by total assets (column 5).

In order to quantify the economic impact of the determinants of net interest margin, Figure 3 shows the change, in basis points (bp), in the net interest margin associated with an interquartile variation of each of the explanatory variables, i.e. a change from percentile 25 to 75 of the distribution. For this purpose, we take the estimated parameters in column 5 as the reference. The figure ranks the variables from largest to smallest impact, showing the biggest effect to be that of the change in the short-term interest rates. Specifically, going from percentile 25 to 75 of the distribution entails an extremely large change in the interest rate of 430bp (given the big drop in rates that had taken place during the period analysed as a consequence of the aggressive monetary policy), with an impact of 65bp on the net interest margin. The impact of the second variable affected by monetary policy (the slope of the yield curve) is much smaller, as the interquartile change of 171bp implies a change of 16bp in the margin.

The second variable with a large economic impact on net interest margin is implicit payments, with a change of 60bp on moving from percentile 25 to 75 of the distribution. Market power is the third variable in importance, with an impact of 48bp. The other statistically significant variables have smaller economic impacts: 13bp in the case of efficiency, 12bp in that of the opportunity cost of holding reserves, and 3bp in that of average costs.

>Insert Figure 3 <

If, rather than assume a variation equivalent to the interquartile range, we use the variations in the level of interest rates from 2008 to 2014, as shown in Table 3, the drop in the net internet margin explained by falling interest rates is 68bp in the euro area, 48bp in the United States, 74bp in the United Kingdom 12bp in Japan, and 65bp in the other countries. In the case of the slope of the yield curve, as can be seen in Figure 1, the sharp drop began in 2010 in the majority of countries in our sample, not in 2008 as in the level of interest rates. Hence we have estimated its impact on the net interest margin over the period 2010 to 2014. In this case, the flattening of the yield curve translates into a drop in the net interest margin of 11bp for euro area banks, 6bp in the United States, 11bp in the United Kingdom, 6bp in Japan, and 11pb in the other countries. For the common period 2010-14, the joint impact of the drop in the interest rate and flattening of the yield curve is 22bp in the euro area, 10bp in the United States, 14bp in the United Kingdom, 9bp in Japan, and 16bp in the other countries. However, in the early years of the crisis, up until 2010, the increase in the slope of the yield curve had a positive impact on net interest margins, which considerably buffered the negative impact of falling interest rates.[6]

>Insert Table 3<

5. Conclusions

This paper analyses the importance for trends in the bank net interest margin of the expansionary monetary policy measures adopted by various central banks to combat the financial crisis that began in 2008. To do so, we have examined a broad sample of banks from 32 countries covering the period 2008-2014, focusing on the effect of two variables reflecting the impact of monetary policy: the level of short-term interest rates and the slope of the yield curve. When quantifying these two variables, we have controlled for the effect of other explanatory variables for net interest margin, such as market power, credit risk and interest rate risk, efficiency, risk aversion, size, etc.

The results show the importance of expansionary monetary policy measures on bank's net interest margins, and that the impact of falling interest rates exceeds that of the flattening of the yield curve. In both cases the effect is quadratic rather than linear, such that the rise in interest rates and the slope of the yield curve has more impact when the level of interest rates and slope of the curve are low. Therefore, in the current context of low interest rates, a further drop would have a substantial impact on banking margins. By the same token, when monetary policy returns to normal, the recovery in interest margins will be significant. For

[6] The total net effect on financial margins was a drop of 6bp in the euro area banks, 10bp in the United States, 4bp in the United Kingdom, 7bp in Japan, and 17bp in the other countries.

example, an increase of 100bp in the money market's short-term interest rate would boost *ceteris paribus* the interest margin by around 20bp. If, at the same time, there were an increase of 50bp in the spread between the long-term interest rate (ten-year bond) and short-term interest rate (i.e. the slope of the yield curve), the margin would also increase by a further 6bp. Thus, *ceteris paribus*, return on assets (ROA) would rise by 26bp.

The results obtained are in line with recent empirical evidence offered by Borio et al. (2015) and Claessens et al. (2016), in so far as both papers find a non-linear relationship between interest rates and net interest margin. Therefore, our evidence confirms the negative impact that expansionary monetary policy has had on interest margin, as it has led to a scenario of ultra-low interest rates, making a return to profitability difficult. In this context, the problem of low profitability facing certain sectors of the banking industry (at least in Europe) will persist as long as the current low-interest-rate environment lasts (in which rates are negative, even, over the short term). There is, therefore, a trade-off between the positive effect of monetary policy and economic growth and its negative effect on financial stability (with the increased likelihood of a banking crisis due to its negative impact on bank profitability). Although we have concentrated here on the effect of monetary policy on interest margin, the results of Borio et al. (2015) show that the effect on profitability is also negative. This explains the concern of institutions such as the IMF (2016b), which warn of the negative effects of a lasting scenario of low interest rates for banks' profitability.

In the case of European banks, the evidence obtained here allows us to venture that the current scenario of low profitability, with returns sometimes below the cost of capital, may exact a price in terms of financial stability. In the specific case of the euro area, the low rate of GDP growth, and the current scenario of ultra-low inflation, falling far short of the ECB's 2% target, suggest monetary policy will remain expansionary for some considerable time. This means the low interest-rate scenario will also persist. Against this backdrop, the major challenge European banks face is to raise efficiency by cutting costs, while at the same time, focusing more on income from sources other than interest charges.

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Table 1. Descriptive statistics (averages)

	Net interest margin/ total assets (%)	Short-term interest rate (%)	Slope of the yield curve (%)	Implicit interest payments (%)	Efficiency	Lerner index	Volatility of market interest rates	Credit risk 1 (loans/assets) (%)	Credit risk 2 (prov/loans) (%)	Loans (log)	Total assets (log)	Risk aversion (%)	Operating costs (% total assets)	Reserves (% total assets)	Customer deposits/ assets (%)	GDP growth (%)	Number of obs.
Austria	1.82	1.30	1.70	0.89	70.35	0.30	29.76	56.51	1.51	12.67	13.40	8.94	3.09	1.73	64.71	0.57	876
Australia	1.86	4.12	0.39	0.88	57.99	0.29	8.32	68.76	0.34	15.23	15.78	7.32	1.59	3.94	58.52	2.64	228
Belgium	1.67	1.18	2.09	0.57	64.48	0.35	29.40	36.13	0.43	13.32	15.00	9.07	2.15	1.89	56.75	0.70	207
Canada	1.85	1.18	1.30	0.73	64.39	0.33	8.53	66.34	0.29	14.65	15.27	9.76	1.93	2.28	69.39	2.18	201
Switzerland	1.23	0.46	1.04	0.64	70.11	0.33	71.27	72.34	2.03	12.89	13.41	7.32	1.73	5.55	65.71	1.29	2354
Colombia	5.55	5.21	2.97	1.91	62.70	0.43	9.95	66.51	11.36	12.68	13.59	18.29	5.72	7.52	52.18	4.65	288
Czech Republic	1.96	1.41	1.92	1.48	79.54	0.32	10.86	58.79	0.53	14.15	14.77	10.23	2.57	3.29	67.82	0.14	127
Germany	2.24	1.23	1.13	1.26	70.07	0.29	30.01	56.36	3.77	13.45	14.17	8.23	2.48	2.38	65.88	0.74	4943
Denmark	3.15	1.66	0.92	1.90	75.36	0.36	20.32	55.54	2.35	12.61	13.29	12.16	3.22	4.76	67.73	-0.88	437
Spain	1.63	1.33	3.11	0.65	84.01	0.34	29.11	56.12	4.95	14.78	15.77	8.64	1.52	1.49	52.33	-0.77	304
Finland	1.39	0.85	1.47	0.67	66.69	0.40	30.71	65.23	0.19	13.35	13.96	8.40	2.03	2.37	63.00	-0.69	155
France	1.97	1.27	1.68	0.72	68.40	0.34	29.93	56.40	0.70	14.17	15.02	9.85	2.73	2.50	41.08	1.26	1157
United Kingdom	1.48	1.38	1.71	0.83	63.72	1.08	17.09	46.58	1.01	12.66	13.80	11.41	1.95	6.44	65.79	0.82	811
Greece	2.10	1.36	7.88	0.69	60.28	0.36	27.57	66.81	3.16	14.93	15.58	11.44	1.67	2.58	43.74	-3.76	59
Ireland	0.91	1.07	4.23	-0.30	36.98	0.44	30.02	34.25	0.42	14.48	16.03	16.41	2.26	2.96	31.44	0.67	61
Iceland	1.98	1.81	2.68	1.19	75.31	0.35	25.92	63.13	0.33	15.59	16.08	6.66	2.37	16.24	82.32	2.48	47
Italy	3.15	8.19	-0.97	2.37	25.35	0.17	12.61	57.50	2.62	12.41	12.99	12.87	3.14	12.61	60.81	0.41	40
Japan	2.02	1.26	3.21	1.00	80.48	0.31	29.59	63.11	1.32	14.11	14.75	10.30	2.32	1.29	42.78	-0.49	985
Korea, Rep.	1.30	0.40	0.54	0.84	212.41	0.11	6.14	59.20	0.26	16.18	16.82	5.35	1.17	4.45	84.86	0.72	635
Luxembourg	1.03	0.65	1.55	-0.08	63.02	0.46	29.71	24.51	0.85	12.83	14.95	11.00	1.50	4.70	54.21	2.55	286
Latvia	1.88	4.18	2.67	0.45	80.36	0.42	37.88	43.17	3.54	12.35	13.56	10.16	2.45	9.24	72.98	-1.84	110
Netherlands	1.42	1.28	1.45	0.25	49.41	0.43	29.79	43.37	0.84	14.33	15.60	11.93	1.17	9.68	57.43	0.98	95
Norway	2.02	2.79	0.38	0.92	61.97	0.33	10.29	79.82	0.27	12.96	13.20	9.65	1.45	2.84	64.67	1.25	809
New Zealand	1.95	3.41	1.28	0.82	55.15	0.32	7.04	70.21	0.25	15.01	15.39	10.10	1.40	3.83	62.98	2.25	63
Poland	3.16	4.20	1.04	1.10	59.51	0.37	7.76	65.83	1.20	14.36	14.85	11.92	2.64	4.71	52.22	3.76	184
Portugal	2.27	0.76	6.43	1.31	71.07	0.30	32.38	51.95	1.06	11.97	12.70	11.32	2.20	1.21	71.39	-0.47	421
Russian Federation	5.29	8.30	-0.14	3.06	86.88	0.34	23.58	52.62	0.38	10.70	11.46	20.56	24.87	5.54	14.70	1.78	4915
Sweden	2.92	1.29	1.26	1.42	61.34	0.41	39.66	68.39	0.43	12.72	13.14	13.53	3.16	0.70	74.04	0.69	537
Slovenia	2.07	1.21	3.56	0.71	47.45	0.33	30.45	63.84	4.24	13.94	14.46	8.37	1.81	4.45	52.55	-0.53	102
Slovak Republic	2.83	1.09	2.77	1.41	65.06	0.39	29.58	58.96	1.32	13.80	14.36	17.64	2.29	6.43	63.60	1.34	82
United States	3.09	0.63	2.13	1.76	78.12	0.39	28.60	63.03	0.90	14.18	14.70	11.04	3.04	5.27	75.28	2.37	4516
South Africa	3.58	6.54	1.83	0.88	70.18	0.39	5.19	53.03	1.92	13.52	14.58	12.72	4.87	15.30	67.52	2.12	114

Source: BankScope and authors´ calculations

Table 2. Determinants of net interest income: 2008-2014

	[1]	[2]	[3]	[4]	[5]
NIM-1	0.564 ***	0.471 ***	0.479 ***	0.490 ***	0.497 ***
	(0.069)	(0.070)	(0.070)	(0.067)	(0.067)
Short term interest rate	0.066 **	0.211 ***	0.205 ***	0.195 ***	0.193 ***
	(0.031)	(0.046)	(0.047)	(0.050)	(0.049)
Short term interest rate^2		-1.134 ***	-1.112 ***	-0.900 **	-0.887 **
		(0.335)	(0.336)	(0.390)	(0.379)
Slope of the yield curve	0.012	0.086	0.077	0.133 **	0.129 **
	(0.020)	(0.057)	(0.055)	(0.055)	(0.055)
Slope of the yield curve^2		-0.786	-0.692	-1.296 **	-1.252 **
		(0.554)	(0.547)	(0.516)	(0.514)
Implicit interest payments	0.398 ***	0.514 ***	0.520 ***	0.488 ***	0.483 ***
	(0.106)	(0.103)	(0.103)	(0.101)	(0.100)
Efficiency	-0.006 ***	-0.005 ***	-0.005 ***	-0.005 ***	-0.005 ***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Lerner index	2.987 ***	3.625 ***	3.759 ***	3.079 ***	3.204 ***
	(0.853)	(0.820)	(0.822)	(0.677)	(0.675)
Interest rate risk	0.001	0.001	0.001	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)
Credit risk (provisions/loans)	0.008 **	0.007 **	0.007 **		
	(0.003)	(0.003)	(0.003)		
Credit risk (loans/total assets)				0.005	0.004
				(0.006)	(0.005)
Risk covariance	-0.018	-0.011	-0.011	0.004	0.004
	(0.016)	(0.015)	(0.015)	(0.009)	(0.009)
Log (loans)	-0.055	-0.014		-0.056	
	(0.054)	(0.055)		(0.065)	
Log (total assets)			-0.054		-0.083
			(0.070)		(0.075)
Risk aversion	0.020	0.013	0.011	0.012	0.011
	(0.015)	(0.014)	(0.014)	(0.013)	(0.013)
Average cost	-0.005	-0.007	-0.010	-0.009 *	-0.011 *
	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
Reserves	-0.041 ***	-0.039 ***	-0.041 ***	-0.034 ***	-0.035 ***
	(0.013)	(0.012)	(0.012)	(0.010)	(0.010)
GDP growth	0.011	-0.002	0.000	-0.001	0.000
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
Constant	0.005	-0.004	0.002	0.000	0.005
	(0.007)	(0.007)	(0.010)	(0.007)	(0.010)
Max. short term interest rate		0.093	0.092	0.108	0.109
Max. slope yield curve		0.055	0.056	0.051	0.052
Number observations	16479	16479	16479	16479	16479
Arellano-Bond test for AR(1) in first differences [p-valor]	-3.13 [0,002]	-3.27 [0.001]	-3.28 [0.001]	-3.52 [0.000]	-3.59 [0.000]
Arellano-Bond test for AR(2) in first differences [p-valor]	-0.24 [0.809]	-0.18 [0.859]	-0.18 [0.858]	-0.19 [0.851]	-0.18 [0.855]
Sargan test of overid. Restrictions [p-valor]	56.79 [0.237]	47.55 [0.491]	46.65 [0.528]	56.58 [0.213]	57.32 [0.194]

* p<0.10, ** p<0.05, *** p<0.01

Note: Dependent variable: net interest margin (NIM). NIM, short term interest rates and slope of the yield curve are in parts per unit. All estimations include fixed and time effects. Estimations are done using the generalised method of moments (GMM) based on Arellano and Bond (1991) and Blundell and Bond (1998), where NIM is instrumented with its own second and third differences, Lerner index with Herfindahl index and other endogenous variables with their own first differences.

Source: Authors' calculations

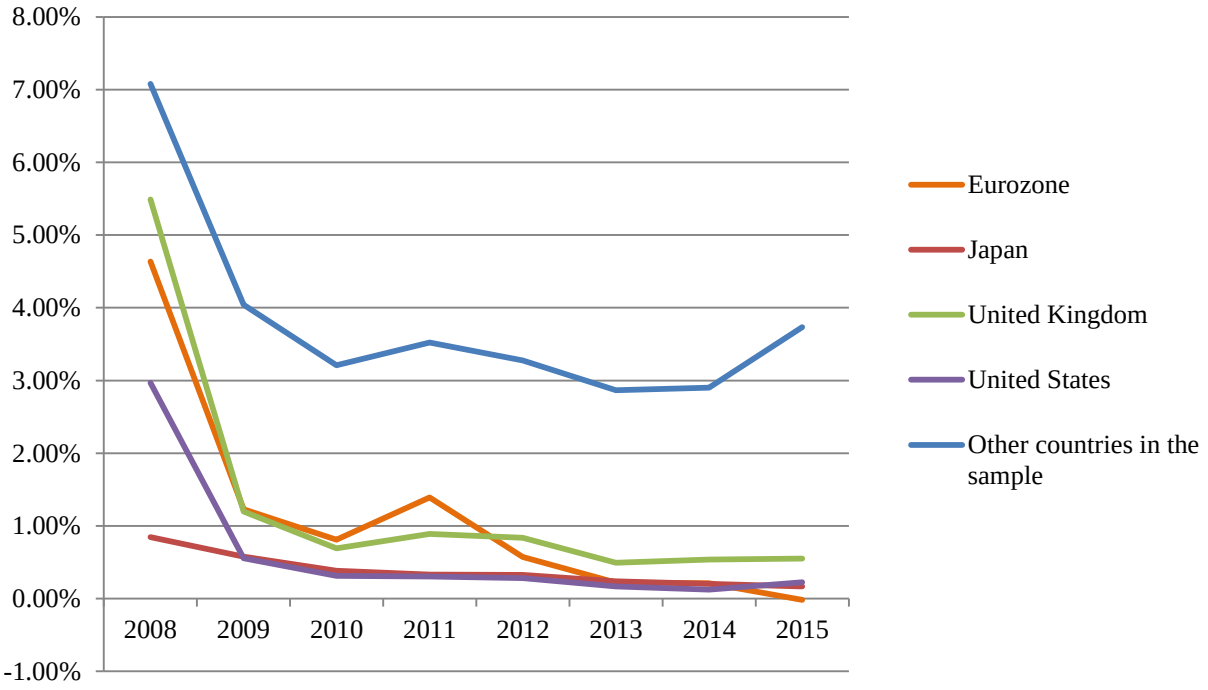
Table 3. Observed changes in interest rate and yield slope curve and predicted changes in net interest margin (bp)

	Change in 3-month interest rate 2008-2014	Predicted change in net interest margin 2008-2014	Change in yield slope curve 2010-2014	Predicted change in net interest margin 2010-2014	Change in 3-month interest rate 2010-2014	Predicted change in net interest margin 2010-2014	Total Predicted change in net interest margin 2010-2014
Eurozone	-442	-68	-90	-11	-60	-11	-22
United States	-284	-48	-49	-6	-19	-4	-10
United Kingdom	-495	-74	-90	-11	-15	-3	-14
Japan	-64	-12	-45	-6	-18	-3	-9
Other countries in the sample	-418	-65	-91	-11	-31	-6	-16

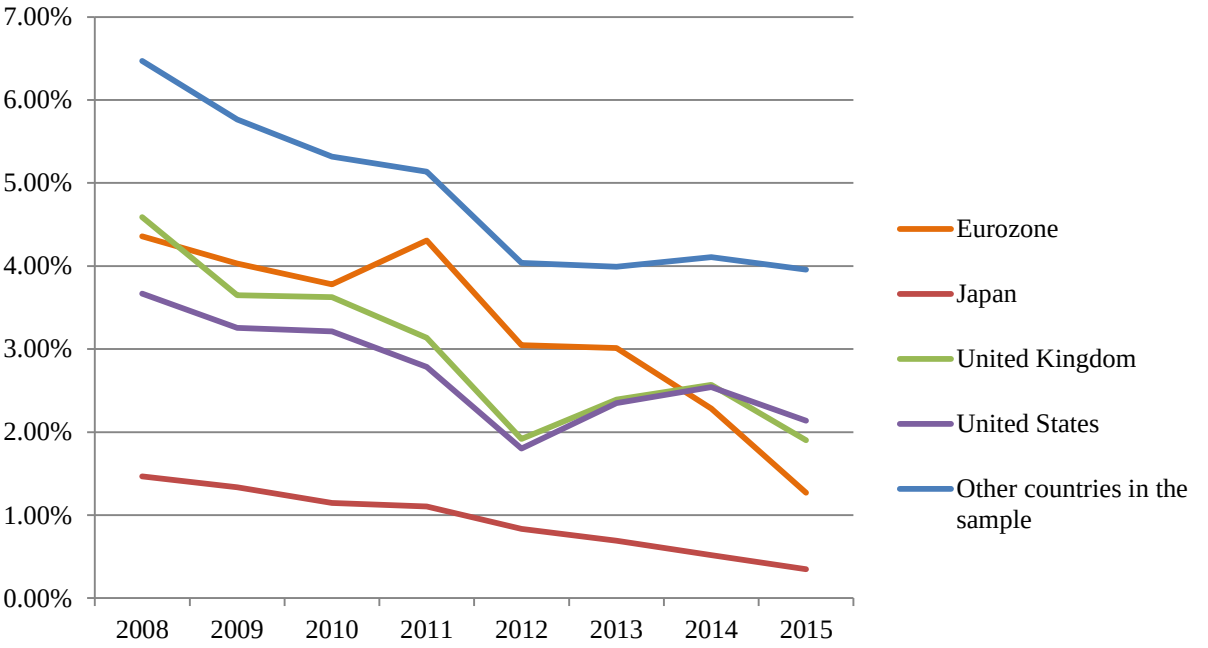
Source: Authors' calculation

Figure 1. Interest rates and yield curve

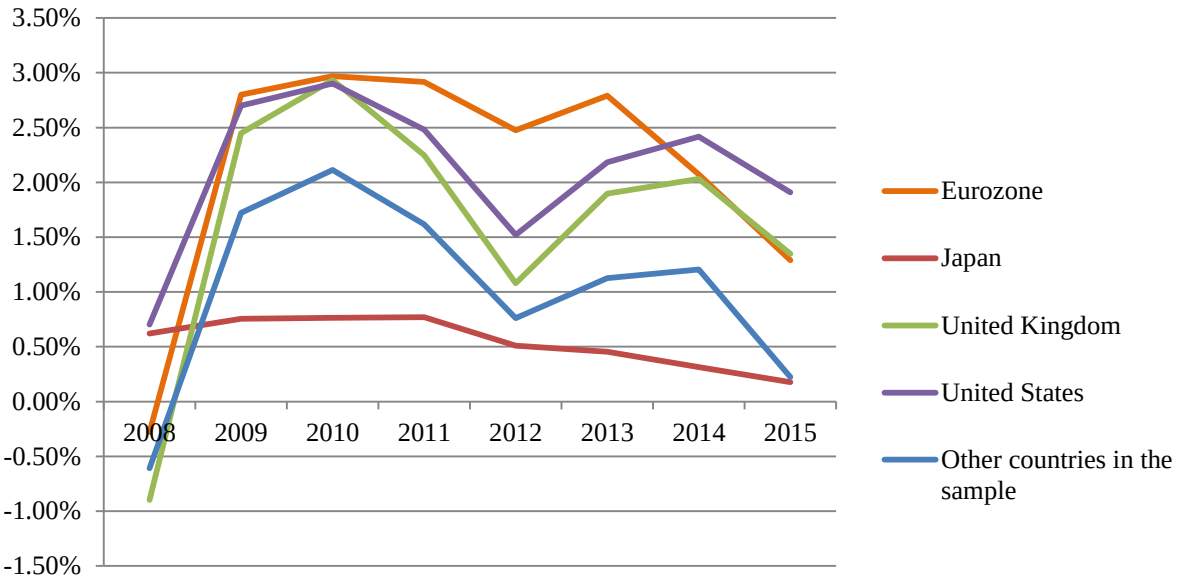
a) 3-month interbank rates



b) 10-year government bond rate

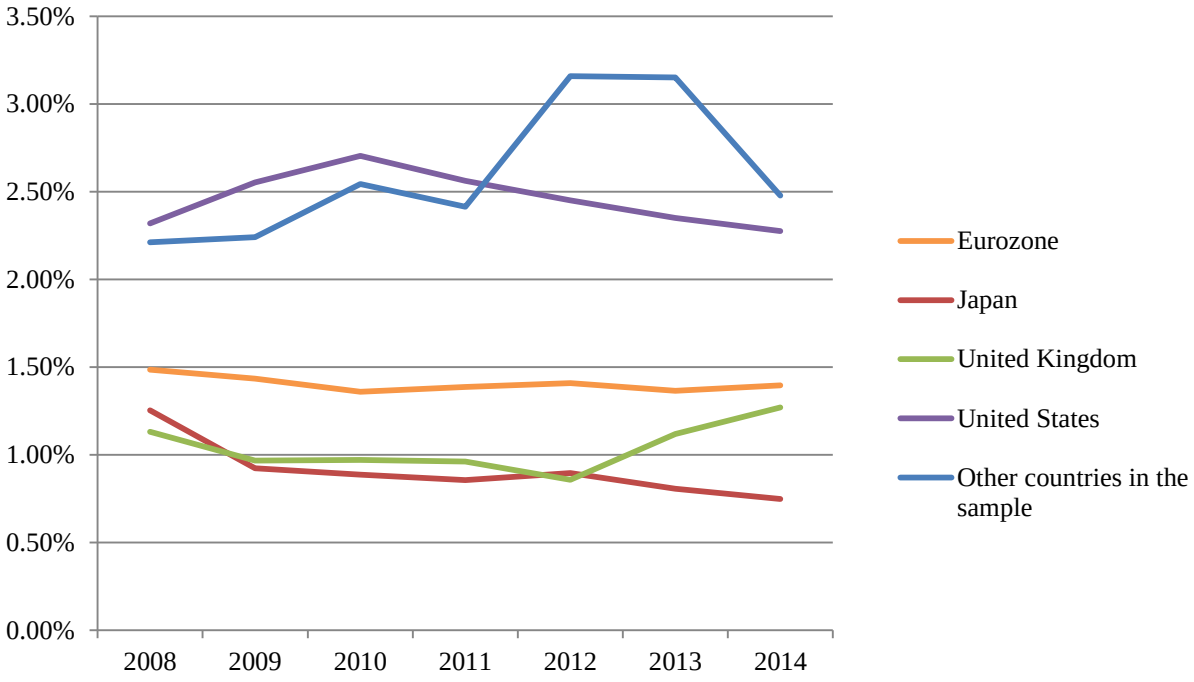


c) Slope of the yield curve



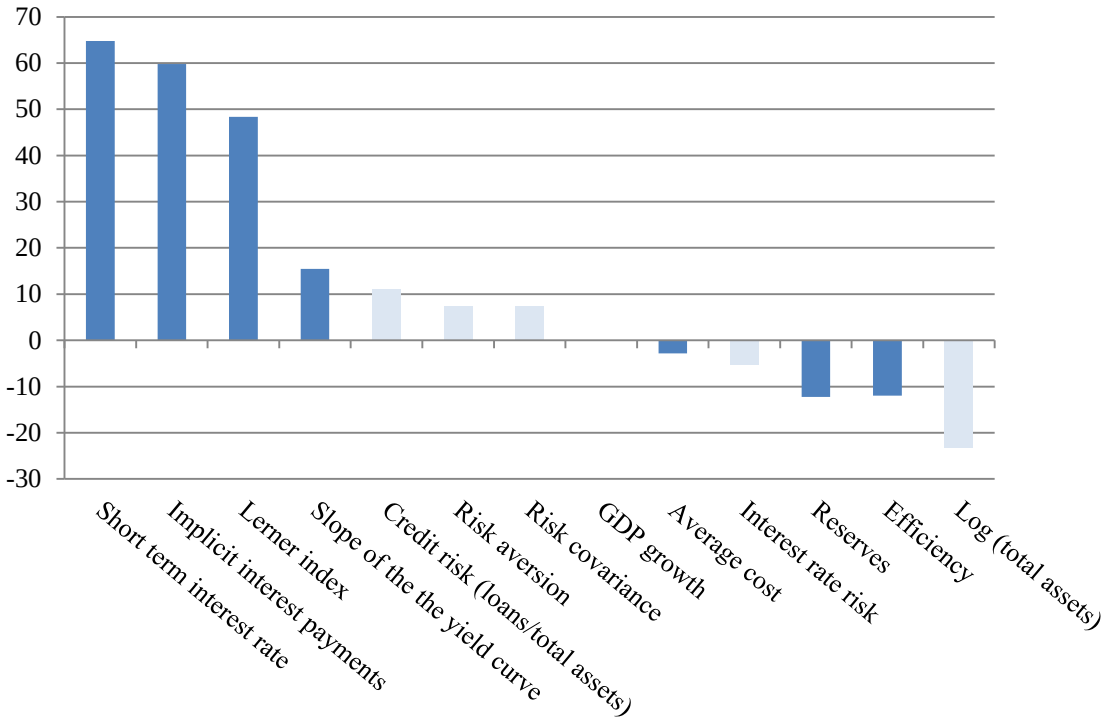
Source: OECD and authors' calculations

Figure 2. Net interest income (% total assets)



Source: BankScope and authors' calculations

Figure 3. Economic impact of the net interest margin determinants (bp)



Note: The graph shows the effect on net interest income of a variation of 25 to 75 percentile of the distribution in each of the explanatory variables. The bars that have a more subdued colour correspond to variables whose effect is not statistically significant. The variables are sorted from highest to lowest impact on net interest income.

Source: Authors' calculations