How do 400 European Banks Portray the Effect of Risk on Profitability under Low Policy Interest Rates?

Alexandra Campmas[a,*]

[a] *LAREFI - Université de Bordeaux*
Avenue Léon Duguit,
33 608 Pessac - France

Abstract

European policy interest rates have been low and trending downwards for almost a decade now and expectations do not seem to change. Hence, in such an environment, this paper investigates whether and how bank risk has influenced profitability across the European banking sector from 1999 to 2015. Using a dynamic panel model, we clearly find that bank insolvency risk, proxied by the asymmetric Z-score and credit risk, captured by two financial ratios, have a negative impact on profits: the higher the risk, the lower the profit. This result is confirmed by the three measures of profitability we rely on: net interest margins and overall profitability, namely the Return on Assets and Return on Equity. Furthermore, our analysis suggests that monetary policy's main instrument adversely affects bank income. Nevertheless, when policy interest rates are particularly low, the effect on net interest margin is still positive, while the effect on the overall profitability becomes negative. These results induce that European banks succeed in increasing their profitability despite a compression of their net interest income.

Keyword: Profitability; Bank risk; Policy interest rate; Dynamic panel data models; European countries.

JEL: C23, E5, G21.

*Corresponding author
Email address: alexandra.campmas@u-bordeaux.fr (Alexandra Campmas)

1. Introduction

The recent European environment was marked by the Global Financial Crisis (GFC) which resulted in a recession escalating into a sovereign debt crisis. These latest crisis events have raised great concerns about credit and insolvency risks within debt issuers. In order to fight against slack economic growth and to respect the objective of inflation, many central banks have drastically lowered their policy interest rates. These latter have been trending downwards for almost a decade now, presenting a challenging environment for banks. Not only in terms of profit but also in term of risk: low interest rates may encourage banks to take on more risk. Borio and Zhu (2008) is the first work to describe this mechanism and to name it the risk-taking channel of monetary policy.

Hence, as bank profitability is a key indicator of a stable and sound banking industry, studying the determinants of bank profitability (Hoffmann, 2011, Trujillo-Ponce, 2013) and especially the relationship between bank risk-taking and profitability (Berger et al., 2009, Martynova et al., 2015, Boadi et al., 2016, among others) regained substantial attention in the light of recent crisis events. Risk-taking behaviour in terms of credit risk is widely studied in the literature, however, the GFC revealed that bank insolvency risk did not disappear. Analysing their effects on bank profitability is important since it is a predominant vector to ensure financial stability. Nonetheless, while individual bank risk awakes the attention concerning financial stability, today banks must challenge the low interest rate environment. This is especially true in Europe and Japan where interest rates fall below zero. Empirical analysis are still relatively limited, somewhat surprisingly. Only few papers have focused on this matter (Weistroffer, 2013, Genay and Podjasek, 2014, Borio et al., 2015, Bikker and Vervliet, 2017, Claessens et al., 2017) but none of them focus on the European banking system. The effect of low interest rates on bank profitability is an utmost issue, not only for investors but also for policy makers. This environment is likely to

encourage banks to increase their level of risk. Hence, studying both the effects of bank risk and low interest rates on bank profitability allows to assess whether these two determinants of bank profitability are harmful for bank profit and thus, for financial stability.

Indeed, a relaxation of monetary policy through a decrease of policy interest rate is expected to erode net interest margin (NIM). This latter decreases if banks are reluctant to lower their interest rates on deposit, while the one on the asset-side drops. Nonetheless, the effect of low interest rates on bank's overall profitability is not as clear. Even if NIM declines, in the short run, banks benefit from low interest rates through valuation gains on securities they hold, and indirectly, from a lower burden in non-performing loans as borrowers' debt decreases. In addition, as low interest rates spur the economy, bank profitability increases over the time via new lending. But on the long run, it is not sure whether these benefits, offsetting the cut in the NIM, allow to continuously increase (or maintain) profitability. Obviously, shareholders and other investors are those with the greatest interest in understanding how changes in the interest rate may affect profitability. Although the effects may vary by banks, due to different interest rates' exposure, degree of maturity transformation and risk management (as well as derivatives), monetary authority is interested in such a channel. When the economy is doing badly, central banks may decide to reduce interest rates, influencing banks' ability to grant loans which, *in fine*, affects bank profitability, a key determinant to ensure financial stability.

Therefore, our study firstly aims at adding extra information regarding the effect of two types of bank risk on profit. We take into account credit risk, the most important risk banks might face (Alshatti, 2015, Gilchrist and Mojon, 2014), and we also rely on the asymmetric Z-score in order to consider insolvency risk. Unexpectedly, while credit risk has been widely studied in literature, insolvency risk has been somewhat disregarded. Another contribution concerns our

European sample, as none of the studies investigating the relationship between low interest rates environment and bank profitability focus on the European banking industry. We evaluate whether and how policy interest rates influence the NIM but also the overall profit. Consistently, we expect the coefficient of central banks' main instrument to be positively correlated with NIM. However, as stated before, its effect on the overall profitability is not as clear. Lastly, we simultaneously examine the effects of bank risk-taking and low interest rate environment on bank profitability. More precisely, we firstly investigate the overall effect of policy interest rates on bank profitability, then, we emphasise the effect of low policy interest rates. We rely on the General Method of Moments estimators (Arellano and Bover, 1995, Blundell and Bond, 1998) in order to take into account the dynamic nature of bank profitability and to mitigate the potential endogeneity issues our regression may face.

The rest of the paper is organised as follows. Section 2 provides an overview of related literature. Section 3 describes data and variables and explains the econometric methodology used. Section 4 comments our results. Section 5 summarises our main findings and concludes.

2. Literature Review

By contradicting the traditional predictions of corporate finance theory, it is puzzling why some big and high profitable banks decided to become exposed to such high and international risk, through untested market-based instruments Martynova et al. (2015). Ensuring safety of the banking system is an important issue regarding the stability of the national economy. Financial stability is not only based on the overall performance of the banking institutions but relies also on both individual and systemic risks, which are able to jeopardise the activity. Therefore, literature grants special attention to both performance and risk, which are at the core of the financial stability issues. Indeed, the GFC

has shown that banks' exposure to international risks is particularly important nowadays. Moreover, individual risk should not be disregarded; behind a bank manager decision, the level of risk is systematically taken into account and evaluated. Thus, bank performance and bank risk are two indistinguishable matters. As an example, some studies explain the effect of some specific factors on bank performance, considering performance as both risk and profitability indicators (Camara et al., 2013, Bitar et al., 2016, Trad et al., 2017). Because bank risk and bank performance are interrelated, the control and the interpretation of bank risk indicators have to be made through the causes, the consequence and the impacts on bank profitability.

As a consequence, several types of studies exist: some are trying to investigate the effect of bank risk-taking on profitability (Alshatti, 2015, Boadi et al., 2016, Bhattarai, 2016), others reverse the relationship (IMF's Global Financial Stability Report, 2009, Camara et al., 2013, Martynova et al., 2015) while some authors consider both variables as dependent and independent (Berger et al., 2009, Koutsomanoli-Filippaki and Mamatzakis, 2009). But in all these studies, the overall performance of a bank characterises its global results, given its level of risk, and is often expressed through indicators of profitability and financial soundness (Boadi et al., 2016, Claessens et al., 2017, among others). The risk defines an uncertain but possible event which can cause some losses. It corresponds only to negative deviations from the expected outcome, a positive one would be considered as an opportunity. Financial ratios are mainly employed to evaluate credit risk (Alshatti, 2015, Bhattarai, 2016, Trad et al., 2017, Bikker and Vervliet, 2017, among others), the most assessed risk regarding this issue. We also find risk measures for insolvency risk as the Z-score (Camara et al., 2013, Abdullah, 2015, Boadi et al., 2016), reflecting the level of capitalisation of banks with respect to their return distribution and the distance to default, (Koutsomanoli-Filippaki and Mamatzakis, 2009) which expresses the market

perception of bank risk or risk measures considering market risk (Ekinci, 2016).

However, the main focus in covering this topic in literature has been on the relationship between credit risk and bank performance. Although banks face different risks, credit risk is by far the most significant risk, it requires reliable measurements and efficient management to a greater extent than any other risks (Giesecke, 2002, Boffey and Robson, 1995). Notwithstanding, there is no general consensus about the different conclusions drawn in literature, making this area worth studying. An early study on the topic, Berger (1995), shows that there was a strong positive relationship between capital-assets ratio and profitability for U.S. banks in the 1980s, while Alshatti (2015), Ekinci (2016), Bhattarai (2016) report a negative relationship. More specifically, Alshatti (2015) and Bhattarai (2016) run respectively their study on Jordanian banks over 2005-2013 and on Nepali banks over 2010-2015, using non-performing loans as proxy for credit risk. Ekinci (2016) assesses the effect of credit risk through an industrial index.

Beyond the appraisal of credit risk, Ekinci (2016) includes the effect of market risk via interest and FX rate risks. He focuses on the banking system in Turkey with weekly observation from 2002 to 2015. The effect of market risk is found to be unclear. Boadi et al. (2016) take into account two different risks: the funding risk, the likelihood risk arising due to bank's inability to mobilise more deposits, and the resilience risk, the insolvency risk. One may notice that little attention has been paid to insolvency risk. Koutsomanoli-Filippaki and Mamatzakis (2009) is one of the few studies to investigate the relationship via the distance to default. They concentrate their study on the European banking market over the period 1998 to 2006. The sample includes 251 listed banks, as the computation of the distance to default is a market-based measure and requires listed banks' data. Panel-VAR analysis shows that in most cases risk causes inefficiency. The reverse relation is not refuted but presents weaker evidence.

Furthermore, investigating the key role of interest rates in determining prof-

itability is knowing a particular awareness due to the prevalence of a low interest rate environment. Yet, empirical analysis remain relatively limited. Studying the effect of interest rates on bank profitability was mainly considered as a "by-product" (Borio et al., 2015, p.3). Demirgüç-Kunt and Huizinga (1998) is among the first studies to relate bank profitability to macroeconomic indicators, and in particular real interest rates. Running their research on 80 countries from 1988 to 1995, they highlight that higher real interest rates are associated to higher interest margins and profitability. This is especially true for developing countries where deposits are remunerated below market interest rates. More recently, Albertazzi and Gambacorta (2009) focus on 10 major advanced countries, including both Euro area members and Anglo-Saxon countries. Their results suggest a positive effect between net interest income and the yield curve. They also find a positive relationship between loan loss provision and short-term interest rate. Similarly, Bolt et al. (2012) consider a cross-country analysis on 19 developed countries and come to the same findings.

However, only few papers have specifically focused on the effect of interest rates on banks' profitability. English (2002) addresses the issue of interest rate risk - by inspecting its volatility - and interest rate margins in 10 industrialised countries. He finds that a steeper term structure increases NIM as the average yield on assets is closer to long-term rate than the average yield on the liability side. Focusing only on the United-kingdom, Alessandri and Nelson (2014) provide the same results explaining that in response to greater interest rates, banks raise their lending rates, although they reduce their lending volume through a strengthening in their lending standards.

All the same, investigating the effect of low interest rate environment on bank profit has gained prominence in recent literature, even though this issue remains currently under-researched. The foremost finding is that persistent low interest rates weigh on bank net interest income (Weistroffer, 2013, Genay and

Podjasek, 2014, Borio et al., 2015, Bikker and Vervliet, 2017, Claessens et al., 2017). More particularly, Borio et al. (2015) take into account non-linear effects and demonstrate the existence of an inversed U-shape. In other words, the effect of interest rates on banks' NIM is much stronger at lower levels. Although there is a consensus on the effect of interest rates on NIM, its impacts on profitability are more controversial. Indeed, Bikker and Vervliet (2017) find that American banks succeed in maintaining their overall profit by lowering provisioning. Weistroffer (2013) focuses on the Japanese banking system and argues that low interest rate environment has galvanised banks to shift their portfolios over the time towards investments in securities and to have higher reliance on non-interest income, allowing them to maintain profits. Borio et al. (2015) concentrate on advanced countries and find a positive link between short-interest rates and return on assets. They specify that higher interest rates increase loan loss provisions via a growing burden of debt services and have a negative impact on securities' valuation. Whereas Claessens et al. (2017) focus on a cross-country analysis and provide evidence that low interest rates reduce overall bank profit. Genay and Podjasek (2014) are in line with the previous finding, however, their analysis entails that as long as low interest rates result in better economic outcomes, their net effects on banks' profitability may become positive.

3. Data and methodology

In this section, we present the data we employ to conduct our study. Then, we introduce and explain the econometric methodology.

3.1. Data description

Our study focuses on 26 European countries, including countries with different monetary authorities: 15 are euro-area members where monetary policy is conducted by the European Central Bank (ECB), while the rest of the sample

are countries with their own central bank. Thus, it allows us to study the wide effect of bank risk and low policy interest rates on European banks' performance. Our data covers about 421 banks [1] and span from 1999 to 2015 (see Table 1). To summarise, Table 2 provides a full list of variables used in our analysis, their definition, their sources and descriptive statistics.

Table 1: Countries and number of banks included in the sample

	List of countries	# of banks	Monetary authority
1	Austria	18	ECB
2	Belgium	7	ECB
3	Bulgaria	21	Balgarska Narodna Banka
4	Croatia	7	Hrvatska Narodna Banka
5	Czech Republic	15	Česká Národní Banka
6	Denmark	25	Nationalbanken
7	Estonia	6	ECB
8	Finland	1	ECB
9	France	3	ECB
10	Germany	31	ECB
11	Greece	7	ECB
12	Hungary	15	Magyar Nemzeti Bank
13	Ireland	3	ECB
14	Italy	27	ECB
15	Latvia	15	ECB
16	Lithuania	6	ECB
17	Netherlands	16	ECB
18	Norway	27	Norges Bank
19	Poland	30	Narodowy Bank Polski
20	Romania	21	Banca Naţională a României
21	Slovak Republic	15	ECB
22	Slovenia	14	ECB
23	Spain	16	ECB
24	Sweden	8	Sveriges Riksbank
25	Switzerland	32	Swiss National Bank
26	United-Kingdom	35	Bank of England
	Total	**421**	

[1] Banks refer to commercial, holding and saving banks, specialised governmental credit institutions and multi-lateral governmental banks and data are not consolidated.

3.1.1. Bank profitability

We rely on common and reliable indicators to determine bank profitability (or bank performance). We take into account two financial ratios adopted in previous and different studies (Fayed, 2013, Jawadi et al., 2014, Boadi et al., 2016, Trad et al., 2017) the Return on Assets (ROA) and the Return on Equity (ROE). In addition, as we are also investigating the effect of low policy interest rates on bank performance, we also consider the net interest margin (NIM) as a bank performance indicator (Borio et al., 2015, Claessens et al., 2017). In Europe, while NIM pursues a rapid and continued degradation, ROA and ROE heavily suffered from the GFC and knew a sharp decline until recently. Indeed, ROA and ROE have been increasing for the past few years (Appendix A).

3.1.2. Bank risk

Banks are subject to different types of risk. We decide to consider credit risk, the most important risk banks may face (Alshatti, 2015, Gilchrist and Mojon, 2014). We also consider insolvency risk. Even though the literature on this issue did not give yet so much prominence to this type of risk, the GFC has shown the limits of the traditional banking system and proved that insolvency risk did not disappear. Thus, we rely on two financial ratios to proxy credit risk and we employ the Z-score to proxy insolvency risk, the most widely used accounting-based risk measure in the banking literature (Laeven and Levine, 2009, Delis et al., 2012, Ramayandi et al., 2014, Boateng and Nguyen, 2015, Trad et al., 2017, among others). It represents the inverse probability of insolvency, i.e. the lower the Z-score, the higher the risk, and it expresses the inability of a bank to repay its debt and financial obligation because of bankruptcy. Its main advantages are the concept of risk on which it is based and its ease of computation. However, the latter feature is the result of many unrealistic simplifications and assumptions, which are well explained in Lapteacru (2016). To avoid such drawbacks, the author proposes to consider the real distribution of banks' ROA.

Credit risk

As it is well-explained and validated in Bikker and Hu (2001) and Bikker and Metzemakers (2005), a higher exposure to lending activity entails lower margins if loans become riskier. Indeed, an increase of credit risk directly hits profits since provisioning for expected loan losses are deducted from it. We proxy credit risk by two variables: loan loss provisions to gross loans ratio and total equity to net loans ratio. Both variables are considered as good financial ratios to assess banks' financial vulnerability and resilience to financial shocks (Trad et al., 2017).

Insolvency risk

Lapteacru (2016) demonstrates that the traditional Z-score, on which many studies rely, is based on unrealistic assumptions whereas the normality hypothesis regarding the distribution of banks' ROA is the most important. The author explains that - because it is very flexible - the stable distribution allows the best consideration of ROA distribution shapes, thus, providing consistent estimates of the Z-score. A random variable is considered stable if its characteristic function can be written as following:

$$\phi(t;\beta,\alpha,\mu,\sigma) = exp[it\mu - |\sigma t|^{\beta}(1 - i\alpha sgn(t)\phi)]$$

where, $\phi = \begin{cases} tan(\frac{\pi\beta}{2}), if \beta \neq 1 \\ -\frac{2}{\pi} log|t|, if \beta = 1 \end{cases}$ and $\beta \in (0, 2]$ represents the stability index, $\alpha \in [-1; 1]$ the skewness parameter, $\mu \in R$ the location parameter and $\sigma > 0$ the scale parameter. This very flexible distribution comprises normal distribution (for $\beta = 2$), Cauchy distribution (for $\beta = 1$ and $\alpha = 0$) and Lévy distribution (for $\beta = 1/2$ and $\alpha = 1$).

Since the negative traditional Z-score is the point at which the normal cumulative distribution function N(.) is equal to the probability of default, as computed with the normal cumulative distribution function:

$$Z_{trad} = -N^{-1}(N(-COA; \mu, \sigma)) = \frac{COA + \mu}{\sigma}, \tag{1}$$

the same concept is considered for the improved Z-score but with a probability of default that is computed with an estimated stable cumulative distribution function $F_{StD}(.)$, as following:

$$Zscore = -N^{-1}(F_{StD}(-COA; \beta, \alpha, \mu, \sigma)), \tag{2}$$

where COA is the banks capital on assets ratio.

In order to determine the parameters α, β, μ and σ, and because the stable distribution has no analytic functions, we apply the distance minimisation algorithm (Lapteacru, 2016). Parameters' estimations minimise the distance between the stable probability density function and the smooth kernel distribution[2]. The distribution parameters and thus the Z-score are estimated only for banks with at least ten observations.

3.1.3. Policy interest rate

We focus our analysis on an observable monetary policy variable that describes the evolution of monetary policy across Europe: the policy interest rate (i^r). Moreover, the period on which we focus - from 1999 to 2015-, considers pre- and post-crisis years, allowing us to grab the full evolution of the low interest rates environment.

[2]See Lapteacru (2016) for more details.

3.1.4. Bank control variables

We control for a set of bank-specific factors which are well-known to influence bank profitability. We include the equity to total assets ratio (EQUITY) that controls for banks capitalisation. A high level of capital may act as a buffer in case of adverse developments and may help to maintain the level of profitability during an economic slowdown (Athanasoglou et al., 2008). Moreover, since the Basel Accord may shape the level of capital as a percentage of risk-weighted assets, (Iannotta et al., 2007) finds that banks with a higher level of capitalisation could yield higher returns.

We introduce banks' total assets that controls for banks' size (SIZE), even if its effect are inconclusive. Demirgüç-Kunt and Huizinga (1998) and Borio et al. (2015) find a positive effect between bank size and profitability, whereas ECB (2015) concludes on a negative relationship explaining that larger banks are more complex and costly. Athanasoglou et al. (2008) finds no linear evidence for the effect of bank size on bank performance.

The ratio of non-interest income over total income controls for diversification and reflects an income generated by fees and commission but also trading activities. Once again, there is not any strict consensus about the impact of diversification on profitability. Elsas et al. (2010) suggest that non-interest income yield higher returns and enhances bank profitability. While, the converse is found by ECB (2015) and Demirgüç-Kunt and Huizinga (1998). Finally, by identifying three different business models via balance sheet compositions, Roengpitya et al. (2014) deduces that bank performance varies markedly across business models and over the time.

In the end, the ratio of total loans over total assets is important to catch the relative lending size. A large portfolio induces higher net interest income. However, this latter is also subject to credit risk (Demirgüç-Kunt and Huizinga, 1998, ECB, 2015). Some studies find that, on balance, lending has a positive

effect on profitability, although lending is found to be pro-cyclical (Bikker and Metzemakers, 2005).

3.1.5. Country control variables

Since we are using a panel data analysis, it is necessary to control for country-specific characteristics. We include the real GDP growth (RGDPG) to control for the business cycle. This latter has a pro-cyclical effect on the profitability via lending activity and provisioning (Demirgüç-Kunt and Huizinga, 1998, Bikker and Hu, 2001).

Market concentration (MC) is measured by the Herfindahl-Hirschman index and controls for the banking market structure. No clear relationship has been found between market concentration and performance. On the one hand, a high concentration is expected to increase profits because banks have a greater market power and might be able to charge higher interest rates for loans and lower for deposits (Goddard et al., 2004). On the other hand, Athanasoglou et al. (2008) and Berger et al. (2009) argue that efficiency can also explain the effect of market concentration on performance.

Finally, we introduce a variable controlling for the percent change of average consumer price (INFLATION), which also exhibits the business cycle. Most empirical studies assert that there is a positive effect of inflation on profit, however its coefficient is difficult to interpret.

3.1.6. Descriptive statistics

Table 2 provides some summary statistics. Data cover banks with very different profiles. First of all, in terms of profitability the strong negative results correspond to CEE (Central and East European) countries (especially Bulgaria and Slovenia), where the global financial crisis hit these countries even stronger. As expected, the country where insolvency risk is the highest, namely with the lowest Z-score, is Greece. Regarding credit risk, the negative financial ratios are

Table 2: Definition and descriptive statistics of the variables.

Variables	Description	Nr. of obs.	Mean (SD)	Min	Max	Source
Performance (π)						
ROA	Return on assets (%)	6662	0.590 (2.90)	-99.57	44.66	BankScope and Fitch Connect
ROE	Return on equity (%)	6657	6.089 (28.00)	-766.27	560	BankScope and Fitch Connect
NIM	Net interest margin (%)	6598	2.882 (2.75)	-16.94	48.47	BankScope and Fitch Connect
Risk (π)						
$Z - score_{std}$	Zscore estimated with stable cumulative distribution function, Eq. (1).	6674	3.624 (4.24)	-1.89	52.62	BankScope, banks annual reports and authors computations
ENL	Equity on net loans (%)	6628	28.495 (60.14)	-522.79	984.21	BankScope and Fitch Connect
LLP	Loan loss provisions on gross loans (%)	6433	1.382 (3.33)	-66.67	55	BankScope and Fitch Connect
Interest rate						
i^r	Policy interest rate	7129	3.626 (4.55)	-0.75	35	DataStream and central banks annual reports
Bank control (B)						
EQUITY	Equity to total assets ratio (%)	6791	10.511 (10.31)	-3.93	98.78	BankScope and Fitch Connect
SIZE	Size of banks, expressed as banks total assets in thousand billions of USD	6791	0.097 (0.304)	4.58e-06	3.8	BankScope and Fitch Connect
DIVERSIFICATION	Non-interest income over total income (%)	6634	37.325 (36.64)	-1465.02	662.68	BankScope and Fitch Connect
LENDING	Total loans over total assets (%)	6675	55.067 (50.99)	0	1637.98	BankScope and Fitch Connect
Country control (C)						
MC	Market concentration, computed with Herfindahl index	7157	0.082 (0.05)	0.02	0.41	DataStream and authors computation
RGDPG	Real GDP growth rate (%)	7157	2.155 (3.09)	-14.81	26.28	DataStream
INFLATION	Percent change of average consumer prices	7157	2.994 (4.57)	-1.68	45.8	FMI database

Notes: This table defines our variables and reports summary statistics.

associated to CEE countries. Hence, this first overview on the data suggests that riskier banks may be less efficient in terms of performance. Very high interest policy rates correspond to crisis periods of nineties in many CEE countries and correspond to Roumania in our data base. Negative values reflect unconventional monetary events.

Moreover, the data exhibits many heterogeneous banks in terms of characteristics across equity, size, lending and diversification and various banking markets in term of concentration, real GDP growth and inflation. Note that the very negative and high value of GDP growth corresponds to crisis events of the nineties in CEE transition economies and to the very high and recent Irish economic boom, respectively. Again, the very high percent change of inflation coincides with the crisis events of nineties in Roumania, while the negative one coincides with the post-crisis period when many countries have struggled with a low (even negative) inflation rate.

3.2. Econometric methodology

The estimated models use panel data to measure banks' soundness in terms of profitability. In a first step, we assess the ability of banks to generate profits while taking into account its level of incurred risks and the overall effect of the policy interest rates. We also control for bank- and country-specific characteristics. The robustness of results is ensured by employing a set of financial indicators to measure bank profitability (ROA, ROE and NIM). The empirical literature strongly suggests to consider the dynamic nature of bank performance in the model (i.e. the lagged dependant variable is treated as an explanatory variable). Indeed, many authors (Athanasoglou et al., 2008, Berger et al., 2009, Dietrich and Wanzenried, 2011, Hoffmann, 2011, among others) support that bank performance tends to persist over time. Thus, we adopt the following

model:

$$\begin{aligned}\pi_{i,j,t} = \quad & \alpha_0 + \alpha_1 \pi_{i,j,t-1} + \alpha_2 Risk_{i,j,t} + \alpha_3 i^r_{j,t} + \alpha_4 B_{i,j,t} \\ & + \alpha_5 C_{j,t} + \theta_t + \epsilon_{i,k,t}\end{aligned} \tag{3}$$

where $\pi_{i,j,t}$ denotes the set of financial indicators to measure bank profitability, namely ROA, ROE and NIM, for the bank i in the country j and for the year t. $Risk_{i,j,t}$ breaks down into two types of variables determining credit risk (ENL and LLP) and insolvency risk ($Zscore_{std}$). The variable $i^r_{j,t}$ defines the policy interest rate in each country. The set of bank and country characteristics is included in $B_{i,j,t}$ and $C_{j,t}$, respectively. Finally, θ_t is the time (year) dummy and $\epsilon_{i,k,t}$ is an error term. Moreover, the coefficient α_1 captures the level of persistence of bank profitability. If α_1 is between 0 and 1, profits display persistence but will return to its normal level. If α_1 is close to zero, the speed of adjustment is high and persistence is low, inducing a quite competitive banking industry. While if α_1 is close to one, persistence is strong, inducing low competitiveness (Athanasoglou et al., 2008).

However, the traditional econometric methods, as OLS or fixed effect, do not prevent the endogeneity problems the equation may face. Firstly, the dynamic panel bias resulting from the correlation between the lagged dependent variable and the error term makes the traditional econometric methods inconsistent. In addition, equation (3) might face other endogeneity issues caused by potential reverse causality regarding some bank profitability determinants and/or by omitted variable bias. Bikker and Metzemakers (2005), Hoffmann (2011) and Trujillo-Ponce (2013) argue that a loop of causality exists between bank characteristics and profitability. Garca-Herrero et al. (2009) show that more profitable banks are more likely to increase their level of equity by transforming a part of their profit into reserves. Also, more profitable banks employ more and spend more on advertising, thus, increasing the size. Since our sam-

ple includes exclusively advanced countries who have suffered from the GFC, particular attention might be addressed to another potential reverse causality between bank profitability and the policy interest rate. Policy maker could have attempted to contain the crisis by reducing interest rates (Claessens et al., 2017). Finally, unsurprisingly, by looking into the level of profit bank managers may be encouraged to take on more risk or not. As a consequence, all bank characteristics, bank risk measures and the policy interest rate are treated as endogenous variables in our model. All macroeconomic variables (i.e. MC, RGDPG and INFLATION) are treated as exogenous.

Given all these arguments, we decide to apply the General Method of Moments (GMM) using the Arellano and Bover (1995) and Blundell and Bond (1998) estimators. This method transforms exogenous regressors in first differences which are instrumented by themselves, while endogenous variables (also transformed in first differences) are instrumented by their own lags in level, allowing to solve the endogeneity problems. The authors have shown that difference GMM can be improved by relying on system GMM which introduces equations in level in the estimation procedure. Indeed, Arellano and Bover (1995) claim that regressors in level can be weak instruments for first-differences equations. The system GMM completes first-differences equations with equations in level, lagged levels of endogenous regressors and lags of first-differenced regressors are respectively used as instruments for difference and level equations. Moreover, we use the robust command and the two-step estimator since the command xtabond2, that we apply to estimate our model, allows to make the Windmeijer (2005) finite-sample correction to the reported standard errors in two-step estimation, without which those standard errors tend to be severely downward biased (Roodman, 2009, p.1).

In a second step, we focus on the effect of low interest rates environment and bank risk on bank profitability. Following Borio and Gambacorta (2017),

we integrate an interaction term between the i^r and a dummy $Lowrate_{j,t}$ for a low interest rate environment. $Lowrate_{j,t}$ takes the value of 1 when the value of the policy interest rate are in the first quartile of the distribution. Therefore, the model becomes:

$$\begin{aligned}\pi_{i,j,t} = \quad & \alpha_0 + \alpha_1 \pi_{i,j,t-1} + \alpha_2 Risk_{i,j,t} + \alpha_3 i^r_{j,t} + \alpha_4 i^r_{j,t} * Lowrate_{j,t} \\ & + \alpha_5 B_{i,j,t} + \alpha_6 C_{j,t} + \theta_t + \epsilon_{i,k,t}\end{aligned} \tag{4}$$

4. Results

This section introduces and comments the results of both the effect of insolvency and credit risks on bank profitability. Firstly, we look at the overall effect of the policy interest rate on bank profitability. Then, we focus on the effect of low policy interest rates.

4.1. The overall effect of policy interest rates and bank risk on profitability.

First of all, we consider the overall effect of the policy interest rate on bank profitability, taking into account both the insolvency risk and the credit risk.

4.1.1. Insolvency risk, policy interest rates and bank profitability.

Table 3 presents the results for Eq (3) where *Risk* corresponds to insolvency risk. The persistence of bank profit is well caught by the model. Coefficients are between 0 and 1, inducing that profit will return to its normal level. However, the different values of these coefficients entail a moderate speed of adjustment of profitability. Focusing on insolvency risk reveals that a higher Z-score instils confidence in the banking sector and increases profits. This is confirmed by all our bank profitability measures, although the effect is stronger on the overall profitability and especially on ROE. This latter seems more sensitive since shareholders may pay greater attention to default risk. In line with Boadi

et al. (2016), this result backs that stability in the banking sector promotes bank profitability.

The policy interest rate is highly significant in all regressions, indicating that a relaxation of monetary policy negatively affects banks' profit. This finding corroborates the idea that banks are reluctant to lower their interest rates on deposits. Thereby, interest expenses drops less than interest income and compress NIM. One may notice that ROA and especially ROE, shrink even more after a fall in policy interest rate. As it is explained in Claessens et al. (2017), European banks still have a low share of non-interest income in their revenues. Thus, a weaker NIM has a great negative impact on the overall profitability of banks. But valuation gains in securities held by banks may mitigate the negative effect coming from a decrease in NIM and explain the lower effect on ROA (comparing with ROE).

Bank characteristics have various effects. We cannot conclude that an increase in EQUITY improves bank performance because higher capital is often supposed to be costly for banks, implying a reduction in profitability. In addition, the recent strengthening in bank regulation may exacerbate this statement and explain the negative relationship between ROE and EQUITY. We also notice that SIZE has a negative effect. This is in line with Martynova et al. (2015), who indicate that big and high profitable banks took greater risk through substantial exposures to market risk. Thus, when the crisis erupted these same banks registered important losses. Similarly, LENDING has a relatively slight and negative effect on ROA. Finally, a greater DIVERSIFICATION is likely to enhance the overall profitability.

Country control variables present consistent results. A vigorous GDP growth improves profit. INFLATION is only significant for the regression with ROA and shows that higher inflation negatively affects bank profitability. Lastly, MC displays a positive relationship between bank concentration and NIM inducing

Table 3: The effect of policy interest rates and bank insolvency risk on profitability.

Variables	Dependent variables (π)		
	ROA	ROE	NIM
π_{t-1}	0.366***	0.553***	0.655***
	(0.110)	(0.083)	(0.088)
$Z-score_{std}$	0.261**	1.992***	0.050*
	(0.129)	(1.006)	(0.029)
i^r	0.174***	0.852***	0.159***
	(0.044)	(0.280)	(0.040)
EQUITY	-0.011	-0.687**	0.013
	(0.038)	(0.286)	(0.022)
SIZE	-0.232	-4.967***	-0.223**
	(0.195)	(1.913)	(0.999)
LENDING	-0.006***	-0.003	-0.001
	(0.002)	(0.030)	(0.001)
DIVERSIFICATION	0.014**	0.301***	-0.006
	(0.007)	(0.086)	(0.006)
RGDPG	0.067***	0.821***	0.036***
	(0.010)	(0.106)	(0.007)
MC	1.932	12.225	2.098**
	(1.452)	(13.209)	(1.074)
INFLATION	-0.129***	-0.393	-0.062**
	(0.030)	(0.251)	(0.025)
CONST.	-1.046*	-11.480**	
	(0.606)	(4.663)	
Total observations	6119	6112	6097
Nr. of instruments	81	67	54
AR(1) (p-value)	0.000	0.002	0.001
AR(2) (p-value)	0.752	0.681	0.770
Hansen test (p-value)	0.223	0.293	0.343

Notes: Heteroscedastic robust t-statistics are in parentheses. ***, ** and * are statistical significances at 0.01, 0.05 and 0.10 level, respectively. AR(1) and AR(2) are the tests for first and second-order autocorrelation and Hansen is the test for over-identifying restrictions. The results associated to tests of exogeneity of instruments are not reported but validate our instruments. Time (years) dummies are not reported and dropped from regressions when they do not bring any additional information in the model. Note that the constant for the model with NIM as dependent variable disappears because of time fixed effects. The command "collapse" is used to limit the number of instruments.

that the higher the concentration on the banking sector, the greater the net interest income is. Stronger market power allows financial institutions to impose and practice higher interest rate.

4.1.2. Credit risk, policy interest rate and bank profitability.

Table 4 presents the results of Eq (3) when *Risk* corresponds to credit risk, namely two ratios: equity on net loans (ENL) and loan loss provisions on gross loans (LLP). With high significant coefficients for π_{t-1}, the model grabs, once again, the dynamic feature of bank profitability.

ENL provides evidence that capital requirement is costly for European banks; a raise in equity impairs the overall profitability but particularly ROE. Kauko (2012) argues that banks have a high propensity to avoid strong capitalisation. Financial institutions might have industry-specific incentives to prevent issuing equity which, in turn, contradict the irrelevance Modigliani-Miller theorem. Indeed, banks are subjected to deposit runs, a specific problem to credit institutions. Hence, distributing dividends sends a positive signal, but not doing so may trigger a run. However, it is costly if banks have low returns and banks may be reluctant to increase the share of capital in order to pay less dividends. Furthermore, the recent strengthening in banking regulation passes partially through an increase in capital requirement, compelling banks to expand their equity level although it is more expensive. We also notice that the effect of ENL on NIM is low but still negative. New facilities will certainly cover the cost of capital via net interest income. Nevertheless, existing facilities may, in some cases, disable banks to cover their substantial increase costs of capital from their borrower, decreasing their internal rates of return. Our results for the ratio LLP are in line with expectations and literature (Bikker and Hu, 2001, Alhadab and Alsahawneh, 2016, Mustafa et al., 2012). As profit is calculated by deducing credit loss provisions from net profits, an important share of loan loss provisions necessarily diminishes bank profitability. This outcome performs an important

Table 4: The effect of policy interest rates and bank credit risk on profitability.

Variables	Dependent variables (π)					
	ROA		ROE		NIM	
π_{t-1}	0.511***	0.233***	0.319***	0.388***	0.604***	0.765***
	(0.087)	(0.095)	(0.122)	(0.100)	(0.099)	(0.081)
ENL	-0.005**		-0.040***		-0.004**	
	(0.002)		(0.015)		(0.002)	
LLP		-0.297***		-3.239***		-0.080*
		(0.074)		(1.198)		(0.051)
i^r	0.108***	0.089***	1.768***	0.698**	0.165***	0.136***
	(0.033)	(0.030)	(0.446)	(0.350)	(0.041)	(0.042)
EQUITY	0.029	0.018	-0.170	-0.274	-0.029	0.013
	(0.002)	(0.029)	(0.311)	(0.022)	(0.018)	(0.025)
SIZE	-0.977	-0.227**	-0.170	-2.245**	-0.209**	-0.155*
	(0.110)	(0.120)	(0.311)	(1.532)	(0.880)	(0.871)
LENDING	-0.013***	-0.011***	-0.040	-0.030	-0.003**	-0.002
	(0.002)	(0.002)	(0.025)	(0.022)	(0.001)	(0.002)
DIVERSIFICATION	0.016**	0.014***	0.312***	0.251***	-0.009*	-0.001
	(0.008)	(0.004)	(0.131)	(0.092)	(0.006)	(0.006)
RGDPG	0.073***	0.040***	0.867***	0.425**	0.035***	0.022**
	(0.011)	(0.010)	(0.112)	(0.190)	(0.008)	(0.011)
MC	0.488	3.368**	6.121	32.876*	2.551**	2.126*
	(1.089)	(1.543)	(13.385)	(17.913)	(1.114)	(1.135)
INFLATION	-0.095***	-0.056***	-1.100***	-0.212	-0.054**	-0.067***
	(0.028)	(0.019)	(0.316)	(0.366)	(0.023)	(0.025)
CONST.	0.043	0.318	-6.099	-1.748		
	(0.274)	(0.207)	(4.580)	(3.660)		
Total observations	6105	5944	6097	5937	6083	5922
Nr. of instruments	88	88	88	46	61	40
AR(1) (p-value)	0.000	0.000	0.002	0.001	0.001	0.001
AR(2) (p-value)	0.576	0.316	0.922	0.978	0.782	0.834
Hansen test (p-value)	0.222	0.372	0.562	0.435	0.637	0.493

Notes: ***, ** and * are statistical significances at 0.01, 0.05 and 0.10 level, respectively. s.e. correspond to standard errors. AR(1) and AR(2) are the tests for first and second-order autocorrelation and Hansen is the test for over-identifying restrictions. The results associated to tests of exogeneity of instruments are not reported but validate our instruments. Time (years) dummies are not reported and dropped from regressions when they do not bring any additional information in the model. Note that the constant for the model with NIM as dependent variable disappears because of time fixed effects. The command "collapse" is used to limit the number of instruments.

role for bank manager and especially financial stability.

The effects of control variables are consistent with previous findings in Table 3. Coefficients associated to i^r are highly significant and all negative, confirming last results and supporting that a low interest rate environment compresses banks' revenues when using credit risk. Same signs and significance are found for bank and country control variables. Except for EQUITY which is not significant at all and DIVERSIFICATION which consistently reduces NIM since higher diversification corresponds to an increase of non-interest income. The positive effect of MC on the overall profit is well confirmed when using LLP ratio.

4.2. Bank risk and profitability under low interest rates

In a second step, we are interesting in analysing whether policy interest rates at low level have an effect on bank profitability. Thus, we introduce a dummy variable in order to capture the effect of low policy interest rates.

4.2.1. Insolvency risk and profitability under low interest rates

By including the interaction term in the regression (see Eq (4)), we first notice that, in Table 5, insolvency risk still positively influences bank profitability even though the coefficient for the regression ROA lacks of statistical significance. The response of bank profitability to changes in policy interest rates is significant and positive in accordance with previous results. Findings are close to the previous values we found in table 3 and 4. However, although the interaction term is significant and negative for the regression with ROA and ROE, the policy interest rates effect at low level is insignificant[3]. Whereas, as expected, policy interest rates at low level worsens NIM.

All the coefficients of the control variables have the expected sign and are similar to the previous findings. Among bank characteristic variables, SIZE and

[3]The policy interest rates impact in a low interest rate environment is given by -0.004 - 0.396 = -0.400

Table 5: Insolvency risk, policy interest rates at low level and profitability.

Variables	Dependent variables (π)		
	ROA	ROE	NIM
π_{t-1}	0.500***	0.604***	0.721***
	(0.178)	(0.092)	(0.093)
$Z-score_{std}$	0.082	1.903***	0.072**
	(0.171)	(0.679)	(0.039)
i^r	0.063**	0.574**	0.147***
	(0.029)	(0.290)	(0.039)
i^r*Lowrate	-0.230**	-1.109**	0.014
	(0.112)	(0.583)	(0.049)
EQUITY	-0.023	-0.622**	0.028
	(0.064)	(0.282)	(0.018)
SIZE	-0.101	-4.331**	-0.889
	(0.349)	(1.625)	(0.905)
LENDING	0.004	0.002	-0.001
	(0.005)	(0.027)	(0.002)
DIVERSIFICATION	0.001*	0.175***	-0.008
	(0.017)	(0.091)	(0.009)
RGDPG	0.086***	0.816***	0.022***
	(0.018)	(0.103)	(0.005)
MC	1.186	8.904	0.850
	(2.478)	(11.233)	(0.997)
INFLATION	-0.070***	-0.304	-0.090***
	(0.028)	(0.271)	(0.024)
CONST.	-0.291	-7.077*	0.124
	(0.791)	(4.039)	(0.380)
Policy interest rates	-0.168	-0.536	0.161***
effect at low level	(0.008)	(1.062)	(0.001)
Total observations	6119	6112	6097
Nr. of instruments	44	68	28
AR(1) (p-value)	0.001	0.002	0.000
AR(2) (p-value)	0.455	0.948	0.905
Hansen test (p-value)	0.756	0.161	0.748

Notes: Heteroscedastic robust t-statistics are in parentheses. ***, ** and * are statistical significances at 0.01, 0.05 and 0.10 level, respectively. AR(1) and AR(2) are the tests for first and second-order autocorrelation and Hansen is the test for over-identifying restrictions. The results associated to tests of exogeneity of instruments are not reported but validate our instruments. Time (years) dummies are not reported and dropped from regressions when they do not bring any additional information in the model. The line "policy interest rates effect at low level" is computed by summing the coefficients associated to i^r and i^r*Lowrate. The command "collapse" is used to limit the number of instruments.

DIVERSIFICATION are the most significant variables. Confirming that bigger banks took on greater risk and faced lower profitability while a higher diversification increases the overall profitability. Among country characteristics, the real GDP growth is highly significant and still consistently indicates that a vigorous growth enhances all profitability indicators. INFLATION still negatively influences bank's income.

4.2.2. Credit risk and profitability under low interest rates

In table 6, both credit risk ratios, i.e. ENL and LLP, have the expected signs: the higher the credit risk, the lower the profitability. However, these results become insignificant for NIM.

Furthermore, the overall effect of i^r is still positive and highly significant for all regressions. Focusing on the interaction term, results appear to be different than the overall effect of i^r, but are consistent with previous findings. Although the results for NIM are expected, because low policy interest rates directly affect bank profit margin by compressing it, the effect of low policy interest rates on overall profitability is less obvious. Controlling for the periods when policy interest rates are low, shows that banks succeed in increasing overall profitability despite a reduction of their net interest income (this is in line with the recent evolution of ROA and ROE, see Appendix B). It suggests that banks may for example increase their commissions or invest in riskier assets, in order to inflate overall profit. Financial institutions may have anticipated such a reduction in policy interest rates and thus, in NIM, encouraging them to rely on other sources of profit. At last, bank and country control variables have expected signs.

Investigating only the effect of policy interest rates at low level on the different profitability indicators (i.e. excluding bank risk variables from the regressions), entails the same results (Appendix B). Despite a lack of significance of the coefficient of i^r, the interaction terms bring to light that when policy interest rates are low, NIM diminishes while ROA and ROE increase.

Table 6: Credit risk, policy interest rates at low level and profitability.

Variables	Dependent variables (π)					
	ROA		ROE		NIM	
π_{t-1}	0.432***	0.213***	0.367***	0.221***	0.773***	0.714***
	(0.081)	(0.076)	(0.100)	(0.066)	(0.135)	(0.109)
ENL	-0.009**		-0.045**		-0.004	
	(0.005)		(0.020)		(0.004)	
LLP		-0.238*		-2.033*		-0.017
		(0.150)		(1.149)		(0.077)
i^r	0.072*	0.057**	0.693**	1.587***	0.164**	0.121***
	(0.040)	(0.030)	(0.336)	(0.607)	(0.075)	(0.051)
i^r*Lowrate	-0.124**	-0.276***	-1.109**	-4.397***	0.160	-0.056
	(0.054)	(0.078)	(0.583)	1.159	(0.160)	0.067
EQUITY	-0.006	0.024	-0.055	-0.629***	0.042	0.005
	(0.050)	(0.033)	(0.206)	(0.198)	(0.032)	(0.025)
SIZE	-0.278**	-0.193	-1.857	-0.994	-0.559	-0.114
	(0.144)	(0.158)	(1.684)	(2.658)	(0.177)	(0.121)
LENDING	-0.007**	3.97e-04	-0.040*	0.039**	-0.004*	-4.53e-05
	(0.003)	(0.002)	(0.023)	(0.017)	(0.002)	(0.002)
DIVERSIFICATION	0.009	-0.009	0.207*	0.324	-2.80e-04	-0.017
	(0.008)	(0.016)	(0.112)	(0.277)	(0.007)	(0.012)
RGDPG	0.076***	0.070***	0.926***	0.967***	0.018	0.040**
	(0.012)	(0.020)	(0.108)	(0.206)	(0.016)	(0.018)
MC	1.713	3.293*	-0.366	38.796***	0.674	2.209*
	(1.323)	(1.915)	(10.071)	(13.732)	(1.849)	(1.284)
INFLATION	-0.076**	-0.040	-0.544	-1.283**	-0.104***	-0.046
	(0.036)	(0.035)	(0.358)	(0.93)	(0.036)	(0.031)
CONST.	0.508	0.934	-0.686	18.346*		
	(0.358)	(0.775)	(3.495)	(10.747)		
Policy interest rates	-0.0519	-0.219***	-1.134*	-2.810**	0.324*	0.0641
effect at low level	(0.010	(0.001)	(0.192)	(0.348)	(0.0146)	(0.027)
Total observations	6105	5944	6097	5937	6083	5922
Nr. of instruments	89	36	105	20	35	43
AR(1) (p-value)	0.000	0.000	0.001	0.001	0.001	0.001
AR(2) (p-value)	0.720	0.318	0.763	0.978	0.619	0.489
Hansen test (p-value)	0.120	0.372	0.356	0.435	0.663	0.315

Notes: ***, ** and * are statistical significances at 0.01, 0.05 and 0.10 level, respectively. s.e. correspond to standard errors. AR(1) and AR(2) are the tests for first and second-order autocorrelation and Hansen is the test for over-identifying restrictions. The results associated to tests of exogeneity of instruments are not reported but validate our instruments. Time (years) dummies are not reported and dropped from regressions when they do not bring any additional information in the model. Note that the constant for the model with NIM as dependent variable disappears because of time fixed effects. The line "policy interest rates effect at low level" is computed by summing the coefficients associated to i^r and i^r*Lowrate. The command "collapse" is used to limit the number of instruments.

5. Conclusion

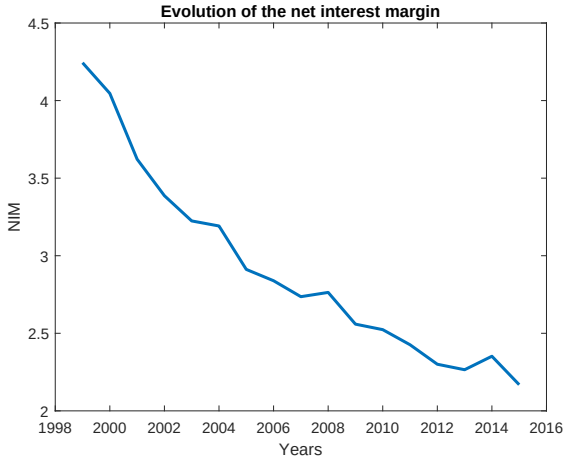
We examine the effect of bank risk and low interest rate environment on banks' net interest margin (NIM) and overall profitability across the European banking sector from 1999 to 2015. As interest policy interest rate has been trending downwards, this time span allows to capture its evolution. We rely on an accounting-based risk measure, namely the asymmetric Z-score to proxy insolvency risk, and two financial ratios, equity on net loans (ENL) and loan loss provisions on gross loans (LLP), to grab credit risk. We build our model on the Generalised Method of Moments (GMM) in order to take into account the dynamic nature of bank profitability, and to overcome endogeneity issues which may appear in our regressions.

This article provides evidence that both risks are harmful in terms of return. A higher Z-score enhances profits and corroborates the idea that financial stability in the banking sector promotes profitability. ENL shows that capital requirement is costly for banks and as expected, LLP has a negative impact on profit measures. Furthermore, our findings highlight the important role of monetary policy's recent evolution on bank profitability. The overall effect of policy interest rates pushes NIM downwards and globally worsens the overall profitability, i.e. the Return on Assets (ROA) and the Return on Equity (ROE). However, shifting the attention on the effect of policy interest rates only at low level, reveals that despite a compression of the NIM, banks succeed in increasing their overall profitability. Hence, banks' ability to generate profits from their traditional activity is eroded by persistent low interest rates. Nevertheless, banks may have anticipated such a reduction in their NIM and thus, generate profit from other sources as commissions or trading activity.

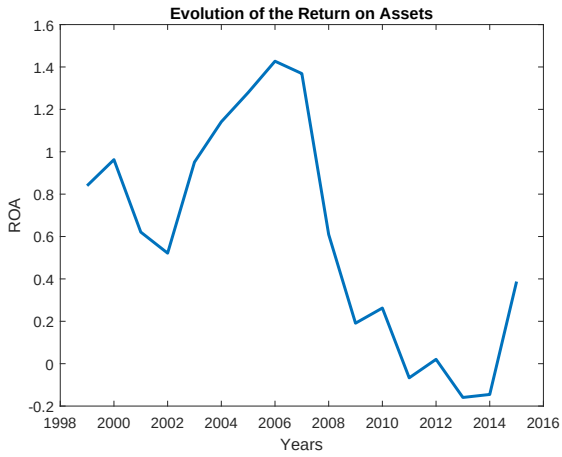
Consequently, it raises some policy issues. One is the possible adverse effect of monetary policy. While low interest rates environment is an uncontrollable obstacle for banks, European financial institutions may pay much attention to

the management and the evaluation of credit risk. If interest rates remain "too low for too long", it may alter European banks' business model by encouraging them to increase their trading activity, impeding the bank lending channel and making the policy interest rate a less efficient tool. However, studying the effectiveness of monetary policy in stimulating economic growth constitutes a caveat. Indeed, as it is well-explained in Genay and Podjasek (2014), as long as policy interest rates are efficient in outweighing the negative effects on bank profitability by boosting economic activity, interest rates may remain low. Another important issue is the prominent role and need of financial stability which, on the one hand, boosts banks' profitability but which, on the other hand, is ensured itself by banks' performance.

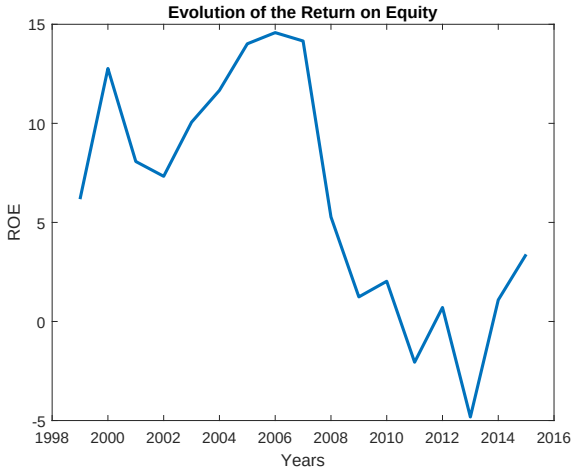
Appendix A. Evolution of bank profitability



(a)



(b)



(c)

Appendix B. The effect of policy interest rates at low level on bank profitability.

Variables	Dependent variables (π)		
	ROA	ROE	NIM
π_{t-1}	0.321**	0.480***	0.782***
	(0.164)	(0.123)	(0.113)
i^r	-0.004	0.199	0.173***
	(0.064)	(0.459)	(0.070)
i^r*Lowrate	-0.396**	-3.628***	0.144
	(0.182)	(1.303)	(0.154)
EQUITY	-0.083*	-0.748*	0.024
	(0.046)	(0.419)	(0.029)
SIZE	-0.451***	-3.559**	-0.053
	(0.145)	(1.569)	(0.124)
LENDING	-0.001	0.011	-0.002
	(0.006)	(0.052)	(0.002)
DIVERSIFICATION	0.028*	0.417***	-0.001
	(0.017)	(0.144)	(0.006)
RGDPG	0.102***	0.889***	0.022*
	(0.016)	(0.145)	(0.014)
MC	4.031***	24.047	0.998
	(1.646)	(18.344)	(1.556)
INFLATION	-0.007	0.037	-0.113***
	(0.007)	(0.480)	(0.034)
CONST.	-0.071	-7.990	
	(0.593)	(5.610)	
Policy interest rates	-0.400**	-3.429***	0.317*
effect at low level	(0.013)	(0.430)	(0.012)
Total observations	6147	6139	6097
Nr. of instruments	25	25	33
AR(1) (p-value)	0.000	0.001	0.001
AR(2) (p-value)	0.855	0.735	0.641
Hansen test (p-value)	0.836	0.329	0.685

Notes: Heteroscedastic robust t-statistics are in parentheses. ***, ** and * are statistical significances at 0.01, 0.05 and 0.10 level, respectively. AR(1) and AR(2) are the tests for first and second-order autocorrelation and Hansen is the test for over-identifying restrictions. The results associated to tests of exogeneity of instruments are not reported but validate our instruments. Time (years) dummies are not reported and dropped from regressions when they do not bring any additional information in the model. Note that the constant for the model with NIM as dependent variable disappears because of time fixed effects. The line "policy interest rates effect at low level" is computed by summing the coefficients associated to i^r and i^r*Lowrate. The command "collapse" is used to limit the number of instruments.

References

Abdullah, M. An empirical analysis of liquidity, profitability and solvency of Bangladeshi banks. *Journal of Business & Financial Affairs*, 5:157, 2015.

Albertazzi, U. and Gambacorta, L. Bank profitability and the business cycle. *Journal of Financial Stability*, 5(4):393-409, 2009.

Alessandri, P. and Nelson, B. Simple banking: profitability and the yield curve. Temi di discussione (Economic working papers) 945, Bank of Italy, Economic Research and International Relations Area, 2014.

Alhadab, M. and Alsahawneh, S. Loan loss provision and the profitability of commercial banks: Evidence from Jordan. *International Journal of Business and Management*, 11(12), 2016.

Alshatti, A. S. The effect of credit risk management on financial performance of the Jordanian commercial banks. *Investment Management and Financial Innovations*, 12(1), 2015.

Arellano, M. and Bover, O. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1):29-51, 1995.

Athanasoglou, P. P., Brissimis, S. N., and Delis, M. D. Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money*, 18(2):121-136, 2008.

Berger, A. The relationship between capital and earnings in banking. *Journal of Money, Credit and Banking*, 27(2):432-56, 1995.

Berger, A., Klapper, L., and Turk-Ariss, R. Bank competition and financial stability. *Journal of Financial Services Research*, 35(2):99-118, 2009.

Bhattarai, Y. R. Effect of credit risk on the performance of Nepalese commercial banks. *NRB Economic Review*, 28(1):41-64, 2016.

Bikker, J. and Hu, H. Cyclical patterns in profits provisioning and lending of banks and procyclicality of the new Basel capital requirements. Technical Report 39, Netherlands Central Bank, Directorate Supervision, 2001.

Bikker, J. and Metzemakers, P. Bank provisioning behaviour and procyclicality. *Journal of International Financial Markets, Institutions and Money*, 15(2): 141-157, 2005.

Bikker, J. A. and Vervliet, T. Bank profitability and risk-taking under low interest rates. Working Paper No. 560, De Nederlandsche Bank, 2017.

Bitar, M., Saad, W., and Benlemlih, M. Bank risk and performance in the MENA region: The importance of capital requirements. *Economic Systems*, 40(3):398-421, 2016.

Blundell, R. and Bond, S. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115-143, 1998.

Boadi, E. K., Li, Y., and Lartey, V. C. Role of bank specific, macroeconomic and risk determinants of banks profitability: Empirical evidence from Ghanas rural banking industry. *International Journal of Economics and Financial Issues*, 6(2):813-823, 2016.

Boateng, A. and Nguyen, V. H. T. An analysis of involuntary excess reserves, monetary policy and risk-taking behaviour of Chinese banks. *International Review of Financial Analysis*, 37:63-72, 2015.

Boffey, R. and Robson, G. Bank credit risk management. *Managerial Finance*, 21(1):66-78, 1995.

Bolt, W., de Haan, L., Hoeberichts, M., van Oordt, M. R., and Swank, J. Bank profitability during recessions. *Journal of Banking & Finance*, 36(9):2552-2564, 2012.

Borio, C. and Gambacorta, L. Monetary policy and bank lending in a low interest rate environment: Diminishing effectiveness? *Journal of Macroeconomics*, 2017. ISSN 0164-0704.

Borio, C. and Zhu, H. Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism? *Journal of Financial Stability*, 8(4):236-251, 2008.

Borio, C., Gambacorta, L., and Hofmann, B. The influence of monetary policy on bank profitability. *International Finance*, 20(1):48-63, 2015.

Camara, B., Lepetit, L., and Tarazi, A. Ex ante capital position, changes in the different components of regulatory capital and bank risk. *Applied Economics*, 45(34):4831-4856, 2013.

Claessens, S., Coleman, N., and Donnelly, M. S. 'low-for-long' interest rates and banks' interest margins and profitability : Cross-country evidence. International finance discussion papers, Board of Governors of the Federal Reserve System (U.S.), 2017.

Delis, M. D., Hasan, I., and Mylonidis, N. The risk-taking channel of monetary policy in the USA: Evidence from micro-level data. MPRA Paper 34084, University Library of Munich, Germany, 2012.

Demirgüç-Kunt, A. and Huizinga, H. Determinants of commercial bank interest margins and profitability : Some international evidence. Policy research working paper series, The World Bank, 1998.

Dietrich, A. and Wanzenried, G. Determinants of bank profitability before and during the crisis: Evidence from Switzerland. *Journal of International Financial Markets, Institutions and Money*, 21(3):307-327, 2011.

ECB. Bank profitability features in Euro area banks: The role of cyclical and structural features. Financial Stability Review:134-145, 2015.

Ekinci, A. The effect of credit and market risk on bank performance: Evidence from Turkey. *International Journal of Economics and Financial Issues*, 6(2): 427-434, 2016.

Elsas, R., Hackethal, A., and Holzhuser, M. The anatomy of bank diversification. *Journal of Banking & Finance*, 34(6):1274-1287, 2010.

English, W. B. Interest rate risk and bank net interest margins. Quarterly review, BIS, 2002.

Fayed, M. Comparative performance study of conventional and Islamic banking in Egypt. *Journal of Applied Finance & Banking*, 3(2):1-14, 2013.

Garca-Herrero, A., Gavil, S., and Santabrbara, D. What explains the low profitability of Chinese banks? *Journal of Banking & Finance*, 33(11):2080-2092, 2009.

Genay, H. and Podjasek, R. What is the impact of a low interest rate environment on bank profitability? *Chicago Fed Letter*, (Jul):324, 2014.

Giesecke, K. *Credit Risk Modeling and Valuation.* Humboldt-Universitt zu Berlin, Wirtschaftswissenschaftliche Fakultt, 2002.

Gilchrist, S. and Mojon, B. Credit risk in the Euro area. Working Paper 20041, National Bureau of Economic Research, 2014.

Goddard, J., Molyneux, P., and Wilson, J. O. S. Dynamics of growth and profitability in banking. *Journal of Money, Credit and Banking*, 36(6):1069-1090, 2004.

Hoffmann, P. S. Determinants of the profitability of the US banking industry. *International Journal of Business and Social Science*, 2(22):255-269, 2011.

Iannotta, G., Nocera, G., and Sironi, A. Ownership structure, risk and performance in the European banking industry. *Journal of Banking & Finance*, 31 (7):2127-2149, 2007.

IMF's Global Financial Stability Report. Responding to the financial crisis and measuring systemic risks. Chapter 3, International Monetary Fund, 2009.

Jawadi, F., Jawadi, N., and Louhichi, W. Conventional and Islamic stock price performance: An empirical investigation. *International Economics*, 137 (Supplement C):73-87, 2014.

Kauko, K. Why is equity capital expensive for opaque banks? Research Discussion Papers 4/2012, Bank of Finland, 2012.

Koutsomanoli-Filippaki, A. and Mamatzakis, E. Performance and Merton-type default risk of listed banks in EU: a panel VAR approach. Discussion paper series, Department of Economics, University of Macedonia, 2009.

Laeven, L. and Levine, R. Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93(2):259-275, 2009.

Lapteacru, I. On the consistency of the Z-score to measure the bank risk. Larefi Working Papers 1604, Larefi, University of Bordeaux, 2016.

Martynova, N., Ratnovski, L., and Vlahu, R. Bank profitability and risk-taking. IMF Working Papers 15/249, International Monetary Fund, 2015.

Mustafa, A. R. U., Ansari, R. H., and Younis, M. U. Does the loan loss provision affect the banking profitability in case of Pakistan? *Asian Economic and Financial Review*, 2(7):772-783, 2012.

Ramayandi, A., Rawat, U., and Tang, H. C. Can low interest rates be harmful: An assessment of the bank risk-taking channel in Asia. Working Papers on Regional Economic Integration 123, Asian Development Bank, 2014.

Roengpitya, R., Tarashev, N., and Tsatsaronis, K. Bank business models. *BIS Quarterly Review*, 2014.

Roodman, D. How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal*, 9(1):86-136, 2009.

Trad, N., Trabelsi, M. A., and Goux, J. F. Risk and profitability of Islamic banks: A religious deception or an alternative solution? *European Research on Management and Business Economics*, 23(1):40-45, 2017.

Trujillo-Ponce, A. What determines the profitability of banks? Evidence from Spain. *Accounting and Finance*, 53(2):561 - 586, 2013.

Weistroffer, C. Ultra-low interest rate: How Japanese banks have coped. Technical report, Deutsche Bank, 2013.