BANKS' BUSINESS MODELS AND PERFORMANCE: THE IMPACT OF INTEREST RATES AND CAPITAL REQUIREMENTS

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Abstract

This paper proposes an evaluation of the impact of interest rates and banks' specific capital buffers on the performance of different banks' business models, in a context of accommodative monetary policy and stricter prudential requirements. We examine a population of 217 large international banking institutions from 25 countries between 2005 and 2016. The proposed approach for the identification and classification of banks' business models is data-driven and mainly based on balance sheet characteristics. Our econometric framework explicitly recognizes the role of the macrofinancial and regulatory environment as well as idiosyncratic factors in the explanation of banks' profitability. The results first highlight differences in terms of sensitivity to interest rate changes across banks' business models. We find some evidence of nonlinear relationship between interest rates and the performance of commercial and universal banks, but to a lesser extent for these latter. The effect of interest rates appears less significant for trading banks. The results also reveal that higher capital buffers appear to be beneficial to banks during financial crisis episodes.

JEL classification: G20, G21, G28

Keywords: business model, performance, interest rates, capital requirements, crisis.

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1. Introduction

More than ten years after the financial crisis, market confidence in banking systems has not yet been fully restored. External factors such as a weak macroeconomic environment or a long lasting low interest rate environment only explain part of the equation. Another reason may be the idiosyncratic factors, at a time where some banks face strong challenges to adapt their business models to the new regulatory and technology-led environment.

The financial crisis has highlighted the necessity to pay due attention to the vulnerabilities of banks' business models, some of which were at the core of the 2007-2008 crisis (excessive reliance on unstable market funding, high leverage, excessive risk taking). In response to the crisis, international regulators, under the umbrella of the Basel Committee, initiated the revision of the prudential regulation and supervision in order to better assess and control the risks in the banking system. The quality and quantity of capital held by banks have been particularly improved by requiring higher levels of capital buffers and imposing a minimum leverage ratio. These regulatory changes are likely to modify banks' funding structure and therefore their profitability[2].

Monetary policies have also responded to the crisis by becoming more accommodative in order to facilitate banks' refinancing and to ensure an efficient financing of the economy. Nevertheless, this historically low interest rates environment could have adverse effects on banks' profitability and risk taking. The impact would depend on the balance sheet composition and the maturity mismatch between assets and liabilities, in particular. Concerning the effect of higher capital requirements - which ceteris paribus increase the share of equity in the capital structure - on banks' performance, the theoretical literature does not reach a consensus.

The objective of this paper is therefore to analyze how interest rates and capital requirements have had a differentiated impact on banks' performance depending on their business model. This assessment is carried out on a large number of international banks and on different subsamples: pre-crisis, crisis and post-crisis. However, the paper does not address whether the choice of business model lead to unhealthy risks, which is also a concern among supervisors and policy makers. Instead we use a proxy to isolate the contribution of the idiosyncratic risk.

By deepening the understanding of how these factors affect differently the performance of banks' business models could help supervisors to be more effective in identifying and assessing future risks. Robust works have been done on banks' business model and profitability. While some papers investigates how a variety of macroeconomic factors – in particular interest rates – and bank-specific variables affect banks' profitability irrespective of their business model. Other works focus on the identification of banks' business models or

[2] Beyond the prudential regulations, worldwide regulators also proposed legislative reforms to address the weaknesses in banks' business models and structural reform projects are currently being discussed or implemented in the US (Volcker), the UK (Vickers), and the EU (Liikanen).

analyse how the choice of business model in terms of income and funding diversification impact banks' risk and return (Demirgüç-Kunt and Huizinga, 2010; Ayadi et al.,2012).

Our paper attempts to contribute to this literature in the following ways. First, we assume that macrofinancial, idiosyncratic factors and the regulatory environment do not affect banks with different business model in the same way. More precisely, we examine whether the impact of interest rates and capital held beyond the changing regulatory requirements on banks' profitability differs across the types of business model. This question is even more crucial in the context of low interest rate environment and tightening of regulatory requirements. Second, we consider an estimation period which covers a boom, a crisis and a post crisis, allowing capturing differences in sensitivity, based on the recent data on a large number of international banks. However, the paper does not address whether the choice of business model lead to unhealthy risks, which is also a concern among supervisors and policy makers.

We mainly find a differentiated effect of interest rates and regulatory constrained capital on profitability across the types of business model and economic cycle. In fact, the results reveal some evidence of non-linear relationship between interest rates and profitability for commercial and to a lesser extent for universal banks. The effect of interest rates is less significant for trading banks. Furthermore, we show that higher capital buffer appears to be beneficial to banks in crisis periods.

The remainder of this paper is organized as follows: Section 2 provides an overview of the literature and explains the objective of our paper. In Section 3, we describe the data and the methodology to identify banks' business models. Section 4 presents stylized facts on the evolution of profitability and its main drivers for the types of banks' business models. Section 5 describes the empirical strategy and the results. The final section concludes.

2. Motivation and related literature

How the profitability of different banks' business models is affected by macroeconomic conditions, regulatory environment and idiosyncratic factors is a central question for supervisors and central bankers concerned by preserving financial stability and an optimal level of bank lending to finance the economy. Indeed, the reinvestment of profits increases the capital held by banks. Banks have more room to raise their credit supply. Higher capital detention also increases ceteris paribus the loss-absorbing capacity of the banking system. In this context, the analysis of banks' profitability according to their business model has emerged recently as a key research topic for regulators and academics.

There is a growing strand of the literature analysing the choice of business model in terms of income and funding diversification and its impact on banks' risk and return. There is evidence that banks with a strong reliance on wholesale funding were significantly more likely to fail during the crisis (Demirgüç-Kunt and Huizinga, 2010) while banks with a more diversified income structure were found to be more stable (Altunbas et al., 2011). Ayadi et al.

(2012), Gatev et al. (2009) and Mergaerts and Vander Vennet (2016) complement the literature and document that retail-oriented banks generally tend to have better long-term performance in terms of profitability of assets and stability; they also demonstrate that a more diversified funding structure can support profitability during a downturn. Köhler (2015) show that banks with higher share of non-interest income are more stable and profitable; such benefits are particularly large for banks that are more retail-oriented.

The increase in capital requirements leading to the modification of the mix between capital and debt in the capital structure can have a significant impact on banks' profitability. In a world à la Modigliani and Miller (1958), the sources of financing do not have an effect on cash flow generated by the assets and the weighted average cost of capital remains constant when a firm modifies its funding mix. Nevertheless, the agency problem, information asymmetries and transaction costs distort the Modigliani-Miller's perfect market and theoretical framework. Admati and Hellwig (2014) nevertheless suggest that capital is not an inherently more expensive source of funds than debt. A second view pretends that the increase in the share of equity in funding structure reduces the market discipline of debtholders on managers and therefore negatively impact firm performance (Hart & Moore, 1995). Another strand of the theoretical literature claims that higher capital can reduce the moral hazard between shareholders and creditors. The most exposed shareholders to losses in case of default would increase their costly monitoring effort. Asset cash flows would be positively affected and the returns increased (Chemmanur & Fulghieri, 1994; Holmstrom & Tirole, 1997; Boot & Thakor, 2000; Mehran & Thakor, 2011; Allen et al., 2011). Moreover, under regulatory capital requirements, more capitalized banks have more room to extend their activities and are less likely to be affected by adverse macroeconomic shocks. Empirical studies also evaluate the impact of capital on bank's profitability. Berger (1995) highlights a positive effect of capital ratios on ROE for the US banking sector. Berger and Bouwman (2013) show that the US small banks with higher capital ratios report higher ROE. This result is valid for large banks during time of crisis. de Bandt et al. (2017) show that capital held by banks independently to capital requirements positively affect the performance of French large banks while capital held due to regulatory requirements do not show significant effect.

Another strand of the literature investigates how a variety of macroeconomic factors – in particular interest rates – and bank-specific variables affect banks' profitability irrespective of the business model. Demirgüç-Kunt and Huizinga (1999) find that higher real interest rates are associated with higher interest margin and profitability. A number of studies found that banks experienced difficulties when rates were low. For example, Borio, Gambacorta and Hofmann (2015) assess whether and how interest rate level and the slope of the yield curve affect the return on assets (ROA) of banks. They find a nonlinear relationship. Claessens, Coleman and Donnelly (2016) evaluate the impact of the low interest rates environment on profitability and show that low interest rates are contributing to weaker net interest margins. They identify an adverse effect that is materially larger when interest rates are low.[3]

Finally, some papers focus on identifying banks' business models that can be used by supervisory and regulatory authorities as a benchmark for impact assessment studies and risks

[3] Their results are robust when controlling for general economic conditions and bank-specific balance sheet variables, including using bank fixed-effects.

analysis. The use of balance sheet and income statement data has a long history in the literature on banks strategic choices. To compute business model indicators, most papers use direct classifications based on balance sheet variables. Martel et al. (2012) and Gambacorta and Rixtel (2013) define an indicator of the retail activity of banks and explain their resilience during the 2007-2009 crisis according to their involvement in retail and commercial activities. Indirect classifications, usually based on cluster or factor analysis, combine the information from a set of continuous variables to identify groups of observations, that are as homogeneous as possible (Roengpitya et al., 2014, 2017; Ayadi et al., 2011, 2012; Ayadi & De Groen, 2014; Ayadi et al., 2016). Roengpitya et al. (2017) identify four different business models by classifying balance sheet compositions and find that profitability and efficiency vary markedly across business models and over time. Lucas et al. (2017) identify six business models and discuss how their properties evolve over time. They show that the global financial crisis and the euro area sovereign debt crisis have had a substantial different impact on banks according to their business model. Their results also suggest that banks' business models change over time as a response to changes in long-term interest rates. Some papers directly relates individual business model characteristics to performance (Mergaerts and Vander Vennet, 2016). However, this approach does not allow to clearly identify how the individual characteristics affect business models. Using a different approach, Cernov and Urbano (2018) propose a standardised classification of business models of the European banks using a qualitative component based on an expert knowledge of the supervisory authority, reinforced by some quantitative indicators.

3. Data

3.1. Sample selection

We exploit a dataset of both bank-specific and macroeconomic variables with annual frequency. To construct the sample, we select banks that satisfy all the following criteria: (i) the bank is active, (ii) the country of origin is an OECD member, and (iii) the absolute size of the total assets is larger than 30 billion euros at end-2016. These banks represent a large share of their domestic banking system. We exclude domestic subsidiaries from our sample since decisions regarding the business model choices are taken at the level of the parent firm, which will consider the performance of the whole banking group. For the selected institutions, we gather balance sheet and income statement data at the highest level of consolidation from SNL Financial over the period 2005-2016.

Therefore, our database includes both periods of crisis and periods of relative stability. Our panel is unbalanced in the time dimension due to missing values at the beginning of the sample (mainly for 2005 and 2006). Most banking institutions are located in the US, Europe and Japan as presented in Table A1 in the Appendix.

Furthermore, performance can be strongly affected by macroeconomic conditions in countries where banks have activities. For this reason, we expand the bank-specific dataset with country-specific macroeconomic and financial statements in order to capture interest rates and welfare effects. This will also allow us to take into account aspects related to the

demand for banks' assets as determinant of profitability. Macroeconomic data are obtained from SNL Financial and Bloomberg.

For the econometric estimations, extreme values have been neutralized without dropping these banks which bring useful information. For the return on equity (ROE), this corresponds to twelve observations for which bank net losses exceed their total equity and four observations with a net profit greater than the total equity. The same process is applied to the return on asset (ROA) and we identify ten extreme values for which banks net profit or losses is greater than 5% of the total assets. Sixteen banks present these extreme values and one bank has been removed from the final sample due to a lack of information. The application of the whole selection criteria described results in a dataset of 217 large worldwide banking institutions from 25 OECD countries.

3.2. Identification of business models

Over the last decades, structural patterns of worldwide banking systems have considerably changed mainly due to changes in the global banking environment and in the functioning of financial markets. Therefore, it is useful to start by analyzing the structural changes that drove changes in the level of profitability during the last few years. To this end, we seek to identify banks with similar structural patterns and group them according to specific criteria.

To a large extent, the business models in banking can be distinguished by the nature and the scope of the activities they engage in. The procedure that we employ in this paper is primary driven by data and combines technical aspects of clustering inspired by the studies of Ayadi et al. (2012, 2014), focused on European banks, and Roengpitya et al. (2014), considering a sample of worldwide banks. Some methodological differences should be nevertheless be highlighted.

First, our main intuition is that banks with similar business strategies make similar choices regarding the composition of their asset portfolios. Therefore, we base our definition of the business models on one dimension of the balance sheet and namely, on their involvement in market based activities. Compared to Ayadi et al. (2012, 2014) and Roengpitya et al. (2014) using a larger number of variables for the definition of business models, on both sides of the balance sheet, the input for our model characterizes assets' portfolio and is given by the share of securities as of total assets[4]. This choice allows to simplify the process since considering both sides of the balance sheet could ask for an additional qualitative judgement and require for a larger number of business model's types. Additionally, our identification approach remains relevant compared to the existing literature since it leads to sensible categories of business models.

[4] The weaker availability of the variable 'trading securities' constraints us to base our analysis on the variable 'total securities' to should reflect the involvement of institutions in market based activities; we find a 31.7 % correlation coefficient between the two variable, statistically significant at a 5 % level. Expressing the variable as share of total assets allows to avoid distortions of the metrics related to differences in reporting accounting standards across different jurisdictions included in the sample.

Then, we choose to allocate banks into classes of business models on the basis of a point in time (end-2016) for two main reasons: (i) we assume that banks' business models is a long-term strategy, and (ii) we seek to deal with problems related to the presence of missing values at the beginning of the study period. Roengpitya et al. (2014) focuses on bank/year pairs that allow banks to switch between different categories of business models at any point in time.

The core of the methodology is the cluster algorithm that allows to group banking institutions into distinct buckets of business models. It is based on the statistical classification method proposed by Ward (1963) who allows to cluster observations that are the closest to each other[5]. Accordingly, banks are classified into three groups, which we will further refer to as categories of banks' business models.

- The first category of business model is labeled 'Commercial' and contains banks with the lowest proportion of securities (securities/total assets up to 17%[6]); implicitly they report a stronger reliance to lending. This group includes 51 institutions.
- The second group of business model called 'Universal' is the largest group; it includes 132 institutions with a share of total securities as of total assets between 17% and 34%. The reliance on traditional activities (lending and deposit collect) is lower than for banks oriented on commercial activities from the previous category.
- The third group of business model is characterized by a stronger involvement in market activities. Called 'Trading' it includes 34 institutions with a share of total securities/total assets above 34%.

In the existing literature on the definition of business models using cluster analysis, some papers mix both assets and funding structure. Ayadi et al. (2012) splits a sample of European banks in three classes: retail, investment and wholesale, while Ayadi and al. (2014) proposes four classes by distinguishing between diversified and focused retail. Similar classifications are provided by Roengpitya et al. (2017): retail-funded, wholesale-funding, universal and trading. The classification that we propose in this paper is closer to the one of Martel et al. (2012)[7] that distinguishes between commercial-oriented and investment-oriented universal banks on the basis of their retail ratio.

4. Some stylised facts

The global financial system has gone through important transition over the last decade in terms of financial and macroeconomic conditions as well as regulatory constraints. The structural and cyclical factors that have impacted the evolution of profitability metrics over

[5] The algorithm evaluates the distance between two observations by the sum of squared differences and then group observations with similar values.

[6] The thresholds representing the share of securities as of total assets that allows to distinguish between the three categories of business model at end-2016.

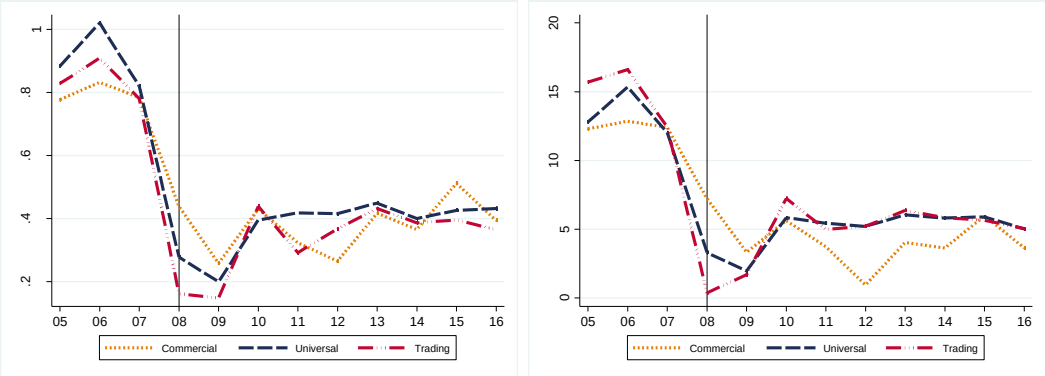
[7] Martel et al. (2012) introduces an indicator of banks' retail activity called retail ratio calculated as the share of retail activities (sum of total customer loans and total customer deposits) as of total assets. Thus, it describes the involvement of banks' in traditional activities and higher values of the ratio are associated to banks oriented on commercial activities.

this period are either pervasive or particular to geographies or business models. We use two measure of profitability namely the return on equity (ROE) and the return on assets (ROA). Although the ROE is a widely used indicator of banks' performance, since the management of the asset allocations is based on the performance of the business as measures by this indicator, this measure can be source of bias. Some works suggest that the use of the ROE generates adverse incentives to increase leverage (Admati et al, 2010; Goodhart, 2014). Moreover, at a short horizon, the ROE could be a strong tool of executives to evaluate the performance that is at the basis of their compensation (Bennett, Gopalan and Thakor, 2016; Moussu and Petit-Romec, 2017). Therefore, it will also describe the riskiness of banks. For this reasons, a joint analysis of the ROE and risk indicators (such as the ROA or assets' risk density) is crucial for a better evaluation of banks' performance. We now provide a short overview of the evolution of their performance and of the main drivers.

Figure 1 shows that profitability has declined considerably for many banks over the past decade. The ROE – net profit divided by the amount of equity – were generally in the range of 10–15% in the few years preceding the financial crisis. The ROA – net income divided by total assets – followed similar trend and reached values of around 1% in the pre-crisis period. International banks of our panel have slowly recovered after the crisis but they still face some challenges in terms of performance. The ROE and ROA remain below the pre-crisis levels. However, the dispersion in ROE values recorded during the financial crisis period has been reduced and the rates of returns have started to converge over the last few years. Concerning the long term values, the ROA and ROE averages over the period are respectively 0.46% and 6.24% for the overall sample (Table A2 in the Annex). The significant difference between the first and last decile reveals disparities between banks and over the period.

From a business model perspective, the rates of returns have sharply declined for all types of banks in 2008 and in a lesser extent in 2009 while they stabilized starting with 2010. However, systematic differences are observed between different categories of business models. The values of return on assets for commercial-oriented banks are structurally higher than for other banks regardless of the time period (Figure 1). Additionally, the decline was sharper for universal and trading-oriented banks than for commercial banks between 2007 and 2009. Banks' returns on equity evolved differently across business models. One can notice a switch in the ranking of ROE values between 2007 and 2008 when trading-oriented banks and universal banks, due to important losses on market activities, became less profitable than commercial oriented banks.

Figure 1: Banks' returns - ROA (%) and ROE (%)

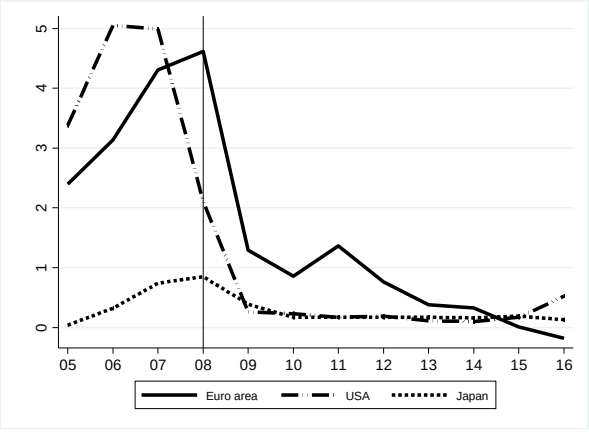


Source: SNL Financial, authors' calculations. ROA and ROE are defined as the net income as of total assets and total equity respectively.

As indicated early, macrofinancial, regulatory and idiosyncratic factors explain the evolution of banks' profitability.

The interest rates policy is undoubtedly a significant determinant to be considered. Indeed banks in advanced economies face important challenges due to interest rates being historically low for almost a decade now. While for US and European banks this low-interest rate environment was set up after the financial crisis (Figure 2), Japanese banks are facing nearly two-decade experience with low-for-long interest rates. This contributed significantly to the declining NIMs (Deutsche Bank, 2013) and forced them to adapt their business model by expanding internationally.

Figure 2: Region-specific short-term interest rates (%)



Source: SNL Financial
Notes: The short-term rate is given by the money market interest rate of 3M maturity.

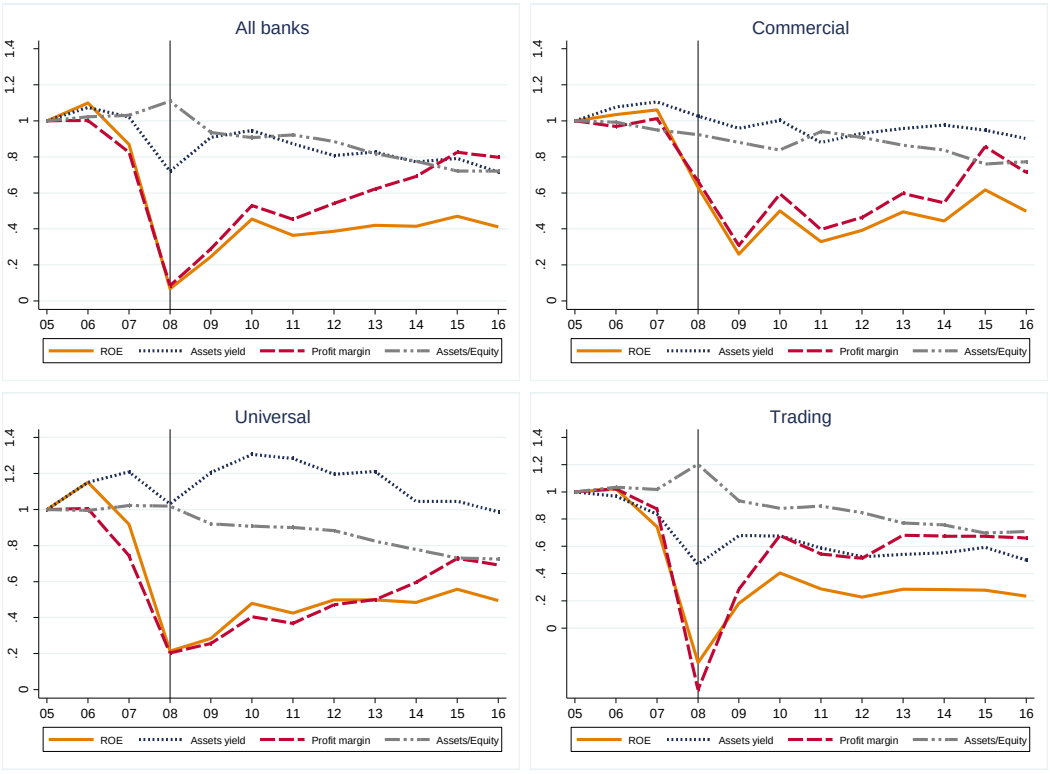
We are now interested in idiosyncratic factors. One can have a deeper insight of the ROE drivers through a DuPont analysis[8]. It allows breaking down ROE into three subcomponents: financial leverage (assets/equity), asset yield (revenue/assets) and profit margin (net profit/revenue), with the latter two ratios corresponding to a decomposition of ROA.

Figure 3 shows that overall the decline of the ROE in the period 2005-2008 was mainly driven by a sharp decline of the profit margin and to a lesser extent by a small decline of the asset yield. Between 2008 and 2010, the ROE has recovered mainly because of the recovery of the profit margin. After 2010, the ROE has remained broadly unchanged with two opposite effects: in a context of deleveraging and capital build-up, lower leverage has pressured down the ROE while profit margin has kept increasing. Overall, the impact from asset yields has been less than the other components because asset yields have remained broadly unchanged.

When looking at the DuPont decomposition for the three business models, it turns out that the sharp decline of the ROE for trading oriented banks in the period 2007-2008 is mainly due to the decline of the profit margin. From 2009, the profit margin recovered and then stabilized between 2010 and 2016 for commercial oriented and trading oriented banks, which did not help to improve the ROE while the profit margin was more dynamic for universal banks. Regarding the decline of the leverage, this was sharper for trading oriented banks and universal banks which pushed upward the ROE after 2010. At last, although this does not seem to affect the ROE path too much, the asset yield shows quite different evolutions by business models with notably a sharp decrease for trading oriented banks from 2005 to 2008.

[8] According to the DuPont analysis, the ROE can be decomposed into net profit margin, asset yields, and the leverage multiplier, as it follows $= \frac{\text{Net Income}}{Total\ Revenue} * \frac{\text{Total Revenue}}{Total\ Assets} * \frac{\text{Total Assets}}{Equity}$. The *Profit margin* shows how much earning is generated from a single money unit of sale (in banking terms revenue generated by the assets, mostly interest incomes). The *Asset yield* determines how much sales (or Revenue) a bank generates from each monetary unit of asset. The leverage shows how the bank can take profit from debt financing. A bank's ROE may thus differ from one year to the next, or from a competitor's, as a result of differences in profit margin, asset yield or leverage.

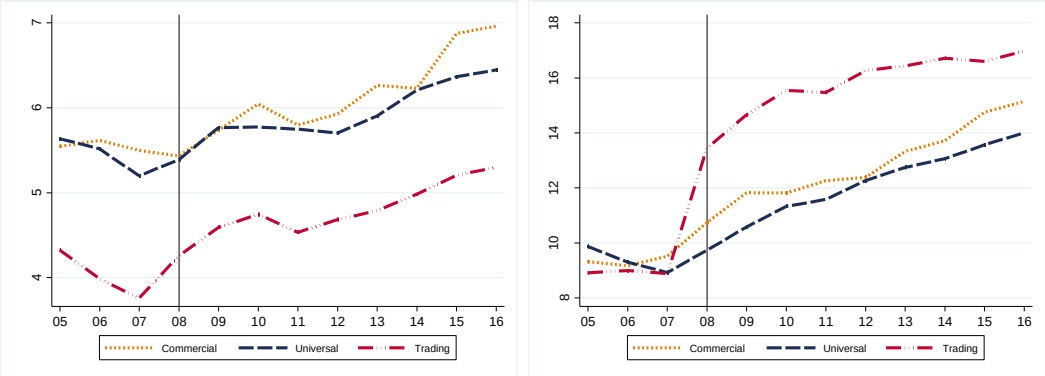
Figure 3: DuPont Analysis by banks' business models



Source: SNL Financial and author's calculations
Notes: The ratios are calculated as share of total assets.

The performance of banks might be affected by changes in the mix between debt and capital especially during the implementation of new regulatory standards. Indeed, under new rules and market pressure, banking institutions have considerably improved their solvency ratios in the post-crisis period. However, one can notice that changes occurred differently across business models (Figure 4 below). There is clear evidence that trading-oriented banks have increased more their risk weighted capital ratios as of 2011 and surpassed the other business models, especially commercial-oriented banks that used to report the highest levels of Tier 1 ratios before 2011 (Figure 4, left-plot). The trading-oriented banks remain among the most leveraged although efforts have been made to increase core capital relative to total asset (Figure 3, right-plot).

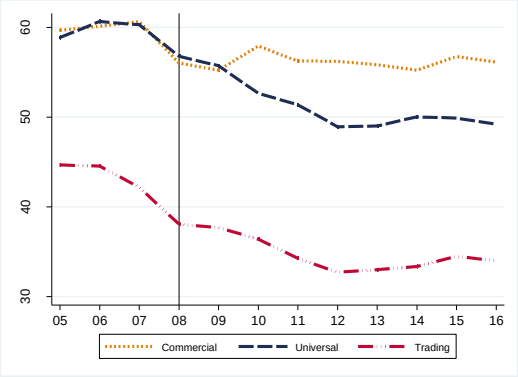
Figure 4: The level of leverage ratio and capitalization (Tier 1 capital in % of RWA)



Source: SNL Financial and authors' calculations
Notes: The graphs show annual average values by business model. The risk-weighted capital ratio is defined as the ratio of Tier1 capital to the amount of risk-weighted assets (RWA). The leverage ratio is defined as the accounting amount of equity over total assets; this variable is strongly correlated with the prudential Tier 1 capital ratio (coefficient of correlation of 0.9, statistically significant at a 1% confidence level).

In this context, a further concern for regulators and supervisors is the risk-taking behavior of banks. Figure 5 shows that banks have globally reduce the ratio of risk-weighted assets to total assets (RWA density) since 2007. Trading-oriented banks have considerably lowered RWA densities and their level remain low compared with universal and commercial banks; the decline in RWA density is more similar for universal and trading banks than for commercial-oriented ones characterised by almost unchanged RWA density since 2008. However, among the different drivers of the decline in this ratio, the changes in business mix including a faster increase in assets that carry lower risk-weights had a considerable impact (Le Leslé and Avramova, 2012).

Figure 5: Evolution of the RWA density (%)



Source: SNL Financial and authors' calculations
Note: The RWA density is defined as the ratio of RWA divided by total assets.

5. Empirical specification and results

5.1. Identification strategy

Our aim is to evaluate, in a context of accommodative monetary policy and restrictive prudential regulation, the role of two important explanatory factors of the financial performance of the different banks' business model: the macroeconomic effect of interest rates and the role of banks' specific capital held beyond the regulatory requirements (capital buffers). We take into account other bank specific and macroeconomic variables that are relevant in the explanation of banks' profitability. This latter is measured by the return on equity and return on asset. ROE and ROA are constructed by dividing net income by total equity and assets, respectively.

Interest rates are an important driver of banks' income and expenses. Some business models can be more resilient to adverse shocks on interest rates. For example, in a low interest rate environment, universal banks can compensate a decrease in the net interest income by increasing non-interest income (like fees and commissions). The effect of interest rates can be spread in two components: the level of the short-term interest rate (*Short_ir*) and the spread between the long and short-term rates (*Spread*). The short term interest rate is measured by the 3 month money market interest rate. To calculate the spread, we use the long term sovereign bond rate which also reflects the exposure to sovereign risk. The first component instantaneously impact the entire volumes granted at floating rate according to the clauses of the contrat while only new volumes granted at a fixed rate are affected. The second component has an impact on the maturity transformation activity of banks and particularly captures changes in margin taken from banking book assets. As a significant part of loans are granted at fixed rate with some differences between countries, the margin presents some persistence effects. Borio et al. (2015) evaluate the impact of interest rates on the profitability of large international banks. As Borio et al. (2015), we test a non linear hypothesis in the relationship between interest rates and profitability. We expect differences in the interest rate effects across business models, depending on the macroeconomic context in particular. To determine the effect of the capital buffer, we first measure the difference between the ratio of Tier1 capital to risk weighted assets of the bank and the minimum required by the Basel Committee on Banking Supervision (BCBS). This minimum requirement was set at 4% under Basel II and was progressively increased under Basel III to reach 6% in 2015 under the phase-in arrangement. We construct two groups of banks according to their capital buffer and introduce in the model a dummy variable (*Buffer_low*) which is equal to 1 when bank capital buffer is lower than the median value of the sample at the beginning of the year. We do not take into account non-publicly pillar 2 requirements which correspond to the additional bank-specific capital requirements beyond the minimum pillar 1. We go deeper in our investigations by explaining revenue generation for low versus high capital buffer banks of each business model. All things being equal, higher buffer banks should present a lower probability of default and therefore more favourable financing conditions. They are more able to seize investment opportunities particularly in crisis periods which are likely to positively impact their profitability.

Other specific and macroeconomic variables are potentially relevant in the explanation of profitability. We first isolate the effect of the liabilities and equity characteristics, differences in asset composition being captured by business model differences. We include in the specification the ratios of equity to asset (*Equity ratio*). In a world à la Modigliani and Miller (1958), the funding characteristics do not affect the firm performance. However, due to the existence of market imperfections (asymmetries of information and difference in tax treatment), funding structure is likely to be a determinant of banks' performance. We also control for customer deposit financing using the ratio of household and corporate deposits over total assets (*Deposit ratio*). Retail deposit is generally a less costly funding source than market funding. In particular, non-maturing deposits are less sensitive to market interest rates and some deposit rates can be subject to regulation. At the other hand, banks with a larger share of deposit may have incentive to take more risk (Merton, 1977; Keeley, 1990). In fact, deposits could benefit from implicit or explicit guarantee. The risk associated to the assets held by banks is an important determinant of profitability. The riskiness of the assets depends on banks' business model. We use the regulatory risk weights. The period analyzed in the paper contains three regulatory frameworks. Before 2008, a uniform risk weights were applied to each large asset class under the Basel I. Basel II introduces more granularities in the calculation of risk weighting from 2009. Banks can now evaluate their exposures' risk using their validated internal models or counterparty ratings made by rating agencies. The risk weights calculation was revised to better take into account securitization and market risk in response to the financial crisis. It is important to note that some differences in the application of the Basel framework can exist between the different jurisdictions. This is not problematic since we are interesting in the average effect on banks' profitability. As in Berger (1995) and Berger and Bouwman (2013), *RWA density* is calculated as risk-weighted assets over total assets.

Welfare effects in each economy are apprehended by the growth rate of the gross domestic product (*GDP growth*) and the stock market return (*Stock return*). This latter variable captures approximately 70% of the global market capitalization and is constructed using the main stock market indexes.

Finally we control for the effects of the two major crises that took place during the period analyzed. For the worldwide financial crisis, we include a dummy variable $Crisis_1$ which is equal to 1 for the period 2007-2008 and 0 otherwise. $Crisis_2$ is equal to 1 for the period 2010-2012 and 0 otherwise and control for the European sovereign debt crisis impact.

We estimate a fixed effect model and therefore control for banks' invariant specificities. We adjust the standard errors of the estimated coefficients which tend to be underestimated in the presence of heteroscedasticity. We take into account the fact that contemporaneous values of the idiosyncratic determinants of bank profitability such as capitalization can be endogenous and would lead to biased estimated coefficients consequently.

The econometric specification is the following:

$$Y_{i,j,t,b} = \alpha_i + \beta_1 Short\_ir_{j,t} + \beta_2 Short\_ir_{j,t}^2 + \gamma_1 Spread\_ir_{j,t-1} + \gamma_2 Spread\_ir_{j,t-1}^2 + +\delta_1 Buffer\_low_{i,j,t-1} + \varphi_s X_{i,j,t-1,b} + \omega_m Z_{j,t} + \partial_1 Crisis_{1t} + \partial_2 Crisis_{2t} + \varepsilon_{i,j,t,b} \quad (1)$$

$Y_{i,j,t,b}$ represents respectively the ROE and the ROA of the bank *i* with the business model b in the country *j* at the period *t*. $Short\_ir_{j,t}$ is the 3-month interest rate and $Spread\_ir_{j,t-1}$ the one year lagged values of the difference between the 10-year government bond and the 3-month interest rate and reflects the persistence effects of banks' long term activities. $Buffer\_low_{i,j,t-1}$ is a dummy variable which is equal to 1 when the bank's capital buffer calculated as the difference between the Tier 1 regulatory ratio and its minimum required is lower than the median value of the sample at the beginning of the year. $X_{i,j,t-1}$ is the vector of the *s* control bank-specific variables: *Equity ratio*, *Deposit ratio* and *RWA density*. Bank-specific variables are one-year lagged. We also control for *m* other $Z_{j,t}$ macroeconomic and financial effects, namely the real *GDP growth* and the return of the stock market (*Stock return*). $Crisis_{1t}$ and $Crisis_{2t}$ are dummy variables which respectively captures the effects of the worldwide financial crisis and the European sovereign debt crisis[9]. α_i is the bank fixed effect and $\varepsilon_{i,j,t,b}$ the error term.

5.2. Results

5.2.1. Interest rates, capital buffer and profitability of different business models

Table 1 presents the results of the impact of interest rates and capital buffer on banks' ROE and ROA for the three business models identified, after controlling for other banks' specific variables, macroeconomic and financial effects.

The link between interest rates and banks' profitability differs across business models. We generally find a significant relationship for commercial and universal banks. On average, the short-term interest rate positively impacts commercial banks (ROE, column 2) with a concave effect on ROA (column 6). This effect is also positive for positive rate values in the case of diversified banks (columns 3 and 7). This positive effect tends to indicate that, on average, banks' assets are more sensitive than liabilities to changes in interest rates. The less sensitivity of non-maturing retail and regulated deposits notably explain the more rigidities of bank's cost of funding. The low interest rate environmement would contribute to reduce banks' profitability. We do not find any significant effect of the short term rate for trading banks (columns 4 and 8). Thiscould be related to the complexity of trading activities and the greater reliance on derivatives. The impact of the spread on profitability (ROE and ROA) is non linear for commercial banks. Higher sovereign spreads are associated with lower

[9] We include a deterministic trend in an alternative specification. Our conclusions remain globally unchanged. The result of these estimations are available at request.

profitability with a smaller negative effect as the spread converges towards the optimum. Banks exposed to countries with higer sovereign spreads are less profitable. The potential positive effect of spreads on margin are more than counterbalanced by an increase in losses and provisions for non-performing loans and losses. Very high spread also tends to reduce bank's activity due to demand effects while at the same time, banks' cost of funding increase. This negative effect of spreads tends to be observed in adverse macroeconomic context as identified for estimations in crisis period (table A3). Moreover, after 2012, the post crisis period, we identify a positive or non significant relationship between the sovereign spreads and banks' return[10]. Borio et al. (2015) find a concave relationship for the period 1995-2012 characterized by a more favorable macroeconomic context on a longer period. Universal banks exposed to high sovereign spreads also realized lower net return. For trading banks, the effect of the spread on ROE and ROA is respectively weakly negative and non significant. However the results of trading banks should be interpreted with caution due to a lower number of observations. The business models of commercial and universal banks appear to be more exposed to adverse changes in interest rates whereas their profitability would benefit from favourable evolutions. For the whole estimation period, we do not observe a significant effect of differences in capital buffer on banks' profitability. However, when we consider the period 2007-2012 which includes the financial and European sovereign debt crisis, we find that banks with less capital buffer according to the regulatory requirements are less profitable (table A3 in appendix – columns 1 and 5). Low capital buffer banks are more constrained by the regulation and are also likely to have less favourable market financing conditions in crisis periods. They are therefore less able to seize investment opportunities.

The coefficient associated with the control variables generally present the expected sign. The one year lagged equity to total asset ratio positively impacts the profitability of commercial and universal banks to a lesser extent. We find a similar positive effect of deposit financing for commercial and universal banks. The effect of the risk weighted assets is not very significant. This can be partly explained by important changes in the calculation of risk weighted assets over the period analyzed. The growth rate of domestic GDP has a positive and significant impact on the profitability of commercial and universal banks. This effect is not significant for trading banks and becomes negative in crisis period, reflecting their less dependency to domestic macroeconomic context. Stock market returns' increases generally contribute to boost banks' profitability with a more significant effect on trading banks as expected. Higher stock market return exerts a direct positive effect on some market activities and also reflect a positive effect of more profitable large corporate on banks' activity. As expected, the 2007-2008 financial crisis had a strong significant negative impact on the profitability of trading and diversified banks beyond the effects of the idiosyncratic and macroeconomic factors of the model. This confirms the fact that banks with higher market activities have been more impact by the financial crisis.

[10] These results are available at request.

5.2.2. Explaining banks' profitability by crossing business models and capital buffers

For each group of business model, we build two sub groups of low and high capital buffer banks. While a general pattern does not emerge, we find some differences across the six groups of banks relative to the impact of interest rates on profitability. The results are presented in tables A4a and A4b in the annex, respectively for ROE and ROA. However, at this stage, these results have to be considered with caution due to the limited number of observations for some sub categories.

High buffer banks appear more sensitive to the sovereign spread (tables A4a and A4b, columns 1 and 2). This is likely to reflect differences in assets characteristics notably in term of maturity length. For example, a significant number of high buffer commercial institutions are specialized in savings and mortgage lending, particularly sensitive to changes in the interest rate curve. For trading banks, the effect of interest rates remains non-significant for low buffer banks whereas we identify a non linear effect of the spread for high buffer banks.

Table 1. Business models, interest rates, capital buffer and banks' profitability

	ROE				ROA			
	All	Commercial	Universal	Trading	All	Commercial	Universal	Trading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short_ir$_{j,t}$	0.860	1.960**	0.638	1.485	0.043	0.167***	-0.004	0.046
	(0.608)	(0.958)	(0.748)	(1.669)	(0.034)	(0.050)	(0.044)	(0.075)
Short_ir$_{j,t}^2$	0.106	-0.161	0.198*	-0.052	0.012*	-0.019***	0.027***	0.003
	(0.097)	(0.135)	(0.112)	(0.340)	(0.007)	(0.007)	(0.009)	(0.015)
Spread_ir$_{j,t-1}$	-2.014***	-2.242***	-1.723***	-2.822*	-0.157***	-0.187***	-0.153***	-0.144*
	(0.481)	(0.676)	(0.628)	(1.583)	(0.037)	(0.047)	(0.048)	(0.087)
Spread_ir$_{j,t-1}^2$	0.103**	0.168***	0.061	0.149	0.009**	0.015***	0.007	0.008
	(0.043)	(0.032)	(0.054)	(0.376)	(0.004)	(0.003)	(0.005)	(0.024)
Buffer_low$_{i,t-1}$	0.387	2.927	-0.196	-0.073	0.018	0.155	0.014	-0.022
	(0.773)	(2.185)	(0.907)	(1.365)	(0.041)	(0.101)	(0.055)	(0.078)
Equity ratio$_{i,t-1}$	0.346*	0.633***	-0.132	0.381	0.039***	0.035***	0.039*	0.033
	(0.196)	(0.231)	(0.409)	(0.573)	(0.010)	(0.011)	(0.023)	(0.036)
Deposit ratio$_{i,t-1}$	0.098	0.100	0.261***	-0.007	0.011***	0.010**	0.020***	-0.004
	(0.061)	(0.105)	(0.094)	(0.094)	(0.004)	(0.005)	(0.006)	(0.008)
RWA density$_{i,t-1}$	0.069*	0.122	0.029	-0.036	-0.002	-0.000	-0.005*	0.001
	(0.037)	(0.081)	(0.040)	(0.101)	(0.002)	(0.004)	(0.003)	(0.008)
GDP growth$_{j,t}$	0.587***	1.040***	0.606***	-0.454	0.048***	0.064***	0.054***	-0.012
	(0.148)	(0.324)	(0.189)	(0.393)	(0.009)	(0.018)	(0.013)	(0.016)
Stock return$_t$	0.123***	0.046	0.108***	0.315***	0.005***	0.005*	0.004*	0.015***
	(0.025)	(0.048)	(0.032)	(0.070)	(0.001)	(0.003)	(0.002)	(0.003)
Crisis$_{1,t}$	-4.753***	-2.172	-4.964***	-7.234**	-0.368***	-0.139	-0.450***	-0.305**
	(0.970)	(2.074)	(1.169)	(2.954)	(0.068)	(0.116)	(0.088)	(0.154)
Crisis$_{2,t}$	-0.202	-0.312	-0.342	0.770	0.001	0.026	0.015	-0.016
	(0.544)	(1.217)	(0.693)	(1.180)	(0.035)	(0.059)	(0.050)	(0.067)
Constant	-11.292*	-13.946	-15.803**	2.191	-1.002***	-2.124***	0.681**	0.255
	(6.419)	(9.735)	(7.961)	(8.547)	(0.369)	(0.575)	(0.277)	(0.673)
Number of obs.	1,893	425	1,150	318	1,899	426	1,154	319
Adj. R^2	0.324	0.412	0.301	0.370	0.439	0.552	0.423	0.513

*Notes: For each business model, the table presents the estimation' results of the impact of interest rates and capital buffer on banks' profitability after controlling for the effects of other bank specific, macroeconomic and financial variables. Data are collected from SNL and Bloomberg. The coefficients are estimated using on a panel of large international banks from 25 developed countries over the period 2005-2016. The definitions of the variables are in the annex, Table A1. Robust standard errors in the presence of heteroscedasticity are reported in brackets. ***, ** and * denote statistical significance at 1%, 5% and 10% respectively.*

6. Conclusion

This paper contributes to the debate on the performance of different banks' business models in a changing macroeconomic and regulatory environment. We focus on two important factors: the macroeconomic effect of interest rates and the impact of additional capital holdings beyond the minimum regulatory requirements. We assume a differentiated effect of these factors according to banks' involvement in market activities, and by symmetry in bank lending. To reflect these differences, we classify banks into three groups and namely commercial, universal and trading banks.

The profitability metrics of our panel of international banks has sharply declined during the financial crisis but is slowly recovering since 2009. A DuPont analysis first shows that the decline of the ROE during this crisis was due to a decrease in the profit margin. This effect was stronger for the trading banks. Since 2010, the further pressure on the ROE is rather due to deleveraging notably in response to the post-crisis regulation. The lower leverage effect was stronger for trading and universal banks.

The results of our econometric estimations show differences of sensitivity to interest rate changes across business models. We find some evidence of nonlinear relationship between interest rates and profitability for commercial and universal banks, but to a lesser extent for these latter. While the association is generally positive for the short term interest rate, higher sovereign spreads are associated with lower profitability with a smaller negative effect as the spread converges towards the optimum. Banks exposed to countries with higher sovereign spreads are less profitable. The negative effect of the increase in non-performing loans and losses in particular dominate the potential positive effect of spreads on margin. Very high spread also tends to reduce bank's activity due to demand effects while at the same time, banks' cost of funding increase. This negative effect of spreads tends to be observed in adverse macroeconomic context. Commercial and universal banking models are more exposed to adverse changes in interest rates whereas their profitability would benefit from favorable evolutions. For trading banks, the great variety of complex products and their greater reliance on derivatives could explain their lower sensitivity to interest rate changes. Finally, we find that sizeable capital buffers are beneficial during the crisis periods. Less constrained banks have higher capacity to seize investment opportunities, especially for activities that require the detention of relatively higher amount of capital. These well capitalized banks are also likely to have more favorable financing conditions specifically in stressed period.

Our findings reinforce the supervisors' initiatives to consider banks' business models when comparing and benchmarking financial risks. Indeed, it appears that banks, according to their business model, react differently depending on the position in the economic cycle and their state of implementation of new regulatory standards. Therefore, the speed of adjustment toward new bank-specific regulatory standards and the position in the interest rate cycle of each economy should be considered when assessing banks' performance.

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APPENDIX

Table A1. Sample composition – the distribution of banks by country

Country	Nb. of banks	Nb. Obs.	Representativeness (% TA)
Australia	8	82	3,9%
Austria	4	43	0,6%
Belgium	4	34	1,1%
Canada	7	66	5,0%
Danemark	3	33	1,1%
Finland	1	11	0,2%
France	6	58	11,1%
Germany	18	170	6,1%
Greece	4	35	0,4%
Hungary	1	11	0,1%
Israel	5	17	0,5%
Italy	10	107	4,1%
Japan	48	388	17,2%
Luxembourg	1	9	0,1%
Mexico	1	7	0,1%
Netherlands	4	30	2,9%
Norway	1	11	0,4%
Poland	2	22	0,2%
Portugal	3	24	0,3%
South Korea	9	73	2,6%
Spain	14	89	4,9%
Sweden	5	52	2,1%
Switzerland	11	111	3,4%
USA	36	300	21,5%
United Kingdom	11	100	10,0%
Total	**217**	**1883**	**100%**

Source: SNL Financial, author's calculations.
Notes: ranking according to banks' total assets at end-2016.

Table A2A. Descriptive statistics of the variables

Variable	Definition	Mean (%)	SD (%)	1st decile (%)	Median (%)	9th decile (%)
Bank-specific variables						
ROE	Net income over total equity	6.24	10.15	0.30	6.74	15.12
ROA	Net income over total assets	0.46	0.64	0.02	0.42	1.09
Tier 1 Capital ratio	Prudential ratio of Tier 1 capital to risk-weighted assets	12.37	5.73	7.70	11.57	17.08
Equity ratio	Accounting equity over total assets	6.78	2.94	3.57	6.15	11.23
Deposit ratio	Customer deposits over total assets	58.74	22.70	25.97	61.41	87.93
RWA density	Risk-weighted assets over total assets	58.77	22.68	25.99	61.49	87.93
Macrofinancial variables						
Short_ir	Money market interest rate of 3M maturity ; country-specific/monetary zone variable	1.38	1.72	0.10	0.57	4.63
Spread_ir	Difference between 10Y country-specific bond and 3M money market interest rate	1.27	1.46	- 0.18	0.96	2.71
GDP growth	Growth rate of gross domestic product ; country-specific variable	1. 29	2.25	-1.70	1.61	3.67
Stock return	Stock market return	4.09	13.05	-17.03	7.94	17.01

Source: SNL and Bloomberg. Authors' calculations.
Notes: Descriptive statistics for the sample of international banks from 25 developped countries over the period 2005-2016.

Table A2B. Descriptive statistics (mean values) by business model and by period

Mean	Whole period				Pre-crisis				Crisis				Post-crisis			
	All banks	Commercial	Universal	Trading	All banks	Commercial	Universal	Trading	All banks	Commercial	Universal	Trading	All banks	Commercial	Universal	Trading
ROA	0.46	0.46	0.47	0.41	0.91	0.81	0.96	0.87	0.39	0.40	0.41	0.34	0.42	0.42	0.43	0.39
ROE	6.24	5.78	6.41	6.25	14.06	12.58	14.15	16.20	5.27	5.33	5.38	4.86	5.39	4.35	5.69	5.72
Retail ratio	116.06	132.91	116.55	91.77	106.91	125.05	106.45	77.95	115.57	131.38	116.99	91.63	119.10	137.06	118.62	95.36
Deposits (%TA)	58.77	58.71	59.10	57.62	50.46	53.04	51.21	43.06	58.25	57.26	58.82	57.57	61.61	62.11	61.51	61.28
Equity ratio	6.78	7.11	6.88	6.00	6.49	6.48	6.77	5.39	6.52	6.84	6.63	5.76	7.19	7.61	7.21	6.48
Loans (%TA)	57.31	74.21	57.45	34.15	56.45	72.01	55.24	34.90	57.35	74.12	58.18	34.07	57.49	74.95	57.11	34.08
Total securities (%TA)	26.54	13.42	25.36	48.84	25.21	15.17	24.40	45.49	27.30	14.53	25.57	49.53	25.94	11.58	25.34	48.72
Trading assets (%TA)	7.66	4.00	6.13	16.40	12.91	6.56	10.02	29.12	8.10	4.37	6.32	17.10	6.08	3.02	5.18	12.75
Risk density	49.96	53.48	52.42	36.28	58.16	60.75	60.08	46.02	50.42	53.26	53.49	36.39	47.20	51.63	49.08	33.72
Tier 1 ratio	12.37	12.35	11.72	14.77	9.40	9.25	9.57	8.96	11.62	11.49	10.85	14.42	14.10	14.29	13.36	16.69
Leverage ratio	5.71	6.08	5.86	4.67	5.36	5.58	5.57	4.14	5.45	5.75	5.62	4.48	6.14	6.60	6.24	5.07

Source: SNL and Bloomberg. Authors' calculations.

Notes: Mean values are reported for the whole period (2005-2016)and by subperiods: pre-crisis (2005-2006), crisis (2007-2012) and post-crisis (2013-2016). The sample includes 217 international banks from 25 developped countries over the period, of which 51 commercial banks, 132 universal and 34 trading banks.

Table A3. Business models, interest rates, capital buffer and banks' profitability in crisis periods

	ROE				ROA			
	All	Commercial	Universal	Trading	All	Commercial	Universal	Trading
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short_ir$_{j,t}$	-2.395**	0.670	-3.051***	-3.573	-0.128***	0.089	-0.232***	0.020
	(0.941)	(1.245)	(1.150)	(3.229)	(0.049)	(0.069)	(0.067)	(0.133)
Short_ir$_{j,t}^2$	0.412***	-0.059	0.573***	0.438	0.027***	-0.009	0.047***	-0.006
	(0.137)	(0.197)	(0.154)	(0.533)	(0.008)	(0.011)	(0.011)	(0.022)
Spread_ir$_{j,t-1}$	-2.938***	-1.547	-2.910***	-4.060	-0.091***	-0.075	-0.092**	-0.245
	(0.755)	(1.273)	(0.950)	(2.889)	(0.033)	(0.055)	(0.044)	(0.165)
Spread_ir$_{j,t-1}^2$	0.182*	-0.067	0.215*	-0.074	-0.004	-0.006	-0.002	0.030
	(0.105)	(0.206)	(0.115)	(0.892)	(0.003)	(0.004)	(0.005)	(0.051)
Buffer_low$_{i,t-1}$	-3.045**	-1.952	-2.249	-3.555	-0.107*	-0.055	-0.063	-0.194
	(1.405)	(2.957)	(1.779)	(2.458)	(0.064)	(0.137)	(0.087)	(0.117)
Equity ratio$_{i,t-1}$	0.163	-0.099	0.238	1.263	0.038	-0.004	0.064	0.021
	(0.540)	(0.907)	(0.756)	(1.057)	(0.029)	(0.047)	(0.041)	(0.065)
Deposit ratio$_{i,t-1}$	0.116	0.012	0.447*	-0.290	0.013**	0.011	0.028***	-0.004
	(0.139)	(0.183)	(0.230)	(0.253)	(0.006)	(0.008)	(0.009)	(0.012)
RWA density$_{i,t-1}$	0.076	0.222	-0.003	-0.110	-0.003	0.002	-0.007	-0.000
	(0.054)	(0.141)	(0.055)	(0.147)	(0.003)	(0.007)	(0.005)	(0.009)
GDP growth$_{j,t}$	0.416**	0.951**	0.438**	-1.391**	0.015	0.034*	0.021	-0.070***
	(0.185)	(0.391)	(0.214)	(0.562)	(0.010)	(0.018)	(0.013)	(0.021)
Stock return$_t$	0.168***	0.048	0.148***	0.544***	0.009***	0.005*	0.007***	0.026***
	(0.039)	(0.053)	(0.050)	(0.119)	(0.002)	(0.003)	(0.003)	(0.005)
Constant	-12.185	-3.354	0.704	27.469	-1.143**	-0.051	-0.634	0.408
	(13.907)	(5.132)	(3.313)	(24.474)	(0.573)	(0.206)	(0.827)	(1.130)
Number of obs.	971	215	587	169	978	216	592	170
Adj. R^2	0.308	0.355	0.317	0.394	0.523	0.480	0.557	0.542

*Notes: For each business model, the table presents the estimation' results of the impact of interest rates and capital buffer on ROA after controlling for the effects of other bank specific, macroeconomic and financial variables over the period 2007-2012 covering the wordwide financial crisis and the European sovereign debt crisis. Data are collected from SNL and Bloomberg. The coefficients are estimated using on a panel of large international banks from 25 developped countries. The definitions of the variables are in Table A2. Robust standard errors in the presence of heteroscedasticity are reported in brackets. ***, ** and * denote statistical significance at 1%, 5% and 10% respectively.*

Table A4A. Explaining banks' return on asset (ROE) by crossing business models and capital buffers

	All		Commercial		Universal		Trading	
	Low Buffer	High Buffer	Low Buffer	High Buffer	Low Buffer	High Buffer	Low Buffer	High Buffer
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Short\_ir_{j,t}$	4.243***	-0.335	2.721	2.276***	4.783**	-1.756*	-0.374	4.145*
	(1.218)	(0.849)	(1.918)	(0.809)	(1.867)	(1.057)	(2.483)	(2.408)
$Short\_ir_{j,t}^2$	-0.450***	0.298**	-0.310	-0.322**	-0.551**	0.513***	0.200	-0.335
	(0.174)	(0.140)	(0.262)	(0.151)	(0.266)	(0.150)	(0.478)	(0.398)
$Spread\_ir_{j,t-1}$	-0.036	-2.670***	-0.348	-1.298	1.012	-2.955***	-0.667	-8.260***
	(0.788)	(0.656)	(1.950)	(0.958)	(0.865)	(0.838)	(2.136)	(2.349)
$Spread\_ir_{j,t-1}^2$	-0.030	0.195***	-0.321	0.149***	-0.092**	0.202***	-0.547	1.388***
	(0.044)	(0.031)	(0.460)	(0.053)	(0.041)	(0.045)	(0.630)	(0.370)
$Equity\ ratio_{i,t-1}$	0.035	0.351	1.365	0.294	-0.815	0.263	-0.785	1.646**
	(0.664)	(0.405)	(1.056)	(0.849)	(0.853)	(0.472)	(0.798)	(0.791)
$Deposit\ ratio_{i,t-1}$	-0.026	0.230***	-0.247	0.323***	0.083	0.325**	-0.103	0.104
	(0.106)	(0.082)	(0.178)	(0.119)	(0.128)	(0.145)	(0.220)	(0.093)
$RWA\ density_{i,t-1}$	0.257***	-0.091**	0.442***	-0.015	0.229***	-0.072	0.095	-0.331**
	(0.070)	(0.041)	(0.153)	(0.081)	(0.084)	(0.045)	(0.177)	(0.130)
$GDP\ growth_{j,t}$	0.566**	0.696***	0.911*	1.153**	0.382	0.834***	-0.280	-0.063
	(0.243)	(0.211)	(0.536)	(0.453)	(0.322)	(0.247)	(0.566)	(0.434)
$Stock\ return_t$	0.142***	0.039	0.090	-0.086	0.112**	0.053	0.381***	0.186***
	(0.036)	(0.037)	(0.069)	(0.059)	(0.044)	(0.046)	(0.101)	(0.069)
$Crisis_{1,t}$	-4.358***	-5.311**	-0.754	-1.880	-3.530***	-5.941**	-6.621	-13.320**
	(1.196)	(2.154)	(2.753)	(2.154)	(1.220)	(2.829)	(4.553)	(5.154)
$Crisis_{2,t}$	-3.018***	1.151	-4.605*	0.778	-2.398***	1.455	-2.676	3.919**
	(1.009)	(0.818)	(2.771)	(1.407)	(0.873)	(1.137)	(2.182)	(1.787)
$Constant$	-5.010	-17.379**	-86.534***	-10.227	-13.013	-20.389***	10.972	1.134
	(11.795)	(8.177)	(30.790)	(8.803)	(18.883)	(7.658)	(22.719)	(9.701)
Number of observations	911	972	210	213	552	592	149	167
Adj. R^2	0.385	0.335	0.450	0.581	0.394	0.320	0.406	0.468

*Notes: For each business model and capital buffer group, the table presents the estimation' results of the impact of interest rates on ROE after controlling for the effects of other bank specific, macroeconomic and financial variables. Data are collected from SNL and Bloomberg. The coefficients are estimated using on a panel of large international banks from 25 developped countries over the period 2005-2016. The definitions of the variables are in table A2. Robust standard errors in the presence of heteroscedasticity are reported in brackets. ***, ** and * denote statistical significance at 1%, 5% and 10% respectively.*

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Table A4B. Explaining banks' return on equity (ROA) by crossing business models and capital buffers

	All		Commercial		Universal		Trading	
	Low Buffer	High Buffer	Low Buffer	High Buffer	Low Buffer	High Buffer	Low Buffer	High Buffer
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Short\_ir_{j,t}$	0.189***	0.001	0.191**	0.170***	0.174**	-0.074	-0.124	0.129
	(0.051)	(0.055)	(0.096)	(0.056)	(0.073)	(0.073)	(0.145)	(0.140)
$Short\_ir_{j,t}^2$	-0.011	0.024**	-0.023*	-0.026**	-0.008	0.042***	0.020	-0.004
	(0.008)	(0.011)	(0.013)	(0.010)	(0.013)	(0.013)	(0.024)	(0.021)
$Spread\_ir_{j,t-1}$	-0.065*	-0.198***	-0.022	-0.120*	-0.049	-0.220***	-0.103	-0.409***
	(0.035)	(0.048)	(0.072)	(0.066)	(0.042)	(0.067)	(0.137)	(0.105)
$Spread\_ir_{j,t-1}^2$	-0.000	0.018***	-0.010*	0.015***	-0.000	0.019***	-0.006	0.084***
	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.004)	(0.051)	(0.021)
$Equity\_ratio_{i,t-1}$	0.031	0.063**	0.047	0.006	0.016	0.078**	-0.021	0.084*
	(0.025)	(0.026)	(0.041)	(0.046)	(0.029)	(0.032)	(0.055)	(0.050)
$Deposit\ ratio_{i,t-1}$	0.005	0.016***	-0.004	0.018***	0.011	0.028***	-0.025	0.008
	(0.005)	(0.006)	(0.008)	(0.006)	(0.007)	(0.009)	(0.015)	(0.006)
$RWA\ density_{i,t-1}$	0.007**	-0.009***	0.015**	-0.002	0.006	-0.009**	0.015	-0.017***
	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)	(0.004)	(0.010)	(0.006)
$GDP\ growth_{j,t}$	0.045***	0.041***	0.033	0.066**	0.049***	0.053***	0.010	-0.006
	(0.012)	(0.015)	(0.026)	(0.027)	(0.017)	(0.020)	(0.028)	(0.016)
$Stock\ return_t$	0.006***	0.003	0.006*	-0.002	0.004	0.002	0.017***	0.009**
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.004)
$Crisis_{1,t}$	-0.380***	-0.400**	-0.045	-0.146	-0.397***	-0.554**	-0.233	-0.515*
	(0.081)	(0.156)	(0.119)	(0.188)	(0.099)	(0.218)	(0.190)	(0.267)
$Crisis_{2,t}$	-0.155***	0.117**	-0.203*	0.083	-0.151***	0.170*	-0.283*	0.167*
	(0.048)	(0.057)	(0.113)	(0.080)	(0.054)	(0.088)	(0.155)	(0.085)
$Constant$	-0.798	-1.374**	-3.160***	-0.414	-0.976	-2.345***	1.937	-0.149
	(0.487)	(0.564)	(1.188)	(0.479)	(0.732)	(0.444)	(1.385)	(0.609)
Number of observations	916	971	211	213	555	591	150	167
Adj. R^2	0.504	0.499	0.525	0.754	0.512	0.434	0.574	0.582

*Notes: For each business model and capital buffer group, the table presents the estimation' results of the impact of interest rates on ROA after controlling for the effects of other bank specific, macroeconomic and financial variables. Data are collected from SNL and Bloomberg. The coefficients are estimated using on a panel of large international banks from 25 developped countries over the period 2005-2016. The definitions of the variables are in table A2. Robust standard errors in the presence of heteroscedasticity are reported in brackets. ***, ** and * denote statistical significance at 1%, 5% and 10% respectively.*