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Does bank's business model affect their capital and profitability?

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Abstract

We use a data-driven classification of systemically important European banks into business models based on confidential granular supervisory data and investigate whether banks following different models differ with respect to their capitalisation and profitability. Our aim is to locate banks' business model into a risk-return space. Using an instrumental variables approach, our econometric methodology addresses potential endogeneity issues. Overall, we find that wholesale funded and securities holding banks are positioned on a relatively high risk-return trade-off plane compared to commercial banks. On the other hand, traditional commercial banks earn lower returns with moderate risk.

Keywords: Banking sector, Business models, Strategic groups, Cluster analysis, Single Supervisory Mechanism

JEL classification codes: C63, G21, L21, L25

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1. Introduction

This paper investigates the performance of a large sample of Eurozone banks that includes all systemically important institutions. Our aim is to link differential performance across banks' business models and, more specifically, answer the question whether Eurozone banks following different business models after the financial crisis exhibit different performance, as measured by the RoE and RoA indicators, and different capital ratios. For this purpose we utilise a uniquely granular dataset assembled from banks' supervisory reporting to the European Central Bank.

The main contribution of this study is the investigation on the link between banks' business models and performance based on a rigorous econometric analysis which addresses also endogeneity issues. The analysis is based on a classification of banks into business models which is robust to misspecification, as it utilizes very granular supervisory data. Specifically, the research question of this study is whether banks following different business models exhibit differential performance, a conjecture that had been already discussed in the 'strategic groups' literature of the 70's and 80's which was triggered by the seminal work of Porter (1979). Specifically, the idea proposed in this strand of the literature is that there may exist different rates of returns across business models which could not be equalized by competition as there may be mobility barriers in moving a firm to another strategic group (see e.g. Mascarenhas and Aaker 1989).

In this literature, due to the lack of granular micro-data, the classification of firms into business models was based on a narrow set of indicators. In addition, this literature usually examines firms operating in one single specific jurisdiction; therefore a comparison of the performance of business models is confounded by the country-level economic conditions. We use a cross-country sample in which harmonized granular data are available while our econometric analysis is able to condition on the macroeconomic environment. In other words, our approach is akin to a difference-in-difference approach, as we exploit variability both in the country- and the business model dimensions. A challenge here is that the local conditions could affect both banks' business models and banks' performance. The ensuing challenge of potential endogeneity is addressed by instrumenting banks' business models with the share of banks in a country following the business model, as this variable is unlikely to directly influence an individual banks'

performance.

Our analysis is based on a robust classification of banks into business models, in which the input set comprises very granular supervisory data, in contrast to existing literature that uses classifications based on narrow input sets (usually of less than 10 variables). In contrast to the existing literature, we use a clustering of banks into business models as described in Farnè and Vouldis (2017) which is characterised by the use of an exceptionally granular decomposition of banks' balance sheet. The granularity of the input set implies that our classification into business models is robust to misspecifications that can potentially arise when only a narrow set of input variables is used. The clustering algorithm underpinning the banks' classification used combines optimally the components of classification, input variable dimensionality reduction, and outlier detection and accounts for the existence of idiosyncratic mixtures of banks' activities (see Mergaerts and Vennet, 2016).

Our paper is also related to the diversification literature on banks' performance as we provide empirical evidence that the business model choice can explain the differential performance of banks in addition to the country- and other bank-specific determinants. The literature on diversification classifies banks on the dimension of heterogeneity of their activities or income sources, or both (see e.g. Laeven and Levine 2007). The business model concept seems to be a more informative distinction across banks, as it is defined based on specific compositions of activities, therefore investigating its link with performance one can infer whether specific combinations of activities exhibit economies or diseconomies of scale.

Our investigation about banks' differential capital levels allows us to locate banks into a risk-return plane, as capital is the main buffer to absorb losses when risk materialises. Therefore our paper is the first one to characterise banks' business models in the risk-return dimensions based on econometric analysis.

The remainder of the paper is organized as follows. Section 2 presents a review of the relevant literature. Section 3 provides details on the data used and the banks' classification. Section 4 presents the econometric methodology and the results obtained. Section 5 provides a discussion about the risk-return features of the various different business models and concludes.

2. Literature review

The concept of the business model is widely used in management studies whereby the business model is a new "unit of analysis". This literature focuses on the holistic nature of the concept and defines it referring to the activities of a firm. In Zott and Amit (2011) a comprehensive review is provided. In economics the concept is not clearly defined and Teece (2010) argues that a general equilibrium approach is not consistent with the 'business model' concept.

Consistently with the framework of 'strategic groups' as developed by Porter (1979) but also the more recent work on banks' business models (e.g. as in Roengpitya et al. 2014), we define in this paper banks' business models based on 'choice' variables, rather than 'outcome' variables. The latter captures the various activities that banks' management is steering the bank into as well as the relative extent to which the bank is involved in each of them. In other words, 'choice' variables reflect the composition of the banks' activities. In this conceptual framework, the banks' size does not belong to the set of 'choice' variables, as it does not reflect the composition of activities (not directly, of course there may be second-order links as larger banks may use to a larger degree complex instruments like derivatives). Banks' size can be viewed as an outcome of past performance and risk management i.e. can be primarily linked to 'outcome variables'.

An important distinction in this literature is between the business strategy and the business model. Specifically, for Magretta (2002) the business model refers to how "the pieces of a business fit together" (Magretta 2002, p. 89) while on the other hand the business strategy refers to the market competition and how a firm tries to stand out from its peers. In general, this literature while paying attention to the definition of the business model concept, focuses on the identification part rather than a relation between business models and outcome variables e.g. related to performance.

There are only few studies about the linkage between banks' business models and their performance. Ayadi et al. (2018) investigate the determinants of banks' migrations across business models. They find that relatively low profitability is a driver behind inducing banks to change their business model and that the migrating banks perform better

compared to their peers after migrating, also in terms of profitability.

Demiralp et al. (2019) focus on the impacts of negative interest rate policy, specifically as regards banks that rely on retail deposits, which is a funding instrument floored at zero. They find that negative rates, in combination with the asset purchase programme, have incentivised banks to seek higher returns by granting more loans. The business model classification in this paper is based on one variable, namely on the reliance to retail deposit, specifically high-, medium- and low-retail-deposit-intensity banks are distinguished using the 33rd and 66th percentiles of the sample.

De Haan and Kakes (2018) identify two business models using factor analysis and 15 bank characteristics as an input set, namely *Big investment banks* and *Retail banks*. The sample includes 69 EU banks with at least EUR 30 bn total assets. They find that the large investment banks suffered mostly during the global financial crisis period (2007-2009) while the retail banks were hit mostly during the European debt crisis period (2010-2016).

Ayadi et al. (2016b) look into how compliance with the Basel regulatory framework has impacted banks' efficiency which is measured using Data Envelopment Analysis (DEA). It is found that large banks and banks with higher loan-to-asset ratios are more efficient. The sample used comprises 1146 banks across 75 countries spanning the period 1999-2014.

The literature reviewed above uses a concept of the business model either consisting of some specific aspects of banks' activities (e.g. funding structure) or defined based on a narrow set of input variables. Therefore, there is a risk of mismeasuring banks' activities as the correspondence between some type of activities and the balance sheet items is not one-to-one but frequently one-to-many, meaning that one needs to consider more than one balance sheet item in order to gauge accurately the extent to which a bank is involved in this type of activity.

For example, one important element behind banks' classification into business models that have been used in all existing studies is defined by the degree to which a bank provides 'lending to the real economy'. It seems straightforward that one should simply include a variable like 'loans to the real economy' to capture this type of activity. However, it can happen that a bank may be financing the real economy via alternative

ways e.g. via off-balance sheet items, like loan commitments or by buying debt instruments issued by non-financial corporations (NFCs). In such cases, there can be a wide discrepancy between the measure of 'lending to the real economy' implied by the input set and the actual banks' activities. If the input set includes e.g. all of these three forms with which a bank can lend to the real economy i.e. loans, off-balance sheet commitments or debt securities, and the methodology is such that all three variables comprise a composite variable measuring 'lending to the real economy', the issue of misspecification can be addressed.

For example, a look into the balance sheets of two large European banks shows that their involvement into real lending would be significantly affected depending on whether off-balance sheet commitments would be taken into account or not.

Table 1: Comparison of gross loans to the real economy compared to the off-balance sheet commitments to real economy agents (Amounts in billion €) for 2018.

	Gross loans to the real economy	Off-balance sheet commitment to real economy agents
Deutsche Bank[3]	335,4	188,7
BNP Paribas[4]	309,8	77,6

Therefore, the classification of such banks into business models, for example whether they are considered commercial or investment banks, will be impacted by the way that 'lending to the real economy' is measured. The risk of misclassification will be minimized if alternative measures are included in the input set and utilized by the classification methodology.

The measurement of banks' lending to the real sector banks' can be also affected by ex-

[3] https://www.db.com/ir/en/download/Deutsche_Bank_Annual_Report_2018.pdf (p. 108)
[4] https://invest.bnpparibas.com/sites/default/files/documents/ddr2018-gb-bnp_paribas.pdf (p. 361).

ante credit risk, in the form of non-performing loans and the concomitant requirement for the bank to record provisions for the risky loans. Specifically, due to the fact that loans in banks' balance sheet are recorded in net terms i.e. after provisions have been deducted, the variable of loans as used in the literature may underestimate significantly the extent to which banks conduct loan-granting relative to their other activities, particularly in jurisdictions with high levels of credit risk. Classification results may be consequently distorted. This phenomenon could be especially important when classifying banks across different countries as there may be a significant country-specific component of credit risk[5].

Other types of activities are even more sensitive to the way they are measured. For example, the extent of derivatives use, which in existing studies is considered to be a defining element of business models, would be assessed differently depending on whether carrying amounts or notional values are used or whether asset-side or liability-side values are used. These different measures of derivatives can differ substantially across banks, also in relative terms. Consequently, the ensuing classification of banks into business models will be highly sensitive to the measure of derivatives used.

These cases exemplify the sensitivity of business model classification that is obtained when a narrow set of variables is used. Therefore, there is a strong argument in favour of using a granular input set because the detailed information renders the classification more robust to mismeasurement. In fact, most existing studies have relied on a narrow input set to characterize banks' business models.

In addition, in many cases the analysis of the extant literature is purely descriptive as the emphasis is on deriving a classification for banks' business models rather than on rigorously investigating the relationship between business models and outcome variables, such as performance. In contrast, this study uses a business model classification derived using granular data and is robust to the mismeasurement of banks' activities.

[5] For example in Greece between end-2009 and end-2016 the amounts of gross loans to the domestic real economy remained almost unchanged (from EUR 188 bln to EUR 185 bln), however net loans decreased by 20% (from EUR 177 bln to EUR 141 bln) due to much higher provisions according to the Bank of Greece statistics on the aggregate balance sheet of Greek credit institutions.

3. Data and descriptive statistics

We use the business model classification derived in Farnè and Vouldis (2017) for a set of 365 banks residing in all the 19 Eurozone countries. The sample contains all institutions labelled as "Significant Institutions" (SIs) and supervised directly by the ECB but also other large institutions (which do not satisfy the criteria set by the ECB, e.g. assets more than 30 billion euros, and are not included in the SIs). The proprietary dataset that has been used to classify the banks based on the granular breakdown on their activities has a reference date of end-2014. The data definitions are harmonised across jurisdictions, using IFRS accounting concepts but also definitions provided by the European Banking Authority e.g. on credit risk. This is a critical prerequisite of obtaining meaningful results, as for example the accounting treatment of derivatives or the concept of non-performing loans may differ widely across different parts of the globe.

Specifically, the banks in our sample are classified to the following four business models. First, *wholesale funded banks* (58 banks) which are usually large banks, mostly granting loans and relying on debt for their funding much more than other types of banks (and less on deposits from households). These banks also use derivatives much more than the rest. Second, *securities holding banks* (86 banks) have a relatively large securities portfolio and cash buffer. Their funding composition comprises mostly deposits. Third, *traditional commercial banks* (77 banks) which are medium-sized and represent the textbook prototype of banks as financial intermediaries, having the largest relative amount of loans on their asset side and funding themselves mostly with deposits. Fourth, *Complex commercial banks* (108 banks) possess a significant percentage of loans on their asset side but also own securities to a significant extent. Their funding consists mostly of deposits but to a lesser extent compared to traditional commercial banks while in addition these banks make use of derivatives mostly for trading purposes. Finally, 36 'outlier' banks were identified which follow idiosyncratic business models. Table 2 presents descriptive statistics on the size of the institutions. It can be seen that on average the wholesale banks are the largest with a mean size of 137 billion euros. However, there are large banks within each cluster, as testified by the maximum bank size that can be found within each cluster. Table 3 shows the share of each business model per country. Germany possesses the most wholesale banks, while two Baltic countries (Estonia and Latvia) have

the relatively highest percentage of securities holding banks. The two types of commercial banks are distributed more evenly across countries and their sum percentage is usually around 50%.

Table 2: Descriptive statistics of total assets per business model (billion euros).

Variable: total assets	Observations	Mean	Std. dev	Min	Max
Wholesale funded	58	137.2	227.2	1.4	1,302.5
Securities holding	86	48.5	224.6	0.1	1,684.6
Traditional commercial	77	75.4	243.6	0.1	1,903.1
Complex commercial	108	71.5	176.0	0.1	1,258.7

Table 3: Share of business models per country.

Country	Wholesale funded	Securities holding	Traditional commercial	Complex commercial	Outliers
Austria	23%	32%	32%	9%	5%
Belgium	20%	24%	20%	16%	20%
Cyprus	0%	50%	0%	50%	0%
Germany	38%	4%	13%	46%	0%
Estonia	0%	83%	0%	17%	0%
Spain	9%	30%	21%	25%	15%
Finland	13%	27%	53%	0%	7%
France	21%	8%	46%	8%	17%
Greece	0%	40%	0%	60%	0%
Ireland	14%	0%	43%	14%	29%
Italy	21%	2%	2%	70%	5%
Lithuania	0%	50%	0%	50%	0%
Luxembourg	17%	26%	26%	22%	9%
Latvia	0%	77%	8%	8%	8%
Malta	0%	33%	0%	67%	0%
Netherlands	22%	33%	11%	22%	11%
Portugal	0%	31%	31%	19%	19%
Slovenia	0%	38%	25%	38%	0%
Slovakia	0%	50%	13%	38%	0%

When looking into the descriptive statistics (see Table 4), it can be seen that wholesale funded and securities holding banks seem to exhibit better performance than the more traditional business models. Furthermore, the complex commercial banks seem to present a consistently lower performance, irrespectively of whether the RoE or the RoA metric is used.

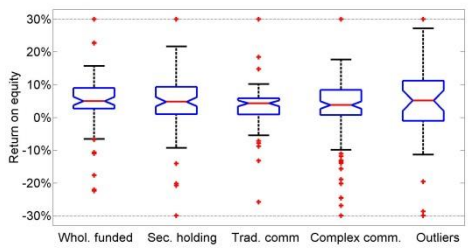
In Figure 1, a scatterplot or the RoA measure of performance against credit risk is shown. One could for example see that wholesale banks tend to exhibit somewhat higher returns,

however the result is not visually obvious for the other cases.

Having said that, the descriptive statistics cannot be considered to represent real evidence for the existence of differential performance across business models, as they may reflect bank- or country-specific factors. Therefore, in the next section we undertake an econometric analysis.

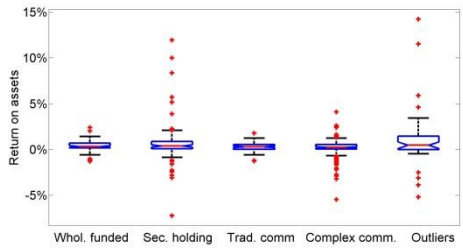
Table 4: Performance and efficiency indicators.

(a) Return on equity



	Wholesale funded	Securities holding	Traditional commercial	Complex commercial	Outliers
mean	4.85%	3.67%	2.64%	0.75%	1.49%
median	5.02%**	4.78%*	4.28%**	3.79%*	5.15%*
std	9.61%	17.73%	6.03%	3.79%	28.01%
c.v.	1.98	4.83	2.29	1.19	18.58

(b) Return on assets



	Wholesale funded	Securities holding	Traditional commercial	Complex commercial	Outliers
mean	0.37%	0.71%	0.28%	0.07%	1.13%
median	0.33%*	0.4%**	0.31%*	0.24%**	0.48%*
std	0.66%	2.39%	0.48%	1.22%	3.53%
c.v.	1.79	3.38	1.69	16.94	3.13

Figure 1: Scatterplot of return on assets against realised credit risk per business model. The size of the dots corresponds to banks' size.

4. Econometric analysis

This section presents the results of the econometric analysis on the relationship between banks' business models and performance. The investigation of business model differences with respect to performance utilises two alternative measures of banks' performance, namely the RoE and RoA variables.[6] The first hypothesis that we would like to test is that performance indicators for banks in a specific business model *i*, where $i \in \{1, 2, 3, 4\}$,[7] differ with respect to banks following other business models.

H1(i): Banks following business model i exhibit differential performance compared to the banks that do not follow business model i.

This formulation nests four hypotheses, one for each of the identified business models. At this point, we remain agnostic whether each model i exhibits higher or lower performance and we focus on investigating the existence of evidence for differential performance, a hypothesis which can be explained via the mobility barriers concept of the strategic groups literature e.g. as in Porter (1979) and the literature which followed. Given our aim to test for the existence of differential performance characteristics, we run four separate regressions, one for each business model, and include each time a dummy variable for a specific business model. In other words, our focus is on whether each of the identified business models is associated with different performance outcomes compared to all the remaining banks, rather than on making pairwise comparisons across business models.

We perform two baseline estimations and two additional robustness checks. The first baseline estimation uses fixed effects and country-level clustering of the error terms while the second uses OLS with within-cluster residual correlation. In the next section, the

[6] Following e.g. Aebi et al., 2012 and the literature cited therein, we also investigate the results using the buy-and-hold returns, as extracted from the S&P Global Market Intelligence database. However, the sample in that case is small, consisting in total of 48 observations. Consistently with our findings using RoA and RoE, there is empirical evidence that wholesale funded banks exhibit statistically significant higher returns compared with the other business models. These results are available upon request.

[7] Here $i = 1$ refers to wholesale funded banks, $i = 2$ to securities holding banks, $i = 3$ to traditional commercial banks, and $i = 4$ to complex commercial banks.

robustness checks address the potential endogeneity of business models and explore another estimation method namely the step-wise regression.

We also conduct an econometric investigation whether leverage and regulatory capital ratios differ among business models. Specifically, the set of four hypotheses is tested.

H2(i): Banks following business model i exhibit differential capital ratios compared to the banks that do not follow business model i.

The leverage ratio is defined as the equity-to-assets ratio. We investigate this set of hypotheses in order to understand how the different business models are positioned in the dimensions of risk and return.

4.1. OLS and fixed effects models

We perform two baseline estimations: one with country fixed effects and country-level clustering of the error terms and the second with OLS and country-level clustering of residuals. In detail, the OLS model combines country-level variables for the country in which bank j is operating, denoted as Z_k, and X_j a vector of bank-specific controls. The model can be written as follows:

$$y_{j,t} = a_0 + a_1 Z_{k(j),t-1} + \beta X_{j,t-1} + c\mathbf{1}(i)_{t-1}, + e_{j,t}. \qquad (1)$$

In the previous equation, the index j spans the different banks in our sample, $j = 1, \dots, 365$ and $k(j)$ is a function that maps each bank j to the country in which it is operating and its range is within the set $\{1, \dots, 19\}$ as our sample includes banks operating in 19 countries. Furthermore, y_j represents the dependent variable measuring performance and $\mathbf{1}(i)$ is an indicator variable that shows whether bank j has been classified as following the business model i. The model is estimated separately for $i = 1, \dots, 4$ as each time we aim to estimate the coefficient c quantifying the average statistical difference of profitability between the banks following the i-th business model and the banks following the three remaining ones. In other words, the coefficient of interest c, is the estimated effect of the business model i on bank's performance. For example, a positive coefficient $\hat{c}$ means that the banks following the business model i attain on average higher profitability compared to the other banks following the other business

models. Finally, a_1 and β represent vectors of regression coefficients. The time index *t* represents end-2015 data while the index *t-1* the end-2014 data. Finally, $e_{j,t}$ represents the residual term.

Given that the banks in our sample operate in different countries, we can plausibly assume that there are country-specific shocks and correlation of the residuals within each country. In such a case, if the default OLS standard errors are used there is a risk of greatly overstating the error precision consequently leading to high t-statistics. We use cluster-robust standard errors, in order to avoid attributing to business model effects the country-specific correlation of errors.

Specifically, the clustering of residuals across countries assumes

$$E\left[e_{j,t}e_{j^*,t}|X_{j,t-1},X_{j^*,t-1}\right] = 0, \text{ when } k(j) \# k(j^*)$$

$$E\left[e_{j,t}e_{j^*,t}|X_{j,t-1},X_{j^*,t-1}\right] \# 0, \text{ when } k(j) = k(j^*)$$

We use observations for end-2015 i.e. a date which follows the end-2014 reference date of the data that were used to define the business models. This time lag is used in order to address potential endogeneity with respect both to the definition of the business model and the bank-specific determinants. The theoretical justification which underlies our choice of variables aims also to address endogeneity caused by omitted variables. Additional robustness checks are also used below to address potential endogeneity biases with respect to the business model variable utilising instrumental variables estimation.
In the baseline regressions the lagged business model variable is assumed to be exogenous. The argument behind this assumption is that the business model is a feature which is slowly and infrequently changing e.g. in the course of one year, and therefore there is no reverse causation stemming from the outcome variable. However, migration of banks across business models cannot be excluded and one could argue that endogeneity may be present. This leads us to further investigate below the potential impact of endogeneity.

Following the literature we include a number of bank-specific variables namely the size of the bank, the ratio of deposits to liabilities, the leverage ratio, the past growth of assets and income and the market share within its country. (see Albertazzi and Gambacorta

2009; Demirgüç-Kunt and Huizinga 1999; Elsas et al., 2010; Laeven and Levine 2007). Specifically, we include bank's size, which could affect performance due to economies of scale (or diseconomies of scale), banks' level of capitalisation, which could also reflect country-specific shocks, banks' market shares, reflecting market power and variables measuring banks' growth of assets and operating income, which control also for the country-level macroeconomic conditions.

Furthermore, we control for bank's funding structure and therefore we also include the ratio of deposits to assets. Lopez et al. (2018) find that the deposit ratio is able to differentiate banks as regards their performance in a low rate environment, as banks are in general unwilling to charge their retail depositors (Eggertson et al. 2017). As a source of funding deposits cost less than issuing debt, therefore they can be expected to positively affect profitability.[8]

Our specification also remains the same when examining the relationship of business models with capital ratios. Gropp and Heider (2010) investigate the drivers of banks' funding structure using a specification which is consistent with their aim to compare the determinants of banks' capital structure with those for non-financial firms. Their specification is consistent with that adopted here given the close relationship of their variables with those of our adopted specification, the only exception being variables like 'collateral' and 'dividends' which are typical for the corporate finance literature.[9] We have also tested the robustness of the results obtained here to an alternative specification which includes profits as an explanatory variable, instead of profit growth, following the Gropp and Heider specification.

So far we have not included cluster-specific fixed effects in the form of a separate intercept for each cluster. The corresponding model with country fixed effects and

[8] Some bank-specific control variables are also inputs to the classification algorithm. Therefore, we have examined the multicollinearity of our baseline model variables by checking the VIF values and in all cases they are less than 1.1, therefore multicollinearity can be safely ignored. The absence of significant multicollinearity effects can be attributed to the multi-dimensional nature of our business model classification methodology. However, multicollinearity would represent an issue for the business model classifications that are based on a small number of pre-selected dimensions. Therefore, due to our granular approach to business model classification we are able to control for such bank-specific variables which may differ within business models and whose omission may have led to omitted variable biases.

[9] We have tested the inclusion of the 'collateral' variable in our model, defined as the percentage of 'high quality assets' to total assets, which did not modify the statistical significance of the business model variable.

country-level clustering of the error terms can be written as

$$y_{j,t} = a_{0,k(j)} + \beta X_{j,t-1} + cIND(i)_{t-1} + e_{j,t} \quad (2)$$

The condition for the residual term $e_{j,t}$ remains the same as above.

In the specification estimated with OLS we include country specific variables such as GDP and unemployment measures in order to capture the effects of the macroeconomic environment in different time horizons. Concretely, macroeconomic conditions are taken into account by including the y-o-y real GDP growth and the 2009-2015 change in unemployment, so as to capture both short-run macroeconomic effects and the long-run effects of the crisis.[10]

4.2. Controlling for endogeneity

The results obtained above may be susceptible to biases stemming from potential endogeneity or by the use of the specific estimation methods. Therefore, we conduct robustness checks based on alternative estimation methods in order to ensure the reliability of our results.[11]

As discussed, there are arguments pointing to the endogeneity of the business model variable, even if lagged instances are used. In other words, it cannot be taken for granted that only business models affect outcome variables and that there is no effect in the other direction i.e. from outcome variables to business models. The reason is that the lag structure used in the previous section may not fully address this issue as the business model is a semi-stable characteristic for each bank, which may evolve throughout time even though only gradually. One cannot also exclude the presence of unobserved variables at the bank level, for example the quality of governance of an institution which may have a bearing on its performance.

The endogeneity issue will be tackled using instrumental variables estimation. We are looking therefore for an instrument for bank's business models that would be a predictor of bank's business model but which would not have a direct effect on their profitability

[10] The results are qualitatively similar when we interchange the use of long-run and short-run measures for GDP and unemployment or when inflation is also included.

[11] An additional robustness check was to include efficiency as an explanatory variable, consistently with the 'bad management' and 'skimping' hypotheses of Berger and DeYoung (1997). The results are qualitatively similar and available upon request.

(see Angrist and Pischke 2009). The aim of such an instrument would be to proxy for the unobserved institutional features of each jurisdiction which would influence banks' choices of their business models. For example, such features could be the role of a country as a financial hub, past regulatory interventions[12], propensity of households to take mortgage loans.[13] Such features would affect banks' profitability only via their choice of business model but not in a direct way.

This approach is complicated by the fact that it is not clear what the determinants of business models are. This is a question which requires further investigation and is not addressed in this paper. However, for the purpose of controlling for endogeneity, we would like to instrument the business model dummy to ensure that no endogeneity drives the results. An aspect which further complicates this issue is that it is not certain that a common instrument can be used for all four business models. To address these issues we adopt a practical approach in which an instrumental variable that is common to all four business variables is used. This instrumental variable is the share of each business model within the subsample of banks of that country. Specifically, we use the instrumental variable $SHARE(i)_{k,t-1}$ which denotes the percentage of banks following business model i in country k in end-2014. We argue that this variable provides a proxy for the aforementioned unknown institutional features that determine banks' business model at the country level. First, this instrumental variable is highly correlated to each bank's business model indicator. On the other hand, one can argue that it does not represent a direct determinant of each bank's profitability as it is mainly a proxy variable for country-level institutional factors. In other words, one could argue that the share of banks following a specific business model in a country is unrelated to any unobserved features at the bank level.

In this set-up a relationship between the share of banks in a country that follow a specific business model and a bank's performance is attributed to the relationship between the share of banks variable and the bank's business model variable. In other words, we have the exclusion restriction that $Cov\left(SHARE(i)_{k,t-1}, e_{j,t}\right) = 0$. Furthermore it can be seen

[12] The reference date of our sample (end-2014) corresponds to the inauguration of the Single Supervisory Mechanism, meaning that all banks in our sample are under the same regulatory regime. However still there could be regulatory interventions of the past which may have shaped banks' selection of business models.
[13] This analysis of potential endogeneity is at this stage simply a robustness check as there is no available literature on the determinants of banks' business models.

in the data that the variable $SHARE(i)_{k,t-1}$ is a strong predictor of $IND(i)_{t-1}$[14].
A further robustness check is conducted by performing a backward stepwise regression estimation. A backward stepwise regression with 20% significance level for removal from and 10% for addition to the model is used.

4.3. Results

The results of the OLS and country fixed effects estimations with RoE as the dependent variable are presented in Table 5. Furthermore, Table 6 presents the OLS and country fixed effects when RoA is used as a measure of performance. Finally, Table 7 presents the results of the robustness checks for the RoE performance metric, and Table 8 for the RoA.

It can be seen in Table 5 that both country- and bank-specific variables turn up to be significant predictors of returns. Specifically, there is a persistently statistically significant coefficient on unemployment which implies a negative link between macroeconomic conditions and banks' profitability. Our results show overall a statistically significant positive coefficient of banks' size when RoE is the dependent variable. This can be interpreted as reflecting the capability of larger banks to generate more profits per unit of capital compared to smaller banks. Other studies such as Mergaerts and Vennet (2016) report a negative relationship between size and profitability using a sample of banks covering the period 1998-2013. Our sample is different and covers the post-crisis European financial landscape, in which a number of crisis-hit banks had to be recapitalised and our results reflect the aftermath of this turbulent period. The evidence therefore is that in this economic environment and conditional on the other bank-specific and country-specific variables, the larger banks were able to generate higher returns per unit of capital compared to smaller banks.

The deposits-to-liabilities coefficient is generally positive but not statistically significant. The literature on the determinants of banks' profitability has generally found that

[14] We have performed the F-statistics for the instrumental variables, which show that our chosen instrument is quite strong (in the sense of being correlated with the potentially endogenous business model variable). These results are available upon request.

traditional banks relying on interest income and funded with deposits exhibit higher profitability (see for example Carbó-Valverde and Rodriguez-Fernández 2007; Stiroh 2004). On the other hand, this feature is captured in our model by the respective business model dummy and this explains the lack of statistical significance.[15] In addition, in the low interest environment featuring in our sample, the positive relationship found in the literature may be weaker due to the downward stickiness of deposit rates.

The coefficient of the capital ratio is positive and statistically significant, implying that better-capitalised banks are able to obtain higher profits. This result is consistent with Kok et al. (2015) who examine also a panel of European banks.

The estimated coefficients relative to the business model dummy provide evidence that for two business models there is a relationship between performance and business model membership. Specifically, wholesale funded banks exhibit on average higher returns in comparison to the banks which follow other business models, while complex commercial banks perform systematically worse. These results are robust to the estimation method. Furthermore, these results are consistent when RoA is used as a measure of performance, as shown in Table 6. Importantly, the results remain robust both to estimation methods and to the change in the performance variable.

The robustness checks in Table 7 and Table 8 do not lead overall to significant reversals of the above results. Stepwise regressions preserve statistical significance of the variables for wholesale funded banks and complex commercial banks. It should be noted however, that in the case of instrumental variable estimations, the statistical significance of the coefficient for complex commercial banks indicator is preserved, while this does not happen for the wholesale funded banks. Therefore, one could infer that there may be a reverse causality mechanism operating, whereby banks are able to adopt the wholesale funded business model because they are more profitable. This result is consistent with Ayadi and De Groen (2014, p. 43) who find that their 'wholesale' banks have performed significantly better than the rest during the post-crisis period.

With respect to the hypothesis of differential capital ratios across banks we use the same set of explanatory variables to ensure consistency with our previous investigation,

[15] In a specification in which we excluded the business model dummies the deposits to liabilities variables turned to be statistically significant. These results are available upon request.

excluding of course the equity-to-assets ratio. The lag structure remains as in *H1* in order to address endogeneity stemming from the bank-specific and macroeconomic variables.

When the dependent variable is the leverage or the capital ratio, the results also identify differences across business models. The macroeconomic conditions, and specifically GDP growth, turn out to be consistently a significant driver of leverage with a positive sign, implying a positive effect of macroeconomic developments to banks' capitalisation. This result holds irrespectively of whether capitalisation is risk-adjusted or not. Furthermore, consistently with both the corporate finance literature for non-banks (e.g. Rajan and Zingales, 1995; Brewer III et al., 2008; Gropp and Heider. 2010) and the bank capital structure literature emphasising recapitalisation costs (e.g. Peura and Keppo, 2006) or implicit public subsidies due to systemic risk or economies of scale in monitoring their borrowers (Stolz and Wedow, 2011; Lammertjan and Koetter, 2012) we find a negative relationship of size (as measured by the market share within each jurisdiction) with leverage, but not with risk-based capital. On the other hand, risk-adjusted capital is negatively related with past growth in income, which points to the fact that profitable banks are able to keep lower risk-adjusted capital buffers.

With respect to the main variables of interest, namely the business model indicators, we find consistently statistical significant coefficients for three business models: First, wholesale funded banks possess less capital than the other banks, both in accounting and in risk-adjusted terms. Second, securities holding banks hold more capital than the other banks, again when both capital metrics are used. Finally, the complex commercial banks have less capital than the banks following other business model, a result that holds for both measures of capital. These results are confirmed when the Tier 1 capital ratio is used as a dependent variable instead of the total regulatory capital ratio.[16] These results are also robust to instrumental variables estimation that controls for endogeneity of the business model and when using a stepwise regression (see Table 11 and Table 12). Therefore, we find evidence for a statistically significant relationship between capital and business models for three out of the four considered business models, a relationship which is robust to alternative metrics, specifications and estimation methods.

[16] In addition, these results change are very similar when the narrower Tier1 capital ratio is used, instead of the total capital ratio. These results are available upon request.

Our results are broadly in line with the evidence of the existing literature. Roengpitya et al. (2017) examine a global sample of banks from 2005 to 2015 and find that for the sub-sample of banks in advanced economies, wholesale funded banks exhibit the highest RoE, as is the case in our study. The retail banks, corresponding loosely to the traditional commercial banks in this paper, attain also a high ranking with respect to performance as they are the most effective type of banks in collecting net interest income. These findings are very much in line with our results. Mergaerts and Vennet (2016) use a panel of 505 banks over the period 1998 to 2013 and find that banks with a traditional funding structure exhibit on average higher RoE and RoA while, in addition, diversified banks also perform better. In that paper, two "factors" are distinguished, corresponding to business models, "retail" and "diversification". They found that in the between dimension both factors have a positive relationship with RoA, however only the "diversification" factor has a positive effect on RoE. This is also consistent with the results obtained here. Finally, Ayadi et al. (2016a) find that their "focused retail" banks have lower RoA than the wholesale banks while the reverse is true as regards the RoE.

Table 5

The dependent variable is RoE as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Deposits/liabilities is the ratio of deposits to liabilities. Equity/assets is the ratio of equity to assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses.

Dependent variable: RoE								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects
GDP growth	0.211 (0.741)		0.203 (0.702)		0.197 (0.683)		0.209 (0.758)	
Unemployment change	-0.255* (2.402)		-0.256* (2.397)		-0.262* (2.343)		-0.234* (2.358)	
Log (total assets)	0.005 (1.643)	0.005 (1.69)	0.006* (1.846)	0.006* (1.87)	0.006* (2.006)	0.006* (2.09)	0.006* (2.071)	0.006* (2.10)
Deposits/liabilities	0.032 (0.994)	0.030 (1.01)	0.031 (0.924)	0.032 (0.94)	0.034 (1.003)	0.042 (1.38)	0.029 (0.939)	0.031 (0.98)
Equity/assets	0.065 (0.861)	0.042 (0.51)	0.063 (0.863)	0.044 (0.53)	0.066 (0.856)	0.048 (0.59)	0.054 (0.714)	0.040 (0.49)
Growth in assets	0.027 (0.735)	0.029 (0.82)	0.026 (0.703)	0.027 (0.78)	0.027 (0.748)	0.030 (0.94)	0.026 (0.697)	0.028 (0.801)
Growth in income	0.008 (0.794)	0.008 (0.76)	0.008 (0.697)	0.008 (0.65)	0.008 (0.745)	0.008 (0.74)	0.008 (0.711)	0.008 (0.65)
Market share	-0.055 (1.220)	-0.006 (0.13)	-0.065 (1.422)	-0.014 (0.31)	-0.068 (1.540)	-0.015 (0.32)	-0.059 (1.350)	-0.014 (0.30)
Business model dummy	0.021** (3.188)	0.020*** (3.55)	0.002 (0.174)	0.001 (0.09)	-0.007 (0.823)	-0.018** (2.49)	-0.066* (2.164)	-0.066 (1.77)

Constant	-0.076 (0.762)	-0.075 (0.76)	-0.104 (0.912)	-0.103 (0.90)	-0.107 (1.010)	-0.114 (1.09)	-0.092 (0.944)	-0.100 (0.99)
Observations	313	313	313	313	313	313	313	313
R-squared	0.14	0.10	0.14	0.09	0.14	0.10	0.14	0.11

Table 6

The dependent variable is RoA as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Deposits/liabilities is the ratio of deposits to liabilities. Equity/assets is the ratio of equity to assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses.

Dependent variable: RoA								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects
GDP growth	0.025 (1.03)		0.024 (1.00)		0.024 (0.98)		0.025 (1.04)	
Unemployment change	-0.021** (2.703)		-0.021* (2.71)		-0.021** (2.61)		-0.019** (2.60)	
Log (total assets)	0.000 (0.746)	0.000 (0.46)	0.000 (1.03)	0.000 (0.81)	0.000 (1.12)	0.000 (0.91)	0.000 (1.11)	0.000 (1.10)
Deposits/liabilities	0.004 (1.304)	0.004 (1.27)	0.004 (1.22)	0.004 (1.18)	0.004 (1.29)	0.005 (1.61)	0.004 (1.23)	0.004* (1.80)
Equity/assets	0.019** (2.112)	0.017* (1.82)	0.019** (2.10)	0.018* (1.85)	0.019** (2.11)	0.018* (1.91)	0.019* (2.01)	0.018*** (3.54)
Growth in assets	0.001 (0.307)	0.001 (0.49)	0.001 (0.27)	0.001 (0.44)	0.001 (0.28)	0.002 (0.54)	0.001 (0.25)	0.001 (0.36)
Growth in income	0.001 (0.944)	0.001 (1.04)	0.001 (0.85)	0.001 (0.89)	0.001 (0.90)	0.001 (1.02)	0.001 (0.87)	0.001 (1.09)
Market share	-0.001 (0.348)	0.004 (1.03)	-0.002 (0.54)	0.003 (0.84)	-0.002 (0.61)	0.003 (0.85)	-0.002 (0.45)	0.000 (0.11)

Business model dummy	0.002*** (4.576)	0.002*** (4.99)	0.000 (0.12)	0.000 (0.12)	-0.000 (0.45)	-0.001 (1.71)	-0.001** (2.10)	-0.001* (1.65)
Constant	-0.003 (0.395)	-0.002 (0.23)	-0.006 (0.57)	-0.005 (0.44)	-0.006 (0.63)	-0.005 (0.55)	-0.005 (0.54)	-0.003 (0.60)
Observations	313	313	314	314	314	314	314	314
R-squared	0.16	0.13	0.15	0.12	0.15	0.13	0.16	0.12

Table 7

The dependent variable is RoE as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Deposits/liabilities is the ratio of deposits to liabilities. Equity/assets is the ratio of equity to assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses. For each business model regression, the first column presents results with an instrumental variables estimation while the second column with a backward stepwise approach.

Dependent variable: RoE Robustness checks								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise
GDP growth	0.101 (0.34)		0.222 (1.10)		0.224 (0.99)		0.227 (1.10)	
Unemployment change	-0.430* (1.88)	-0.272** (2.74)	-0.240 (3.49)***	-0.277** (2.75)	-0.229*** (3.55)	-0.277** (2.75)	-0.186*** (2.68)	-0.250** (2.68)
Log (total assets)	-0.004 (0.20)		0.007 (2.50)**	0.004 (1.73)	0.004* (1.69)	0.004 (1.73)	0.006** (2.56)	0.003 (1.49)
Deposits/liabilities	-0.012 (0.33)		0.030 (1.51)		0.010 (0.39)		0.024 (1.11)	
Equity/assets	0.076 (0.72)		0.056 (0.83)		0.049 (0.72)		0.034 (0.49)	
Growth in assets	0.180** (2.09)		0.028 (0.73)		0.020 (0.44)		0.024 (0.61)	
Growth in income	0.002 (0.06)		0.007 (0.67)		0.008 (0.81)		0.008 (0.78)	
Market share	0.076 (0.39)		-0.077 (1.71)*	-0.050 (1.41)	-0.036 (0.95)	-0.050 (1.41)	-0.050 (1.38)	

Business model dummy	0.128 (0.35)	0.025*** (3.42)	0.016 (0.53)		0.054 (0.56)		-0.047*** (2.97)	-0.017* (1.98)
Constant	0.129 (0.28)	0.057 (8.27)***	-0.129 (1.55)	-0.026 (0.52)	-0.049 (0.71)	-0.026 (0.52)	-0.074 (1.13)	-0.008 (0.17)
Observations	313	313	313	313	313	313	313	313
R-squared		0.13		0.14		0.14		0.13

Table 8

The dependent variable is RoA as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Deposits/liabilities is the ratio of deposits to liabilities. Equity/assets is the ratio of equity to assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses. For each business model regression, the first column presents results with an instrumental variables estimation while the second column with a backward stepwise approach.

Dependent variable: RoA Robustness checks								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise
GDP growth	0.030 (0.47)		0.025 (1.30)		0.025 (0.85)		0.026 (1.28)	
Unemployment change	-0.020 (1.23)	-0.024*** (3.30)	-0.020*** (3.98)	-0.024*** (3.22)	-0.014 (0.39)	-0.024*** (3.22)	-0.016*** (2.86)	-0.022*** (3.25)
Log (total assets)	-0.000 (0.06)		0.000 (1.37)		-0.000 (0.09)		0.000 (1.36)	
Deposits/liabilities	0.004 (1.15)	0.004 (1.48)	0.004** (2.18)		-0.002 (0.06)		0.003* (1.78)	
Equity/assets	0.020* (1.81)	0.018** (2.24)	0.019** (2.30)	0.015 (1.74)*	0.016 (0.86)	0.015 (1.74)*	0.017** (1.99)	0.014 (1.65)
Growth in assets	0.001 (0.22)		0.001 (0.27)		-0.001 (0.10)		0.001 (0.19)	
Growth in income	0.001 (0.61)		0.001 (0.74)		0.001 (0.63)		0.001 (0.84)	
Market share	0.003 (0.06)		-0.003 (0.70)		0.005 (0.14)		-0.001 (0.28)	

Business model dummy	0.012 (0.10)	0.002*** (3.49)	0.001 (0.33)		0.014 (0.20)		-0.004*** (2.67)	-0.001* (1.76)
Constant	0.009 (0.06)	0.001 (0.48)	-0.007 (0.92)	0.004*** (4.25)	0.008 (0.12)	0.004*** (4.25)	-0.003 (0.58)	0.005*** (4.71)
Observations	313	313	314	314	314	314	314	314
R-squared		0.14		0.12		0.12		0.13

Table 9

The dependent variable is the leverage ratio as observed in 2015, defined as the equity to assets ratio. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. T-statistics are reported in parentheses.

Dependent variable: Leverage ratio								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects
GDP growth	0.340** (2.26)		0.363** (2.19)		0.356** (2.23)		0.360** (2.41)	
Unemployment change	0.042 (0.72)		0.063 (1.15)		0.042 (0.63)		0.060 (0.97)	
Growth in assets	-0.022 (0.64)	-0.035 (1.20)	-0.019 (0.57)	-0.031 (1.09)	-0.021 (0.61)	0.034 (1.17)	-0.022 (0.68)	-0.033 (1.26)
Growth in income	0.003 (0.55)	0.004 (0.85)	0.002 (0.34)	0.003 (0.51)	0.004 (0.62)	0.005 (0.93)	0.004 (0.57)	0.004 (0.74)
Market share	-0.022 (0.68)	-0.066* (2.02)	-0.028 (0.82)	-0.064* (1.93)	-0.025 (0.74)	-0.070** (2.11)	-0.020 (0.59)	-0.067* (2.05)
Business model dummy	-0.016*** (3.20)	-0.009** (2.23)	0.017** (2.52)	0.016* (1.99)	-0.007 (1.07)	0.006 (0.89)	-0.010** (2.22)	-0.013** (2.32)
Constant	0.096*** (4.44)	0.104 (5.41)***	0.087*** (5.13)	0.096*** (10.10)	0.095*** (4.52)	0.104*** (4.20)	0.096*** (9.02)	0.106*** (4.49)
Observations	316	316	316	316	316	316	316	316

R-squared	0.20	0.27	0.20	0.23	0.20	0.23	0.21	0.25

Table 10

The dependent variable is the total regulatory capital ratio as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. T-statistics are reported in parentheses.

Dependent variable: Total regulatory capital ratio								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects	OLS	Country fixed effects
GDP growth	1.015*** (3.39)		1.038*** (3.47)		1.026*** (3.26)		1.034*** (3.68)	
Unemployment change	-0.040 (0.49)		-0.011 (0.15)		-0.047 (0.53)		-0.016 (0.20)	
Growth in assets	-0.022 (0.54)	-0.044 (1.03)	-0.019 (0.48)	-0.040 (0.98)	-0.020 (0.49)	-0.041 (0.97)	-0.023 (0.54)	-0.043 (1.01)
Growth in income	-0.012*** (2.98)	-0.010* (2.09)	-0.014*** (3.10)	-0.012** (2.38)	-0.012*** (2.97)	-0.009* (1.94)	-0.012** (2.87)	-0.010** (2.11)
Market share	0.008 (0.11)	0.001 (0.01)	-0.000 (0.01)	0.002 (0.02)	0.001 (0.02)	-0.004 (0.06)	0.011 (0.16)	-0.002 (0.03)
Business model dummy	-0.014* (1.86)	-0.014* (1.92)	0.024*** (2.56)	0.021* (2.00)	-0.023** (2.24)	-0.024** (2.09)	-0.014* (1.87)	-0.012* (1.84)
Constant	0.160*** (6.11)	0.179*** (5.50)	0.149*** (5.20)	0.170*** (4.90)	0.163*** (5.85)***	0.184*** (4.24)	0.161 (6.49)***	0.181*** (5.92)
Observations	312	312	312	312	312	312	312	312
R-squared	0.22	0.15	0.22	0.15	0.22	0.15	0.22	0.15

Table 11

The dependent variable is the leverage ratio as observed in 2015, defined as the equity to assets ratio. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses. For each business model regression, the first column presents results with an instrumental variables estimation while the second column with a backward stepwise approach.

Dependent variable: Leverage ratio Robustness checks								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise
GDP growth	0.211 (1.52)	0.264** (2.17)	0.330* (1.86)	0.252* (1.91)	0.316** (2.06)	0.278** (2.29)	0.318** (2.11)	0.264 (2.14)**
Unemployment change	0.000 (0.01)		0.061 (1.20)		0.021 (0.29)		0.035 (0.46)	
Growth in assets	-0.043 (1.19)		-0.034 (1.25)		-0.040 (1.55)		-0.040 (1.63)	
Growth in income	-0.002 (0.22)		-0.003 (0.43)		0.001 (0.15)		0.001 (0.11)	
Market share	-0.023 (0.72)		-0.039 (1.24)		-0.028 (1.02)		-0.026 (0.89)	
Business model dummy	-0.096*** (3.55)	-0.016*** (3.41)	0.040** (2.44)	0.016** (2.39)	-0.000 (0.03)		-0.009 (0.74)	-0.009* (1.87)
Constant	0.103*** (5.53)	0.092*** (30.56)	0.075*** (4.69)	0.086*** (25.40)	0.090*** (7.59)	0.090*** (31.17)	0.092*** (6.86)	0.093*** (28.96)
Observations	316	316	316	316	316	316	316	316

R-squared		0.25		0.26		0.23		0.25

Table 12

The dependent variable is the total regulatory capital ratio as observed in 2015. Real GDP growth is the y-o-y growth in end-2015. Unemployment change is the 6-year change in unemployment until end-2015. The rest of the bank-specific variables are as observed on end-2014 except from the growth rates which refer to yearly rates by end-2015. Log (total assets) refers to the logarithm of bank's total assets. Growth in assets is the yearly growth rate in total assets, from 2014Q4 to 2015Q4. Growth in income is the yearly growth rate in operating income. Market share is the bank's share in total assets in the country. The business model dummy is one if the bank belongs to the respective business model indicated by the column label. t-statistics are reported in parentheses. For each business model regression, the first column presents results with an instrumental variables estimation while the second column with a backward stepwise approach.

Dependent variable: Total regulatory capital ratio Robustness checks								
	Wholesale funded banks (Cluster 1)		Securities holding (Cluster 2)		Traditional commercial (Cluster 3)		Complex commercial (Cluster 4)	
	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise	IV GMM	Stepwise
GDP growth	0.999*** (2.94)	1.085*** (4.73)	1.042*** (3.11)	1.057*** (4.51)	1.030*** (3.08)	1.099*** (4.43)	1.038*** (3.14)	1.073*** (4.91)
Unemployment change	-0.042 (0.64)		0.003 (0.04)		-0.038 (0.56)		0.007 (0.10)	
Growth in assets	-0.023 (0.60)		-0.017 (0.48)		-0.022 (0.56)		-0.023 (0.62)	
Growth in income	-0.013 (1.54)	-0.015** (2.84)	-0.016 (1.86)*	-0.016*** (3.20)	-0.012 (1.44)	-0.014** (2.86)	-0.013 (1.48)	-0.014** (2.79)
Market share	0.008 (0.17)		-0.004 (0.09)		0.006 (0.13)		0.016 (0.31)	
Business model dummy	-0.028 (0.67)	-0.014* (1.88)	0.037* (1.69)	0.024** (2.78)	-0.002 (0.08)	-0.023** (2.25)	-0.030* (1.82)	-0.014* (1.92)
Constant	0.162*** (5.18)	0.154*** (19.21)	0.144*** (5.18)	0.145*** (18.79)	0.159*** (5.54)	0.157*** (17.06)	0.164*** (11.43)	0.157*** (17.11)

Observations	312	312	312	312	312	312	312	312
R-squared		0.17		0.15		0.16		0.16

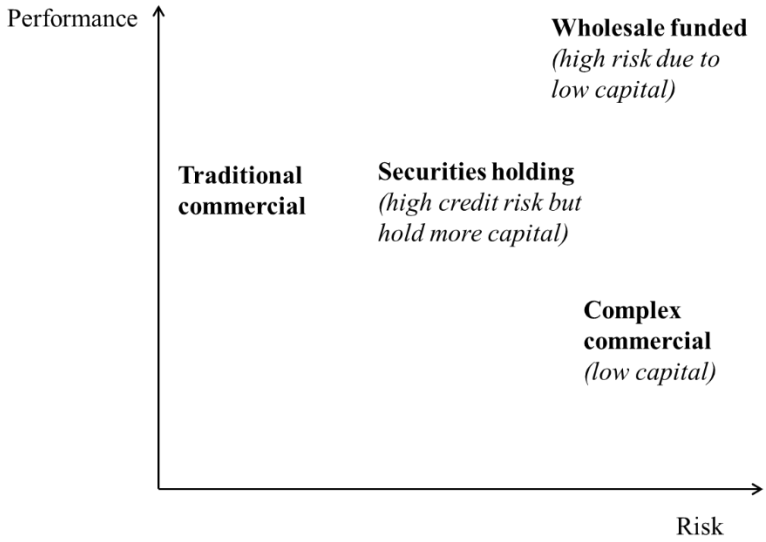
4.4. Discussion

Our results provide evidence that securities holding banks hold on average more capital compared to the other banks, while the complex commercial banks and wholesale banks hold on average the lowest amount of capital. In addition, our econometric analysis has provided evidence that wholesale banks exhibit the highest performance while the complex commercial banks the worst, on average. These results can be combined with the econometric analysis presented in Farnè and Vouldis (2019) in order to locate the different banks' business model into a risk-performance axis.

Specifically, the econometric investigation in Farnè and Vouldis (2019) provides empirical evidence of a relationship between the credit risk in the loan portfolio and the choice of the business model. It is found that traditional commercial banks present significantly lower credit risk compared to the other business models. In addition, securities holding banks are characterized by higher credit risk. These results prove to be largely robust to alternative specifications and when controlling for the endogeneity of the business model.

When these two sets of results are combined, one can get the assessment of banks' business models presented in Figure 2. Specifically, wholesale banks are placed on a high risk – high performance position, given the results of the current paper on their capital levels and their performance. The traditional commercial banks are placed on a low risk – medium performance position, based on the results of Farnè and Vouldis (2019) regarding their low credit risk. We place this set of banks in the middle of the performance axis as our econometric analysis does not find a statistically significant difference of the performance metrics characterising traditional commercial banks from the rest of banks. As regards the securities holding banks, their performance is not statistically different from the average, based on the results obtained here. On the other hand, we have found in this paper that they hold relatively high amount of capital but they also exhibit relatively high credit risk (based on the evidence of Farnè and Vouldis 2019), therefore we place these banks in a medium risk – medium performance position. Finally, the complex commercial banks are placed on a low performance – high risk position, based again on the combined results of this paper and Farnè and Vouldis (2019).

Figure 2: Risk-performance characteristics per business model. The classification is based on the econometric analysis of the current paper combined with the results of Farnè and Vouldis (2019).



There are of course caveats to this assessment, most importantly that it corresponds to a snapshot in time, at the end-2014, so a time dimensional extension of this analysis could be conditioned on changes in the macroeconomic conditions. However, according to our knowledge, this is the first such assessment of business models on the risk-return plane that is backed by econometric analysis and not simply by descriptive statistics.

5. Discussion and conclusion

The present study is the first one that makes use of a business model classification derived using an exceptionally granular data set on European banks, in order to investigate how banks' business models impact on banks' capital and performance. The proposed instrumental variables approach allows to address potential endogeneity issues, like the ones arising from the ability of a bank to adopt a business model due to a specific profitability or risk profile.

We find evidence that wholesale funded banks exhibit higher performance than the other business models, while holding less capital and employing more leverage compared to other business models. On the other hand, the complex commercial business model seems to perform worse than the rest as they possess relatively low amounts of capital and exhibit high leverage. In addition, it is found that securities holding banks have on average higher amounts of capital compared to the remaining banks. When the above results are combined with existing literature, one could reach the conclusion that the two most effective business models are the traditional

commercial banks, which exhibit modest returns with low risk, and the high-performing but risky wholesale funded banks.

The analysis presented is based on the end-2014 state of the largest European banks, thus reflecting the post-crisis environment and especially the recapitalisations and increases in credit risk that have taken place since the outbreak of the European sovereign debt crisis. Therefore, the extension of our analysis in the time dimension would be of great interest so as to examine whether these results hold more generally during the other phases of the business cycle.

Conflict of interest and data availablity

The views expressed in this article do not necessarily represent the views of the ECB or the Eurosystem. Our analysis is based on a proprietary institutional dataset collected for banking supervision in the context of the Single Supervisory Mechanism. The dataset is therefore confidential and not publicly available. The authors have no conflict of interest of any kind to disclose.

References

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

Angrist, J., Pischke, J., 2009. Mostly harmless econometrics: An empiricist's companion. New Jersey: Princeton University Press.

Ayadi, R., De Groen, W., 2014. Banking business models monitor 2014. *Centre for European Policy Studies and International Observatory on Financial Services Cooperatives*

Ayadi, R., De Groen, W. P., Sassi, I., Mathlouthi, W., Rey, H., and Aubry, O., 2016a. Banking business models Monitor 2015: Europe. International Research Centre on Cooperative Finance.

Ayadi, R., Naceur, S. B., Casu, B., Quinn, B., 2016b. Does Basel compliance matter for bank performance? Journal of Financial Stability 23, 15-32.

Ayadi, R., Bongini, P., Casu, B., Cucinelli, D., 2018. Bank business models' migrations in Europe: Determinants and effects. EBA Policy Research Workshop, London 28-29 November

2018.

Berger, A. N., DeYoung, R., 1997. Problem loans and cost efficiency in commercial banks. Journal of Banking and Finance 21, 849-870.

Brewer III, E., Kaufman, G.G., Wall, L.D., 2008. Bank capital ratios across countries: Why do they vary? Journal of Financial Services Research 34, 177-201.

Carbó-Valverde, S., Rodriguez-Fernández, F., 2007. The determinants of bank margins in European banking. Journal of Banking and Finance 31, 2043-2063

De Haan, L., Kakes, J., 2018. European banks after the global financial crisis: Peak accumulated losses, twin crises and business models. DNB Working Paper, No. 600, July 2018.

Demiralp, S., Eisenschmidt, J., and Vlassopoulos, T., 2019. Negative interest rates, excess liquidity and bank business models: Banks' reaction to unconventional monetary policy in the euro area. ECB Working Papers Series, No. 2283, May 2019.

Demirgüç-Kunt, A., and Huizinga, H., 1999. Determinants of commercial bank interest margins and profitability: Some international evidence. The World Bank Economic Review 13, 379-408.

Eggertson, G., Ragnar, E. J., 2017. Are negative nominal interest rates expansionary? NBER Working Paper 24039.

Elsas, R., Hackethal, A., Holzhäuser, M., 2010. The anatomy of bank diversification. Journal of Banking and Finance 34, 1274-1287.

Farnè, M. and Vouldis, A., 2017. Business models of the banks in the euro area. ECB Working Paper Series 2070, May 2017.

Farnè, M. and Vouldis, A., 2019. European banks' business models and their credit risk: A cluster analysis in a high-dimensional context. arXiv:1912.05025.

Gropp, R., Heider, F., 2010. The determinants of bank capital structure. Review of Finance, vol. 14, 587-622.

Kok, C., Móré, C., and Cosimo, P., (2015). Bank profitability challenges in euro area banks: the role of cyclical and structural factors. *ECB Financial Stability Review*, May 2015, pp. 134-145

Laeven L., Levine, R., 2007. Is there a diversification discount in financial conglomerates? Journal of Financial Economics 85, 331-367.

Lammertjan, D., Koetter, M., 2012. Bank bailouts and moral hazard: Evidence from Germany. The Review of Financial Studies 25, 2343-2380.

Lopez, J. A., Rose, A. K., Spiegel, M. M., 2018. Why negative nominal interest rates had such a small effect on bank performance? Cross country evidence. NBER Working Paper 25004, September 2018.

Magretta, J., (2002) "Why business models matter", *Harvard Business Review*, vol. 5 86-92

Mascarenhas, B., and Aaker, D., 1989. Mobility barriers and strategic groups. Strategic Management Journal, 10, 475-485.

Mergaerts, F., Vennet, R. D., 2016. Business models and bank performance: A long- term perspective. Journal of Financial Stability 22, 57-75.

Peura, S., Keppo, J., 2006. Optimal bank capital with costly recapitalization. Journal of Business 79, 2162-2201.

Porter, M. E., 1979. The structure within industries and companies' performance. Review of Economics and Statistics, 61, 214-227.

Rajan, R., Zingales, L., 1995. What do we know about capital structure? Some evidence from international data. Journal of Finance 50, 1421-1460.

Roengpitya, R., Tarashev, N., Tsatsaronis, K., and Villegas, A., 2017. Bank business models: popularity and performance. BIS Working Paper 682, December 2017

Stiroh, K., 2004. Diversification in banking: is noninterest income the answer? Journal of Money, Credit and Banking 36, 853-882.

Stolz, S., Wedow, M., 2011. Banks' regulatory capital buffer and the business cycle: Evidence for Germany. Journal of Financial Stability 7, 98-110.

Teece, D., 2010. "Business models, business strategy and innovation", *Long Range Planning*, vol. 43 172-194.

Zott, C., Amit, R., 2011. The business model: Recent developments, and future research. *Journal of Management*, vol. 37 no. 4 1019-1042