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Cooperative Banks, Business Models and Efficiency: A Stochastic Frontier Approach Analysis

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Abstract

Our study examines the relationship between bank business models (BBMs) and the cost and profit efficiency of cooperative banks from fifteen European countries over the period 2010-2020. Using the cluster analysis method, we identify five BBMs, i.e., three retail-oriented BBMs and two market-oriented BBMs, and suggest that although cooperative banks share common characteristics and objectives, such as mutualism, localism and a stakeholder view, they pursue their goals by implementing different strategies. Moreover, we measure the cost and profit efficiency using the stochastic frontier approach (SFA), and the main results underline different levels of efficiency depending on the BBM implemented. Our results mainly suggest that more retail-oriented banks are more cost and profit efficient, while market-oriented banks are less. However, less cost- and profit-efficient banks can improve their efficiency by changing their bank business model. These results are crucial in shedding some light on the efficiency of cooperative banks and on the diversity in terms of business models observed within these specific groups of banks.

Keywords: bank business models; cooperative banks; stochastic frontier approach; cost efficiency; profit efficiency

1. Introduction

Since the end of the financial crisis, the bank business model (BBM) has become of interest for policy-makers and regulators. BBM analysis goes beyond the traditional classification of banks based on their ownership structure (commercial, savings and cooperatives) and is included in the annual Supervisory Review and Evaluation Process in Europe, signaling that it is a top supervisory priority (Badunenko et al., 2021).

Despite the increasing interest in BBM, to date, a common definition of the bank business model does not exist. During recent years, many authors have approached the bank business model topic following two main approaches: a) the identification of bank business models using different methodologies, including cluster analysis (Ayadi et al., 2014; Cernov and Urbano, 2018;; Farnè and Vouldis, 2021; [Lagasio and Quaranta 2022](#)), and b) the analysis of the relationship between bank business models and bank performance (Mergaets and Vander Vennet, 2016; Farnè and Vouldis, 2021; Ayadi et al., 2021; Badunenko et al., 2021).

With regard to the first strand of literature, previous studies that adopt cluster analysis have obtained different results due to the different assumptions considered in the method. As suggested by Roengpitya et al. (2014), not all banks are the same. Banks engage in different intermediation activities and define their balance-sheet structure depending on their business objectives. This impacts the bank business model structure. In general, using cluster analysis, authors have identified a BBM that remained stable for the whole period investigated (Farnè and Vouldis, 2021). The static allocation of a bank in a BBM disregards the adjustments by banks in the face of a new environment, failing to accommodate the time-varying nature of the BBM (Badunenko et al., 2021). To overcome this limit, some authors prefer to measure a diversification index referring to asset, funding and income structure (DeYoung and Roland, 2001; Stiroh and Rumble, 2006; Nguyen, 2018; Badunenko et al., 2021). In this case, such authors detect the relationship between the diversification of asset and funding sources and bank performance. However, in this case, some limits emerge; i.e., the diversification index only provides information on the level of diversification, without providing information on the “direction” of diversification. For example, if a bank has a low level of diversification, it is not possible to understand whether the bank is more retail or market oriented.

As the first element of our approach of identifying the BBM, we propose a cluster analysis approach where the BBM is time-varying. Depending on the balance-sheet characteristics observed in each year, our method identifies the BBM. Therefore, it is possible to observe a change in BBM (what we call “migration”). Moreover, in our method, we only consider balance-sheet ratios and not income statement ratios because we believe that the inputs used by banks to achieve their objectives are those

considered by the asset-funding approach, no matter whether the income composition is the result of the banking strategy.

Our main aim is to detect the effect of the bank business model on banks' economic sustainability. To do so, as a second element of our analysis, we choose the notion of bank cost efficiency and bank profit efficiency. The use of cost and profit efficiency allows us to observe how banks can implement their resources to achieve economic sustainability (Dia et al. 2020). As suggested by Wheelock and Wilson (2013), cost efficiency is an informative performance measure since it is strongly associated with bank failure. Profit efficiency is a more general measure of performance because it includes both costs and revenues. We link the BBM to bank performance by using a stochastic frontier approach. As final elements in the proposed approach, we focus on European cooperative banks. *Although the cooperative banks' stated objective is to maximize their members' consumer surplus rather than profits, as suggested by Hesse and Cihák (2007), "if a cooperative bank's pursuit of objectives other than profit maximization results in very low profitability, its balance sheet risks grow faster than its capital, leading to deteriorating solvency. If cooperative banks accept lower profitability as the price to pay for delivering financial services at below-market prices to retail clients, they may pull down the profitability of the banking system, with negative repercussions for other banks' soundness."* Additionally, Fiordelisi and Mare (2014) arrive at similar conclusions, underling that more profitable cooperative banks, i.e., those with a higher level of profit efficiency, have a lower probability of default. In light of this evidence, it becomes crucial to consider not only cost efficiency but also profit efficiency.¹

In general, previous studies either analyze the banking system as a whole or focus on commercial banks. However, cooperative banks are well known to be key actors in the European banking sector. Together with savings banks, they are a pillar for a diverse banking system (Ayadi et al. 2010). The three-pillar structure has been shown to have a stabilizing effect during the financial crisis. The coexistence of commercial, savings and cooperative banks has contributed to the resilience of the banking system during periods of financial and economic distress. Unlike commercial banks, although they exhibit equivalent levels of profitability, cooperative banks do not seek to maximize profits; rather, they aim to generate profit to support growth and maximize the surplus of their members. They share common values such as mutualism, localism and stakeholders' views. Additionally, they have shown to play a key role in the sustainable development of local economies by providing credit to local small and medium enterprises (Lang, Signore, and Gvetadze 2016), especially in times of crisis (Ferri, Kalmi, and Kerola 2014). Moreover, Coccoresse and Shaffer (2021)

¹ Several previous papers analyze profit efficiency even if the banks included in the sample are only cooperative banks (for example, Battaglia et al., 2010; Fiordelisi and Mare, 2014; Yamori et al. 2017).

underline that cooperative banks, more than other banks, are associated with firms' growth rate, positive employment rate and enhanced income. One of the possible reasons why cooperative banks have been more stable during the financial crisis than other kinds of banks is because they have relatively little exposure to toxic assets (Bley 2018). This is due to their deep anchoring in local economies and their relationship lending (Neuberger et al. 2008). Usually, in the literature, cooperative banks are considered one homogenous group of banks (Girardone, Nankervis, and Velentza 2009; Makinen and Jones 2015; Battaglia et al. 2010); however, they are very diverse in terms of size, governance structure and activities (Fiordelisi and Salvatore 2014; Ayadi, Ferri, and Pesic 2017; Yamori, Harimaya, and Tomimura 2017). In light of this evidence, analyzing the differences among the three pillars is not sufficient; investigating the differences within the pillar becomes crucial.

Regardless of their specificities, cooperative banks face challenges in Europe that are similar to those faced by commercial banks. European banks generally exhibit low levels of profitability during the studied period due to a context of low interest rates, low levels of credit growth and increasing competition of fintech and big techs (OECD 2020). This is in addition to the challenges related to the increasing costs of digitalization and compliance. These factors pressure banks to increase their levels of efficiency to stay financially sustainable.

Studying the determinants of the efficiency of cooperative banks is important for different stakeholders. For policy-makers, such examination allows us to evaluate the effects of regulation and market structure on bank efficiency. For researchers, it allows the description of the factors that determine efficiency and helps to assess the techniques of measuring efficiency. For managers, it helps them to identify the best (worst) practices associated with high (low) efficiency (Berger and Humphrey 1997) for better economic sustainability.

In this context, this paper addresses the following questions: (1) Does one BM fit all cooperative banks? (2) Does **the distance from the maximum efficiency of** cooperative banks depend on its BM? and (3) Does BM migration **reduce the distance from banks' maximum efficiency?**

To answer our research questions, we collect balance sheet data for a large sample of 3,480 banks from 31 European countries during the period ranging from 2010 to 2020. We define business models using clustering analysis on this sample; then, we select a subsample of cooperative banks composed of 2,096 banks that refer to 15 European countries, i.e., countries in which we observe more than three cooperative banks during the period analyzed. **Then, using the stochastic frontier approach (SFA), we compute bank cost and profit efficiency; then, at the same time, we estimate the relation between efficiency and business models.** The results show that cooperative banks, similar to

commercial banks, adopt five different BMs to achieve their strategy. Additionally, our findings suggest that BMs matter for cost and profit efficiency. Finally, banks with lower profit efficiency are found to improve their efficiency when changing BM; i.e., they reduce their distance from the maximum profit efficiency.

Our contribution to the literature on cooperative banks and bank efficiency is threefold. First, by adding bank business models as determinants of the distance from the maximum bank efficiency, we aim to detect whether the bank's implemented strategy matters in achieving the maximization of profit and the minimization of costs. Second, we consider a new aspect of BM, namely, the change in BM (referred to as BM migration). In previous studies, BM is viewed as static and does not change during the period investigated (Badunenko, Kumbhakar, and Lozano-vivas 2021; Nguyen 2018). The identification of BM and the analysis of bank migration allow us to observe whether, among cooperative banks that may appear very similar, efficiency depends on the strategic choices adopted by implementing different BMs and changing BMs when they are reaching a higher efficiency. Third, we study the efficiency of cooperative banks based on their business models using the stochastic frontier approach. Other studies focusing on efficiency and business models only focus on commercial banks (Badunenko et al. 2021). Overall, the contribution of our paper that analyzes the relationship between the business model adopted by cooperative banks and their distance from the efficient cost and profit frontier is to provide insights into the factors affecting the performance of cooperative banks. By examining the business model of these banks, the current paper can shed light on how cooperative banks can improve their efficiency and profitability and contribute to the development of best practices in the banking industry.

Our main results underline that diversity exists within cooperative banks. These banks adopt five different business models; although the number of banks that implement the investment BM is limited, focused retail and diversified BMs are more common. Moreover, our findings show that depending on the bank business model adopted, banks perform differently in terms of both cost and profit efficiency. In particular, we do not observe a "best" BBM for cooperative banks; rather, banks choose to change the BM to improve their efficiency. However, we find that, in general, more retail-oriented cooperative banks are able to achieve higher technical efficiency than more market-oriented banks. This finding corroborates the high ability of cooperative banks to better perform in traditional banking activities, i.e., supporting the local economy and retail customers. Although the best BM is not identified, our findings underline that cooperative banks are more efficient when they implement a retail-oriented business model.

Our paper confirms that regulation cannot be based on a “one-size-fits-all” approach for either banks in general or for cooperative banks in particular; rather, they should consider the BM dimension of banks, among other characteristics of size and ownership. Moreover, considering the important theme of proportionality in banking, our analysis underlines the importance of considering the bank business model as one of the metrics to define proportionality without focusing only on the ownership structure.

The remainder of the paper is organized as follows. Section 2 reviews the related literature, Section 3 describes the sample, and the following section explains the empirical method. Section 5 presents the empirical results, Section 6 shows the robustness checks, and the last section concludes the paper.

2. Literature review

Cooperative banks were created in the 19th century to allow access to credit and savings for those in small urban and rural areas. They are key players in the European banking landscape, representing approximately 23.1% of the market share of loans (Groeneveld 2021). They were traditionally organized to meet the needs of their members with an organizational model based on democratic governance (one member, one vote rule). **They are structured around stakeholders’ engagement, allowing them to be more stable than other banks (Fiordelisi et al. 2022), hence contributing to better financial stability.** They play a key role in their economies by mobilizing savings and extending credit, thereby fostering social capital and local economic development (Lang et al. 2016). Even during crises, they have shown that their decrease in loan provision is less than that of commercial banks (Ferri, Kalmi, and Kerola 2014; Migliorelli 2018). This can be explained by their in-depth knowledge of the local socioeconomic situation in their areas of operations coupled with strong relationship lending. This relationship lending allows banks to have soft information that is used to mitigate screening and monitoring costs to informationally opaque customers (Boot 2000).

Cooperative banks have evolved across countries, meeting local and national legal frameworks and adapting with respect to their environment and clients’ needs. They have usually been considered a homogenous group of banks compared to commercial banks (Girardone et al. 2009; Makinen and Jones 2015; Battaglia et al. 2010; Clark et al. 2018). Today, cooperatives in Europe are different; they develop central institutions and form network alliances with various levels of complexity. They range on a spectrum of large systemic banks and small local and rural banks and have different legal frameworks (Ayadi et al. 2010; Kalmi 2017).

In addition, similar to commercial banks, cooperative banks can have different business models, as shown by Ayadi et al. (2021). Bank business models can change and adapt to gain competitive

advantages and maintain a sustainable level of profitability. They are shaped by several factors, such as technological advances, monetary context and regulatory framework (Mckillop et al. 2020; Sena et al. 2019). Technological advances such as the digitalization of products and services and the use of big data, fintech and online banking allow cost cutting by reducing the number of branches and enhancing the reach for potential customers. The economic context of successive crises and a low interest rate environment pushes banks to seek fee-based revenues rather than interest income, shaping their business models. Finally, the regulatory pressure of capitalization can push banks to consolidate and change their business models to seek economies of scale.

The identification of banks' BMs has become important in recent years, as economic and financial crises are becoming more frequent and regulators are questioning the precrisis models of doing business in banks. Two approaches in the literature arise from the identification and analysis of the BM of banks. The literature on bank's BM identification builds on the stream of the management literature defining the business model of a firm or a bank with respect to its activities. Amel and Rhoades (1988) were the first to identify and classify BMs in the banking industry. In the banking sector, the general approach of the identification and classification of business models is based on balance sheet data (Ayadi and De Groen 2014; 2011; Farnè 2020; Flori et al. 2021; Hryckiewicz and Kozlowski 2017; Ayadi et al. 2021). The choice of balance sheet data to identify the strategic choices of banks, rather than income composition or income statement variables, is based on the fact that balance sheet variables can be linked directly to banks' strategic choices, while income statement variables are the result of the strategies adopted. Using data-driven methods of clustering analysis (Farnè 2020; Ayadi et al. 2021) or using mixed quantitative and qualitative methods (Cernov and Urbano 2018), four or five BBMs have been identified, and they distinguish between retail-oriented business models (closer to traditional intermediation) and market-oriented business models (engaged in less stable funding and trading activities). The second stream of literature focuses on the characteristics of banks' business models such as risk, size and funding (Altunbas, Manganelli, and Marques-Ibanez 2011; Bolivar et al., 2022), performance, efficiency and ownership (Ayadi and De Groen 2014; Badunenko, Kumbhakar, and Lozano-vivas 2021; Bolivar et al., 2023) or market features (Flori et al. 2021; Lucas, Schaumburg, and Schwaab 2019). Business models are found to be different in terms of risk appetite and profit potential, and they are important for risk assessment and regulation (Ayadi et al. 2017).

Bank BMs are dynamic, and they change depending on regulatory, monetary and structural reforms (Köhler 2014). The change in BMs is defined by Ayadi et al. (2021) as the migration of BMs. These authors find that banks migrate their BMs to seek better levels of profitability and lower their risk.

Banks' profitability and efficiency are important to ensure their sustainability and financial stability. Efficiency is the ability of a bank to minimize its costs or maximize its profits. Bank efficiency is assessed in the literature either by studying cost efficiency or profit efficiency. Cost efficiency measures the proximity between the bank's cost and the cost of the most efficient bank that has the same output and same input prices and conditions. Profit efficiency measures the proximity of bank profits to those of a best-practice or most efficient bank under the same conditions (Assaf et al. 2019; Berger and Mester 1997).

The analysis of bank efficiency has always raised a great level of interest in the academic and professional world, with an increasing number of studies on this topic (Berger 2007; Berger and Humphrey 1997; Bhatia et al. 2018). A significant amount of quality research has involved comparisons of bank efficiency within a country (Mester 1997; Altunbas, Evans, and Molyneux 2001), across countries (Yildirim and Philippatos 2007) and across ownership types (Girardone, Nankervis, and Velentza 2009). Additionally, studies have examined the impact of management decisions such as mergers and acquisitions (Coccorese and Ferri 2020) and economic factors such as competition (Yin 2021) on banks' efficiency.

Bank efficiency is found to be important both at the bank level and at the macroeconomic level. High levels of efficiency reduce bank risk taking and increase bank survival in the long run by ensuring the sustainability of their operations in their markets (Berger and Deyoung 1997; Badunenko, Kumbhakar, and Lozano-vivas 2021). Such efficiency also favors economic growth (Belke, Haskamp, and Setzer 2016) and allows a more resilient banking system (Diallo 2018).

Bank efficiency has been studied from the perspective of ownership structure. Some scholars find that cooperative banks are more efficient than commercial banks (Altunbas et al. 2001; Girardone et al. 2009; Mäkinen and Jones 2015). More recently, the efficiency of the BMs of commercial banks was examined by Badunenko et al. (2021); their findings show that not only a persistent BM and the adjustment of the asset-focused BM but also the diversification of funding and income portfolios are factors of cost-efficient BMs. This paper studies the cost and profit efficiency of the BM in the context of cooperative banks using the BM identification put forth by Ayadi et al. (2021).

3. Sample

Our initial analysis was based on a large sample of 3,480 European banks from 31 countries observed during the period ranging from 2010 to 2020 that we use to run the cluster analysis and identify BBMs. The decision to use the whole European banking system to identify bank business models is crucial to classify each bank in a specific cluster. In fact, to comprehend what a bank does, it is

important to observe its work in the entire ecosystem within which it operates every day. Then, we focus only on the cooperative banks; specifically, we collect 2,134 European cooperative banks located in 31 European countries for a total of 16,235 bank year observations. However, in this subsample, there are some countries in which the number of cooperative banks is limited; therefore, we select only those countries where there are cooperative banks for which we have at least three consecutive year observations. This operation leads to the exclusion of some European countries; ultimately, we obtain a sample based on 15 European countries (Table 1). Our final sample is composed of 2,096 banks for a total of 15,973 bank year observations. Due to merger and acquisition operations and the availability of data in the S&P Capital database, our sample is an unbalanced sample; i.e., the number of banks in each year changes from a maximum of 1,648 in 2016 to a minimum of 783 in 2020.

We collect balance-sheet data from the S&P Capital database, while the macroeconomic data are collected from the World Bank database.

Table 1 Sample description: total asset and number of banks at country level

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AT	293507.5 200	313322.0 200	315822.8 201	303827.4 203	296801.6 202	301400.6 198	473248.6 245	361346.4 238	368981.4 230	362158.5 110	386600.8 88
BE	14405.6 4	24995.3 4	26137.6 4	26668.2 4	27524.4 4	27472.5 4	84704.1 6	84850.1 6	81313.6 6	87375.3 5	67694.6 4
CH	72808.1 33	86242.0 37	94762.3 38	184713.4 31	187424.0 27	198837.8 28	193157.8 35	179640.6 35	187242.1 35	198818.7 32	197475.3 31
DE	1340503.1 957	1438051.5 960	1508967.0 964	1660457.3 957	1668713.9 952	1650226.0 909	1610822.1 896	1630095.2 849	1652891.2 796	1482732.5 388	1476769.7 345
DK	5535.9 10	5397.5 10	5475.4 11	4827.0 11	4792.9 11	6652.6 9	7180.4 9	7264.0 7	7936.1 7	8868.2 7	9758.8 7
ES	126520.6 21	141039.1 26	125961.9 29	128104.2 29	120537.3 32	118574.6 31	116000.7 31	113820.0 31	123576.5 28	107391.6 13	126351.1 13
FI	85273.3 6	93356.4 6	101358.9 6	103693.8 8	113386.4 8	128615.9 8	144068.7 22	148294.5 21	151572.2 19	159605.1 19	174119.4 14
FR	3424525.3 19	3680612.7 19	3637622.4 19	3573676.4 21	3795481.7 21	3704119.5 19	3841811.1 20	3924322.3 19	4074545.4 18	4368258.8 16	4773954.7 16
GB	495109.5 41	532135.8 45	630079.8 49	538128.9 49	586025.3 54	631321.4 53	610843.0 58	611838.0 57	628951.7 58	748435.4 57	757055.9 55
IT	611664.2 206	643227.5 222	692438.3 241	702995.5 275	711918.9 271	695502.8 262	636322.2 252	419804.2 224	421899.2 209	414178.4 187	440767.3 154
LU	138560.4 10	40414.6 10	44499.7 10	55996.9 8	21699.4 6	23976.4 6	26070.2 6	26816.0 6	30659.6 6	30373.7 5	32420.3 5
NL	673108.7 4	753260.6 4	771928.1 5	676038.3 2	690775.7 3	683046.3 3	679774.9 4	621446.1 4	614471.6 4	615867.2 4	658343.1 3
NO	16381.8 18	18475.7 19	19960.1 19	10998.4 12	11730.3 13	7491.0 12	9832.0 11	10942.3 11	12463.1 11	13953.7 11	14291.6 11
PT	17591.1 8	17495.9 8	18345.5 8	16510.3 7	16790.9 7	16440.8 6	47007.0 34	48672.4 34	47814.0 33	45486.2 24	49617.7 18
SE	18375.5 18	20381.2 18	22823.5 18	23062.0 21	13828.2 20	15354.9 20	15234.5 19	16047.4 19	16569.2 19	16505.3 19	18684.2 19
All	7,333,870.8 1555	7,808,407.7 1588	8,016,183.2 1622	8,009,697.8 1638	8,267,430.9 1631	8,209,033.2 1568	8,496,077.4 1648	8,205,199.5 1561	8,420,886.9 1479	8,660,008.6 897	9,183,904.6 783

Note: Table reports the distribution of banks in term of number and total assets across countries and years.

4. Empirical methods

To answer our research question, this study proceeds in **two main** steps. First, we identify the bank business models using the cluster analysis proposed by Ayadi et al. (2021); second, we **analyze the determinants of cost and profit efficiency using the model proposed by Battese and Coelli (1995), which allows us to simultaneously perform the analysis of the cost and profit frontier and the analysis of the determinants of the cost and profit inefficiency.**

4.1 Identification of bank business models

In similar previous studies, authors have measured bank business models by using an Herfindahl–Hirschman Index (HHI) that considers the composition of assets, funding and income of a bank. This approach allows one to distinguish between more focused or more diversified banks (Badunenko, Kumbhakar, and Lozano-vivas 2021; Curi, Lozano-vivas, and Zelenyuk 2015; Nguyen 2018). However, these studies do not truly identify a specific business model; rather, they just observe the level of bank diversification in terms of assets, funding and income, thereby identifying a diversification index. This method does not allow one to distinguish between the type of diversification and the type of specialization. In fact, being less diversified may mean different things; for example, the bank can be specialized in focused retail lending or may be specialized in trading activities. In our study, following Ayadi et al. (2021), we identify the bank business model using Ward’s cluster analysis. To obtain the **final** identification of bank business models, we run this analysis on a larger sample of more than 3,000 European banks—which also includes commercial, savings and public banks—for the period ranging from 2010 to 2020. We obtain a business model for each year, and we focus our analysis only on cooperative banks. This approach allows us to identify BBMs considering the whole European banking system and not only the subsample of cooperative banks. **We base our cluster analysis on the entire European banking system because we assume that to identify the effective business model implemented by a bank, it is crucial to observe the bank in the economic environment in which it operates, thereby considering all the competitors independently based on the ownership structure that they have. In this way, it is possible to define the business model considering what each bank does in comparison to other banks. Considering only cooperative banks in the cluster analysis may lead to a partial result that does not comprehend the effective business model implemented by observed banks.**

In the cluster analysis, we follow the asset-liability approach, considering five balance-sheet indices as input variables: (a) loans to customer loans over total assets, which is an indicator of the share of customer loans to nonbank customers and suggests a reliance on more traditional banking activities; (b) loans to banks over total assets, which is a measure of the scale of wholesale and interbank

activities and a proxy for the exposure to risks arising from interconnectedness in the banking sector; (c) trading assets over total assets, which is an indicator of the prevalence of investment activities that are prone to market and liquidity risks²; (d) debt liabilities³ over total assets, which is a measure of general insight into the bank's exposure to market funding; and finally, (e) derivative exposures⁴ over total assets, which is an indicator of the key financial exposures of banks with heavy investment and trading activities.⁵ This approach considers expenses and income as an outcome of changes in the asset and liability composition (Wagenhofer 2014). An alternative approach would be the revenue and expenses approach, which places primacy on the income statement. However, in recent decades, on the basis of the stated superiority of the asset-liability model over the revenue-expense model, a movement toward the asset-liability model has been strongly supported by the Financial Accounting Standards Board and rapidly embraced by many national standard setters (Moscariello et al. 2020).

To form the clusters, Ward's (1963) procedure to calculate the distance between clusters is used. The procedure forms partitions in a hierarchical manner, starting from the largest number of clusters possible (i.e., all bank/years in a separate cluster), and merges clusters by minimizing the within-cluster sum-of-squared-errors for any given number of clusters. To diagnose the appropriate number of clusters, the Calinski and Harabasz's (1974) pseudo-F index is used as the primary 'stopping rule'. Moreover, we run additional tests to define the correct number of clusters identified by the methodology, such as the dendrogram and the between cluster sum of squares test.⁶

4.2 Measurement of bank efficiency

We measure the bank's economic efficiency by comparing its performance to that of the best-practice bank. Aigner et al. (1977) defined bank efficiency as the ability of a bank to minimize its cost or maximize its profit. Following Berger and Mester (1997), we measure bank cost efficiency by determining how close that bank's actual cost is to what a best-practice bank's cost would be to produce the same outputs. The same is done to determine bank profit efficiency. We use the stochastic frontier approach (SFA), which is a parametric technique largely diffused in the economic literature (Aigner, Lovell, and Schmidt 1977; Berger and Mester 1997). **The main advantage of SFA over other methods is that it allows for measurement error and provides a bank-specific efficiency estimate.**

² Trading assets include all types of financial instruments such as speculative assets, government bonds and stocks measured as noncash assets other than loans.

³ Debt liabilities are measured as nonequity liabilities other than customer and bank deposits and derivatives.

⁴ Derivative exposures aggregates the carrying value of all negative derivative exposures of a bank.

⁵ Before arriving at the definition of these five balance-sheet indicators, we run several alternative models where we include more than five indicators, less than five indicators and alternative indicators. However, these five ratios allow to obtain the better identification of BBM.

⁶ For more information on the cluster analysis and the BBM identification, see Ayadi et al. (2020) Bank business model migration in Europe: determinants and effects. *British Journal of Management*.

More specifically, we adopt the standard translog cost and profit function, which has been widely used in studies of banking efficiency.

To measure the cost and profit efficiency, we define the outputs and inputs of banks following the intermediation approach proposed by Sealey and Lindley (1977) and the model proposed by Battese and Coelli (1995). The bank's outputs are two: loans (Y1) and other earning assets (Y2). The bank's inputs are labor, physical capital and total loanable funds. The prices of these inputs are the price of labor (P1) measured as the total labor expenses, i.e., the staff costs, divided by total assets; the price of physical capital (P2) measured as the total operating costs minus labor expenses divided by fixed assets; and the price of loanable funds (P3) defined as the ratio between interest expenses and total loanable funds. The total cost is the sum of the interest expenses, labor expenses and other operating costs (TC). The choice of inputs and outputs is consistent with those made by Berger et al. (2010), Ncube (2009), Nguyen (2018), Jiang et al. (2013) and Badunenko et al. (2021).

Following Casu et al. (2013) and Badunenko et al. (2021), we also include a variable that measures the reliance of the economy on the banking sector, i.e., the bank credit to the private sector over the gross domestic product (Bank_GDP).⁷

Finally, similar to Berger et al. (2010) and Nguyen (2018), we add year and country dummy variables to the cost and profit frontiers to account for both technical changes over time at banks in the sample and unobservable country heterogeneity.

We specify the cost frontier model as follows:

$$\ln TC_{it} = f(y_{it}, w_{it}; \Theta) + v_{it} + u_{it}, \quad (1)$$

where TC is the total cost of bank i at time t, and f(.) is the deterministic cost frontier that represents the multioutput production technology specified in Equation (2).

The error term is divided into four components. v_{it} is the random noise, while u_{it} refers to the cost inefficiency.

TC can be specified using the input–output model reported below:

$$\begin{aligned} \ln TC_{i,t} = & \beta_0 + \sum_{q=1}^2 \beta_q \ln Y_{qit} + \sum_{w=1}^2 \beta_w \ln P_{wit} + \frac{1}{2} \sum_{q=1}^2 \sum_{j=1}^2 \beta_{qj} \ln Y_{qit} \ln Y_{jit} + \\ & + \frac{1}{2} \sum_{w=1}^2 \sum_{j=1}^2 \beta_{wj} \ln P_{wit} \ln P_{jit} + \sum_{q=1}^2 \sum_{w=1}^2 \Omega_{qw} \ln Y_{qit} \ln P_{wit} + \alpha_b \ln \text{BankGDP}_{it} + \text{TFE} + \text{CFE} + \\ & v_{it} + u_{it}, \quad (2) \end{aligned}$$

⁷ The description of variables is reported in Appendix A.

Equation (2) allows us to measure the efficiency components; from them, we can obtain the cost efficiency using the following formula:

$$\text{Cost efficiency} = \exp(u_{it}) \quad (3)$$

The score ranges from 0 to 1, where 1 indicates full cost efficiency.

The same is done regarding the profit frontier efficiency measuring profit maximization. The maximization of a profit function results in profit-inefficiency measures due to a suboptimal choice of output quantities given output prices (or suboptimal output prices given quantities). In a perfect market, profit and cost efficiency should be equal; however, our banks operate in nonperfect markets, and therefore, a cost-efficient bank may be inefficient in terms of profits and vice versa (Bos and Kool 2006).

Model (3) displays the variables included in the SFA. The variables are the same as those used in the cost efficiency frontier (see Equation 2). We replace the left-hand side with profit before taxes, representing the logarithm of the bank's profits (PP). Additionally, the sign of the inefficiency term now becomes negative ($-v_{it}$ and $-u_{it}$). We also add the negative profit indicator (NPI) as a proxy to control for negative profit (J. W. B. Bos et al. 2009; Nguyen 2018). Profit before taxes takes the value of 1 if the profit is zero or negative, while it takes the value of the actual profit when the profit is higher than zero. Then, we generate the NPI variable, which equals 1 if the bank has a positive profit, and it takes the value of the absolute profit before taxes if the bank has a negative profit. This approach does not affect the error term structure and takes into account bank losses by adding the NPI variable in the profit efficiency model:

$$\begin{aligned} \ln PP_{i,t} = & \beta_0 + \sum_{q=1}^2 \beta_q \ln Y_{qit} + \sum_{w=1}^2 \beta_w \ln P_{wit} + \frac{1}{2} \sum_{q=1}^2 \sum_{j=1}^2 \beta_{qj} \ln Y_{qit} \ln Y_{jit} + \\ & + \frac{1}{2} \sum_{w=1}^2 \sum_{j=1}^2 \beta_{wj} \ln P_{wit} \ln P_{jit} + \sum_{q=1}^2 \sum_{w=1}^2 \Omega_{qw} \ln Y_{qit} \ln P_{wit} + \alpha_b \ln \text{BankGDP}_{it} + \delta \ln \text{NPI}_{it} + \\ & \text{TFE} + \text{CFE} - v_{it} - u_{it}. \end{aligned} \quad (4)$$

From Equation (4), we find the profit efficiency measured as follows:

$$\text{Profit efficiency} = \exp(-u_{it})$$

From Equations (2) and (4), we obtain the cost and profit efficiency, as suggested by Battese and Coelli (1995). Finally, in Equations (2) and (4), TFE and CFE are the time fixed effects and the country fixed effects, respectively.

In both cases of cost and profit estimation, it is necessary to assume that all banks in the sample share the same technology and comparable environmental conditions when using a common frontier for

comparison. This assumption is reflected in the definition of inefficiency components u_{it} , which are assumed to be identically distributed in the base model. However, if there is heterogeneity, then efficiency estimates can be significantly biased. To address this issue and account for the impact of different bank business models, we adopt the technical inefficiency effects (TE) model proposed by Battese and Coelli (1995). This model allows for the simultaneous estimation of efficiency scores and the investigation of the impact of bank business models, avoiding the limitations of a two-step approach. In a two-step approach, efficiency estimates from a base model are regressed on a vector of variables thought to influence firm performance, which can lead to strong inconsistencies if the coefficients are not equal to zero. The Battese and Coelli model assumes that all banks share a common technology and that environmental variables only affect the distance from the best practice (i.e., inefficiency). The inefficiency component is assumed to be distributed independently but not identically. The technical inefficiency effect for each bank is obtained by truncating a normal distribution at zero, where the mean is a function of m factors representing the bank's specific environment (i.e., in our analysis the BBM adopted), according to Battese and Coelli (1995).

Therefore, we also run, contemporary with the previous regression, the following equation:

$$\mu_{i,t} = \delta_0 + \delta_1 BM_{i,t-1} + \delta_2 Migration_{i,t-1} \quad (5)$$

Delta coefficients are parameters that need to be estimated.

According to Battaglia et al. (2010), the efficiency estimates obtained take into consideration the impact of external factors, making them comprehensive indicators of efficiency. This approach, as explained in Bos et al. (2005), allows for the variation between banks to be taken into account while still enabling all banks to be compared against a common benchmark. As a result, this model is well suited to our goal of comparing cooperative banks that employ various business models, avoiding the restrictions of a two-stage procedure.

BM refers to the business model adopted by the cooperative bank at time $t-1$, while Migration is a dummy variable equal to 1 if the bank changes its business model and passes from a BM to another at time $t-1$. Moreover, in a third model, we interact the BM and Migration variables to observe whether banks can increase their efficiency by changing their BM.

5. Results

5.1 Business model identification

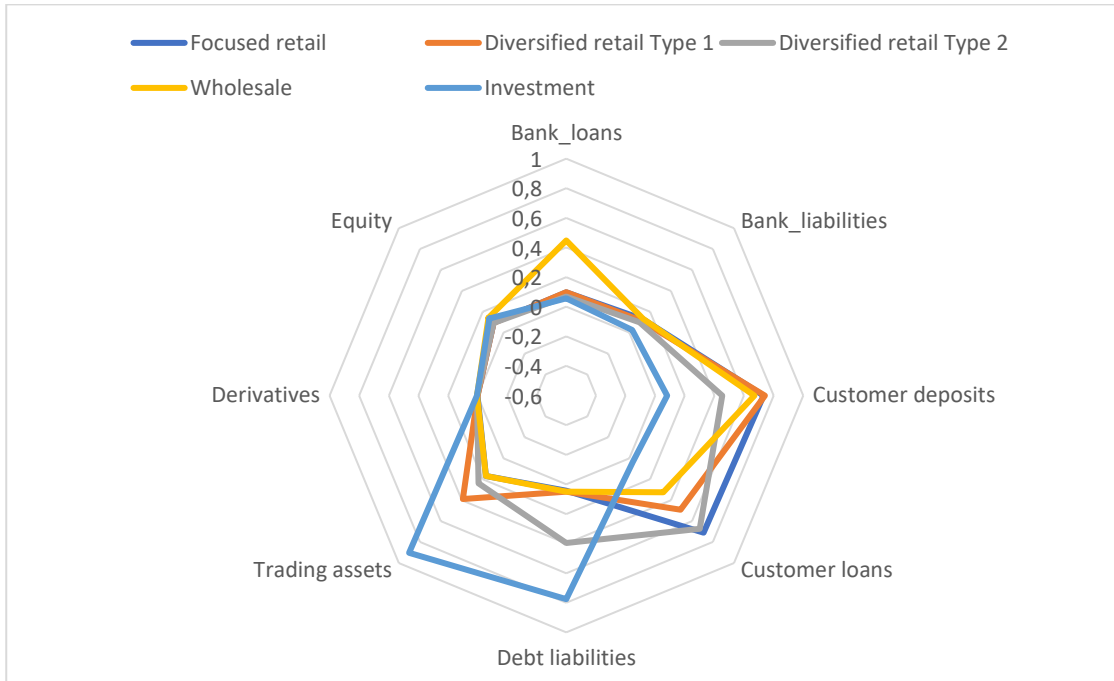
By running the cluster analysis and observing the results of the F-pseudo index test and the dendrogram, we identify five business models that can be distinguished into two main groups: retail-oriented banks and market-oriented banks.

In the first group—retail-oriented banks—we observe that the focused retail banks are those banks that are more retail oriented with high levels of both loans to customer ratio and deposits from customers ratio. Their main activity is lending, and they collect sources mainly from retail customers. Moreover, in this group, we have two diversified retail BMs. The first is diversified retail type 1, which is similar to focused retail on the liability side; however, it shows higher diversification on the asset side. In fact, in addition to lending activity, this BM is also market oriented, showing more trading assets than the focused retail BM. The second diversified BM is diversified retail type 2, which is similar to the focused retail BM on the asset side; however, it shows higher diversification on the liability side. This BM, in addition to customer deposits, shows a higher level of debt liabilities as a source of funding.

Referring to market-oriented BMs, we can distinguish between wholesale BMs and investment BMs. The former is a BM that is more oriented to the interbank market, while on the asset side, we observe a high level of bank loans. The latter is more oriented to the financial market with a higher percentage of trading assets over the total asset ratio. These two BMs also have more diversified sources of funding. With regard to investment banks, due to cooperative ownership, it is important to clarify that in this case, the term investment banks does not mean that these banks invest in speculative-grade financial instruments; rather, they are classified as investments because they allocate a large part of their assets to government bonds and similarities.

Figure 1 shows the asset and liability characteristics of the five business models observed in our sample of cooperative banks. This figure underlines that although in the cluster analysis we include only five balance sheet ratios, each cluster groups together banks that also have similar characteristics in terms of other ratios. This figure allows us to better comprehend the balance sheet structure of each cluster. **In Appendix A, we report the average of each indicator used in the cluster analysis for each bank business model.**

Figure 1. Bank business models' description



Note: Figure shows the balance-sheet structures of the five business models identified. In the figure, both indicators used in cluster analysis and other ratios are reported to better describe bank structure. In this figure we also include other balance sheet ratios not included in the cluster analysis to better describe the asset and liability composition of the five business models.

Although we identify five business models, cooperative banks are more likely to adopt retail-oriented BMs; in particular, the focused retail BM is the most adopted model.

Table 2 shows the distribution of banks and business models for cooperative banks only adopted across the period investigated. Our results underline that cooperative banks are not always focused on retail banks. In fact, we observe that these banks adopt all five business models identified. However, as expected, the most popular BMs are focused retail and diversified retail type 1, which represent more than 80% of the total observations. In Appendix A, figures with the BM distribution—in terms of the number of banks and total assets—across countries and years are reported. Our data underline that, in general, both in terms of number and total assets, cooperative banks tend to adopt retail-oriented business models, while only a small part of our sample adopts market-oriented BMs. Except for Luxemburg, where the market-oriented BMs represent almost half of the total in terms of the number of banks, in the other European countries considered in our analysis, more market-oriented BMs represent only a small part of the total.

Table 2. Distribution of banks across BM

BM		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Focused retail	N	624	671	671	695	703	696	771	772	847	567	452	7,469
	%	40.10	42.23	41.34	42.43	43.10	44.39	46.78	49.46	57.27	63.21	57.73	46.76
Diversified retail type 1	N	617	600	645	660	673	636	680	605	438	189	175	5,918
	%	39.65	37.76	39.74	40.29	41.26	40.56	41.26	38.76	29.61	21.07	22.35	37.05
Diversified retail type 2	N	184	187	176	155	134	133	65	43	35	41	95	1,248
	%	11.83	11.77	10.84	9.46	8.22	8.48	3.94	2.75	2.37	4.57	12.13	7.81
Wholesale	N	115	116	117	114	109	90	106	100	90	55	52	1,064
	%	7.39	7.30	7.21	6.96	6.68	5.74	6.43	6.41	6.09	6.13	6.64	6.66
Investment	N	16	15	14	14	12	13	26	41	69	45	9	274
	%	1.03	0.94	0.86	0.85	0.74	0.83	1.58	2.63	4.67	5.02	1.15	1.72
Total	N	1,556	1,589	1,623	1,638	1,631	1,568	1,648	1,561	1,479	897	783	15,973

Note: Table shows the distribution of banks across business models adopted and years.

BMs are identified for each year observed, and they are not static. Therefore, it is possible that some banks changed their business model during the period observed. We call this change migration. Following Ayadi et al. (2021), we check migrations to omit the possibility of identifying anomalous migrations (i.e., driven by one-off extraordinary balance sheet operations). We consider a migration only if the bank does not return to the previous BM in the following year. More specifically, we identify “stable migrations” when a) the bank remains in the same business model for at least two years after migration; or b) if the bank changes BM consequently, the yearly change in BM refers to a continuous evolution of business models (e.g., moving from focused retail to diversified retail type 1 to diversified retail type 2, year by year). Table 3 reports the migration matrix and emphasizes that bank business models are substantially stable. The investment BM shows the lowest level of persistence (74.21%), while the focused retail BM shows the highest level of persistence (94%). Investment banks move over all to focused retail and diversified retail type 1 BMs. These two BMs show the highest percentage of income banks, i.e., banks that arrive from other BMs and implement focused retail and diversified retail type 1 BMs. There are 851 banks that move at least once, for a total of 1,292 migrations, representing 9.31% of the total bank-year observations.

Table 3. Bank business model migration

BM	Focused retail	Diversified retail type 1	Diversified retail type 2	Wholesale	Investment
$t \downarrow$					
$t+1 \rightarrow$					
Focused retail	94.35%	3.03%	1.42%	0.47%	0.73%
Diversified retail type 1	7.54%	89.85%	0.87%	1.03%	0.70%
Diversified retail type 2	7.95%	11.60%	79.61%	0.09%	0.75%
Wholesale	4.65%	6.92%	0.65%	86.16%	1.62%
Investment	5.26%	12.63%	4.21%	3.68%	74.21%

Note: Table reports the percentage of banks that remain in the same business model (cells in grey) and the percentage of banks that change BM and move to a specific BM.

This evidence weakens the strong assumption of Mergaerts and Vander Venet (2016) that banks choose only long-run strategies and that the BBM is stable over time. Our findings suggest that banks change their business models over time on the basis of their strategy.

5.2 Cost and profit efficiency and the relationship with bank business models

With regard to the SFA, Table 4 reports the descriptive statistics of total costs, profits, inputs and outputs used to run the frontier efficiency model. As this table shows, the banks vary relatively widely in regard to total cost, pretax profit, input prices and output quantities.

Table 4 descriptive statistics of outputs, price of inputs and, cost and profit

Variable	Obs	Mean	Std. Dev.	Min	Max
TC(000 euro)	11,995	732.274	8519.333	-411.097	242,296
PP(000 euro)	11,995	21.962	304.951	-4291.665	10,468
Y1(000 euro)	11,995	3616.541	36550.342	0.000	989,433
Y2(000 euro)	11,995	2289.789	31008.571	1.474	1,035,661
P1	11,995	0.015	0.049	-0.011	0.879
P2	11,995	7.002	143.332	-20.746	13,681.752
P3	11,995	1.475	70.885	-0.033	6,591.252
NPI	11,995	4.144	67.002	0.004	4,291.671

Note: Table reports the descriptive statistics of outputs, inputs, total costs and total profits

Table 5 presents the parameter estimations of the cost and profit functions. Bank costs are explained by both input price and output quantity variables. Bank profits are explained by output quantity variables and labor costs. **The results mainly underline that banks more oriented to lending activities show, on average, not only lower costs but also lower profits.**

As a second step, we detect the relationship between bank business models and cost and profit inefficiency using the Battese and Coelli model (1995). With regard to cost efficiency, Model 1 shows that more diversified retail banks are more efficient than focused retail banks; i.e., the relationship between diversified retail type 1 and type 2 BMs and cost inefficiency is negative, suggesting that

these BMs are more cost efficient than focused retail BMs (the relative BMs in the analysis). On the other hand, market-oriented BMs (investment and wholesale) underline a positive and statistically significant relationship with cost inefficiency, suggesting that these BMs are less cost efficient than the focused retail BM. These results are in line with Badunenko et al. (2021), who find that greater diversification in the funding and income dimensions enhances cost efficiency.

It is interesting to note the existence of a negative and significant relationship between bank cost efficiency and bank migration (Model 2), underling an increase in cost efficiency when a bank changes its BM (negative sign between migration and cost inefficiency). When we interact BBMs and the migration dummy (Model 3), we observe that all BMs, except diversified retail type 2, show a negative and significant relationship with cost inefficiency. This result may suggest that less cost-efficient BMs (i.e., wholesale and investment BMs) can increase their cost efficiency after changing their business model. Additionally, diversified retail type 1 can improve its cost efficiency after changing its BM. In contrast, neither focused retail and diversified retail type 2 BMs increase their cost efficiency if they change their BM, which may be due to the high cost efficiency already achieved.

Considering profit efficiency (Models 4-6), our results underline that more retail-oriented banks show the highest profit efficiency. Additionally, in this case, diversified retail type 2 shows the highest profit efficiency, followed by diversified retail type 1 and focused retail BMs. These results suggest that banks more oriented to traditional bank activities are more able to achieve high profit efficiency; in particular, diversified retail type 2 banks are those more oriented to lending activity, as are focused retail banks. In contrast, investment banks have the lowest level of profit efficiency.

We also observe a negative and significant relationship between migration and bank profit inefficiency, suggesting that banks that change BMs have a higher profit efficiency than banks that do not move (Model 5). Looking at the interaction term (Model 6), all BMs, except diversified retail type 2, emphasize an increase in profit efficiency after the change in their BMs. This suggests that if a bank has low level of profit efficiency, it can increase its efficiency by changing its strategy. For cost efficiency, diversified retail type 2 and focused retail BMs are the only BMs that do not benefit from a change in their BMs, which may be due to the high profit efficiency already achieved by these two BMs.

Table 5 SFA results: dependent variables are total costs and profit before taxes

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Cost Efficiency			Profit efficiency		
Constant	-2.129*** (0.474)	-2.029*** (0.534)	-2.124*** (0.478)	4.656* (1.791)	1.087*** (0.522)	6.703*** (1.003)
lnY1_TA	0.229** (0.090)	0.279*** (0.093)	0.248*** (0.091)	1.357*** (0.124)	1.724*** (0.146)	1.597*** (0.144)
lnY2_TA	0.0792* (0.100)	0.187* (0.107)	0.122* (0.101)	1.392*** (0.159)	1.981*** (0.176)	1.673*** (0.173)
lnP1	1.701*** (0.095)	1.789*** (0.098)	1.703*** (0.096)	0.094 (0.149)	0.530*** (0.162)	0.261 (0.160)
lnP2	0.059 (0.037)	0.056 (0.039)	0.059 (0.037)	-0.051 (0.064)	0.186*** (0.069)	0.001 (0.069)
lnY1_alf_TA	0.071*** (0.021)	0.063*** (0.019)	0.074*** (0.021)	-0.012 (0.018)	-0.071*** (0.018)	-0.0293 (0.018)
lnY2_alf_TA	-0.087*** (0.027)	-0.108*** (0.029)	-0.076*** (0.027)	-0.198*** (0.039)	-0.111*** (0.042)	-0.237*** (0.042)
lnP1_alf	0.317*** (0.019)	0.316*** (0.019)	0.317*** (0.019)	-0.117*** (0.028)	-0.027* (0.030)	-0.074** (0.029)
lnP2_alf	0.015*** (0.005)	0.021*** (0.005)	0.015*** (0.005)	-0.002 (0.009)	-0.006 (0.009)	-0.006 (0.009)
lnY1lnY2_TA	-0.292*** (0.025)	-0.304*** (0.026)	-0.287*** (0.025)	0.098** (0.043)	0.070 (0.047)	0.098** (0.046)
lnY1lnP1_TA	-0.008 (0.018)	-0.022 (0.015)	-0.010 (0.018)	-0.300*** (0.025)	-0.392*** (0.031)	-0.360*** (0.030)
lnY1lnP2_TA	-0.007 (0.012)	-0.004 (0.012)	-0.006 (0.012)	-0.107*** (0.018)	-0.067*** (0.020)	-0.096*** (0.020)
lnY2lnP1_TA	-0.049** (0.021)	-0.082*** (0.023)	-0.052** (0.021)	-0.351*** (0.033)	-0.463*** (0.036)	-0.427*** (0.036)
lnY2lnP2_TA	0.023** (0.009)	0.020** (0.009)	0.022** (0.009)	-0.065*** (0.015)	-0.078*** (0.016)	-0.050*** (0.016)
lnP1lnP2	0.007 (0.007)	0.006 (0.008)	0.007 (0.007)	-0.042*** (0.014)	0.017 (0.015)	-0.026* (0.015)
ln_bank_gdp	5.203*** (0.085)	5.060*** (0.098)	5.198*** (0.086)	0.340** (0.168)	0.638*** (0.050)	0.161 (0.194)
ln_NPIS				0.049*** (0.005)	0.045*** (0.005)	0.041*** (0.005)
Technical inefficiency						
Constant	-2.399*** (0.037)	-2.270*** (0.041)	-2.389*** (0.038)	-0.782*** (0.089)	-0.711*** (0.014)	-0.784*** (0.014)
DIV_TYPE1 _{t-1}	-1.246** (0.524)	-0.696*** (0.268)	-0.766** (0.369)	-0.013* (0.020)	-0.074*** (0.022)	-0.010* (0.022)
DIV_TYPE2 _{t-1}	-8.691*** (3.296)	-7.010*** (2.355)	-8.519*** (3.072)	-0.240*** (0.030)	-0.770* (0.478)	-0.367*** (0.037)
WHOLESALE _{t-1}	1.666*** (0.646)	0.889*** (0.324)	2.013*** (0.730)	0.001 (0.039)	-0.003 (0.040)	-0.001 (0.044)
INVESTMENT _{t-1}	5.629*** (1.868)	3.964*** (1.056)	5.889*** (1.930)	0.236*** (0.090)	0.362*** (0.099)	0.886*** (0.174)
MIGRATION		-0.670**	1.957***		-0.125***	0.017**

		(0.272)	(0.753)		(0.024)	(0.022)
DIV_TYPE1 _{t-1} #MIGRATION			-2.756**			-0.076**
			(1.127)			(0.036)
DIV_TYPE2 _{t-1} #MIGRATION			-0.328			0.493***
			(1.716)			(0.080)
WHOLESALE _{t-1} #MIGRATION			-2.810**			-0.123**
			(1.242)			(0.088)
INVESTMENT _{t-1} #MIGRATION			-2.379**			-0.825***
			(1.135)			(0.202)
Observations	11,235	11,235	11,235	10,734	10,734	10,734
COUNTRY_FE	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES

*Note: Tables reports the cost and profit frontier parameter for the sample using the SFA model. ***, **, * represent significance at 1%, 5%, 10% levels, respectively.*

From the previous regression model reported in Table 5, we obtain the cost and profit efficiency level for each bank included in our sample. Table 6a–c reports the efficiency scores by year, country, and bank business models. **We report the cost and profit efficiency obtained from the three regression models, but we discuss only the results of the first model because the other results are similar to the first.** The cost and profit efficiency scores span from 0 to 1, with a score of 1 representing the optimal efficiency of cost or profit. This means that, for example, if a bank has a cost efficiency score of 0.60, compared to the best-practice bank in the sample, it can save 40% of its costs without changing its inputs and outputs. The same is true for profit efficiency; i.e., if a bank has a profit efficiency score of 0.70, it means that compared to the best-practice bank in the sample, it can increase its profit by 30% without changing its inputs and outputs.

Looking at the trend during the period under investigation, we observe that bank cost efficiency decreases from 0.808 in 2011 to 0.395 in 2020. In contrast, profit efficiency increases from 0.512 to 0.737 during the same period. This may be due to the increase in banking costs after the financial crisis, and the data underline a drastic decrease in 2020, i.e., the first year of the COVID-19 pandemic. In contrast, despite the low interest rates of the last decade, the profit efficiency level of cooperative banks has increased. This may be due to the capability of these banks to work on both the territory and their relationship with their customers, which allows them to positively face such periods.

Considering the countries investigated, Italy, the Netherlands, Denmark and Germany show the highest value of cost efficiency, with an average percentage higher than 70%. In terms of profit efficiency, the Netherlands, Italy, France and Finland show the highest average percentage, higher than 60%. Additionally, looking at the bank business models, we can observe differences in terms of cost and profit efficiency. It seems that banks that adopt the diversified retail type 2 BM are both the most cost efficient (80.3%) and the most profit efficient (65.4%), while the investment banks are the

least cost efficient (50.4%) and the least profit efficient (50.2%). These findings confirm the results observed in the empirical model.

Table 6a Estimated cost efficiency across years

YEAR	Cost efficiency			Profit efficiency		
	Mod 1	Mod 2	Mod 3	Mod 1	Mod 2	Mod 3
2011	0.808	0.751	0.809	0.512	0.569	0.571
2012	0.818	0.830	0.818	0.495	0.647	0.461
2013	0.800	0.814	0.801	0.529	0.662	0.491
2014	0.806	0.816	0.806	0.525	0.641	0.488
2015	0.762	0.779	0.763	0.574	0.688	0.529
2016	0.721	0.744	0.722	0.577	0.694	0.531
2017	0.657	0.685	0.659	0.581	0.689	0.544
2018	0.618	0.647	0.621	0.624	0.735	0.578
2019	0.657	0.680	0.661	0.579	0.696	0.540
2020	0.395	0.429	0.397	0.737	0.836	0.697
Total	0.725	0.736	0.726	0.564	0.696	0.531

Note: Tables reports the cost and profit efficiency in term of yearly average.

Table 6b Estimated cost efficiency across countries

Country	Cost efficiency			Profit efficiency		
	Mod 1	Mod 2	Mod 3	Mod 1	Mod 2	Mod 3
BE	0.613	0.648	0.613	0.622	0.779	0.598
CH	0.700	0.727	0.704	0.514	0.613	0.484
DE	0.722	0.731	0.722	0.549	0.668	0.512
DK	0.755	0.764	0.752	0.565	0.688	0.536
ES	0.711	0.735	0.708	0.562	0.700	0.542
FI	0.620	0.656	0.627	0.607	0.748	0.586
FR	0.681	0.716	0.685	0.608	0.780	0.601
GB	0.693	0.715	0.697	0.576	0.702	0.553
IT	0.785	0.793	0.786	0.606	0.807	0.587
LU	0.580	0.627	0.585	0.557	0.657	0.508
NL	0.773	0.831	0.776	0.657	0.913	0.709
NO	0.617	0.648	0.625	0.575	0.705	0.552
PT	0.670	0.690	0.668	0.589	0.723	0.566
SE	0.548	0.606	0.555	0.570	0.686	0.538
Total	0.725	0.736	0.726	0.564	0.696	0.531

Note: Tables reports the cost and profit efficiency in term of country's average.

Table 6c Estimated cost efficiency across bank business models

Panel A

BM	Cost efficiency			Profit efficiency		
	Mod 1	Mod 2	Mod 3	Mod 1	Mod 2	Mod 3
Focused retail	0.712	0.723	0.717	0.561	0.670	0.524
Diversified retail type 1	0.736	0.747	0.733	0.552	0.692	0.518
Diversified retail type 2	0.803	0.822	0.805	0.654	0.646	0.668
Wholesale	0.643	0.664	0.640	0.559	0.669	0.529

Investment	0.504	0.544	0.501	0.502	0.586	0.409
Total	0.725	0.736	0.726	0.564	0.696	0.531

Note: Tables reports the cost and profit efficiency in term of BM's average.

Panel B – T-test on the Model 1

	Cost efficiency					Profit efficiency				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
(1) Focused retail	-					-				
(2) Diversified retail type 1	*	-				*	-			
(3) Diversified retail type 2	***	**	-			***	***	-		
(4) Wholesale	***	***	***	-		**	***	**	-	
(5) Investment	***	***	***	*	-	**	**	**		-

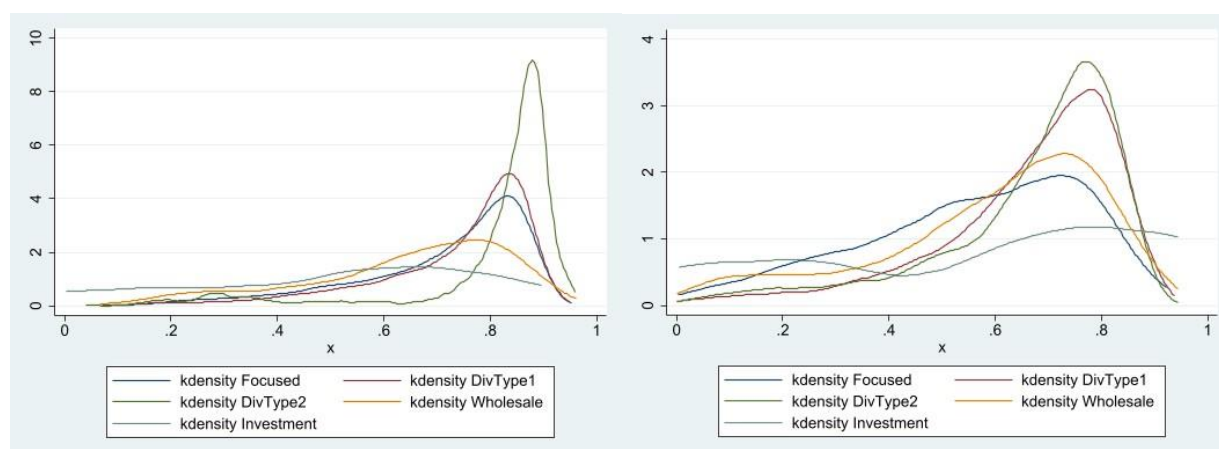
Note: Table reports the results of the t-test on the differences of means on Model 1

Although the average scores of cost and profit efficiency are similar, the kernel density estimator presented in Figure 2 shows that the variance of cost and profit efficiency is different across BMs. The results underline the higher cost and profit efficiency of diversified retail BMs, in particular of diversified retail type 2 BMs. Moreover, we can observe the lower efficiency of market-oriented BMs.

Figure 2 Kernel density function for cost and profit efficiency among BMs

a) Cost efficiency

b) Profit efficiency



Note: Figure reports the Kernel density of cost and profit efficiency for each BM identified.

6. Robustness checks

The adoption of one business model rather than another could depend on a bank decision strategy usually driven by bank management. Therefore, our dependent variable (BM) may suffer from the problem of endogeneity. To control for this problem, we run the two-step Heckman model. In the first step, we investigate the determinants of adopting a specific business model. From this first step, we calculate the inverse Mills ratio (IMR) that we include in the second-step regression (see Heckman 1979; Hamilton and Nickerson 2003).

Usually, in the literature, the two-step Heckman model has as its first step a probit or a logit regression, where the dependent variable is a binary variable. However, Lee (1983) proposed an extended version of the Heckman two-step model where selectivity is modeled as a multinomial logit case with a simple approach that requires the estimation of only one parameter in the correlation term. However, due to the reasonably restrictive assumption of this approach, as suggested by Bourguignon et al. (2007), we prefer the method proposed by Dubin and McFadden (1984), which leads to the estimation of one IMR for each category assumed by the endogenous variable. Although the first- and second-step regressions can contain common variables, identification via the exclusion restriction scheme requires the first step to contain at least one variable that is not included in the main equation (second-step regression) and that displays significant time variability (Mátyás and Sevestre 2008; Semykina and Wooldridge 2013). For this reason, we include only in the first step the vector `DISTANCE_BM_COUNTRY` (as explained below), which represents our exclusion restriction from the first step of our model, which in turn explains the decision to adopt one BM rather than another. The regression model is reported as follows:

$$\Pr(BM_{i,t} = s) = \alpha_0 + \beta Z_{i,t-1} + \eta \text{DISTANCE_BM_COUNTRY} + \varepsilon_{i,t} \quad (5)$$

where Z is the vector of bank characteristics, which includes the following variables: i) bank size, which is measured as the natural logarithm of total assets (`SIZE`), ii) risk propensity, which is measured using risk-weighted assets over total assets (`RWA_DENSITY`), iii) bank capitalization, which is measured by the equity over total asset ratio (`E_TA`), iv) credit portfolio quality, which is measured using nonperforming loans over gross loans (`NPL_RATIO`), and v) the weight of intangible assets over total assets as a proxy of bank investment in digitalization (`INTANGIBLE_ASSET`). Moreover, we include in Z a macroeconomic variable, i.e., the Herfindahl-Hirschman index, which measures the level of bank system concentration at the country level (`HHI`). `DISTANCE_BM_COUNTRY` is the vector of our exclusion restriction. To construct these five variables (one for each BM), we first consider the overall distribution of banks (cooperative and noncooperative banks) across the five business models each year and calculate yearly averages per BM in our whole sample. Then, we calculate the same yearly averages at a country level and determine the distance to the percentage measured at the European level for each BM and year. This variable allows us to observe the composition of the country banking system in terms of business models. We hypothesize that banks from the same area (i.e., of the same country) are more likely to adopt similar business models because of peer pressure and country-level regulations.

From the equation, we obtain the IMRs following the specification of Dubin and McFadden (1984):

$$\lambda_{ist} = \sum_{\substack{j=0 \\ j \neq s}}^5 \left(\frac{P_{ijt}^{\wedge} \ln P_{ijt+1}^{\wedge}}{1 - P_{ijt}^{\wedge}} - \ln P_{ist}^{\wedge} \right) \quad (6)$$

where $P_{ist}^{\wedge} = P^{\wedge}(BM_{it} = s)$.

Therefore, we include in Equation (5)—**both for cost and profit efficiency**— λ_{ist} , which is the vector that collects the IMR used as controls for the endogeneity of the dummies of BMs.

The results of the first step of the Heckman model are reported in Table 7. We report the margin coefficients of the multinomial regression model. Our findings underline the main characteristics of banks that adopt one business model rather than another. Looking at the instrumental variable, as we expected, we observe that when there is a greater number of banks that adopt a specific business model in a country, the probability that a specific bank in that country will adopt the same BM is higher. Moreover, it is interesting to note that the adoption of other BMs may also have a positive effect on the adoption of another BM. In particular, a higher presence of diversified retail type 1 has a positive effect not only on the adoption of diversified retail type 1 but also on a higher probability of adopting investment BM. In addition, a high presence of diversified retail type 2 has a positive effect not only on the adoption of both diversified retail type 2 and type 1 but also on the adoption of investment BM. This is because diversified retail banks, although they are retail oriented, differ from focused retail and are more similar to the investment BM on the asset side (type 1) and on the liability side (type 2). A high presence of focused retail banks in a country positively affects not only the probability that a specific bank adopts the focused retail BM but also the probability that the diversified retail type 1 BM is adopted. Finally, when there is a high number of investment banks in a country, the probability that a specific bank will adopt an investment BM is higher, but the number of investment banks also positively affects the probability that the specific bank will adopt the focused retail BM.

Table 7 First step Heckman: multinomial logit regression

	FOCUSED RETAIL dy/dx	TYPE1 dy/dx	TYPE2 dy/dx	WHOLESALE dy/dx	INVESTMENT dy/dx
SIZE _{t-1}	0.013*** (0.004)	-.020*** (0.004)	0.020*** (0.002)	-0.004*** (0.001)	-0.009*** (0.001)
RWA_DENSITY _{t-1}	1.154*** (0.044)	-1.201*** (0.042)	0.161*** (0.021)	-0.124*** (0.020)	0.009 (0.015)
E_TA _{t-1}	-1.825*** (0.215)	1.922*** (0.213)	-0.550*** (0.105)	0.387*** (0.045)	0.065 (0.042)
NPL_RATIO _{t-1}	0.742*** (0.250)	-0.547* (0.255)	0.178* (0.106)	-0.360*** (0.116)	-0.012 (0.066)
INTANGIBLE_ASSET _{t-1}	3.052 (5.130)	-4.353 (5.433)	-1.238 (1.509)	1.654* (0.988)	0.889 (1.072)
HHI _{t-1}	0.603*** (0.135)	-.713*** (0.142)	0.191*** (0.045)	0.022 (0.028)	-0.104* (0.043)
COUNTRY_DISTANCE_TYPE1	-0.911*** (0.157)	1.343*** (0.165)	-0.290*** (0.057)	-0.182*** (0.020)	0.042* (0.026)
COUNTRY_DISTANCE_TYPE2	-0.485*** (0.147)	0.470*** (0.154)	0.188*** (0.048)	-0.240*** (0.022)	0.067 (0.042)
COUNTRY_DISTANCE_FOCUSED	0.484*** (0.154)	0.045 (0.162)	-0.280*** (0.048)	-0.248*** (0.022)	-0.001 (0.026)
COUNTRY_DISTANCE_INVESTMENT	1.492*** (0.394)	-1.159** (0.419)	-0.296* (0.159)	-.160** (0.061)	0.123** (0.047)
R2	0.2752	0.2752	0.2752	0.2752	0.2752
OBS	7,894	7,894	7,894	7,894	7,894
TIME_FE	YES	YES	YES	YES	YES

Table reports the results of the first step Heckman model, where we adopt the multinomial regression. The table reports the margins and the instrumental variable refers to the composition of the banking system at country level in term of business model adopted compared to the average of business models adopted at European level.

The second step results are reported in Table 8, and they confirm our main findings. Depending on the bank business model adopted, cooperative banks show different levels of both cost and profit efficiency. More retail-oriented BMs seem to have a higher level of cost efficiency and a higher level of profit efficiency, while more market-oriented BMs show a lower level of both cost and profit efficiency. Additionally, in this case, changing the BMs can be seen as a strategy to improve technical efficiency, both in terms of cost and profit. In fact, our findings underline that wholesale and investment banks that change their business models are able to improve their efficiency.

The IMR is in general significant, suggesting that a problem of endogeneity is observed, and the IMRs allow us to reduce this problem and to obtain unbiased coefficients.

Table 8. Second step of the Extended Two-step Heckman model

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Cost Efficiency			Profit efficiency		
Constant	-	-	-	-	-	-
	16.340***	-16.640***	-16.810***	4.007***	14.580***	4.431***
	(0.582)	(0.586)	(0.554)	(1.255)	(0.780)	(1.261)
lnY1_TA	0.803***	0.799***	1.054***	0.441	1.229***	0.455
	(0.172)	(0.172)	(0.166)	(0.297)	(0.303)	(0.296)
lnY2_TA	0.860***	0.864***	0.842***	1.143***	2.101***	1.130***
	(0.146)	(0.146)	(0.142)	(0.255)	(0.261)	(0.253)
lnP1	2.007***	2.001***	1.974***	0.791***	1.368***	0.805***
	(0.113)	(0.112)	(0.109)	(0.199)	(0.208)	(0.198)
lnP2	0.013	0.016	0.010	0.473***	0.784***	0.455***
	(0.051)	(0.051)	(0.050)	(0.095)	(0.098)	(0.095)
lnY1_alf_TA	0.361***	0.361***	0.399***	-0.166**	-0.129*	-0.177**
	(0.040)	(0.040)	(0.039)	(0.073)	(0.072)	(0.072)
lnY2_alf_TA	0.025	0.027	0.021	-0.150**	0.056	-0.160**
	(0.038)	(0.038)	(0.036)	(0.066)	(0.067)	(0.066)
lnP1_alf	0.323***	0.322***	0.319***	0.067*	0.134***	0.064*
	(0.021)	(0.021)	(0.020)	(0.037)	(0.039)	(0.036)
lnP2_alf	0.016**	0.016**	0.015**	0.045***	0.033***	0.046***
	(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.011)
lnY1lnY2_TA	-0.175***	-0.177***	-0.199***	0.268***	0.185***	0.251***
	(0.027)	(0.027)	(0.026)	(0.053)	(0.055)	(0.052)
lnY1lnP1_TA	0.009	0.008	-0.022	-0.129**	-0.284***	-0.141***
	(0.028)	(0.028)	(0.027)	(0.050)	(0.051)	(0.050)
lnY1lnP2_TA	-0.020	-0.021	0.004	-0.154***	-0.125***	-0.161***
	(0.019)	(0.019)	(0.018)	(0.035)	(0.036)	(0.035)
lnY2lnP1_TA	-0.153***	-0.154***	-0.150***	-0.290***	-0.446***	-0.293***
	(0.021)	(0.028)	(0.027)	(0.048)	(0.049)	(0.048)
lnY2lnP2_TA	0.036**	0.035***	0.044***	-0.078***	-0.135***	-0.082***
	(0.012)	(0.012)	(0.012)	(0.021)	(0.021)	(0.021)
lnP1lnP2	0.001	0.0014	0.004	0.061***	0.128***	0.056***
	(0.011)	(0.011)	(0.010)	(0.020)	(0.021)	(0.020)
ln_bank_gdp	4.610***	4.673***	4.706***	1.496***	0.748***	1.428***
	(0.098)	(0.099)	(0.094)	(0.252)	(0.086)	(0.252)
ln_NPIS				-0.160***	-0.052***	-0.157***
				(0.019)	(0.012)	(0.018)
<i>Technical inefficiency</i>						
Constant	-1.918***	-1.927***	-1.973***	-0.902***	-0.310***	-0.911***
	(0.019)	(0.019)	(0.018)	(0.0187)	(0.694)	(0.0188)
DIV_TYPE1 _{t-1}	-0.007*	-0.005*	-0.048*	-0.011*	-0.0569**	-7.21e-06*
	(0.007)	(0.008)	(0.026)	(0.0269)	(0.0287)	(0.0272)
DIV_TYPE2 _{t-1}	-0.532***	-0.559***	-0.786***	-0.380***	-0.465***	-0.523***
	(0.092)	(0.095)	(0.113)	(0.0398)	(0.0449)	(0.0439)
WHOLESALE _{t-1}	0.186*	0.155*	0.426***	-0.00126	0.180	0.027
	(0.138)	(0.134)	(0.130)	(0.0672)	(0.070)	(0.074)
INVESTMENT _{t-1}	0.054*	0.078**	0.155**	0.103**	0.083**	0.527**

	(0.082)	(0.087)	(0.000)	(0.014)	(0.023)	(0.235)
MIGRATION		-0.175***	0.083**		-0.032**	0.005*
		(0.043)	(0.037)		(0.009)	(0.002)
DIV_TYPE1 _{t-1} #MIGRATION			-0.007*			-0.095**
			(0.019)			(0.043)
DIV_TYPE2 _{t-1} #MIGRATION			-0.043			0.636***
			(0.186)			(0.087)
WHOLESALE _{t-1} #MIGRATION			-0.818***			-0.085
			(0.165)			(0.134)
INVESTMENT _{t-1} #MIGRATION			-1.319***			-0.537**
			(0.000)			(0.261)
IMR TYPE1	0.019***	0.017***	0.0401***	0.106***	0.076***	0.107***
	(0.006)	(0.006)	(0.004)	(0.007)	(0.005)	(0.006)
IMR TYPE2	0.011***	0.008***	0.004**	0.019***	0.031***	0.016***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)
IMR WHOLESALE	0.026***	0.028***	0.025***	-0.043***	-0.016***	-0.043***
	(0.003)	(0.003)	(0.002)	(0.005)	(0.002)	(0.004)
IMR INVESTMENT	-0.069***	-0.070***	-0.061***	-0.052***	-0.030***	-0.053***
	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.004)
Observations	6,345	6,345	6,345	5,982	5,982	5,982
COUNTRY_FE	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES

*Note: Tables reports the cost and profit efficiency determinants and the relationship with BBMs for the sample using the Heckman two-step model to control for the endogeneity bias. ***, **, * represent significance at 1%, 5%, 10% levels, respectively. To test the for differences of coefficients, we run the Wald test on BM coefficients. In all cases, the p-value is lower than 0.10, therefore the null hypothesis that there is not differences between coefficients can be rejected and accepted the alternative hypothesis of differences between coefficients.*

As an additional robustness analysis, we focus on countries in which cooperative banks represent an important part of the country banking system. We consider eight European countries in our subsample: Austria, France, Germany, Italy, Spain, the UK, Finland and the Netherlands. We select these countries because, as is well known, in these countries, the importance of cooperative banks is relevant. In fact, these countries are those with the longest history of cooperative enterprises, both financial and nonfinancial, among European countries (Ayadi et al., 2010). **The results are reported in Table 9 and strongly confirm our main findings, underling once again that cooperative banks that are more retail oriented show a lower technical inefficiency, both in terms of cost and profit. Moreover, market-oriented banks that are less efficient can improve their efficiency by changing their business strategy. In contrast, focused retail and diversified retail type 2 (which are the BBMs with the highest levels of cost and profit efficiency) reduce their efficiency when they change their BM.**

Table 9 Robustness check on Countries where cooperative banks are more present

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Cost Efficiency			Profit efficiency		
Constant	-21.290*** (0.474)	-20.290*** (0.534)	-21.240*** (0.478)	4.656 (9.791)	10.870*** (0.522)	6.703*** (1.003)
lnY1_TA	0.229** (0.090)	0.279*** (0.093)	0.248*** (0.091)	1.357*** (0.124)	1.724*** (0.146)	1.597*** (0.144)
lnY2_TA	0.079 (0.100)	0.187* (0.107)	0.122 (0.101)	1.392*** (0.159)	1.981*** (0.176)	1.673*** (0.173)
lnP1	1.701*** (0.095)	1.789*** (0.098)	1.703*** (0.096)	-0.094 (0.149)	0.530*** (0.162)	0.261 (0.160)
lnP2	0.059 (0.037)	0.056 (0.039)	0.059 (0.037)	-0.051 (0.064)	0.186*** (0.069)	0.001 (0.069)
lnY1_alf_TA	0.071*** (0.021)	0.063*** (0.019)	0.074*** (0.021)	-0.012 (0.018)	-0.071*** (0.018)	-0.029 (0.018)
lnY2_alf_TA	-0.087*** (0.0279)	-0.108*** (0.029)	-0.076*** (0.027)	-0.198*** (0.039)	-0.111*** (0.042)	-0.237*** (0.042)
lnP1_alf	0.317*** (0.019)	0.316*** (0.019)	0.317*** (0.019)	-0.117*** (0.028)	-0.027 (0.030)	-0.074** (0.029)
lnP2_alf	0.015*** (0.005)	0.021*** (0.005)	0.015*** (0.005)	-0.002 (0.009)	-0.006 (0.009)	-0.006 (0.009)
lnY1lnY2_TA	-0.292*** (0.025)	-0.304*** (0.026)	-0.287*** (0.025)	0.098** (0.043)	0.070 (0.047)	0.098** (0.046)
lnY1lnP1_TA	-0.008 (0.018)	-0.022 (0.018)	-0.010 (0.018)	-0.300*** (0.025)	-0.392*** (0.031)	-0.360*** (0.030)
lnY1lnP2_TA	-0.007 (0.012)	-0.004 (0.012)	-0.006 (0.012)	-0.107*** (0.018)	-0.067*** (0.020)	-0.096*** (0.020)
lnY2lnP1_TA	-0.043** (0.028)	-0.082*** (0.023)	-0.052** (0.021)	-0.351*** (0.033)	-0.463*** (0.036)	-0.427*** (0.036)
lnY2lnP2_TA	0.023** (0.009)	0.020** (0.009)	0.022** (0.004)	-0.065*** (0.015)	-0.078*** (0.016)	-0.050*** (0.016)
lnP1lnP2	0.007 (0.007)	0.006 (0.008)	0.007 (0.00794)	-0.042*** (0.0141)	0.017 (0.015)	-0.026* (0.015)
ln_bank_gdp	5.203*** (0.085)	5.060*** (0.098)	5.198*** (0.0867)	0.340** (0.168)	-0.638*** (0.050)	0.161 (0.194)
ln_NPIS				0.049*** (0.005)	0.045*** (0.005)	0.041*** (0.005)
Technical inefficiency						
Constant	-2.399*** (0.037)	-2.270*** (0.041)	-2.389*** (0.038)	-0.782*** (0.089)	-0.711*** (0.014)	-0.784*** (0.014)
DIV_TYPE1 _{t-1}	-1.246** (0.524)	-0.696*** (0.268)	-0.766** (0.369)	-0.013* (0.020)	-0.074*** (0.022)	-0.010 (0.022)
DIV_TYPE2 _{t-1}	-8.691*** (3.296)	-7.010*** (2.355)	-8.519*** (3.072)	-0.240*** (0.030)	-0.770 (0.478)	-0.367*** (0.037)
WHOLESALE _{t-1}	1.666*** (0.646)	0.889*** (0.324)	2.013*** (0.730)	0.000 (0.039)	-0.003 (0.040)	-0.001 (0.044)
INVESTMENT _{t-1}	5.629*** (1.868)	3.964*** (1.056)	5.889*** (1.930)	0.236*** (0.090)	0.362*** (0.099)	0.886*** (0.174)
MIGRATION		-0.670**	1.957***		-0.125***	0.017*

		(0.272)	(0.753)	(0.024)	(0.022)	
DIV_TYPE1 _t						
_i #MIGRATION			-2.756**		-0.076**	
			(1.127)		(0.036)	
DIV_TYPE2 _t						
_i #MIGRATION			-0.328		0.493***	
			(1.716)		(0.080)	
WHOLESALE _t						
_i #MIGRATION			-2.810**		-0.123*	
			(1.242)		(0.088)	
INVESTMENT _t						
_i #MIGRATION			-2.379**		-0.825***	
			(1.135)		(0.202)	
Observations	5,477	5,477	5,477	4,971	4,971	4,971
COUNTRY_FE	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES

*Note: Table reports results obtained on a subsample of eight European countries, i.e. Austria, Finland, France, Italy, Spain, Germany, Great Britain, Netherland. ***, **, * represent significance at 1%, 5%, 10% levels, respectively. To test for differences of coefficients, we run the Wald test on BM coefficients. In all cases, the p-value is lower than 0.10, therefore the null hypothesis that there is no differences between coefficients can be rejected and accepted the alternative hypothesis of differences between coefficients.*

Finally, as a last robustness check, we run propensity score matching (PSM). The use of PSM to control for pretreatment imbalances on observed variables in nonrandomized or observational studies analyzing the causal effects of treatments has become widespread over the past decade (McCaffrey et al. 2013). We run five different PSM, one for each business model. Treated banks are those that move from one specific business model to another general business model; i.e., we consider a) banks that are focused retail banks and change to another BM; b) banks that adopt the diversified retail type 1 BM and move to another BM; c) banks that adopt the diversified retail type 2 and move to another BM; d) banks that are wholesale banks and move to another BM; and f) banks that adopt the investment BM and move to another BM. Untreated banks are those that remain in the same business model and do not move.

Our results are reported in Table 10 and confirm what we find in the main analysis. Market-oriented banks and diversified retail type 1 can improve their cost efficiency by changing their BMs. In contrast, focused retail and diversified retail type 2 do not show statistically significant coefficients, suggesting that the banks that adopt these BMs do not achieve a higher cost efficiency if they change their BMs.

Table 10 Propensity score matching – Migrating vs Non migrating banks and cost efficiency

BM at time t-1	Coeff.	Std. err.	P-value	[95% conf.	Interval]
Focused retail	-0.002	0.008	0.799	-0.018	0.013
Div. Type1	0.014	0.008	0.070	-0.001	0.031
Div. Type2	-0.108	0.078	0.166	-0.261	0.044
Wholesale	0.030	0.031	0.042	-0.032	0.092
Investment	0.159	0.055	0.004	-0.051	0.267

Note: Table reports the results of the propensity score matching results on cost efficiency, comparing treated banks (banks that change their business model) with non-treated banks (banks do not move). We consider the BM that bank adopts before the migration.

We also run the same analysis with regard to profit efficiency, and we report our findings in Table 11. The results confirm the main analysis; in particular, they show that diversified retail type 1, wholesale and investment banks are able to improve their profit efficiency by changing their business models more than banks that do not change their BM. In contrast, focused retail and diversified retail type 2 decrease their profit efficiency after migration, suggesting that banks that adopt these two BMs achieve a higher profit efficiency with these specific BMs than adopting others.

Table 11 Propensity score matching – Migrating vs Non migrating banks and profit efficiency

BM at time t-1	Coeff.	Std. err.	P-value	[95% conf.	Interval]
Focused retail	-0.013	0.004	0.001	-0.021	-0.005
Div. Type1	0.169	0.010	0.000	0.148	0.191
Div. Type2	-0.021	0.004	0.000	-0.029	-0.013
Wholesale	0.037	0.014	0.010	0.066	0.008
Investment	0.146	0.018	0.000	0.182	0.109

Note: Table reports the results of the results of the propensity score matching on profit efficiency, comparing treated banks (banks that change their business model) with non-treated banks (banks do not move). We consider the BM that bank adopts before the migration.

7. Discussion and Conclusions

The diversity of the European banking system is not limited to the three-pillar structure of commercial, savings and cooperative banks. Rather, diversity is extended to include the diversity within the pillars themselves (Ayadi, 2021). Structural diversity enhances stability; therefore, regulators and policy-makers should preserve and strengthen it (Bley 2018).

Cooperative banks are credit institutions that contribute to the sustainable development of local economies. The pillar of cooperative banks represents in Europe one of the most important both in terms of the number of banks with this ownership structure and of support for the real economy. Cooperative banks are the main lenders of small and medium enterprises and families, and they support regional economies. Recently, several studies have confirmed that European cooperative

banks contribute to diversity and stability in the financial system, largely due to their specific member-based governance (Goglio and Alexopoulos 2014). However, there is diversity within the pillar of cooperative banks. In our study, we try to answer the following question: “Does one BM fit all cooperative banks?” Although these banks share many similar characteristics, such as mutualism, localism, stakeholder views and knowledge of their territory and customers, cooperative banks may differ in terms of both funding sources implemented to achieve their objectives and activities realized. Therefore, despite their common mutuality objectives, these banks can exhibit very different strategies to achieve them.

First, our analysis aims to detect which business models are implemented by cooperative banks in Europe. To do so, we use the cluster analysis method suggested by Ayadi et al. (2021) on a very large sample of European banks and then focus on a subsample of European cooperative banks. We find that although cooperative banks are often considered a common group of banks, they adopt five different business models; therefore, we can observe not only that cooperative banks are more oriented to retail activities but also that cooperative banks are more oriented to market activities. However, the number of cooperative banks that adopt the investment business model is limited. Our results underline that European cooperative banks tend to implement retail-oriented BMs, such as focused retail and diversified BMs (type 1 and type 2).

Second, we contribute to the ongoing debate on bank efficiency considering both cost and profit efficiency. We focus on how banks can enhance their efficiency in the utilization of resources to achieve their economic sustainability. Usually, previous studies have investigated the relationship between bank diversification and bank efficiency. Bank business models have been defined by identifying the level of diversification in terms of assets, funding, and income; however, to the best of the authors’ knowledge, no study has analyzed the relationship between bank business models—identified using a cluster analysis method—and bank efficiency. Moreover, previous studies have classified three levels of bank diversification: asset, funding, and income. Some previous studies have criticized the use of cluster analysis as a method to identify BBMs because in general, this approach leads to static business models (Badunenko et al., 2021); however, we go beyond this limit by using a cluster analysis that allows us to observe a dynamic BBM that can change every year depending on the asset and liability composition of the bank balance sheet structure. In our study, we identify specific BBMs, and we can distinguish between banks that are focused on retail activity and banks that are focused on market activity, as well as banks that are diversified on the asset side and banks that are diversified on the liability side. This approach allows us to better identify what banks do and how their activity affects operational efficiency.

With regard to profit and cost efficiency, our findings underline that the BM adopted matters in regard to influencing the level of bank efficiency. Considering cost efficiency, it seems that more retail-oriented banks are more efficient than market-oriented banks. In particular, cooperative banks that adopt the investment BM show the lowest efficiency. However, both wholesale and investment banks can improve their efficiency by changing their business models. Therefore, our findings underline that cooperative banks are able to achieve the highest cost efficiency when they are focused on the more traditional banking activity, i.e., customer lending and customer deposits. Additionally, with regard to profit efficiency, similar results are observed. More retail-oriented banks, in particular those banks that implement the diversified retail type 2 BM, show higher levels of profit efficiency than more market-oriented banks. Therefore, also in this case, cooperative banks oriented to more retail activities are more able to achieve high profit efficiency.

Our results underline that the level of efficiency of cooperative banks depends on the bank business model adopted. Cooperative banks are not all the same, and although these banks are stakeholder oriented, their aim is to maximize stakeholder interest. They achieve their goals following different strategies. Sometimes, in the literature, the cooperative structure has been considered a business model (Clark et al. 2018); however, this is not correct. A cooperative is an ownership structure that shapes the incentives and objectives prosecuted (i.e., stakeholder interest), but it does not identify a business model. A BM is a strategy implemented by the institution to achieve its objective (Geissdoerfer et al. 2017).

Our results are interesting for several reasons. First, we shed some light on the different business models adopted by cooperative banks, underlining that cooperative banks are very different from each other and are able to pursue their objectives by implementing different strategies. This result may be helpful for regulators to better understand the diversity that exists within the pillar of cooperative banks. Our results are particularly important considering the proportionality principle. It becomes crucial to consider not only the specific business model adopted by banks but also the ownership structure because, as underlined in this analysis, banks belonging to the same pillar may implement different business strategies, resulting in different business models. The analysis of the banking system should be based not only on the three-pillar structure (i.e., distinguishing by private, savings and cooperative banks) but also on the business model adopted.

Second, our findings are also useful for managers who have to define their business strategy and understand the relationship between the business model adopted and bank efficiency. Our results show that there are some business models of cooperative banks that perform better in terms of cost efficiency and others that perform better in terms of profit efficiency. This suggests that there is not

an absolute business model that is better than another, **although, in general, more retail-oriented business models show a higher level of efficiency**. Moreover, our findings underline that banks with lower levels of cost or profit efficiency show an improvement of efficiency when they change their business model compared to those banks that maintain the same BM, **while banks that have already achieved a high level of cost and profit efficiency they decrease their efficiency if they change their BM**. All these results confirm that regulations cannot be based on the “one-size-fits-all” approach; despite the similar ownership structures of cooperative banks, their implemented strategies differ.

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Appendices

Appendix A

Table Average of indicators used in the cluster analysis

BM	CUSTOMER LOANS	TRADING ASSETS	BANK LOANS	CUSTOMER DEPOSITS	DEBT LIABILITIES
Focused retail	0.710	0.169	0.097	0.732	0.042
Diversified retail Type 1	0.491	0.389	0.098	0.741	0.049
Diversified retail Type 2	0.672	0.239	0.069	0.453	0.396
Wholesale	0.324	0.169	0.447	0.670	0.050
Investment	0.034	0.903	0.057	0.081	0.776
AVERAGE TOTAL	0.587	0.270	0.118	0.695	0.087

Figure 1A Distribution of BBM across countries (number of banks)

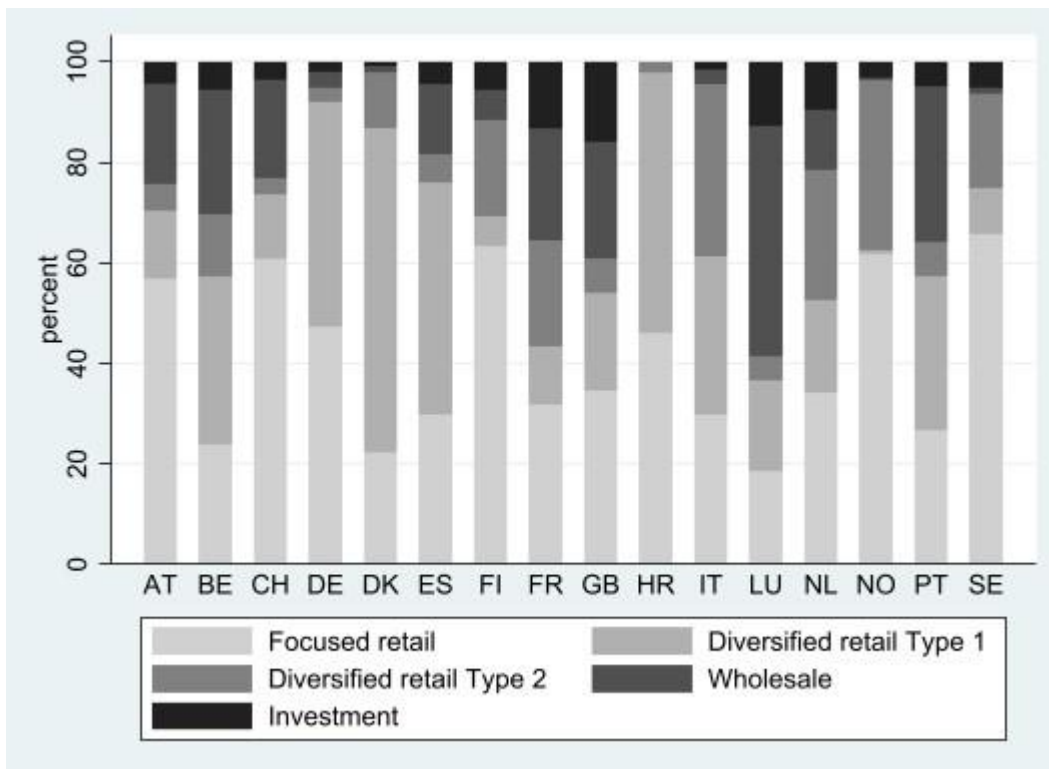


Figure 2A Distribution of BBM across countries (total asset)

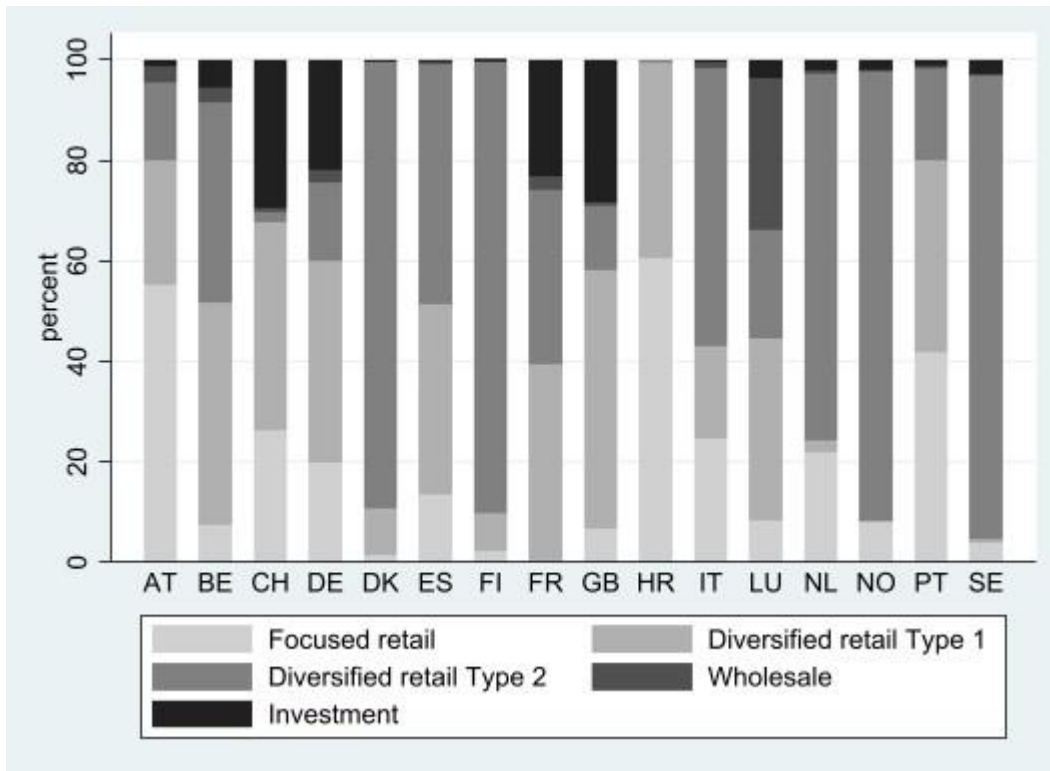


Figure 3A Distribution of BBM across years (number of banks)

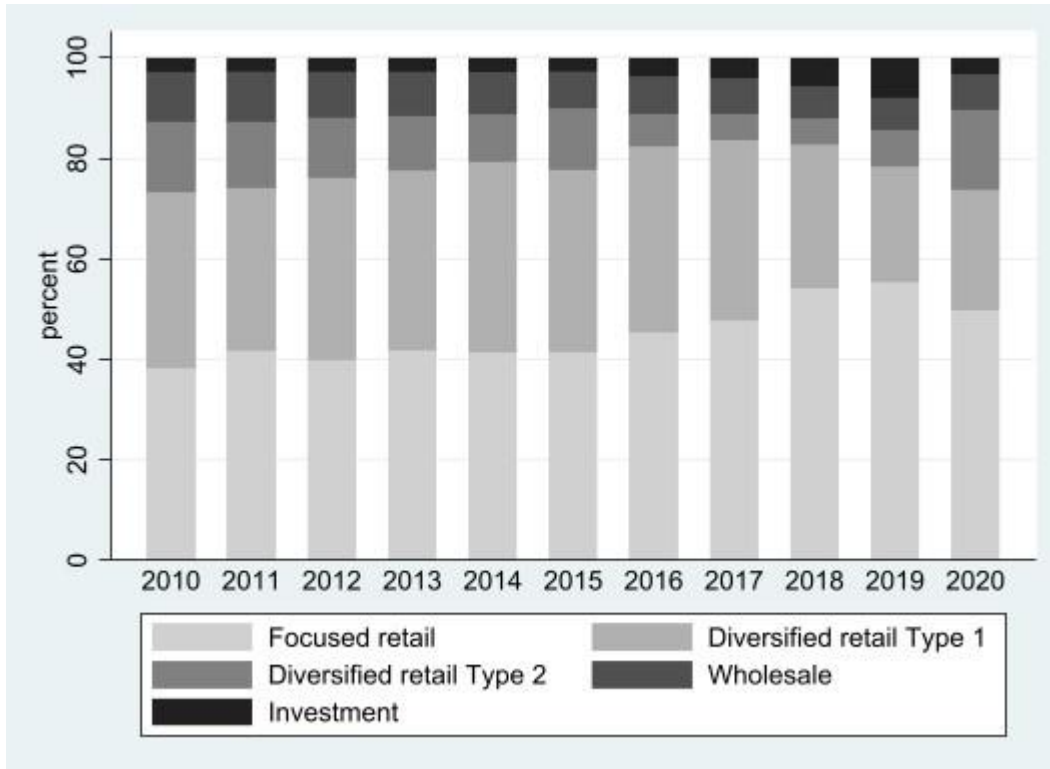
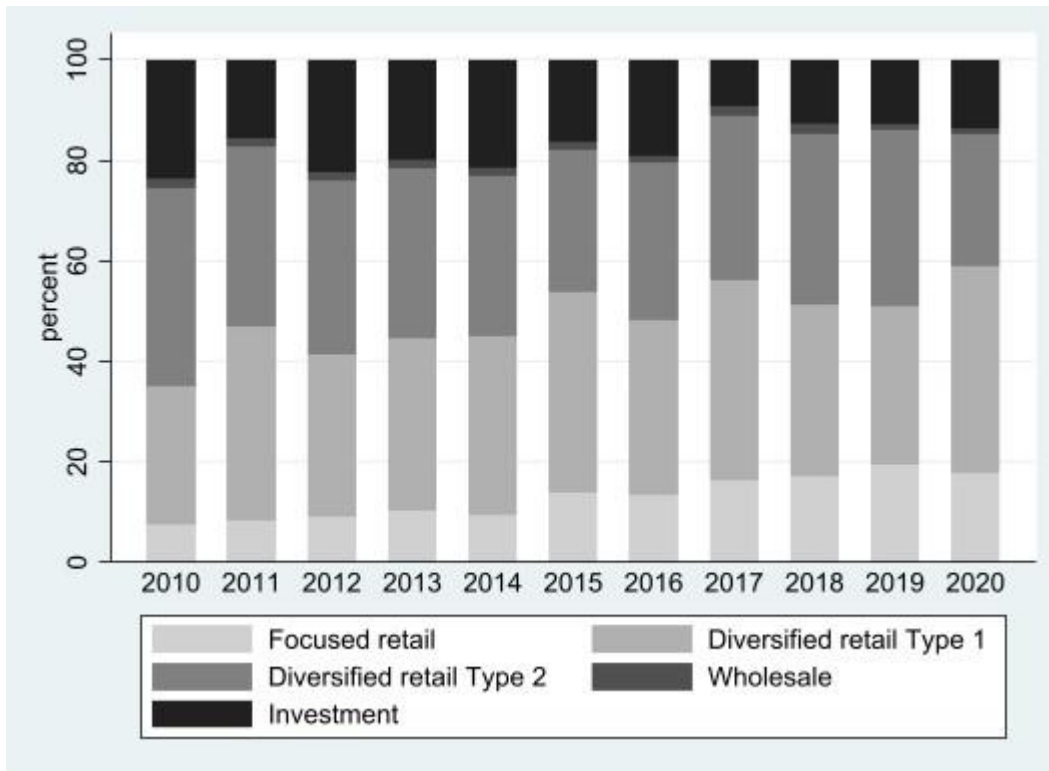


Figure 3A Distribution of BBM across years (total asset)



Appendix B Variable description

Variable	Meaning	Measure
TC	Total costs	Sum of interest expenses, labor expenses and the other operating costs
PP	Total profit	Profit before taxes
Y1	Loans	Gross loans
Y2	Earning assets	Customer deposits
P1	Labour price	Staff costs divided by total assets
P2	Physical capital	Total operating costs minus labor expenses divided by fixed asset
P3	Price of loanable funds	Ratio between interest expenses and total loanable funds
NPI	Negative profit indicator	Takes the value of 1 if profit is zero or negative, while takes the value of actual profits when profit is higher than zero
Bank_GDP	The reliance of the economy on banking sector	Bank credit to private sector over gross domestic product
FOCUSED	Focused retail business models	Dummy variable equals 1 if bank adopts the focused retail BM, zero otherwise
DIV_TYPE1	Diversified retail type 1 BM	Dummy variable equals 1 if bank adopts the diversified retail type 1 BM, zero otherwise
DIV_TYPE2	Diversified retail type 2 BM	Dummy variable equals 1 if bank adopts the diversified retail type 2 BM, zero otherwise
WHOLESALE	Wholesale BM	Dummy variable equals 1 if bank adopts the wholesale BM, zero otherwise
INVESTMENT	Investment BM	Dummy variable equals 1 if bank adopts the investment BM, zero otherwise
MIGRATION	Change in business model	Dummy variable equals 1 if bank changes its business model, zero otherwise
SIZE	Bank's size	natural logarithm of total asset
RWA_DENSITY	Bank risk appetite	Risk weighted assets over total asset
E_TA	Bank's capitalization	Equity over total asset
NPL_RATIO	Quality of credit portfolio	Non-performing loans over gross loans
INTANGIBLE_ASSET	Investment in innovation	Intangible asset over total asset
HHI	Bank system concentration	Herfindahl–Hirschman index