Bank and Credit Union Business Models in the UNITED STATES

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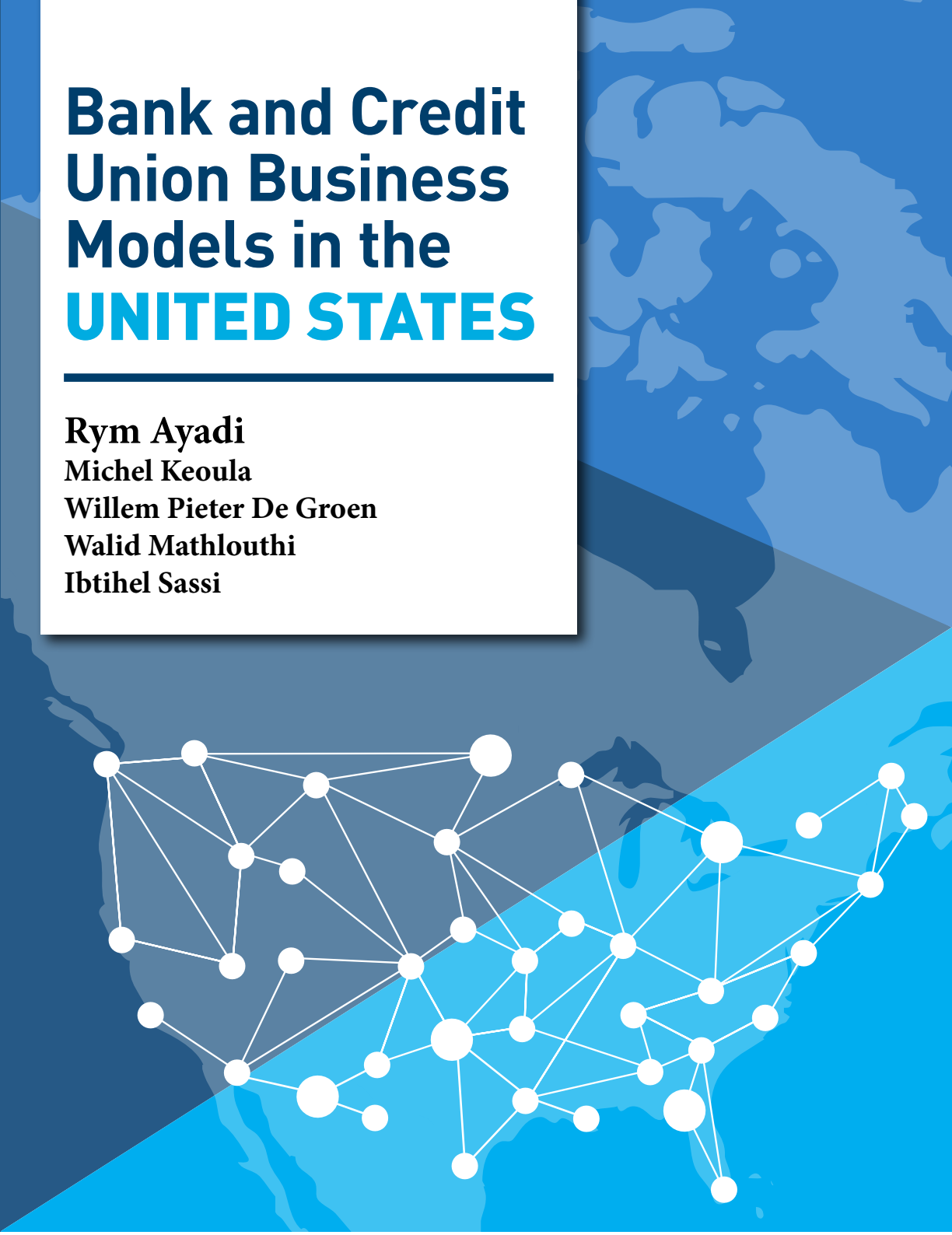

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International Institute
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The study is led and co-authored by Rym Ayadi, Professor at HEC Montreal and Director of the IRCCF, of Alphonse and Dorimène Desjardins International Institute for Cooperatives. It is co-authored by Michel Keoula, Researcher at the IRCCF and Willem Pieter de Groen, Associate Researcher at the IRCCF and Research Fellow at the FIPP Unit at CEPS and with the contributions of Walid Mathlouthi, Harol Rey and Jorge Ruiz, researchers at the IRCCF, as well as that of Ibtihel Sassi during her time as researcher at the IRCCF.

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Contents

1 Introduction

Since the beginning of the 21st century, the financial sector in the United States has experienced fundamental changes induced by the interplay of financial innovation, competitive pressures and excessive risk taking. The banking sector[1] has largely suffered after the collapse of Lehman Brothers in September 2008. The initial context of decades of deregulation has been followed by the Dodd-Frank Act in response to the overly damaging 2007-2009 global financial crisis, with the aim of safeguarding financial stability and putting an end to government bailouts.

Two major distinguishing features characterize the typology of the banking sector in the US. First, the survival of state charters along with federal charters, usually referred to as the duality of the US banking system, is a reflexion of the political and administrative organization of the United States of America. Second, an early functional separation, endorsed by the banking reforms of the 1930s, fostered the coexistence of three types of depository institutions: commercial banks devoted to business lending, savings institutions designed to encourage home ownership and credit unions aiming for financial inclusion of underserved segments of the population. Currently, the frontiers of the activities and investment powers of the different groups of banks are still relevant, even if they have been blurred by innovations and the evolving financial regulation.

In effect, the end of the 1990s can be considered as the culmination of the wave of liberalization that started in the 1970s in the US financial sector. In 2000, the Commodity Futures Modernization Act that regulates over-the-counter (OTC) derivatives was adopted. This was a year after the Financial Services Modernisation Act, also known as the Gramm-Leach-Bliley Act (GLBA), partially removed the separation of commercial and investment banking activities, completing earlier initiatives to erode the Glass-Steagall Act of the 30s. Earlier in the decade, the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994, removed the restrictions on interstate bank branching. In the same vein, the 1998 Credit Unions Membership Access Act (CUMAA) fixed the legal uncertainties about their ability to expand across state borders.

These regulations unleashed most of the internal and external competitive pressures on the banking system in the US. In particular, the GBLA has allowed Bank Holding Companies to develop investment banking activities as one of their segments, with appreciable synergies with the other segments. Consequently, a *British style universal banking system* was fostered in the US, with separate legal entities for commercial banking, investment banking and insurance activities and very limited involvement in merchant banking[2]. The new regulatory environment has seriously boosted the business models of large, complex financial institutions.

Thus, the banking sector pursued its consolidation via mergers and acquisitions. According to the Federal Deposit Insurance Corporation (FDIC) data, from 2000 to 2014, the number of commercial banks dropped from 8,375 to 5,607, which is a net decrease of 2,216 after

1. The reference to the "banking sector" is meant to include all depository institutions: commercial banks, savings institutions and credit unions.

2. Mishkin and Serletis, 2014, p.

accounting for 552 failures. The number of savings institutions also shrank from 1,589 to 902 over the period. Overall, the number of banks has declined, in contrast to the number of their branches. For example, for commercial banks, the number of branches rose by 29.4%, from 64,903 to 82,011 over the 15-year period. While their size increased, a trend that started near the end of the 1990s has deepened as well. A new cycle of "return to retail" (Clark et al. 2007) was mainly led by the largest American banks, which were heavily investing in retail banking infrastructure to counter the poor performance of non-retail banking and financial market intermediation incomes.

As the new century unfolded, another important trend of the banking sector in the United States – its decreasing importance in the financial intermediation system – has persisted. In 1980, assets of depository institutions represented 57.9% of the total assets of the financial intermediaries[3]. In 2005, this share dropped to 34.3% as mutual funds, pension funds and insurance companies competed more aggressively to capture the savings of households and businesses in a lower interest rate environment. On the asset side, aggressive competition with new types of lender, dubbed shadow banks – non depository financial institutions that engage in capital market lending funded by global wholesale money markets – has also become a prominent feature of the market structure. Although financial globalization was already developing over decades, it made great strides with the help of the technological advances of the desktop computer and Internet era. Significant product and process innovations that expand consumer choices and lower operational costs, as well as risk shifting innovations,[4] have spilled over the banking sector.

In particular, risk-shifting innovations have increased the liquidity and the size of capital markets with the help of credit derivatives (Ayadi and Behr, 2009). These innovative instruments completed the derivatives market which can, henceforth, fully support the securitization of loans by allowing the trading of interest rate risk, price risk and credit risk and off-balance-sheet risk. The global derivatives market expanded quickly from 106 trillion in 2001 to 531 trillion in 2008 (Sherman, 2010). But by 2006, non-conforming MBS (including subprime mortgages) were already much larger than the agency-conforming MBS market (Ashcraft et al, cited by Sherman, 2010). A larger and stronger derivatives market gave a new impetus to the transformation of the balance sheet of banks, with more of their lending activities evolving from the originate-to-hold to the originate-to-distribute model.

Currently, there is a broad consensus that the pricing of risk on one of the most important components of the capital market – the mortgage market – was inadequate due to various implicit and explicit government guarantees. The predominant illustration of those guarantees was the perception of too-big-to-fail (too large social costs of a failure) of large, complex financial institutions and the leading role on the mortgage market of the two Government-Sponsored Enterprises (GSE), Fannie Mae and Freddie Mac. The mispricing worsened principal-agent problems of moral hazard and adverse selection in the financial system. In particular, for banks in the originate-to-distribute model, there was less incentive to keep the same quality of screening and monitoring of customers for the securitized loans that they intermediate.

3. See Mishkin, F. S. (2007), Web chapter on nonbank finance.
4. According to a taxonomy in Llewelyn (2009).

In the first half of 2007, economic conditions started to deteriorate. The mortgage market was still bullish, but delinquency rates on subprime mortgages rose. Starting in the fall of 2007, the Federal Reserve made various and unprecedented interventions in the financial market, to ease the stress on the financial infrastructure caused by the subprime mortgage crisis. More precisely, the fall of the values of collateral assets, due to massive delinquencies on subprime mortgages, caused liquidity shortages as more investors were unwilling to roll out their lending on the money market and were transferring resources to safer assets such as Treasury bills. But the Fed's actions fell short of averting a run on the shadow banking system.

In 2008, the Federal Reserve and the FDIC rescued the investment banks Bear Stearns and Merrill Lynch, the insurance group AIG and the savings bank Washington Mutual that were deemed too-big-to-fail. But in September 2008, the Fed declined to bail out the investment bank Lehman Brothers, which prompted its bankruptcy, with tremendous reverberations throughout the World financial system. These developments accelerated the run on the shadow banking system, bringing the whole US financial system to the brink of collapse. The federal government was then compelled to commit, via the Troubled Assets Relief Program (TARP), 700 billion in capital support for a total of 791 banks[5] mortgage servicers, insurance companies, state housing agencies and credit unions[6]. The return to normal credit flowing in the economy came no later than 2013 with the end of the credit crunch.

Regulatory initiatives soon emerged. An international consensus on necessary capital, liquidity and transparency requirements has built up into the Basel III agreement. In addition, the newly created Financial Stability Board has been put in charge of the international coordination and cooperation on the reforms of the financial sector. On the domestic front, in 2010 the US Congress seized the political momentum to pass the Dodd-Frank Financial Stability and Consumer Protection Act, a sweeping reform of the US financial sector. The new law, implemented mostly through the federal regulatory agencies' rulemaking[7] has brought into domestic regulations the provisions of the Basel III agreement. In addition, it restores a moderate form of the Glass-Steagall restrictions between investment banking and commercial banking activities and provides for the resolution of Systematically Important Financial Institutions (SIFI).

By the summer 2017, it is greatly anticipated that the tide of new agency rules applying the Dodd-Frank Act will recede. Indeed, under President Trump's Executive Order 13772 on Core Principles for Regulating the United States Financial System, the financial regulatory system is expected to reverse back to more deregulation, either through agency rulemaking or Congress lawmaking. The latter option has become a real possibility in June 2017, with the Financial Choice Act heading to the Senate after the bill cleared the House of Representatives.

5. Figure is from the Treasury TARP monthly report to Congress of September 2016.

6. The case of credit unions is the least well-known. To elaborate, in September 2010, 48 eligible credit unions were granted a total capital support of $70 billion through the TARP loan program of Community Development capital Initiative (CDCI).

7. The percentage of completion of rulemaking was estimated to have crossed the 50% line in March 2014 (Davis Polk cited by Barth et al. (2015) and the 75% in December 2015.

This study is purported to analyze, in the context of evolving market structures and regulations, the business models of US banks (commercial and savings) and those of US credit unions. We define bank or credit union business models by their activity-funding patterns, based on balance sheet indicators, as in Ayadi et al (2016). Business models are groups or clusters that are identified by a model-free, data-driven clustering methodology. From the two separate samples of banks and credit unions, four bank business models and three credit union business models emerge. The analyses are intended as tools for a wide range of stakeholders – from market participants, depositors and creditors to regulators and supervisors – to better understand the nature of risk attached to each bank and credit union business model and its contribution to systemic risk throughout the economic cycle.

The study is presented as follows: The next chapter focuses on the definitions and identification methods adopted, as well as the description of the indicators used for the clustering and those further used in the analysis. Chapter 3 presents the main descriptive features of bank and credit union business models in the US, including the interaction with their sizes. In the subsequent three chapters, US bank and credit union business models and categories of US bank sizes are thoroughly assessed and compared, with focus on their financial performance, contribution to the real economy, risk and response to regulation over the fifteen-year period of the study.

2 How are the Business Models for banks and credit unions identified?

In the United States, the banking sector incorporates a variety of business models, charter types and size ranges. Universal-type large commercial banks, with a focus on a broad mix of banking activities, co-exist with a large number of smaller specialized institutions. To a large extent, the business models can be distinguished by the scope of activities and funding strategies these institutions engage in. Most-retail oriented banks (which also include savings institutions) provide traditional banking services to the general public[8]. Investment-oriented banks focus on trading activities, relying on a variety of funding sources and often maintaining a retail network of their own. Other banks provide services to their institutional clients, including large and mid-sized corporations, real estate developers, international trade businesses, network institutions and other financial institutions. In addition to the conventional commercial and savings banks, the sector includes cooperative institutions commonly known as credit unions (i.e. member-owned). Although these institutions do not have the same regulators as banks, they provide banking services[9] in particular loans and deposits to their members. Credit unions are regulated under a different regime than banks with, among others, different reporting requirements. The business models for banks and credit unions are, therefore, analyzed separately in this investigation.

In this chapter, the bank and credit union samples, and the indicators used to identify the different business models are presented. Then the clustering methodology is outlined.

2.1 Sample selection and data

The samples cover large parts of the US banking and credit unions sectors in number and total assets (see Figure 2.1.).

For banks, 10,352[10] commercial and savings institutions[11] active at least one or more years during the period from 2000 to 2014, corresponding to 98% of total assets of the industry (as of end year 2014) were included. Bank holding companies and other types of holdings are not included in this sample. Overall, the banks sample comprises 108,226 bank-year observations included in this analysis. The balance sheet and income statement data were retrieved from the SNL database. The market data was obtained from Bloomberg.

Concerning the sample of credit unions, 10,392 credit unions active during the period from 2000 to 2014 with 83% of total assets of the industry at the end of 2014 were included. In total, 115,516 credit union-year observations were analyzed. The dataset used was

8. Retail-oriented banks provide products and services to consumers and small businesses through branches, the Internet, and other channels.

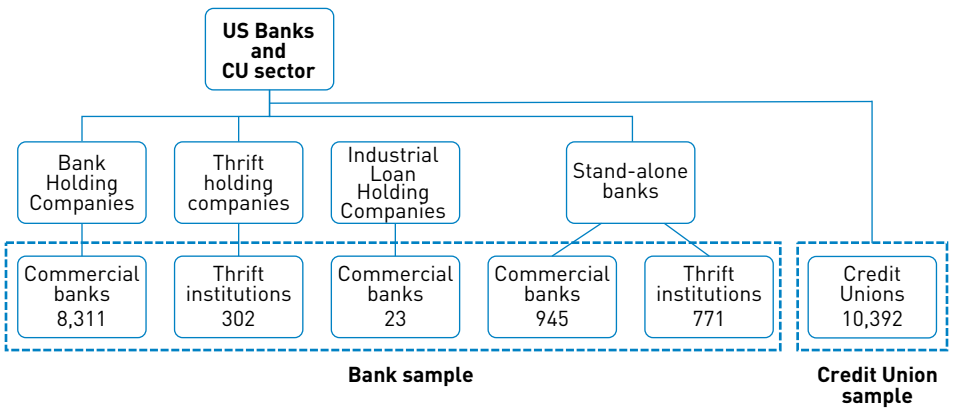
9. http://www.cuna.org/Research-And-Strategy/Credit-Union-Data-And-Statistics/

10. See also Figure 2.1.

11. Savings institutions (also called thrift institutions, or thrifts) include savings banks, savings associations (formerly savings and loan associations), and cooperative banks. For simplicity, we generally refer to "commercial banks and savings institutions" as banks throughout this study.

gathered from the database of the National Credit Union Administration (NCUA) and SNL. Data was carefully reviewed, treated and harmonized by the IRCCF team in a comprehensive dataset for the business model analysis.

FIGURE 2.1 – Structure of the US Banking and Credit Unions Sectors (2000-14)



Notes: The information on the charter type in the dataset only provides the most recent ownership status. The Bank Sample covers 8,311 commercial banks owned by Bank Holding Companies, 302 thrift institution owned by Thrift Holding Companies, 23 commercial banks owned by Industrial Loan Holding Companies, 945 stand-alone commercial banks and 771 stand-alone thrift institutions. The Credit Union sample covers 10,382 natural-person credit unions. Bank Holding Companies, Thrift Holding Companies and Corporate Credit Unions are excluded from the analysis.

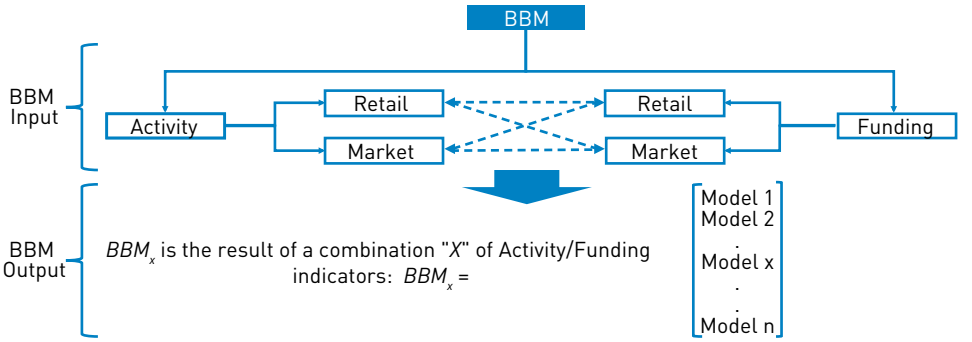
Source: Authors

2.2 Model and indicators

The business models' analysis is undertaken in two steps: Firstly, several indicators from Tables 2.1 and 2.2 were used to identify the business models of banks and credit unions using the business model definition and the clustering statistical technique used in Ayadi et al (2016) and carefully adapted to the sample under study. Secondly, the business models of both banks and credit unions are assessed and compared, based on their relative performance, risk factor and compliance with regulation.

Based on the adopted definition, the selection of indicators for the clustering (called instruments) assumes that banks and credit unions consciously choose their business models. Accordingly, any cluster analysis should be based on instruments over which the banks and credit unions can have a direct influence. In this study, following similar procedures as in Ayadi et al., (2016), we have elected to use only balance sheet indicators as instruments. Indeed, even though a bank or credit union is likely to have a great degree of choice over its general structure, organisation, financial position and some of the risk indicators, most of the performance indicators are related to instruments that are beyond the institution's control, such as market and competitive conditions, systemic risks, consumer demand, etc. In particular, the breakdowns of income sources (i.e. interest vs. non-interest income) are not used as instruments to define the clusters.

FIGURE 2.2 – Bank and credit unions Business Models features



Source: Ayadi et al (2016)

As in Ayadi et al (2016), the business models definition distinguishes primarily between the key activities (i.e. retail versus market or mixed) and the funding strategies (i.e. retail versus market or mixed) (Figure 2.2). To account for these factors collectively, without over-representing any particular factor, seven instruments for banks and six instruments for credit unions, were used to form the clusters. These are:

1. *Loans to banks/credit unions (as% of assets).* This indicator includes all loans other than those secured by real estate to deposit taking institutions (e.g. commercial banks, savings institutions, credit unions, etc.). Hence, this indicator measures the scale of interbank (inter-credit unions) activities, which proxy for exposures to risks arising from interconnectedness in the banking and credit unions sectors.

2. *Customer loans (as% of assets).* This indicator identifies the share of customer loans to non-bank customers not held for sale, indicating a reliance on more traditional banking activities in the case of banks. The loans are netted from allowances for loan losses.

3. *Trading assets (as% of assets).* These are for banks defined as the book values of the total securities, loan and leases held for sale and other trading assets on the balance sheet[12], while for credit union these include trading securities.[13] Large values would indicate the prevalence of investment activities, which are prone to market and liquidity risks.

4. *Bank/credit union liabilities (as% of assets).* This indicator identifies the share of liabilities owed to other banks/credit unions, including deposits and issued debt. This may highlight banks/credit unions with greater interbank funding requirements,

12. Accounting terminology uses a narrower definition of trading assets and would exclude securities/loans available for sale. The point of our clustering is to separate business models, so that 20% in "our trading assets" may fit as a non-trading bank and, since we are letting the data speak for itself, it might be 50% in "our trading assets" that makes banks a "wheeler-and-dealer" heavy trader type.

13. Trading securities are securities that are held to be sold in the near future.

often due to an excessive reliance on short-term funding. This indicator includes all borrowings from deposit taking institutions (e.g. commercial banks, savings institutions, credit unions, etc.).

5. *Customer deposits (as% of assets).* The indicator identifies the share of deposits from non-bank/non credit union customers, e.g. households or enterprises, in the total balance sheet, indicating reliance on more traditional funding sources.

6. *Derivative exposures (as% of assets).* This measure aggregates the carrying value of all negative derivative exposures, which are often identified as one of the key (and most risky) financial exposures of banks/credit unions with substantial investment and trading activities.[14]

7. *Debt liabilities (as% of assets).* These are defined as demand notes issued to the US treasury, other borrowings and outstanding subordinated debt. The debt liabilities indicator provides a general insight into the bank's exposure to market funding. This instrument was not used for credit unions, since hardly any of the credit unions issues debt instruments.

TABLE 2.1 – Description of the clustering instruments in the bank sample

Variable	Median	Mean	Std. dev.	P1.	P99.	Completeness (%)
(FINANCIAL) ACTIVITIES						
Loans to banks (% of assets)	0.34	1.17	2.37	0.00	11.84	100
Customer loans (% of assets)	54.53	53.17	17.41	5.65	88.35	100
Trading assets (% of assets)	26.15	26.08	12.44	0.08	64.12	100
Bank liabilities (% of assets)	0.54	1.01	2.66	0.00	8.90	100
Customer deposits (% of assets)	61.79	58.22	20.71	2.79	90.96	100
Debt liabilities (% of assets)	7.64	8.90	8.71	0.00	45.50	100
Derivative exposure (% of assets)	0.99	2.70	3.96	0.00	18.98	100

Note: P1 and P99 are the 1st and 99th percentiles.
Source: Authors

Observations with missing values for any of the clustering instruments have been discarded from the sample, so that the completeness of those activities and funding indicators is 100%. On average, 79.42% of the assets side of bank balance sheets is covered, in particular by loans to banks, loans to customers and trading assets, whereas 70.83% of the liabilities side is covered through debt to banks, deposits, debt liabilities and derivatives exposures. The remainder of the assets primarily consists of cash, (non-trading) securities and intangibles, whereas the remainder of the liabilities consists of equity and funds obtained from the Federal Reserve and by repurchase agreements (see also Tables 3.1 and 3.2 for more details).

14. For credit unions, the notional value has been used as the instrument for the clustering.

TABLE 2.2 – Description of clustering instruments in the credit union sample

Variable	Median	Mean	Std. dev.	P1.	P99.	Complete-ness (%)
(FINANCIAL) ACTIVITIES						
Loans/deposits to/in credit unions and banks (% of assets)	2.11	7.24	11.42	0.00	53.12	100
Customer loans (% of assets)	61.68	60.25	16.05	20.16	88.96	100
Trading assets (% of assets)	0.00	0.08	1.05	0.00	1.26	100
Credit union liabilities (% of assets)	0.00	1.49	2.75	0.00	10.69	100
Customer deposits (% of assets)	87.60	86.79	3.86	75.79	92.62	100
Derivative exposure (% of assets)	0.00	0.02	0.46	0.00	0.00	100

Note: P1 and P99 are the 1st and 99th percentiles.
Source: Authors

For this sample, the completeness of activities and funding indicators is 100%[15]. On the asset-side of the credit unions' balance sheet, the two indicators i.e. loans to banks and loans to customers, cover on average 53% of the total assets[16], while on the liabilities-side four indicators i.e. bank liabilities, customer deposits, derivatives and tangible common equity cover 81% on average of the balance sheet.

2.3 Clustering

Clustering is a statistical technique for assigning a set of observations (i.e. a particular bank or credit union in a particular year) to groups (i.e. business models) that do not generally overlap. By definition, observations that are assigned to the same cluster share a certain degree of similarity within the cluster, while being insufficiently dissimilar between themselves. The preliminary step is the selection of the instruments, as explained in the previous subsection. The clustering method itself includes a specification of the similarity or dissimilarity measure, the algorithm for recovering the clusters, and the determination of the appropriate number of clusters (i.e. the 'stopping rule'). This procedure follows the same definition, statistical techniques and analytical framework used in Ayadi et al. (2016).

For this investigation, a hybrid method combining the hierarchical Ward's (1963) procedure and the non-hierarchical k-means algorithm is used to form the clusters. The Ward procedure is an aggregative clustering algorithm that iteratively forms partitions in a hierarchical manner, starting from the largest number of clusters possible (i.e. all institution/years in a separate cluster) and merging clusters by minimising the within-cluster sum-of-squared-errors for any given number of clusters. The procedure does not require a prior specification of the number of groups. One shortcoming of the algorithm is that the iterative process does allow an observation to be reassigned to another group.

15. The particular case of derivative exposures of credit unions is explained in the next subsection on the clustering methodology.

16. These figures are derived from computations of the weighted averages.

In contrast, the k-means algorithm allows observations to be reassigned across partitions during the iterations. This comes at the expense of the requirement to provide the exact number of clusters and their centers. The algorithm then proceeds by assigning each observation to the temporary cluster of the nearest center. The new center of a group is the average of the observations in that group. The process is iterated until the change in group centers becomes close to zero. The final clusters consist of the observations that are nearest to the centers in the last iteration.

The hybrid method, as applied to the two samples of US banks and credit unions, develop as follows:

Step 1: perform a non hierarchical algorithm; specify a very large number of groups (e.g. 500 groups)

Step 2: An hierarchical algorithm (Ward) is implemented by treating these 500 centroids as observations. This clustering will suggest taking Q groups

Step 3: perform a non-hierarchical clustering with Q clusters using the Q centroids, found in the previous step, as the starting seeds.

Note that, for the success of the application of the hybrid method to this study, indicators, which are ratios, are not standardized as is common in the literature, because they are already dimensionless. In addition, standardization results in clusters that are less intuitive to interpret.

One of the key problems often encountered in clustering is the presence of missing values. When a particular observation has one or more missing instrument values, it has to be dropped from the cluster analysis, since the similarity to other institution-year observations cannot be determined. Both the bank and credit union samples used in the study contain such cases, despite efforts to choose indicators with high coverage ratios. In order to accommodate the entire credit unions sample of observations, when the 'derivative exposures' were not reported, they were assumed to be zero in the calculation of 'Derivative exposures,' since credit unions are not required to report the item when not applicable.

TABLE 2.3 – Pseudo-F indices for bank clustering configurations

Number of clusters	Pseudo-F index (Calinski & Harabasz)	Number of clusters	Pseudo-F index (Calinski & Harabasz)
1	..	6	53,000
2	54,000	7	50,000
3	57,000	8	48,000
4	65,000	9	47,000
5	57,000	10	47,000

Note: The Calinski & Harabasz (1974) pseudo-F index is an estimate of the between-cluster variance divided by within-cluster variance.
Source: Authors

To diagnose the appropriate number of clusters in Step 2, Calinski & Harabasz's (1974) pseudo-F index was used as the primary 'stopping rule'. The index is a sample estimate of the ratio of between-cluster variance to within-cluster variance.[17] The configuration with the greatest pseudo-F value is chosen as the most distinct clustering. The results for the bank sample show that the pseudo-F indices attain a single maximum, suggesting the four-cluster configuration as the most distinct one (see Table 2.3). For credit unions, the results show that a three-cluster configuration is the most distinct one (see Table 2.4).

TABLE 2.4 – Pseudo-F indices for credit union clustering configurations

Number of clusters	Pseudo-F index (Calinski & Harabasz)	Number of clusters	Pseudo-F index (Calinski & Harabasz)
1	..	6	10,000
2	11,000	7	9,600
3	12,000	8	9,200
4	11,000	9	8,900
5	10,000	10	8,800

Note: The Calinski & Harabasz (1974) pseudo-F index is an estimate of the between-cluster variance divided by within-cluster variance.
Source: Authors

The number of clusters is confirmed by alternative stopping rules, namely the Semi Partial R-Squared measure, the Between Cluster Sum of Squares and the Dendrogram (see Appendix I).

Nonetheless, the business model analysis remains dependent on methodological choices, including most notably the selection of indicators (which is linked to the definition used), procedures for forming clusters and the 'stopping rule' used to determine the optimal number of clusters[18]. The instruments mentioned above led to the most consistent and distinct clustering. Dropping instruments resulted in a substantial worsening of the statistical measures of distinct clustering whereas a larger set did not change the results substantially, as long as the defined indicators were included. Such experiments suggest that the chosen set of indicators, or instruments, adequately identifies the main distinguishing characteristics of the sampled banks and credit unions. As the discussion in the following chapter makes clear, the characteristics of the business models that are identified by the cluster analysis are, by and large, in line with expectations. Despite these efforts, it is certainly true that the outcomes may change when using other configurations. Notwithstanding this qualification, using the configuration of this study is useful for a continuous dynamic analysis of the business models of banks, credit unions and other financial institutions using similar definitions and methodologies.

17. Evaluating a variety of cluster stopping rules, Milligan & Cooper (1985) single out the Calinski and Harabasz index as the best and most consistent rule, identifying in simulations the sought configurations correctly in over 90% of all cases.

18. See Everitt et al. (2001) for an introduction to cluster analysis and some of the practical issues in the choice of technical procedures.

In what follows, we present the indicators for the assessment of the business models for banks and credit unions.

2.4 Indicators for the assessment

A large variety of indicators were compiled to get a better picture of the bank and credit union business models. The assessment covers: performance, risk, stability and regulation over the period from 2000 to 2014.

Following are the definitions of the indicators used in this study[19]:

Return on assets (ROA): Income before taxes/Total assets; and
Return on equity (ROE): Income before taxes/Total equity.

For credit unions, Total equity is replaced by net worth.

We computed the two profitability indicators with data on pre-tax income, to ensure comparability across the many US tax jurisdictions and with credit unions. This amount is divided by total assets (ROA) or total equity (ROE).

There are conceptual differences between ROA (net income) for stock-owned banks and credit unions. Bank net income is pre-tax, while credit unions are largely exempt from corporate income taxes, requiring one to make some adjustment to compare the figures.

Also, bank net income is reported before paying dividends to stock holders. In contrast, for CUs net income is reported without taking into account that credit unions' owners are borrowers who benefit from paying lower rates than at banks (which is a form of owner compensation that depresses reported net income) and that credit unions owners are depositors who benefit from the fact that credit unions, on average, pay higher rates on deposits than banks (again a form of owner compensation that depresses reported net income).

For banks, the meaning of equity is clear. It is the capital contributions of stockholders (whether from the IPO or from retained earnings) and they compute ROE to see what return they are getting.

For credit unions, the meaning of net worth is more diffused. Net worth accumulates to protect the credit unions from shocks and to meet capital requirements, but the link between credit union member's contributions, length of membership, voting power and ability to extract equity from the credit union are far more complicated. Members receive benefits proportional to their amount of loans or deposits today, not to their length of membership (which would be correlated with the accumulation of retained earnings over time). Members have one vote, regardless of past or current deposits, or length of membership. Members cannot extract equity from the credit unions (like bank stockholders can by selling their stock).

As a result, bank managers must manage ROEs. They are important to stockholders. But credit union managers shouldn't really manage ROEs, since it is far less clear what they mean to members. Members care about low loan rates, high rates on deposits, lots

19. Some of these definitions come from the metadata of SNL, which is our main source of accounting data.

of cheap services and, perhaps, the long-term solidity of the institution (perhaps proxied by the capital ratio). If ROE is somewhere among credit union members' concerns, it would be a pretty low concern, when it is at the top for bank stockholders.

Cost-to-income ratio (CIR): operational expenses/income from operations. Since it is a cost, a higher CIR indicates that an institution is less efficient. For credit unions, the denominator is total gross income.

Net interest income: Total Interest Income/Total Interest Expense

Commission and fees: Income from fiduciary activities, service charges on deposit accounts in U.S. offices, trading gains from foreign exchange transactions, other foreign transaction gains, gains and fees from assets held in trading accounts, and other non-interest income.

Trading income: Net gain realized during the calendar year-to-date from the sale, exchange, redemption, or retirement of all securities reported as held to maturity securities and available-for-sale securities. This indicator only applies to banks.

Customer loan growth: (Gross customer loan of the current year/Gross customer loans of previous year)/Gross customer loan of the previous year.

Z-score or distance-to-default: the **Z-score** is a balance sheet based indicator that provides an estimate of a bank's distance to default. In essence, the risk measure uses historical earnings volatility and returns, as well as current capital levels, to construct the level of a (one-time) shock beyond the historical average that would lead to default. The greater the Z-score, the further a bank is from default and the lower is the probability of a default. For full details on the computation, see appendix III. This indicator has also been constructed for credit unions, with current capital levels proxied by the net worth.

Loan loss provisions: Value needed to make the allowance for loan and lease losses adequate to absorb expected loan and lease losses, based upon management's evaluation of the reporting institution's current loan and lease portfolio and value of the provision for allocated transfer risk, if the institution is required to maintain an allocated transfer reserve by the International Lending Supervision Act of 1983.

Average daily stock returns are only available for listed banks and, in most cases, only shares of holding companies are listed. This indicator only applies to banks.

The share returns' indicators of both individual banks and holding companies are used. The share returns of the holding companies are linked to individual banks, when the share capital of the bank representing the majority of the holding`s equity and the bank was not listed. Again, this approach ensures that the share returns are only linked, when the bank forms a significant part of the holding company.

Annual standard deviations in daily stock returns have been calculated by annualizing the standard deviation of daily stock returns. This indicator only applies to banks.

Risk-weighted assets (RWA) (% of assets): Risk weighted assets which, depending on institution attributes and time period, is either reported under the U.S. Basel III (B3) revised regulatory capital rules, advanced approaches rules or otherwise, or the General

risk-based (GRB) regulatory capital rules. Preference between the GRB, B3 and B3-Post Parallel Run values is provided, based on the nature of the filing and the attributes of the various Tier 1 common/common equity Tier 1 risk-based ratios.

The closest concept for credit unions is the **risk-based net worth (RBNW) ratio**. This is a risk-weighted average of on and off-balance sheet items, reported as a share of the total assets of a credit union.

Tier 1 capital: Tier 1 capital which, depending on institution attributes and time period, is either reported under the General risk-based (GRB) regulatory capital rules or the U.S. Basel III (B3) revised regulatory capital rules. Preference between GRB and B3 values is provided, based on the nature of the filing and the attributes of the various Tier 1 risk-based ratios. This indicator only applies to banks.

Total capital: Total risk-based capital which, depending on institution attributes and time period, is either reported under the U.S. Basel III (B3) revised regulatory capital rules, advanced approaches rules or otherwise, or the General risk-based (GRB) regulatory capital rules. Preference between the GRB, B3 and B3-Post Parallel Run values is provided, based on the nature of the filing and the attributes of the various total capital ratios. This indicator only applies to banks.

Tangible common equity: Total equity capital excluding minority interests, adjusted for preferred stocks, goodwill and other intangibles. Mortgage servicing rights are not treated as intangible assets.

The closest concept for credit unions is the **net worth ratio** (i.e. largely retained earnings as a share of total assets). Higher levels of net worth indicate that the credit union has a higher loss-absorbing capacity.

Net Stable Funding Ratio (NSFR): Available stable funding/required stable funding. For the full definition and computation, see Appendix IV. This indicator only applies to banks.

Summary statistics of the indicators for the **bank sample** are reported in Table 2.5.

TABLE 2.5 – Description of indicators for the assessment of banks

Variable	P99.	Median	Mean	Std. dev.	P1.	Completeness (%)
(FINANCIAL) ACTIVITIES						
Return on assets (ROA, in %)	1.24	1.28	2.00	2.00	5.53	100
Return on equity (ROE, in %)	12.42	12.31	14.13	14.13	48.36	100
Cost-to-income ratio (CIR, in %)	60.23	61.26	17.35	17.35	106.74	100
Net interest income (% of operating income)	60.11	60.39	19.02	19.02	97.72	100
Trading income (% of operating income)	20.85	24.07	19.12	19.12	89.80	100
Commission & fee income (% of operating income)	0.11	0.40	6.64	6.64	7.66	100
Other income (% of operating income)	13.32	15.88	12.53	12.53	70.24	92
Customer loan growth (% change)	3.99	4.42	12.08	12.08	39.60	86
RISKINESS						
Z-score (nr. of standard deviations from default)	19.03	20.04	12.78	2.51	66.59	97
Loan loss provisions (% of gross customer loans)	0.53	0.53	2.05	2.05	7.02	100
Stock returns (average daily returns, in %)	0.06	0.06	1.66	1.66	4.15	18
Stock returns (standard deviation of daily returns, in %)	2.29	2.29	5.89	5.89	22.86	18
REGULATORY CAPITAL						
Risk-weighted assets (RWA) (% of assets)	71.94	72.19	15.09	32.40	114.17	100
Tier 1 capital (% of risk-weighted assets)	10.20	11.15	6.67	6.46	28.07	100
Total capital (% of risk-weighted assets)	12.93	14.46	61.53	10.13	35.53	100
Tangible common equity (% tangible assets)	7.12	7.80	3.41	3.33	18.75	100
NSFR (available/required funding, in %)	129.42	150.25	1405.27	92.71	251.64	92

Note: P1 and P99 are the 1st and 99th percentiles.
Source: Authors

It has been possible to compute financial performance indicators for almost all observations in the bank sample; except for customer loans growth (90%) for which one lag of observation is always required to calculate the growth, the completeness ranges between 96% and 100%. In contrast, the completeness of riskiness and regulatory indicators ranges between 7.3% and 100%. In particular, the completeness of market indicators (i.e. average and standard deviation of daily stock returns) is rather low, since many of the smaller banks that are included in the sample are not dependent on market funding and are analyzed on an individual-basis rather than at a consolidated group level.

Likewise, for the **credit union sample**, a dozen of indicators are summarized in Table 2.6.

TABLE 2.6 – Description of indicators for the assessment of credit unions

Variable	P99.	Median	Mean	Std. dev.	P1.	Completeness (%)
FINANCIAL PERFORMANCE						
Return on assets (ROA, in %)	0.74	0.68	6.58	-1.69	1.97	100.00
Return on equity (ROE, in %)	6.66	6.02	10.17	-17.24	18.10	99.99
Cost-to-income ratio (CIR, in %)	74.00	73.80	13.09	40.43	106.21	99.94
Net interest income (% of gross income)	54.17	54.15	9.92	32.23	78.02	99.98
Trading income (% of gross income)	0.00	0.01	0.36	-0.04	0.25	99.98
Commission & fee income (% of gross income)	12.50	13.67	7.96	0.49	37.85	99.86
Other income (% of gross income)	7.60	8.51	6.78	0.00	28.05	99.98
Customer loan growth (% change)	6.31	6.48	9.92	-17.59	32.81	98.69
RISKINESS						
Z-score (nr. of std. dev. from default)	27.29	30.04	16.94	5.54	86.33	98.02
Loan loss provisions (% Gross loans)	0.48	0.68	0.83	-0.26	3.87	99.91
REGULATORY CAPITAL						
Net worth ratio (% of assets)	10.24	10.83	2.96	6.70	22.04	100
Risk-based net worth requirements (% of assets)	6.51	6.74	0.79	6.01	9.97	5.52

Note: P1 and P99 are the 1st and 99th percentiles.
Source: Authors

Their financial performance indicators could be exhaustively calculated (hence a completeness of 100%). Also, estimates for the riskiness indicators are almost exhaustive, with only the Z-score below 100% due to credit unions with just one observation. Moreover, since credit unions are non-listed institutions, market indicators are not available. Finally, the net worth ratio has been reported for all credit unions in the sample, while for the second regulatory indicator, the risk-based net worth requirement is only available for large credit unions and has not been regularly reported[20].

In a nutshell, this chapter has presented the activity-funding approach to the business model analysis and elaborated on the indicators for recovering relevant clusters in the data, as well as those used to consider the performance and risk analyses. The next chapter complements this presentation by detailing the identification of business models of banks and credit unions and providing a thorough description of each business model.

20. They are only reported in SNL since 2005 and are applicable to larger and more complex credit unions.

3 Identification of Business Models of US banks and credit unions

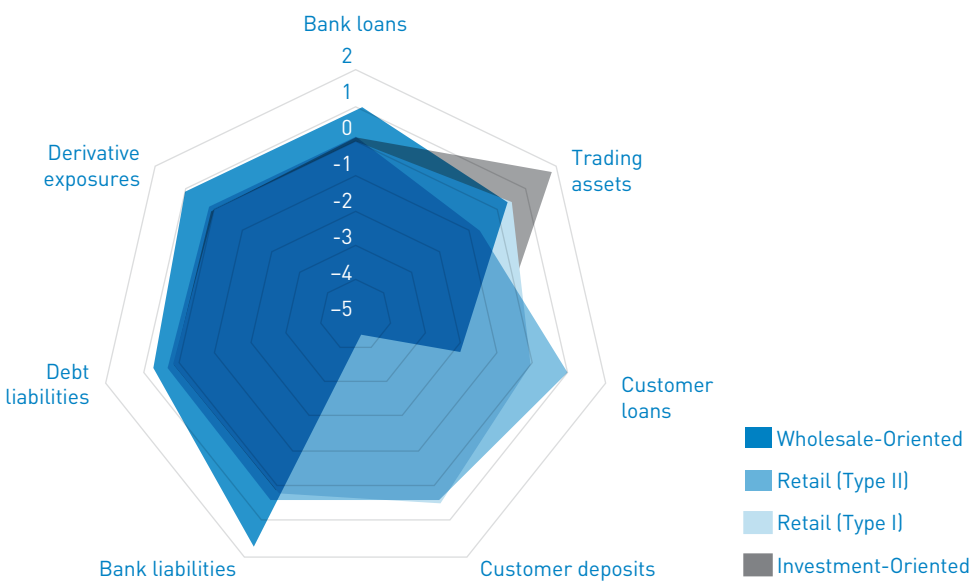
In this chapter, a comprehensive account is given of how business models are identified in the clustering outputs of the bank and credit union samples. Further descriptive steps are taken to account for the interaction of the identified business models with the size of US banks and credit unions. Migrations between business models are analysed in the last part of each of the sections on banks and credit unions.

3.1 Business Models of US banks: identification, interactions with sizes and charter types and migration

First, Figure 3.2 and Table 3.1 give the descriptive statistics of the four models resulting from the cluster analysis of the entire bank-sample for the US during the overall period of analysis (2000-2014), based on the seven instruments used to define them. Second, an overview of the main structural and financial attributes of the clusters is provided. Third, a complementary analysis is performed on the size categories of banks, to better understand the interaction between business models and size.

3.1.1 Identification

FIGURE 3.1 – Identification of bank clusters, standardized scores



Notes: Indicators are those used for the clustering. The figures represent the number of standard deviations from the sample mean.

Source: Authors

Model 1 includes banks that are active in the intermediation between banks, with a relatively heavy reliance on market / interbank lending and funding. Indeed, on average, interbank lending along with trading assets represent more than one-third of their balance sheet, a share similar to that of customer loans[21].

This model also shows a significantly lower share of customer deposits (30.21% of total assets) as compared to the other business models (58% or more on average), hinting at a relatively high reliance on wholesale markets for funding sources. Indeed, under this bank model, the liabilities of an average bank to other banks, including deposits and other interbank debt and (negative) derivative exposures, represent 18.64% of the total assets. In the remainder of this study, the Model 1-banks will be referred to as **"wholesale-oriented"**. The wholesale banks are the smallest group in terms of number of sampled institutions, representing only 2.5% of the sample. These banks, nevertheless, represent more than 25% of total assets and represent the largest banks in term of total assets. The average size of a bank in this cluster is approximately $15 billion (See appendix II). However, the median size of banks is the lowest (See appendix II), which means that the models also includes a sizable proportion of the tiniest banks in the sample.

Models 2 and 3 represent retail-oriented banks. In essence, these banks are more active in lending to customers and they use customer deposits as the primary means for funding. Hence, the clusters' means for the share of customer loans in the balance sheet total are respectively 55.35% and 71.38%, which is around or above the sample average of 53.17% and clearly higher than the other models. In turn, customer deposits account for 67.72% and 68.33% of total assets respectively, which are well above the sample average of 58.22%.

Looking at the differences between these two retail-oriented models, Model 3-banks are, on average, more active in traditional deposit-loan intermediation, with a relatively small difference between loans and deposits as a share of total assets, respectively 71.38% and 68.33%. The remaining exposures, such as trading assets and loans to banks are relatively limited with, respectively 13.57% and nearly 0.56%. Although Models 2 and 3 represent similar funding strategies, with a relatively high dependence on customer deposits and limited reliance on both bank deposits and debt liabilities, Model 2 shows a greater diversification in its activities with relatively more trading assets which account for 26.08% of total assets.

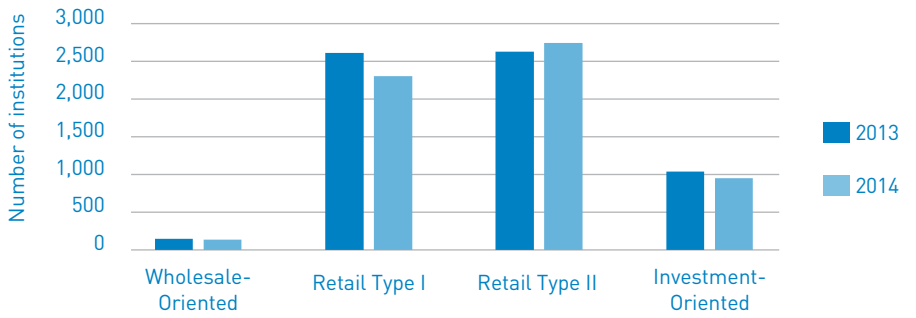
Together, Models 2 and 3, account for 84% of the total number of institutions under study and 66% of total assets. Model 2 represents 39% of the observations in the sample and 38% of the total assets. **Model 2** will be referred to as **"retail (type 1)"** as they are more of a diversified type. Model 3 covers 45% of the sampled banks but represents only 28% of total assets. Model 3-banks are the smallest banks among the retail-oriented models, both in terms of total and average assets. **Model 3** will be referred to as **"retail (type 2)"** as they are less of a diversified type or more focused".

21. The control variable of cash and cash equivalents (see last column to the right on Table 3.1) gives the third most important component of their assets, with an average of 20.34%. A partial explanation to this excess liquidity is probably provided by the presence in this business model of a relatively high proportion of small trust banks, representing about one third of the cluster, which are probably keeping substantial amounts of cash to fulfil their fiduciary duties.

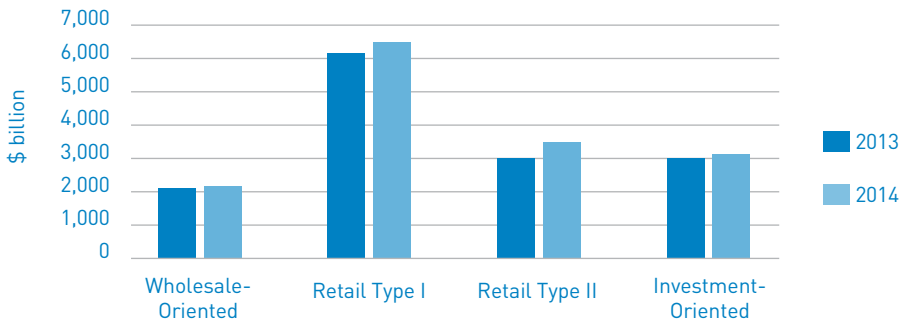
Model 4 groups together investment-oriented banks; these banks have substantial trading activities in combination with other activities. Indeed, the cluster average for trading assets, representing 44.26% of total assets, stands about 1.5 standard deviations above the sample mean (See Figure 3.1). For their funding, the focus is on traditional funding; in particular 66.93% of the funding consists of customer deposits. In what follows, Model 4 will be referred to as the cluster of **"investment-oriented banks[22]"**. Model 4 represents about 14% of the observations in the sample and, on average, only about 9% of the total assets. The average size of a bank in this cluster is comparable to that of retail (type 2) banks.

FIGURE 3.2 – Total size of business models, 2013-14

a) Number of institutions



b) Total assets



Note: Total assets of each business model is obtained by summing the total assets of all the individual banks in the business model.
Source: Authors

22. Note that what we refer to as "investment-oriented banks" are institutions with "commercial bank" charters, and (are separate from what are commonly called "investment banks" which operate with separate charters and historically are not included in commercial bank databases. Bank Holding Companies (BHCs) are allowed since the repeal of Glass-Steagall in 1999 to engage in both "commercial banking" (taking deposits and making loans) and "investment banking" (i.e., assisting non-financial corporations in issuing their stocks and bonds, plus mergers, etc.), but BHCs must engage in the two activities through separate subsidiaries: one called a commercial bank (which may trade securities in secondary markets) and one called an investment bank (which may help non-financial corporations issue securities in primary markets (IPOs, etc.) and which, again, are not included in commercial bank databases).

TABLE 3.1 – Descriptive statistics for bank business models, weighted

		Loans to banks (% assets)	Customer loans (% assets)	Trading assets (% assets)	Bank liabilities (% assets)	Customer deposits (% assets)	Debt liabilities (% assets)	Derivative exposures (% assets)	Tang. Comm. eq. (% tang. assets)	Cash (% assets)
Model 1 - Wholesale-oriented	Median	1.44%	35.85%	34.12%	0.65%	32.71%	8.42%	5.83%	5.57%	18.55%
	Mean	2.12%***	37.3%***	33.44%***	1.06%	30.21%***	10.85%**	6.73%***	7.31%***	20.34%***
	St. dev.	2.68%	16.38%	10.48%	3.95%	11.35%	11.79%	5.32%	4.96%	11.40%
	P1.	0.00%	3.51%	0.00%	0.00%	0.00%	0.25%	0.00%	4.39%	0.51%
	P99.	12.79%	93.55%	63.77%	7.89%	47.14%	74.06%	23.77%	20.96%	52.45%
	Obs.	2,665	2,665	2,665	2,665	2,665	2,665	2,665	2,665	2,665
Model 2 - Retail (Type 1)	Median	0.24%	55.35%	26.15%	0.71%	68.77%	6.38%	0.99%	7.12%	8.75%
	Mean	1.07%***	55.27%***	26.08%***	0.95%**	67.72%***	7.06%***	1.65%***	7.6%***	9%***
	St. dev.	2.12%	6.14%	5.40%	1.27%	11.60%	5.05%	1.94%	2.27%	6.28%
	P1.	0.00%	41.30%	10.92%	0.00%	43.89%	0.00%	0.00%	3.57%	1.12%
	P99.	11.84%	67.11%	39.80%	5.65%	90.68%	26.52%	7.38%	15.67%	33.47%
	Obs.	41,993	41,993	41,993	41,993	41,993	41,993	41,993	41,993	41,993
Model 3 – Retail (Type 2)	Median	0.00%	70.58%	14.79%	0.29%	69.51%	8.91%	0.04%	8.15%	4.88%
	Mean	0.56%***	71.38%***	13.57%***	1.04%**	68.33%***	10.67%**	0.44%***	8.32%**	6.24%***
	St. dev.	2.40%	7.08%	5.75%	2.82%	13.71%	9.18%	0.93%	2.94%	5.18%
	P1.	0.00%	56.93%	0.01%	0.00%	28.19%	0.00%	0.00%	2.99%	0.65%
	P99.	10.59%	90.02%	23.00%	13.82%	90.66%	40.85%	6.66%	17.51%	28.98%
	Obs.	48,739	48,739	48,739	48,739	48,739	48,739	48,739	48,739	48,739
Model 4 – Investment-oriented	Median	0.30%	31.22%	42.54%	0.39%	61.54%	5.82%	0.58%	7.19%	12.62%
	Mean	0.7%***	32.62%***	44.26%***	1.11%**	66.93%***	5.55%***	2.64%***	8.31%**	17.07%***
	St. dev.	1.21%	10.68%	14.83%	1.60%	16.14%	5.84%	2.94%	3.37%	13.78%
	P1.	0.00%	0.17%	21.17%	0.00%	43.85%	0.00%	0.00%	4.20%	0.07%
	P99.	5.23%	49.90%	92.65%	4.19%	93.15%	29.33%	9.60%	19.87%	51.35%
	Obs.	14,829	14,829	14,829	14,829	14,829	14,829	14,829	14,829	14,829

		Loans to banks (% assets)	**Customer loans (% assets)**	**Trading assets (% assets)**	**Bank liabilities (% assets)**	**Customer deposits (% assets)**	**Debt liabilities (% assets)**	**Derivative exposures (% assets)**	Tang. Comm. eq. (% tang. assets)	Cash (% assets)
All banks	Median	0.34%	54.53%	26.15%	0.54%	61.79%	7.64%	0.99%	7.12%	8.77%
	Mean	1.17%	53.17%	26.08%	1.01%	58.22%	8.90%	2.70%	7.79%	11.85%
	St. dev.	2.37%	17.41%	12.44%	2.66%	20.71%	8.71%	3.96%	3.44%	10.25%
	P1.	0.00%	5.65%	0.08%	0.00%	2.79%	0.00%	0.00%	3.33%	0.72%
	P99.	11.84%	88.35%	64.12%	8.90%	90.96%	45.50%	18.98%	18.72%	47.46%
	Obs.	108,226	108,226	108,226	108,226	108,226	108,226	108,226	108,226	108,226

Notes: The independence of clusters (a.k.a. business models) was tested using Welch's two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (*, **, and ***) stands for the statistical difference of any given cluster from that number of other clusters for that indicator. For example, two asterisks (**) imply that the cluster is statistically different from two other clusters but not the third (closest) one. Variables in **bold** highlight the instruments used in forming the clusters. P1 and P99 are the 1st and 99th percentiles.

Source: Authors

TABLE 3.2 – Descriptive statistics for bank size categories, weighted

		Loans to banks (% assets)	Customer loans (% assets)	Trading assets (% assets)	Bank liabilities (% assets)	Customer deposits (% assets)	Debt liabilities (% assets)	Derivative exposures (% assets)	Tang. Comm. eq. (% tang. assets)	Cash (% assets)
Micro (<1bn)	Median	0.00%	66.30%	19.70%	0.01%	82.86%	2.79%	0.00%	9.07%	6.05%
	Mean	0.1%****	63.81%***	22.26%**	1.5%****	80.25%****	4.89%****	0.01%****	10.02%****	8.39%**
	St. dev.	1.65%	15.48%	14.60%	5.50%	11.66%	6.29%	0.17%	5.43%	8.33%
	P1.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.01%
	P99.	98.77%	98.77%	99.80%	94.00%	100.00%	89.17%	11.30%	100.00%	40.71%
	Obs.	100,430	100,430	100,430	100,430	100,430	100,430	100,430	100,430	100,430
Very small (1-5bn)	Median	0.00%	66.16%	19.85%	0.05%	78.42%	4.68%	0.00%	8.57%	4.30%
	Mean	0.16%****	63.34%***	22.51%*	1.01%**	74.15%****	7.22%****	0.03%****	9.52%***	7.31%**
	St. dev.	1.29%	16.13%	14.23%	3.78%	16.51%	9.19%	0.15%	5.15%	10.03%
	P1.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.66%	0.50%
	P99.	30.09%	99.24%	97.35%	64.06%	94.71%	95.80%	3.54%	91.80%	52.48%
	Obs.	5,628	5,628	5,628	5,628	5,628	5,628	5,628	5,628	5628
Small (5-10bn)	Median	0.00%	63.55%	21.40%	0.05%	71.83%	7.03%	0.00%	8.14%	3.87%
	Mean	0.51%***	60.54%***	24.02%**	0.74%***	65.67%****	10.89%***	0.11%****	9.26%***	7.96%*
	St. dev.	2.99%	17.40%	16.45%	2.04%	20.91%	14.62%	0.39%	4.40%	11.97%
	P1.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.72%	0.26%
	P99.	53.30%	97.20%	98.58%	23.60%	93.80%	88.35%	7.37%	40.96%	78.81%
	Obs.	854	854	854	854	854	854	854	854	854
Mid-sized (10-50bn)	Median	0.00%	63.68%	20.94%	0.16%	68.01%	9.27%	0.05%	7.52%	4.60%
	Mean	0.63%***	60.36%***	23.21%*	0.92%*	62.69%****	12.54%***	0.35%****	8.21%****	8.15%*
	St. dev.	2.73%	17.93%	16.10%	3.68%	20.73%	14.75%	0.80%	3.08%	9.38%
	P1.	0.00%	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.36%	0.12%
	P99.	50.49%	98.06%	98.84%	78.67%	94.56%	93.53%	6.94%	25.46%	42.80%
	Obs.	908	908	908	908	908	908	908	908	908

		Loans to banks (% assets)	Customer loans (% assets)	Trading assets (% assets)	Bank liabilities (% assets)	Customer deposits (% assets)	Debt liabilities (% assets)	Derivative exposures (% assets)	Tang. Comm. eq. (% tang. assets)	Cash (% assets)
Large (>50bn)	Median	1.04%	50.61%	27.75%	0.84%	52.33%	7.95%	2.78%	6.60%	11.00%
	Mean	1.6%****	48.4%****	27.8%****	0.96%**	51.33%****	9%****	4.06%****	7.04%****	13.87%****
	St. dev.	2.34%	15.76%	10.21%	1.04%	18.15%	6.39%	4.30%	2.28%	10.05%
	P1.	0.00%	2.58%	0.00%	0.00%	0.11%	0.00%	0.00%	1.56%	1.51%
	P99.	30.10%	93.60%	79.96%	25.06%	93.15%	77.07%	40.64%	20.73%	47.46%
	Obs.	406	406	406	406	406	406	406	406	406
All banks	Median	0.34%	54.53%	26.15%	0.54%	61.79%	7.64%	0.99%	7.12%	8.77%
	Mean	1.17%	53.17%	26.08%	1.01%	58.22%	8.90%	2.70%	7.80%	11.85%
	St. dev.	2.37%	17.41%	12.44%	2.66%	20.71%	8.71%	3.96%	3.41%	10.25%
	P1.	0.00%	5.65%	0.08%	0.00%	2.79%	0.00%	0.00%	3.33%	0.72%
	P99.	11.84%	88.35%	64.12%	8.90%	90.96%	45.50%	18.98%	18.75%	47.46%
	Obs.	108,226	108,226	108,226	108,226	108,226	108,226	108,226	108,226	108,226

Notes: The independence of bank size categories was tested using Welch two-sample tests at 5% significance. To report to the results of these tests, the number of asterisks (*, **, ***, and ****) stands for the statistical difference of any given size category from that number of other size categories for that indicator. For example, two asterisks (**) imply that the size category is statistically different from two other size categories but not the third and fourth (closest) ones. P1 and P99 are the 1st and 99th percentiles.

Source: Authors

3.1.2 Interaction with size

The second dimension used in this study to assess different types of banks is size, using total assets. In the US, regulators and supervisors such as the Federal Reserve (Fed) and the Federal Deposit Insurance Corporation (FDIC) use different classifications of both individual banks and holding companies that can be adjusted over time. In this study, we adopt a classification that is inspired by the thresholds used by the various regulators. The U.S. banking sector features a wide range of banks, from the generally considered small community banks (with total assets of less than $10bn) to mid-size regional banks (between $10bn and $50bn) and large national and global banks (more than $50bn). Each category of bank has a role to play in the financial system, e.g. serving retail customers, SMEs, larger companies, governments, etc.

About 98.8% of the banks[23] in the sample have $10bn or less in total assets. In terms of the share of total assets, this category of bank is, nevertheless, only responsible for 22.5%. This category has been split into three categories of sizes - namely banks with less than $1bn, between $1bn and $5bn and between $5bn and $10bn - to better understand the size dimension.

Table 3.2 provides descriptive statistics for these banks across the five categories of size for the overall period of analysis (2000-2014). A list of (large) systemic banks and selected banks in the other bank size categories in 2014 is provided in Appendix V.

The **first category** includes institutions of less than $1bn in total assets covering almost 90% of the observations, which makes it the largest size category of banks in numbers in the sample, but only accounting for 11% in total assets. The average size of these banks is just about $180 million. They are mostly active in traditional deposit-loan intermediation with customer loans and deposits respectively of 63.81% and 80.25%, and relatively below the sample average of market and inter-bank activities. These banks operate with capital levels amounting to 10.02% in tangible common equity which is significantly above the capital level of the other size categories. This first size category is referred to as **"micro"**.

The **second category** includes banks with between $1bn and $5bn in total assets. These account for around 5.2% of the number of observations and 7.2% of the total assets and are, therefore, larger than the previous size category, with an average of $2 billion in total assets. In terms of balance sheet composition, these banks are fairly similar to micro banks. Customer loans are lower (63.34%) but not statistically, a smaller share of funding is obtained from customer deposits (74.15%) and a higher share from debt liabilities (7.22% compared to 4.89% for micro banks). The institutions operate with less capital at 9.52% of tangible common equity. In the remainder of this report, this size category is referred to as **"very small"**.

The **third category** includes banks with between $5bn and $10bn in total assets. These banks represent 0.8% of the total observations and 3.8% of the total assets, with an average bank size of $7bn. The composition of the assets is similar to those of micro banks. The main items, customer loans (60.54%) and trading assets (24.02%), are not significantly different. In turn, a larger share of funding is obtained from market sources with debt liabilities considerably higher than both previous size categories, while their customer deposits (of 65.67%) rank below that of both categories. This third category of banks is referred to as **"small"**.

23. So-called community banks include both commercial banks and savings institutions.

The **fourth category** includes banks with assets between $10 and $50bn. Although the number of observations is comparable to the small banks (0.8%), the share in total assets amounts 12.2%. The composition of the assets is comparable to that of the third size category while the liability is less reliant on customer deposit. Indeed, with this size category, the decreasing reliance on customer deposits and the increasing reliance on debt liabilities continue. But the debt liabilities of 12.54% are not significantly different from those for small banks. This fourth category of banks is referred to as **"mid-sized".**

The **fifth category** includes banks with more than $50 billion of assets (with an average size of $250bn). They are the smallest in number, but control the majority of the assets. These banks represent only 0.4% in number but 65.3% in total assets. They are significantly less active in traditional deposit-loan intermediation, with customer loans (48.4%) and deposits (51.33%) being well below the sample average, while are heavily involved in market-based activities. Moreover, they tend to have lower capital ratios than smaller banks. This fifth category is referred to as **"large"** banks.

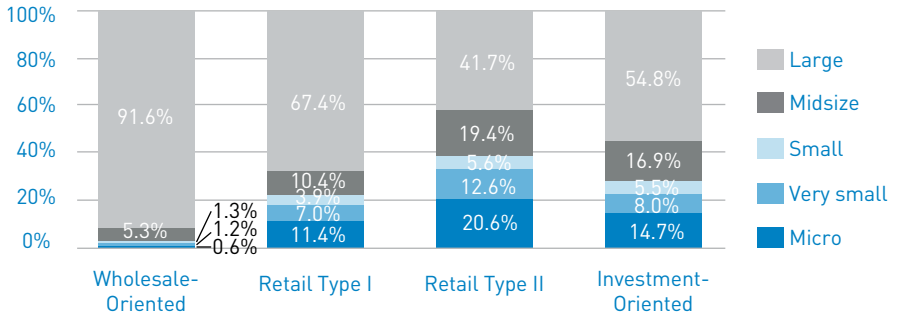
TABLE 3.3 – Size attributes of bank business models (% of observations)

	Model 1 - Whole-sale-oriented	Model 2 – Retail (Type I)	Model 3 – Retail (Type II)	Model 4 – Investment-oriented	ALL
Micro (<1bn)	86.5%***	89.8%*	88.3%*	91.5%*	89.3%
Very small (1-5bn)	5.6%**	7.3%***	8.2%**	5.6%***	7.3%
Small (5-10bn)	3.5%***	1.4%*	1.7%*	1.4%*	1.6%
Mid (10-50bn)	2.6%***	1.2%***	1.4%***	1.2%***	1.3%
Large (>50bn)	1.8%***	0.3%*	0.4%*	0.3%*	0.4%

Notes: All figures are the average values for the year-end observations for the relevant business model. The independence of cluster sub-samples was tested using the Wilcoxon-Mann-Whitney non-parametric two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (*, **, or ***) stands for the statistical difference of any given cluster from that number of other clusters in the size category. For example, two asterisks (**) imply that the cluster is statistically different from two other clusters but not the third and fourth (closest) ones.
Source: Authors

Turning to the distribution of the various size categories across business models in terms of number of observations, Table 3.3 shows that the large majority of institutions are micro banks (between 86.5% and 91.5% across business models). As for the remaining categories, the very small institutions are relatively more represented in the retail type 1 and type 2 business models while small, mid-sized and large banks are relatively more represented in the wholesale-oriented business model.

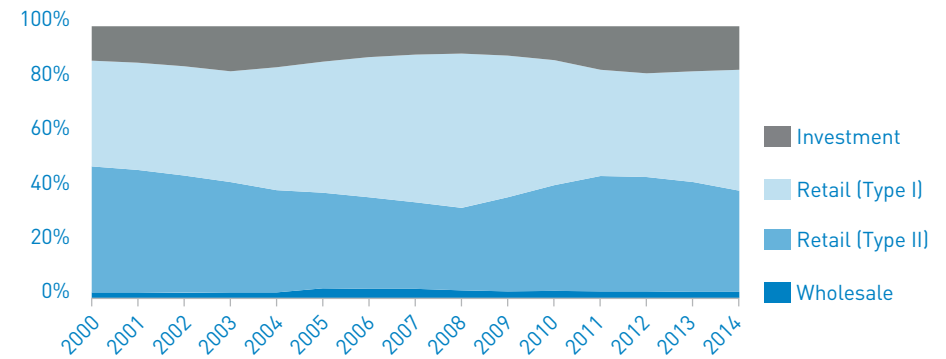
FIGURE 3.3 – Distribution of sizes across bank business models (% of assets)



Source: Authors

The distribution of assets per size and business model provides a different picture. Figure 3.3 illustrates that large banks are dominant across all business models, in particular under the wholesale-oriented (91.6%), retail (type 1) (67.4%) and investment-oriented (54.8%) business models), while the share of large banks among the retail (type 2) business model is relatively lower (41.7%). The micro banks using the wholesale-oriented model are not sufficiently numerous to account for a significant share (0.6%). To the contrary, those falling under the retail (type 2) account for the largest asset share of micro-banks in any business model (20.6%).

FIGURE 3.4 – Bank business models over time (2000-14, % of institutions)



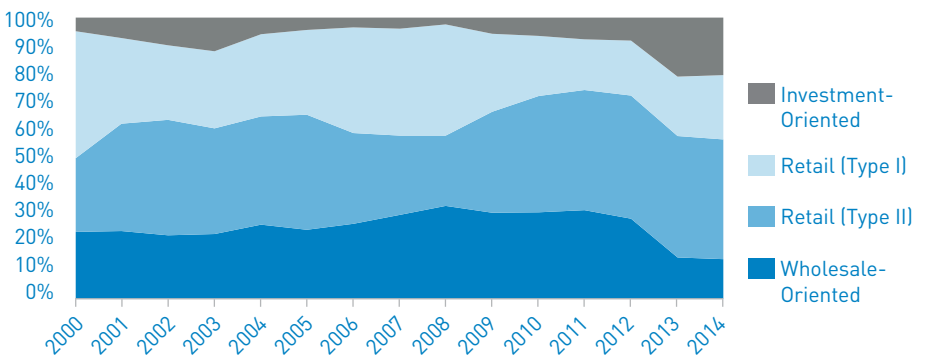
Note: The figure gives the share of banks that belong to a specific model for a given year.
Source: Authors

Although the distribution of banks across different models remains relatively steady over time, evolutions are worth highlighting. Figure 3.4 shows that in the early 2000s the share of investment-oriented banks increased about a third from 12.6% in 2000 to 16.6% in 2003, while the share of retail (type 1) decreased from 46.3% to 40.6% during the same period. Afterwards, in the period up to the 2007-2009 Global Financial Crisis (GFC), the share of retail (type 1) decreased further and the growth of the investment-oriented bank segment reverted, bottoming out in 2008. In turn, the share of retail (type 2) banks increased by more than a third during the same period, from 40.7% in 2003 to 56.7% in 2008. In the aftermath of the GFC, the share of retail (type 1) banks increased two-fifths to around 42.5% in 2011/12 and investment-oriented banks by almost three-quarters from 10.1% in 2008 to 17.3% in 2012, while the share of retail (type 2) banks decreased by a third to 38.1% in 2012. In the most recent years sampled, the trend reversed and the investment-oriented and retail (type 1) declined again, and the share of retail (type 2) increased slightly. Over the whole period, the share of wholesale-oriented banks fluctuates between 1.93% and 3.34% and appears to be marginal.

However, the breakdown by total assets (Figure 3.5) shows that the share of that business model varies between 20% and 30% from 2000 through 2013, before falling into the range 14-15% in 2013 and 2014. During the same two (2) years, the share of investment-oriented banks has fallen into the range 20-21%. Prior to that, they accounted for lower total assets shares of between 2.39% and 11.87%. Together, the two retail bank business models have accounted for 60.61 to 71.35% of the total assets (in 2011 and 2000 respectively). From 2006 to 2008, the retail type II bank business model is the largest in total assets. Since 2009, it has been overtaken by the retail type I bank business model, the assets share of which has exceeded 40% over the last five years.

The foregoing conclusions should be discounted if the sample is not close to full coverage in every year. Our bank sample does not have such a limitation.

FIGURE 3.5 – Bank business models over time (2000-14, % of bank assets)



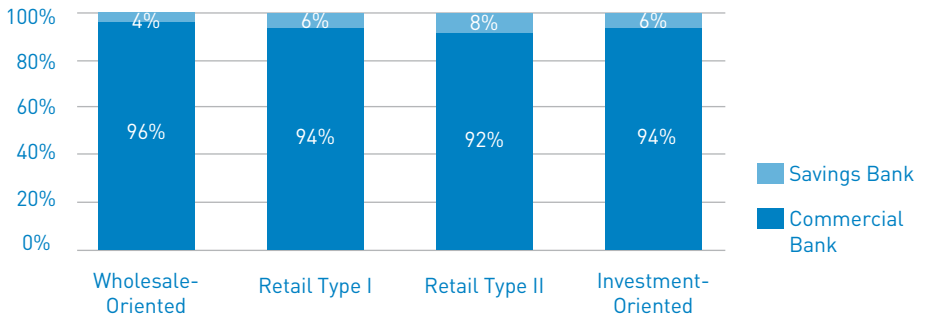
3.1.3 Interaction with charter types

Another dimension is to look at banks through their charter types. Figure 3.6 shows an overwhelming representation of commercial banks in the sample, which are distributed across all business models with similar percentages. Savings institutions represent less than 10% in terms of the number of observations and these are distributed under all business models. The shares of savings institutions vary between 4% among the wholesale-oriented banks to 8% for retail (type 2) banks. This does not come as a surprise, since savings institutions are considered to engage predominantly in traditional deposit-loan intermediation.

TABLE 3.4 – Charter type and public listings in the bank sample (% of observations)

CHARTER AND PUBLIC LISTING	Completeness (%)	Mean (%)	Std. dev. (%)
Commercial (dummy variable)	100	93.1	25.4
Savings (dummy variable)	100	6.90	25.4
Listed (dummy variable)	100	21.1	40.8

FIGURE 3.6 – Charter types across bank business models (2000-14, % of institutions)



Source: Authors

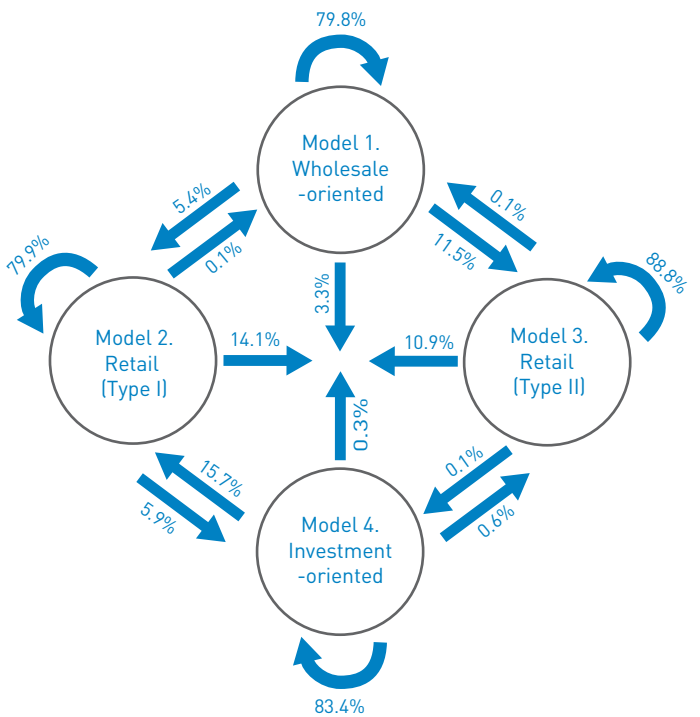
3.1.4 Migration

Business models can change over time when internal and external pull and push factors interact, leading to a change in the original bank business model. The key factors are: i) market forces and competitive pressures (e.g. mergers and acquisitions); ii) regulatory and government led decisions (i.e. increase of capital, changes in monetary policy, resolution planning, others); iii) other non-obvious reasons (i.e. political or other excessive risk taking activities) which could be essential to understanding the behaviour of banks.

Moving from one business model to another, named "migration" in Ayadi et al. (2016), can "*provide a wealth of information to market participants, regulators, creditors and depositors about the strategy of banks and their behaviour in the markets where they are active and about their risk profiles and, over time, their contribution to systemic risk*".

Looking more closely at the migrations between bank business models, Figure 3.7 provides the transition matrix for the four models during the years 2000 to 2014. The assignment of banks to the focused retail (type 2) model shows the highest persistence; 88.8% of the banks remained the same from one year to the next. The vast majority of the retail (type 1), wholesale-oriented and investment-oriented banks remained within the same model throughout the sampled years (79.9%, 79.8% and 83.4% respectively). The notable migrations were primarily to retail (type 1), with flows of 15.7% from investment-oriented, 10.9% from retail (type 2) and 5.4% from wholesale-oriented banks. The other large migration flows are to retail (type 2) banks, with 14.1% migrating from retail (type 1) and 11.5% of wholesale-oriented banks. Many wholesale-oriented banks further migrated to investment-oriented banks (5.4%) and an almost similar proportion (5.9%) of retail (type 1) banks migrated to investment-oriented banks.

FIGURE 3.7 – Model transition matrix, share of banks (2000-14)



Note: The amounts in percentages give the share of banks that belong to a specific model in one period switching to another model (or remaining assigned to the same model) in the next period.
Source: Authors

The exploration presented above has highlighted some important features of the banking sector in the US over the period 2000-2014.

First, the polar cases of small, community banks heavily oriented towards relationship banking and large banks more akin to transaction banking operations while maintaining a large retail network. A striking observation is that there is a positive relationship between the sizes of the banks and their leverage. As far as business models are concerned, large banks have been overwhelmingly assigned to the wholesale-oriented model by our data-driven, behavioral approach to the elicitation of the activity-funding patterns of banks. The three other business models elicited by the method, the two retail-oriented business models and the investment-oriented business model, are embraced primarily by small and mid-size banks.

Roughly, at least 80% of the population of each business model has kept their activity-funding pattern over the decade and half under study: the incidence of migrations among business models ranges from 11 to 20%.

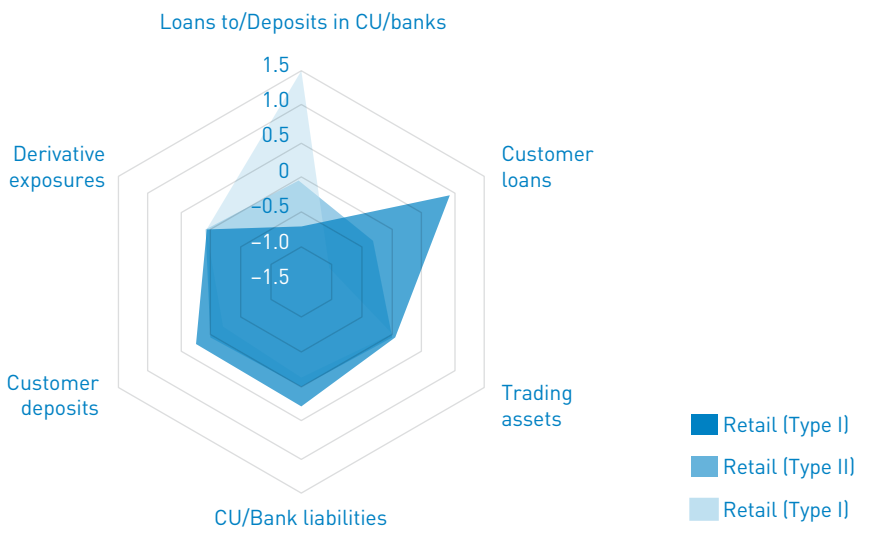
In the next section, a similar exploration is undertaken for credit unions.

3.2 Business Models of credit unions: identification, interaction with size and migration

3.2.1 Identification

First, Table 3.5 gives the descriptive statistics of the three models resulting from the cluster analysis on the credit unions sample for the US over 2000-2014, based on the six instruments used to define them. Second, a brief overview of the main structural and financial attributes of the credit union business models is provided.

FIGURE 3.8 – Identification of credit union clusters, standardized scores



Notes: The figures are the number of standard deviations from the sample mean.
Source: Authors

Our cluster analysis of credit unions resulted in three distinct Models:

Model 1 is composed of credit unions that are focused on traditional deposit-loan intermediation. In particular, customer loans account on average for 71.35% of total assets, surpassing the sample average of 60.30%. On the liability side, these credit unions are largely funded via customer deposits. Their exposures to other credit unions are quite limited with 1.96% on average, compared to the sample average of 7.20%. The Model 1 credit unions are less capitalized than the other categories, with an average tangible common equity to assets ratio of 10.24%, compared to a sample average of 10.80%. In the remainder of this study, model 1 — credit unions are referred to as **"retail type I" business model**.

The retail type I credit unions form the largest group of credit unions. They represent respectively 58% of the total assets and 41% of the number of institutions. Their average size is well above the sample average with $122 million, compared to the $86 million in total assets for the sample average (See also appendix II).

Models 2 and **3** have relatively more diversity in their activities than Model 1. Though there are some differences.

Model 2 institutions are, on average, more active in conventional deposit-loan intermediation. In particular, customer loans account for 46.22% while loans to/deposits in credit unions and banks represent an average 7.63% of the total balance sheet. These credit unions are relatively more capitalized (with 11.30% net worth ratio[24]) than Model 1 credit unions. Model 2 is referred to as "retail type II" in the remainder of this study.

Model 2 represents the second largest group in terms of both number of institutions and total assets, with 36% of the total observations and a similar share of the total assets. With $89 million in total assets, the average size of Model 2 credit unions is close to the sample average of $86 million.

Model 3 primarily includes credit unions that are depositing or lending a larger share of their funds in/to other credit institutions. Indeed, on average, "interbank" deposit/lending activity represents nearly half of their balance sheet; customer loans account for only 36.90% on average. These credit unions are substantially less leveraged than their peers, with the highest net worth ratio of 13.77% among the three models. Model 3 is referred to as "retail type III" in the remainder of this study.

Model 3 is the smallest group of credit unions. This group only represent 23% of the observations and 5% of the total assets. The average assets of these credit unions are $18 million.

24. For credit unions, the net worth ratio is the closest concept to the leverage ratio for banks.

TABLE 3.5 – Descriptive statistics for credit union business models, weighted

		Loans and deposits to/ in credit unions and banks (% assets)	**Customer loans (% assets)**	**Trading assets (% assets)**	**Bank liabilities (% assets)**	**Customer deposits (% assets)**	**Derivative exposures (% assets)**	Net worth (% assets)	Cash (% assets)
Model 1 - Retail type I	Median	1.63%	70.59%	0.00%	0.00%	87.74%	0.00%	9.89%	6.40%
	Mean	3.91%**	71.35%**	0.12%**	1.96%**	86.83%*	0.02%*	10.24%**	7.57%**
	St. dev.	5.11%	8.64%	1.28%	3.11%	3.89%	0.52%	2.46%	5.05%
	P1.	0.00%	56.45%	0.00%	0.00%	76.33%	0.00%	6.44%	0.98%
	P99.	21.35%	89.36%	2.79%	10.96%	92.79%	0.00%	18.87%	24.55%
	Obs.	47,574	47,574	47,574	47,574	47,574	47,574	47,574	47,574
Model 2 - Retail type II	Median	2.04%	47.90%	0.00%	0.00%	87.46%	0.00%	10.78%	7.20%
	Mean	7.63%**	46.22%**	0.03%**	0.92%**	86.89%*	0.01%*	11.31%**	10.09%**
	St. dev.	9.89%	10.17%	0.65%	2.06%	3.64%	0.39%	3.08%	9.22%
	P1.	0.00%	16.62%	0.00%	0.00%	75.28%	0.00%	6.98%	0.48%
	P99.	33.97%	63.20%	0.10%	9.65%	92.38%	0.00%	22.65%	42.44%
	Obs.	41,655	41,655	41,655	41,655	41,655	41,655	41,655	41,610
Model 3 - Retail type III	Median	43.29%	37.92%	0.00%	0.00%	86.47%	0.00%	12.86%	7.13%
	Mean	45.13%**	36.9%**	0%**	0.19%**	85.53%**	0%**	13.77%**	8.61%**
	St. dev.	10.11%	10.13%	0.22%	0.94%	4.90%	0.00%	4.83%	6.53%
	P1.	27.81%	11.31%	0.00%	0.00%	69.88%	0.00%	6.78%	0.39%
	P99.	71.66%	54.71%	0.00%	4.65%	92.75%	0.00%	29.21%	31.80%
	Obs.	26,359	26,359	26,359	26,359	26,359	26,359	26,359	26,359
All Credit Unions	Median	2.11%	61.68%	0.00%	0.00%	87.60%	0.00%	10.25%	6.71%
	Mean	7.2%	60.3%	0.1%	1.5%	86.8%	0.02%	10.8%	8.6%
	St. dev.	11.42%	16.05%	1.05%	2.75%	3.86%	0.46%	2.97%	7.08%
	P1.	0.00%	20.16%	0.00%	0.00%	75.79%	0.00%	6.57%	0.70%
	P99.	53.12%	88.96%	1.26%	10.69%	92.62%	0.00%	22.01%	39.79%
	Obs.	115,588	115,588	115,588	115,588	115,588	115,588	115,588	115,588

Notes: The independence of clusters (a.k.a. business models) was tested using Welch's two-sample tests at 5% significance. To report the results of these tests, one asterisks (*) implies that the cluster is statistically different from one other cluster but not the third (closest) one. Two asterisks (**) mean that the cluster is statistically different from the other two clusters. Variables in **bold** highlight the instruments used in forming the clusters. P1 and P99 are the 1st and 99th percentiles.

Source: Authors

3.2.2 Interaction with size

Credit unions are, in general, substantially smaller than banks. Indeed, the size of an average credit union is about $86 million, 17 times smaller than an average US community bank. Thus, there are also very few credit unions that pass the threshold of $10bn. In fact, only five credit unions hold $10 billion or more total assets, of which only the Navy Federal Credit Union could be considered large[25] and of systemic importance. For the evaluation of credit unions across sizes, therefore, lower thresholds based on the NCUA`s chart pack are used (i.e. less than $10m, between $10m and $100m, between $100m and $500m and more than $500m).

TABLE 3.6 – Size attributes of credit union business models (% of institutions)

	Retail type I	Retail type II	Retail type III	ALL
Less than $10m	38.7%**	42.5%**	56.5%**	44.1%
Between $10m and $100m	40.1%**	42.9%*	41.7%*	41.5%
Between $100m and $500m	16.0%**	11.1%**	1.7%**	11.0%
More than $500m	5.1%**	3.5%**	0.1%**	3.4%

Notes: All figures are the average values for the year-end observations for the business model. The independence of cluster sub-samples (a.k.a. business models) in each size category was tested using the Wilcoxon-Mann-Whitney non-parametric two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (* or **) stands for the statistical difference of any given business model from that number of other business models. For example, two asterisks (**) imply that the business model is statistically different from two other business models.
Source: Authors

Table 3.6 shows that most credit unions are, indeed, very small. The large majority of credit unions have assets either less than $10m (44.1%) or between $10m and $100m (41.5%). Compared to Table 3.3, where the thresholds are a hundred times higher, the breakdown shows a relatively less polarized industry. This remark is also confirmed by the coefficients of variations on the two samples of banks and credit unions. Over the period, this normalized measure of standard deviation is about three to four times as high for banks as for credit unions.[26]

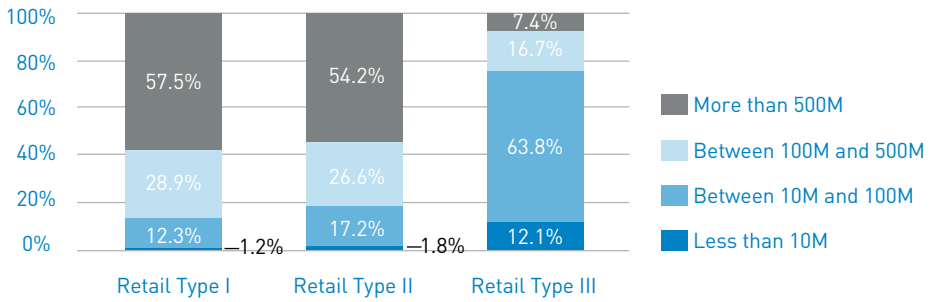
Looking at the size distribution across business models, the retail type I business model includes relatively more large credit unions (i.e. between $100m and $500m as well as more than $500m). In turn, the distribution of the retail type II is close to the sample average and the retail type III are relatively smaller. Hence, the retail type III have a relatively large number of credit unions with less than $10m total assets.

25. In 2014, the following credit unions had more than $10bn in total assets: Navy Federal Credit Union ($60.5bn); State Employees' Credit Union ($28.6bn); Pentagon Federal Credit Union ($18.3bn); Boeing Employees Credit Union ($12.5bn), and Schools First Federal Credit Union ($10.4bn). Although the Navy Federal Credit Union meet the condition of $50 billion or more in total assets, to be a designated systemically important financial institution under the Dodd-Frank Act, the Financial Stability Oversight Council has so far refrained from making that move.

26. For concrete evidence, in 2008, the coefficients of variation of banks and credit unions are respectively (in $ million) 13.49 and 4.82. In 2014, these measures are 17.8 and 4.08.

The difference in distribution of institutions across size categories is reflected in the assets share, presented in Figure 3.9. The largest credit unions, with more than $500m total assets, hold the majority of the assets among the retail type I and retail type II. The credit unions with less than $100m total assets that account for most observations hold respectively only 13.5% and 19.0% of the retail type I and retail type II total assets. The smaller credit unions are only dominant among the retail type III model, in which the smallest credit unions with less than $10m assets hold 12.1% and the credit unions with between $10m and $100m total assets hold the large majority with 63.8%.

FIGURE 3.9 – Distribution of size across credit union business models (% of assets)

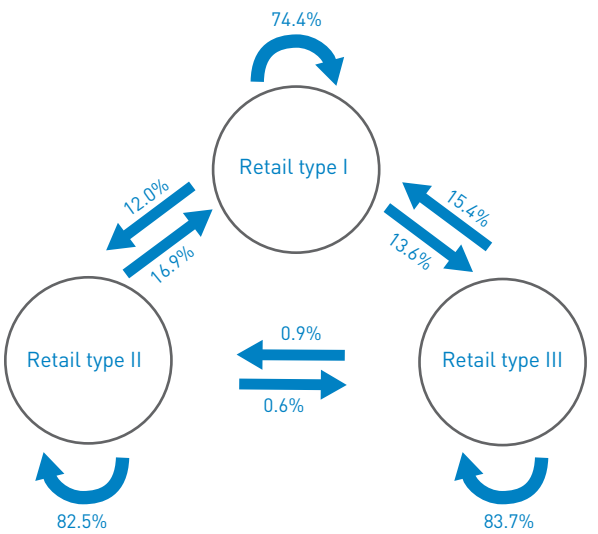


Notes: The figure shows the cumulative share in total assets of the different size categories for the entire sample period from 2000 to 2014.
Source: Authors

3.2.3 Migration across business models

Although the composition of the different models remains relatively steady over time, transitions do occur - and more in some models than in others. Figure 3.10 provides the transition matrix for the three models over the period from 2000 to 2014. The assignment of credit unions to the retail type III and retail type I model shows the highest persistence; respectively 83.7% and 82.5% of the credit unions of these groups remained the same from one year to the next. The retail type II credit unions showed a lower persistence with only 74.4% of the institutions remaining within the same model. The migration was primarily between retail type I and retail type II and retail type II and retail type III, with flows ranging between 12.0% and 16.9%. The migration between retail type I and retail type III was substantially less with just 0.6% and 0.9% to and from retail type III.

FIGURE 3.10 – Model transition matrix, share of credit unions (2000-14)



Note: The figures give the share of credit unions that belong to a specific model in one period switching to another model (or remaining assigned to the same model) in the next period.
Source: Authors

To summarize, in contrast to the banking industry where sizes are usually in billions, sizes of credit unions are usually in the order of a few millions or tens of millions. Similarly to the banking industry, the largest credit unions (more than $500 million total assets size) are a small minority in terms of the number of institutions but they control the largest share of the assets within the industry. But overall, the credit union industry in the United States is less polarized with respect to the size ranges of its institutions.

Our behavioral approach to clustering has revealed three business models in the data, all of retail type. The retail type I business model is more involved in the traditional deposit loan intermediation. The other two retail business models (type II and type III) are also heavily deposit-funded, but with more diversification in their activities and investments. The largest credit unions control more than half of the assets of the retail type I and retail type II business models. The retail type III credit union business model is a residual cluster (3% of the assets of the industry) featuring small credit unions with excess liquidity.

In the next three chapters, comprehensive analyses of the US banking and credit union industries are carried out, covering their financial performance, contribution to the real economy, risk and response to regulation.

4 Bank and Credit Union Financial Performance and Contributions to the Real Economy

This phase of the analysis provides an overview of bank and credit union financial performance and contributions to the real economy across business models and bank size categories. Table 4.1 provides the comparative performances across business models and bank size categories.

Retail type 1 banks reported both the highest return on assets (ROA) and return on equity (ROE) of all the bank business models. More precisely, ROAs for the two retail business models are the highest, almost equal, and statistically distinct from those for the other business models. Wholesale-oriented banks posted the lowest ROA but the second highest ROE of all the bank business models, but the latter ranking could not be confirmed statistically. ROAs for the other business models are all close to the sample mean, whereas ROEs are more distinct. Across bank size categories, the mid-sized banks dominate their peers both with respect to ROA and ROE. Similarly, micro banks were the least active according to both return-measures. In between, the results for the very small and large banks are, for both ROA and ROE, relatively close to one another. Among credit unions, retail type I institutions have the highest ROE, followed respectively by retail type II and retail type III. The ROAs of retail type I and retail type II are the two highest and are not statistically different.

Wholesale-oriented and investment-oriented banks are the least efficient business models, reporting significantly higher cost-to-income ratios. The two retail business models are the most efficient. The mean efficiency scores for all the other business models are relatively close to the mean for all banks. The differences across size categories are equally large, with the micro banks appearing to be the least efficient and the small and mid-sized banks operating significantly more efficiently. Large banks operate at an efficiency level close to that of the sample average. The differences between the credit union business models are significant. With the highest efficiency scores, retail type III credit unions are by far the least efficient and the retail type I the most efficient.

Turning to growth of customer loans, the retail (type 2) banks reported the highest loan growth, followed by the retail type 1 banks. Their respective loan growth is significantly higher than those of all other business models. The wholesale-oriented banks reported the lowest, negative loan growth, which is not significantly different from the loan growth of investment-oriented banks, also negative. The differences between sizes of category are similarly pronounced, with micro, very small and large banks reporting an overall loan growth significantly higher than those of mid-sized and small banks. These latter size categories reported the highest loan growth over the period. Among the credit union business models there is a significantly large difference in the weighted average loan growth. While retail type I credit unions reported substantial increases in their customer loans, the loan book of retail type II credit unions has moderately expanded and the increase loans provided by retail type III credit unions is rather weak.

TABLE 4.1 – Performance, income and contribution to real economy indicators

a) Bank business models

	Model 1 – Wholesale-oriented	Model 2 – Retail (type 1)	Model 3 – Retail (type 2)	Model 4 – Investment-oriented	All
Return on assets (ROA)	1.15%**	1.35%**	1.35%**	1.2%**	1.28%
Return on equity (ROE)	12.40%	12.5%**	12.05%*	12.07%*	12.31%
Cost-to-income (CIR)	63.28%**	61.04%***	59.53%***	62.54%**	61.26%
Net interest (as % of total income)	48.83%***	62.79%***	67.31%***	60.61%***	60.39%
Commission & fees (as % of total income)	34.33%***	21.61%***	18.35%***	23.65%***	24.07%
Trading (as % of total income)	0.34%*	0.57%**	0.19%**	0.74%***	0.40%
Customer loan growth	-0.38%**	2.81%***	8.93%***	-0.13%**	4.42%

b) Bank size categories

	Micro (<$1bn)	Very small (1-$5bn)	Small (5-$10bn)	Mid ($10-$50bn)	Large (>$50bn)	All
Return on assets (ROA)	1.1%***	1.32%**	1.5%**	1.75%***	1.21%**	1.28%
Return on equity (ROE)	10.36%****	12.01%**	13.29%**	15.94%****	11.91%**	12.31%
Cost-to-income (CIR)	68.58%****	62.44%***	57.89%***	56.24%***	61.17%***	61.26%
Net interest	74.8%****	67.54%***	67.42%***	58.73%***	56.87%***	60.39%
Commission & fees	17.03%****	21.38%***	19.63%***	23.66%***	26.03%***	24.07%
Trading	0.34%	0.18%	-0.20%	0.28%	0.51%	0.40%
Customer loan growth	4.38%**	3.81%**	12.32%****	9.03%****	3.62%**	4.42%

c) Credit Union business models

	Retail type I	Retail type II	Retail type III	All
Return on assets (ROA)	0.7%*	0.68%*	0.4%**	0.68%
Return on equity (ROE)	6.54%**	5.8%**	2.78%**	6.02%
Cost-to-income (CIR)	73.1%**	74.22%**	81.84%**	73.80%
Net interest	52.78%**	55.94%**	61.51%**	54.15%

	Retail type I	Retail type II	Retail type III	All
Commission & fees	13.89%**	13.48%**	11.62%**	13.67%
Trading	0.02%**	0%*	0%*	0.00
Customer loan growth	7.89%**	4.03%**	1.45%**	6.48%

Notes: All figures are weighted averages for the year-end observations for the business models/size categories. The independence of clusters was tested using Welch two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (*, **, *** or ****) stands for the statistical difference of any given business model/size category from that number of other business models/size categories for that indicator. For example, two asterisks (**) in sub-table b imply that the size categoriy is statistically different from the two (furthest) size categories but not the third and fourth (closest) ones.
Source: Authors

The average performances of the business models and bank size categories over the decade and half under review are not informative on the evolution over the sample period. This is particularly interesting during the period when the financial markets and economy have been rather volatile, as was clearly the case with, among others, the 2007-09 Global Financial Crisis.

Figure 4.1 and Figure 4.2 show ROAs and ROEs for US banks for the period from 2000 to 2014. When the time span of the profit indicators is considered, the period under review can be divided into three sub-periods: the pre-crisis period, crisis (from 2007 to 2009) and the post-crisis period. In addition, one should be mindful that the US economy experienced another economic downturn from the middle of 2000 to the middle of 2002, amplified by the attacks on the World Trade Center on September 11th 2001.

Prior to the 2007-09 crisis, US banks were posting ROA and ROE that ranged, on average, between 1.3% and 2.1% per annum. This bullish trend was particularly present amongst retail (type 2) banks that consistently quoted the highest ROA, except for 2001. In turn, during the crisis years, the retail (type 2) banks suffered the most. Starting in 2007 profits decreased across all business models. In 2008 and 2009 the lowest profits were reported, with retail (type 2) banks actually having negative returns of -0.01% and -0.5% respectively. All other business models managed to remain profitable, on average, although they were all close to break-even in 2008. Investment-oriented banks appeared to have recovered most from the crisis, with relatively high returns in 2009 and 2010. Over the whole fifteen-year period, this group also had the least variance in returns. In contrast, retail (type 2) banks exhibited the highest variance in average returns. They, however, posted the highest returns in the last four years of the sample-period (from 2011 to 2014). Like the other business models, the retail (type 2) banks have recovered to levels only slightly below their pre-crisis returns. Expressed in terms of equity the returns are, however, substantially lower than before the crisis. The difference between the post-crisis ROA and ROE is due to deleveraging. In response to the crisis, regulators and markets required banks to hold higher capital levels, i.e. higher capital ratios (capital per total assets) or lower leverage ratios (total assets over capital).

Turning to bank size categories, in the early 2000s, small banks recorded the highest returns. In the remainder of the pre-crisis years, very small and mid-sized banks reported

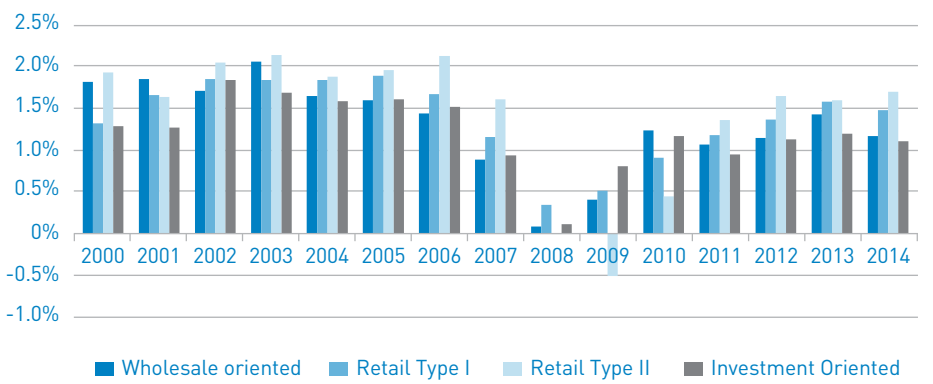
the highest profits. Micro and large banks posted the lowest returns during this period. During the 2007-2009 crisis, the picture became more dispersed. The returns for all bank size categories were fairly similar in 2007, with only very small banks reporting profits in the range of pre-crisis returns. In 2008, micro and mid-sized banks reported the highest returns, while small banks reported a loss. In 2009, the mid-sized banks remained most profitable, while micro banks, on average, posted a small loss. The largest losses were, however, posted by very small banks. In the post-crisis period, mid-sized banks had the highest profits in most years, although small and large banks also recorded high profits in certain years. In turn, the micro and very small banks had the lowest profitability in the aftermath of the crisis.

The 2007-2009 financial crisis has significantly deteriorated performance across all credit union business models. In the run-up to the financial crisis, the differences between the business models were relatively limited, with retail type III credit unions lagging behind, in particular when ROE is used to measure performance. During the crisis, retail type I credit unions were the only business model reporting a loss. In the aftermath of the crisis, earnings at credit unions more or less returned to pre-crisis levels, except for retail type III. The latter reported returns close to break-even from 2004 to 2014.

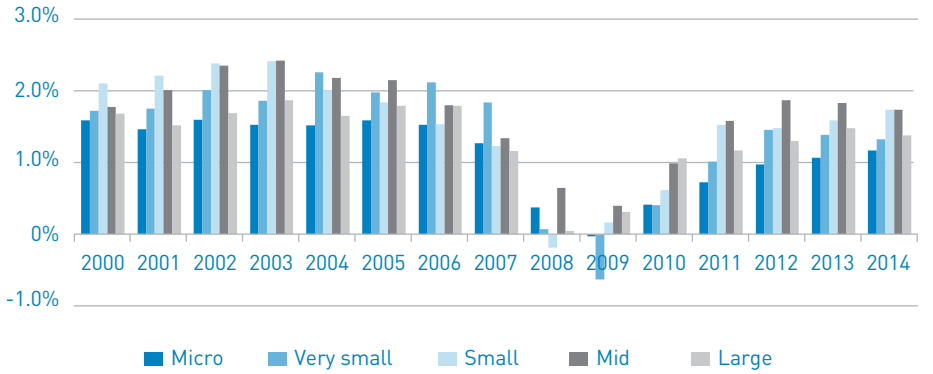
There is a striking difference between the magnitude of returns on assets of credit unions compared to the same metric for banks. Credit union ROAs in 4.1 c) look way lower than bank ROAs but would not look so low compared to adjusted ROAs of banks, i.e. after taking out taxes – which CUs do not need to pay – and after taking out compensation to owners (stock dividends) because the equivalent compensation is already excluded from credit union ROAs. In other words, the reported ROA of CUs is most closely equivalent not to bank ROAs, but to banks' additions to retained earnings (i.e. net income minus taxes minus dividends).

FIGURE 4.1 – Evolution of return on assets (ROA) (weighted averages)

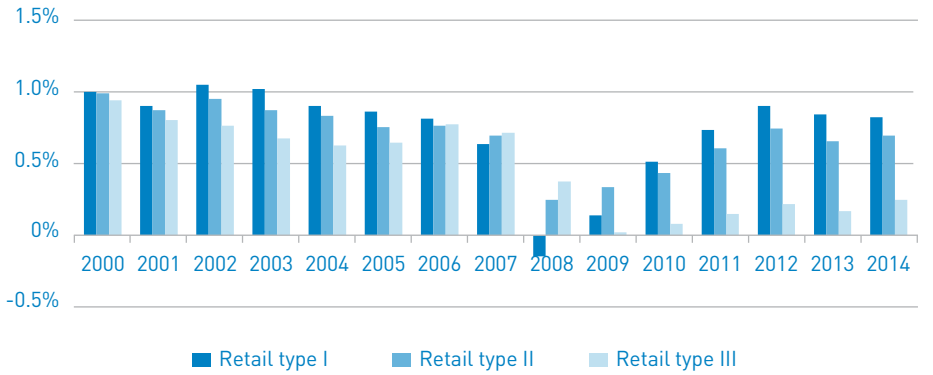
a) Bank business models



b) Bank size categories



c) Credit union business models



Notes: All figures are the weighted average values for each accounting year, by business model/size category. The weighting scheme uses individual total assets.
Source: Authors

With respect to **return on equity (ROE)**, gaps are less pronounced among bank business models. Indeed, ROEs pre- and post-crisis are comparable across all business models, with the exception of 2000 and 2010. This means that, for instance, the strong showing of retail (type 2) banks for return on assets has been mitigated both pre- and post-crisis. The results are more convergent, due to the differences in capital as share of total assets that mirror the differences in ROA. During the crisis, the directions and order of the different business models for ROE was similar to the ones for ROA.

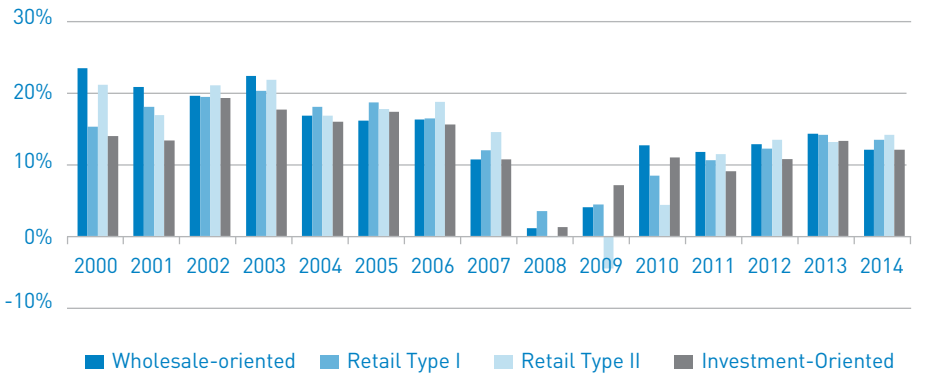
For bank size categories, the qualitative differences between ROAs and ROEs are less clear-cut. Small banks still report, also measured in ROE terms, the highest profits in the period up to 2002. The difference, however, is that in the remainder of the pre-crisis period, it was not very small and mid-sized banks, but midsize and large banks, that reported the highest ROEs. This can be explained by the relatively low leverage of very small banks and the higher leverage of large banks. The least leveraged micro banks, during the entire

sample period, reported the lowest or close to the lowest returns, with the exception of the crisis years 2008 and 2009. The mid-sized banks continued to quote the highest returns during and in the aftermath of the crisis, while very small, small and large banks reported fairly similar returns in the post-crisis period.

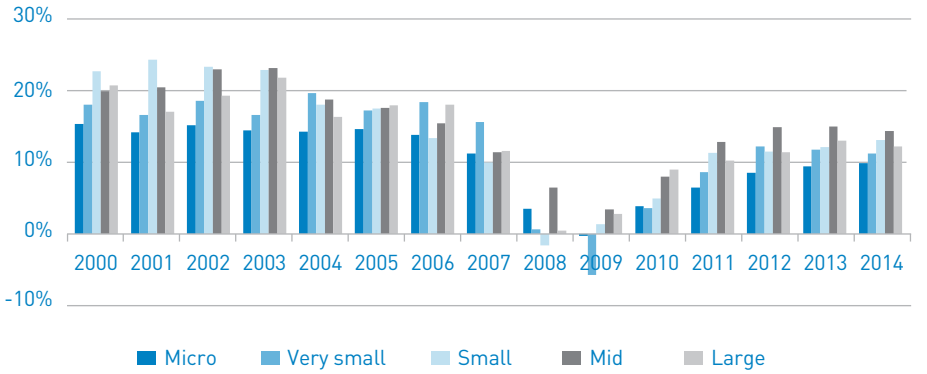
The qualitative differences between ROAs and ROEs across credit union business models are marked. Differences in capital ratios (i.e. net worth [equity] as share of total assets, see chapter 6) that determine the difference between return on assets and equity have translated into larger gaps among ROEs than there are among ROAs across credit union business models. More precisely, retail type I credit unions have a lower capital ratio than the retail type II and retail type III, which has amplified the gap among returns on equity. Since retail type I credit unions were the institutions with the highest ROAs, the relative difference between ROEs has widened compared to differences in ROAs.

FIGURE 4.2 – Evolution of return on equity (ROE) (weighted averages)

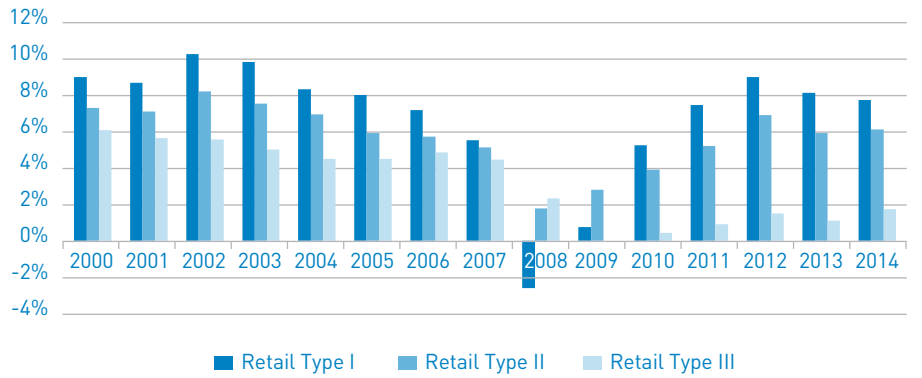
a) Bank business models



b) Bank size categories



c) Credit union business models



Notes: All figures are the weighted average values for each accounting year, by business model/bank size category. The weighting scheme uses individual total equities.
Source: Authors

Operational efficiency is measured using the **cost-income ratio (CIR)**, i.e. a higher CIR indicates that an institution is less efficient. Overall, the efficiency across all business models has deteriorated over the fifteen years under review, from 60.6% in 2000 to 63.5% in 2014. Efficiency, however, initially improved to 58.8% in 2006.

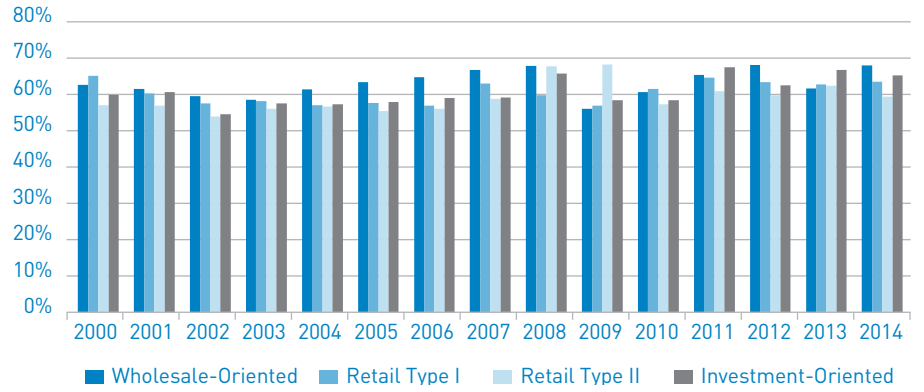
Across the bank business models, retail (type 1) banks have become considerably more efficient, while the CIR of the wholesale-oriented and investment-oriented banks deteriorated. Figure 4.3 shows that wholesale-oriented banks are generally the least efficient, but retail (type 2) banks became more inefficient during the financial crisis in 2008 and 2009, around the same time also that wholesale-oriented banks were especially inefficient. On one hand, banks have been investing substantially in IT infrastructures to enhance operational efficiency, but on the other hand they had much higher compliance costs due to new regulatory requirements. In the post-crisis period, retail (type 2) banks were the most efficient.

Since 2000, the CIR increased across all bank size categories, except for mid-size banks. Micro banks have consistently been the least efficient. Micro-banks were followed by very small and large banks that were also not particularly efficient. Efficiency scores for very small and investment-oriented banks deteriorated during the crisis and have not recovered since. Small and mid-sized banks have been relatively efficient throughout the sample period and, in particular, in the post-crisis period.

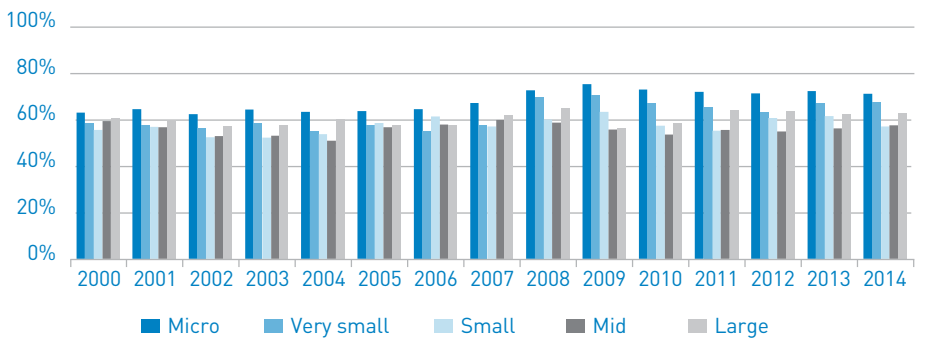
Efficiency across credit union business models has deteriorated since 2000. More specifically, efficiency scores increased in the run-up to the financial crisis across all business models. The scores were fairly similar, with retail type II credit unions slightly more efficient. After the eruption of the financial crisis, efficiency scores initially increased and then dropped substantially in 2009, except for retail type III. The efficiency scores of retail type I and retail type II credit unions increased afterwards, s similar to pre-crisis levels. In addition, after a jump in 2010, the retail type III credit union business model posted efficiency scores of about 90%, which are by far the worst across credit union business models over the period under review.

FIGURE 4.3 – Evolution of cost-income ratio (CIR) (weighted averages)

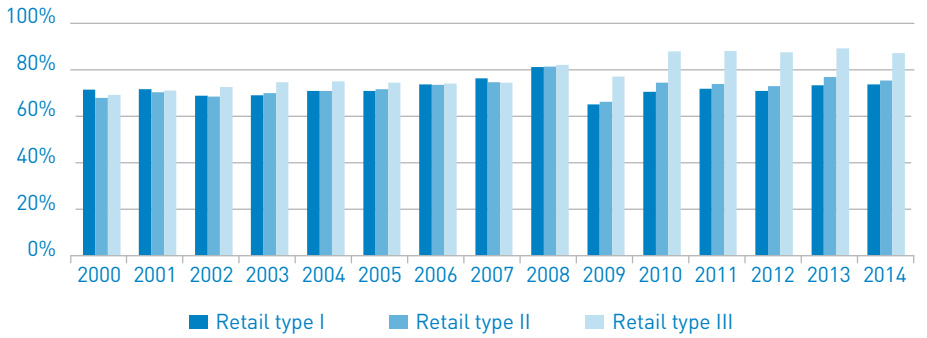
a) Bank business models



b) Bank size categories



c) Credit union business models



Notes: All figures are the weighted average values for each accounting year, by business model/bank size category. The weighting scheme uses individual total operational incomes and total gross income, respectively for banks and credit unions.

Source: Authors

Looking more closely at the **income structures**, the analysis reveals a mixed picture. Figure 4.4 shows that almost all bank business models rely mostly on net interest income. The wholesale-oriented banks are the only exception, with 48.8% net interest income and 34.3% commission and fee income as a share of total income. Commission and fees are also a sizable part of the income of the other business models, with shares ranging between 18.3% and 23.2% of their income.

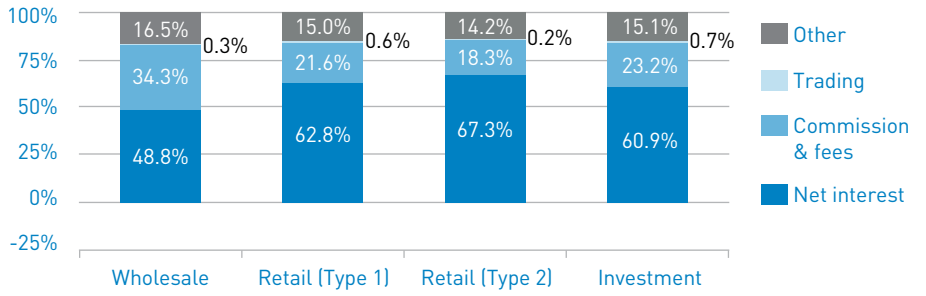
The last key income component, trading income, is only a minor contribution to total income. The contribution of trading income ranges from 0.2% for retail (type 2) to 0.7% for investment-oriented banks. Although the median trading income is zero for all business models, their distributions are significantly different from one another. Some banks have reported significant losses for some years, predominantly in 2000 and the crisis years of 2007 to 2009.

The variation in the income components across bank size categories is limited. All size categories primarily depend on net interest income for their revenues. The larger the bank, the less they, in general, rely on net interest income. Hence, the contribution of net interest income ranges from 56.9% for large banks to 74.8% for micro banks. The remainder of income is primarily obtained from commissions and fees, as well as other income. Trading income is negligible at the aggregate level. Small banks quoted a slightly negative income of -0.2% on average; for other bank size categories, the share of this source of income ranges between 0.2% and 0.5%.

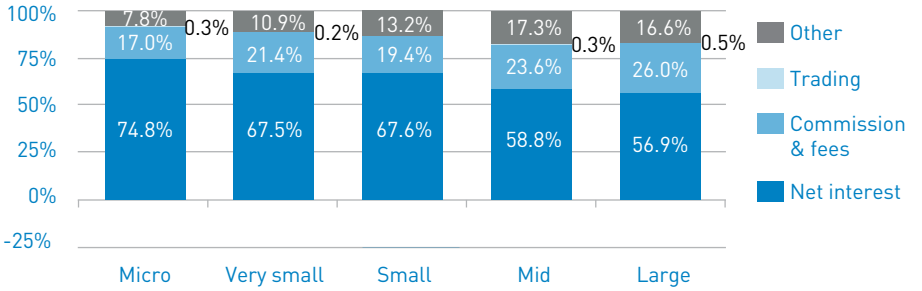
Net interest income is also the predominant income component for all three credit union business models. However, net interest income represents a larger share for retail type III credit unions than for retail type II and retail type I credit unions. The latter credit union business model has the larger share of fee income in its total income, while the retail type II has a larger share of other income sources. In addition, trading income is negligible for all three business models.

FIGURE 4.4 – Main income sources, 2000-2014 (aggregates)

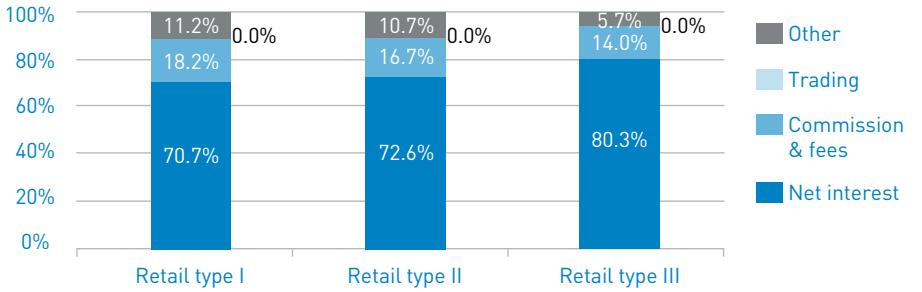
a) Bank business models



b) Bank size categories



c) Credit union business models



Note: The figures represent the aggregate proportions obtained by summing up the observations for each income item for the period from 2000 to 2014.
Source: Authors

Net interest income as share of total operating income provides an indication of the reliance on interest income. The institutions that predominantly conduct traditional loan-deposit activities are expected to rely more on net interest income.

Figure 4.5 provides an overview of the development of net interest income for both bank and credit union business models, as well as bank size categories across time. Net interest income has remained relatively stable during the pre-crisis period, ranging between 57.7% and 59.2%. During the crisis and post-crisis period, banks relied more on interest income, ranging between 2008 and 2014 from 59.7% to 63.5%.

Wholesale-oriented banks rely traditionally less on net interest income, but during the crisis the net interest income share increased significantly and remained stable thereafter. More precisely, net interest income represented only around 40% of the operating income before the crisis and, since the crisis, accounts for the majority of income (50% to 55%). The high net interest income during and after the crisis might be due to cheap funding from money market funds that transferred funds to non-interest bearing deposit accounts[27] and because the Federal Reserve followed an expansionary policy. In contrast, the other

27. See for example the annual report of the Office of the Comptroller of the Currency for 2009, p. 22.

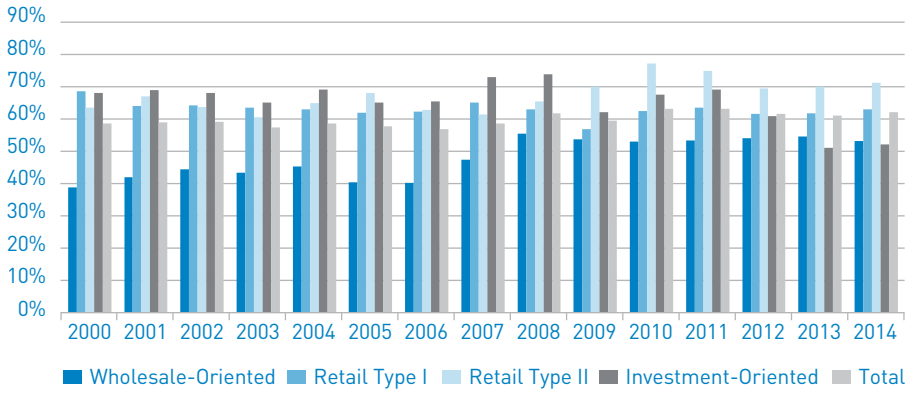
business models have depended for the entire period primarily on net interest income. Whereas the shares of net interest income have been consistently high for both types of retail banks, those of investment-oriented banks have fluctuated. In fact, investment-oriented banks relied on interest income before the crisis and, in particular, during the crisis, but net interest income as a share of total income decreased substantially after 2008 and has even dropped to the level of wholesale-oriented banks in 2013 and 2014.

Net interest income has increased across all bank size categories during the period from 2000 to 2014, except for micro banks. All bank size categories have relied for more than half of the operating income on net interest income. Pre-crisis, the smaller banks relied relatively less on net interest income than larger banks, although the difference between mid and large banks was very small. In the aftermath of the crisis, the net interest incomes of most size categories converged. In particular the difference between micro, very small and small banks is very limited since 2009. The mid and large banks still rely less on interest income, but the difference across sizes has increased. Since 2009, the mid-sized banks are substantially more dependent on interest income.

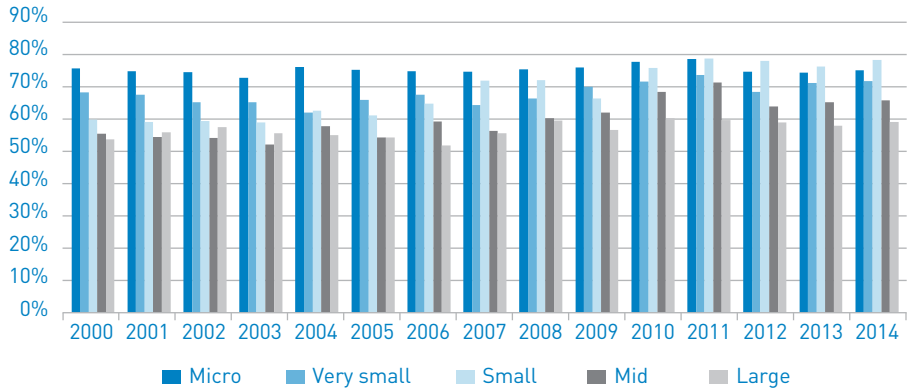
Net interest income for credit unions has been quite volatile between 2000 and 2014. Retail type III credit unions clearly had the largest share in net interest income every year. Net interest income for retail type I credit unions was, in most years, slightly below that of retail type II credit unions. All three business models followed more or less the same trend. In the early years of 2000 to 2004 the net interest income increased, but dropped in the run up to the financial crisis. During the crisis years, net interest income became more important as an income source. In the aftermath of the crisis (between 2010 and 2014) net interest income remained stable.

FIGURE 4.5 – Evolution of net interest income (weighted averages)

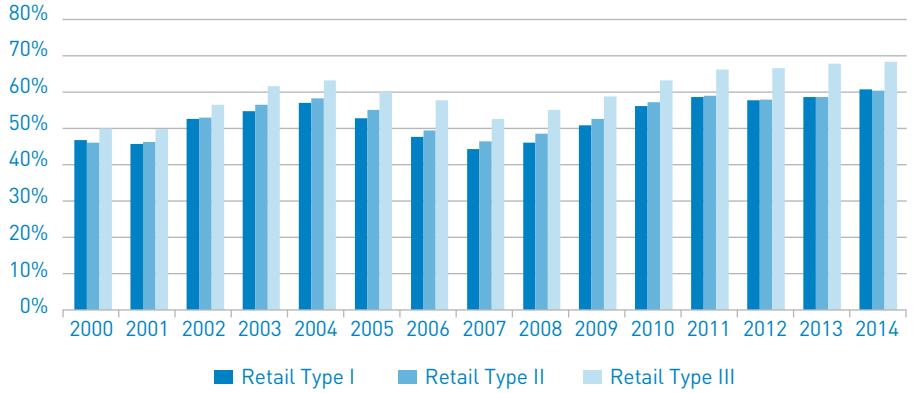
a) Bank business models



b) Bank size categories



c) Credit union business models



Note: The figures represent the average proportions obtained by dividing the net interest income by total operating income and gross income, respectively for banks and credit unions. The method is equivalent to the computation of weighted averages with data on individual ratios, using total operating income and gross income as amounts for the weights.
Source: Authors

The **trading income** (i.e. gains/losses on trading accounts) as a share of total operating income provides an indication of the reliance of institutions on market activities, i.e. the banks that conduct more market activities should also receive more trading income or incur corresponding losses. Figure 4.6 provides an overview of the evolution of trading income for both business models and bank size category from 2000 to 2014. Trading income is considerably more volatile than other income components. Whereas trading income has been negligible, on average, particularly in some years during the crisis the losses have been substantial, especially in relation to average trading income.

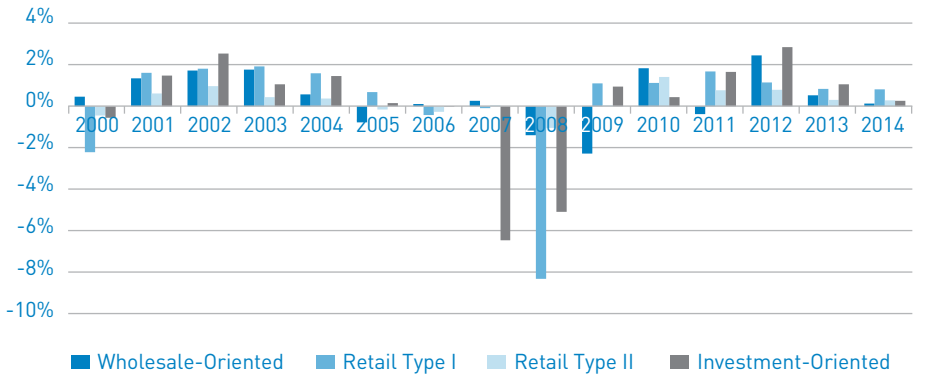
The results for bank business models are erratic. Trading income is very volatile and there are no clear distinctions for the various business models across years. All business

models, except for wholesale-oriented banks, sustained trading losses in 2000. In the years that followed, all business models recorded trading gains, with retail (type 2) banks obtaining relatively lower income from trading. Even before the eruption of the 2007-2009 financial crisis, wholesale-oriented banks incurred, on average, trading losses and other banks saw their trading income vanish. In 2007 and 2008, investment-oriented banks recorded substantial losses, while in 2008 all business models incurred trading losses. Wholesale-oriented banks incurred further losses in 2009 and 2011, but also relatively large gains in 2010 and 2012. In the 2010 to 2012 post-crisis years, trading income further returned to 2001-2004 levels, falling again to very low levels in 2013 and 2014.

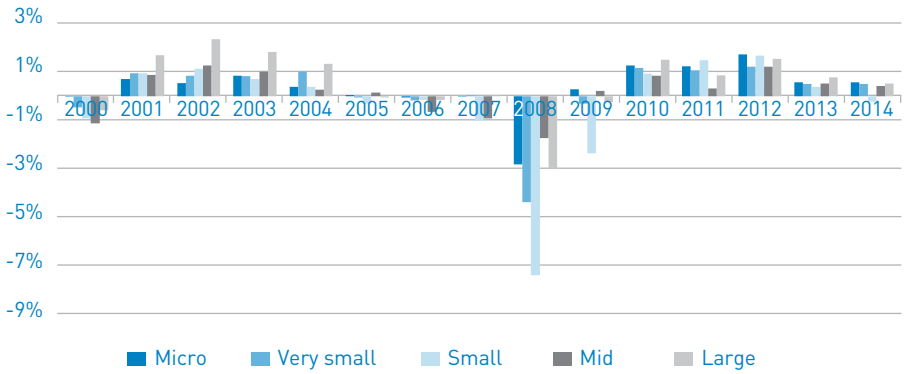
Bank size categories follow the overall same trends as the business models – with losses across all size categories in 2000, positive trading income from 2001 to 2004, slightly negative trading income in 2005 and the largest losses during the 2007-2009 financial crisis. During the post-crisis years, trading income initially recovered to then fall again to relatively low levels in 2013 and 2014. The differences between the size categories are generally relatively small. Though pre-crisis, large banks recorded the highest trading income, while very small and small banks recorded the highest trading losses during the crisis years. Concerning credit unions, their trading incomes for different credit union business models are negligible and are, thus, not plotted.

FIGURE 4.6 – Evolution of trading income (weighted averages)

a) Bank business models



b) Bank size categories



Note: The figures represent the total trading and dividend income as share of total operating income. The method is equivalent to the computation of weighted averages with data on individual ratios, using total operating incomes as amounts for the weights.
Source: Authors

Customer loan growth provides an indication of the institutions' contributions to financing of the real economy. Hence, an institution that lends more to customers and small and medium enterprises is potentially contributing more to the growth of the economy. However, these results should be treated carefully. Growth in loans is not indicative of their use or their economic return. Figure 4.7 provides an overview of the evolution of customer loan growth for both bank and credit union business models and bank size categories.

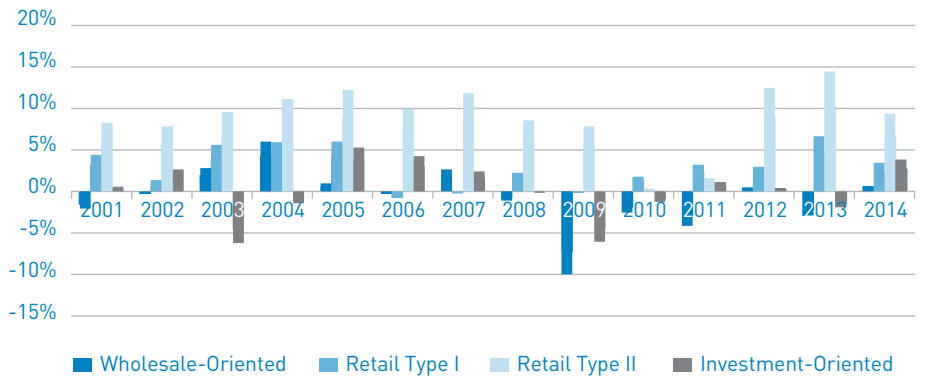
Up until 2008, annual weighted average customer loan growth has been substantial for most business models, but has slowed considerably in the period 2009-2011. In 2009, 2010 and 2013, average loan growth actually became negative for both wholesale-oriented and investment-oriented business models. On a yearly basis, the retail type 2 business model has posted the highest loan growth. The lowest levels in 2010 and 2011 of this indicator for the retail type 2 business model remain positive. Retail type 1 banks recorded considerably lower loan growth in the pre-crisis years, less contraction during the crisis years, followed by lower growth during the post-crisis years.

During the period from 2001 to 2014, most of the bank size categories, except the very small ones, followed a more or less similar trend. In 2001 and 2002, customer loans grew across all size categories, except for the category of very small banks. In the years that followed, all size categories recorded positive or even high loan grow up to 2007. From 2009 to 2011, loan growth across most sizes categories contracted. In particular, loan portfolios of very small banks turned negative in 2009 and 2011, whereas those of small banks contracted severely in 2011. From 2012 to 2014, all size categories posted positive loan growth. Since the financial crisis broke out in 2008, large banks have only experienced negative growth rates in 2009. Although weak, the customer loan growth of micro banks has been consistently positive over the fifteen year period under review.

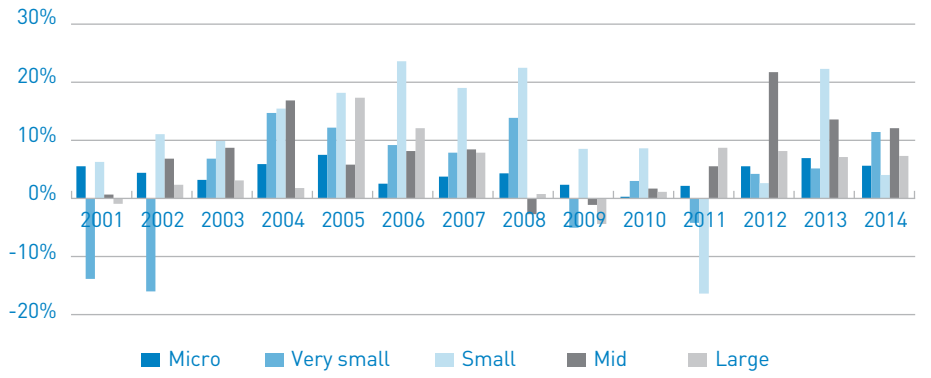
Credit union business models clearly show different loan growth rates. Indeed, loan growth for retail type I credit unions was consistently higher than for both retail type II and retail type III credit unions, except for 2000 when the retail type II reported the highest loan growth. Loan growth for retail type I credit unions was relatively high pre-crisis, while loan growth for retail type II fluctuated and was more erratic for retail type III, even indicating negative values in 2002 and 2003. During the financial crisis, average loan growth nosedived, but remained positive for retail type I. Just after the financial crisis, retail type II (in 2010) and retail type III (in 2010 and 2011) recorded declines in their loan portfolios. Afterwards, loan growth for both retail type I and retail type II credit unions gradually increased to pre-crisis levels. Post crisis, retail type III credit unions have contracted their loan books or posted very weak positive loan growth.

FIGURE 4.7 – Growth of outstanding customer loans (% change from last year)

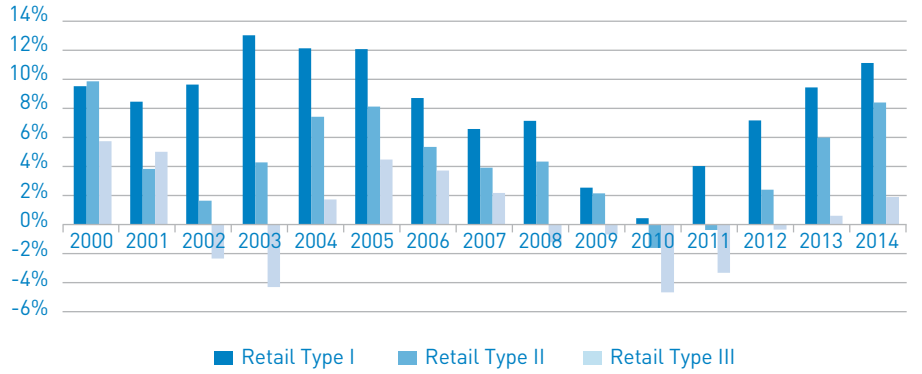
a) Bank business models



b) Bank size categories



c) Credit union business models



Note: Figures for the chart are the weighted average for growth in net customer loans compared to the previous accounting year. The observations with zero-customer loans are excluded from the analysis.
Source: Authors

To conclude, the financial crisis of 2007-2009 has had a limited impact on investment oriented banks, which maintained relatively high returns. Wholesale–oriented banks and retail type I banks were, on average, able to maintain slightly positive returns. Conversely, retail type II banks were most affected by the crisis; their average returns having turned negative in 2007 and 2008.

Regarding bank size categories, what stands out is the lowest returns reported for large and micro banks, at the two ends of the size spectrum. Returns of very small banks are the most volatile, with significantly negative average values in 2009. Also, returns of small banks were slightly negative in 2008. Mid-size banks emerge as the best performing banks over the period, having maintained relatively high average returns even during the financial crisis years (2007-2009), which resulted in an overall low volatility.

As far as credit unions are concerned, their weighted average returns are far lower than those of banks and rank in decreasing order from retail type I to retail type II to retail type III. Average returns of retail type I credit unions have been the most volatile, even turning negative in 2008.

The volatility of returns is more thoroughly integrated in the computation of the Z-score, as the first step of the risk assessment carried out in the next chapter.

5 What are the Risks and How are they Mitigated?

This chapter provides a risk assessment of bank and credit union business models and bank size categories. The key risk indicators are summarized in Table 5.1.

In summary, the results across bank business models show that, overall, the weighted average Z-score is just over 20. Within this average, the distance to default for the entire period was largest for investment-oriented banks, followed by retail (type 1). The wholesale-oriented and retail (type 2) banks are the closest to default. Loan loss provisions show a different picture, with the weighted average loan loss provisions of wholesale-oriented banks significantly above and those of investment-oriented banks below those of both types of retail banks. The retail (type 2) banks that are closer to default have the second largest loan loss provisions.

Stock returns are largest for wholesale banks, but the ranking is not statistically significant. The riskiness of banks measured by the standard deviation of stock returns indicates that investment banks are the least risky. Results are, however, only significantly different from those for retail (type 2) banks that have the highest standard deviations. The difference between wholesale and both retail banks is also significant.

Turning to the results across bank size categories, within an average low Z-score for the overall industry, micro banks were furthest from default, while mid-sized banks are closest to default. The Z-score of very small, small and large banks were statistically indifferent from each other. Loan loss provisions almost follow bank sizes, i.e. the larger the size category, the higher the weighted average loan loss provisions as a share of total gross customer loans. At the lower end of the size range, micro banks have posted provision levels that are statistically distinctive from the other business models.

The stock returns are also not significantly different across bank size categories, except for the stock returns of the micro banks, which were significantly higher than for all the other size categories. The differences in volatility are, in most cases, significant. The standard deviation of the daily returns of micro banks and very small banks are significantly higher than for all the other sizes of bank. Hence, these might thus be considered by investors to be more risky.

The results across credit union business models show that retail type I credit unions were closest to default, although the differences with retail type II and retail type III, albeit statistically significant, are not pronounced. In turn, retail type I credit unions posted the highest provisions for loan losses, while retail type III credit unions, which are furthest from default, have the lowest loan loss provisions. The weighted average values for both the Z-score and loan loss provisions are significantly different across all credit union business models.

TABLE 5.1 – Risk Indicators

a) Bank business models

	Model 1 – Wholesale-oriented	Model 2 – Retail (type 1)	Model 3 – Retail (type 2)	Model 4 – Investment-oriented	All
Z-score (std. dev. from default)	18.29**	21.58***	18.64**	22.99***	20.04
Loan loss provisions (% of gross customer loans)	1.7%***	0.85%***	1.08%***	0.46%***	1.07%
Stock returns (avg. daily returns)	0.44%	0.33%	0.35%	0.25%	0.34%
Stock returns (std. dev. of daily returns)	3.9%**	4.3%**	5.4%***	3.5%*	4.8%

b) Bank size categories

	Micro (<$1bn)	Very small (1-$5bn)	Small (5-$10bn)	Mid ($10-$50bn)	Large (>$50bn)	All
Z-score (std. dev. from default)	24.51****	21.65***	21.08**	16.97****	19.59***	20.04
Loan loss provisions (% of gross customer loans)	0.6%****	0.89%***	0.9%***	1.19%***	1.18%***	1.07%
Stock returns (avg. daily returns)	0.46%****	0.08%*	0.05%*	0.04%*	0.04%*	0.34%
Stock returns (std. dev. daily returns)	5.9%****	2.8%****	2.2%**	2.0%**	2.4%**	4.8%

c) Credit union business models

	Retail type I	Retail type II	Retail type III	All
Z-score (std. dev. from default)	29.02**	31.60**	30.08**	30.04
Loan loss Provisions (% of gross customer loans)	0.74%**	0.58%**	0.53%**	0.68%

Notes: The Z-score and loan loss provision figures are weighted averages for the year-end observations for the business models/bank size categories. The independence of clusters was tested using Welch two-sample tests at 5% significance. Stock returns and their standard deviations are median values for the year-end observations for the business models/bank size categories. The independence of clusters (a.k.a business models) was tested using non-parametric Wilcoxon-Mann-Witney two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (*, **, *** or ****) stands for the statistical difference of any given business model/size of category from that number of other business models/bank size categories for that indicator. For example, two asterisks (**) in sub-table a imply that the business model is statistically different from the two (furthest) business models but not the third (closest) one.

Source: Authors

The **Z-score** is a balance sheet based indicator that provides an estimate of a bank's distance to default.[28] In essence, the risk measure uses historical earnings volatility and returns, as well as current capital levels, to construct the level of a (one-off) shock beyond the historical average that would lead to default. The greater the Z-score, the further a bank X is from default while the lower is the probability of a default.

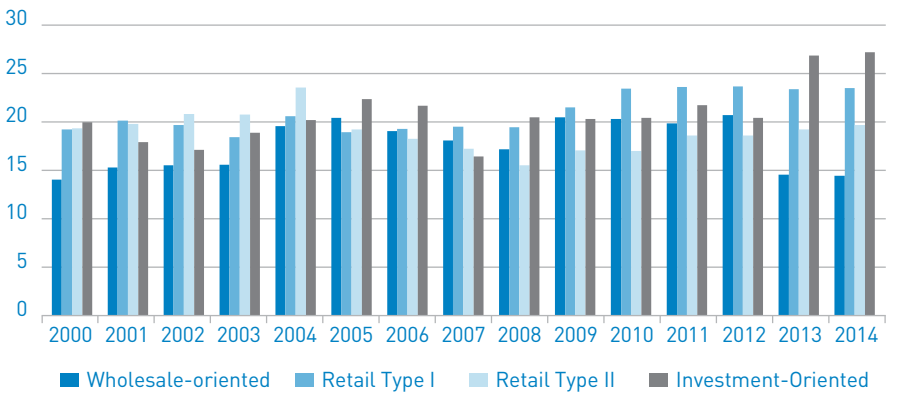
Figure 5.1 shows the differences in Z-scores across business models during the investigated period. Overall, the Z-scores were relatively low for all business models before the onset of the financial crisis years, with a continued trend during the crisis. In particular, whereas from 2000 to 2003, wholesale-oriented banks were the closest to default, in the years just before 2007-2009 their weighted averages were largely comparable, with those for retail (type 2) and investment-oriented banks recording only slightly higher Z-scores. Retail (type 2) banks recorded the lowest distance to default during and after the financial crisis up to 2012. Retail (type 1) banks had the largest distance to default during those years. In the most recent years, wholesale-oriented banks again recorded the lowest Z-scores and investment-oriented banks the highest.

The rankings of the weighted average Z-scores for the study period seem to hold as well for annual cross sections before the financial crisis. During the crisis and post-crisis, small banks have consistently ranked among the top 2 size categories farthest from default, along with micro banks.

The results for the credit union business models show limited variation for most years, pre and post financial crisis. Retail type II credit unions appear to be the safest over the 15 years under study. The difference with diversified-retail types II and retail type III credit unions was limited in the pre and post- financial crisis periods. During the crisis, the Z-score of retail type I credit unions dropped, while the score of the other two business models temporarily increased.

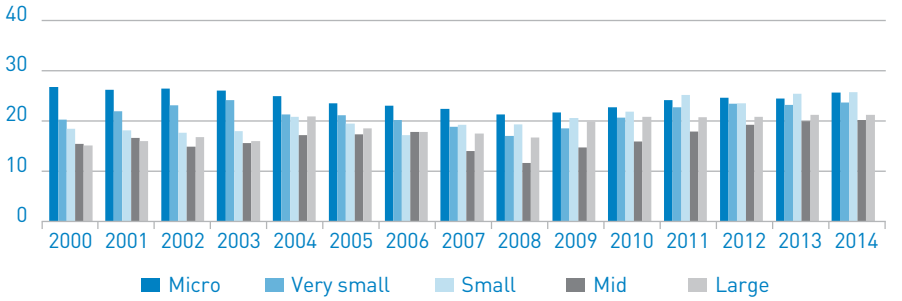
FIGURE 5.1 – Evolution of Z-scores

a) Bank business models

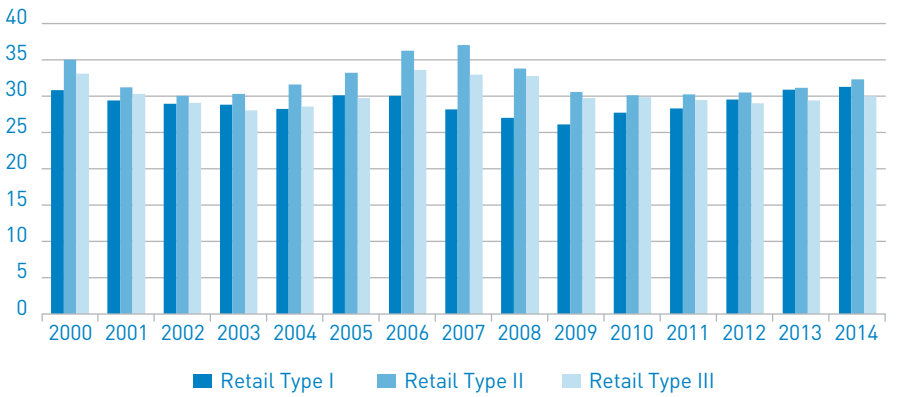


28. See Appendix III for the calculation of the Z-score. This same indicator was used in Ayadi et al. (2016) for Europe's banks identification and assessment of business models.

b) Bank size categories



c) Credit union business models



Note: The amounts expressed in the figure are asset-weighted averages of distance to default. Since the in-sample standard deviation of returns as well as the in-sample mean returns, are constant over time, the differences across the years are due to changes in levels of equity, as well as in the composition of business models.
Source: Authors

Loan loss provision as a share of gross customer loans is a proxy-measure for credit losses. (Loans to banks are excluded, since losses on loans to banks have historically been lower than on loans to other customers.) Notwithstanding some high-profile cases, like the collapse of Lehman Brothers in September 2008, even during the crisis, banks were largely shielded from bearing losses on loans to banks. This was primarily due to various government and central bank interventions that limited disorderly liquidations of banks and concentrated burden sharing on equity holders and junior debt holders.

The results displayed in Figure 5.2 show that, pre-crisis, provisions were relatively low, except for wholesale-oriented banks. During the financial crisis, in particular in 2008 and 2009, all bank business models posted substantially higher provisions for loan losses. Wholesale-oriented banks also reported the highest provisions during the crisis, while investment-oriented banks showed the lowest loan loss provisions. The difference might be explained by a difference in the composition of the credit portfolios, which can only be explored with more granular data. Investment-oriented banks have relatively more credit

outstanding to larger corporations and public bodies, compared to other customers. After the crisis, credit losses slowly dropped to levels comparable to pre-crisis years, or even lower for wholesale-oriented banks.

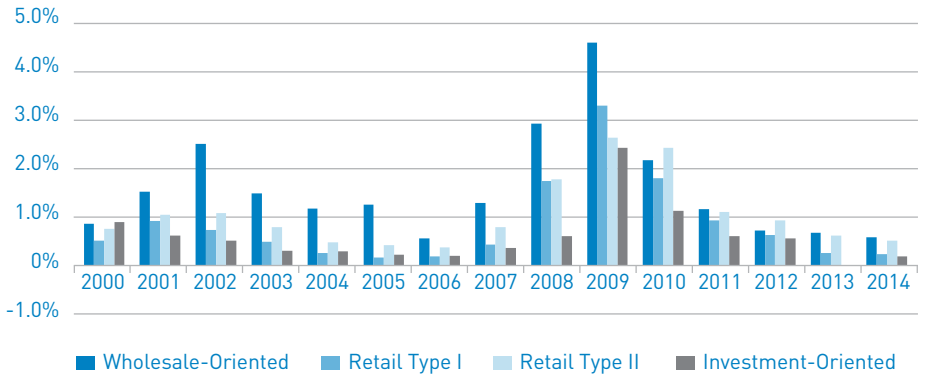
Turning to results across bank size categories, in the pre-crisis period, results are largely consistent for both median and weighted assets values. Hence, larger banks bear higher loan loss provisions, except for the largest banks. Loan loss provisions were considerably higher in the period from 2008 and 2010, with micro banks taking the lowest and large banks the highest provisions. Overall, provision levels doubled across bank size categories. A decreasing trend started in 2010 and loan loss provisions have stabilized at pre-crisis levels in the past few years.

Loan loss provisions have been relatively stable across credit union business models, with only a pick-up in response to the financial crisis. During the crisis, provisions across all business models surged. However, provisions for retail type I and retail type II credit unions were way above those for retail type III credit unions. Retail type I credit unions reported the highest provisions. In the aftermath of the financial crisis, loan loss provisions converged while dropping.

It is worthwhile to point out that, historically, credit unions bear lower provisions for loan losses than banks[29], as can be seen in the comparisons between Figure 6.2c and 6.2a. The incentive of structures of stock-owned vs. cooperatives may help explain that difference, since managers and stockholders of banks benefit from risk-taking, while in credit unions, managers and members do not reap gains from risk-taking and may prefer institutional survival.

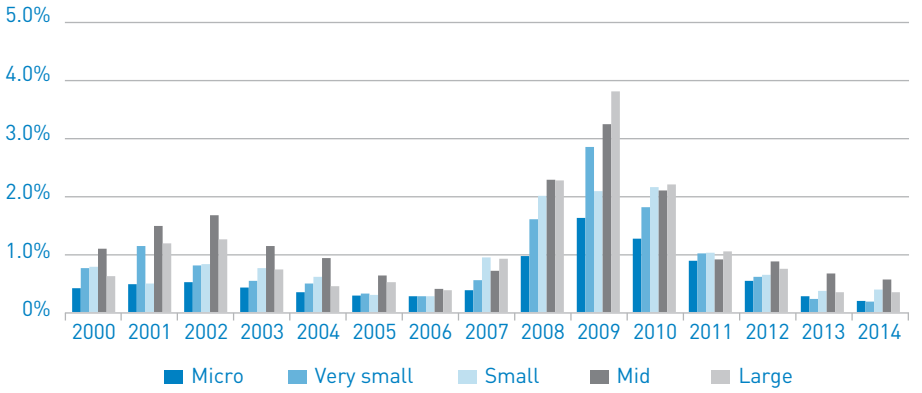
FIGURE 5.2 – Loan loss provisions (% of gross customer loans)

a) Bank business models

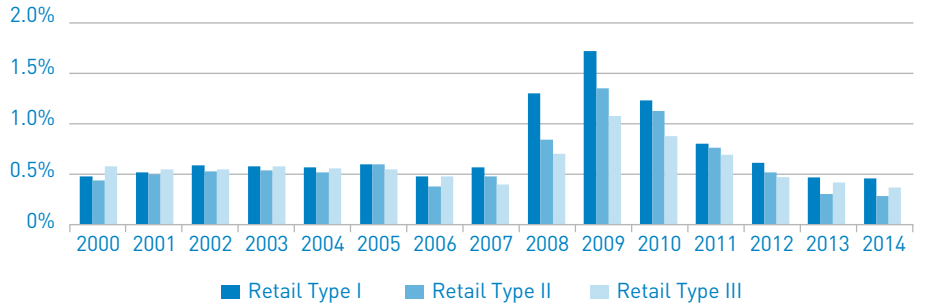


29. See Wilcox (2011), p. 16

b) Bank size categories



c) Credit union business models



Note: The amounts expressed in the figure are total loan loss provisions as a share of total gross customer loans. The observations with zero gross customer loans are excluded from the calculations. The method is equivalent to the computation of weighted averages with data on individual ratios, using total gross customer loans as amounts for the weights.
Source: Authors

Average daily stock returns are a rough proxy-measure for the evolution of market values. Only part of bank assets is accounted at fair value, while the equity markets are considered to value the banks' equity according to market principles. Changing economic circumstances are, therefore, considered to impact on market values faster than book values. The share-based indicators have, however, an important limitation in that they are only available for listed banks and, in most cases, only shares of holding companies[30] are listed. The results displayed in Figure 5.3 show that share returns fluctuated substantially during the sample period. In the pre-crisis years, shares displayed high values across almost all business models for most years in the early 2000s. Wholesale-oriented banks were the only banks that quoted high returns in 2000 and negative average returns in the two con-

30. The share returns indicators of both the individual banks and holding companies are used. The share returns of the holding companies are linked to individual commercial and savings banks when the share capital of the bank represented the majority of the holding`s equity and the bank was not listed. Again, this approach ensures that the share returns are only linked when the bank forms a significant part of the holding company.

secutive years. After 2003, average daily returns deteriorated and turned negative during the financial crisis; banks across all business models quoted negative returns on their shares. However, investment-oriented banks fared relatively well through the crisis, with the lowest losses in 2007 and they were the only model that did not post losses in 2008. Returns recovered in 2009 and 2010, but remained low till 2012/2013 when they reach pre-crisis levels. In 2014, share returns dropped again.

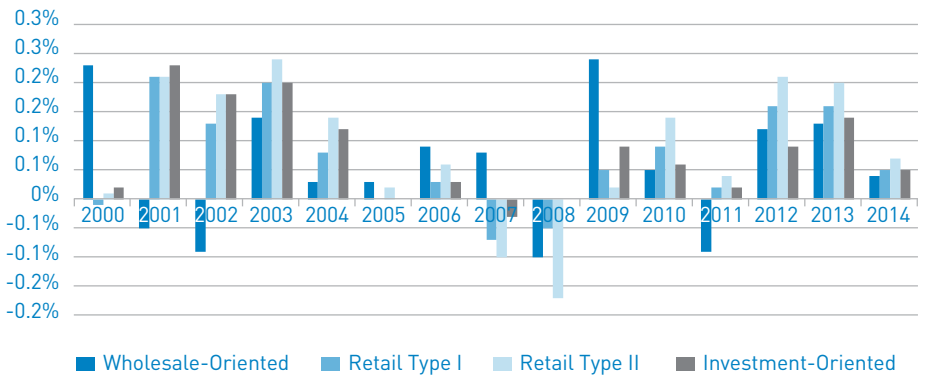
Results across bank size categories show no clear, consistent differences for the sample period. During the period from 2000 to 2004, returns across most bank size categories were positive, except for micro and very small banks in 2000 and large banks in 2001 and 2002. Afterwards, returns deteriorated and turned negative in 2007 for all size categories, for micro, very small and large banks in 2008 and for very small and small banks in 2009. Returns recovered afterwards, in particular micro banks reported high returns.

Annual standard deviations in daily stock returns measure the risk sensitivity of listed banks. These measures may be affected by government interventions. However, when governments obtain all the shares for a bank, or when trading is suspended, changes in value are no longer reported and the individual bank concomitantly also disappears from volatility measures.

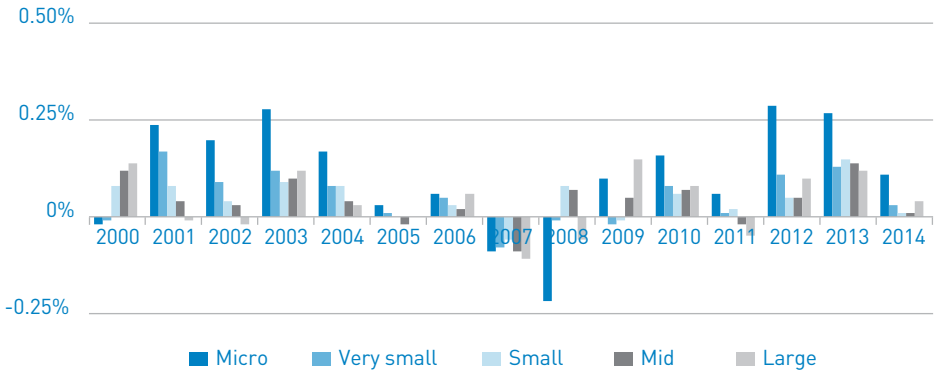
The volatility of stock returns has been similar across most business models, except for wholesale-oriented banks that quoted less volatility in most years. The low degree of volatility exhibited by this type of banks is statically distinguishable from other clusters. The volatility increased substantially during the financial crisis years, to return to pre-crisis levels afterwards. Returns for retail (type 2) bank shares were considerably more volatile than for other models during this period.

FIGURE 5.3 – Evolution of stock returns (avg. daily returns)

a) Bank business models



b) Bank size categories

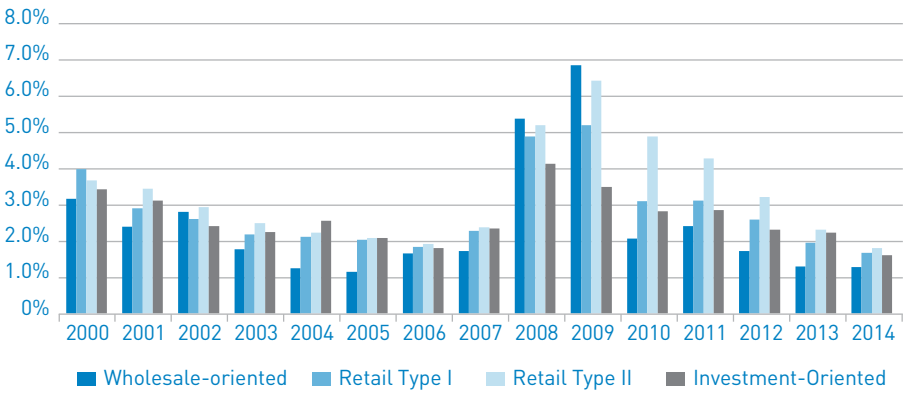


Note: The figure shows the median values of annual average daily returns on publicly listed shares.
Source: Authors

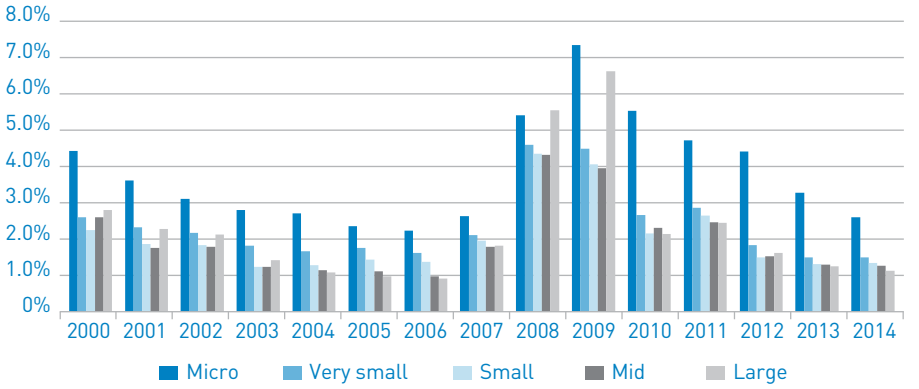
Figure 5.4 equally shows that the differences between bank size categories are more substantial. The share returns of micro banks were the least volatile, based on annualized data. Volatility increased for all size categories during the financial crisis, in particular in 2008 and 2009. Volatility decreased afterwards to pre-crisis levels.

Figure 5.4 – Evolution of stock return volatility

a) Bank business models



b) Bank size categories



Note: The amounts expressed in the figure are median annual standard deviations of daily stock returns.
Source: Authors

In summary, this section assessed the risks associated with the different business models and bank size categories. Using a rich palette of risk measures, investment–oriented and retail (type 1) banks appear to be the safest. Wholesale-oriented and retail type 2 banks were more exposed to the 2008-09 financial crisis. In fact, the deposit funded retail (type 1) and investment-oriented banks have the greatest distance to default (i.e. less prone to default), whereas the more market funded retail (type 2) and wholesale-oriented and banks are closer to default. However, the markets perceive the default probabilities for the retail business models to be higher than for the other business models. Across bank size categories, the safest banks are at the lower end of the size range, based on the balance sheet indicators. In particular, micro banks appear to be the safest. Concerning credit unions, the retail type II business model appear to be the safest in most years.

6 How do US Bank and Credit Union Business Models respond to Regulatory and Supervisory measures?

Regulators and supervisors increasingly influence the behaviour of banks and credit unions. This section assesses the robustness and resilience across bank and credit union business models and the bank size categories using the evolution of several regulatory and supervisory indicators. Robustness and resilience refer to the capacity of banks and credit unions to withstand stress conditions, respectively at a point in time and over time.

The regulation and supervision of banks and credit unions differ. Banks are regulated by three different federal authorities, depending on whether they are federally or state chartered: the Office of the Comptroller of the Currency (OCC) regulates depository banks that have a federal charter; state chartered banks are regulated by state regulators, by the Federal Reserve (for those that choose to be members of the Federal Reserve System) and by the Federal Deposit Insurance Corporation (FDIC). All federally chartered credit unions are regulated and supervised by the National Credit Union Administration (NCUA), while state chartered credit unions are also supervised at the state level. While the three banking supervisors coordinate their regulatory initiatives very closely, credit union regulation can often differ more. In general, credit union capital requirements follow broadly similar principles to those of banks. While significant differences in regulation did exist in the past, many have gradually been smoothed out.

The key regulatory and supervisory indicators are summarized in Table 6.1.

The regulatory capital ratios for banks suggest that retail oriented banks have significantly higher average risk weights than wholesale-oriented and investment-oriented banks. In turn, the latter business models have significantly higher Tier 1 and Total capital ratios. Considering the leverage ratio, investment-oriented banks have the least leverage (i.e. total assets over tangible common equity) and wholesale-oriented banks the highest. Among bank size categories, the average risk weights of very small, small and large banks are comparable and close to the sample average, while those of micro and small banks are the lowest. In turn, generally, the capital ratios (Tier 1 capital and Total regulatory capital) decrease with the size. This statement is also true for the leverage ratio..

For credit unions, the net worth ratio suggests that the retail type III have significantly higher median risk weights than retail type II and retail type I credit unions. In other words, retail type III credit unions have the least leverage.

The liquidity ratios (Net Stable Funding Ratios) only apply to the bank sample. The indicators suggest that the liquidity position of the market-oriented business models is higher than for the retail-oriented models. The differences across bank size categories are less apparent but, statistically, the micro and large banks have significantly higher NSFR than the intermediate-sized categories. The weighted averages are all well above the future requirement of 100%.

TABLE 6.1 – Regulatory & supervisory indicators

a) Bank business models

	Model 1 – Wholesale-oriented	Model 2 – Retail (Type 1)	Model 3 – Retail (Type 2)	Model 4 – Investment-oriented	All
Risk-weighted assets (RWA) (% of assets)	64.83%***	72.81%***	82.33%***	58.82%***	72.19%
Tier 1 capital ratio (% of risk-weighted assets)	11.4%**	10.98%**	10.44%**	14.43%***	11.15%
Total regulatory capital (% of risk-weighted assets)	14.45%***	13.32%***	12.71%***	16.21%***	13.60%
Tangible common equity (% tang. assets)	7.29%***	7.61%***	8.34%**	8.33%**	7.80%
NSFR(Avail./req. funding)	139.96%***	133.45%***	120.76%***	159.92%***	134.02%

b) Bank size categories

	Micro (<$1bn)	Very small (1-$5bn)	Small (5-$10bn)	Mid ($10-$50bn)	Large (>$50bn)	All
Risk-weighted assets (RWA) (% of assets)	69.28%***	72.26%**	69.45%***	72.33%**	72.83%**	72.19%
Tier 1 capital ratio (% of risk-weighted assets)	14.37%****	13.13%***	13.12%***	11.85%****	10.16%****	12.08%
Total regulatory capital (% of risk-weighted assets)	15.55%****	14.49%**	14.74%***	13.92%***	13.05%****	14.46%
Tangible common equity (% tang. assets)	10%****	9.48%***	9.27%***	8.23%****	7.04%****	7.79%
NSFR(Avail./req. funding)	130.99%****	127.85%**	126.15%**	128.04%**	136.69%****	134.02%

c) Credit union business models

	Retail type I	Retail type II	Retail type III	All
Net Worth (% of assets)	10.27%**	11.34%**	13.77%**	10.83%
Risk-based net worth requirement	6.49%**	6.93%**	6.8%**	6.74%

Notes: All figures are weighted averages of the year-end observations. The independence of clusters (a.k.a. business models) and size categories was tested using Welch two-sample tests at 5% significance. To report the results of these tests, the number of asterisks (*, **, *** or ****) stands for the statistical difference of any given cluster/size category from that number of other clusters/size category for that indicator. For example, two asterisks (**) in sub-table a for business models imply that the business models are statistically different from the two (furthest) business models but not the third (closest) one.

Source: Authors

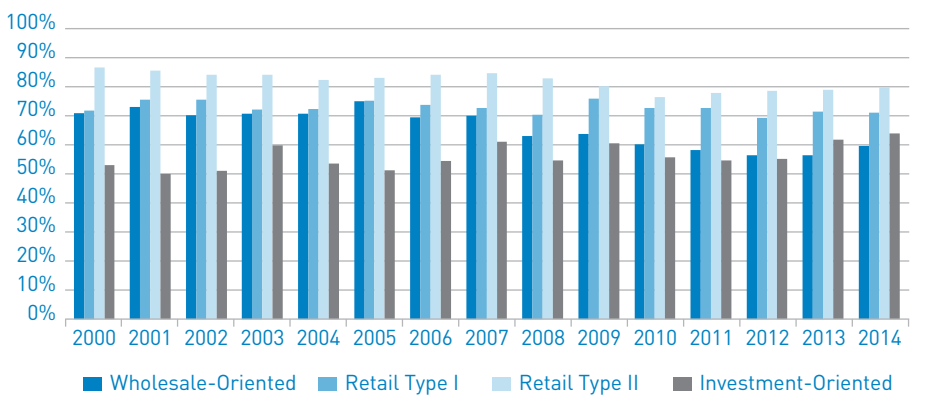
Risk-weighted assets (RWA) to total assets, or average risk-weights, provide a regulatory measure of risk. Banks with higher RWA are expected to be more sensitive to risks and, thus, are required to hold more regulatory capital to account for their riskier investment and lending practices. Figure 7.1 shows that the average risk weights of retail (type 2) banks are higher, while those for wholesale-oriented and investment-oriented banks are lower, relative to the other business models. However, the gap between investment-oriented banks and retail type 2 banks has tightened over the fifteen-year period. Risk-weights have gradually declined in the years since the financial crisis. Afterwards, in 2013 and 2014, average risk-weights increased slightly. The largest changes are driven by wholesale-oriented and investment-oriented banks, which have displayed gaps, in respect to both retail oriented banks and between themselves.

The differences between bank size categories are generally rather limited, except for the early 2000s. The mid-sized and large banks had, between 2000 and 2003, higher average risk-weights, in some cases above 80%. The time profile for bank sizes shows a convergence in the run-up to the crisis, with declining risk-weights for mid-sized and large banks and increasing risk weights for other banks. The risk-weights remained stable during the early crisis years, only to decline in the period from 2009 to 2012. In more recent years, 2013 and 2014, risk-weights have slightly increased.

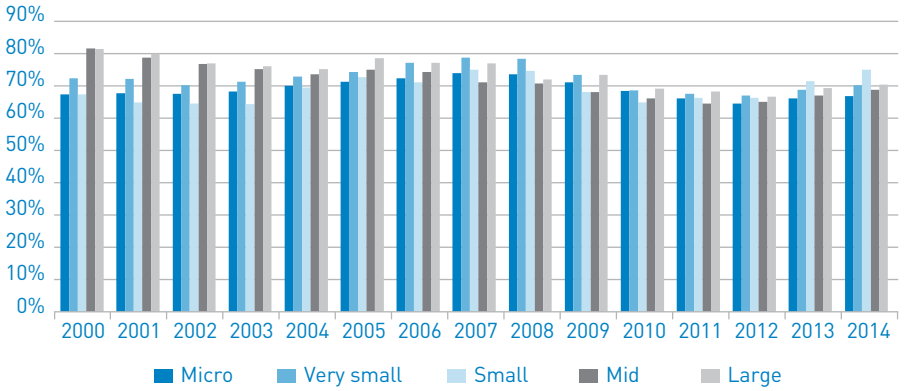
The changes in average risk-weights are due to changes in exposures as well as changes in capital regulation. Focusing on the changes in regulation, the US has applied the international capital standards Basel I since 1991 and was in the process of introducing further changes (Basel II) when the financial crisis struck. The latter is only applied to large and internationally active banks and was widely suspected of permitting them to lower their risk-weights using internal models to determine the risk-weights. Since then, the US has implemented further changes in international capital standards (Basel III) that generally seek to increase and tighten capital requirements.

FIGURE 6.1 – Evolution RWAs (% of total assets)

a) Bank business models



b) Bank size categories



Note: The amounts expressed in the figure are the total weighted assets as share of total assets. The method is equivalent to the computation of weighted averages with data on individual ratios of RWA to total assets, using total assets as amounts for the weights.
Source: Authors

Prompt corrective action capital guidelines for US banks

In the US, implementation of the Basel capital standards has been integrated in a Prompt Corrective Action (PCA) framework for banks. Provisions for the PCA are part of the Federal Deposit Insurance Corporation Improvement Act of 1991 and mandate the FDIC to impose on banks a series of measures that help restore an adequate level of capital. The table below shows the framework of the thresholds that were binding over the period 2000-2014 under review. The exception was limited in scope. Indeed, in 2014, the federal agencies enforced additional provisions, including a common equity Tier-1 ratio, to enforce Basel III on banks that are required to use advanced approaches for the risk-weighted assets computation (generally banks with more than $10 billion in total assets). Smaller banks (i.e. community banks) are subject to the new rule from January 2015 onwards. While the threshold has been maintained over the period under review, the definitions of the components of the ratios (Tier-1, total capital, RWA) have changed for PCA purposes.

Prompt corrective action threshold for banks

Capital categories	Total risk-based capital ratio		Tier 1 risk-based capital ratio		Leverage ratio
Well capitalized	10% or greater	AND	6% or greater	AND	5% or greater
Adequately capitalized	8% or greater	AND	4% or greater	AND	4% or greater*
Undercapitalized	Less than 8%	OR	Less than 4%	OR	Less than 4%*
Significantly undercapitalized	Less than 6%	OR	Less than 3%	OR	Less than 3%
Critically undercapitalized	Tangible equity/Total Assets Less than or equal to 2%				

*Depends as well on the results of examinations
Source: Spong (2000)

Risk-weighted assets are central to the Basel capital standards; in the US, they are key metrics of the capital adequacy framework, because, as denominator, they help gauge capital adequacy indicators of Tier-1 capital ratio and total (risk-based) capital ratio. Besides the Tier-1 ratio and the total (risk-based) capital ratio, the leverage ratio (per total assets) is considered to determine whether a bank is well capitalized.

The Tier-1 capital ratio is the **loss-absorption capacity of banks under the rules for core capital**. For any given level of risk, holding more capital could, in principle, imply greater stability. For most of the period in our samples, simplified somewhat, for them to be considered well capitalized by the FDIC, banks in the US must, at least, have a Tier-1 component of more than 6.0% of risk-based assets. To be adequately capitalized, the Tier-1 ratio must be above 4.0%. Following the financial crisis, capital requirements of banks in the US have become even more complex, with several new, generally higher, requirements. These various new requirements are scheduled to be introduced gradually at different points throughout the next few years depending on bank size, complexity and even future developments in the business cycle.

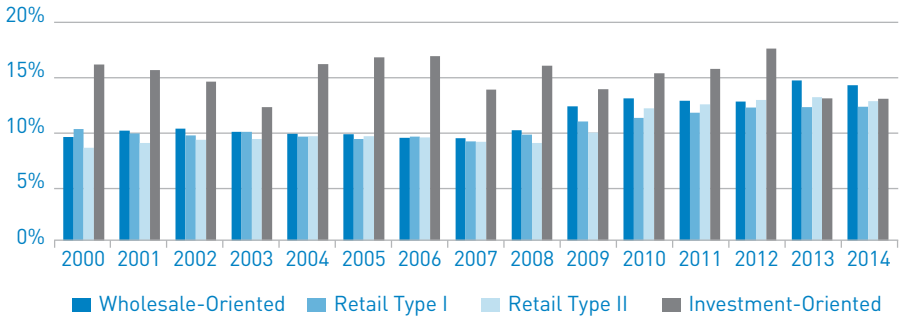
The results in Figure 6.2 show that weighted average Tier-1 ratios for all business models have been above the 8.0% threshold for well capitalized banks throughout the sample period. The investment-oriented banks had a clearly higher Tier-1 capital ratio in most years, while the values for the other models are largely comparable. The regulatory capital ratios have been quite stable up to the financial crisis. Of course, the apparent stability during the financial crisis includes (1) large inflows of public (e.g., TARP) and private capital into commercial banks and (2) the removal of failing banks (with lower capital ratios) from the sample. In the aftermath of the crisis, regulatory capital gradually increased, except for investment-oriented banks, for which the Tier-1 capital ratio decreased in 2013 and 2014. Hence, with these changes, Tier-1 ratios across business models nearly converged.

Results across bank size categories show that, except for large banks in 2000, average Tier-1 capital ratios were high enough to be considered well capitalized. Moreover, a similar increase in loss absorption capacity over the years and the differences between size categories decline over time. In general, larger banks had the lowest regulatory capital and smaller banks posted the highest Tier 1 ratios over the period, except for 2009, 2010 and 2011.

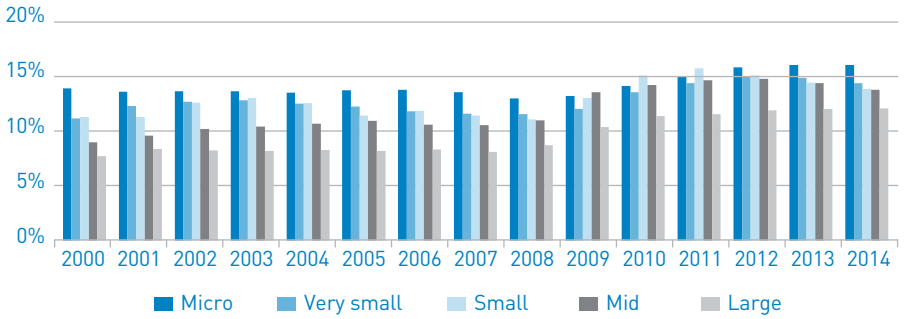
The fact that the differences in risk and absorption capacity are barely reflected in the risk weights and Tier-1 ratios is intriguing and suggests the possibility that either the main regulatory instruments currently in use may not be adequate for capturing (or signalling) loss-absorption capacity of a bank, in particular for wholesale-oriented banks, or there is potential evidence of misallocation of capital, particularly for micro banks.

FIGURE 6.2 – Evolution of Tier-1 capital ratios

a) Bank business models



b) Bank size categories



Note: The amounts expressed in the figure are total values of Tier-1 capital as a share of risk weighted assets. The method is equivalent to the computation of weighted averages with data on individual ratios, using RWA as amounts for the weights.
Source: Authors

As already indicated, the total capital ratio is the **total risk-based capital requirement** under the rules for bank capital. For any given level of risk, holding more capital could, in principle, imply greater stability. To be considered well capitalized by the FDIC, banks in the US must have total capital of more than 10.0% of risk-based assets. To be adequately capitalized, the total capital ratio must be above 8.0%. A bank is undercapitalized when total capital falls below that threshold.

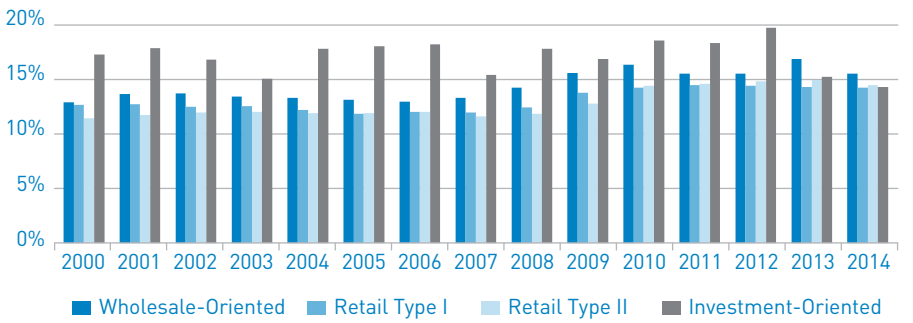
The results in Figure 6.3 show that the weighted average total regulatory capital ratios for all business models have been above the 10.0% threshold for well capitalized banks for the entire period. Total capital ratios were quite stable up to the financial crisis. In the aftermath of the crisis and up to 2012, total capital ratios gradually increased and reduced part of the inter-business models gap. During this period, investment-oriented banks had a clearly higher total regulatory capital, with the exception of 2011 in which wholesale-oriented banks reported the highest capital ratios. After 2012 the ratios across

bank business models nearly converged. Values for the retail models remained largely comparable throughout the sample-period.

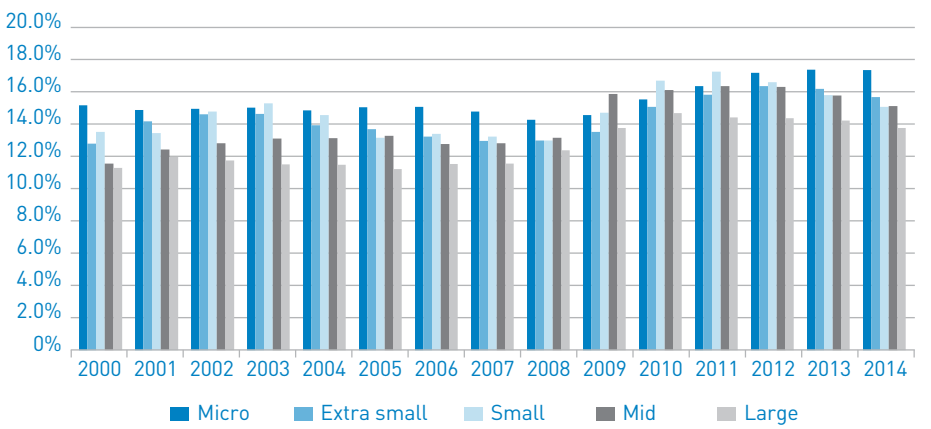
Results across bank size categories are largely similar to the results for the Tier 1 capital ratio, which means that most banks did not issue additional capital instruments to comply with the broader total capital requirement. All the average total regulatory capital ratios were high enough to be considered well capitalized. Moreover, a similar increase in loss absorption capacity is reported over the years and the differences between bank size categories decline over time up to 2009. Small and very small banks doubled their total regulatory capital ratios in 2010 and 2011 respectively. In general, larger banks had the lowest regulatory capital but, especially among the smaller banks, this difference is not always clear.

FIGURE 6.3 – Evolution of total capital ratios

a) Bank business models



b) Bank size categories



Note: The amounts expressed in the figure are total values of total risk-based capital as a share of risk weighted assets. The method is equivalent to the computation of weighted averages with data on individual ratios, using RWA as amounts for the weights.
Source: Authors

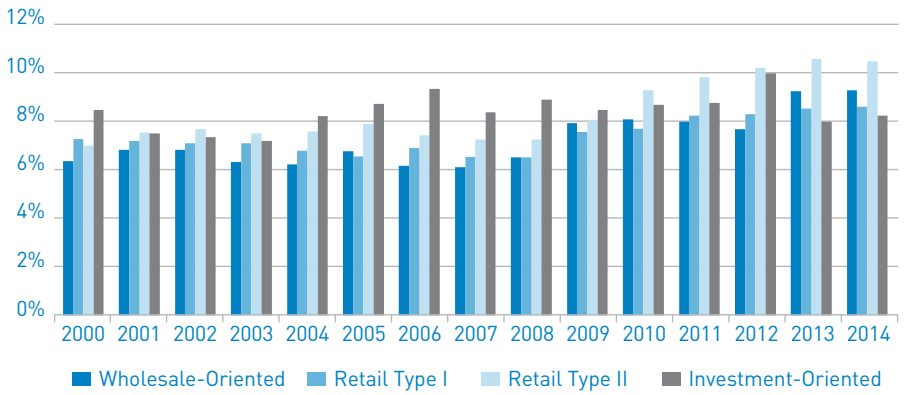
The **leverage ratio** measures loss-absorption capacity based on the total balance sheet size, unadjusted for risk. In order to be considered well capitalized by the FDIC, the leverage ratio should, notwithstanding the risk-weighted capital ratios, be at least 5.0%. To be considered adequately capitalized the leverage ratio should at least be above 4.0% and banks are considered undercapitalized when the ratio is less than 3.0%. The leverage ratio used in this exercise is a proxy, i.e. tangible common equity over total assets[31].

Figure 6.4 shows that, for almost all business models across the sample period, the average leverage ratio was sufficient to be considered well capitalized. The only exception, were wholesale-oriented banks that in 2010 reported a leverage ratio that was slightly below the 5.0% threshold. Leverage ratios diverged in the run-up to the financial crisis. Hence, the leverage ratio of wholesale-oriented and retail (type 1) banks decreased, while the ratio of retail (type 2) and investment-oriented banks increased between 2000 and 2006. Afterwards, the leverage ratios increased across all business models, except for wholesale-oriented banks. These reported substantially higher leverage ratios in 2013 and 2014, while in those years the leverage ratio of investment-oriented banks fell.

Leverage ratios for all bank size categories were high enough to be considered well capitalized every year. Larger banks had lower leverage ratios, although the ratios converged over time. More specifically, while the leverage ratio of micro, very small and small banks gradually increased over time to similar levels, the ratios for mid-sized and large banks remained stable over time, only increasing in the aftermath of the financial crisis.

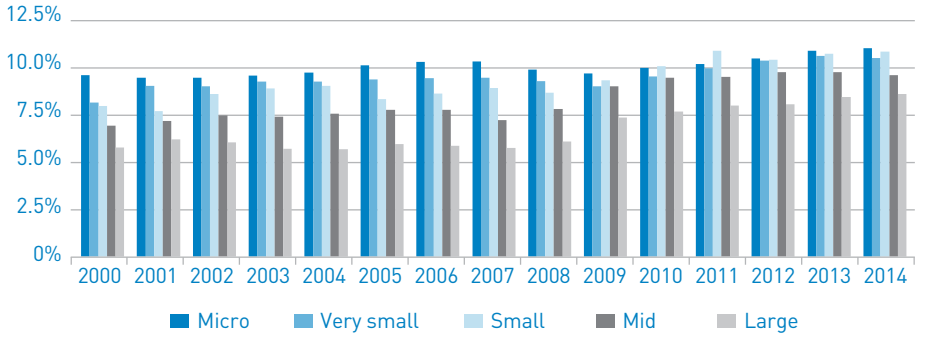
FIGURE 6.4 – Leverage ratios (tangible common equity)

a) Bank business models



31. The desired denominator is tangible assets.

b) Bank size categories

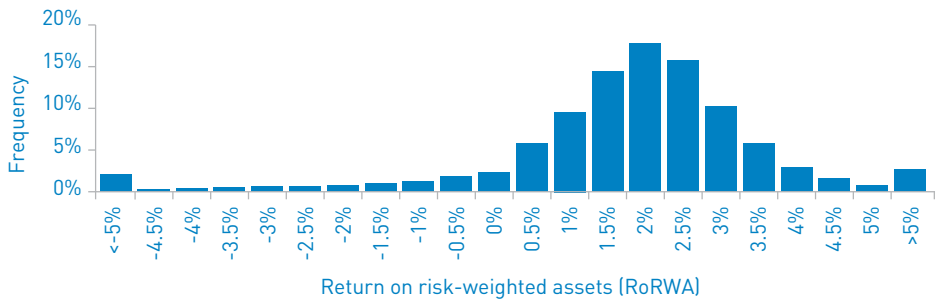


Note: The leverage ratios in the figure above are total tangible common equity as a share of total assets. The method is equivalent to the computation of weighted averages with data on individual leverage ratios, using total assets for the weights.
Source: Authors

An alternative assessment of default risks follows the "top-down" approach to calibrating regulatory minimum capital requirements under stress conditions, as described in BCBS (2010b) and applied in Ayadi et al. (2016) to banks in Europe. This method allows for assessing the resilience of banks per business model to external shocks. More specifically, the quantiles of the return to risk-weighted assets (RoRWA) are used to construct expected losses that banks may face under a stress scenario. If the most loss-absorbing parts of equity (i.e. tier 1 capital ratio) remain below or close to such a measure, then the likelihood of a default would be equally high under those stress conditions (See Ayadi et al. (2016)).

As an illustrative example, consider a bank that achieves 3% RoRWA in normal years. Let us assume that in a bad year, which occurs randomly once every 20 years, the bank faces a 7% loss. Assume as well that the loss corresponds precisely to the 5th percentile of the distribution function. Although effective average earnings of 2.5% RoRWA may be considered healthy, the bank will, nevertheless, default if its risk-adjusted capital level is below 7% in a bad year. Assuming a similar distribution for other banks, the regulators should ensure that banks have at least this amount of capital at all times, to cope with stress conditions when needed.

FIGURE 6.5 – Distribution of risk-weighted returns (RoRWA)

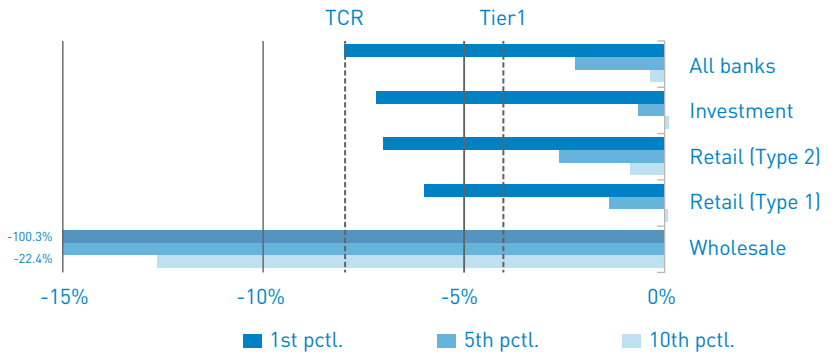


Note: This figure depicts the distribution for all banks covered in the study for the years 2000 to 2014.
Source: Authors

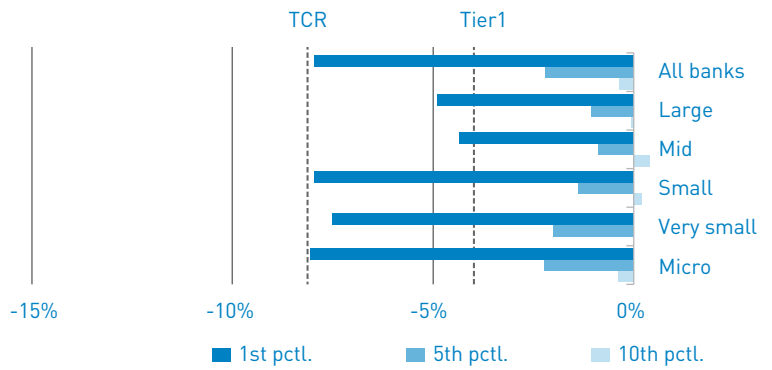
Naturally, the distribution of returns of actual banks is substantially more varied than in the example above. Figure 6.5 charts the distribution of the risk-weighted returns for all banks and years in the sample. The highest frequency of the distribution is around 2% RoRWA, implying healthy returns for most banks in normal years. Assuming that a bad year is defined as a once-in-a-10-year event, i.e. lower 10th percentile return, banks face RoRWA moderate losses of 0.4% (see also Figure 6.6). If a bad year is defined as rarer and, thus, a more destructive event, i.e. lower 5th percentile, the potential losses increase to 2.2%.[32]

FIGURE 6.6 – Return on risk-weighted assets (top percentiles)

a) Bank business models



b) Bank size categories



Note: This figure depicts the RoRWA of the top percentiles (1st, 5th, and 10th) for all banks covered in the study for the years 2000 to 2014. The dotted lines show the minimum regulatory requirements to be considered adequately capitalized by the FDIC; Tier 1 requirement of at least 4% and Total Capital requirement (TCR) of at least 8% respectively.

32. Assuming that earnings are randomly and independently distributed, the estimates would imply that a bank with risk-adjusted capital less than 1.7% would face a default likelihood of 5% at any given point in time. However, the earnings distributions of different banks are typically highly correlated, especially when interbank activities and common exposures are substantial. It is also assumed that losses are not correlated over time, which is also not likely to be the case. Based on these shortcomings, the actual default likelihoods are likely to be much higher than the levels implied by the percentile estimates.

The lower percentile estimates depicted in Table 6.2 provide an insight into the losses that banks have faced in recent years. When the entire sample is considered, the risk-adjusted losses are approximately 8.0% at the 1st percentile. However, the depicted period had a large impact on returns. Losses were substantially greater during the financial crisis years than during the pre- and post-crises period, with the pooled sample of banks having faced risk-adjusted 1st percentile losses of respectively 6.7% and 6.6%, compared to 11.8% during the crisis.

Looking at results by business models, it is shown that, following the financial crisis, wholesale-oriented banks are suffering greater losses at the 1st percentile, as compared to the retail-oriented and investment-oriented banks[33]. This leads to question the resilience of the wholesale-oriented business model when it is facing extreme stress conditions. Post-crisis, investment-oriented banks fare relatively better than all other business models. However, such a finding must be closely monitored annually to form a view on the long-term resilience of the business models of U.S. banks.

As for the bank size categories, micro, very small and small banks are subject to more losses in extreme stress conditions than mid-sized and large banks (See also Figure 6.6). This result may suggest that the returns of smaller banks are either more volatile and/or more risky than for larger banks.

TABLE 6.2 – Lower percentile estimates for return on risk-weighted assets (RoRWA)

a) Bank business models

	Obs.	Sample statistics		
		1st	5th	10th
ALL YEARS (2000-14)				
Model 1 - Wholesale-oriented	2,664	-100.3%	-22.4%	-12.7%
Model 2 - Retail (T1)	41,993	-6.0%	-1.4%	0.1%
Model 3 - Retail (T2)	48,738	-7.0%	-2.6%	-0.9%
Model 4 - Investment-oriented	14,828	-7.2%	-0.7%	0.4%
All banks	108,223	-8.0%	-2.2%	-0.4%
PRE-CRISIS (2000-06)				
Model 1 - Wholesale-oriented	1,310	-51.7%	-21.2%	-14.7%
Model 2 - Retail (T1)	22,210	-5.1%	-0.3%	0.6%
Model 3 - Retail (T2)	23,822	-4.2%	-0.6%	0.4%
Model 4 - Investment-oriented	7,593	-7.9%	-0.2%	0.7%
All banks	54,935	-6.7%	-0.7%	0.5%
FIN.-CRISIS (2007-09)				
Model 1 - Wholesale-oriented	601	-73.6%	-29.0%	-13.8%
Model 2 - Retail (T1)	6,857	-9.1%	-3.5%	-1.3%
Model 3 - Retail (T2)	11,567	-9.9%	-4.8%	-2.8%
Model 4 - Investment-oriented	2,218	-13.1%	-2.1%	-0.1%
All banks	21,243	-11.5%	-4.6%	-2.4%

33. It is difficult to make a firm statement due to the low data coverage before 2007.

	Obs.	Sample statistics		
		1st	5th	10th
POST-CRISIS (2010-14)				
Model 1 - Wholesale-oriented	753	-292.2%	-20.7%	-3.3%
Model 2 - Retail (T1)	12,926	-5.4%	-1.6%	-0.3%
Model 3 - Retail (T2)	13,349	-6.8%	-2.8%	-1.2%
Model 4 - Investment-oriented	5,017	-5.3%	-0.7%	0.3%
All banks	32,045	-6.6%	-2.2%	-0.6%

b) Bank size categories

	Obs.	Sample statistics		
		1st	5th	10th
ALL YEARS (2000-14)				
Micro (<1bn)	100,427	-8.1%	-2.3%	-0.4%
Very small (1-5bn)	5,628	-7.5%	-2.0%	0.0%
Small (5-10bn)	854	-8.0%	-1.4%	0.2%
Mid (10-50bn)	908	-4.4%	-0.9%	0.4%
Large (>50bn)	406	-4.9%	-1.1%	-0.1%
All banks	108,223	-8.0%	-2.2%	-0.4%
PRE-CRISIS (2000-06)				
Micro (<1bn)	51,711	-6.9%	-0.8%	0.4%
Very small (1-5bn)	2,246	-1.1%	0.7%	1.2%
Small (5-10bn)	388	-1.7%	0.5%	1.0%
Mid (10-50bn)	437	-0.9%	0.6%	1.0%
Large (>50bn)	153	0.2%	0.6%	1.4%
All banks	54,935	-6.7%	-0.7%	0.5%
FIN.-CRISIS (2007-09)				
Micro (<1bn)	19,653	-11.5%	-4.5%	-2.3%
Very small (1-5bn)	1,177	-13.1%	-6.4%	-3.7%
Small (5-10bn)	167	-9.6%	-5.7%	-2.7%
Mid (10-50bn)	152	-9.5%	-5.3%	-2.4%
Large (>50bn)	94	-16.3%	-4.9%	-2.5%
All banks	21,243	-11.5%	-4.6%	-2.4%
POST-CRISIS (2010-14)				
Micro (<1bn)	29,063	-6.7%	-2.3%	-0.6%
Very small (1-5bn)	2,205	-6.4%	-1.6%	0.0%
Small (5-10bn)	299	-8.3%	-1.2%	0.4%
Mid (10-50bn)	319	-2.9%	-0.2%	0.5%
Large (>50bn)	159	-3.4%	-0.1%	0.7%
All banks	32,045	-6.6%	-2.2%	-0.6%

Note: The figures correspond to the 1st, 5th, and 10th percentile estimates of the distribution of the RoRWA, conditional on the business models/bank size categories and time periods across the sample.
Source: Authors

A more dynamic analysis shows that the order in peak-losses differs substantially for the different sub-periods in the sample. During the pre-crisis years from 2000 to 2006, losses occurred almost exclusively in the 1st and 5th percentile, while during the crisis even the 10th percentile was prone to losses. As expected, the losses of all business models during the aftermath of the crises recovered only slowly, leading to peak-losses in between the pre-crisis and crisis levels.

The analysis of the different crisis periods shows that diversity of business models and bank size categories can be a factor of resilience, as the capacity of different business models and bank size categories to withstand extreme stress conditions differ, depending on the nature of the crisis and, hence, the overall banking system remains afloat. In this analysis, retail-oriented and investment-oriented banks, as well as mid-sized banks, have provided systemic resilience to the US banking sector. Conversely, wholesale-oriented and large banks have dragged the overall banking system to high levels of loss during the financial crisis.

The order of the bank size categories has changed during the period under review. Micro banks are among the most sensitive to extreme stress conditions before and after the financial crisis of 2007-2009. Also, pre and post-crisis the two categories of largest banks (mid-sized and large banks) appear to be the most resilient. Noticeably, the large `systemically important` banks have incurred the highest losses during the financial crisis in the 1st percentile while before the crisis, they came out as the most robust category. Overall, mid-sized banks have emerged over the fifteen years under study as the most resilient, with contained peak losses in each period.

Another dimension is the comparison of the mean values for RoRWAs (Table 7.3), which shows that wholesale-oriented and investment-oriented banks, on average, reported distinctly higher RoRWAs than banks belonging to one of the retail-oriented models. Looking at all the financial crisis years (2007-09), investment-oriented banks are by far the best performing, while retail (type 2) banks reported the lowest average RoRWAs. Post-crisis, wholesale-oriented and investment-oriented banks were performing significantly better than retail-oriented business models.

The averages for the different bank sizes show that no size category has reported losses for the entire sample period or in any of the three sub-periods. The lowest mean returns of 0.6% were reported during the financial crisis by small and large banks. Large banks that looked most resilient, based on the peak-losses reported, on average, the lowest average RoRWA. These low RORWA were, however, not significantly different from those of small banks. Micro banks that reported the highest peak losses are also in the lower echelons when comparing the averages.

The findings show clear distinctions across business models and bank size categories in terms of peak losses, which suggests that the average risk weights – which are the denominators of RoRWA – do not reflect the underlying risks of certain banks in the clusters. In particular, wholesale-oriented banks faced severe default risks during the financial crisis. Nevertheless, these differences appear in the underlying risks, not in the average risk weights.

TABLE 6.3 – Mean RoRWA

a) Bank business models

	Model 1 – Wholesale-oriented	Model 2 – Retail (Type 1)	Model 3 – Retail (Type 2)	Model 4 – Investment-oriented	All
All years (2000-14)	2.3%***	1.9%***	1.6%***	2.4%***	2.0%
Pre-crisis (2000-06)	3.0%***	2.4%***	2.3%***	3.2%***	2.6%
Financial crisis (2007-09)	0.8%***	0.9%***	0.5%***	2.3%***	0.8%
Post-crisis (2010-14)	2.8%***	1.8%***	1.7%***	2.0%***	2.1%

b) Bank size categories

	Micro (<$1bn)	Very small (1-$5bn)	Small (5-$10bn)	Mid ($10-$50bn)	Large (>$50bn)	All
All years (2000-14)	1.8%***	3.1%***	3.6%**	2.5%***	1.7%*	2.0%
Pre-crisis (2000-06)	2.4%****	2.9%*	6.1%*	2.8%*	2.2%*	2.6%
Financial crisis (2007-09)	0.9%	1.0%	0.6%	1.9%	0.6%	0.8%
Post-crisis (2010-14)	1.4%****	4.4%***	2.0%**	2.5%**	1.9%*	2.1%

Notes: All figures are the mean values for all banks in the business models/bank size categories. The independence of business models/bank size categories was tested using Wilcoxon-Mann-Whitney non-parametric two-sample tests at 5% significance. The number of asterisks (*, **, ***, ****) stands for the statistical difference of any given business model/size category from that number of other business models/bank size categories for that indicator. For example, two asterisks (**) in sub-table a imply that the business model is statistically different from the two (furthest) business models but not the third (closest) one.
Source: Authors

One explanation for the finding that regulatory measures appear to be misaligned with underlying risks is the possibility that greater risk-weights are associated with more capital, which leads banks to report lower RWA to avoid matching it with additional capital. If banks with greater RWA also hold more capital, partly to fulfill binding regulatory requirements, they should face lower default risks. This may possibly explain the distorted relationship.

An alternative explanation is that banks may be engaging in "risk optimisation" to reduce their risk-weights (and the implied capital charges) without shedding any risks or transferring the risk off balance sheet. Indeed, despite sound arguments for making capital requirements risk-sensitive, the complexity and flexibility of these rules has led to concerns over the potential for regulatory arbitrage.[34] Since raising capital is not always possible during

34. The theoretical literature provides a simple argument for making capital requirements risk-sensitive. Faced with purely linear (i.e. risk-insensitive) capital requirements, banks may shift their portfolios towards riskier assets, offsetting their losses from higher capital levels by increasing their portfolio risks (Kahane, 1977; Koehn & Santomero, 1980; Kim & Santomero, 1988; Rochet, 1992). Empirical studies have confirmed that fixed capital requirements may increase risk, conditional on the size and the adequate capitalisation of the bank (Keeley & Furlong, 1990; Gennotte & Pyle, 1991; Calem & Rob, 1999).

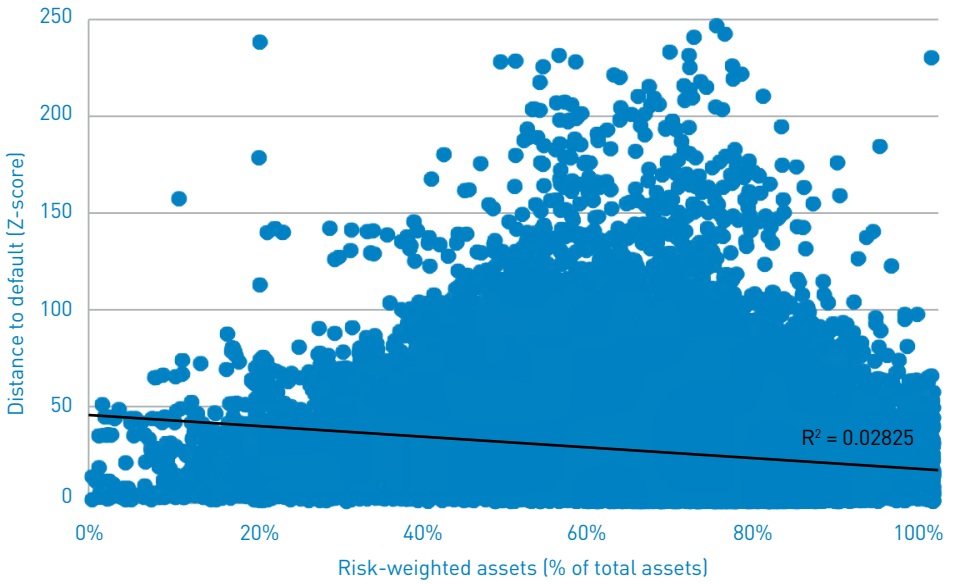
crisis periods, some banks choose to respond to regulatory shortfalls by decreasing their risk-weighted assets. This can be done through deleveraging or changing the calibration of the risk-weights (i.e. changing from standard to internal models with lower average ratios or changing the internal models) or changing the composition of the exposures to ones with lower risk-weights. There is a concern among researchers, supervisors and policy makers about the usage of internal models, which implies that the risk-weights and, thus capital requirements, are reduced without reducing the underlying risks (i.e. regulatory arbitrage).[35]

Empirical evidence of the potential misalignment of risk-sensitive capital requirements is growing. Ayadi et al., (2011, 2012, and 2016) and Ayadi & De Groen (2014) provide evidence of a negative relationship between average risk-weights and a number of risk factors for the EU's top banks in recent years, including estimates of default likelihood, Tier-1 ratio and earnings volatility. Supplemental evidence from the study also shows that investment-oriented banks may have found ways to take on more risk than their regulatory risk measures would reflect. Das & Sy (2012) have shown that banks with lower average risk-weights (measured by the risk-weighted-assets to asset ratio) do a poor job in predicting market measures of risk, especially during the crisis. The Basel Committee on Banking Supervision (2013) conducted a benchmarking exercise, using data for more than 100 banks, which showed that there are large differences between the internal models used to determine the risk- weighted assets (see BCBS (2013)). More recently, using a sample of European banks, Ayadi, Ferri and Pesic (2016) explains the differences in bank risk levels by the adoption of the Internal Risk Based (IRB) approaches and the RWA dispersion. Their findings point to a systematic regulatory arbitrage by diversified retail type 2 banks.

In what follows, the univariate regressions of Ayadi & De Groen (2014) and Ayadi et al (2016) are repeated. It provides the results of censored regressions to assess whether the average risk weights explain distance from default (Z-Score). To be a good regulatory risk measure, there should be a strong relation between risk-weighted assets and underlying risk. Notwithstanding differences in capital levels, the relationship between Z-scores and RWA to assets should be negative, which would imply that banks with a higher RWA are closer to default.

35. Jones (2000) discusses several forms of 'cosmetic' adjustments that banks can undertake to reduce risk-weights, including the concentration of assets in the highest risk classes for a given risk-weight, various forms of credit enhancements, remote-origination and structured transactions. More recently, some observers note that the introduction of the IRB approach under Basel II has effectively enlarged the opportunities of the more sophisticated banks to engage in regulatory arbitrage, (Blundell-Wignall & Atkinson, 2008; Dewatripont et al., 2010; Independent Commission on Banking, 2011). More specifically, there is substantial evidence from the financial crisis of 2007-09 that losses from off-balance sheet, asset-backed commercial paper (ABCP) conduits have remained with the originating banks (Acharya et al., 2010).

FIGURE 6.7 – Relation between Z-score and RWA



Note: The axes have been cut at a Z-score of 250 and RWA 100% of assets to make it easier to visualize the large majority of the observations.
Source: Authors

The estimation results for retail oriented banks show a persistent, significantly negative relation between the regulatory risk measure and distance to default. The results for the entire sample also show a negative relation (See also Figure 6.7 for a scattered plot of the observations). However, the results for wholesale-oriented and investment-oriented banks (not reported here) show a positive relation, which implies that RWA are inversely related to underlying risk. The relationship is weaker than when capital is controlled for (reported in Table 6.4). This implies that banks with greater RWA are holding more capital, which can partly offset their lower risk profile.

The estimations for bank size categories are more in line with expectations. Accordingly, the risk-weights for each size categories are negatively related to Z-scores. In addition, capital levels have the expected significantly positive effect, except for small banks (See Table 6.4), which is counter to expectations and for large banks where the result is not significant.

Overall, RWA does appear able to capture the underlying risks for business models having most exposures in loans to customers (i.e. retail oriented banks). In turn, it fails to do so for wholesale-oriented and investment-oriented banks. The relationship between the two measures of risk is ambiguous for these business models, even after controlling for capital levels. The findings suggest that the risk-weighted assets of these banks are not well calibrated. This implies that the risk-weights of certain assets or activities, conducted primarily by these banks, might be incorrect. Wholesale-oriented and investment-oriented banks, for example,

engage more in interbank and trading activities. The effective risk-weights for these activities are quite low, due to the possibility of lowering the exposures (e.g. derivative exposures are reduced using compression, hedging, offsetting and netting), which is particularly attractive to banks with larger market activities that can benefit from scale advantages.

TABLE 6.4 – Relationship between Z-score and RWA, 2000-14

a) Bank business models

	Model 1 – Wholesale-oriented	Model 2 – Retail (Type 1)	Model 3 – Retail (Type 2)	Model 4 – Investment-oriented	All
RWA/TA	34.70***	-17.66***	-35.06***	7.77***	-24.34***
	(5,1)	(1,1)	(0,9)	(1,5)	(0,5)
TCE	49.79***	107.38***	51.36***	134.98***	21.82***
	(4,7)	(2,8)	(2,2)	(3,7)	(0,8)
Cons.	-18.48	28.79	42.64	13.22	39.56
	(4,5)	(0,8)	(0,7)	(0,9)	(0,4)
Obs.	2450	40675	46926	14424	104475
Log L.	-13940	-182716	-203237	-65193	-478048
LR chi2(2)	116	1716	1954	1292	3684
Prob>chi2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nb. Obs. left censored	7	13	66	1	87
Pseudo R2	0.00414	0.00467	0.00467	0.00981	0.00383

b) Bank size categories

	Micro (<$1bn)	Very small ($1-$5bn)	Small ($5-$10bn)	Mid ($10-$50bn)	Large (>$50bn)	All
RWA/TA	-24.93***	-15.92***	-7.31**	-10.35***	-9.38***	-24.34***
	(0.55)	(1.7)	(3.4)	(2.6)	(3.5)	(0.5)
TCE	21.20***	2.79	-17.17	28.73*	2.81	21.82***
	(0.85)	(5.4)	(15.2)	(17.4)	(22.4)	(0.8)
Cons.	40.24	33.23	27.63	22.21	24.78	39.55
	(0.41)	(1.3)	(2.5)	(2.0)	(2.8)	(0.4)
Obs.	97098	5322	813	847	395	104475
Log L.	-445536	-23370	-3552	-3452	-1546	-478048
LR chi2(2)	3394	86	8	14	8	3684
Prob>chi2	<0.0001	<0.0001	0.01832	0.00091	0.01832	<0.0001
Nb. Obs. Left censored	87	0	0	0	0	87
Pseudo R2	0.00379	0.00184	0.00112	0.00202	0.00258	0.00384

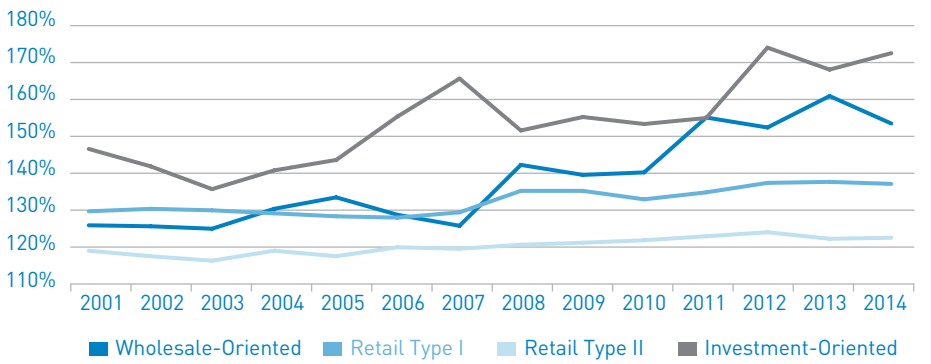
Notes: Regressions present results for Tobit regressions with the Z-score as the dependent variable and left-censored at zero. Robust standard errors are in parentheses. ***, **, and * signify significance at 1%, 5%, and 10% p-values. RWA: risk-weighted-assets as % of total assets; TCE: tangible common equity as % of tangible assets; Log L.: log likelihood ratio.
Source: Authors

Besides the capital requirements, the latest international prudential banking rules also have requirements for liquidity. The liquidity requirements, as foreseen under Basel III, consist of the liquidity coverage ratio and the **net stable funding ratio (NSFR).** These are meant to ensure that banks have respectively sufficient liquid funds to cover 30 days and 1 year. The NSFR used in this study is an estimate of the proposed long-term liquidity risk measure under the Basel III rules, (BCBS, 2010a). Expressed simply, the measure gives an estimate of the available stable funding sources as a share of required stable funding, which is constructed with the available data. Although the measure should be interpreted with caution, a greater value should point to lower liquidity risks.[36]

Figure 6.8 shows that all models satisfy the 100% funding requirement, as will be required by 2018. The wholesale-oriented and investment-oriented banking models face relatively lower liquidity risks, while the retail-oriented models may face higher risks. Moreover, the liquidity conditions have remained relatively stable for retail models, while they have clearly improved for the wholesale-oriented and investment oriented business models, the liquidity of which has been more volatile while improving since 2011. The differences between the bank size categories are less pronounced; but, since 2009, large banks seem to have a clearly higher liquidity ratio. The NSFR of the different bank size categories decreased in the run-up to the crisis and increased to reach, in 2012, the highest levels in ten years. In the more recent years, the liquidity ratio decreased again.

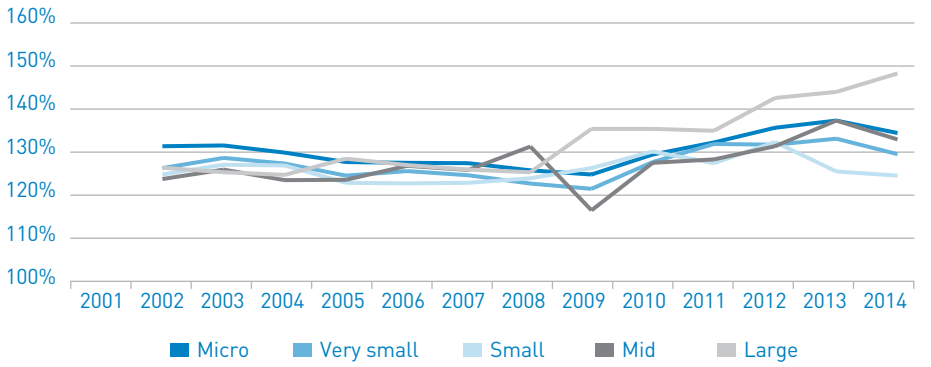
FIGURE 6.8 – Evolution of net stable funding ratio (NSFR)

a) Bank business models



36. See Appendix V for a detailed description of the measure used in this study. Note that the developed indicator suffers substantially from the unavailability of detailed information. In particular, the disclosure requirements that are currently applicable do not require banks to distinguish between different maturities, secured transactions and many specific asset and liability classes that are relevant for determining liquidity in an institution.

b) Bank size categories



Note: The amounts expressed in the figure are the weighted averages of individual NSFR computed with year-end observations, using total assets as amounts for the weights.
Source: Authors

Turning to credit unions, capital requirements over the period of fifteen years under review consist of balance sheet size capital requirements per total assets and a risk-sensitive ratio, which only applies for large, "complex" institutions. By and large, most credit unions in the U.S. may only count retained earnings toward their capital requirements. While credit union capital requirements had historically been more lenient, in 1998 the Congress established today's balance sheet size capital requirements (per total assets) for most credit unions and directed the NCUA to implement an additional risk-based net worth requirement for larger, more complex credit unions.

Prompt corrective action capital guidelines for US credit unions

For US credit unions, the PCA framework is coded in the Credit Union Membership Access Act (CUMAA) of 1998. The requirements in the table below are those that were binding over the period 2000-2014. The only provision that changed is the definition of complex credit union, raising the total asset threshold in 2013 from $10 million to $50 million.

Prompt corrective action threshold for credit unions

Classification	Net Worth ratio		And subject to
Well capitalized	7% or above	AND	If complex, meet applicable RBNW requirements
Adequately capitalized	6% to 6.99%	AND	If complex, meet applicable RBNW requirements
Undercapitalized	4% to 5.99%	OR	If complex, fails applicable RBNW requirement
Significantly undercapitalized	2% to 3.99	OR	If undercapitalized at 0-5% net worth ratio and fails to timely submit or materially implement net worth restoration plan
Critically undercapitalized	0% to 2%		None

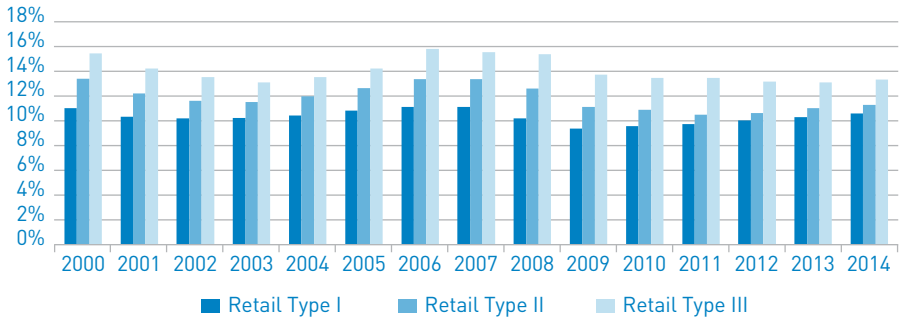
Note that, in 2015, the NCUA has redesigned this framework into a risk-based capital (RBC) system that more closely mimics bank risk-based capital requirements. The new RBC will become binding in 2019.

Source: Code of Federal regulations, Title 12, 702.10

The balance sheet size capital requirement for a credit union is its **net worth ratio** (i.e. largely retained earnings as a share of total assets). Higher levels of net worth indicate that the credit union has a higher loss-absorbing capacity. The NCUA considers that non-complex credit unions are well capitalized when they maintain a minimum net worth to assets ratio above 7.0%, adequately capitalized when the ratio is above 6.0% and undercapitalized when it falls below that threshold.

Figure 6.9 shows that, across business models, average net worth ratio was more than sufficient for credit unions to be considered well capitalized, assuming they are not complex. For all three business models, average net worth decreased between 2000 and 2003 and rose in the years before the crisis. During the crisis, the average net worth ratio deteriorated and remained fairly stable in the aftermath of the crisis. Retail type III credit unions had the highest average net worth ratio throughout the 15 year-period covered, followed by retail type II and retail type I credit unions respectively. All in all, average net worth was more than sufficient for credit unions to be considered well capitalized, assuming they are not complex.

FIGURE 6.9 – Net worth ratio of credit unions

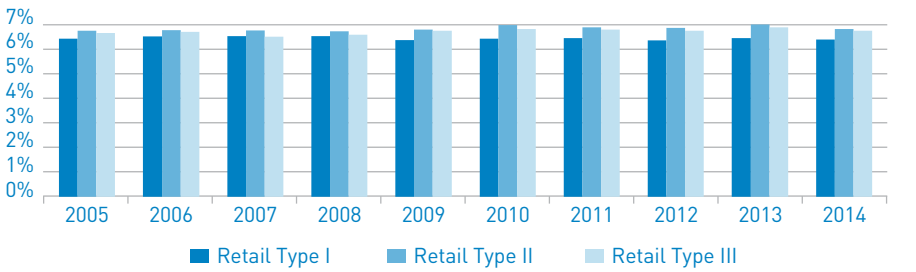


Note: The net worth ratios in the figure above are the assets-weighted means of the individual net worth ratios.
Source: Authors

The risk-based net worth (RBNW) ratio is a risk-weighted average of on and off-balance sheet items, reported as a share of the total assets of a credit union. It applies to complex credit unions, i.e. those with assets greater than $10 million prior to 2013 and greater than $50 million from 2013 onward. In addition to the 6% minimum net worth ratio, the RBNW requirement is the threshold that binds for complex credit unions, on an individual basis[37]. The information on risk-based requirements is only reported since 2005. Overall, the risk-based indicators are available for 5.52% of the credit-union-year observations.

The results in Figure 6.10 suggest that the weighted average of RBNW requirements, which are between 6% and 7%, are hardly distinguishing indicators for credit union business models. Indeed, the average RBNWs are very close, even though the retail type II credit unions exhibit the highest average RBNW every year. According to the NCUA PCA schedule, complex credit unions, on average, can seldom be considered well capitalized. But they have been consistently adequately capitalized (RBNW between 6% and 7%) over the ten years covered by the data.

FIGURE 6.10 – Evolution of reported average risk based net worth ratios of credit unions



Note: The amounts expressed in the figure are the asset-weighted means of the risk-based net worth requirements.
Source: Authors

37. While these risk-based net worth requirements are currently still binding, the NCUA has recently redesigned them into a risk-based capital (RBC) system that more closely mimics bank risk-based capital requirements. The new RBC will become binding in 2019.

7 Conclusions

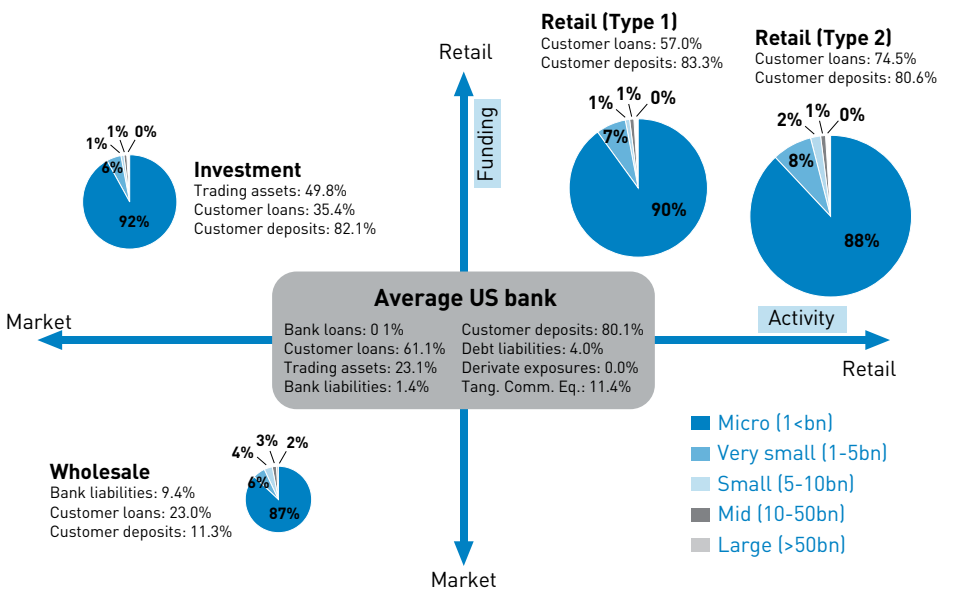
This investigation into business models in the United States assesses the banking sector structure in light of the changing economic, legislative and supervisory environment. In particular, it analyzes the interaction between business models and size categories, as well as the migration, financial performance, contribution to the real economy, risk and response to regulation, through four bank and three credit union business models and five bank size categories

The study includes 10,352 commercial banks and savings institutions, as well as 10,392 credit unions, which respectively account for almost all total banking assets of the country and more than 80% of the total assets of credit unions. Two cluster analyses are performed by using a definition and adapting a robust clustering methodology, initially applied on bank data for European banks in Ayadi et al (2016). The definition uses the activity and funding profiles of a bank or a credit union based on balance sheet indicators.

The first clustering is carried out on the bank sample over the period 2000-2014 with 108,226 bank-year observations, which are clustered into four groups: wholesale-oriented, retail (type 1), retail (type 2), and "investment-oriented" banks. The second clustering, on a sample of 115,588 credit union-year observations, has yielded three groups of retail business models called type I, type II and type III.

The results of the bank business model identification are summarized in Figure 7.1 and the key findings per bank business model in Table 7.1.

FIGURE 7.1 – Bank business models and bank sizes in the US



Note: The shares by size category in each pie are based on the share of bank-year observations (See also Table 3.3).
Source: Authors

Wholesale-oriented banks are the smallest model in number of institutions and the second smallest based on total assets. This group relatively includes the largest shares of larger banks (e.g. small, mid-sized and large banks) but also a relatively high share of the tiniest banks in the sample. Wholesale-oriented banks primarily engage in interbank borrowing and, to a lesser extent, lending. The model includes predominantly commercial banks and the lowest share of savings institutions. The model is among the least stable models with banks primarily migrating to retail (type 2) and, to lesser extent retail (type 1).

Wholesale-oriented banks are the only model that does not obtain the majority of operating income from net interest income. Although net interest income still represents a predominant share of their income, a sizable share of the income was obtained from commissions and fees as well as other income. Trading income is a relatively unimportant income source, but it is volatile, with several years of trading losses.

Wholesale-oriented banks reported the highest loan loss provisions throughout the sample period. These banks were also closest to default with a very low z-score. Wholesale-oriented banks' operational efficiency has been worse than those of other business models. Returns have, nevertheless, been only slightly lower than those for other models. Although there are many wholesale-oriented banks without customer loan books, the ones that do have one reported high loan growth in the run-up to the crisis and a large contraction from 2009 to 2011. The large share of tiny banks might also partially explain why the average risk-weight is relatively lower than those for other models despite higher loan losses.

Retail (type 1) banks form the largest group of banks measured by assets, but are the second largest measured by number of institutions. Bank distribution across size categories follows the sample average. Among these banks are predominantly commercial banks and a moderate share of savings institutions. The model is rather unstable with banks primarily migrating to retail (type 2) and, to a lesser extent, to investment-oriented banks. Further, it is the most important recipient of migrating banks. Retail banks (type 1) combine lending to customers with a moderate percentage of trading activities using primarily customer deposits for funding.

The other activities are reflected in relatively high commission and fee income, in addition to the net income that accounts for the majority of operating revenues. Although trading income is negligible relative to operating income, the level is close to the highest among the different clusters.

Retail (type 1) bank returns deteriorated during the crisis, but remained positive. Retail (type 1) banks' loan losses were substantial during the crisis, while relatively low pre- and post- crisis. These banks reported moderate customer loan growth, except for the crisis years, in which the loan portfolio remained more or less stable. The distance to default has increased over time, in particular during the post-crisis period, where retail (type 1) banks had a relatively high z-score. This was not reflected in regulatory ratios. In particular, the average risk-weight was substantially higher than those for non-retail business models.

Retail (type 2) banks are the largest group measured by number of institutions. Measured in asset terms, retail (type 2) banks are, however, substantially smaller than the first type of retail banks. This group includes a considerable number of very small banks. The activities of the second type of retail banks consist primarily of lending to customers, mainly using customer deposits. These banks are predominantly commercial banks but the share

of savings banks is, nevertheless, the highest of all business models. The model is the most stable with only limited migration. Retail (type 2) banks that change business models almost exclusively move to retail (type 1).

Their relatively high lending activities result in the largest share from net interest income among the business models. The shares of commission and trading income are substantially lower than those for other business models. Although the distance to default (based on the z-score) has been moderate, the average risk-weight was the highest of all bank business models.

Retail (type 2) bank returns have been relatively volatile. In fact, their returns were relatively high pre- and post- crisis, while retail (type 2) banks reported the lowest returns during the crisis years. In parallel, retail (type 2) banks showed high customer loan growth in the run-up to the crisis and recovered relatively swiftly after the drop during the financial crisis.

The banks identified as **investment-oriented** are the smallest group based on total assets and the second smallest measured by number of institutions. However, in 2013 and 2014, total assets have increased substantially, making it overtake wholesale-oriented banks and catch up with the retail (type 2) banks. This group includes relatively many micro banks. Investment-oriented banks primarily engage in trading activities while relying on customer deposits for funding. Investment-oriented banks are predominantly commercial banks, but there is a moderate share of savings institutions. The model is fairly stable with banks almost exclusively migrating to retail (type 1).

Investment-oriented banks rely for an important share of their income on non-interest income. Commissions and fees as well as other income form, after the wholesale-oriented banks, the largest share of their income. Trading income is relatively low but, nevertheless, higher on average than for all other bank business models. This income has been quite volatile during the sample period, with relatively high trading income during most years and high losses during the crisis.

Notwithstanding the trading losses, the financial crisis has had limited impact on investment-oriented banks. For example, returns on assets were relatively higher during the crisis and risk costs were lower. The relative resilience of investment-oriented banks was also reflected in a higher z-score and lower average risk-weights. Moreover, although investment-oriented banks have been more efficient than other business models in the non-crisis periods, their returns were relatively lower during these years. Investment-oriented banks had the lowest customer loan growth over the sample period.

Turning to results across bank size categories, results for micro, very small, small and mid-sized banks show a clear trade-off between risk and returns, while the results for large banks are more distinct.

Micro banks (less than $1bn in total assets) account for more than ninety percent of the institutions, but only about a tenth of total assets. Micro banks primarily engage in deposit-loan intermediation. These banks, besides high amounts of customer loans and deposits, also have sizable trading activities.

Micro banks performed substantially worse than the other size categories. Indeed, returns on assets were lowest and efficiency scores were highest among all size categories.

TABLE 7.1 – Results across bank business models, 2000-14

	Model 1 – Wholesale-oriented (2,665 obs.)	Model 2 – Retail (Type 1) (41,993 obs.)	Model 3 – Retail (Type 2) (48,739 obs.)	Model 4 – Investment-oriented (14,829 obs.)
Size	Relatively many large banks (small, mid-sized, large) but also tiniest of micro banks	Similar to the sample average, slightly more micro banks	Similar to sample average, slightly more very small and fewer micro banks	Similar to sample average, slightly micro and fewer very small banks
Charter types	Predominantly commercial banks, lowest share of savings institutions	Predominantly commercial banks, average share of savings institutions	Predominantly commercial banks, largest share of savings institutions	Predominantly commercial banks, average share of savings institutions
Migration	Less stable business model (80%); migration to retail (type 1 & 2)	Less stable business model (80%); exchange with retail (type 1) and investment-oriented	Most stable business model (89%); exchange with retail (type 1)	Stable business models (83%); exchange with retail (type 1)
Financial performance & operational efficiency	Returns stable, except for losses during fin. crisis, and less efficient	Returns deteriorated during the fin. crisis, while efficiency improved	Returns most volatile and only model posting losses, operational efficiency after the fin. Crisis	Returns rather low but stable and became lower after fin. crisis
Contribution to the real economy	Low and volatile customer loan growth, low pre-crisis and contrac-tion during and after crisis	High customer loan growth (but lower than retail type 2)	Highest customer loan growth, least contraction during fin. crisis	Low and volatile customer loan growth, low pre-crisis and contraction during crisis
Risk	Low distance to default and highest loan loss provisions	Average distance to default and moderate loan loss provisions	Average distance to default and moderate loan loss provisions	High distance to default and lowest loan loss provisions
Response to regulation	Low risk weights; sharply increasing reg. cap. and tan. eq.; very highly liquid	High risk weights; moderate reg. cap. and tan. eq.; least liquid	High risk weights; moderate reg. cap. and tan. eq.; moderately liquid	Low risk weights; very high reg. capital and tan. eq.; highly liquid

In turn, micro banks appeared to be less risky overall. They were furthest from default based on the Z-score, had the lowest loan losses and the lowest risk-weights. Moreover, capital, measured by both the leverage and tier 1 capital ratios, was significantly higher than for other size categories.

Overall, micro banks increased their customer loan portfolio significantly less than other size categories. They kept a positive customer loan growth during the crisis, in particular in 2009.

The results for both **very small** (between $1bn and $5bn in total assets) and **small** (between $5bn and $10bn in total assets) banks are largely comparable. Very small banks account for about five percent of the observations and more than seven percent of total assets, while small banks account for less than one percent of the observations and almost four percent of assets. Banks in both these size categories primarily engage in deposit-loan intermediation with small banks engaging more in market activities (i.e. debt liabilities and trading assets).

Compared to micro banks, very small and small banks have slightly higher returns, but they are also slightly more risky. These banks faced higher loan losses than micro banks, in particular during the financial crisis. The higher loan losses were reflected in negative returns during some of the financial crisis years. Overall however, small and very small banks reported higher returns than micro banks, among other reasons being due to more efficient operations. Small and very small banks are relatively more leveraged than micro banks, with both lower leverage and capital ratios.

Mid-sized banks (between $10bn and $50bn in total assets) represent less than one percent of the observations, but about twelve percent of total assets. The activities of mid-sized banks consist, for the most part, of deposit-loan intermediation, but they also obtain substantial funding from debt liabilities and have relatively larger trading and bank exposures than smaller banks.

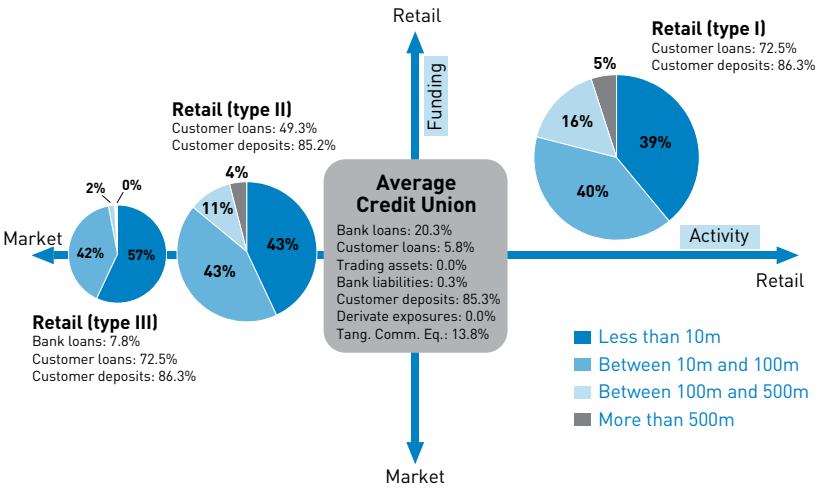
Mid-sized banks report substantially higher returns, but are also the most risky of all size categories. Although mid-sized banks took high loan loss provisions, in particular during the crisis years, they reported the highest ROA and ROE throughout the sample period. Mid-sized banks were, nevertheless, closest to default based on the z-score measure, predominantly because of their low capital levels.

Large banks (more than $50bn in total assets) account for less than half a percent of observations, but about two-thirds of assets. Large banks are relatively more active in market activities, with relatively large debt liabilities and derivative exposures, as well as the lowest level of customer deposits and loans.

On one hand, the performance of large banks is similar to that of very small and small banks while, on the other hand, their risk profile is barely better than that of mid-sized banks, which were relatively more risky than smaller banks. Loan loss provisions were, for example, during the pre- and post- crisis period relative low, but among the highest during the crisis. Moreover, large banks were also the size category with the largest contraction in loan portfolios across all size categories during the financial crisis.

Looking at capital positions, large banks had the largest leverage. Indeed, both the plain leverage ratio and the regulatory capital ratio, that encloses the high average risk-weight for large banks, are the lowest of all size categories.

FIGURE 7.2 – Credit union business models and sizes in the US



Note: The shares by bank size categories in each pie are based on the share of bank-year observations.
Source: Authors

The results for the credit union business model identification are summarized in Figure 7.2 and the key findings per business model are discussed below.

Retail type I credit unions are the largest model in terms of both number of institutions (41%) and total assets (58%). It contains relatively most of the credit unions with total assets above $100m. Retail type I credit unions, like all credit unions, deliver services for their member-owners. They are most active in deposit-loan intermediation, with the highest level of customer deposits and loans. Retail type I credit unions are relatively stable, with almost all migrations occurring with retail type II credit unions.

Retail type I credit unions performed substantially better than the other models, with the highest ROA and ROE. Their returns are supported by more efficient operations. Their returns are, however, more volatile. Retail type I credit unions were the only credit unions reporting negative returns for 2008; they were, therefore, also the closest to default. Moreover, retail type I credit unions absorbed the most loan losses, both for the entire sample period and during the financial crisis. Except for 2000, they also had consistently the highest loan growth; even during the financial crisis their loan portfolio increased in size.

Retail type II credit unions are the second largest model and represent respectively 36% and 37% of the number of institutions and total assets. Also, retail type II contains fewer credit unions with assets above $100m. Retail type II credit unions also obtain most of their funding from customer deposits, but their activities are more diversified with, besides substantial lending to customers, also sizeable deposits and lending to (corporate) credit unions and banks. Retail type II credit unions are the least stable among the credit unions, with migrations from and to both retail type I and retail type III credit unions.

The relatively hybrid profile of retail type II, compared to retail type I credit unions, results in relatively lower margins. Retail type II credit unions, therefore, perform worse than retail type I credit unions. In fact, their efficiency scores are significantly higher and both the ROA and ROE are lower. The difference between their average ROEs is even larger because retail type II credit unions are relatively less leveraged. Also, retail type II credit unions are the

furthest from default based on their z-scores. The loan growth of retail type II has been relatively more pro-cyclical, with increasing growth rates in the run-up to the crisis and contraction during the crisis.

Retail type III credit unions are the smallest model and account for about a quarter of the observations and only 5% of total assets. It has the largest share of credit unions with total assets below $10m and least with assets above $100m. The majority of assets are, however, held by the credit unions with between $10m and $100m total assets. Retail type III credit unions, like the other two credit union business models, obtain most of their funding from customer deposits, but their diversified activities consist, for a relatively larger share of deposits, in (corporate) credit unions and banks. Hence, credit unions with excess liquidity park those excess funds elsewhere, even if they earn relatively small returns on those funds. Retail type III credit unions are relatively stable. Most of their migrations are interchanges with the retail type II credit union business model.

The even higher reliance of retail type III credit unions on low-yielding deposits in corporate credit unions and banks, results in even lower performance compared to retail type II credit unions. Hence, the efficiency scores are significantly higher and both the ROA and ROE are the lowest among the credit union business models. Retail type III credit unions are the least leveraged, which implies that the difference in ROE, compared with the other models, is even larger. The contribution to the real economy expressed in customer loan growth is even more pro-cyclical for retail type III than for retail type II.

The findings provide new evidence about the role of different business models in the United States banking sector, in terms of financial performance and operational efficiency, contribution to the real economy, contribution to systemic risk and impact on financial (in)stability. It is clear that retail-oriented banks are more inclined to contribute to the real economy, while maintaining equivalent levels of financial performance and contributing at a lesser level to the accumulation of risk at a system level and are more resilient to extreme stress conditions.

The Monitor's findings also shed light on the continuing misalignment of the regulatory indicators, in particular the risk weights and the Tier-1 capital ratio to the underlying risks of banks in the United States. This means that further improvements in risk weights ought to be made to ensure that this misalignment is properly addressed.

Continued monitoring of bank business models is essential to improve the understanding of this concept and, ultimately, to detect the accumulation of risk at a system level. Based on our analysis, it seems that in each business model, there are worse and better performing cases, depending on the overall macro and micro economic conditions in which banks are operating. Further research is being conducted, based on this Monitor sample, definition and analytical framework in order to shed light on the characteristics of the best performing banks within each business model, to which worse performing banks should converge in the long run.

The business model analysis also has a predictive power that is essential for regulators and supervisors to detect excessive risk accumulation at a system level over a period of time and, especially, when external shocks are simulated. Our prediction is that bank business models would respond differently to this shock and some might be more resilient than others. Moreover, understanding the systemic risk accumulation process is paramount to achieving a targeted macro-prudential regulation. Clustering the institutions per business model that tend to drive systemic risk upward and acting accordingly with the appropriate regulatory and supervisory measures, would be the beginning of a new dynamic and targeted regulatory framework. This would complement the current framework, which when improved (as discussed earlier), would work together in tandem.

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List of Abbreviations

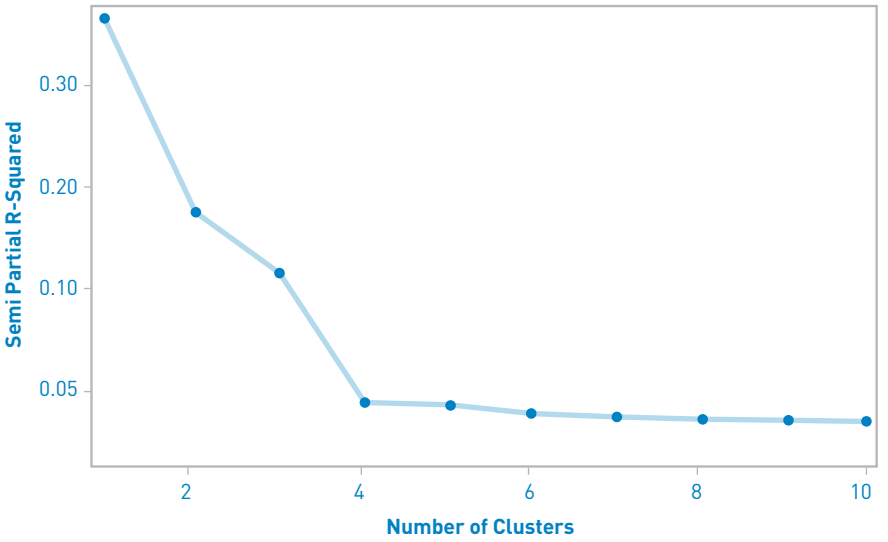
ABCP	Asset-backed commercial paper
AQR	Asset quality review
BCBS	Basel Committee on Banking Supervision
BSS	Between cluster sum of square
CET1	Common equity Tier-1
CIR	Cost-to-income ratio
FDIC	Federal Deposit Insurance Corporation
FED	Federal Reserve
IRB	Internal rating-based
NCUA	National Credit Union Administration
NSFR	Net stable funding ratio
ROA	Return on assets
ROE	Return on equity
RoRWA	Return on risk-based assets
RWA	Risk-weighted assets
SME	Small and medium-sized enterprises
SSB	Some of Square Between
SPRSQ	Semi partial R-squared
TA	Total assets
TCE	Tangible common equity
TCR	Total capital requirement
US	United States
USD	United States Dollar
OCC	Office of the Comptroller of the Currency

Appendix I.
Determining the Optimal Number of Clusters

The pseudo-F statistics of Calinski & Harabasz confirms four clusters as the optimal solution for banks and three clusters for credit unions. We present here three other popular selection criteria; Semi Partial R-Squared, Between Cluster Sum of Squares and Dendogram (Sum of Squares Between. They all support the five-cluster configuration.

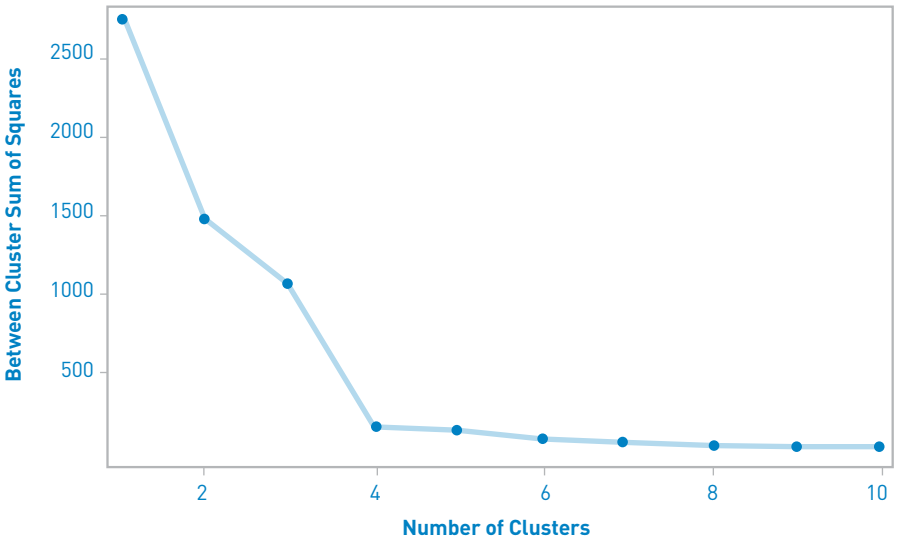
Bank business models

Semi Partial R-Squared (SPRSQ) – Banks



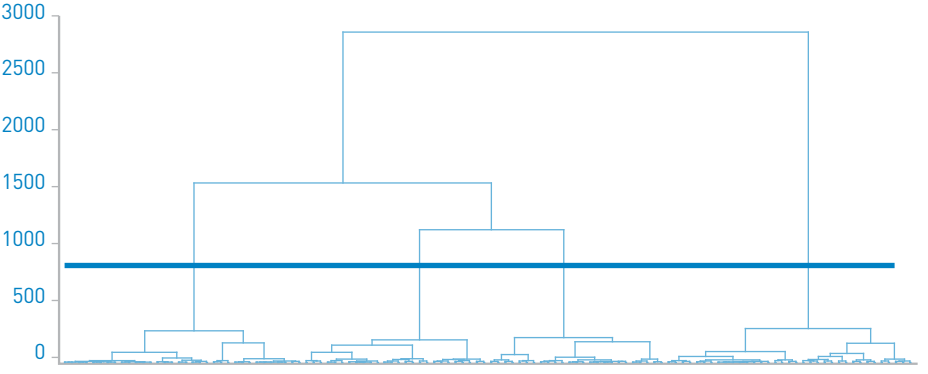
Note: The Semi Partial R-Squared measures the loss of homogeneity when a new group is created. Since we are seeking homogeneous groups, it must be small enough. Also, the number of clusters must be parsimonious. It is clear from the figure that four is an important break point for the number of clusters, where the curve has leveled off and most of the drop in the semi-partial R-squared has been achieved.
Source: Authors

Between Cluster Sum of Squares (BSS) – Banks



Note: Available only when Ward's method is used. It measures the distance between the two clusters that have been grouped together. Hence, the value of adding an additional cluster should be limited, i.e., low value of the between cluster sum of squares. It is clear from the figure above that four clusters form an important breaking point for the number of clusters.
Source: Authors

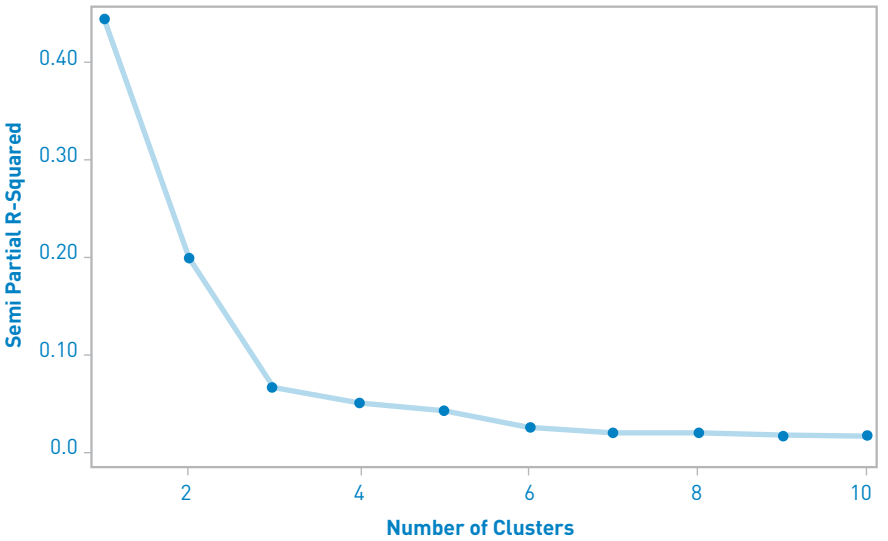
Dendrogram – Banks



Note: On the Dendrogram, new clusters are formed in a hierarchical way by partitioning existing clusters. The Y-axis represents the distance between datasets according to the measure Sum of Square Between (SSB). More precisely, for each horizontal line, one reads the distance between two clusters. The cut off line for four clusters can even drop below 200, while keeping the number of clusters at four. It is clear, again, that by selecting four clusters, most of the reduction in SSB is achieved.
Source: Authors

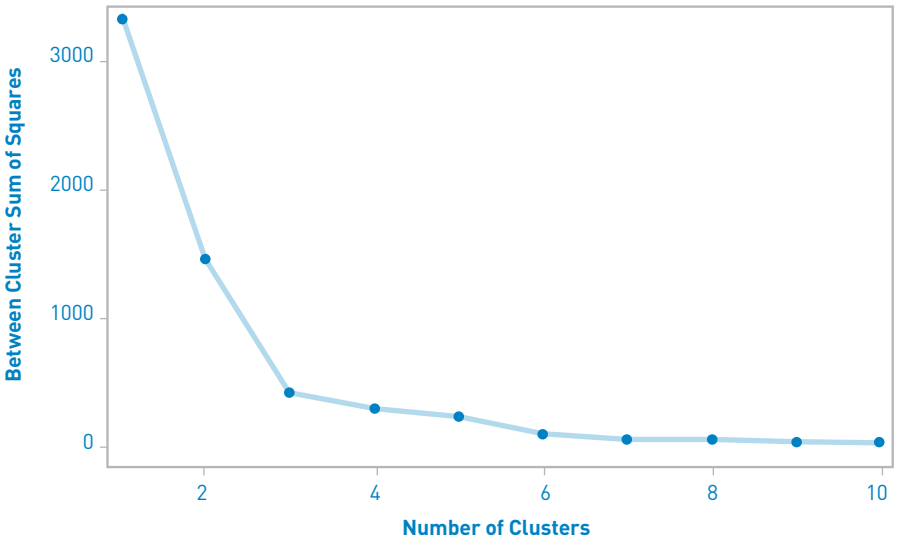
Credit Union business models

Semi Partial R-Squared (SPRSQ) – Credit unions



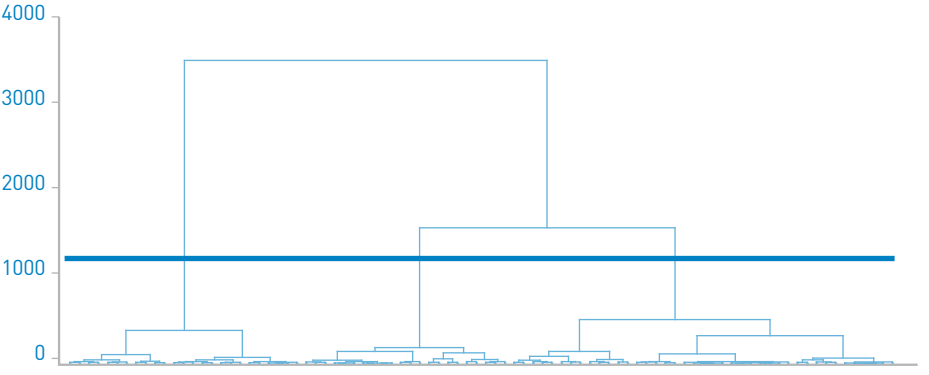
Note: The Semi Partial R-Squared measures the loss of homogeneity when a new group is created. Since we are seeking homogeneous groups, it must be small enough. Also, the number of clusters must be parsimonious. It is clear from the figure that three is an important break point for the number of clusters, where the curve has started to level off and most of the drop in the semi-partial R-squared has been achieved.
Source: Authors

Between Cluster Sum of Squares (BSS) – Credit unions



Note: Available only when Ward's method is used. It measures the distance between the two clusters that have been grouped together. Hence, the value of adding an additional cluster should be limited, i.e. low value of the between cluster sum of squares. It is clear from the figure above that three clusters form the most important breaking point.
Source: Authors

Dendrogram – Credit unions



Note: On the Dendrogram, new clusters are formed in a hierarchical way by partitioning existing clusters. The Y-axis represents the distance between datasets according to the measure Sum of Square Between (SSB). More precisely, for each horizontal line, one reads the distance between two clusters. The cut off line for three clusters can drop below 500, while keeping the number of clusters at three. It is clear that by selecting two or three clusters, most of the reduction in SSB is achieved.
Source: Authors

Evolution of size across bank business models

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total assets (€ billion)															
Wholesale-oriented	1,501	1,614	1,629	1,787	2,243	2,227	2,679	3,319	4,022	3,570	3,639	3,938	3,965	2,094	2,141
Retail (Type 1)	1,654	2,547	2,957	2,907	3,269	3,696	3,223	3,134	3,037	4,169	4,886	5,303	6,077	6,100	6,423
Retail (Type 2)	2,850	2,035	1,904	2,119	2,482	2,725	3,759	4,231	4,808	3,229	2,529	2,246	2,710	2,991	3,455
Investment-oriented	307	484	710	918	497	402	352	428	290	667	772	966	1,128	2,967	3,090
All banks	6,313	6,680	7,200	7,730	8,491	9,050	10,013	1,112	2,156	11,635	1,826	12,453	13,880	14,153	15,109
Number of institutions															
Wholesale-oriented	176	167	153	158	148	261	248	245	195	161	163	148	156	148	138
Retail (Type 1)	3,884	3,668	3,417	3,169	2,873	2,678	2,521	2,325	2,160	2,372	2,549	2,686	2,824	2,592	2,275
Retail (Type 2)	3,269	3,218	3,189	3,174	3,457	3,672	3,844	3,981	4,024	3,562	2,990	2,477	2,546	2,609	2,727
Investment-oriented	1,058	1,083	1,168	1,297	1,153	985	850	765	715	738	817	1,008	1,156	1,064	972
All banks	8,387	8,136	7,927	7,798	7,631	7,596	7,463	7,316	7,094	6,833	6,519	6,319	6,682	6,413	6,112
Median total assets (€ billion)															
Wholesale-oriented	0.033	0.097	0.089	0.097	0.126	0.022	0.027	0.027	0.053	0.060	0.059	0.061	0.054	0.046	0.053
Retail (Type 1)	0.078	0.087	0.094	0.098	0.100	0.104	0.104	0.105	0.111	0.133	0.150	0.162	0.177	0.171	0.177
Retail (Type 2)	0.098	0.100	0.108	0.120	0.130	0.143	0.156	0.165	0.169	0.168	0.165	0.169	0.174	0.194	0.209
Investment-oriented	0.058	0.069	0.079	0.080	0.076	0.077	0.078	0.079	0.084	0.098	0.104	0.116	0.124	0.121	0.125
All banks	0.082	0.090	0.097	0.104	0.110	0.115	0.121	0.128	0.136	0.146	0.148	0.155	0.165	0.168	0.178
Average total assets (€ billion)															
Wholesale-oriented	8.530	9.663	10.645	11.308	15.157	8.531	10.804	13.545	20.625	22.172	22.324	26.611	25.414	14.149	15.511
Retail (Type 1)	0.426	0.694	0.865	0.917	1.138	1.380	1.278	1.348	1.406	1.758	1.917	1.974	2.152	2.353	2.823
Retail (Type 2)	0.872	0.632	0.597	0.667	0.718	0.742	0.978	1.063	1.195	0.906	0.846	0.907	1.065	1.147	1.267
Investment-oriented	0.290	0.447	0.608	0.708	0.431	0.408	0.414	0.560	0.406	0.904	0.944	0.958	0.976	2.789	3.179
All banks	8.530	9.663	10.645	11.308	15.157	8.531	10.804	13.545	20.625	22.172	22.324	26.611	25.414	14.149	15.511

Notes: All computations are based on year-end observations.
Source: Authors

Evolution of size across bank size categories

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total assets (€ billion)															
Micro	1,056	1,095	1,131	1,160	1,187	1,224	1,245	1,260	1,290	1,279	1,210	1,206	1,308	1,265	1,238
Very small	579	591	622	615	663	700	750	792	796	787	784	797	922	930	972
Small	374	388	371	394	366	439	389	382	396	393	378	363	439	450	511
Mid	1,423	1,359	1,476	1,545	1,444	1,280	1,271	1,147	881	935	1,004	1,015	1,415	1,454	1,612
Large	2,881	3,247	3,601	4,016	4,831	5,407	6,358	7,531	8,793	8,240	8,449	9,072	9,796	10,054	10,777
All banks	6,313	6,680	7,200	7,730	8,491	9,050	10,013	1,112	2,156	11,635	1,826	12,453	13,880	14,153	15,109
Number of institutions															
Micro	7964	7708	7494	7343	7163	7099	6943	6785	6567	6301	5985	5780	6055	5780	5463
Very small	287	291	296	311	330	353	378	392	389	396	399	403	463	467	473
Small	54	55	52	57	52	62	56	56	56	55	52	51	61	63	72
Mid	64	62	65	66	63	57	60	53	48	51	53	55	70	70	71
Large	18	20	20	21	23	25	26	30	34	30	30	30	33	33	33
All banks	8,387	8,136	7,927	7,798	7,631	7,596	7,463	7,316	7,094	6,833	6,519	6,319	6,682	6,413	6,112
Median total assets (€ billion)															
Micro	0.08	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.15	0.15
Very small	1.72	1.78	1.73	1.65	1.65	1.68	1.68	1.70	1.72	1.66	1.64	1.62	1.67	1.67	1.68
Small	6.77	7.02	6.91	6.31	6.40	6.80	6.45	6.47	6.80	6.83	7.09	6.64	6.79	6.77	6.81
Mid	17.39	19.11	20.04	20.39	21.42	18.98	15.97	17.06	14.91	14.26	16.31	15.26	16.60	17.82	19.43
Large	90.78	81.12	83.02	89.30	88.74	81.07	91.49	106.59	109.0	122.1	127.64	114.34	104.82	105.29	118.21
All banks	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.18
Average total assets (€ billion)															
Micro	0.133	0.142	0.151	0.158	0.166	0.172	0.179	0.186	0.196	0.203	0.202	0.209	0.216	0.219	0.227
Very small	2.018	2.029	2.101	1.977	2.009	1.983	1.984	2.020	2.046	1.988	1.966	1.977	1.992	1.991	2.055
Small	6.930	7.060	7.126	6.913	7.048	7.083	6.948	6.818	7.072	7.154	7.267	7.108	7.194	7.141	7.091
Mid	22.231	21.922	22.707	23.408	22.926	22.456	21.177	21.642	18.356	18.331	18.946	18.451	20.219	20.778	22.699
Large	160.032	162.367	180.033	191.248	210.031	216.264	244.539	251.034	258.62	274.66	281.637	302.407	296.860	304.659	326.581
All banks	0.753	0.821	0.908	0.991	1.113	1.191	1.342	1.519	1.714	1.703	1.814	1.971	2.077	2.207	2.472

Note: All computations are based on year-end observations.
Source: Authors

Evolution of size across credit union business models

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total assets (€ billion)															
Retail type I	297	306	296	307	342	428	457	434	453	462	451	333	342	406	474
Retail type II	80	133	182	212	183	142	130	137	148	221	277	462	498	457	427
Retail type III	11	17	26	31	35	31	22	26	29	36	41	39	44	43	41
All Credit Unions	388	456	504	550	560	601	608	597	629	719	769	834	884	906	942
Number of institutions															
Retail type I	5,877	4,647	3,762	3,362	3,420	3,850	4,118	3,907	3,185	2,556	2,223	1,724	1,543	1,623	1,741
Retail type II	2,313	3,259	3,513	3,510	3,089	2,588	2,339	2,372	2,434	2,553	2,661	2,994	2,855	2,699	2,440
Retail type III	1,268	1,557	1,936	2,011	2,025	1,731	1,373	1,280	1,630	1,822	1,983	1,972	2,059	1,910	1,802
All Credit Unions	9,458	9,463	9,211	8,883	8,534	8,169	7,830	7,559	7,249	6,931	6,867	6,690	6,457	6,232	5,983
Median total assets (€ billion)															
Retail type I	0.009	0.011	0.013	0.015	0.018	0.019	0.019	0.020	0.027	0.033	0.036	0.032	0.038	0.047	0.055
Retail type II	0.007	0.009	0.010	0.011	0.011	0.011	0.011	0.011	0.013	0.016	0.021	0.028	0.033	0.032	0.034
Retail type III	0.004	0.005	0.006	0.007	0.007	0.007	0.006	0.007	0.008	0.009	0.010	0.011	0.012	0.012	0.012
All Credit Unions	0.008	0.009	0.010	0.010	0.011	0.012	0.012	0.013	0.014	0.016	0.018	0.019	0.021	0.023	0.025
Average total assets (€ billion)															
Retail type I	0.051	0.066	0.079	0.091	0.100	0.111	0.111	0.111	0.142	0.181	0.203	0.193	0.221	0.250	0.272
Retail type II	0.034	0.041	0.052	0.060	0.059	0.055	0.055	0.058	0.061	0.087	0.104	0.154	0.174	0.169	0.175
Retail type III	0.008	0.011	0.013	0.016	0.017	0.018	0.016	0.020	0.018	0.020	0.021	0.020	0.022	0.022	0.023
All Credit Unions	0.041	0.048	0.055	0.062	0.066	0.074	0.078	0.079	0.087	0.104	0.112	0.125	0.137	0.145	0.157

Note: All computations are based on year-end observations.
Source: Authors

Appendix III. Calculation of Z-scores

The Z-score used in the study follows the one derived in Boyd & Runkle (1993), which is a simple indicator of the risk of failure or the distance to default. To derive the measure, it is assumed that default occurs when the one-time losses of bank *j* in year *t* exceed its equity, or when

$$\pi_{jt} + E_{jt} < 0. \tag{A1}$$

Then, assuming that the bank's return on total assets (ROA), or π_{jt} / TA_{jt}, is normally distributed around the mean μ_j, and standard deviation σ_j, the probability of failure is given as

$$pr(\pi_{jt} < -E_{jt}) = pr(\pi_{jt} / TA_{jt} < -E_{jt} / TA_{jt}) = \int_{-\infty}^{D_{jt}} \phi(r)dr, \tag{A2}$$

where ϕ represents the standard normal distribution, r is the standardized return on assets and D is the default boundary that separates a healthy bank from an unhealthy one, described as the normalized equity ratio:

$$D_{jt} = \frac{-(E_{jt} / TA_{jt}) - \mu_j}{\sigma_j}, \tag{A3}$$

Note that a greater D implies a greater probability of default and, therefore, a greater risk for the bank. The average and standard deviation calculations were obtained using available data for the years 2000-14.

Since D admits negative values in most cases, the Z-score is set to be represented as a positive number, or as

$$Z_{jt} = -D_{jt}. \tag{A4}$$

This implies that a greater Z-value implies a lower probability of default.

Appendix IV. Assumptions for the NSFR

The assumptions for the net stable funding ratio (NSFR) are similar to those put forward in IMF (2011). Introduced by the Basel Committee on Banking Supervision (BCBS, 2010a), the NSFR aims to restrict banks from having an excessive reliance on short-term funding, in an attempt to promote more balanced, mid-to-long-term financial resources, in order to support assets through stable funding sources. More specifically, the measure requires the available stable funding to exceed the required stable funding.

Available stable funding sources include total Tier-1 and Tier-2 capital, as well as reserves that count as part of equity. Stable forms of funding, including customer deposits and other liabilities with more than one-year maturities, are also included. Lower maturity liabilities, including term deposits and retail deposits from non-financial institutions, enter as available funding after the application of various haircuts. Short-term liabilities to financial institutions and secured wholesale funding are generally not included as available, due to substantial rollover risks and potential margin calls that may materialize in times of market stress.

Required stable funding includes assets that cannot be quickly sold off without substantial costs during adverse market conditions, lasting up to one year. Most customer loans are assumed to have long-term maturities and will, thus, face liquidation costs. All encumbered securities that are posted as collateral enter directly into the calculation of required stable funding, as they cannot be sold off without changing the original contract. Shorter maturity retail loans are also treated as required funding, albeit with an appropriate haircut. In turn, more liquid unencumbered assets, such as cash or marketable securities, receive lower factors, as they are, typically, readily available for sale without substantial potential losses.

Since the available data is quite restricted in nature, assumptions regarding many specific items were made. The following table provides the assumptions and the relevant multiplicative factors that were used to build the NSFR measure used in this study. Although comparable to the measure developed by IMF (2011), the validity of the results is likely to depend on the assumptions for certain factors more than on those for others. This is particularly the case for debt liabilities and trading assets, which make up more than one-third of the balance sheets of most banks, especially in the investment and wholesale banking models.

Balance sheet items	Factors
AVAILABLE STABLE FUNDING	
Customer deposits	85%
Deposits from banks	0%
Derivative liabilities (negative, fair-value)	0%
Debt liabilities	50%
Equity & reserves	100%

Balance sheet items	Factors
REQUIRED STABLE FUNDING	
Cash	0%
Customer loans	80%
Loans to banks	0%
Derivative assets (positive, fair-value)	90%
Trading assets	50%

Source: Ayadi *et al.* (2012)

Appendix V.
List of (large) systemic banks and selected banks in the other size categories in 2014

Bank name	Total assets in 2014 ($ thousands)	Size category	Year of 1st observation	Business model(s)
JPMorgan Chase Bank, National Association	2,074,981,000	Large	2000	W,I
Bank of America, National Association	1,574,093,000	Large	2000	R1, R2
Wells Fargo Bank, National Association	1,532,784,000	Large	2000	R1,R2
Citibank, N.A.	1,356,442,000	Large	2000	W
U.S. Bank National Association	398,978,359	Large	2000	R1, R2
PNC Bank, National Association	335,060,015	Large	2000	R1, R2
Bank of New York Mellon	304,166,000	Large	2000	W
State Street Bank and Trust Company	269,781,143	Large	2000	W
Capital One, National Association	255,011,219	Large	2000	R1, R2
TD Bank, N.A.	230,280,000	Large	2000	R1, R2,I
SunTrust Bank	185,888,583	Large	2000	R1, R2
Branch Banking and Trust Company	182,489,046	Large	2000	R1, R2
HSBC Bank USA, National Association	178,676,927	Large	2000	W,R1,I
Chase Bank USA, National Association	130,662,640	Large	2001	W, R2
Morgan Stanley Bank, National Association	125,528,000	Large	2000	W,R1,I
Regions Bank	118,801,412	Large	2000	R1, R2
Goldman Sachs Bank USA	118,214,000	Large	2008	W, I
MUFG Union Bank, National Association	113,120,106	Large	2000	R1, R2
Charles Schwab Bank	111,278,000	Large	2003	I

Bank name	Total assets in 2014 ($ thousands)	Size category	Year of 1st observation	Business model(s)
Northern Trust Company	109,596,957	Large	2000	W
Ally Bank	104,474,692	Large	2004	R1, R2
Citizens Bank, National Association	102,971,333	Large	2005	R1, R2
BMO Harris Bank, National Association	97,496,905	Large	2000	R1, R2
Manufacturers and Traders Trust Company	95,920,564	Large	2000	R2
KeyBank National Association	91,782,513	Large	2000	R1, R2
Capital One Bank (USA), National Association	90,652,741	Large	2000	W, R1, R2
Santander Bank, N.A.	80,472,892	Large	2012	R1, R2
Compass Bank	79,624,593	Large	2000	R1, R2
Bank of the West	71,682,343	Large	2000	R2
Comerica Bank	69,310,249	Large	2000	R2
USAA Federal Savings Bank	67,301,894	Large	2012	R1
Huntington National Bank	66,111,039	Large	2000	R2
Deutsche Bank Trust Company Americas	53,547,000	Large	2000	W
Synchrony Bank	49,594,943	Midsize	2000	W
UBS Bank USA	48,481,911	Midsize	2003	R1, R2,I
First Republic Bank	48,353,330	Midsize	2010	R2
American Express Bank, FSB	44,887,004	Midsize	2012	R2
E*TRADE Bank	44,672,387	Midsize	2012	I
New York Community Bank	44,281,869	Midsize	2000	R1
First Niagara Bank, National Association	38,494,804	Midsize	2010	R1
Silicon Valley Bank	37,619,619	Midsize	2000	R1, I
Hudson City Savings Bank	36,565,446	Midsize	2000	R1, I
People's United Bank, National Association	35,755,742	Midsize	2000	R1, R2
American Express Centurion Bank	34,758,392	Midsize	2000	W, R1, R2
Citizens Bank of Pennsylvania	32,914,202	Midsize	2001	R1, R2,I

Bank name	Total assets in 2014 ($ thousands)	Size category	Year of 1st observation	Business model(s)
City National Bank	32,314,043	Midsize	2000	R1, R2
BOKF, National Association	28,953,664	Midsize	2000	R1, I
Frost Bank	28,327,456	Midsize	2000	R1, I
Morgan Stanley Private Bank, National Association	27,356,000	Midsize	2010	R1, R2
Signature Bank	27,318,640	Midsize	2001	R1, I
Banco Popular de Puerto Rico	27,091,000	Midsize	2000	R1, R2,I
Synovus Bank	26,777,424	Midsize	2000	W, R1, R2
Associated Bank, National Association	26,653,631	Midsize	2000	R1, R2
BMW Bank of North America	9,948,711	Small	2000	R2
International Bank of Commerce	9,892,151	Small	2000	R1, I
Israel Discount Bank of New York	9,783,466	Small	2000	W,R1,I
MidFirst Bank	9,781,238	Small	2012	R2
Flagstar Bank, FSB	9,779,461	Small	2012	R1
Great Western Bank	9,636,848	Small	2000	R1, R2
National Penn Bank	9,525,061	Small	2000	R1, R2
Fulton Bank, National Association	9,499,104	Small	2000	R1, R2
Wells Fargo Bank South Central, National Association	9,493,324	Small	2000	W, R1, R2, I
First Midwest Bank	9,314,575	Small	2000	R1, R2
Bremer Bank, National Association	9,158,286	Small	2000	R1, R2
Comenity Bank	9,149,194	Small	2000	W,R2,I
Capitol Federal Savings Bank	9,070,573	Small	2012	R1, R2
Wells Fargo Bank Northwest, National Association	9,066,813	Small	2000	W,R2,I
PlainsCapital Bank	8,685,931	Small	2000	R1, R2
Columbia State Bank	8,574,401	Small	2000	R1, R2
Provident Bank	8,523,228	Small	2000	R1, R2
Glacier Bank	8,288,508	Small	2000	R1, R2,I

Bank name	Total assets in 2014 ($ thousands)	Size category	Year of 1st observation	Business model(s)
Cadence Bank, N.A.	7,925,450	Small	2011	R1, R2
Mercantil Commercebank, National Association	7,903,578	Small	2000	R1, I
WestAmerica Bank	4,995,062	Very Small	2000	R1, I
TowneBank	4,982,485	Very Small	2000	R1, R2
INTRUST Bank, National Association	4,950,396	Very Small	2000	R1, R2
S&T Bank	4,944,773	Very Small	2000	R2
World's Foremost Bank	4,913,482	Very Small	2001	W
Wilmington Savings Fund Society, FSB	4,849,015	Very Small	2012	R1, R2
Central Pacific Bank	4,826,837	Very Small	2000	R1, R2
Scotiabank de Puerto Rico	4,823,553	Very Small	2000	R2
1st Source Bank	4,815,555	Very Small	2000	R1, R2
NBH Bank, National Association	4,800,524	Very Small	2010	I
Southside Bank	4,798,372	Very Small	2000	I
National Bank of Arizona	4,770,870	Very Small	2000	R2
Washington Trust Bank	4,767,725	Very Small	2000	R1, R2
Beneficial Bank	4,744,679	Very Small	2000	R1, R2
Columbia Bank	4,673,068	Very Small	2012	R2
TrustCo Bank	4,643,460	Very Small	2012	R1, R2
Simmons First National Bank	4,633,578	Very Small	2000	R1, R2
Carter Bank & Trust	4,629,941	Very Small	2006	R1, I
First Security Bank	4,626,323	Very Small	2000	R1, R2,I
Sabadell United Bank, N.A.	4,605,891	Very Small	2000	R1, R2
Centreville Savings Bank	997,957	Micro	2000	I
Avenue Bank	997,562	Micro	2000	R1, R2
Redding Bank of Commerce	996,565	Micro	2000	R1, R2
American Trust & Savings Bank	996,226	Micro	2000	R2
Bank of Commerce	994,470	Micro	2000	R1
Norway Savings Bank	994,239	Micro	2000	R1, R2

Bank name	Total assets in 2014 ($ thousands)	Size category	Year of 1st observation	Business model(s)
FirstBank Southwest	992,129	Micro	2000	R1, I
South Shore Bank	992,007	Micro	2000	R1, R2,I
Putnam County Savings Bank	991,048	Micro	2000	R1, I
Newtown Savings Bank	988,017	Micro	2000	R1, R2
Conway National Bank	982,419	Micro	2000	R1, I
Bank of Utica	981,131	Micro	2000	I
Westfield Bank, FSB	979,243	Micro	2012	R1, R2
CharterBank	978,362	Micro	2012	R1
Triumph Community Bank, National Association	978,251	Micro	2001	R1, R2
Crescent Bank & Trust	977,709	Micro	2000	R2
Savings Bank of Mendocino County	974,642	Micro	2000	R1, I
First Federal Bank of Florida	972,551	Micro	2012	R1
Chelsea Groton Bank	971,503	Micro	2000	R1, R2
State Bank & Trust Company	970,659	Micro	2000	R2

Symbols for the business models: **W** (wholesale-oriented), **R1** (retail type 1) **R2** (retail type 2), **I** (investment)

The Bank and Credit Union Business Models (BBM) in the United States is the first comprehensive edition for the USA of the International Research Centre on Cooperative Finance (IRCCF) of HEC Montreal's research initiative, led by Professor Rym Ayadi, to develop a Global Monitor of bank and credit union business models. The Global Monitor covers Europe, the United States of America and Canada. More countries will be added subject to data availability.

The BBM in the United States identifies the business models of 10,352 commercial banks and savings institutions from 2000 to 2014, representing 108,226 bank-year observations covering almost all total banking assets. It also identifies the business models of 10,392 credit unions over the same period, with 115,588 credit union-year observations accounting for more than 80% of the total assets of credit unions. To this end, two cluster analyses are performed by using a unique definition and adapting a robust clustering methodology, yielding four bank business models and three credit union business models. The study proceeds then by analyses on the interaction between business models and size, as well as the migration, financial performance, contribution to the real economy, risk and response to regulation of US banks and credit unions.

The BBM in the United States is geared towards bank practitioners, policy makers, regulators, supervisors and academics who are interested in independent research, analysis and expert views on the banking sector in Europe. The business model identification results are available upon request.

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