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WORKING PAPER

Business models and their impact on bank performance: A long-term perspective

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Business models and their impact on bank performance: A long-term perspective*

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Abstract

This paper examines the effects of bank business models on performance and risk for a sample of more than 500 banks from 30 European countries over the period from 1998 to 2013. Since we analyze strategic or business model choices, our methodology is designed to identify the long-run effects and separates these from short-run time effects. Our findings confirm that business model characteristics are important determinants of performance, but that no specific bank type outperforms in all dimensions. We find that deposit funding, high asset quality, income diversification and capital adequacy positively affect performance, while size and the asset composition have a more ambiguous impact. We also report substantial variation of business model effects over different bank types. Our results lend support to the new capital and funding rules proposed in the Basel III framework, but we also argue that business model considerations should be more fundamentally integrated in the post-crisis regulatory and supervisory practice.

JEL classification: G20, G21, G28

Keywords: Banks, business model, bank performance, risk-taking, profitability

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1 Introduction

This paper examines the impact of bank business model choices on their profitability, net interest margin and default risk for a panel of over 500 banks from 30 European countries over the period from 1998 to 2013. We add to the understanding of this subject by focusing on the long-term effects of bank characteristics, on the basis of a definition of a bank business model as a set of interrelated strategic choices. The motivation for this research originates in the financial crisis and the subsequent policy initiatives to strengthen the resilience of banks. Various studies (Altunbas et al., 2011; Beltratti and Stulz, 2012) have shown that some types of banks proved to be particularly vulnerable, whereas others have weathered the crisis relatively unscathed. Furthermore, reform in banking regulations, most notably Basel III, will induce banks to reconsider their funding strategy, pricing policy and risk management. Other policies aim to improve financial stability through the enforcement of a more stringent bank structure framework, for example the ring-fencing measures elaborated by the Vickers Commission in the UK. In order to assess the value of these initiatives, it is essential to understand the performance outcomes associated with different bank business models.

In order to elucidate the role of bank business models with respect to performance, we first formulate a definition that can be made operational based on publicly available data. The identification of business models is often left rather vague in the existing literature (Demirgüç-Kunt and Huizinga, 2010; Köhler, 2014). Our approach is based on an explicit definition that can be made operational on the basis of balance sheet and income statement data, which are reported at least at an annual frequency. To be concrete, we define a bank business model as the result of interrelated[1] strategic, i.e. long-term, choices that affect the banks' risk profile and the structure of their assets, liabilities, capital and income. In our descriptive analysis we indeed find that differences across banks are more important than the evolution of individual banks over the sample period, providing support to the notion that fundamental adjustments of bank strategy occur only slowly. We also examine the relations

[1]There is, for example, some theoretical backing for the complementarity of deposit funding and lending (Kashyap et al., 2002; Song and Thakor, 2007). Demirgüç-Kunt and Huizinga (2010), furthermore, suggest that there might also be some complementarity between non-traditional activities and funding strategies as they both require more sophisticated personnel and infrastructure.

between the business model characteristics and find strong support for interdependence.

In the investigation of the impact of the business model on bank performance, we use four indicators: return on equity (ROE), return on assets (ROA), net interest margin (NIM) and bank stability. Following most of the literature (e.g. Köhler, 2014), bank stability is approximated with the Z-score[2], as its calculation does not require market information, which is unavailable for the majority of banks in our sample. We also examine the impact of business model features on the subcomponents of the performance indicators, i.e. net interest income, non-interest income, operating expenses and the variability of ROA. Such an analysis of the transmission of the business model effects enables a more accurate interpretation of the results. The econometric methodology is based on the method of panel estimation proposed by Mundlak (1978). This approach considers both the within and the between dimension of our panel data and hence uses more information than the fixed effects approach that would otherwise be advised. Importantly, it allows an interpretation of the results that differentiates between short- and long-term effects. In previous studies long-term effects were left largely unexplored, whereas we deem them crucial to understand the impact of business models on bank performance. Finally, this paper also examines the heterogeneity of the effects of strategic choices on performance, as they may vary for different bank business models. We propose a framework based on overlapping rolling regressions. While the literature most often uses an approach based on interaction variables or subsample analysis, rolling regressions avoid the linearity of interaction effects and allow us to more easily abstract from the noise that is typically present in separate subsamples.

This paper is related to a growing literature that focuses on the concept of bank business models to explain bank performance. Altunbas et al. (2011), who use a broad set of pre-crisis bank characteristics to capture business models, report that financial institutions with less capital, larger balance sheets, greater reliance on short-term market funding and aggressive credit growth were more likely to experience distress during the financial crisis. Business models characterized by a strong deposit ratio and greater income diversification

[2]The Z-score is most often used as a direct measure of bank risk. Delis et al. (2014), however, document the failure of the Z-score to measure the build-up of risk prior to the crisis in the US. For our purposes, however, the Z-score is still preferable as it measures the ex-post realization of default risk and, as such, the distress experienced by banks.

proved to be more resilient. Ayadi et al. (2011, 2012) use cluster analysis to subdivide banks in different business model classes and monitor their performance during and after the banking crisis. They document that retail-oriented banks are less likely to default and are able to better manage their liquidity risks. The more diversified retail banks are, however, less likely to face losses during downturns than focused retail banks. Wholesale banks are shown to carry a range of risks, especially through an apparent failure to build adequate liquidity buffers. Demirgüç-Kunt and Huizinga (2010) and Köhler (2014) examine the effect of income and funding diversification on bank profitability and stability. The former find that, for an international sample of banks in the years preceding the financial crisis, a more diverse activity mix and a larger share of wholesale funding materially increase bank risk, while diversification benefits are only observed at low levels. Köhler (2014), on the other hand, using a sample of listed and unlisted banks from 15 EU countries over a period that includes the crisis, provides evidence that income diversification benefits performance for retail banks, but hurts the stability of investment banks. A larger share of wholesale funding, however, improves the stability of investment banks, while the reverse is true for retail banks.

We attempt to contribute to this literature in a number of ways. First, our analysis is founded on an explicit definition of a business model that can be applied on the basis of publicly available data. This is important, because it guides our specific choice of variables to capture business models, while also setting out prerequisites for our econometric methodology, i.e. the need to separate short- from long-term effects. Second, the econometric approach, based on Mundlak (1978), differentiates in a clear way the within and between dimension of the panel data. This is important for two reasons. Statistically, we find that the differences across banks, i.e. the between dimension, are quite large compared with the observed changes within individual banks over time. Our approach allows us to model this cross-sectional information explicitly. Economically, the estimation enables an interpretation that disentangles short- and long-term effects (Baltagi and Griffin, 1984). Third, we use rolling-regression analysis to examine the heterogeneity of the impact of business model characteristics on bank performance, because this approach is both more flexible than interaction effects and more robust than subsample analysis. Fourth, our dataset is based

on a careful sample selection in which we exclude domestic subsidiaries of banking groups. This is important since the strategic choices and performance of these subsidiaries are not independent from their parent firms, so that their inclusion might bias the results. These considerations are to a lesser extent valid for foreign subsidiaries since these might enjoy more autonomy to adjust to local market conditions. Over the period covered by our sample, foreign subsidiaries and the parent bank moreover fall under the jurisdiction of different supervisory agencies.

Our results provide evidence for the importance of business model characteristics as determinants of bank performance. At the same time, we find that there is no typical business model strategy that performs uniformly better and that the long-term impact of bank characteristics often depends on other features of banks' balance sheet and income structures. First, banks with a more traditional asset composition appear to be less profitable, because a positive effect on the net interest margin is more than offset by higher operating expenses and exposure to loan impairments. We find that increasing loan quality, which is shown to improve bank performance in terms of both profitability and risk, cannot resolve this issue as it also diminishes the positive effect on the NIM. Instead, we document that typical retail characteristics, such as a high loan, deposit or capital ratio, to support the generation of non-interest income. Such a broadening of income sources, e.g. through the cross-selling of financial products to retail clients, can then support retail banks' profitability - all the more so since we find that income diversification unambiguously improves banks' performance. Second, our results also lend support to the new regulations regarding capital adequacy set out in the Basel III framework. A high capital ratio appears to elevate ROA and decrease banks' susceptibility to distress. The impact is, moreover, found to be stronger for very large and highly leveraged banks. For such banks the effects on income are even large enough to compensate for the mechanical negative effect of capital on ROE. Our results therefore indicate that these banks may benefit from the proposed capital buffers for systemically important banks. With respect to funding risk, we find that a higher net stable funding ratio does not hurt bank profitability as higher funding expenses are offset by additional interest income. Finally, the impact of size is ambiguous. While we find that large banks are more stable in the long run, we also document that an increase of the balance sheet

lowers banks' interest margin and profitability. We furthermore remark that this study is bank-specific in nature so that we cannot claim that the increased stability of an individual bank through size is consistent with the macroprudential aim of financial stability. Apart from stressing the importance of a long-term perspective to evaluate the impact of banks' business models on performance, which is important for bank managers and shareholders, this paper also argues that business model considerations should be an integral component of post-crisis regulatory and supervisory practice.

This paper is organized in the following way. In the next section, we discuss the data and the criteria used to construct our sample. In Section 3 we develop a definition of bank business models. Section 4 describes the variables and section 5 discusses the econometric methodology. In section 6 we present the results of the baseline regressions and the rolling-regression analysis. In the final section, we state our conclusions and consider some implications.

2 Sample selection

We construct a dataset containing both bank-specific and macroeconomic variables with annual frequency. Balance sheet and income statement data of banks from 30 European countries are retrieved from the Bankscope database, which is maintained by Bureau Van Dijk. Macroeconomic time series data are obtained from Eurostat, the IMF International Financial Statistics database and national central banks. Long-term credit ratings for all included countries' sovereign debt are gathered from Fitch Ratings. The sample period runs from 1998 to 2013. We select the banks that satisfy all four of the following criteria:

1. The bank is headquartered in a country of the EU (28), Norway or Switzerland or is active through a local subsidiary in any of these countries. This excludes subsidiaries of one bank operating in a single country but we include foreign subsidiaries that themselves satisfy the remaining criteria.

2. According to the Bankscope classification system, the bank is one of the following: a commercial bank, a savings bank, a cooperative bank, a mortgage bank, a specialized

governmental institution or a bank holding company. This filter ensures that we include banks with different specializations in order to capture a broad spectrum of business models. However, this criterion excludes investment banks.

3. The bank satisfies at least once, over the period from 2005 to 2013, one or both of two size criteria: absolute size (total assets) larger than 5 billion euro or systemic size (total assets to domestic GDP) exceeding 5%. Assessing this criterion for the period 2005-2013 instead of the full sample period 1998-2013 assures that the selected banks were active in the period covering the financial crisis.

4. The institution is engaged in bank intermediation activity. We therefore apply extra criteria based on the importance of customer deposits in funding, loans in earning assets and data availability outlined in table 1 . This criterion excludes the Luxembourg-based foreign subsidiaries, since these banks are mainly responsible for the wholesale activities of their parent groups.

The application of the four criteria results in a dataset of 513 banks for a total of 6845 bank-year observations. These banks represent a large share of their domestic banking sector.

In line with Köhler (2014) our sample includes both listed and unlisted banks to allow for a wider variety of bank specializations, as for instance the majority of savings banks are unlisted. More important, we exclude domestic subsidiaries from our sample.

	Condition	**If condition is not satisfied**
Deposits		
	- Customer deposits exceed 10% of liabilities at least once in the sample period.	All bank observations are removed.
	- Customer deposits exceed 5% of liabilities.	Bank-year observation is removed.
Loans		
	- Loans exceed 10% of earning assets at least once in the sample period.	All bank observations are removed.
	- Loans exceed 5% of assets.	Bank-year observation is removed.
Availability		
	- Income data are fully available.	Bank-year observation is removed.
	- Bank data are continuously available (no gaps).	All bank observations are removed.

Table 1: Additional criteria for sample selection.

First, from the perspective of the individual bank, management decisions with respect to fundamental business model choices are taken at the level of the parent firm, which will consider the performance of the whole banking group. The performance of a local subsidiary is furthermore influenced by the state of its parent bank. We therefore follow Stiroh and Rumble (2006) in excluding (domestic) subsidiaries. Second, from the point of view of bank supervisors, the main interest lies with either the performance of a domestic banking group or a local subsidiary of a foreign banking group. The coexistence of a strongly interconnected banking market and a network of separate national supervisory agencies was typical for Europe before the Banking Union. The activation of the Single Supervisory Mechanism (SSM) in November 2014, under which the ECB takes over euro area bank supervision, is outside the scope of our sample. Taking these considerations into account, we do include foreign subsidiaries that satisfy the size and activity criteria.

Finally, the size criteria restrict the sample to the most important European banking groups. These criteria are also found to be important to ensure the geographical balance of our sample, since a further loosening would give more weight to countries with extensive networks of local savings and cooperative banks, such as Germany. The dominance of such countries would hinder the generality of the results as they may be driven by the specific characteristics of the local institutional environment. In table 2 we present the distribution of the banks and observations of our sample over different countries and size classes.

3 Definition of business models

We define a bank business model on the basis of two criteria. First, it should be a reflection of long-term strategic choices made by management in terms of assets, funding, capitalization and diversification. Assessing the impact of the business model on performance, measured as profitability and stability, therefore requires a dedicated empirical setup able to capture the long-term impact. Second, to be constitutive of a business model, these choices should not be independent from each other, i.e. some combinations of strategic variables should be more common than others. We suggest a practical implementation of this definition that is similar to the approach of Altunbas et al. (2011), who identify four relevant groups of business

	Banks	Obs.	Freq.	> €30 bln.	< €30 bln. > €10 bln.	< €10 bln. > €5 bln.	< €5 bln.
Austria	26	383	5.6%	22%	27%	33%	18%
Belgium	11	142	2.1%	52%	15%	18%	15%
Bulgaria	9	132	1.9%	-	-	5%	95%
Croatia	7	112	1.6%	-	8%	28%	64%
Cyprus	9	116	1.7%	6%	8%	18%	68%
Czech Republic	5	80	1.2%	20%	46%	13%	21%
Denmark	5	80	1.2%	48%	26%	18%	9%
Estonia	2	26	0.4%	-	-	8%	92%
Finland	5	66	1.0%	50%	33%	5%	12%
France	12	132	1.9%	92%	-	2%	7%
Germany	100	1461	21.3%	25%	13%	44%	17%
Greece	10	140	2.1%	35%	36%	6%	23%
Hungary	7	112	1.6%	6%	16%	42%	36%
Ireland	13	144	2.1%	42%	24%	18%	16%
Italy	41	534	7.8%	34%	28%	18%	20%
Latvia	9	122	1.8%	-	-	5%	95%
Lithuania	5	75	1.1%	-	-	21%	79%
Luxembourg	2	32	0.5%	44%	6%	16%	34%
Malta	4	54	0.8%	-	-	11%	89%
Netherlands	15	173	2.5%	42%	23%	20%	15%
Norway	14	208	3.0%	12%	13%	25%	50%
Poland	18	243	3.6%	6%	28%	31%	35%
Portugal	13	161	2.4%	39%	23%	20%	17%
Romania	8	121	1.8%	-	12%	21%	66%
Slovak Republic	6	80	1.2%	-	16%	44%	40%
Slovenia	9	141	2.1%	-	6%	8%	86%
Spain	76	793	11.6%	22%	32%	25%	22%
Sweden	6	88	1.3%	74%	7%	14%	6%
Switzerland	27	409	6.0%	18%	38%	30%	14%
United Kingdom	39	485	7.1%	39%	28%	21%	12%
Total	513	6845	100.0%	25%	21%	26%	28%

Table 2: Distribution of banks and observations over countries and size classes.

model characteristics. In order to confirm that the second criterion holds, we examine the dependence structure between the variables in our set of business model characteristics[3].

We measure business model characteristics by a set of variables that capture strategic choices. We define bank business models as a long-term concept. Hence, the variables used to capture strategic choices should be publicly available on a consistent basis. This, unfortunately, excludes detailed information on different types of non-interest income or a detailed composition of the loan portfolio[4].

4 Variable selection

4.1 Performance indicators

Bank profitability is captured by three indicators: return on equity, return on assets and the net interest margin. Profits are calculated as the sum of net interest income and non-interest income minus operating expenses and loan loss provisions, i.e. we focus on the recurring part of profits on a pre-tax basis. The NIM should reflect the ability of a bank to tap into various funding sources and transform those funds into assets with attractive yields. In the absence of public sources of granular and reliable interest income and expense data on different types of assets and liabilities, we use the ratio of net interest income to earning assets.

We measure individual bank distress using the Z-score, or rather its natural logarithm as the variable itself is strongly positively skewed. This variable is defined in the following way:

$$Z - score_{it} = \frac{\frac{Total\ Equity_{it}}{Total\ Assets_{it}} + E_{it}(ROA)}{\sigma_{it}(ROA)} = \frac{CAP_{it} + E_{it}(ROA)}{\sigma_{it}(ROA)}$$

Following Beck et al. (2013b) we construct $E_{it}(ROA)$ and $\sigma_{it}(ROA)$ over a rolling

[3]Previous research has used other methods to distinguish bank types that are also consistent with our definition. Köhler (2014), for instance, uses banks' specializations, as reported by Bankscope, to allocate them to one of four business models. There is nonetheless quite some heterogeneity within some groups, which is then left unexplored. Second, cluster analysis allows the researcher to combine several relevant characteristics into one measure, which is then used to assign bank-year observations to specific groups (bank business models) based on their similarity (Ayadi et al., 2012). These methods, however, describe business models by a single qualitative variable, as opposed to a set of quantitative variables.

[4]From a business model perspective, it would be useful to capture the banks' involvement in, e.g., mortgage lending or corporate versus retail loans.

window with three observations of ROA over the period $t-2$ to t[5]. This procedure reduces the number of available observations slightly and removes banks with less than three consecutive observations. The Z-score should be interpreted as a distance-to-default measure, i.e. as the number of standard deviations ROA can diverge from its mean before the bank defaults. A higher Z-score indicates a safer bank.

Figure 1 demonstrates the negative evolution of European bank performance during the sample period. We note that the observed evolution of the Z-score underlines its usefulness as a distress indicator, rather than as a direct measure of bank risk-taking.

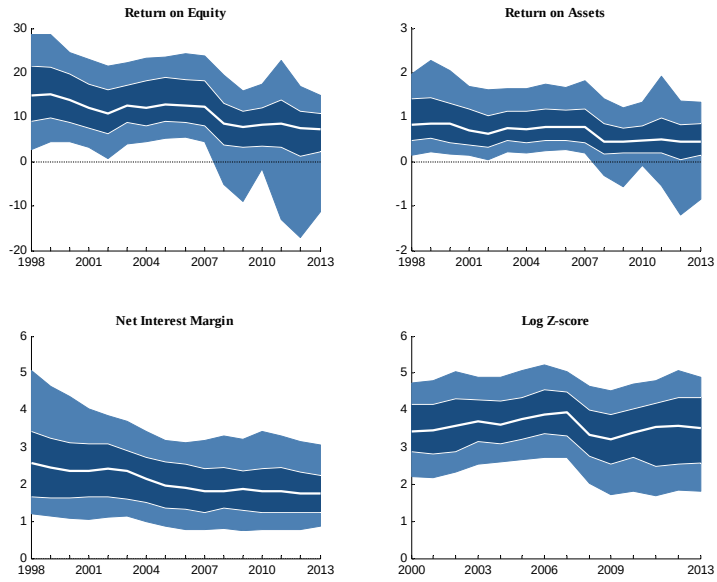


Figure 1: Evolution of the distribution of the performance indicators for European banks. The fat white line indicates the median. The dark area represents the second and third quartiles, whereas the lighter area spans the values between the tenth and ninetieth percentile.

[5]The calculation of the expected value and the standard deviation of ROA is problematic for at least four reasons. First, we only have a limited number of observations available for each bank as we have annual data for a maximum of 16 years. Any estimation of $E_{it}(ROA)$ or $\sigma_{it}(ROA)$ could therefore be quite noisy. Second, the moments of ROA are probably time-varying, decreasing the relevance of observations that are further away in the past. Third, not all banks are observed over the same period, decreasing the comparability of the estimated moments across banks if we would use the entire sample to calculate them. Finally, the use of lagged values of ROA to construct its mean and standard deviation consumes observations. Apart from the first argument, these considerations support a reduction in the number of observations used to calculate the mean and standard deviation of ROA.

4.2 Business model characteristics

4.2.1 Asset structure

The relative amount of loans to earning assets captures the extent to which a bank is engaged in traditional intermediary activities, i.e. the transformation of liquid deposits into illiquid loans in the role of a delegated monitor (Diamond, 1984). The descriptive statistics, which can be found in table 3, show that the loan ratio is approximately 65% on average in our sample. We furthermore find that the loan ratio varies more over the between dimension than over the within dimension, which is consistent with our definition of business models as a long-term strategic concept, i.e. the differences between banks are more important than changes over time.

We measure asset quality as the ratio of loan loss provisions (LLP) to net loans. LLP can, however, be used to smooth income (Laeven and Majnoni, 2003) and may be distorted by forbearance, especially during the crisis period. However, considering that this indicator is forward-looking and that it is a reflection of a bank's own opinion of the quality of its loans, we prefer this variable to measure asset quality. The mean of the LLP ratio reached a minimum of 0.43% in 2007, after which it peaked at 1.2% in 2009. The temporal evolution

	Unit	**Obs.**	**Mean**	**Standard Deviation**			
				Within	***Between***	***Overall***	***Between/Within***
Return on Equity	%	6844	10.14	11.82	9.53	13.77	0.81
Return on Assets	%	6845	0.70	0.76	0.64	0.94	0.84
Net Interest Margin	%	6845	2.21	0.62	1.04	1.21	1.69
Log Z-score		5814	3.55	0.90	0.81	1.12	0.90
Loans to Earning Assets	%	6845	65.15	8.97	15.96	18.07	1.78
Loan Loss Provisions to Loans	%	6845	0.75	0.95	0.68	1.12	0.71
Log Assets		6845	9.42	0.42	1.64	1.68	3.94
Deposits to Liabilities	%	6845	60.01	8.47	20.10	21.38	2.37
Net Stable Funding Ratio	%	6845	92.05	9.23	14.90	17.37	1.61
Income Diversification	%	6845	32.31	9.23	13.10	15.72	1.42
Equity to Assets	%	6845	6.79	1.77	2.93	3.38	1.65
Cost to Income	%	6845	64.28	13.72	14.19	18.18	1.03
Real GDP Growth	%	6845	1.98	2.60	1.24	2.82	0.48
Sovereign PD	%	6839	1.19	1.73	2.06	2.71	1.19
3m Money Market Rate	%	6820	3.62	3.48	2.74	4.51	0.79

Table 3: Descriptive statistics. All variables are winsorized at the 0.01 and 0.99 quantiles. Bank-specific data series are obtained from Bankscope. Macroeconomic data and money market rates were retrieved from Eurostat and IMF international financial statistics and national central banks. Sovereign ratings and historical default rates were taken from the Fitch rating agency.

explains why the within variation is relatively high with respect to the between variation.

Finally, a bank's size is also an important part of its business model, as it determines a bank's possibilities to exploit economies of scale and scope. In our analysis we use the natural logarithm of total assets, expressed in millions of 2005 euros to measure bank size. Banks grew tremendously during the sample period: in 1998 the median bank in our sample had €6.9 billion in total assets, while in 2013 this number had increased to €17.8 billion. Although there is an important common evolution, the between variation greatly exceeds the within variation. Hence, the differences with respect to size remain very substantial across banks.

4.2.2 Funding structure

Retail deposits represent the traditional source of bank funding as they are related to their core intermediary function. Gatev et al. (2009) furthermore show that banks with access to deposits may benefit from synergies with their lending activities, especially in periods of financial market stress. We measure the importance of traditional funding with the ratio of total customer deposits to total liabilities. In our sample, banks on average rely for 60% on customer deposits. In accordance with the loan ratio, we find that the between variation of the deposit ratio exceeds its within variation by a factor of 2.37.

The deposit ratio, however, does not capture the risks related to different funding strategies that originate in the mismatch between the liquidity of a bank's assets and liabilities. Our measure for funding risk is based on the net stable funding ratio (NSFR), which is an important part of the new Basel III regulatory framework[6]. This ratio applies specific weights, determined by the Basel Committee on Banking Supervision (BCBS), to different asset and liability classes based on their stability[7]. A higher NSFR indicates a lower level of funding risk. Table 4 presents both the weights proposed by the BCBS (2014) and our own weighting scheme. The NSFR has a mean of 92% in our sample; in future the Basel III regulations require it to be at least 100%.

[6]It should be noted that during our sample period the NSFR ratio was not compulsory for the banks. Nevertheless we use it as a useful proxy for funding risk.

[7]We cannot exactly replicate the NSFR, due to the granularity of data required by the BCBS proposal. In line with the existing literature on the NSFR (Dietrich et al., 2014), we propose an approximation taking into account both the BCBS classification and data availability.

Available Stable Funding

Basel	*Factor*	*Own calculations*	*Factor*
Regulatory Capital	100%	Customer Deposits	90%
Other capital instruments and liabilities (maturity > 1 year).	100%	Deposits from banks	25%
Stable deposits of retail and SME customers (maturity < 1 year).	95%	long-term funding	100%
Less stable deposits of retail and SME customers (maturity < 1 year).	90%	Loan loss and other reserves	100%
Deposits from non-fin. corporate customers, sovereigns, public sector entities, development banks (maturity < 1 year).	50%	Other Liabilities	0%
Deposits from central banks and financial institutions (6 months < maturity < 1 year).	50%	Total Equity	100%
Other funding (6 months < maturity < 1 year).	50%		
Operational deposits	50%		
Other liabilities	0%		

Required Stable Funding

Basel	*Factor*	*Own calculations*	*Factor*
Cash and central bank reserves	0%	Loans to customers	100%
Unencumbered level 1 assets.	5%	Loans to banks	50%
Unencumbered loans to financial institutions (maturity < 6 months, secured against level 1 assets).	10%	Securities	50%
Unencumbered level 2A assets .	15%	Derivatives	50%
Unencumbered level 2B assets.	50%	Cash	0%
High quality liquid assets (encumbered for a period between 6 and 12 months).	50%	Other assets	100%
Interbank loans (6 months < maturity < 1 year).	50%		
Deposits at other banks (operational).	50%		
Other assets (maturity < 1 year).	50%		
Unencumbered loans (risk weight < 35%, maturity > 1 year, excluding financial institutions).	65%		
Unencumbered loans (risk weight > 35%, maturity > 1 year, excluding financial institutions).	85%		
Non-HQLA unencumbered securities	85%		
Commodities	85%		
Other assets	100%		

Table 4: Weights for the calculation of the net stable funding ratio (NSFR). The weights in the first column refer to those given in BCBS (2014).

4.2.3 Capital structure

We measure banks' capital adequacy, which captures the capacity to absorb unexpected losses, with the ratio of equity to total assets, rather than with regulatory risk-weighted ratios. As a consequence of declining risk weights, unweighted and regulatory ratios have diverged in the preceding decade (Le Leslé and Avramova, 2012; BCBS, 2013; EBA, 2013). Mariathasan and Merrouche (2014) attribute the decline in risk weights to the strategic use of internal risk models by banks. Table 3 shows that the variation across banks is more important than the evolution over time, indicating that certain banks consider strong capital adequacy as a strategic advantage.

4.2.4 Income structure

The final variable with which we define bank business models is the structure of their revenues. To measure income diversification we follow most of the empirical literature by defining it as the ratio of non-interest income to the sum of non-interest and net interest income. The calculation of the share of non-interest income is rendered problematic by its evolution during the financial crisis, when its level dropped substantially for most banks and in some cases even became negative. We mitigate this problem by setting negative values of non-interest income to zero since a negative income diversification ratio lacks a clear economic interpretation. Although previous research has shown that not every type of non-interest income is equally volatile or conducive to bank stress (Stiroh, 2007; DeYoung and Torna, 2013), the data concerning non-interest income subcategories are not sufficiently granular to implement such subdivisions in our analysis. On average, we find that banks obtain 32% of their revenues from non-interest sources, a statistic that remains relatively stable over the sample period. Again we find that the between variation exceeds that of the within dimension, indicating that certain banks strategically opt to be more diversified than their peers.

4.2.5 Relations between business model indicators

To be constitutive of a clearly interpretable business model, strategic variables must be interrelated, i.e. there exist combinations of strategic features that are more common than others. An examination of the relations between these variables can furthermore provide insight into the typology of the European banking sector. To this purpose, for each variable, we distribute all banks over three equally sized buckets, based on the average value of the respective variable over the entire sample period. Since there are 513 banks in the sample, each bucket contains 171 banks. We then construct bivariate frequency tables to formally test the interdependence of these variables, which allows for a richer characterization than would be possible with simple bivariate correlation coefficients.

The results of this analysis are presented in table 5 . The Pearson test-statistics, reported in the lower right corner of each frequency table, indicate that independence is rejected at the 10% level of significance in all but two cases: asset quality appears to be independent from both funding composition and size. These results establish the interrelatedness of the strategic variables and thus their relevance in the determination of bank business models.

The analysis of the specific dependence structure confirms some expected relationships. For example, banks that rely most on non-interest income typically have a lower loan ratio than their peers with a more traditional income structure: 42.7% of these banks are in the low category for the loan ratio, while only 24.6% are in the high category. Banks with a large loan share are more frequently found in the middle category of the deposit ratio, which means that they diversify their funding composition, e.g. through the issuance of covered bonds. This finding adds some qualifications to theoretical models that predict the interdependence of lending and deposit-taking (Kashyap et al., 2002), which were empirically confirmed using correlation coefficients by, among others, Demirgüç-Kunt and Huizinga (2010). Another expected finding is that banks with a higher proportion of loans face more funding risks, although their strong presence in the middle group for the NSFR (52.0%) suggests that they mitigate the effects of an illiquid asset portfolio with a higher reliance on stable funding. In general, these banks also have higher-quality assets and are not as leveraged as banks

		Deposits to Liabilities			Loans to Earning Assets			Income Diversification		
		Low	***Mid***	***High***	***Low***	***Mid***	***High***	***Low***	***Mid***	***High***
Loans to Earning Assets	***Low***	49.7***	15.2***	35.1						
	Mid	26.3*	40.9*	32.7						
	High	24.0**	43.9**	32.2						
				(46.5)***						
Income Diversification	***Low***	21.1***	32.7	46.2***	31.6	26.9	41.5**			
	Mid	29.8	39.8	30.4	25.7*	40.4*	33.9			
	High	49.1***	27.5	23.4**	42.7**	32.7	24.6**			
				(39.1)***			(19.7)***			
Log(Assets)	***Low***	14.6***	35.1	50.3***	31.0	35.7	33.3	42.7**	29.2	28.1
	Mid	18.7***	40.4*	40.9*	23.4**	31.6	45.0***	39.2	34.5	26.3*
	High	66.7***	24.6**	8.8***	45.6***	32.7	21.6***	18.1***	36.3	45.6***
				(141.2)***			(27.6)***			(31.2)***
LLP to Total Loans	***Low***	36.8	29.2	33.9	34.5	21.1***	44.4***	42.7**	29.2	28.1
	Mid	35.7	36.3	28.1	35.1	37.4	27.5	39.2	28.7	32.2
	High	27.5	34.5	38.0	30.4	41.5**	28.1	18.1***	42.1**	39.8
				(6.6)			(22.2)***			(27.6)***
Net Stable Funding Ratio	***Low***	69.0***	29.8	1.2***	35.1	31.0	33.9	21.6***	29.8	48.5***
	Mid	19.9***	53.2***	26.9	16.4***	31.6	52.0***	42.1**	35.1	22.8**
	High	11.1***	17.0***	71.9***	48.5***	37.4	14.0***	36.3	35.1	28.7
				(266.2)***			(65.2)***			(31.0)***
Equity to Assets	***Low***	55.6***	24.0**	20.5***	49.1***	26.9	24.0**	42.1**	25.1*	32.7
	Mid	24.6**	37.4	38.0	24.6**	38.0	37.4	36.8	35.7	27.5
	High	19.9***	38.6	41.5**	26.3*	35.1	38.6	21.1***	39.2	39.8
				(58.4)***			(29.4)***			(21.7)***

		Log(Assets)			LLP to Total Loans			Net Stable Funding Ratio		
		Low	***Mid***	***High***	***Low***	***Mid***	***High***	***Low***	***Mid***	***High***
LLP to Total Loans	***Low***	26.3*	35.7	38.0						
	Mid	35.1	33.3	31.6						
	High	38.6	31.0	30.4						
				(6.4)						
Net Stable Funding Ratio	***Low***	20.5***	24.0**	55.6***	31.6	36.8	31.6			
	Mid	31.6	40.4*	28.1	35.7	39.2	25.1*			
	High	48.0***	35.7	16.4***	32.7	24.0**	43.3**			
				(68.4)***			(16.0)***			
Equity to Assets	***Low***	19.9***	23.4**	56.7***	52.0***	32.7	15.2***	48.5***	28.1	23.4**
	Mid	31.6	40.4*	28.1	25.7*	41.5**	32.7	32.7	37.4	29.8
	High	48.5***	36.3	15.2***	22.2***	25.7*	52.0***	18.7***	34.5	46.8***
				(75.7)***			(68.5)***			(40.2)***

Table 5: Bivariate frequency tables. For each variable banks are distributed over three equally-sized buckets (each containing 171 out of 513 banks), based on the average of the respective variable over the whole sample period. The numbers in the tables are all row/column percentages, and as such columns and rows both sum to 100. Each column and row holds the exact same number of banks (171), so that row and column percentages are equal. The Pearson chi-squared statistic, which tests the null hypothesis of independence, is given in parentheses. We furthermore test whether the percentages in separate cells are significantly different from 33.3%, using a binomial distribution with parameters n and p equal to 513 and 1/9 respectively. Stars indicate significance levels of 10% (*), 5% (**), and 1% (***).

with a less specialized asset composition. The analysis also confirms that large banks' asset composition, funding mix and revenue sources are typically less traditional than those of smaller banks, for instance two thirds of the largest banks also have the lowest deposit ratios. Considering that bigger banks are often more highly leveraged (56.7% of large banks are in the low category for the capital ratio) and face more funding risk (a low NSFR), while their asset quality does not differ substantially, the data suggest that large banks have a very different risk profile compared to their smaller peers.

Business model characteristics are usually related to each other in a consistent way. However this is not always the case. For instance, both banks with a low deposit ratio and banks with a low reliance on non-interest income turn out to have the lowest capital ratio. Yet, non-retail funding and a low degree of revenue diversification are usually negatively correlated. In other words, mechanical labels, such as retail versus diversified banks cannot be applied unambiguously. Hence, one must be cautious when applying statistical methods to construct standard business models types.

4.3 Control variables

We introduce a number of control variables to capture differences that are not directly related to a bank's business model, but are nonetheless important to determine bank performance. At the bank level we must account for operational efficiency. We use a simple cost-income ratio, where costs include all non-interest operational expenses and income is defined as the sum of non-interest and net interest income. We do not consider efficiency to be a business model characteristic, as it can be regarded as an outcome of other strategic choices. Vander Vennet (2002), for instance, finds that European financial conglomerates, i.e. larger and more diversified banks, are more efficient.

We also control for the effects of the macroeconomic environment since these may also drive differences in performance outcomes for otherwise similar banks. First, we capture business cycle changes using real GDP growth. Second, we add the three-month money market rate as an explanatory variable. As financial intermediaries, banks engage in maturity transformation, which exposes them to yield curve dynamics. Finally, we take the financial soundness of banks' domestic government into account using their long-term credit

ratings. We link this rating information to observed 10-year cumulative sovereign default probabilities (Fitch Ratings, 2014). During the European sovereign crisis, some countries experienced substantial increases in their default risk, causing their ratings to drop. Through different transmission channels, this creates a negative feedback loop with the perceived creditworthiness of the banks that are exposed to these countries (De Bruyckere et al., 2013).

5 Empirical approach

5.1 Econometric methodology

The empirical literature has used several approaches to investigate the impact of bank business models on bank performance. In general, these methods can be divided into two categories. First, Altunbas et al. (2011) and Beltratti and Stulz (2012) use cross-section analysis to relate pre-crisis bank characteristics to crisis performance. Although such an approach avoids endogeneity-related issues, it does not fully exploit the information that is available in a panel dataset and might be sensitive to unobserved heterogeneity. The second approach uses panel data analysis, ranging from pooled OLS (Demirgüç-Kunt and Huizinga, 2010; Van Oordt and Zhou, 2014) to fixed effects and dynamic panel GMM methods (Dietrich et al., 2014; Köhler, 2014). Stiroh and Rumble (2006) furthermore investigate the relationship between income diversification and bank performance using both the between, i.e. across banks, and the within dimension of the data. They argue that long-term strategic choices are best captured by the between dimension, as it averages out noisy short-term fluctuations.

Our approach is based on the simultaneous exploration of both the within and the between dimension using the methodology proposed by Mundlak (1978). This approach avoids the bias introduced by the correlation between explanatory variables and unobserved effects in the random effects estimator by modeling it explicitly. The random effects model is therefore extended with the individual means of the independent variables as regressors. In practice we estimate the following model using the random effects feasible GLS estimator:

$$y_{it} = x'_{it}\beta_W + \bar{x}'_i\gamma + \delta_t + \varepsilon_{it}$$

where y_{it} represents the performance indicator of bank i in year t. The matrix x contains the levels of all independent variables and $\bar{x}$ the bank-specific averages of those variables over the whole sample period. To control for endogeneity we use the first lag of the bank-specific variables x_{it}. We furthermore include period fixed effects to control for unobserved market-wide evolutions. The within and between parameters, given by $\hat{\beta}_W$ and $(\hat{\beta}_W + \hat{\gamma})$ respectively, are directly reported in the results section.

Statistically, this model accounts for unobserved heterogeneity and correlation between unobserved effects and explanatory variables, while also exploiting the cross-sectional dispersion of the data. The latter is important because business model characteristics generally vary more over banks than over time. Economically, this empirical setup allows a convenient interpretation of the estimation results since the within estimator is typically considered to capture the short-run effects, while the between estimator captures the long run impact of the explanatory variables (see Baltagi and Griffin, 1984)[8]. Our econometric methodology is therefore able to analyze long-run effects, which is important because we define bank business models as long-term concepts.

5.2 Heterogeneity of effects

A core part of this paper is the investigation of the heterogeneity of the effects of strategic choices on performance with respect to a bank's business model. We propose an estimation framework based on rolling regressions. The purpose of this approach is to identify patterns in the effect of bank characteristics on bank performance for low versus high levels of a set of identified business model characteristics. For each set of rolling regressions, we first sort the banks based on one of the business model features. The size of the subsample used in each regression is equal to 171 banks, i.e. one third of all banks. This number assures that we have sufficient observations in each subsample to accurately estimate the model. For convenience we set the step size to 19 banks, which results in 19 parameter estimates per

[8]Baltagi and Griffin (1984) find that a difference between the two dimensions is caused by dynamic misspecification, i.e. the underlying model is dynamic in nature, but the dynamics are not fully accounted for in the estimated model. Pirotte (1999) argues that the between estimator provides a solution, because it allows one to obtain long run effects directly from a static model. This means that the use of the Mundlak estimator can provide a simple alternative for a distributed lag model, while at the same time modeling the unobserved heterogeneity.

rolling regression[9].

Such an approach offers some advantages over alternative methods found in the literature. First, the expansion of the model with interacted variables (see Demirgüç-Kunt and Huizinga, 2010) would maintain the full sample size, but imposes the constraint that the effect of the variables vary linearly with the level of the interacted variable. The second alternative is based on separate estimations of the model for non-overlapping subsamples (see, for instance, Köhler, 2014). The main difficulties with this approach are that the limited number of parameter estimates might not fully reflect the variation and that the separate subsample parameters might be quite noisy. Rolling regressions, on the other hand, yield a more complete picture of the parameter heterogeneity, making it easier to abstract from noise in separate parameter estimates. One must of course be careful not to overfit the data. We therefore focus on the global pattern of the parameter variability and never on individual parameters.

6 Results

6.1 Baseline regressions

The results of the baseline model are presented in table 6, in which the first four columns each refer to one of the performance indicators (ROE, ROA, NIM and log Z-score respectively). Columns 5 and 6 report regressions for ROE and ROA in which the NIM is included as an explanatory variable in order to control for the transmission of business model effects on profitability through the NIM[10]. In table 7 we further examine the transmission of business model characteristics to profitability by decomposing the ROA in its separate components: net interest income, non-interest income and operating expenses, all relative to total assets[11]. This table also includes results for the pre-impairment and total ROA, i.e. before and after provisioning. The upper half of each table displays the within (short-term) effects, whereas

[9]Larger (smaller) step sizes reduce (increase) the volatility of the different parameter estimates, but this does not affect any of the conclusions drawn from the rolling regressions.

[10]In an unreported regression we also include the NIM as a regressor for the Z-score. Its effect is not statistically significant and coefficients of all other variables are not affected.

[11]We do not include a regression for the ratio of loan loss provisions to assets in our results, as the ratio of LLP to total loans is one of our explanatory variables.

	ROE (1)	ROA (2)	NIM (3)	Log Z-score (4)	ROE (5)	ROA (6)
Within						
Loans to earning assets	-0.046*	-0.003*	0.003	0.003	-0.057**	-0.004**
	(0.027)	(0.002)	(0.002)	(0.002)	(0.027)	(0.002)
Deposits to liabilities	0.138***	0.010***	0.012***	0.009***	0.121***	0.008***
	(0.034)	(0.002)	(0.002)	(0.003)	(0.034)	(0.002)
Share of non-interest income	0.019	0.001	-0.014***	-0.003	0.053**	0.004***
	(0.022)	(0.001)	(0.001)	(0.002)	(0.024)	(0.002)
Log size	-2.723***	-0.207***	-0.227***	-0.005	-2.508***	-0.166***
	(0.912)	(0.066)	(0.065)	(0.075)	(0.925)	(0.064)
LLP to total loans	-2.780***	-0.194***	0.055***	-0.190***	-2.897***	-0.205***
	(0.357)	(0.025)	(0.018)	(0.020)	(0.373)	(0.026)
Net stable funding ratio	-0.030	-0.003*	-0.003**	-0.003	-0.033	-0.003*
	(0.026)	(0.002)	(0.001)	(0.002)	(0.026)	(0.002)
Capital ratio	-0.428***	0.028**	0.046***	0.043***	-0.531***	0.018
	(0.141)	(0.011)	(0.010)	(0.010)	(0.144)	(0.012)
Cost-income ratio	-0.140***	-0.011***	-0.005***	-0.012***	-0.128***	-0.009***
	(0.021)	(0.001)	(0.001)	(0.001)	(0.022)	(0.001)
NIM					1.269**	0.144***
					(0.626)	(0.045)
Real GDP growth	1.106***	0.088***	0.029***	0.035***	1.095***	0.086***
	(0.131)	(0.009)	(0.007)	(0.011)	(0.133)	(0.009)
Sovereign PD	-0.567***	-0.020**	-0.001	-0.044***	-0.594***	-0.022**
	(0.164)	(0.010)	(0.009)	(0.009)	(0.162)	(0.009)
Money market rate	0.136	0.019*	0.023***	-0.011	0.129	0.018
	(0.129)	(0.012)	(0.006)	(0.008)	(0.131)	(0.012)
Between						
Loans to earning assets	-0.069***	-0.003**	0.008***	0.003	-0.117***	-0.007***
	(0.019)	(0.001)	(0.002)	(0.003)	(0.014)	(0.001)
Deposits to liabilities	0.119***	0.007***	0.013***	0.005**	0.039**	0.002*
	(0.020)	(0.001)	(0.002)	(0.002)	(0.016)	(0.001)
Share of non-interest income	0.195***	0.013***	-0.003	-0.001	0.219***	0.015***
	(0.023)	(0.002)	(0.002)	(0.003)	(0.021)	(0.001)
Log size	-0.220	0.006	-0.010	0.078***	-0.176	0.007
	(0.181)	(0.012)	(0.021)	(0.025)	(0.134)	(0.008)
LLP to total loans	-5.902***	-0.268***	0.435***	-0.496***	-8.718***	-0.491***
	(0.853)	(0.051)	(0.074)	(0.057)	(0.659)	(0.037)
Net stable funding ratio	0.001	0.003	0.002	-0.001	-0.004	0.002*
	(0.026)	(0.002)	(0.002)	(0.003)	(0.019)	(0.001)
Capital ratio	-0.564***	0.050***	0.083***	0.090***	-1.086***	0.010
	(0.157)	(0.010)	(0.018)	(0.017)	(0.160)	(0.007)
Cost-income ratio	-0.390***	-0.024***	-0.001	-0.015***	-0.388***	-0.025***
	(0.026)	(0.002)	(0.003)	(0.003)	(0.024)	(0.001)
NIM					5.987***	0.451***
					(0.443)	(0.025)
Real GDP growth	0.367	0.043**	0.014	-0.040*	0.232	0.031**
	(0.284)	(0.019)	(0.027)	(0.023)	(0.207)	(0.013)
Sovereign PD	0.345*	0.025*	0.075***	-0.078***	-0.144	-0.013
	(0.177)	(0.013)	(0.020)	(0.017)	(0.144)	(0.009)
Money market rate	0.500***	0.030***	0.083***	0.012	0.004	-0.006
	(0.142)	(0.011)	(0.013)	(0.009)	(0.130)	(0.010)
Observations	6282	6301	6301	5807	6282	6301
Banks	508	508	508	499	508	508
Av. nr. of periods	12.4	12.4	12.4	11.6	12.4	12.4
R^2 (within)	0.27	0.32	0.37	0.18	0.27	0.33
R^2 (between)	0.61	0.68	0.69	0.54	0.75	0.85
R^2 (overall)	0.36	0.45	0.65	0.28	0.41	0.52
Between Effects	156.12***	133.23***	255.11***	49.02***	210.03***	299.62***

Table 6: Results of the baseline regressions. Standard errors in parentheses are clustered at the bank level. Stars indicate significance levels: *, **, *** represent significance at the 10%, 5%, and 1% level respectively.

	Total int. income (1)	Total int. expenses (2)	Net int. income (3)	Non-int. income (4)	Operating expenses (5)	Pre-imp. ROA (6)	Log σ_{ROA} (7)
Within							
Loans to earning assets	0.014***	0.013***	0.001	0.000	-0.004*	0.005***	-0.002
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Deposits to liabilities	0.004	-0.008***	0.011***	0.001	0.009***	0.003	-0.005*
	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Share of non-interest income	-0.011***	0.002	-0.013***	0.015***	0.008***	-0.004***	0.002
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Log size	0.159	0.390***	-0.186***	-0.193***	-0.294***	-0.075	-0.029
	(0.098)	(0.096)	(0.058)	(0.045)	(0.058)	(0.055)	(0.074)
LLP to total loans	0.074***	0.032	0.042***	0.031**	0.081***	-0.001	0.140***
	(0.025)	(0.020)	(0.016)	(0.013)	(0.018)	(0.015)	(0.019)
Net stable funding ratio	-0.001	0.006**	-0.005***	0.002*	0.001	-0.003**	0.002
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Capital ratio	-0.012	-0.048***	0.042***	0.032***	0.047***	0.034***	0.038***
	(0.016)	(0.013)	(0.009)	(0.007)	(0.010)	(0.007)	(0.010)
Cost-income ratio	-0.005***	-0.001	-0.005***	0.003***	0.010***	-0.012***	0.009***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real GDP growth	0.029***	0.002	0.024***	0.007	0.007	0.026***	-0.023**
	(0.011)	(0.009)	(0.006)	(0.005)	(0.007)	(0.006)	(0.010)
Sovereign PD	0.032**	0.035***	-0.005	0.005	0.014**	-0.011**	0.041***
	(0.016)	(0.013)	(0.007)	(0.006)	(0.006)	(0.005)	(0.009)
Money market rate	0.108***	0.107***	0.020***	0.018***	0.034***	0.014***	0.014*
	(0.014)	(0.014)	(0.004)	(0.004)	(0.005)	(0.005)	(0.007)
Between							
Loans to earning assets	0.004	-0.001	0.006***	0.004***	0.008***	0.002*	0.000
	(0.004)	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Deposits to liabilities	0.002	-0.012***	0.013***	0.004***	0.010***	0.008***	-0.002
	(0.004)	(0.004)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Share of non-interest income	-0.018***	-0.012***	-0.005**	0.044***	0.029***	0.012***	0.005**
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log size	-0.037	-0.006	-0.021	-0.031**	-0.056***	0.006	-0.080***
	(0.042)	(0.037)	(0.018)	(0.013)	(0.019)	(0.011)	(0.022)
LLP to total loans	0.281***	-0.124	0.380***	0.172***	0.302***	0.296***	0.512***
	(0.104)	(0.088)	(0.063)	(0.036)	(0.051)	(0.043)	(0.049)
Net stable funding ratio	0.008*	0.011**	-0.002	0.006***	0.004*	0.001	-0.001
	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Capital ratio	-0.039	-0.114***	0.070***	0.023***	0.035**	0.055***	0.038***
	(0.025)	(0.021)	(0.016)	(0.009)	(0.015)	(0.010)	(0.014)
Cost-income ratio	0.001	0.003	-0.002	-0.002	0.019***	-0.022***	0.011***
	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Real GDP growth	-0.072**	-0.063*	0.007	0.011	-0.005	0.016	0.037*
	(0.035)	(0.034)	(0.024)	(0.016)	(0.022)	(0.015)	(0.022)
Sovereign PD	0.118***	0.061**	0.052***	0.033***	0.055***	0.032***	0.065***
	(0.029)	(0.025)	(0.017)	(0.010)	(0.017)	(0.010)	(0.015)
Money market rate	0.221***	0.177***	0.057***	0.038***	0.070***	0.026***	-0.013
	(0.025)	(0.022)	(0.011)	(0.008)	(0.011)	(0.008)	(0.009)
R^2 (within)	0.52	0.54	0.38	0.30	0.49	0.22	0.13
R^2 (between)	0.48	0.29	0.67	0.82	0.72	0.76	0.58
R^2 (overall)	0.53	0.44	0.63	0.68	0.67	0.60	0.30
Observations	6298	6270	6301	6301	6301	6301	5807
Banks	508	507	508	508	508	508	499
Av. nr. of periods	12.4	12.4	12.4	12.4	12.4	12.4	11.6
Between Effects	147.43***	92.59***	206.06***	240.32***	168.34***	286.30***	81.94***

Table 7: Results of the baseline regressions. Standard errors in parentheses are clustered at the bank level. Stars indicate significance levels: *, **, *** represent significance at the 10%, 5%, and 1% level respectively.

the lower part presents the between (long-term) impact of the business model variables on performance. The model fits the data reasonably well, but is more powerful in explaining the between than the within variation, as can be seen from the R^2 statistics. We furthermore note that many of the between effects are found to be statistically significant, both jointly and individually. These findings support the central thesis of this paper, i.e. business models, defined as coherent clusters of long-term strategic choices, are important to explain bank performance. In the following sections we discuss the short- and long-term effects of each of the business model characteristics.

6.1.1 Asset composition: the loan ratio

First, table 6 shows that, notwithstanding a positive impact on the net interest margin, a higher loan ratio decreases profitability in the long run. Combined with the statistically insignificant effect on the Z-score, this implies that a focus on lending activity results in a worse risk-return trade-off than alternative asset structures. Table 7 clarifies the underlying drivers of these findings. A higher loan ratio appears to enable banks to generate both more net interest and non-interest income from each euro of assets (columns 3-4), but also increases operating expenses (column 5), albeit to a lower degree: the impact on pre-impairment ROA is significantly positive (column 6). The total effect on ROA, however, is negative due to the need for extra loan loss provisions per asset. Even for constant credit risk, a higher loan ratio can increase loan impairment charges on the average asset. As a consequence, the increased revenues, induced by a higher loan ratio, are lost to the extra expenses such a strategy entails.

Our analysis allows us to suggest some recommendations. Banks with a high loan ratio may be able to make their lending business more cost-efficient. The short-term effect of the loan ratio on expenses is negative, while the long-run impact is positive. This suggests that loans can in principle be added without leading to extra costs, but that long-run characteristics, such as the infrastructure needed to acquire a high loan ratio and the costs associated with monitoring loans, are the drivers of the expense ratio and hence also potential targets for cost improvements. Banks might moreover dedicate more attention to cross-selling financial products to retail customers in order to increase the positive effect on non-interest income

(e.g. the bancassurance model). On the other hand, decreasing (maintaining) the risk of the loan portfolio, while maintaining (increasing) lending rates might not be reconcilable. The underlying problem is that competition may prevent a bank from charging higher interest rates on its loans to compensate for the concentration of loans in its asset portfolio. Herein lies a rationale for a more diversified asset composition.

6.1.2 Asset quality: loan loss provisions to total loans

Table 6 shows that the effects of the asset quality measure (the ratio of LLP to total loans) are statistically significant for every performance indicator, both in the short and the long term. Taking more credit risk is compensated by a higher NIM, but it also causes profitability, ROE and ROA, to drop. A more detailed examination of the effect of asset quality on ROA in table 7 reveals that banks with more credit risk generate more net interest and non-interest income per asset, and that these effects are large enough to yield a positive impact on pre-impairment ROA. In contrast, the effect on total ROA is significantly negative, because banks with a lower-quality loan portfolio have, ceteris paribus, higher loan impairment charges per asset. Taken together these results suggest that the improvement of income due to higher credit risk does not sufficiently compensate this risk. Finally, as might be expected, credit risk also negatively affects the Z-score, implying that banks with lower asset quality are more vulnerable to distress. Hence, when a bank strategically concentrates on risky lending or is forced by disintermediation to target more risk loan segments, it is can only pursue this option in a viable way when it succeeds in lowering impairments by developing effective screening and monitoring capabilities.

6.1.3 Size: total assets

The long-run effect of size on performance is generally positive (table 6). It increases the Z-score without causing lower profitability or net interest margins. There is, however, a decidedly different impact in the short term: a negative effect on ROE, ROA and NIM and no significant effect on the Z-score. Table 7 sheds some light on the underlying mechanism.

In the short term size negatively affects net interest income per asset (column 3), which appears to be the consequence of increased funding expenses rather than lower interest

income (columns 1-2). This implies that banks use non-capital funding in order to grow or that growth induces the cost of funding itself to increase. The absence of a positive effect of size on interest expenses in the long run might be an indication of the funding advantage that is often found for banks considered too big to fail (Haldane, 2012), certainly considering that large banks are typically less well capitalized (see table 5). Furthermore, both in the short and the long term, size negatively affects the amount of non-interest income banks can obtain per asset (column 4). Apart from revenues, size has a negative effect on the operating expenses ratio, both in the short and the long run (column 5). This result is consistent with Wheelock and Wilson (2012) and Hughes and Mester (2013) who find that banks in all size classes can benefit from economies of scale. The combination of the effects on the income and expense ratios results in an impact on pre-impairment ROA that is not significantly different from zero, neither in the short nor the long term (column 6). The difference in profitability outcomes over the two horizons therefore lies in the effect of size on the quality of the average asset: in the short run asset growth results in more loan loss provisions per asset, either by an increasing concentration of loans or by a drop in loan quality. In the long run, on the other hand, larger banks do not suffer from lower asset quality.

These considerations also help to explain the differential impact of size on the Z-score depending on the time horizon. In the short run size does not significantly decrease the volatility of ROA (column 7), whereas in the long run, in which size no longer deteriorates asset quality, the impact on ROA volatility becomes significantly negative, thereby increasing the Z-score. Consequently, since our analysis is bank-specific, the results do not yield unambiguous arguments regarding the merits of bank size and hence on the appropriateness of calls for policies to limit bank size. Yet, there may be a high societal cost associated with very large banks due to systemic risk concerns (see ESRB, 2014). Increasing bank size is therefore probably not the desired channel to achieve bank stability.

6.1.4 Funding composition: the deposit ratio

With respect to the funding composition, Huang and Ratnovski (2011) show that wholesale financiers react strongly to noisy public signals concerning bank soundness and, as a consequence, these funding sources can dry up quickly during a financial crisis. Beltratti

and Stulz (2012) find that markets attached greater value to the stability of deposit funding during the crisis. Other studies also demonstrate that a higher reliance on customer deposits is negatively associated with bank distress (Altunbas et al., 2011; Köhler, 2014; Betz et al., 2013). On the other hand, deposits are not as flexible as wholesale funding sources and can therefore restrict access to profit opportunities. Our results, presented in table 6, support the bulk of recent research in that we find a more traditional funding structure to increase overall profitability, the net interest margin and stability in the cross-section of the banks. The flexibility of wholesale funding does not appear to outweigh the benefits of a high reliance on stable customer deposits.

The regressions in table 7 clarify the transmission of funding composition to performance outcomes. First, a higher deposit ratio increases the net interest income gained from the average asset by decreasing interest expenses (columns 1-3). This implies that funding composition can have a direct impact on the average cost of funding. Second, in the long run a higher deposit ratio adds to non-interest income (column 4). A likely explanation is the greater scope of cross-selling products from other business lines to an expanded group of retail clients, which can raise fee income. Since fully reaping the benefits of cross-selling takes time, it makes sense that the effect is only observed in the long run. Finally, the deposit ratio also increases the operating expenses per asset over both horizons (column 5), but in the long run this effect is not large enough to cancel out the income increase: the effect on pre-impairment ROA is significantly positive (column 6).

6.1.5 Funding stability: the NSFR

Funding stability, as measured by the NSFR, is an essential element of the Basel III regulatory standards. Although it is generally expected that banks with fragile funding structures will need to adjust their business models (King, 2013), it is far from certain that its implementation will affect profitability or even interest margins (Dietrich et al., 2014). The results in table 6 indeed indicate that there is only weak evidence for the effects of the NSFR: the significantly negative short-run effect on ROA and NIM disappears in the long run (columns 2-3).

The regression results presented in 7, however, demonstrate that the absence of a

significant impact on performance is in fact the outcome of a combination of effects. The differences between the short- and long-run effects furthermore indicate that the mechanisms to increase the NSFR depend on the horizon over which these changes are achieved. In the short term a higher NSFR can only be accomplished by increased funding expenses, which can only be partially compensated by rising non-interest income (columns 1 and 4). Hence the negative impact on ROA and NIM. Over a longer horizon the NSFR also positively affects operating expenses (column 5), suggesting that banks must undertake sustained investments to acquire or intensify their presence in stable funding markets. In the long term higher funding expenses are moreover offset by increased interest income (column 1). However, a loan-oriented asset composition, which is required to generate interest income (see section 6.1.1), is irreconcilable with a high NSFR[12]. These results therefore imply that the NSFR increases banks' lending rates to compensate for higher interest expenses.

With respect to bank stability, we find that the results for the Z-score in table 6 indicate that a higher mandatory NSFR, which is part of the Basel III regulatory framework, does not provide an effective safeguard against distress. Finally, we note that these findings should not be interpreted as a genuine impact study of the NSFR regulation, since the relationship between various sources of funding and their respective funding costs might change when the banking industry as a whole increases the demand for stable funding.

6.1.6 Income diversification: share of non-interest income

Prior literature concerning the effects of income diversification advances different hypotheses regarding bank performance. Theoretically, diversification should allow banks to reach a better position on the risk-return frontier. Stiroh and Rumble (2006) report that for a sample of US bank holding companies revenue diversification is associated with higher risk-adjusted profits, but that the gains are offset by costs of increased exposure to volatile non-interest activities. Demirgüç-Kunt and Huizinga (2010) find that income diversification is indeed beneficial for the ROA, but that it also increases bank risk. Altunbas et al. (2011) and Köhler (2014), on the other hand, find that more diversified banks are generally less

[12]Loans are subject to a high weight in the calculation of required stable funding, i.e. the denominator of the NSFR. In our scheme customer loans uniformly receive a weight of 100%. In the Basel III framework the weight also depends on encumbrance and credit risk (see table 4).

susceptible to distress. With respect to market valuation, Baele et al. (2007) show that markets value diversified banks more highly, while Laeven and Levine (2007) find evidence for a conglomerate discount, i.e. diversified banks' market values are lower than those of their specialized peers.

The results in table 6 support the hypothesis that income diversification improves long-term bank performance: a higher reliance on non-interest income sources improves both ROE and ROA (columns 1-2), without making banks more susceptible to distress, i.e. the effect on the Z-score is not statistically significant (column 3). In the short run we only find a significantly negative effect on the NIM (column 3). This effect feeds through to the profitability measures. Columns 5 and 6 demonstrate that if we control for the effect of the NIM in the regressions, the impact of income diversification on ROE and ROA becomes significantly positive.

Again, the results in table 7 provide a more detailed analysis of these effects. First, as one would expect, more diversified banks generate more non-interest income for each euro of assets (column 4). This effect even increases over the long run. Second, the effect on net interest income per asset is significantly negative (column 3), due to decreasing gross interest income (column 1). In the long run this effect is compensated to some extent by declining funding expenses (column 2), but the effect on net interest income remains negative. Third, income diversification raises operating expenses per asset (column 5), possibly because of the specialized personnel and infrastructure that is required to conduct the activities associated with non-interest income. In this sense, it is natural that the effect increases over time as these investments are also made over a longer horizon. The combination of these effects leads to an insignificant impact on ROA in the short run, but a significantly positive one in the long run. Note, moreover, that the short-term impact of income diversification on pre-impairment ROA is significantly negative (column 6), implying that increasing the share of non-interest income positively affects asset quality. Overall, the benefits of income diversification for profitability are mostly observed in the long run: only then does income diversification also lead to a funding advantage, while the additional non-interest income outweighs extra operating expenses even more than in the short term. We do not observe an effect of income diversification on the Z-score, but the explanation for this lack of impact differs according to

the horizon. In the short run diversification has no significant effect on ROA and the effect on ROA volatility (column 7 of table 7) is also insignificant. In the long run, on the other hand, income diversification raises both ROA and ROA volatility. These two counteracting effects on the Z-score appear to offset each other. These results suggest that income diversification is essential to attain sustainable bank profitability in the long term. We remark, however, that the limited granularity of our data does not allow us to discern which types of non-interest income support this objective best.

6.1.7 Capital structure: the capital ratio

Theoretically, the impact of banks' capital structure on their performance is unclear. More equity financing might reduce the ability of creditors to exert market discipline (Diamond and Rajan, 2001). Mehran and Thakor (2010), on the other hand, show that more capital may induce banks to screen borrowers more intensively, counteracting shareholders' incentives to increase risk at the expense of bank creditors. Furthermore, during the financial crisis banks with higher capital ratios performed better and were less likely to experience severe distress (e.g. Beltratti and Stulz, 2012).

The results in table 6 suggest that banks with a high capital ratio perform better in terms of ROA and NIM, both in the short and the long term. The effect on the ROE, however, is significantly negative, implying that the positive impact on ROA does not suffice to compensate for the mechanical negative effect of bank capital on ROE. A more detailed examination of the results, presented in table 7, enables us to elucidate the underlying mechanisms. First, the positive effect on the NIM can be attributed to decreasing interest expenses (column 2). A higher capital ratio indeed permits banks to decrease their reliance on interest-bearing funding instruments and might moreover negatively affect banks' own risk premiums. Second, a higher capital ratio raises the amount of non-interest income gained per asset (column 4), although operating expenses also increase (column 5). Taken together, these effects explain the significantly positive impact on ROA.

In line with most empirical work we find that capital reduces banks' fragility, i.e. the effect of the capital ratio on the Z-score is significantly positive (column 4 of table 6). In contrast, our results also confirm the findings of, among others, Delis et al. (2014),

who show that a higher capital ratio increases bank risk, as the effect on the variability of ROA is significantly positive (column 7 of table 7). These results can therefore reconcile the seemingly contradictory findings: additional capital and the ensuing rise of ROA more than compensate for the increase of bank risk. Consequently, our results support the more stringent capital rules imposed by Basel III, since a higher capital ratio lowers the cost of funding and has a positive effect on ROA, which in turn increases the capacity of the bank to further strengthen its capital base through profit retention.

6.1.8 Control variables

The set of control variables contains one bank-specific variable, i.e. the cost-income ratio. As expected, table 6 shows that it negatively affects both ROE and ROA. Less efficient banks also appear to increase risk-taking, resulting in a positive effect on ROA variability (column 7 of table 7). The combination of these effects, lower and more volatile profits, explains the negative effect on the Z-score, i.e. less efficient banks are more susceptible to distress.

The interpretation of the effect of real GDP growth depends on the horizon that is taken into account. It is no surprise that its impact in the long run differs from the one in the short run. The within effect of real GDP growth captures the impact of an expansionary phase in the business cycle. Our results, presented in tables 6 and 7, indicate that such a phase is associated with higher net interest income and, given the different coefficients for pre- and post-impairment ROA, lower loan impairment charges. This result is consistent with Beck et al. (2013a) who find that GDP growth was the main driver of non-performing loans in a broad sample of countries. It furthermore increases the stability of ROA, which contributes to the positive effect of real GDP growth on the Z-score. In the long run, however, higher real GDP growth is no longer related to business cycles, but to structural characteristics of the national economy[13]. We find that higher long-run real GDP growth engenders increased ROA volatility. While there is still a significantly positive effect on ROA, it does not suffice to counteract the effect of ROA volatility on the Z-score. As a consequence there is a slightly significant negative impact on the Z-score, i.e. banks in high-growth countries are

[13]In our sample, for example, the Central and East European countries grew on average by 3.2% per annum, while average growth for West European countries was only 1.8%. This difference possibly captures a catching-up effect.

more susceptible to distress. In this regard, Adrian and Shin (2010) have demonstrated that banks increase their leverage in response to rising asset prices, which can make banks in high-growth countries more vulnerable to deteriorating economic conditions.

With respect to interest rates, economic theory finds that low rates are conducive to more risk-taking as they lower informational asymmetry and therefore banks' franchise value (Keeley, 1990, see Delis and Kouretas (2011) for an empirical analysis). However, our results do not provide evidence to support this hypothesis. The long-term effect of the money market rate on ROA variability is indeed negative, but the result is not statistically significant (column 7 of table 7). It also does not appear to have an effect on the Z-score. On the other hand, we do find a positive effect of interest rates on profitability and the NIM. Closer inspection of the results in table 7 suggests that banks adjust their lending rates more than proportionally compared to the increase in funding expenses (columns 1-3).

Finally, the probability of sovereign default affects bank performance both in the short and the long run. An increasing likelihood of sovereign default, i.e. in the short term, makes domestic banks less profitable. It causes additional funding and operating expenses which cannot be covered by rising interest revenues (see columns 1-5 in table 7). An upsurge of sovereign default risk furthermore increases the variability of ROA, which together with lower profitability leads to a higher vulnerability to distress. We find a significantly negative effect on the Z-score. If sovereign risk is structural in nature, i.e. in the long term, it appears to have the opposite effect on banks' profitability. It now causes a rise of interest and non-interest revenues which more than compensate the increased expenses, resulting in a positive effect on ROE, ROA and NIM. These benefits, however, do not outweigh the positive effect of sovereign default risk on ROA variability, leading to a significantly negative effect on the Z-score. These results are broadly consistent with studies that document negative feedback loops between the creditworthiness of banks and the troubled sovereigns they are exposed to (e.g. De Bruyckere et al., 2013).

6.2 Heterogeneity of business model effects

The baseline results reveal several significant long-run associations between business model characteristics and bank performance. However, these results do not suffice to allow firm

statements about the viability of specific bank types. For the classical retail bank model, for example, we show that its funding composition and capital structure support its profitability, but the more concentrated asset and income composition constrain its performance. Similarly, more diversification, which is typical for financial conglomerates, is found to support profitability, but less reliance on customer deposits may hurt profits and increase risk. Hence, it is necessary to further explore the heterogeneity of the effects of strategic characteristics across different business models.

In this section we discuss the results of the rolling-regression analysis, which are displayed in figures 2 to 4. The figures correspond with the following subsections in which the long-term, i.e. between, performance impact of the business model characteristics are discussed. In these figures the horizontal axis corresponds to the business model variable over which the rolling regressions are estimated. The solid line represents the point estimates of the coefficients and the dotted lines represent 90% confidence intervals. In order to conserve space we restrict the number of figures shown, by only presenting the ones that yield interesting interaction effects between business model features and hence require further elaboration[14].

6.2.1 Asset structure

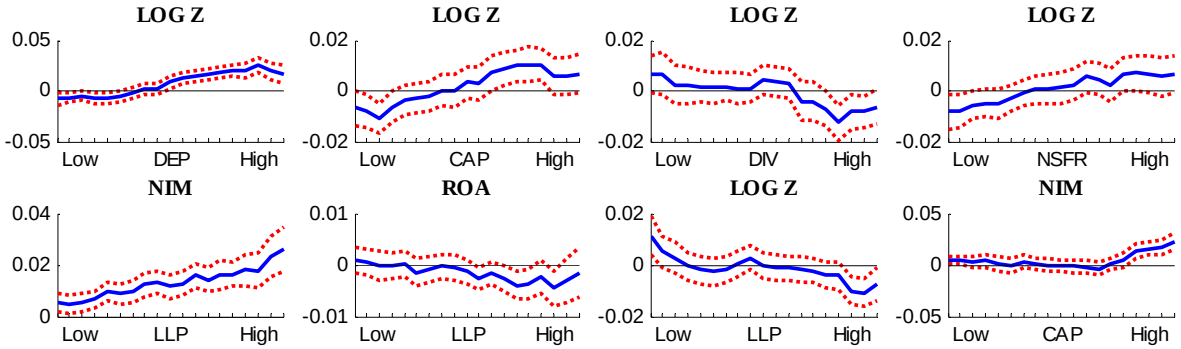
With respect to asset structure the rolling regressions in general confirm the findings from the full sample we identified in tables 6 and 7. The results presented in figure 2, however, demonstrate that it is the interaction of business model choices that determines the ultimate effect on profits and risk profile.

For the full sample a loan-oriented asset composition negatively affects profitability due to additional expenses and an increased sensitivity to loan impairments. There is furthermore no statistically significant effect on bank risk. However, the first row of panel A of figure 2 reveals that a higher loan ratio significantly increases the Z-score (and hence decreases distress) for banks that are closer to the traditional retail bank model, i.e. banks with a higher deposit or capital ratio (columns 1 and 2), a lower reliance on non-interest income

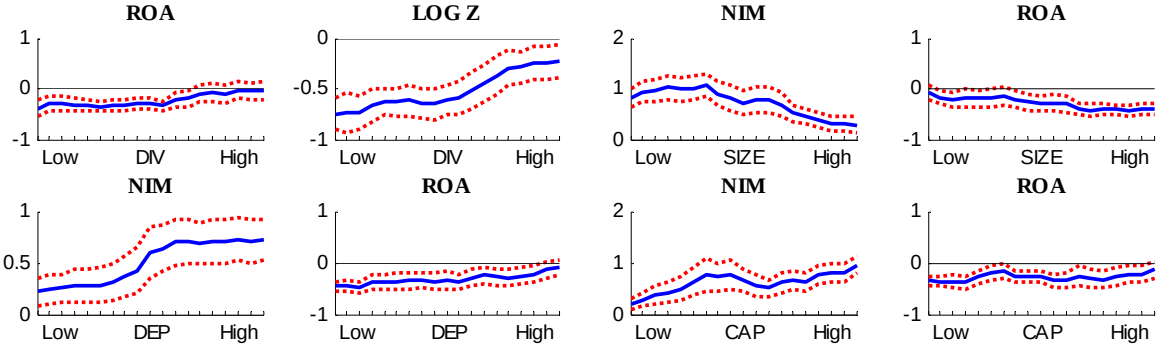
[14]The procedure of performing rolling regressions across all seven business model characteristics for four performance indicators (ROE, ROA, NIM and the natural logarithm of the Z-score) yields 196 ($4 \times 7 \times 7$) figures. A complete list of these figures is available upon request.

Figure 2: Heterogeneity of the impact of asset structure on performance. The title of each chart displays the relevant performance indicator, while the label on the x-axis corresponds to the variable over which the rolling-regressions are conducted. The solid line represents the point estimates of the coefficient and the dotted lines represent 90% confidence intervals based on standard errors clustered at the bank level. Variable names have been abbreviated in the following way: loans to earning assets (LOAN), loan loss provisions (LLP), log of total assets (SIZE), deposits to liabilities (DEP), net stable funding ratio (NSFR), income diversification (DIV), equity to total assets (CAP).

Panel A: Long-term impact of the loan ratio



Panel B: Long-term impact of loan loss provisions



Panel C: Long-term impact of total assets

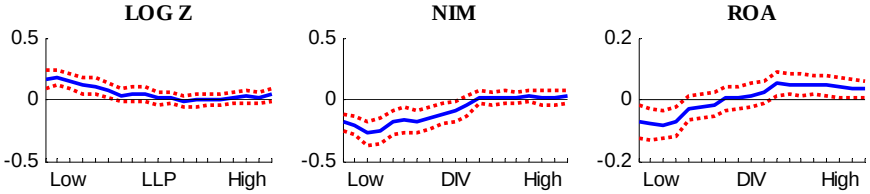
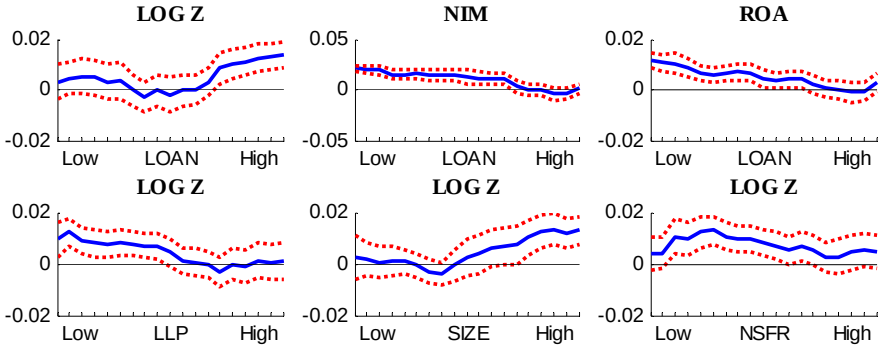


Figure 3: Heterogeneity of the impact of funding structure on performance. The title of each chart displays the relevant performance indicator, while the label on the x-axis corresponds to the variable over which the rolling-regressions are conducted. The solid line represents the point estimates of the coefficient and the dotted lines represent 90% confidence intervals based on standard errors clustered at the bank level. Variable names have been abbreviated in the following way: loans to earning assets (LOAN), loan loss provisions (LLP), log of total assets (SIZE), deposits to liabilities (DEP), net stable funding ratio (NSFR), income diversification (DIV), equity to total assets (CAP).

Panel A: Long-term impact of the deposit ratio



Panel B: Long-term impact of the NSFR

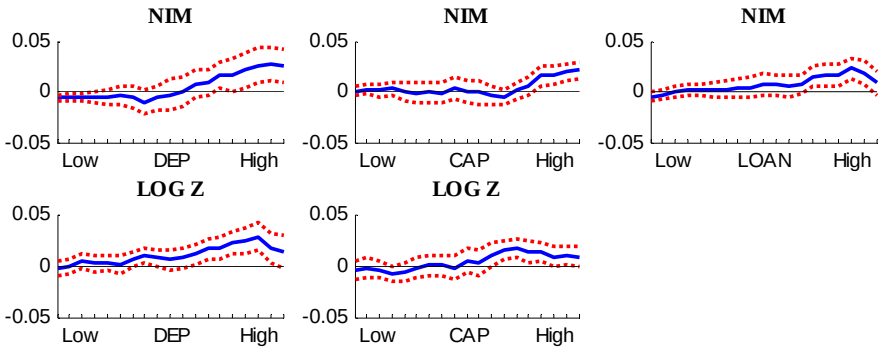
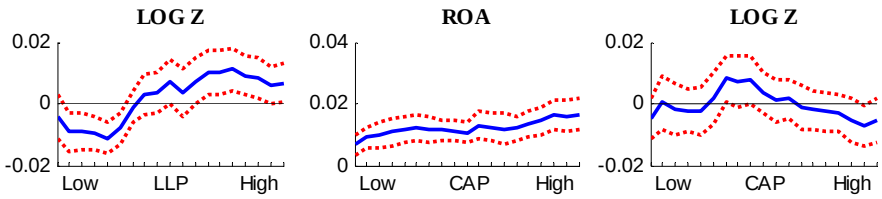
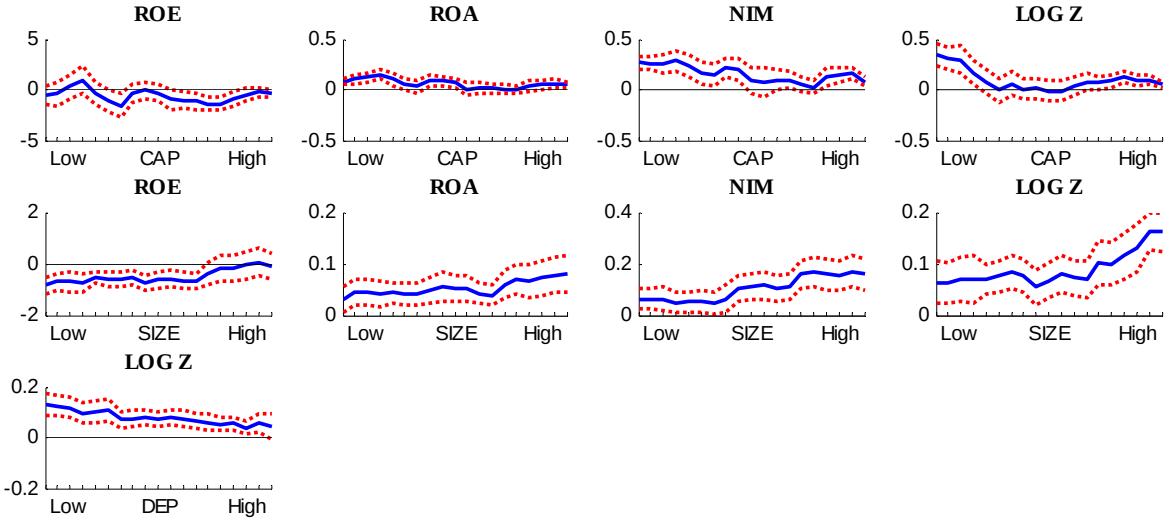


Figure 4: Heterogeneity of the impact of income and capital structure on performance. The title of each chart displays the relevant performance indicator, while the label on the x-axis corresponds to the variable over which the rolling-regressions are conducted. The solid line represents the point estimates of the coefficient and the dotted lines represent 90% confidence intervals based on standard errors clustered at the bank level. Variable names have been abbreviated in the following way: loans to earning assets (LOAN), loan loss provisions (LLP), log of total assets (SIZE), deposits to liabilities (DEP), net stable funding ratio (NSFR), income diversification (DIV), equity to total assets (CAP).

Panel A: Long-term impact of income diversification



Panel B: Long-term impact of the capital ratio



(column 3) or a higher NSFR (column 4). This means that banks that specialize in lending can only achieve a low overall risk profile, i.e. stable profits, if they opt for a conservative, retail-based funding and capital profile. This finding also supports the hypothesis that loans and customer deposits are complementary (Kashyap et al., 2002). The results in the second row of figure 2A indicate that the positive effect of the loan ratio on the NIM increases for banks with lower asset quality (column 1). This implies that banks with high loan loss provisions compensate their additional exposure to impairments, which is generated by a higher loan ratio, by increasing their lending margins. While this strategy appears to be effective in suppressing a negative effect of the loan ratio on ROA (column 2), it cannot prevent a significantly negative impact of the loan ratio on the Z-score for banks with low loan quality (column 3). Finally, we remark that the effect of the loan ratio on the NIM also depends on the capital ratio. For banks with high levels of capitalization, the effect becomes significantly positive (column 4), while it is non-existent for all other banks. This result indicates that well-capitalized banks have a funding cost advantage.

With respect to asset quality the baseline results in tables 6 and 7 suggest that lower loan quality is compensated by higher net interest income, but that this does not outweigh the effects of additional impairments. Consequently, the impact on both profitability and the Z-score is significantly negative. The rolling regressions demonstrate that some types of banks appear better able to mitigate the negative impact of low asset quality on performance. First, the results presented in the first row of figure 2B are in line with expectations: more diversified banks' profitability and Z-score (columns 1 and 2) are less sensitive to low asset quality, as interest income and loan impairment charges represent a smaller part of their income. The second row of figure 2B shows that a high deposit or capital ratio can make banks' funding costs less sensitive to asset quality and, hence, such banks experience a stronger positive effect of the LLP ratio on the NIM (columns 1 and 3). The effect is furthermore transmitted to profitability (columns 2 and 4). The effect of asset quality on the NIM will only compensate the risk banks take in their loan portfolio if funding is stable, i.e. based on customer deposits and capital. The implication is that institutional investors appear to be sensitive to loan quality, implying that wholesale funding cannot be considered as sufficiently stable. Finally, we also find some evidence that smaller banks' funding expenses

are less sensitive to asset quality, as they appear better able to increase the NIM and in this way mitigate the effect of low loan quality on ROA (columns 3 and 4 of row 1).

Finally, in the full sample large banks experience a lower variability of ROA, which lowers their susceptibility to distress. The first result presented in figure 2C, however, indicates that this beneficial size effect only accrues to banks with a high-quality loan portfolio. Second, although size does not have a significant impact on NIM or ROA for the whole sample, we do find that there is a significantly negative effect on these performance indicators for banks that rely more on interest income. For these banks size decreases the NIM (column 2) and since the heterogeneity is also established for ROA (column 3), this negative effect is not fully compensated by other types of income.

6.2.2 Funding structure

For the whole sample tables, 6 and 7 show that a stronger reliance on customer deposits is associated with increased profitability, a higher NIM and lower susceptibility to distress. The rolling regression analysis unequivocally confirms these results for different types of banks, although there is some heterogeneity regarding the asset structure. The results, presented in the first row of panel A of figure 3, indicate that the effect of the deposit ratio on the Z-score is only significantly positive for banks with a high loan ratio (column 1). This suggests that banks with a loan-oriented asset composition need stable deposit funding in order to compensate for their relatively risky and illiquid asset structure. A positive effect on the NIM and ROA, on the other hand, is only established for banks with an asset structure that is less loan-oriented (columns 2 and 3). It implies that deposits mainly serve to reduce funding costs for these banks. Apart from asset composition, we find that the effect of the deposit ratio on the Z-score is significantly positive only for banks with high loan quality (column 1), large banks (column 2) or banks with a low NSFR (column 3). For other banks the effect disappears completely.

For the full sample the NSFR appeared to be largely neutral with respect to bank profitability and risk (see tables 6 and 7). This result is an important finding since the NSFR is a new feature in the Basel III liquidity regulations and banks complain that onerous regulation might permanently affect their profitability. The rolling regressions in figure 3B

suggest that the effect of funding stability is markedly different for retail versus non-retail banks. A higher NSFR has a positive impact on the NIM only for banks with a high loan, deposit or capital ratio (row 1), all typical features of retail banks. The conservative risk profile of such banks may provide a funding advantage. For non-retail banks, attracting more stable deposits or other types of stable funding may prove to be only achievable at higher costs. In terms of bank stability, we observe that a higher NSFR only improves the risk profile for banks with a high deposit or capital ratio (row 2), which again suggests that retail banks have a comparative advantage.

6.2.3 Income structure

Tables 6 and 7 show that in the full sample a higher share of non-interest income positively affects the profitability of the banks, while the effect on the NIM and Z-score are statistically insignificant, suggesting that a certain degree of income diversification is required for sustainable profits. The rolling regression results confirm the sign and significance of these results. The results presented in panel A of figure 4 demonstrate that there is some heterogeneity across bank business models which calls for more detailed consideration. First, the impact of income diversification on bank stability strongly depends on banks' asset quality. Income diversification in the long run increases the vulnerability to distress of banks which take less credit risk, while the opposite is true for banks with a more risky loan portfolio (column 1). This finding implies an important qualification concerning the benefits of income diversification. As long as traditional lending provides stable revenues, the exposure to more volatile non-traditional income sources decreases bank stability (a lower Z-score). Banks that take more credit risk, however, can benefit from income diversification into non-lending activities. In the future increasing disintermediation may force banks into more risky lending activities. In that case bank stability will require a diversified income structure. Second, we find evidence for an interaction effect between income diversification and capital adequacy. A higher non-interest income ratio in the long run improves profitability most for the banks with a high capital ratio (column 2). This implies that the increased stability of the bank, achieved through a higher capital ratio, allows these banks to engage in certain types of potentially more volatile but also more profitable sources of non-interest income without

exposing themselves to severe distress (column 3).

6.2.4 Capital structure

The examination of the full sample revealed that the capital ratio positively affects ROA, NIM and Z-score. The rolling regression analysis unambiguously confirms these results. In panel B of figure 4 we nonetheless show that there is quite some heterogeneity across different business models with respect to the long-run impact of the capital ratio. First, the positive effect on performance is especially effective for the least capitalized banks. For these banks the impact of capital on ROA, NIM and Z-score is significantly positive, while the negative effect on ROE loses its significance (row 1). This implies that, taking a long-term perspective, some banks can benefit substantially from a higher capital ratio. Second, we also find that especially large banks appear to benefit from a high capital ratio in the form of a higher ROA and NIM and lower susceptibility to distress. The more positive effect of the capital ratio on the NIM even fully compensates the mechanically negative effect on ROE (row 2). This result provides justification for the extra capital buffers imposed on systematically important banks (G-SIFIs) in application of the Basel principles. Finally, banks relying less on customer deposits, and hence more on wholesale funding, exhibit a slightly higher Z-score in the long run when the capital ratio increases, while the negative impact on their return on equity is relatively limited (row 3). This suggests that increased capital ratios might be especially useful for banks that fund themselves with wholesale funding. This heterogeneity can be explained by the fact that wholesale financiers appear to have no incentive to monitor banks closely and therefore rely more on broad, but noisy, indicators, such as leverage (Huang and Ratnovski, 2011). A high capital ratio discourages sudden withdrawals of wholesale funding, thereby supporting the profitability of the bank.

7 Discussion and Conclusion

This paper investigates the effects of bank business models on bank performance in Europe using return on equity, return on assets and the net interest margin as profitability indicators and the Z-score as a proxy for banks' distress. The subcomponents of these indicators are

used to examine the transmission of business models to performance outcomes. The objective of this paper is to fully exploit the panel dimension of the bank data to distinguish short-term from long-term effects, because we specifically define the latter as business model effects. Consistent with this aim, we apply an econometric approach that identifies the long-term impact of business models by focusing on the differences across banks. In our empirical setup we also devote particular attention to the composition of the sample. Apart from the largest European banks, which are the most relevant for regulators and supervisors, we also include a large segment of second-tier banks. This ensures that the sample contains a wide variety of banks with different business model features. The smallest European banks, however, are excluded because the inclusion of almost identical small savings and cooperative banks from a limited number of countries might distort the results. We furthermore exclude the domestic subsidiaries of each parent bank, because strategic decisions are taken at the consolidated level. Finally, our sample period, from 1998 to 2013, covers episodes characterized by varying economic conditions, among which are the banking and sovereign crisis in Europe.

Our analysis confirms a number of expected relationships. For example, we document that a higher deposit ratio improves bank performance in all dimensions supporting the notion that banks with access to retail deposits possess a funding cost advantage and are perceived to be less risky. Our results also provide evidence for the importance of cost efficiency as a driver of bank profitability, implying that all bank types need to manage their operational efficiency to remain economically viable. This result appears to be especially important for banks with a loan-oriented asset portfolio. Apart from containing operating expenses, a lower cost-income ratio should flow from increased efforts to generate non-interest income through the cross-selling of financial products to retail customers. Our results furthermore suggest some qualifications to previously identified regularities. Although increased credit risk raises bank revenues, these do not suffice to compensate for the higher operating expenses and increased need for loan loss provisioning - hence the negative effect on ROA. The results pertaining to the impact of loan quality on bank performance should therefore not be interpreted as arguments to restrict credit risk, but rather as arguments to ensure that it is adequately priced. We also find that a higher capital ratio allows banks to pursue a more risky strategy, without making them more susceptible to distress. The capital ratio

itself and its positive effect on ROA more than offset the increase of the variability of profits. Apart from these qualifications, we also find that some bank characteristics, specifically those related to the retail business model, reinforce each other's effects. A high loan ratio can improve the stability of banks, but only if it is combined with a large share of deposit funding or a high capital ratio. Similarly, the positive effect of additional customer deposits on the Z-score is enhanced by a loan-oriented asset portfolio. The conclusion is that no single bank business model outperforms, but that there are different combinations of characteristics that have the potential to achieve long-term viability.

An important finding is that income diversification unambiguously improves the risk-return trade-off for all bank types. In the long run, a diversified income structure improves profitability without decreasing bank stability. Hence, banks should not be too focused on traditional intermediation, a certain degree of universality is necessary to attain a viable level of profitability. Yet, our findings also suggest that the impact of income diversification on stability depends on banks' asset quality. While banks with high-quality loans experience lower Z-scores when they become more exposed to potentially more volatile non-traditional income sources, the opposite is true for banks with low asset quality. Consequently, banks active in the more risky segments of lending need non-interest income sources to achieve a sustainable return-risk profile. These findings have ramifications for the debate about bank structure regulation. While it may be desirable from a financial stability perspective to prohibit banks from engaging in the most risky types of financial and derivatives markets, one should be careful not to limit bank activity beyond the point at which diversification benefits seem to prevail. These results support the thesis that no business model dominates in all dimensions. Retail banks, with a focus on lending, deposit funding and capital adequacy, appear to be more stable, but also less profitable. Such banks could, however, diversify their income sources to increase ROE and ROA in the long run without exposing themselves to more severe distress. While income diversification might decrease the stability of banks with high asset quality, this would be compensated to some extent by the increased stability generated by high loan, deposit and capital ratios.

In all cases, we find that a higher capital ratio improves banks' ROA and NIM, through lower funding expenses, and unambiguously increases banks' stability. These results clearly

lend support to the Basel III regulatory framework (including the additional capital buffers imposed on systemically important banks), all the more so since we document that a higher capital ratio is most beneficial for the performance of large and highly leveraged banks. An important finding is that imposing higher levels of the NSFR does not hurt bank profitability over the period covered in this analysis. It remains to be seen whether the enforcement of the NSFR and LCR ratios will have different effects in the future. The role of size, finally, is ambiguous. We find that in general large banks are more stable in the long run, but that increasing bank size comes at the cost of lower profitability and interest margins in the short run. Moreover, the banking crisis has demonstrated that distress of systemic banks may be associated with a high societal cost. Therefore, size is not the preferred avenue to increase bank stability; the funding and capital structure are shown to be much more effective tools.

The heterogeneity found with respect to some of the performance effects urges caution as regards the implementation of new regulation. First, a broader approach to banking supervision should be considered in which not only the liquidity and capital structure of the banks are regulated to increase their stability. Supervisors should in addition consider a bank's business model to assess the viability of the bank. Supervisory recommendations should be embedded in a broader economic assessment of bank health, taking all components of the business model into account. Moreover, the application of prudential regulation should reflect the heterogeneity of bank business model decisions. A differentiated approach and the disclosure of relevant exposures and business model features may enhance market discipline. Since the ECB and the European Banking Authority are responsible for supervision and coordination of rulemaking, they are ideally placed to maintain and disclose relevant bank data.

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