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DOES REVENUE DIVERSIFICATION STILL MATTER IN BANKING? EVIDENCE FROM A CROSS-COUNTRY ANALYSIS

SIMONE ROSSI

Università Cattolica del Sacro Cuore
Via E. Parmense, 84, Piacenza, Italy
simone.rossi@unicatt.it

ALBERTO DREASSI

University of Trieste, Piazzale Europa, 1, Trieste, Italy
adreassi@units.it

MARIAROSA BORRONI

Università Cattolica del Sacro Cuore, Via Necchi, 5/7, Milan, Italy
mariarosa.borroni@unicatt.it

ANDREA PALTRINIERI

University of Udine, Via Tomadini, 30/A, Udine, Italy
andrea.paltrinieri@uniud.it

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Banks have been revising their business models since the financial crisis, diversifying income sources to pursue profitability and stability in a rapidly evolving environment. The effectiveness of this strategy is still debated. We investigate if revenue diversification of 1250 EU and US banks improved performance or its stability between 2008 and 2016. We adopt a broad econometric approach and define diversification as the share of non-interest revenue and the HH index of the net operating income. We find that diversification is not clearly associated with performance or its volatility, that benefits change remarkably over time and, where present, show significant variability. Our results support recent evidence on the limitations of diversification in banking, raising potential concerns on converging supervisory practices and general calls for revenue diversity. The variability of business models and the impacts of different economic and institutional environments matter.

Keywords: Banks; diversification; *Z*-score; performance.

JEL Classification: G20, G21

1. Introduction

The evolution of business models is inherent to all firms. In the banking sector, this process showed an increased speed over the last decade. Leading changes include financial innovation and technological advances but extend to shifts in clients' behavior and lessons learnt from the financial crisis and embedded in recent supervisory and regulatory responses.

Diversification appears as a natural choice in order to restore or strengthen profitability in an uncertain environment. If excessive concentration could threat stability, banking diversification seems unable to be free from drawbacks: the recent academic debate underlines its limitations and the lack of unambiguous results.

Nonetheless, supervisors call for more income diversification, especially in Europe where the focus on traditional commercial banking is high. Fee-based revenues could be able to counterbalance the degrading quality of loan portfolios and smooth profitability patterns. However, during recessions, an increase in volatility and covariance of income sources can offset diversification benefits and lead to a return to concentration.

The appearance and growth of FinTech companies, despite being worth a fraction of the global banking business, is both a threat and an opportunity for banks struggling with performance, with impacts on traditional (for example, interest income arising from financing SME's working capital digitalizing assessment processes) or diverse sources of revenues (for example, fees and commissions generated from automated asset management advice services).

Moreover, as a response to the financial crisis, regulation and supervision changed dramatically worldwide, but with timing, breadth and depth that vary widely across countries. Changes in regulatory capital absorbed by different activities, in quantity and quality of scrutiny within the Supervisory Review and Evaluation Process (SREP), together with unprecedented changes in the underlying environment (above all, the EU Banking Union) are crucial drivers conditioning banks' business models, operations, profitability and stability over time.

The purpose of this paper is to test the attitude of revenue diversification in enhancing bank profitability or reducing its volatility. In particular, we examine the relationship between the degree of diversification (i.e. the share of non-interest income or the HH Index of the net operating income) and alternative declinations of risk-return profiles.

As a sample to test our hypotheses, we build a dataset of 1250 listed EU and US banks for the period between Q1-2008 and Q4-2016.

In terms of methodology, we firstly explore the cross-sectional nature of our data through OLS regressions on mean values. Then we employ a dynamic fixed-effect panel model to assess its time dimension. Finally, we run static panel regressions to compare within and between dynamics of our panel data.

Our contribution is to empirically test if diversification benefits hold in a cross-country dataset, through different econometric approaches, over a recent sample period experiencing different macroeconomic conditions and evolutionary trends in business models.

While an extended literature investigates the effects of revenue diversification on banks' risks and performance in the US (for example, De Young & Rice 2004a, 2004b, Stiroh 2004), Europe (Kohler 2014, Kholer 2015, Mergaerts & Vander Vennet 2016) and Emerging Markets (Berger *et al.* 2010a, 2010b), there are almost no studies comparing US and EU banks for a period including both the subprime and the European sovereign crisis. Additionally, our paper differs also in investigating a sizeable cross-country sample including both bigger and smaller institutions, through quarterly data, in order to enhance the computation of revenues volatility. Finally, we are also able to compare big EU and US banks, as well as bigger and smaller US banks (due to the lack of small listed banks in EU).

We find that EU and US banks behave significantly different in terms of diversification benefits. European banks lack evidence of positive impacts of non-interest revenues on both nominal and risk-adjusted performance measures. For the US, instead, effects are significant in terms of performance volatility and risk-adjusted profitability, but substantially different between smaller and larger institutions. Finally, effects are stronger between banks rather than within: in other terms, firm-specific diversification strategies and the ability to adapt to the environment seem to matter more than revenue diversity over time.

Our results convey significant implications. On one hand, the convergence of supervisory frameworks may prove unable to grasp fairly advantages and disadvantages of diversification across different business models. Additionally, a generalized call for increased revenue diversity does not seem to be backed by empirical data: we provide evidence that benefits are contingent on "which" diversification, as well as "where" and "when" it occurs.

This paper is structured as follows. In Sec. 2, we provide the review of the literature. In Sec. 3, we describe our sample, data, variables and econometric strategy. In Sec. 4, we discuss our findings and their policy implications. Finally, in Sec. 5, we provide our conclusions.

2. Literature Review and Hypotheses Development

A beneficial "portfolio-effect" generated by revenue diversification is common wisdom in banking management. Goddard *et al.* (2007) analyze the European banking system since the mid-1980s, showing that banks' response to the changing competitive environment has usually included several key strategies: diversification, product differentiation and consolidation. However, the empirical research on the link between diversification and risks or profitability shows mixed results.

We review the leading literature according to the geographical area of the sample (North America, Europe, Emerging Markets and cross-country). Then, we examine the literature focusing on causes and consequences of income diversification.

North America. For the US, Boyd & Graham (1986), using a wide sample of large bank holding companies (BHCs) during the period 1971–1983, note that extending to non-bank activities increases the risk of failure. Demsetz & Strahan (1997), studying a sample of BHCs during the period 1980–1993, find that better diversification does not translate into risk reduction. De Young & Roland (2001) test whether changes in product mix affect earnings volatility in 472 commercial banks between 1988 and 1995. They find that switching to fee-based activities generates an increase in leverage and also in volatility of revenues and earnings. De Young & Rice (2004a), examining 4712 commercial banks between 1989 and 2001, find that marginal increases in non-interest income are associated with poorer risk-return tradeoffs. In another study, De Young & Rice (2004b) analyze banks during the period 1986–2003 and find that diversification gains from fee-based activities appear to be scarce: fee-income boosts bank earnings but increases their volatility.

Stiroh (2004) highlights that non-interest income is typically a volatile component of income. At the bank level, a greater reliance on this revenue source is associated with lower risk-adjusted profits and higher risks. Calmès & Liu (2009) find that non-interest income has driven the variance of Canadian banks' aggregate operating-income growth: by contributing to banking income volatility, market-oriented activities do not necessarily yield diversification benefits. Al-Obaidan (1999), instead, analyzes a panel of US large commercial banks during the period 1985–1990, and finds that while diversification reduces technical efficiency, it improves allocative and scale efficiency, generating an overall economic gain in the industry. Shim (2019) provides evidence that increased loan diversification has a positive impact on the bank's financial strength.

Europe. Focusing on European banks for the period 1996–2002, Lepetit *et al.* (2008) show that bank expansion into non-interest income activities generates higher risks, including insolvency. Baele *et al.* (2007), analyzing a panel of banks over the period 1989–2004, find that a higher share of non-interest income positively affects banks' franchise values, but increases their systematic risk. Acharya *et al.* (2006), analyzing 105 Italian banks over the period 1993–1999, find that diversification fails to produce greater performance and to reduce risks. Hayden *et al.* (2007), employing a unique data set of individual bank loan portfolios of 983 German banks for the period 1996–2002, find scarce evidence of significant links between performance and diversification, that seems to be associated with reductions in bank returns, even after controlling the risk. Busch & Kick (2009), through a panel of German banks during the period 1995–2007, show that risk-adjusted returns on equity and total assets are positively associated to higher fee-income activities; however, a strong engagement in fee-generating activities goes along with higher risks. Again on Germany, Kohler (2014) investigates the impact of non-interest income on bank risks between retail and investment banks, showing that the former increases their stability if they expand their non-interest income, while the latter become riskier. Mercieca *et al.* (2007), using a sample of 755 European small banks for the period 1997–2003, find an inverse association between non-interest income and bank performance. Kholer (2015), analyzing the impact of business models on bank stability in 15 European countries between 2002 and 2011, shows that banks are more stable and profitable if they increase the share of non-interest income. Mergaerts & Vander Vennet (2016), focusing on a large sample of banks from 30 European countries over the period 1998–2013, find that higher levels of diversification are associated with higher profitability.

Emerging Markets and cross-country. On emerging economies, Berger *et al.* (2010a), investigating Russian banks during the period 1999–2006, show that performance tends to be non-monotonically associated to the diversification strategy. In a second study, Berger *et al.* (2010b), focusing on Chinese banks during the period 1996–2006, find that different forms of diversification are steadily associated with lower profits and higher costs. Sanya & Wolfe (2011), studying 226 listed banks across 11 emerging economies, provide evidence that diversification across and within both interest and non-interest income sources reduces insolvency risk and improves profitability. Focusing on four South Asian banking markets (Bangladesh, India, Pakistan and Sri Lanka) during the period 1998–2008, Nguyen *et al.* (2012) argue that banks become more stable through diversification across both interest and non-interest income activities. Comparing Islamic and conventional banks, Paltrinieri *et al.* (2020) show that diversification provides lower rewards for Shariah-compliant banks than conventional ones.

Considering cross-countries' studies, Roengpitya *et al.* (2017), investigating a panel of annual data relative to 178 banks from 34 countries for the period 2005–2015, provide evidence that commercial banking models exhibit more stable profitability than trading, and banks switching to retail-funding see their return on equity (ROE) improve by 2.5% on average, relative to non-switchers. Guerry & Wallmeier (2017), assessing the effects of diversification on bank evaluation unveil that the diversification discount decreases over time and vanishes after the financial crisis, while Kim *et al.* (2020) find that a moderate degree of bank diversification increases bank stability, but excessive diversification has an adverse effect.

Causes and consequences of diversification. A related stream of literature examines causes and consequences of the effect that revenue diversification has on profitability and risks.

Chiorazzo *et al.* (2008), investigating Italian banks during the period 1993–2003, find that income diversification increases risk-adjusted returns, the association is stronger at large banks, but limits to diversification gains exist as banks get larger. Studying US credit unions for the period 1993–2004, Goddard *et al.* (2008) find that similar diversification strategies are not appropriate for large and small credit unions.

De Jonghe (2010) argues that since diversifying financial activities in one "umbrella" institution does not improve the stability of the banking system, financial conglomerates usually trade at a discount. According to this statement, Laeven & Levine (2007) find that there is a diversification discount for financial conglomerates that engage in multiple activities. Elsas *et al.* (2010), using a panel data from nine countries over the period 1996–2008, find robust evidence against a conglomerate discount: diversification increases bank profitability and the resulting market valuation.

Overall, the rich literature in this field corroborates the idea that revenue diversification is not necessarily beneficial, that its strength may depend on other firm- or environment-specific variables, and that resulting gains on profitability and risk are far from being guaranteed. Stiroh & Rumble (2006) elegantly introduce the concept of the "dark side" of diversification by arguing that volatile patterns in non-interest income offset the benefits at the portfolio level: the (adverse) variance effect may counterbalance the (positive) correlation effect. Under this assumption, the net influence of revenue diversification on bank performances is ambiguous.

In line with this literature, we develop the following hypotheses to be tested.

We expect that an increase in the share of non-interest income, in years characterized by market turmoil, is associated to negative performance measures (nominal and risk-adjusted) and to increases in their volatility. Instead, a revenue diversity measure able to capture different potential directions of diversification and concentration strategies should show the opposite behavior: an increase of this variable should be associated with an improved performance and a reduced volatility. However, we also expect to find a very weak significance of these two variables once other firm-level covariates are included as control variables, as well as a high degree of diversity once comparing different banks within different banking systems.

H1. Non-interest income is associated with a poorer nominal or risk-adjusted performance and an increase in its volatility.

H2. Diversification is associated with improvements in the nominal or risk-adjusted performance and a decrease in its volatility.

H3. Both the share of non-interest income and the level of diversification are weakly significant in explaining performance and its volatility.

H4. The ability of non-interest income and diversification to explain changes in performance and its stability varies widely across banks and banking systems.

With reference to typical firm characteristics, we expect a negative association with performance and a positive association with its stability when considering the quality of the loan portfolio, the weight of traditional lending activities for each bank and the level of cost efficiency.

3. Methodology and Data

3.1. *Definition of variables*

Since we are interested both in the level and volatility of bank profitability, we use seven different dependent variables that are widely adopted in the banking literature (Table 1).

Typically, ROAE is more volatile than ROAA and is more influenced by bank leverage: we use both variables to cross-check from different points of view the effects of revenue diversification on bank profitability.

The expected positive portfolio-effect traditionally attributed to income diversification can be further investigated through volatility and risk-adjusted measures: consistently with existing literature (Stiroh & Rumble 2006, Mercieca *et al.* 2007, Goddard *et al.* 2008), we use the standard deviation and risk-adjusted versions for ROAA and ROAE and the Z-Score.

According to Stiroh & Rumble (2006), we calculate two different variables to account for the level of income diversification: NONsh and DIV. NONsh measures the share of net operating income represented by non-interest revenue (i.e. net trading incomes, net fees and commissions incomes, net insurance incomes, other non-interest incomes). Low levels of NONsh suggest the prevalence of traditional banking activities (borrowing and lending), typical for commercial banks. In this sense, a greater share of NONsh signals an income diversification strategy; however, this source of revenue may prevail also in other business models (for example, in corporate banking).

The second measure, DIV, accounts for this issue. This variable is built according to the Herfindahl–Hirschman Index approach; it measures for each bank the overall level of revenue diversification within the net operating income and it is calculated as follows (Eq. (3.1)):

$$\text{DIV} = 1 - [(\text{NONsh})^2 + (1 - \text{NONsh})^2]. \tag{3.1}$$

By construction, DIV assumes values between 0 and 0.5; the minimum value is associated with banks that exhibit a single source of operating revenues (i.e. maximum concentration). The maximum value of the variable is reached when there is an equal contribution of interest and non-interest revenues in total operating income (i.e. maximum diversification).

Consider two banks with a level of NONsh equal to 0.2 and 0.8, respectively. According to Eq. (3.1), DIV is the same for both banks and equals to 0.32. This means that, from a diversification point of view, despite these banks show the same value for DIV, their mix of revenue sources is different. This is the reason why both NONsh and DIV are important for the estimation process and the interpretation of findings. Naturally, as observed by Stiroh & Rumble (2006), these covariates are correlated; however, since DIV is a quadratic transformation of NONsh, the use of both variables in a single estimation follows a mainstream behavior in literature.

Our set of independent variables includes also other information from banks' financials, with their expected signs disclosed also in Table 1. Firstly, we account for size using the natural logarithm of total assets (TA): through this variable we control "size effect" on profitability and earnings volatility. To control leverage effects, we include the ratio between the tangible equity and total assets (Equity/TA): typically, higher levels of this variable signal a greater resilience capacity of the bank in troubled periods. Moreover, since we investigate a period characterized by a severe

Table 1. Variables definition.

Type	Variable	Description	Expected sign for performance	
			Level	Volatility
Dependent variables	ROAA	Return on average assets	/	/
	ROAE	Return on average equity	/	/
	σROAA	Standard deviation of ROAA	/	/
	σROAE	Standard deviation of ROAE	/	/
	RAROAA	Risk Adjusted Return on Average Assets (ROAA/σROAA)	/	/
	RAROAE	Risk Adjusted Return on Average Equity (ROAE/σROAE)	/	/
	Z-Score	(ROAA + Equity/TA)/σROAA	/	/
Independent variables	NONsh	Non-interest revenues on Operating Income	Negative	Negative
	DIV	1 – Herfindahl–Hirschman index (built on NON_{SH})	Positive	Positive
	TA	Natural Logarithm of total assets	Uncertain	Uncertain
	Equity/TA	Tangible equity over total assets	Uncertain	Uncertain
	Loans/TA	Net Loans over total assets	Negative	Positive
	Cost income	Cost income ratio (operating expenses/operating income)	Negative	Positive
	LLP	Loan loss provisions to loans	Negative	Positive
	Asset growth	Annual growth of total assets, computed as $(\text{TA}_t - \text{TA}_{t-1})/\text{TA}_{t-1}$	Uncertain	Uncertain

Notes: This table summarizes and defines the variables used in our analysis. Independent variables are end-of-year figures, with the exception of Asset growth, which is the arithmetical growth rate of assets between year $t-1$ and year t.

credit crisis, we observe the orientation towards lending through the ratio between loans and total assets (Loans/TA).

To control banks' efficiency and the quality of the credit portfolio, we include also the cost-income ratio (Cost Income) and the ratio between the loan loss provision and loans (LLP), the latter in lagged form in order to reduce endogeneity issues.

Finally, we include the level and squared value of asset growth to account for the annual (non-linear) variation in bank size (Asset growth and Asset growth^2).

3.2. *Data*

All data are obtained from the SNL Financial database, which includes a wide range of bank financial information. We focus on banks from Europe and the US for the period Q1 2008–Q4 2016 (36 quarters). Since we need quarterly data to calculate profit volatility for each year, we include in our sample only listed banks.

Saving banks, thrifts and mutual banks are excluded from the sample due to their peculiar asset-liability composition. All data are converted in Euro, but potential effects linked to exchange rates are captured using country and year dummies.

We drop banks that show NONsh values outside the [0;1] range. Yearly observations based only on data from one quarter are excluded (to avoid distortion on volatility measures), as well as banks with less than eight available quarters of data.

Profitability measures (ROAA and ROAE) are built as the average of available quarterly data for a specific year: this is in line with the end-of-year value in the database. However, quarterly data are necessary to build a measure of profit volatility for each year. In our dataset, this measure corresponds to the standard deviation of ROAA and ROAE. Since a single quarterly data produces a null standard deviation, we impose a filter on data excluding years without at least two quarters of available data.

The remaining variables are end-of-year figures, whereas Asset growth is calculated as the arithmetic growth rate of assets between year t and year $t-1$.

The outcome of this selection process is a dataset that includes 1250 banks, with over 95% of the sample from the US. In order to provide a more balanced view of the results, we use a cut-off of 3 billion Euros to split US banks into "bigger banks" and "smaller banks". This threshold corresponds to the minimum value of Total Assets observed in the European bank sample. Therefore, since all the European banks are over the cut-off, the "bigger US banks" sample is directly comparable with the European one. Unfortunately, we do not have a sample of smaller European banks, since in this area the average size of listed banks is greater than in the US. For the

Table 2. Panel composition.

Area	Country	No. of banks
Europe	Austria	4
	Belgium	2
	Cyprus	1
	Finland	2
	France	4
	Germany	7
	Greece	8
	Italy	16
	Luxembourg	1
	Netherlands	2
	Portugal	3
	Spain	6
	United Kingdom	4
US	US (bigger)	134
	US (smaller)	1056

Notes: This table summarizes our sample by geographical area. In order to split US banks into "bigger banks" and "smaller banks", we use a cut-off of 3 billion Euros, a threshold corresponding to the minimum value of Total Assets observed in the European sample. This allows us to compare the "bigger US banks" sample with the European one; furthermore, we can compare smaller and bigger US banks.

sake of our analysis, this process allows us to compare large US and EU institutions, and large and small US institutions, that we consider consistent with the purpose of testing the impact of diversification for different market- and firm-specific backgrounds.

The final sample consists of 60 European banks, 134 larger US banks and 1056 smaller US banks. The composition of our panel is outlined in Table 2.

Given the period of significant instability covered by our dataset, several variables show extreme values. We manage this issue through a winsorizing process (2.5% on each tail of the whole sample of available observations).

Tables 3 presents the summary statistics of our variables for three different subsamples, averaged over the whole period under investigation.

Table 3. Descriptive statistics (mean values over the whole period).

					Percentile			
Variables	No. of Obs.	Mean	Std. Dev.	Min	25th	50th	75th	Max
Panel A: EU Banks								
ROAA	60	0.000*	0.007	−0.028	−0.003	0.002	0.005	0.017
ROAE	60	0.006*	0.099	−0.380	−0.055	0.031	0.071	0.161
σROAA	60	0.007	0.008	0.001	0.002	0.004	0.011	0.039
σROAE	60	0.112*	0.112	0.011	0.041	0.060	0.154	0.546
RAROAA	60	2.418*	2.641	−1.009	0.662	1.938	3.582	13.762
RAROAE	60	2.272*	2.479	−0.866	0.654	1.707	3.080	12.044
Z-Score	60	35.483*	27.298	1.888	20.494	29.610	43.398	163.926
NONsh	60	0.393*	0.121	0.123	0.302	0.412	0.481	0.580
DIV	60	0.430*	0.070	0.204	0.388	0.458	0.485	0.496
TA	60	17.745*	1.344	15.073	16.450	18.071	19.085	19.085
Equity/TA	60	0.058*	0.019	0.028	0.044	0.052	0.070	0.104
Loans/TA	60	0.586*	0.143	0.338	0.501	0.609	0.701	0.786
Cost income	60	0.654	0.117	0.484	0.559	0.641	0.724	1.072
LLP	60	0.012	0.008	0.001	0.006	0.011	0.015	0.034
Asset growth	60	0.021*	0.078	−0.140	−0.012	0.012	0.036	0.466
Panel B: Larger US banks								
ROAA	134	0.006	0.008	−0.033	0.005	0.008	0.011	0.018
ROAE	134	0.043	0.084	−0.383	0.029	0.065	0.088	0.157
σROAA	134	0.006	0.008	0.001	0.002	0.003	0.007	0.044
σROAE	134	0.066	0.091	0.004	0.016	0.028	0.074	0.477
RAROAA	134	8.926	6.275	−1.516	4.614	7.684	12.673	28.479
RAROAE	134	8.286	5.814	−1.539	4.383	7.245	11.913	25.615
Z-Score	134	90.319	53.187	0.910	50.581	81.399	124.699	239.878
NONsh	134	0.276	0.118	0.057	0.203	0.271	0.340	0.580
DIV	134	0.365	0.098	0.106	0.322	0.383	0.438	0.495
TA	134	16.183	1.177	14.841	15.238	15.883	16.665	19.085
Equity/TA	134	0.089	0.019	0.040	0.079	0.088	0.099	0.172
Loans/TA	134	0.633	0.110	0.338	0.589	0.658	0.706	0.856
Cost income	134	0.671	0.121	0.474	0.596	0.661	0.726	1.203
LLP	134	0.010	0.009	0.002	0.005	0.008	0.013	0.049
Asset growth	134	0.102	0.086	−0.140	0.058	0.095	0.151	0.290

Table 3. (*Continued*)

Variables	No. of Obs.	Mean	Std. Dev.	Min	Percentile 25th	50th	75th	Max
Panel C: Smaller US banKS								
ROAA	1056	0.002*	0.009	−0.038	−0.001	0.005	0.009	0.019
ROAE	1056	0.004*	0.119	−0.518	−0.015	0.042	0.074	0.161
σROAA	1056	0.008	0.009	0.000	0.002	0.004	0.011	0.052
σROAE	1056	0.099*	0.140	0.004	0.020	0.040	0.109	0.756
RAROAA	1056	4.930*	5.013	−1.773	0.963	3.817	7.869	34.525
RAROAE	1056	4.392*	4.538	−1.711	0.814	3.397	6.865	28.676
Z-Score	1056	67.338*	50.356	0.273	27.174	59.818	98.329	361.221
NONsh	1056	0.176*	0.097	0.026	0.104	0.166	0.229	0.580
DIV	1056	0.267*	0.105	0.057	0.183	0.272	0.348	0.496
TA	1056	12.711*	0.972	10.926	11.965	12.663	13.449	14.831
Equity/TA	1056	0.094	0.027	0.028	0.077	0.092	0.108	0.179
Loans/TA	1056	0.674*	0.101	0.338	0.615	0.688	0.746	0.858
Cost income	1056	0.804*	0.174	0.472	0.686	0.774	0.892	1.460
LLP	1056	0.009	0.009	−0.001	0.004	0.007	0.011	0.049
Asset growth	1056	0.091	0.101	−0.140	0.036	0.078	0.135	0.570

Notes: This table provides the descriptive statistics on our variables across the three subsamples under investigation. The values marked with (*) means that, for the EU and the US smaller banks subsample, are statistically significantly different than the US larger banks.

Our preliminary result shows that European banks are less profitable than the corresponding US ones, have a higher exposure to non-interest revenues and are more diversified.

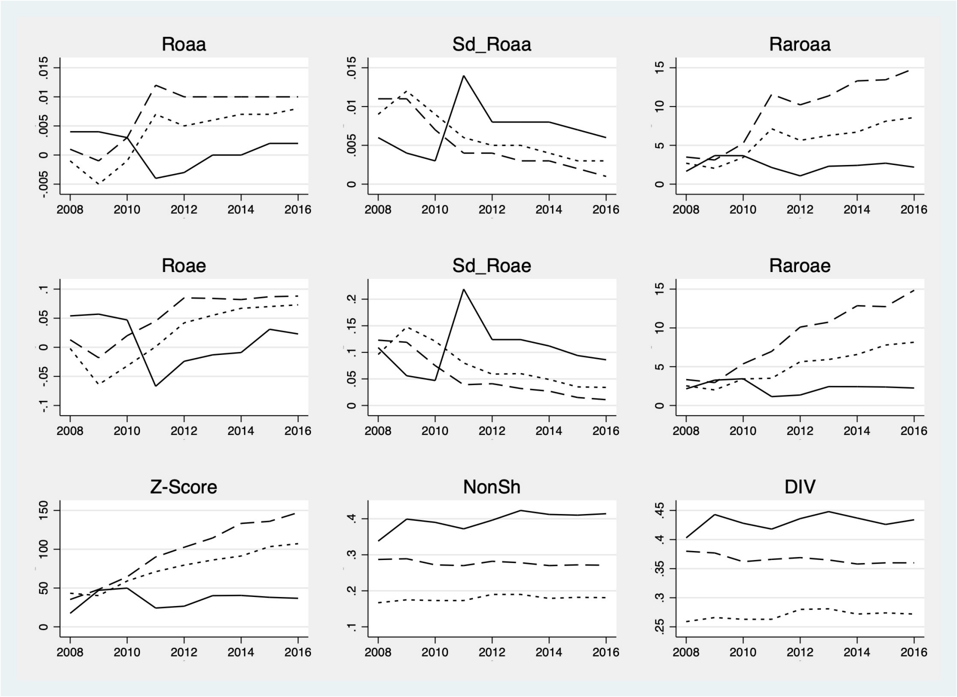
The behavior of our target variables (mean values) for our three subsamples (European banks, large US banks, small US banks) are provided in Fig. 1.

Performance measure (ROAA and ROAE), risk measures (standard deviation of ROAA and ROAE), risk-adjusted measures (RAROAA, RAROAE and Z-Score) and diversification measures (NONsh and DIV), respectively, show similar average trends in the period under investigation but provide some interesting changes occurred in the 2010–2011 years.

EU banks are associated with higher returns, lower standard deviation and comparable risk-adjusted measures until 2010. From 2011 and afterwards, the trend changed significantly. EU banks exhibit worse returns, higher standard deviations and worse risk-adjusted performances, with this trend remaining consistent until the end of our investigated period. In terms of diversification measures, however, the behavior of our three subsamples remains relatively stable, with EU banks increasing significantly especially in terms of NONsh.

3.3. *Econometric estimations*

In order to explore both the within and the between dimensions of our dataset, we employ four different set-ups in our econometric estimation.



Notes: This figure shows the trend over time across our three subsamples of the mean values for main variables under investigation or targeted by our analysis. EU banks are represented by a solid line, bigger US banks by a long-dashed line and smaller US banks by a short-dashed line.

Fig. 1. Target variables behavior over the timespan under scrutiny.

Following Stiroh & Rumble (2006), we start by calculating the mean value of each variable over the time span of our dataset: this allows us to run an OLS regression that explores the cross-sectional nature of the data.

Then, we use a dynamic fixed-effect panel regression on the original data to explore the time dimension of our panel.

Finally, in order to compare the within and between dynamics of the panel data, we run two static panel regressions using, respectively, within and between estimators.

3.3.1. *Cross-sectional analysis*

Equation (3.2) reports the baseline OLS model used to estimate the cross-section effects of revenue diversification on banks' profitability and risk-return measures.

$$\overline{\Pi_i} = c + \beta_1 \overline{\mathrm{NONsh}_i} + \beta_2 \overline{\mathrm{DIV}_i} + \gamma \bar{X}_i + \varepsilon_i, \tag{3.2}$$

where X_i is a vector of bank-specific information, c is the intercept and ε_i is the error term. All the variables are averaged over the whole period under investigation; country dummies are included.

3.3.2. *Panel analysis*

Equation (3.3) reports the baseline dynamic panel model used to estimate the effects of revenue diversification on banks' risk-return measures. We focus on these variables because they are more appropriate for evaluating bank performance, since they directly account for both the profitability and the riskiness (measured as the volatility of profits).

$$\Pi_{i,t} = \Pi_{i,t-1} + \beta_1 \text{NONsh}_{i,t} + \beta_2 \text{DIV}_{i,t} + \gamma X_{i,t} + c_i + \varepsilon_{i,t}. \tag{3.3}$$

In this set-up, profitability variables are averaged over each year; annual standard deviation measures for ROAA and ROAE express their volatility across the available quarters of a specific year. Covariates are end-of-year figures. All regressions include interacted year-country dummies: in static panel estimations, the autoregressive term is omitted. Hausman tests suggest the use of fixed-effect estimators against a random-effect specification; we also include regressions using between estimators in order to explore different behaviors of within and between components of the panel.

3.4. *Robustness checks*

In order to check the robustness of our results, we perform several additional estimations, omitted for space constraints but available from authors upon request.

First of all, we test alternative regressions on original data, winsorizing on each subsample and using different winsorizing approaches (for example, 1% on each tail). Our results are not affected.

We also try different variable specifications, in particular using the standard deviation of ROAA and ROAE calculated on the whole period instead of on a yearly basis. Again, our results do not change.

Third, since efficiency and credit quality deterioration (namely, the cost-income ratio and loan loss provisions) are potential components of the dependent variables, we estimated all the regressions excluding these covariates. Once more, results are confirmed.

Because of NONsh varying significantly in our panel data analysis, we perform a full set of estimations comparing banks with a low level of NONsh with banks showing high level of this covariate, based on the sample median value of NONsh (0.30 for bigger banks and 0.17 for smaller banks). We find significant differences arising only in Europe and only for high values, with a negative association with RAROAE, RAROAA and the Z-Score, and a positive association with ROAE, ROAA and their respective standard deviations.

Finally, since endogeneity concerns are crucial in estimations exploring profitability and diversification strategies, we use two-step system GMM models to examine the robustness of our results also in this direction. Once again, coefficients sign and statistical significance are in line with our main results presented as follows.

Results

4.1. *Cross-sectional analysis*

We conduct the first part of our analysis as follows: we firstly consider EU and bigger US banks, where comparability should be greater (Table 4), and then replicate the analysis for smaller US banks.

Table 4 presents the results for European and bigger US banks in terms of both level and volatility of profitability.

A general lack of statistical significance of NONsh emerges, across all regressions. DIV, on the other hand, shows a weakly significant negative effect on the level of ROAA for the EU sample and a statistically significant negative effect on profits volatility for larger US banks. In general, coefficients deriving from profit volatility estimations are in line with our hypotheses H1 (NONsh positive for volatility) and H2 (DIV negative for volatility), but statistical significance is more closely related

Table 4. OLS regression on mean values for returns and volatility (European and larger US banks).

	ROAA (mean)		ROAE (mean)		σROAA		σROAE	
Variables	US	Europe	US	Europe	US	Europe	US	Europe
NONsh	0.01	0.00	0.08	−0.02	0.00	0.01	−0.02	0.15
	(0.008)	(0.009)	(0.056)	(0.120)	(0.007)	(0.008)	(0.067)	(0.145)
DIV	0.00	−0.03*	0.06	−0.24	−0.01**	−0.01	−0.11**	0.03
	(0.007)	(0.015)	(0.048)	(0.200)	(0.005)	(0.011)	(0.055)	(0.181)
TA	−0.00	−0.00	−0.00	−0.01	−0.00	0.00	−0.01*	−0.00
	(0.000)	(0.001)	(0.003)	(0.010)	(0.000)	(0.001)	(0.004)	(0.008)
Equity/TA	0.04**	0.00	0.19	−0.03	0.02	0.02	−0.45	−0.56
	(0.017)	(0.052)	(0.199)	(0.809)	(0.032)	(0.041)	(0.318)	(0.830)
Loans/TA	−0.01**	−0.01	−0.06*	−0.18**	−0.00	0.00	−0.02	0.05
	(0.002)	(0.005)	(0.031)	(0.080)	(0.004)	(0.005)	(0.043)	(0.089)
Cost income	−0.04***	−0.02**	−0.38***	−0.28**	0.03***	0.02***	0.32***	0.33**
	(0.004)	(0.010)	(0.049)	(0.122)	(0.006)	(0.008)	(0.073)	(0.133)
LLP	−0.32***	−0.26	−3.30***	−5.44**	0.35***	0.38**	4.09***	3.66
	(0.055)	(0.158)	(0.684)	(2.209)	(0.084)	(0.144)	(1.139)	(2.868)
Asset growth	0.02**	0.02	0.29**	0.43**	−0.03	−0.02*	−0.33*	−0.41*
	(0.009)	(0.015)	(0.139)	(0.206)	(0.016)	(0.013)	(0.183)	(0.206)
Asset growth^2	−0.02	−0.02	−0.53*	−0.84*	0.04	0.01	0.56	0.14
	(0.017)	(0.030)	(0.298)	(0.438)	(0.032)	(0.024)	(0.367)	(0.429)
Constant	0.03***	0.05***	0.31***	0.61***	−0.01	−0.02	0.05	−0.16
	(0.004)	(0.014)	(0.068)	(0.226)	(0.007)	(0.014)	(0.082)	(0.207)
No. of Obs.	134	60	134	60	134	60	134	60
Adjusted R^2	0.90	0.74	0.86	0.76	0.76	0.85	0.75	0.77

Notes: This table presents the impact of diversification on profitability and stability measures using OLS estimations for EU and larger US banks samples. Variables are averaged over the whole period. Dependent variables of these estimations are the level and volatility of ROAA and ROAE. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include country dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

with the expectations under H3 (NONsh and DIV are weakly and rarely significant) and H4 (material variability across banking systems). Performance level estimations provide mixed results.

Size is associated with negative but not statistically significant coefficients: since we are here comparing banks of similar size, the explanatory power of this variable is reduced.

Leverage and loans share exhibit a mild effect on the dependent variables. It emerges that a greater loan share depressed bank profitability during the period under examination: this outcome is not surprising given the specific features of the recent crisis.

A clearer role is played by efficiency and loan quality: both variables (Cost Income and LLP) are associated with highly significant coefficients that are negative for profitability levels and positive for volatility. As expected, lower levels of efficiency and higher deterioration of credit portfolio quality depress profitability and increase profit volatility. This effect is likely to be even stronger in a period of falling margins.

Asset growth is associated with positive coefficients in profit level regressions and negative ones in profit volatility estimations; the quadratic term shows an opposite sign, indicating that, as expected, a faster growth can generate more instability in the risk-return profile.

Table 5 shows the results for risk-adjusted performance measures.

We find that NONsh is constantly associated with negative coefficients. Instead, DIV shows positive coefficients in the US sample, while the opposite happens for the European one. Statistical significance is scattered, while it is more common in larger US banks regressions; compared with Table 4 we observe more statistically significant coefficients. This is due to the combination of level and volatility of profits, which contribute to the computation of the dependent variables used in these estimations. Risk-adjusted measures provide a more insightful picture on profitability.

Results are therefore supportive of our four main hypotheses. Overall, outcomes in Table 5 are also consistent with the literature (Stiroh & Rumble 2006): a contrast exists between diversification benefits and the potential adverse effect linked to more volatile non-interest revenues.

Tangible equity and loans share exhibit mainly negative coefficients.

Cost income and loan loss provisions are associated with negative and strongly significant coefficients, underlining the relevance of these two variables during the recent crisis period.

Table 6 includes the results of econometric estimation for smaller US banks.

Overall, results confirm the previous analysis and are in line with all our hypotheses. NONsh increases the volatility of banks' profits and is associated with negative coefficients in risk-adjusted profit regressions. DIV, on the contrary, reduces volatility and gives benefits to risk-adjusted performance measures. In this subsample, characterized by a greater variability in the size of banks, TA shows positive

Table 5. OLS regression on mean values for risk adjusted returns and the Z-Score (European and larger US banks).

	RAROAA		RAROAE		Z-Score	
Variables	US	Europe	US	Europe	US	Europe
NONsh	−10.58*	−4.04	−9.83*	−2.31	−123.94**	−87.47*
	(6.035)	(4.127)	(5.847)	(3.662)	(54.062)	(43.879)
DIV	14.02**	−1.59	14.42**	−4.83	117.78*	55.99
	(6.290)	(4.744)	(5.794)	(4.604)	(62.061)	(69.015)
TA	0.20	−1.00**	0.14	−0.89**	4.76	−6.24
	(0.446)	(0.398)	(0.406)	(0.371)	(3.914)	(4.566)
Equity/TA	−37.44*	−35.46**	−33.68*	−26.66	157.70	−94.29
	(21.634)	(17.210)	(19.777)	(16.737)	(226.848)	(179.002)
Loans/TA	−3.32	−7.19***	−3.38	−7.23***	16.34	−12.91
	(5.278)	(2.334)	(4.740)	(2.251)	(42.724)	(23.185)
Cost income	−23.13***	−8.30**	−23.39***	−6.55**	−146.68***	−92.29**
	(4.808)	(3.234)	(4.626)	(2.822)	(39.135)	(38.358)
LLP	−253.45***	−167.33**	−234.25***	−161.76**	−2472.98***	−1534.60**
	(60.293)	(74.366)	(55.201)	(66.799)	(621.894)	(697.425)
Asset growth	3.88	1.15	1.28	1.93	34.02	−32.42
	(10.808)	(7.613)	(10.401)	(6.952)	(112.361)	(65.909)
Asset growth^2	−9.79	−28.86**	−10.46	−26.47**	−183.49	−104.34
	(24.725)	(13.011)	(23.574)	(12.357)	(249.538)	(106.653)
Constant	27.04***	39.09***	27.01***	35.57***	107.63	279.42***
	(9.650)	(8.837)	(8.689)	(8.269)	(79.913)	(98.976)
No. of Obs.	134	60	134	60	134	60
Adjusted R^2	0.48	0.51	0.50	0.58	0.41	0.46

Notes: This table presents the impact of diversification on profitability and stability measures using OLS estimations for the EU and larger US banks samples. Variables are averaged over the whole period. Bank profitability measures are the risk-adjusted return on average assets (RAROAA), the risk-adjusted return on average equity (RAROAE) and Z-Score. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include country dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

and statistically significant coefficients for risk-adjusted performance measures: larger banks hence benefit in terms of RAROAA, RAROAE and Z-Score.

In these estimations, negative and significant coefficients are associated with leverage, loans share, cost-income ratios and loan loss provisions. The coefficient for Equity/TA in the last column is not surprising: the variable enters the equation used to calculate Z-Score with a positive value.

Asset growth should promote profitability, but the effect on its volatility may be less immediate. In our findings, the coefficients associated with the variable in risk-adjusted performance regressions are not statistically significant: apparently, growth may be beneficial for some entities and increase volatility for others, without an easily predictable outcome.

Table 6. OLS regression on mean values (smaller US banks).

Variables	ROAA (mean)	ROAE (mean)	σROAA	σROAE	RAROAA	RAROAE	Z-Score
NONsh	0.02***	0.11	0.01**	0.13**	−1.98	−3.43	−94.82***
	(0.005)	(0.069)	(0.004)	(0.065)	(3.463)	(2.909)	(28.714)
DIV	−0.00	0.01	−0.01***	−0.20***	2.06	4.77*	48.57
	(0.005)	(0.062)	(0.004)	(0.064)	(3.404)	(2.882)	(31.576)
TA	0.00	0.00	0.00	0.00	0.70***	0.47***	5.91***
	(0.000)	(0.002)	(0.000)	(0.003)	(0.138)	(0.128)	(1.510)
Equity/TA	0.02**	0.42***	0.00	−1.15***	−13.67***	−10.43**	192.58***
	(0.007)	(0.093)	(0.008)	(0.121)	(4.875)	(4.164)	(55.400)
Loans/TA	−0.00***	−0.03**	0.00***	0.04**	−5.31***	−4.57***	−49.05***
	(0.001)	(0.015)	(0.001)	(0.021)	(1.234)	(1.078)	(14.024)
Cost income	−0.03***	−0.30***	0.01***	0.18***	−14.12***	−13.72***	−99.89***
	(0.002)	(0.019)	(0.002)	(0.026)	(0.963)	(0.921)	(9.777)
LLP	−0.47***	−5.97***	0.58***	7.69***	−144.35***	−129.56***	−1744.44***
	(0.039)	(0.514)	(0.051)	(0.709)	(17.086)	(15.466)	(202.820)
Asset growth	0.01**	0.30***	−0.02***	−0.48***	2.07	−0.23	7.94
	(0.005)	(0.068)	(0.006)	(0.083)	(2.538)	(2.280)	(26.023)
Asset growth^2	−0.02*	−0.54***	0.04***	0.94***	−0.88	3.49	−30.93
	(0.011)	(0.140)	(0.012)	(0.172)	(6.070)	(6.026)	(59.457)
Constant	0.03***	0.25***	−0.01***	−0.00	13.18***	13.96***	107.56***
	(0.003)	(0.040)	(0.004)	(0.060)	(2.614)	(2.421)	(28.184)
No. of Obs.	1056	1056	1056	1056	1056	1056	1056
Adjusted R^2	0.85	0.84	0.75	0.78	0.51	0.52	0.43

Notes: This table presents the impact of diversification on profitability and stability measures using OLS estimations for the smaller US banks sample. Variables are averaged over the whole period. Dependent variables of these estimations are the level and volatility of ROAA and ROAE, the risk-adjusted return on average assets (RAROAA), the risk-adjusted return on average equity (RAROAE) and Z-Score. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include country dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Since in the econometric estimation, NONsh and DIV are considered as explanatory variables but they share a common root, it is worth examining their joint effect on dependent variables. More specifically, when the share of non-interest revenues changes (for example, it increases its level), two different effects occur. The first one is simply a greater exposure to this source of revenues: the outcome of this event can be read directly observing the coefficients associated to NONsh. The second one is linked to the income diversification level and requires a specific explanation.

Since interest and non-interest shares sum to one, the equation for calculating DIV can be written as follows (Eq. (4.1)):

$$\text{DIV} = 2\text{NONsh} - 2\text{NONsh}^2. \tag{4.1}$$

An increase in the level of NONsh has two consequences on DIV (a linear and a quadratic one) that are usually referred as direct and indirect effects in the literature (Stiroh & Rumble 2006). The total or "net" influence of a change in NONsh on the dependent variable can be calculated as the sum of these two effects.

We investigate this issue for our risk-adjusted measures (RAROAA, RAROAE, Z-Score), by evaluating the partial and total effect of a 1% increase of the non-interest share of revenues for different percentiles of NONsh for each subsample of banks. This allows us to explore the effect of a change in NONsh for banks that show different compositions of revenues: in fact, we can expect that the benefits stemming from diversification strategies change for different levels of NONsh.

A very easy way to understand this statement is considering two banks that have a level of NONsh equal to 0.4 and 0.6 (40% and 60%, respectively). An increase in NONsh means a gain in diversification for the first bank, but more concentration for the second one. DIV is initially equal to 0.48 for both banks; however, after the change observed in NONsh, its level is equal to 0.4838 for the first bank and 0.4578 for the second.

We consider the 10th, 25th, 50th, 75th and 90th percentile of NONsh for each group of banks. Results for RAROAA are presented in Table 7.

The most noticeable result is the recurring negative sign of the net effect for EU banks: both direct and indirect effects go in this direction. This outcome is indirectly reinforced by the only positive coefficient that can be found in the highest percentile column for the indirect effect: considering that for this cohort the average level of NONsh is 0.55, an increase in this variable means a concentration strategy and not a diversification one.

US banks — larger and smaller — show a common pattern of coefficients: they are mainly negative for the direct effect and positive for the indirect effect. The total influence on RAROAA is mainly positive but turns to negative for the highest percentiles. This suggests that an increase in NONsh provides different outcomes across diverse levels of non-interest income revenues (for instance, banks that are starting their diversification strategy or those that already express higher weights of non-interest income).

Table 8 shows the direct, indirect and total effect of a change in NONsh on RAROAE.

Overall, results remain consistent. For European banks almost all coefficients remain negative, while for US banks we have negative direct effects that are counterbalanced by positive indirect ones. The total effect is mainly positive for the latter sample, while statistical significance varies with the chosen percentile.

Table 9 completes this analysis for the Z-Score.

Here, coefficients for the indirect effect turn to positive for European banks, but the total effect remains negative. For bigger US banks, coefficients are consistent with previous results. For smaller US banks, instead, positive effects of diversification are not sufficient to overcome the negative outcomes stemming from a greater

Table 7. Estimated impact of a 1% change in NONsh on RAROAA.

	NONsh percentiles	10th	25th	50th	75th	90th
European banks	Direct effect	−0.040	−0.040	−0.040	−0.040	−0.040
		0.041	**0.041**	**0.041**	**0.041**	**0.041**
	Indirect effect	−0.017	−0.012	−0.005	−0.001	0.004
		0.051	**0.037**	**0.016**	**0.003**	**0.011**
	Total effect	−0.057	−0.053	−0.046***	−0.041***	−0.037***
		0.048	**0.035**	**0.015**	**0.003**	**0.010**
Bigger US banks	Direct effect	−0.106*	−0.106*	−0.106*	−0.106*	−0.106*
		0.060	**0.060**	**0.060**	**0.060**	**0.060**
	Indirect effect	0.216**	0.164**	0.126**	0.087**	0.036**
		0.097	**0.073**	**0.056**	**0.039**	**0.016**
	Total effect	0.110	0.058	0.020	−0.019	−0.07***
		0.083	**0.063**	**0.048**	**0.033**	**0.014**
Smaller US banks	Direct effect	−0.020	−0.020	−0.020	−0.020	−0.020
		0.035	**0.035**	**0.035**	**0.035**	**0.035**
	Indirect effect	0.035	0.032	0.027	0.022	0.017
		0.059	**0.053**	**0.045**	**0.036**	**0.028**
	Total effect	0.016	0.012	0.007	0.002	−0.003
		0.022	**0.020**	**0.017**	**0.014**	**0.010**

Notes: The table is built on the results of regressions on average values as reported in Tables 5 and 6. Results are evaluated at different average levels of NONsh, corresponding to the 10th, 25th, 50th, 75th and 90th percentile of each sample of banks. The corresponding average figures for European Banks are 0.23, 0.30, 0.41, 0.48 and 0.55. For the bigger US banks, the values are equal to 0.11, 0.20, 0.27, 0.34 and 0.43, while for smaller US banks the corresponding values are 0.06, 0.10, 0.17, 0.23 and 0.29. Direct effect measures the impact of a 1% increase in the average level of NONsh on the dependent variable (RAROAA); indirect effect is calculated as the impact of diversification on the dependent variable, given a 1% increase in NONsh. Total effect is the sum of direct and indirect effect. Standard errors are reported in bold below the estimated coefficients. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

exposure to non-interest revenues. This latter result is stable across all columns, while statistical significance is present only for higher percentiles.

Considered altogether, results from this alternative setting confirm again our hypotheses, in particular the expected weak significance of NONsh (H3) and the variability across banking systems and bank characteristics (H4).

4.2. *Panel analysis*

Our empirical analysis includes also several panel estimations. As for the previous analysis, we first focus on EU and larger US banks, extending then the comparison to smaller US banks.

Table 10 shows the results of dynamic estimates for the first comparison.

Besides a weak autocorrelation of the dependent variables, the regressions confirm the previous analysis. NONsh and DIV are associated respectively with negative and positive coefficients, while rarely being statistically significant, confirming all our hypotheses. Among the other explanatory variables, it is worth noting that cost-

Table 8. Estimated impact of a 1% change in NONsh on RAROAE.

	NONsh percentiles	10th	25th	50th	75th	90th
European banks	Direct effect	−0.023	−0.023	−0.023	−0.023	−0.023
		0.037	**0.037**	**0.037**	**0.037**	**0.037**
	Indirect effect	−0.052	−0.037	−0.016	−0.003	0.011
		0.049	**0.036**	**0.015**	**0.003**	**0.011**
	Total effect	−0.075*	−0.06*	−0.039***	−0.026***	−0.012
		0.043	**0.031**	**0.013**	**0.002**	**0.009**
Bigger US banks	Direct effect	−0.098*	−0.098*	−0.098*	−0.098*	−0.098*
		0.058	**0.058**	**0.058**	**0.058**	**0.058**
	Indirect effect	0.222**	0.168**	0.129**	0.089**	0.037**
		0.089	**0.068**	**0.052**	**0.036**	**0.015**
	Total effect	0.124*	0.070	0.031	−0.009	−0.061***
		0.072	**0.054**	**0.042**	**0.029**	**0.012**
Smaller US banks	Direct effect	−0.034	−0.034	−0.034	−0.034	−0.034
		0.029	**0.029**	**0.029**	**0.029**	**0.029**
	Indirect effect	0.082*	0.075*	0.063*	0.051*	0.039*
		0.050	**0.045**	**0.038**	**0.031**	**0.023**
	Total effect	0.048**	0.04**	0.029**	0.017	0.004
		0.019	**0.017**	**0.015**	**0.012**	**0.009**

Notes: The table is built on the results of regressions on average values as reported in Tables 5 and 6. Results are evaluated at different average levels of NONsh, corresponding to the 10th, 25th, 50th, 75th and 90th percentile of each sample of banks. The corresponding average figures for European Banks are 0.23, 0.30, 0.41, 0.48 and 0.55. For the bigger US banks, the values are equal to 0.11, 0.20, 0.27, 0.34 and 0.43, while for smaller US banks the corresponding values are 0.06, 0.10, 0.17, 0.23 and 0.29. Direct effect measures the impact of a 1% increase in the average level of NONsh on the dependent variable (RAROAE); indirect effect is calculated as the impact of diversification on the dependent variable, given a 1% increase in NONsh. Total effect is the sum of direct and indirect effect. Standard errors are reported in bold below the estimated coefficients. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

income and loan loss provisioning still show negative coefficients, but these are statistically significant only in the US bank subsample. Asset growth has a negative effect on risk-return measures, while the opposite is true for the level of tangible equity.

Table 11 compares within and between estimators for static panel analyses.

Once more, NONsh and DIV take the expected sign (hypotheses H1 and H2). However, the statistical significance of the coefficients is relatively low (hypothesis H3).

Inefficiency and low loan quality adversely affect risk-return measures. The same is true for loans share, which exhibits significant coefficients in RAROAA and RAROAE between-regressions for European banks. The changing sign of some coefficients in within and between regressions (for example, those associated with asset growth) seems to indicate that individual effects have a larger impact in explaining the risk-adjusted profitability.

This represents a relevant finding and is also confirmed by the results obtained on the smaller US banks subsample (Table 12) and once again supports our last hypothesis (H4).

In this case, coefficients associated with DIV and Equity/TA change sign in within and between estimations. Since between estimators explore the cross-sectional nature of data, the last three columns are more similar to the outcome of the previous analysis on mean values (see Table 6). NONsh is still characterized by negative coefficients and the same holds for loans share, Cost income and LLP.

All econometric estimations draw a picture in which there is not a clear-cut evidence of a relationship between income diversification and risk-adjusted performance of banks. This is especially true for the European banks, which exhibit weak statistical significance for the coefficients associated to non-interest share of income and diversification level. Moreover, the joint effect of these variables, when significant, is negative. The implication of this outcome is that during the recent crisis period a greater balance of sources of revenue has not provided better risk-adjusted results for European banks.

Instead, for US banks, the opposite seems to be true. A greater exposure to non-interest income has usually a negative impact on risk-adjusted measures, but

Table 9. Estimated impact of a 1% change in NONsh on *Z*-Score.

	NONsh percentiles	10th	25th	50th	75th	90th
European banks	Direct effect	−0.875	−0.875	−0.875	−0.875	−0.875
		0.439	**0.439**	**0.439**	**0.439**	**0.439**
	Indirect effect	0.598	0.433	0.186	0.032	−0.130
		0.738	**0.534**	**0.230**	**0.040**	**0.160**
	Total effect	−0.276	−0.442	−0.688***	−0.842***	−1.004***
		0.597	**0.432**	**0.186**	**0.032**	**0.129**
Bigger US banks	Direct effect	−1.239**	−1.239**	−1.239**	−1.239**	−1.239**
		0.541	**0.541**	**0.541**	**0.541**	**0.541**
	Indirect effect	1.814*	1.376*	1.055*	0.729*	0.302*
		0.956	**0.725**	**0.556**	**0.384**	**0.159**
	Total effect	0.575	0.136	−0.184	−0.510	−0.937***
		0.826	**0.626**	**0.480**	**0.332**	**0.137**
Smaller US banks	Direct effect	−0.948***	−0.948***	−0.948***	−0.948***	−0.948***
		0.287	**0.287**	**0.287**	**0.287**	**0.287**
	Indirect effect	0.837	0.760	0.640	0.518	0.393
		0.544	**0.494**	**0.416**	**0.337**	**0.255**
	Total effect	−0.111	−0.188	−0.308**	−0.431***	−0.555***
		0.219	**0.199**	**0.167**	**0.135**	**0.103**

Notes: The table is built on the results of regressions on average values as reported in Tables 5 and 6. Results are evaluated at different average levels of NONsh, corresponding to the 10th, 25th, 50th, 75th and 90th percentile of each sample of banks. The corresponding average figures for European Banks are 0.23, 0.30, 0.41, 0.48 and 0.55. For the bigger US banks, the values are equal to 0.11, 0.20, 0.27, 0.34 and 0.43, while for smaller US banks the corresponding values are 0.06, 0.10, 0.17, 0.23 and 0.29. Direct effect measures the impact of a 1% increase in the average level of NONsh on the dependent variable (*Z*-Score); indirect effect is calculated as the impact of diversification on the dependent variable, given a 1% increase in NONsh. Total effect is the sum of direct and indirect effect. Standard errors are reported in bold below the estimated coefficients. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 10. Fixed-effect dynamic panel regression (European and larger US banks).

	RAROAA		RAROAE		*Z*-Score	
Variables	US	Europe	US	Europe	US	Europe
Raroaa_{t-1}	0.07	−0.14*				
	(0.042)	(0.076)				
Raroae_{t-1}			0.05	−0.16*		
			(0.044)	(0.092)		
Z-score_{t-1}					0.04	−0.08
					(0.045)	(0.112)
NONsh	3.34	−17.11**	−1.34	−15.20	−72.25	−129.53
	(18.808)	(7.876)	(17.493)	(9.500)	(196.452)	(83.009)
DIV	0.01	20.99*	10.17	28.51	84.29	99.12
	(18.178)	(11.056)	(17.566)	(18.323)	(183.614)	(92.960)
TA	0.95	2.35	−1.03	1.30	−10.60	21.22
	(2.021)	(1.580)	(1.762)	(1.890)	(20.820)	(17.851)
Equity/TA	8.41	27.87*	19.86	15.12	722.85**	377.51*
	(25.153)	(15.539)	(21.888)	(12.956)	(277.730)	(219.709)
Loans/TA	3.69	1.22	1.10	−0.37	5.63	−16.93
	(5.674)	(7.301)	(5.670)	(5.958)	(67.042)	(99.498)
Cost income	−6.11***	−2.01	−6.20***	−4.55*	−60.97***	−10.17
	(2.136)	(2.244)	(2.077)	(2.614)	(21.551)	(27.292)
LLP	−154.63***	−33.26	−113.20***	−58.70	−756.41**	−262.51
	(35.620)	(37.029)	(34.943)	(44.328)	(371.100)	(442.118)
Asset growth	−5.25	−1.70	−7.18	−2.47	−87.23*	−25.06
	(4.736)	(3.567)	(4.642)	(4.216)	(44.238)	(50.328)
Asset growth^2	−10.14	4.20	−5.46	3.17	−43.98	61.55
	(9.180)	(9.286)	(8.739)	(12.523)	(87.845)	(122.720)
Constant	−9.16	−41.08	19.81	−22.59	198.76	−323.16
	(33.848)	(31.172)	(29.016)	(37.244)	(350.710)	(336.247)
No. of Obs.	936	383	936	372	935	382
No. of Banks	134	60	134	60	134	60
Adjusted R^2	0.24	0.17	0.26	0.13	0.18	0.06

Notes: This table presents the impact of diversification on risk-adjusted profitability measures using dynamic fixed-effects panel estimations for the EU and larger US banks samples. Bank and time fixed effect are used. Bank profitability measures are the risk-adjusted return on average assets (RAROAA), the risk-adjusted return on average equity (RAROAE) and *Z*-Score. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include interacted country-time dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

diversification effects are usually strong enough to counterbalance this effect. We find evidence for this relationship in particular for smaller and less diversified banks.

We see this as a significant contribution to the literature since it holds in a very different economic environment. The seminal work by Stiroh & Rumble (2006) has been conducted in a period of less financial turbulence compared to our analysis. In recent crisis and post-crisis years, both interest and non-interest revenues have

Table 11. Fixed-effect versus between-effect static panel regression (European and larger US banks).

	Fixed-effect estimator						Between-effect estimator					
	RAROAA		RAROAE		*Z*-Score		RAROAA		RAROAE		*Z*-Score	
Variables	US	Europe	US	Europe	US	Europe	US	Europe	US	Europe	US	Europe
NONsh	2.54	−10.10	−1.42	−12.84	−78.14	−79.21	−10.02	−20.31	−9.37	−13.29	−131.73*	−298.69*
	(19.728)	(7.435)	(18.106)	(7.787)	(203.432)	(67.230)	(8.348)	(12.720)	(7.499)	(10.597)	(78.093)	(141.653)
DIV	0.92	12.85	10.38	26.57*	94.68	54.43	15.44*	14.29	15.44*	3.40	144.74*	267.51
	(18.825)	(11.055)	(18.068)	(14.900)	(189.478)	(84.286)	(8.751)	(22.449)	(7.862)	(21.299)	(81.869)	(250.001)
TA	0.98	1.33	−1.05	0.95	−8.87	15.92	0.33	−1.95**	0.26	−1.70**	5.79	−21.21**
	(2.090)	(1.423)	(1.810)	(1.650)	(21.657)	(16.827)	(0.478)	(0.814)	(0.429)	(0.676)	(4.471)	(9.064)
Equity/TA	6.64	18.05	18.79	11.50	742.20***	312.66	−29.29	−70.37	−26.76	−70.00	266.94	−862.53
	(25.380)	(15.155)	(22.186)	(11.936)	(280.593)	(207.423)	(30.218)	(58.053)	(27.147)	(48.507)	(282.691)	(646.493)
Loans/TA	3.03	1.26	0.50	−0.01	−2.70	−22.62	−3.82	−13.79**	−3.67	−11.54**	4.51	−67.74
	(5.934)	(6.259)	(5.773)	(5.333)	(69.305)	(88.816)	(4.326)	(5.894)	(3.887)	(4.793)	(40.472)	(65.637)
Cost income	−5.74***	−3.33	−5.93***	−5.21**	−55.06**	−19.89	−25.40***	−4.78	−23.37***	−5.73	−166.64***	−111.29
	(2.168)	(2.300)	(2.092)	(2.340)	(21.454)	(25.326)	(4.412)	(6.730)	(3.964)	(5.917)	(41.274)	(74.952)
LLP	−162.93***	−30.68	−119.39***	−49.23	−821.95**	−286.28	−290.23***	−145.85	−250.41***	−128.57	−2730.99***	−2315.76
	(37.753)	(36.536)	(36.371)	(40.804)	(385.955)	(433.819)	(81.988)	(155.013)	(73.655)	(114.855)	(766.999)	(1726.274)
Asset growth	−4.73	−0.57	−6.79	−2.76	−80.27*	−14.58	14.24	0.35	12.74	0.66	89.33	−221.21
	(4.836)	(3.464)	(4.672)	(3.995)	(44.888)	(48.241)	(16.641)	(23.069)	(14.950)	(19.614)	(155.677)	(256.903)

Table 11. (*Continued*)

	Fixed-effect estimator						Between-effect estimator					
	RAROAA		RAROAE		Z-Score		RAROAA		RAROAE		Z-Score	
Variables	US	Europe	US	Europe	US	Europe	US	Europe	US	Europe	US	Europe
Asset growth^2	−10.66	3.82	−5.68	4.73	−53.50	36.09	−33.88	−81.59	−34.50	−73.75	−326.56	−314.61
	(9.370)	(8.797)	(8.711)	(11.203)	(89.125)	(105.629)	(35.753)	(63.844)	(32.119)	(51.743)	(334.470)	(710.990)
Constant	−9.23	−21.03	20.51	−17.22	169.96	−215.87	31.94***	65.37	29.31***	57.20	151.29*	836.96*
	(34.748)	(28.302)	(29.643)	(31.967)	(362.599)	(318.700)	(9.654)	(39.241)	(8.673)	(33.059)	(90.317)	(437.003)
No. of Obs.	939	400	939	391	939	400	939	400	939	391	939	400
No. of Banks	134	60	134	60	134	60	134	60	134	60	134	60
Adjusted R^2	0.23	0.20	0.26	0.11	0.18	0.07	0.47	0.33	0.50	0.52	0.37	0.21

Notes: This table presents the impact of diversification on risk-adjusted profitability measures using both static fixed-effects panel estimations and between-effects panel estimations for the EU and larger US banks samples. Bank and time fixed effect are used. Bank profitability measures are the risk-adjusted return on average assets (RAROAA), the risk-adjusted return on average equity (RAROAE) and Z-Score. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include interacted country-time dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 12. Fixed-effect versus between-effect static panel regression (smaller US banks).

	Dynamic panel			Static panel					
	Fixed-effect estimator			Fixed-effect estimator			Between-effect estimator		
Variables	RAROAA	RAROAE	*Z*-Score	RAROAA	RAROAE	*Z*-Score	RAROAA	RAROAE	*Z*-Score
Raroaa_{t-1}	0.00								
	(0.018)								
Raroae_{t-1}		−0.01							
		(0.021)							
$Z\text{-score}_{t-1}$			−0.05**						
			(0.018)						
NONsh	−7.67	−5.89	−120.42**	−6.10	−4.28	−102.17**	−3.97	−5.12*	−119.91***
	(4.801)	(4.085)	(50.174)	(5.163)	(4.428)	(51.359)	(3.370)	(3.050)	(35.991)
DIV	0.93	0.66	44.56	−0.77	−1.09	22.70	5.32	7.10**	84.11**
	(4.473)	(3.797)	(50.204)	(4.695)	(3.998)	(49.989)	(3.261)	(2.955)	(34.825)
TA	2.83***	2.42***	17.34***	2.65***	2.33***	15.77**	0.76***	0.52***	6.51***
	(0.543)	(0.477)	(6.643)	(0.516)	(0.444)	(6.239)	(0.150)	(0.135)	(1.597)
Equity/TA	19.50***	18.16***	402.46***	20.44***	19.37***	425.05***	−10.44*	−8.89*	239.12***
	(5.500)	(4.956)	(71.024)	(5.390)	(4.774)	(68.298)	(5.376)	(4.883)	(57.404)
Loans/TA	−0.37	0.15	−16.56	−0.56	0.18	−18.21	−5.63***	−4.97***	−53.36***
	(1.839)	(1.598)	(21.913)	(1.804)	(1.550)	(20.971)	(1.212)	(1.091)	(12.942)
Cost income	−7.28***	−6.37***	−73.97***	−7.49***	−6.44***	−74.57***	−13.71***	−13.19***	−93.17***
	(0.735)	(0.653)	(8.660)	(0.729)	(0.638)	(8.351)	(0.970)	(0.870)	(10.361)

Table 12. (*Continued*)

	Dynamic panel			Static panel					
	Fixed-effect estimator			Fixed-effect estimator			Between-effect estimator		
Variables	RAROAA	RAROAE	*Z*-Score	RAROAA	RAROAE	*Z*-Score	RAROAA	RAROAE	*Z*-Score
LLP	−34.06***	−22.58***	−133.29	−32.65***	−20.55***	−83.90	−108.58***	−94.53***	−1261.54***
	(9.335)	(8.026)	(113.393)	(9.323)	(7.864)	(111.307)	(19.638)	(17.567)	(209.703)
Asset growth	1.49	0.91	11.13	0.99	0.42	3.12	3.74	1.34	40.59
	(1.306)	(1.076)	(15.432)	(1.313)	(1.075)	(15.352)	(3.103)	(2.827)	(33.136)
Asset growth^2	−14.16***	−12.99***	−156.46***	−13.00***	−12.20***	−142.22***	−13.82**	−9.35	−165.57**
	(2.720)	(2.362)	(31.113)	(2.693)	(2.334)	(30.650)	(6.643)	(6.068)	(70.942)
Constant	−27.00***	−23.34***	−123.23	−24.37***	−22.04***	−103.49	10.47***	11.77***	74.22**
	(7.364)	(6.475)	(88.819)	(7.057)	(6.092)	(83.898)	(2.759)	(2.488)	(29.465)
No. of Obs.	6089	6045	6074	6233	6195	6233	6233	6195	6233
No. of Banks	1031	1030	1031	1035	1034	1035	1035	1034	1035
Adjusted R^2	0.13	0.15	0.10	0.13	0.15	0.10	0.49	0.49	0.42

Notes: This table presents the impact of diversification on risk-adjusted profitability measures using dynamic fixed-effects estimations and both static fixed-effects and between-effects panel estimations for the smaller US banks sample. Bank and time fixed effect are used. Bank profitability measures are the risk-adjusted return on average assets (RAROAA), the risk-adjusted return on average equity (RAROAE) and *Z*-Score. Non-interest income (NONsh) and DIV are income diversification variables. The natural log of total assets (SIZE), the tangible equity to total assets (Equity/TA), loans to total assets (Loans/TA), the cost to income ratio (Cost income), lagged loan loss provisions (LLP), Annual growth of assets (Asset growth) and its square (Asset Growth^2) are the bank-specific control variables. All regressions include time dummies. Robust standard errors are in parentheses. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively.

experienced a high volatility, with uncertain effects on the beneficial portfolio-effect usually attributed to diversification. Our results suggest that for US banks these macroeconomic differences have not changed the relationship between NONsh, DIV and risk-adjusted performance measures.

Given its current modest relative size, it is unlikely that this result is driven by the emergence of alternative business models or competitors from the FinTech industry. Despite it was not the aim of this paper to specifically test a differentiated approach from regulation and supervision in the EU and US markets, this is reasonably a significant contributing factor in explaining why responses vary so widely between the two banking systems. However, results from the between estimators as well as the high variability of statistical significance of covariates in our different econometric approaches suggest another conclusion. Most part of the unreliability of diversification strategies in improving performance or providing stability lies in firm-specific factors, rather than in market-wide or bigger exogenous shocks.

4.3. *Policy implications*

In our view, our results lead to significant policy implications.

On one side, we confirmed empirically that revenue diversification in banking is a complex matter. Its ability to enhance the level and the stability of performance is limited, since they seem more closely linked to firm- and market-specific features. Moreover, the robustness of revenues diversity is especially questionable during financial turmoil.

The impact of non-interest revenues is significant and negative on bank risk for both US (large and small) and EU institutions. At the same time, it is significant and negative for risk-adjusted performance measures for larger US banks, whereas it is significant and positive for smaller US banks only for the ROAA.

We argue that diversification augments firm risk, but at the same time is unable to enhance profitability to balance this effect or is even harmful (for larger US institutions). The benefit for smaller US banks may be attributed to their overall lower engagement in such activities, as well as a potential larger benefit for entities initiating non-interest-bearing operations. Studying the impact of changes in non-interest revenues in different business models (defined by selected percentiles of the related distribution) strengthens this claim.

Among other variables, those that bear most significance in both markets and regardless of the size of institutions are the cost efficiency and the quality of the credit portfolio. Despite not further investigated in this paper but incidentally arising from our results, we argue that diversification, by combining human resources, capital and expertise, shows a short-term improvement of cost efficiency and profitability but, in the long run, venturing in non-interest revenues could result in a higher volatility of earnings.

Moreover, shifting efforts from traditional to innovative banking activities may lower the attention, at least partially, to the quality of the loan portfolio.

Alternatively, non-interest-bearing activities may be the result of the worsening quality of the loan portfolio, without evidence of a gain in terms of risk-adjusted performance.

The overall implication of our results is a call for greater scrutiny and care, for both banks and supervisors, before assuming that diversification could provide an easy path to restore or improve performance, without affecting risks, at the firm-level and in terms of financial stability. This is particularly relevant if revenue diversity is a direct response to worsening macroeconomic conditions.

5. Conclusion

In this paper, we investigate the impact of revenue diversification on bank profitability and its volatility. We examine the relationship between the degree of diversification and several measures of risk-return profiles in a cross-country analysis, including 1250 listed EU and US banks from Q1-2008 to Q4-2016.

Through OLS regressions, dynamic fixed-effect panel models and static panel regressions, we find that diversification is not clearly associated with the level or quality of performance, that benefits change over time and, where present, show significant variability. Moreover, we find a different behavior in US and EU banks in terms of diversification benefits.

European banks do not show a material impact of non-interest revenues on both nominal and risk-adjusted performance measures, while for US banks effects are significant in terms of performance volatility and risk-adjusted profitability, but substantially different for smaller and larger institutions. Finally, we show that firm-specific diversification strategies matter more than the overall sectoral pursuit of revenue diversity over time.

Our results provide additional evidence on the limitations of diversification in the banking sector, supporting significant policy implications. Supervisors should be careful in expecting that more revenue diversity, especially in Europe, bears necessarily benefits for the banking system. The diversity and adequacy of business models to different economic environments, rather than alternative revenue sources, seems to produce greater and persistent effects on bank profitability and volatility.

In terms of future research, it could be useful to understand the impact of specific exogenous (for instance changes in regulation or supervision, growth of the FinTech sector) as well as endogenous shock (such as human capital) on profitability and stability, especially in terms of firm-level factors that determine a different response from banks.

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