International Journal of Financial Markets and Derivatives

ISSN online: 1756-7149 - ISSN print: 1756-7130
https://www.inderscience.com/ijfmd

The effect of bank diversification on the capital, risk, profitability and efficiency of the eurozone and the US banks in the aftermath of the global financial crisis

Dimitra Loukia Kolia, Simeon Papadopoulos

DOI: 10.1504/IJFMD.2023.10053628

Article History:

Received:	07 October 2022
Last revised:	12 December 2022
Accepted:	28 December 2022
Published online:	17 February 2023

The effect of bank diversification on the capital, risk, profitability and efficiency of the eurozone and the US banks in the aftermath of the global financial crisis

Dimitra Loukia Kolia* and
Simeon Papadopoulos

University of Macedonia,
156 Egnatia Street, GR-54636,
Thessaloniki, Greece
Email: dkolia@uom.edu.gr
Email: spapado@uom.edu.gr
*Corresponding author

Abstract: This paper investigates the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator. We also examine: 1) how the influence differs depending on the type of diversification (asset, income, non-interest income diversification); 2) whether diversification affects the eurozone banks differently than the US banks; 3) which banking type (commercial, cooperative and savings banks) is more benefited from diversification. Our findings indicate that income diversification has substantial benefits when compared to other types of diversification. Whereas non-interest income diversification has the most unfavourable results for the reported groups. Additionally, the impact of asset diversification is mixed for the dependent variables and it is contingent on whether a bank belongs to eurozone or to the USA. Finally, our survey highlights how different bank types (commercial, cooperative or savings banks) are influenced by bank diversification.

Keywords: bank; capital; risk; efficiency; profitability; data envelopment analysis; adjusted Herfindahl-Hirschman indices; system-GMM.

Reference to this paper should be made as follows: Kolia, D.L. and Papadopoulos, S. (2023) 'The effect of bank diversification on the capital, risk, profitability and efficiency of the eurozone and the US banks in the aftermath of the global financial crisis', *Int. J. Financial Markets and Derivatives*, Vol. 9, Nos. 1/2, pp.1–42.

Biographical notes: Dimitra Loukia Kolia received her Doctorate in Finance (research field: Banking) from the University of Macedonia, Department of Accounting and Finance, Thessaloniki, Greece.

Simeon Papadopoulos is an Associate Professor of Banking and Finance, Department of Accounting and Finance, University of Macedonia, Thessaloniki, Greece.

1 Introduction

Over the past few decades, the highly competitive environment, the deregulation policies [for example, the Gramm-Leach-Bliley Act (GLBA) of 1999], the managerial innovations and technological progress have created incentives for banking institutions to diversify their activities (Kim et al., 2020). Thus, banking institutions have increasingly become involved in non-traditional banking activities resulting in the significant increase of non-interest income[1] (Wu et al., 2020; Maudos, 2017; Demirgüç-Kunt and Huizinga, 2010; Ferreira et al., 2018). By diversifying their activities, banking institutions attempted to sustain their profitability levels despite the changing conditions, but they were exposed to further risks (Luu et al., 2019).

Nevertheless, in the aftermath of the financial crisis, many weaknesses of the regulatory framework were revealed, many concerns about the threats of bank diversification were raised and "the validity of all financial models have come under serious questioning" (Clark et al., 2019). Therefore the impact of the financial crisis on financial fragility has been thoroughly reassessed (Ashraf et al., 2016) and many governments had to fiscally support banking activity (Triki and Maktouf, 2019). As a result, the non-traditional banking activities are now being carefully monitored and new regulations are being implemented (for example, Basel III framework), aiming at more resilient banking institutions as well as banking systems. Thus, in the post-crisis period, banks of advanced economies have started once again to rely more on traditional banking practices and less on non-interest earning activities (Abuzayed et al., 2018). These modifications have, however, significantly affected bank profitability and income structure (Maudos, 2017).

Bank diversification, and whether or not its benefits outweigh the threats, is a broadly examined issue. Yet the literature remains inconclusive, even the limited number of more recent papers which investigate the after-crisis period, yield conflicting results. A great part of those surveys suggest that bank diversification provides more benefits than drawbacks (such as Moudud-Ul-Huq et al., 2019; Ashraf et al., 2016; Luu et al., 2019), whereas many studies suggest that diversification is harmful for bank stability and/or profitability (such as Nguyen, 2019; Alfadli and Rjoub, 2019; Williams, 2016; Ghosh, 2019). Therefore, further empirical analysis on this crucial topic is required as it could shed more light on this issue.

In order to investigate bank diversification, in our survey, we attempt to convey how assets, income and non-income diversification influence the profitability, capital, risk and efficiency of banking institutions in the post-crisis period. Furthermore, we investigate the sensitivity of our results to the bank characteristics and the general market conditions. Moreover, we assess if diversification affects the eurozone banking institutions differently than those of the USA and whether the impact of diversification varies across different types of banks (commercial, cooperative and savings banks).

The comparison of the eurozone and the US banking systems was selected over other banking groups because, firstly, it is appropriate to compare those two banking systems as both not only have the member countries of both unions the same currency and monetary policy, but also each country maintains its different economic structure and legal system. Secondly, it is very interesting to compare eurozone and the US banking systems as they behaved differently after the global financial crisis; different number of bank failures and different measures and policies implemented for recovery from the financial crisis (Ackermann, 2019; Lakhani et al., 2019). Thirdly, the different speed of

recovery between the two reported country unions is the main reason for this selection, as it helps us to investigate how differently the effect of diversification on capital, risk, profitability and efficiency develops over the post-crisis period.

For the aforementioned purposes, we employ a data sample consisting of aggregated balance sheets and financial data retrieved from 1,584 eurozone banks and 601 US banks during the period 2013–2018. We investigate separately the impact of diversification on capital, risk, profitability and efficiency of both economic unions, that is, the eurozone and the USA. We also examine the three subgroups of banks (commercial, cooperative and savings banks) in the eurozone and the USA. For the purposes of our study, we control for environmental and bank-specific variables which affect the examined relationship.

Concerning the methodology, the dependent variables of our empirical model are efficiency, capital, risk and profitability. We estimate efficiency by employing data envelopment analysis (D.E.A.) developed by Charnes et al. (1978). Additionally, we employ three alternative variables to estimate bank profitability (the net interest margin, the ratio of return on average assets as well as the ratio of profit before tax to average total assets) and two variables to measure risk (Z-score and loan loss provisions ratio as indicators of default risk and credit risk, respectively). Moreover, the capitalisation of the banks in our empirical model is calculated as the ratio of total equity to total assets. Regarding the independent variables, we apply the adjusted Herfindahl-Hirschman indices (AHHI) for the estimation of the diversification measures (assets, income and non-interest income diversification) and a variety of bank-specific and macroeconomic indicators. In the final step of our survey, we implement the two-step system generalised method of moments dynamic panel estimator (system-GMM) devised by Arellano and Bover (1995) and further developed by Blundell and Bond (1998), to estimate the relationships among the dependent and independent variables.

Our study contributes to the existing literature in four important ways. Firstly, unlike previous studies, we investigate a post-crisis period and provide evidence regarding the impact of bank diversification on capital, stability, efficiency and profitability after the global financial crisis. Secondly, our survey is the first to compare the above mentioned relationship between eurozone and the US banking institutions by employing post-financial crisis data. Thirdly, to the extent of our knowledge, this is the first study to examine the effect of diversification across different types of banks, by employing data after the global financial crisis. Fourthly, to the best of our knowledge, our study differs from the former literature as it examines:

1 the three categories of bank diversification (assets, income and non-interest income diversification)

2 the impact on the four following independent variables: profitability, efficiency, stability and capital.

Therefore, our study fills the gap in the existing literature because it is one of the first to provide a broader understanding of how the impact of bank diversification on banking institutions is configured by the new regulations implemented after the global financial crisis.

Regarding the aims of this paper, we examine:

1 the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator (RQ1–RQ4, Table 1)

2 also examine how the influence differs depending on the type of diversification (asset, income, non-interest income diversification) (RQ5)

3 which banking type (commercial, cooperative and savings banks) is more benefited from diversification (RQ6).

As regards the methodology, efficiency is estimated by employing DEA, diversification measures are calculated by applying the AHHI and the impact of bank diversification on capital, risk, efficiency and profitability is estimated by the two-step system generalised method of moments dynamic panel estimator (system-GMM).

Table 1 Research questions

RQ1	How does diversification affect the profitability of banking institutions in the eurozone and the USA in the post-crisis period?
RQ2	How does diversification impact the capital of banking institutions in the eurozone and the USA in the post-crisis period?
RQ3	How does diversification influence the risk of banking institutions in the eurozone and the USA in the post-crisis period?
RQ4	How does diversification affect the efficiency of banking institutions of the eurozone and the USA in the post-crisis period?
RQ5	How does this influence differ depending on the type of diversification (asset, income and non-interest income diversification)?
RQ6	How does the impact of diversification affect different banking sectors (commercial, cooperative and savings banks)?

The remainder of this paper is structured as follows: Section 2 reviews the existing literature, Section 3 introduces our data sample and Section 4 presents the selected variables together with the research methodology. Section 5 analyses our empirical results while Section 6 draws the conclusions.

2 Literature review

There is a large body of literature which provides empirical evidence regarding the impact of bank diversification on risk as well as profitability. Yet, amongst the existing literature there is very little, if any, consensus resulting in an ongoing debate on whether the above-mentioned relationships are direct or adverse.

2.1 Bank diversification and stability

The influence of bank diversification on stability is a well-studied topic and multiple papers employ bank data covering the period before the global financial crisis, however, no consensus is reached yet. Lepetit et al. (2008) examine a sample of European banks during the period 1996–2002 and suggest that income diversification and non-interest income diversification are directly connected with risk. They also control for size and non-interest income activities concluding that a positive relationship is mostly for small banks and for their commission and fee activities. However, there is no positive

association between risk and trading income. Similarly, Baele et al. (2007) investigate the link among bank diversification, profitability and risk for European banks for the period 1989–2004 and deduce that income diversification accelerates both systematic risk and profitability. Demirgüç-Kunt and Huizinga (2010), in like manner, assess the relationship among non-interest income and non-deposit funding before the financial crisis (1995–2007) suggesting that income diversification may lead to higher default risk and greater profitability.

Nevertheless, Lee et al. (2014) demonstrate that the risk of Asian banks, during the period 1995–2009, is negatively affected by income diversification, whereas there is no significant impact on profitability. The study also highlights that important factors affecting the examined relationship are the country's income level and the type of bank (commercial, cooperative, investment and savings banks). Also, Ashraf et al. (2016) investigate the banks from the Gulf Cooperation Council (GCC) region during the period 2000–2011 and suggest that there is a positive relationship between income diversification and financial stability. They also indicate the significant role of bank ownership on the examined relationship. Therefore, we may conclude that there is a lack of consensus in the literature on the link between diversification and risk in the period preceding the financial crisis.

More recent studies including samples for periods during and after the global financial crisis, also report conflicting results. According to Maudos (2017), diversification and risk of European banks are directly related, whereas this finding is less intense during the financial crisis. Interestingly, Kim et al. (2020) analyse OECD banks and conclude that the connection between bank diversification and financial stability diverge when a financial crisis emerges. More precisely, bank diversification was directly related with bank stability before the financial crisis, whereas the relationship was inverted after the global financial crisis. Moreover, they indicate that the association between financial stability and bank diversification is nonlinear (inverted U-shaped), because bank stability increases until bank diversification hits the optimal level and then it begins to decrease above that level. Consistent with this finding, Edirisuriya et al. (2015) analyse Asian banks and conclude that bank diversification is positively related to stock market valuations as well as stability until an optimal level of diversification. Above this level of diversification the relationship is reversed, now negatively affecting stability.

Additionally, Moudud-Ul-Huq et al. (2019) employ data from Asian banks after the global financial crisis and convey that the revenue diversification is positively related to bank performance and bank stability, whereas the impact of asset diversification varies across the reported countries. However, Ferreira et al. (2018) assess a sample of Brazilian banks and find evidence that revenue diversification is directly connected with risk and positively, but insignificantly, connected with performance. Also, Lee et al. (2019) examine the effect of asset correlation on the relationship between income diversification and risk and their findings indicate that although the relationship is positive, it could be inverted because of asset correlation.

Moreover, even the studies analysing the relationship between diversification and bank stability of conventional and Islamic banks are mixed. More specifically, Abuzayed et al. (2018) investigate the period 2001–2014 and conclude that both income and asset diversification are not related with an increase in bank stability. Additionally, they find consistent evidence that conventional bank risk is adversely and more intensely

connected with diversification than the Islamic bank risk levels. Paltrinieri et al. (2020) survey the period 2007–2016 and they also suggest that income diversification is not linked with stability for both conventional and Islamic banks. Their results provide evidence that income diversification is positively related with profitability and that the outcome is more enhanced for conventional banks rather than Islamic banks. Similarly, Daradkah and Al-Sayyah (2020) conclude that, after the financial crisis (2010–2016), the income diversification is directly related with stability, especially from trading income. The sample consists of 16 Islamic banks in the GCC countries. In contrast to the three previous studies, Alkhouri and Arouri (2018) examine the period 2003–2015 and infer that non-interest and revenue diversification are negatively related with the stability of conventional banks and positively with the stability of Islamic banks.

Concerning the impact of diversification on different types of bank, researchers highlight the importance of considering the type of bank when examining the link of bank diversification with stability. Ghosh (2019) investigates the relationship between non-interest income diversification and risk, and suggest that they are directly connected, but the outcome depends on the specialisation of banks. Köhler (2015) also examines the impact of the business model of the bank on the link between risk and diversification. More specifically, the author separately analyses savings, investment, cooperative and commercial banks and provides evidence that savings and cooperative banks are retail-oriented while commercial and investment banks are investment-oriented. Köhler suggests that bank diversification positively affects stability and profitability, especially those of cooperative and savings banks. The survey further reveals that the results of each type of bank differ when examining the influence of diversification on bank stability.

2.2 Bank diversification and profitability

There has been a substantial amount of literature which has thoroughly investigated the effect of diversification on bank profitability. Concerning the pro-crisis period, Elsas et al. (2009) suggest that an increase in bank diversification may lead to a rise in profitability. Likewise, Sanya and Wolfe (2010)point out that income and non-interest income diversification are directly related with performance. Whereas Mercieca et al. (2007) suggest that there is no link between profitability and diversification of eurozone small banking institutions during the period 1997–2003.

Moreover, the empirical literature employing more recent data continues to be inconclusive. Nguyen (2019) and Alfadli and Rjoub (2019) provide evidence that a rise in income diversification is negatively related with profitability. Interestingly, Maudos (2017) concludes that a rise in income diversification is only negatively related with profitability during the financial crisis. Contrary to these findings, Luu et al. (2019) suggest that income diversification impacts positively on bank performance and the outcome is more intense for more experienced banks in the market. This outcome is in line with that of MostakAhamed (2017) indicating that income diversification is favourable for the profitability of Indian banks during the period 1998–2014. Finally, the findings of Edirisuriya et al. (2015) provide evidence that an increase in bank diversification does not necessarily precede a rise in the bank performance of Asian banks during the period 1999–2012.

The effect of diversification of the non-interest income activities on bank performance is also thoroughly investigated, yet no consensus has been reached. Minh and Thanh (2019) assess the impact of non-interest income diversification on the performance of Vietnamese commercial banks and infer a positive relationship. In addition, Elyasiani and Jia (2019) study the relationship between non-traditional banking activities and the performance of US banks during the period 2002–2006 and also convey a positive relationship. However, Alkhouri and Arouri (2018) conclude that non-interest income diversification is adversely connected with the performance of conventional banks. Lastly, Ghosh (2019) research the relationship of non-interest income and profitability and provide evidence that the results are mixed depending on the type of non-interest income activities of each bank.

Additionally, the relationship between diversification and profitability of conventional and Islamic banks is investigated by the following studies and yields conflicting results. Initially, Alkhouri and Arouri (2018) draw the conclusion that asset diversification is positively related with bank performance. Ali and Khattak (2020), in the same way, conclude that income diversification of Islamic and conventional banks in Indonesia is positively linked with bank performance during the period 2007–2017. Their findings also indicate no difference in the relationship between bank performance and income diversification for conventional and Islamic banks. Consistent with the above results, Moudud-Ul-Huq et al. (2020) provide evidence that during the financial crisis the banking institutions of South Africa and Bangladesh employ portfolio diversification in order to increase bank performance. Nevertheless, Chen et al. (2018) suggest that asset diversification negatively impacts on conventional bank performance, while insignificantly affecting Islamic banks.

2.3 Bank diversification in relation to efficiency and capital

The empirical literature focusing on the influence of bank diversification on efficiency and capital is rather limited as more studies investigate the impact on risk and profitability. Concerning efficiency, Tan and Anchor (2017) provide evidence that efficiency is significantly influenced by bank diversification. Moreover, Wu et al. (2020) investigate the impact of diversification on the risk and efficiency of a sample of 1000 commercial banks in emerging countries during the period 2000–2016. The empirical evidence suggests that there is a negative relationship between diversification and default risk and an indirect negative impact of diversification on efficiency. Regarding capital, Meng et al. (2017) examine the determinants of income diversification of Chinese banks during the period 2003–2010 and their findings suggest that bank diversification is directly related with insolvency risk and with the capital of commercial banks, whereas it is negatively related with the bank capital of national banks.

Overall, we may conclude that the recent literature analysing the impact of bank diversification on stability, profitability, efficiency and capital provide conflicting results. Thus, this controversial issue warrants more investigation and motivates our research. We also observe that the type of bank and bank location significantly influence the examined relationship.

Table 2 Overview of the recent literature on bank diversification

Author	*Examined relationship*	*Reported period*	*Countries*	*Methodology*	*Empirical evidence*
Abuzayed et al. (2018)	Bank diversification, bank performance and bank stability	2001–2014	Conventional and Islamic banks	Two-step system GMM methodology	Income and asset diversification are not related with bank stability. Non-interest income is adversely related with risk and conventional banks are more impacted than Islamic banks.
Ali and Khattak (2020)	Non-interest income activities, profitability and risk	2007–2017	Islamic and conventional banks in Indonesia	A system generalised method of moments estimator (GMM)	Income diversification increases bank profitability.
Alkhouri and Arouri (2018)	Revenue diversification, non-interest income diversification and asset diversification, performance, stability	2003–2015	Conventional and Islamic banks	Two-step system GMM methodology	Non-interest and revenue diversification are negatively connected with the stability of conventional banks and positively with the stability of Islamic banks. Non-interest income diversification is adversely connected with the bank performance of conventional banks, asset diversification is positively related with bank performance.
Ashraf et al. (2016)	Income diversification, financial stability and ownership	2000–2011	Banks from GCC region	GLS random effect estimation	Positive relationship between income diversification, financial stability.
Baele et al. (2007)	Diversification, performance and risk	1989–2004	European banks	Regression analysis	Income diversification increases systematic risk and bank profitability.
Chen et al. (2018)	Asset diversification, bank performance	2006–2012	Asian countries (conventional and Islamic banks)	One-step difference and system generalised method of moment (GMM) dynamic panel model	Asset diversification is adversely associated with bank performance of conventional banks, while it has minimum impact on the performance of Islamic banks.
Daradkah and Al-Sayyah (2020)	Income, non-interest income diversification, risk	2010–2016	Banks in Gulf Cooperation Council (GCC) countries	Fixed panel analysis	Income diversification is positively associated with bank stability and especially trading income.
Demirgüç-Kunt and Huizinga (2010)	Income diversification, risk, return	1995–2007	101 countries	Regression analysis	Positive impact of income diversification on bank risk and profitability

Table 2 Overview of the recent literature on bank diversification (continued)

Author	*Examined relationship*	*Reported period*	*Countries*	*Methodology*	*Empirical evidence*
Edirisuriya et al. (2015)	Stock markets and bank diversification	1999–2012	Four South Asian countries (Bangladesh, India, Pakistan, and Sri Lanka)	A general class of panel models	Bank diversification is directly related to stock market valuations and solvency until an optimal level of diversification. From this level of diversification and higher the relationship is adverse. An increase in bank diversification does not necessarily precede a rise in bank performance.
Elsas et al. (2009)	Diversification, profitability	1996–2008	Australia, Canada, France, Germany, Italy, UK, USA, Spain, and Switzerland	fixed-effects regressions	An increase in diversification precedes an increase in bank profitability and thus, an increase in market valuation.
Elyasiani and Jia (2019)	Non-traditional banking activities, performance and risk	2002–2006	US banks	OLS with errors clustered, firm fixed effects regression	Increase of non-traditional banking activities may lead to a rise in bank performance and a decrease in systemic risk during the financial crisis.
Ferreira et al. (2018)	Revenue diversification, risk and performance	2003–2014	Brazilian banks	Generalised method of moments (GMM)	Revenue diversification is directly connected with risk and insignificantly positively connected with performance.
Ghosh (2019)	Non-interest income and bank risk and profitability	2001–2016	US commercial banks	OLS with robust standard errors clustered	Non-interest income and bank risk are related positively, whereas for the impact on profitability the results vary.
Kim et al. (2020)	Bank diversification, bank stability	2002–2012	OECD commercial banks	The square of the diversification measure (lag SQ non-interest income/TOR) and 2SLS method	Significantly nonlinear relationship between bank diversification and bank stability. Bank diversification decreased the risk levels before the financial crisis, whereas it increased the risk levels during the financial crisis.
Köhler (2015)	Risk, non-interest income, business model	2002–2011	European banks	Baseline regression model	Income diversification is positively associated with bank stability and profitability. The outcome is highly affected by the business model.
Lee et al. (2019)	Income diversification, risk and performance	2006–2013	53 countries	Generalised method of moments (GMM)	Income diversification is directly related to systemic risk, yet the results depend on the asset correlation.

Table 2 Overview of the recent literature on bank diversification (continued)

Author	*Examined relationship*	*Reported period*	*Countries*	*Methodology*	*Empirical evidence*
Lee et al. (2014)	Non-interest income, profitability and risk	1995–2009	Asian banks from 22 countries	Dynamic panel data model	Income diversification is negatively related with risk, while there is no significant impact on profitability. Important factors are the country's income level and the type of bank (commercial, cooperative, investment and savings banks).
Lepetit et al. (2008)	Risk and diversification	1996–2002	European banks	Ordinary least squares (OLS)	Income diversification and non-interest income diversification are directly connected with risk. The positive relationship is mostly for small banks and for the commission and fee activities, while there is no positive association between risk and trading income.
Luu et al. (2019)	Income diversification and performance	2007–2017	Vietnamese commercial banks	Panel OLS with fixed effects together with the two-step system GMM estimator	Income diversification impact positively on bank performance and the outcome is more intense for banks more experienced in the market.
Maudos (2017)	Income structure, risk, profitability	2002–2012	European banks	Regression analysis	A rise in the diversification is negatively related with profitability during the financial crisis. Diversification and risk are directly related, whereas this finding is less intense during the financial crisis.
Meng et al. (2017)	Determinants of income diversification	2003–2010	Chinese banks	Pooled OLS, fixed effects, and GMM estimation	Bank income diversification is directly related with insolvency risk and bank capital of commercial banks, whereas negatively related with bank capital of national banks.
Mercieca et al. (2007)	Diversification and profitability	1997–2003	Small European banks	OLS regression	No significant relationship between profitability and diversification
Minh and Thanh (2019)	Non-interest income and performance	2008–2017	Vietnamese commercial banks	Generalised method of moments (GMM)	Non-interest income and the performance of Vietnamese commercial banks are positively related.
MostakAhamed (2017)	Income diversification, profitability	1998–2014	Indian banks	Two-step system GMM methodology	Income diversification is favourable for the profitability

Table 2 Overview of the recent literature on bank diversification (continued)

Author	*Examined relationship*	*Reported period*	*Countries*	*Methodology*	*Empirical evidence*
Moudud-Ul-Huq et al. (2019)	Asset and revenue diversification, performance, risk	2011–2015	ASEAN-5 (Indonesia, Malaysia, the Philippines, Thailand, Vietnam)	Two-step system GMM methodology	Revenue diversification is positively related to bank performance and bank stability. The impact of asset diversification varies across the reported countries.
Moudud-Ul-Huq et al. (2020)	bank diversification, risk and performance	2004–2015	South Africa and Bangladesh	Generalised method of moments (GMM)	During the financial crisis the banking institutions of South Africa and Bangladesh employ portfolio diversification in order to increase bank performance.
Nguyen (2019)	Revenue diversification, risk and performance	2010–2018	Vietnamese commercial banks	Generalised method of moments (GMM)	Revenue diversification is directly connected with risk and adversely with profitability.
Paltrinieri et al. (2020)	Income diversification, bank performance and bank stability	2007–2016	conventional and Islamic banks	Two-step system GMM methodology	Income diversification is not linked with stability. Income diversification is positively related with profitability and the result is more enhanced for conventional banks than Islamic banks.
Sanya and Wolfe (2010)	Income and non-interest income diversification, risk and performance	2000–2007	11 emerging economies	Generalised method of moments (GMM)	Income and non-interest income diversification are indirectly connected with risk and directly related with performance.
Sissy et al. (2017)	Revenue diversification, cross border banking , risk and return	2002–2013	29 African countries	Two-step system GMM methodology	The exploration risk is adversely connected with cross border diversification, yet the capital is positively associated. African banks derive benefits by the simultaneous revenue and cross border diversification.
Williams (2016)	Non-interest income and bank risk	2002–2014	Australian banks	Feasible GLS with panel specific corrections	Income diversification and non-interest income diversification are directly connected with risk. Yet, the outcome depends on the specialisation of banks.
Wu et al. (2020)	Diversification, efficiency and risk	2000–2016	Banks from emerging economies	System generalised method of moments (GMM)	Negative relationship between diversification and default risk, indirect negative impact of diversification on efficiency.

3 Data

Concerning the group of eurozone banks, we analyse 1,584 banks from countries participating in the European Economic Monetary Union; Austria, Belgium, Cyprus, Germany, Estonia, Spain, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Portugal, Slovenia and Slovakia. Additionally, we investigate separately three subgroups of eurozone banks: commercial, cooperative and savings banks which include 273, 838 and 408 banks, respectively. The US bank group is separately examined and it comprises data from 601 banks with three subgroups: commercial, cooperative and savings banks consisting of 382, 154 and 63 banks. We adjust our data by omitting banks with incomplete or missing annual financial data over the investigated period.

4 Research methodology

In this paper, following Abuzayed et al. (2018), Paltrinieri et al. (2020), Alkhouri and Arouri (2018), Moudud-Ul-Huq et al. (2019), Minh and Thanh (2019), Sissy et al. (2017), Luu et al. (2019), we employ the two-step system generalised method of moments dynamic panel estimator (system-GMM) devised by Arellano and Bover (1995) and further developed by Blundell and Bond (1998). This model is designed for panel data analysis and applies the first differences of the variables in order to control for correlation between the lagged dependent variable and the error term.

Generally, the model of the data-generating process can be written as:

$$y_{i,t} = \alpha * y_{i,t-1} + x'_{i,t} * \beta + \varepsilon_{i,t} \tag{1}$$

where

$\varepsilon_{i,t} = \mu_i + u_{i,t}$

$u_{i,t}$ = idiosyncratic shocks

μ_i = fixed effects

$t = 2, \ldots, T$

$i = 1, \ldots, n$.

The embodied assumptions are:

1 the process may be dynamic

2 some regressors possibly are endogenous or predetermined but not strictly exogenous

3 the idiosyncratic disturbances can be uncorrelated, have heteroskedasticity and serial correlation

4 fixed individual effects may be arbitrarily distributed

5 the number of periods can be very small

6 the available instruments are internal (Roodman, 2009).

Additionally, the equation is based on the following conditions:

$$E(\mu_i) = E(u_{i,t}) = E(\mu_i * u_{i,t}) = 0$$

$$E(y_{i,t} * u_{i,t}) = 0$$

Moreover, equation (1) can be rewritten, so that it highlights the key role of the level of *y*:

$$\Delta y_{i,t} = (\alpha - 1) * y_{i,t-1} + x'_{i,t} * \beta + \varepsilon_{i,t} \tag{2}$$

In order to correct for endogeneity issues, system-GMM estimator transforms the data to remove the fixed effects or it instruments endogenous variables with variables that possibly are uncorrelated with the fixed effects (Roodman, 2009). So, equation (1) can be transformed as follows:

$$\Delta y_{i,t} = \alpha * \Delta y_{i,t-1} + \Delta x'_{i,t} * \beta + \Delta u_{i,t} \tag{3}$$

Nevertheless, this model [equation (2)] "suffers from potentially huge small sample bias when the number of time periods is small and the dependent variable shows a high degree of persistence" (Heid et al., 2011). To increase the efficiency of the model, Blundell and Bond (1998) employ the system-GMM approach, which is based not only on the above-mentioned conditions but also on the following conditions:

$$|\alpha| < 1$$

$$E(\varepsilon_{i,t} * \Delta y_{i,t-1}) = 0, \quad \text{for } t = 4, 5, \ldots, T$$

$$E(\varepsilon_{i,3} * \Delta y_{i,2}) = 0$$

$$T \geq 3$$

Using those conditions, the system-GMM approach includes a stacked system of $T - 2$ equations in first differences and $T - 2$ equations in levels, for the periods 3, …, T, of the reported sample. The instrument matrix for this system is as follows (Blundell and Bond, 1998):

$$Z_*^+ = \begin{bmatrix} Z_i & 0 & 0 & \cdots & 0 \\ 0 & \Delta y_{i,2} & 0 & \cdots & 0 \\ 0 & 0 & \Delta y_{i,3} & \cdots & 0 \\ . & . & . & \cdots & 0 \\ 0 & 0 & 0 & \cdots & \Delta y_{i,T-1} \end{bmatrix}$$

where Z_i is the following $(T - 2) * m$ matrix:

$$Z_i = \begin{bmatrix} y_{i,1} & 0 & 0 & \cdots & 0 & \cdots & 0 \\ 0 & y_{i,1} & y_{i,2} & \cdots & 0 & \cdots & 0 \\ . & . & . & \cdots & . & \cdots & . \\ 0 & 0 & 0 & \cdots & y_{i,1} & \cdots & y_{i,T-2} \end{bmatrix}$$

The system-GMM approach is preferred because it is appropriate for banking sector surveys as it effectively estimates samples:

1 with possible endogeneity issues (Paltrinieri et al., 2020; Luu et al., 2019)

2 with autoregressive properties in the dependent variables (Trujillo-Ponce, 2012)

3 with heteroscedasticity problems (Moudud-Ul-Huq et al., 2019)

4 with unobserved bank-specific effects (Alkhouri and Arouri, 2018)

5 with missing data (Alkhouri and Arouri, 2018).

Moreover, the system-GMM is selected because it is applied to surveys with data samples comprised of a small number of periods and a large number of observations (Abuzayed et al., 2018). Moreover, the system-GMM eliminates endogeneity by arranging the predetermined and endogenous variables to their own lags (Abuzayed et al., 2018; Alkhouri and Arouri, 2018). This is a very important advantage of system-GMM model and the main reason for its selection since other vastly employed econometric models for instance *ordinary least squares*, *fixed effect estimation approach* and *generalised effect estimation approach* cannot address these endogeneity issues (Trabelsi and Trad, 2017). Another drawback of the *ordinary least squares* methodology is that it produces bias when attempting to control for autocorrelation and heterogeneity (Sissy et al., 2017). Also, the Granger-causality techniques are sensitive to model specification (Nguyen and Nghiem, 2015), while the SYSTEM-GMM approach "allows for the explicit modelling of the dynamic nature of the diversification-performance nexus by including past bank performance as one of the repressors where this is possible" (Luu et al., 2019). Finally, the system-GMM is preferred as it is more developed than the *difference-GMM* of Arellano and Bond, 1991 because it applies regressions in level as well as in difference (Tran et al., 2016).

Our adopted model can be specified as follows:

$$Y = f(Diversification, Bank\text{-}specific\ indicators, Macroeconomic\ indicators)$$

Y refers to the dependent variables of our regression analysis that is, profitability, capital, risk and efficiency[2]. Thus, we run this regression four separate times and the employed equations are the following[3]:

$$Prof_{i,t} = \alpha_0 + \beta_1 \cdot Prof_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$Cap_{i,t} = \alpha_0 + \beta_1 \cdot Cap_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$Risk_{i,t} = \alpha_0 + \beta_1 \cdot Risk_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$Effic_{i,t} = \alpha_0 + \beta_1 \cdot Effic_{i,t-1} + \beta_2 \cdot DIV_{i,t} + \beta_3 \cdot Bank_{i,t} + \beta_4 \cdot Env_{i,t} + \varepsilon_{i,t} \quad (7)$$

where

i bank

t year

$Prof_{i,t}$	the measures of profitability (NIM, ROA, EBIT/TA) of the bank *i* in the year *t*
$Prof_{i,t-1}$	the profitability of bank *i* in the year $t-1$
$Cap_{i,t}$	the measures of capital (CAP, TCAP) of the bank *i* in the year *t*
$Cap_{i,t-1}$	the capital of bank *i* in the year $t-1$
$Risk_{i,t}$	the measures of risk (Z, CR) of the bank *i* in the year *t*
$Risk_{i,t-1}$	the risk of bank i in the year t-1
$Effic_{i,t}$	the measure of efficiency of the bank *i* in the year t
$Effic_{i,t-1}$	the efficiency of bank *i* in the year $t-1$
α_0	constant
β_1–β_4	coefficient vectors
Div	the measures of diversification; asset diversification (DIVA), incomediversification (DIVI) and non-interest income diversification (DIVNI)
Bank	the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets)
Env	the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE)
$\varepsilon_{i,t}$	error term.

Efficiency, profitability, capital and risk are the dependent variables of our empirical model. As regards the independent variables, we incorporate three diversification measures, four macroeconomic variables and a variety of bank-specific indicators. Efficiency, profitability, capital and risk are the dependent variables of our empirical model. As regards the independent variables, we incorporate three diversification measures, four macroeconomic variables and a variety of bank-specific indicators. The employed variables are extensively described in the following paragraphs and illustrated in Table 3.

Following Kolia and Papadopoulos (2020a), Zhang et al. (2013), Le (2018) as well as Tan and Floros (2013), we measure efficiency (EFF) by employing DEA developed by Charnes et al. (1978). The selected inputs are staff expenses, book value of fixed assets as well as time and demand deposits while the considered outputs are loans and advances to banks and customers together with net interest income. The estimation model is built as follows and analyses the ability of a decision making unit to turn the inputs into outputs:

$$\max Z_0 = \sum\nolimits_t \left(w_t * y_{t0} \right)$$

s.t

$$l = 1, \ldots, n$$

$$i = 1, \ldots, b$$

$$t = 1, \ldots, k$$

$$\sum\nolimits_r (w_t * y_{tl}) - \sum\nolimits_i (q_i * x_{il}) = 0$$

$$\sum\nolimits_i (q_i x_{i0}) = 1$$

$$q_i \geq \varepsilon \geq 0$$

$$w_t \geq \varepsilon \geq 0$$

where

i inputs

t outputs

l decision-making units

q_i relative importance of i

w_t relative importance of t

ε error term.

Table 3 Definition of the employed variables

Classification		*Variable*	*Description*	*Measurement*
Dependent variables	Efficiency measure	EFF	Efficiency	Data envelopment analysis
	Profitability measures	NIM	Net interest margin	$\frac{\text{Interest income} - \text{Interest expenses}}{\text{Average interest earning assets}}$
		ROA	Return on average assets	$\frac{\text{Net income}}{\text{Average total assets}}$
		PROF	The ratio of profit before tax to total assets	$\frac{\text{Profit before tax}}{\text{Average total assets}}$
	Capital measure	CAP	Capital	$\frac{\text{Total equity}}{\text{Total assets}}$
	Risk measures	Z	Insolvency risk (Z-score)	$\ln\left(\frac{\frac{\text{Equity}}{\text{Total assets}} + \text{ROA}}{\sigma(\text{ROA})}\right)$
		Cr	Credit risk	$\frac{\text{Loan loss provisions}}{\text{Net loans}}$

Table 3 Definition of the employed variables (continued)

Classification		*Variable*	*Description*	*Measurement*
Independent variables	Diversification measures	DIVA	Asset diversification	$1-\left[\left(\frac{\text{Non interest earning assets}}{\text{total assets}}\right)^2+\left(\frac{\text{Interest earning assets}}{\text{total assets}}\right)^2\right]$
		DIVI	Income diversification	$1-\left[\left(\frac{\text{Non interest income}}{\text{net operating income}}\right)^2+\left(\frac{\text{Net interest income}}{\text{net operating income}}\right)^2\right]$
		DIVNI	Non-interest income diversification	$1-\left[\left(\frac{\text{fee and commissions income}}{\text{Non-interest income}}\right)^2+\left(\frac{\text{Trading income}}{\text{Non-interest income}}\right)^2+\left(\frac{\text{Other operating income}}{\text{Non-interest income}}\right)^2\right]$
	Bank-specific indicators	SIZE	Bank size	ln(Total assets)
		LIQ	Liquidity rate	$\frac{\text{Liquid assets}}{\text{Total assets}}$
		INT	Intermediation ratio	$\frac{\text{Gross loans}}{\text{Total deposits}}$
		LEND	Lending strategy	$\frac{\text{Net loans}}{\text{Total assets}}$
	Macroeconomic indicators	GDP	GDP real growth rate	GDP real growth rate
		INFL	Inflation rate	Inflation rate
		PUBD	Public debt	Public debt
		UNE	Unemployment rate	unemployment rate

In consistence with Moudud-Ul-Huq et al. (2019), we employ the three following alternative variables to measure bank profitability. Firstly, we use *net interest margin (NIM)* as a margin-type indicator of profitability:

$$NIM = \frac{Interest\ income - Interest\ expenses}{Average\ interest\ earning\ assets}$$

Additionally, in line with Elyasiani and Jia (2019) and Williams (2016), we also employ two return-type indicators of profitability: the ratio of return on average assets (ROA) and the ratio of profit before tax to average total assets (PROF). Moreover, Tan (2017)

estimate efficiency by using both net interest margin (NIM) and return on average assets (ROA) indicators.

$$ROA = \frac{Net\ income}{Average\ total\ assets}$$

$$PROF = \frac{Profit\ before\ tax}{Average\ total\ assets}$$

Concerning the estimation of bank risk, we employ both Z-score and loan loss provisions ratio as indicators of default risk and credit risk respectively. Higher values of Z-score indicate a more resilient and, thus a more stable bank (Paltrinieri et al., 2020) and as mentioned in Abuzayed et al. (2018), "(the Z-score calculates) the number of standard deviations the returns have to fall before a bank becomes insolvent". We incorporate Z-score in our model in line with established literature (Nguyen and Nghiem, 2015; Kabir and Worthington, 2017; Deelchand and Padgett, 2009; Mahdi and Abbes, 2018; Alkhouri and Arouri, 2018; Kim et al., 2020; Sissy et al., 2017).

$$Z = \ln\left(\frac{\frac{Equity}{Total\ assets} + ROA}{\sigma(ROA)}\right)$$

where

Z Z-score

ROA ratio of return on average assets.

Moreover, credit risk is estimated as the ratio of the loan loss provisions to net loans. This ratio denotes the ability of a bank to absorb the cost of non-performing loans, and as a result this variable indicates lower risk (Moudud-Ul-Huq et al., 2020; Chen et al., 2018). Thus, our credit risk ratio is built as follows:

$$Cr = \frac{Loan\ loss\ provisions}{Net\ loans}$$

where

Cr credit risk.

The capitalization (CAP) of the banks in our empirical model is measured as the ratio of total equity to total assets. This ratio is the most frequently used as a capital estimator, for example, Alkhouri and Arouri (2018), Meng et al. (2017) and Kolia and Papadopoulos (2020b).

For the purposes of our survey, we examine the degree of diversification in banking activities; lending and non-lending activities. More specifically, our empirical model consists of the asset, revenue and non-interest income diversification. According to the literature (Abuzayed et al., 2018; Paltrinieri et al., 2020; Sanya and Wolfe, 2010; Elsas et al., 2009), we apply the AHHI for the estimation of the diversification measures. The higher the AHHI is, the greater diversification is and as a result, the lower bank concentration is.

The diversification measures are the independent variables of our analysis and are explained in this section. Our first independent variable is the asset diversification (*DIVA*). This ratio has mainly been used in the recent literature (Moudud-Ul-Huq et al., 2019; Chen et al., 2018; Edirisuriya et al., 2015) and is calculated by breaking down interest and non-interest earning assets. An increased portion of non-interest earning assets indicates an increased diversification in banking activities.

$$DIVA = 1 - \left[\left(\frac{Non\text{-}interest\ earning\ assets}{Total\ assets} \right)^2 + \left(\frac{Interest\ earning\ assets}{Total\ assets} \right)^2 \right]$$

where

$$Non\text{-}interestearning\ assets = Total\ assets - Total\ loans\ and\ advances$$
$$= Securities + Investments$$

$$Interest\ earning\ assets = Total\ loans\ and\ advances$$

Secondly, the *income diversification* (*DIVI*) ratio is commonly employed (Moudud-Ul-Huq et al., 2019; Edirisuriya et al., 2015; Chen et al., 2018; Luu et al., 2019; Ferreira et al., 2018). This measure breaks down the two major categories of income which are non-interest income and net interest income. A diversified bank is expected to retrieve a great portion of income from non-interest activities.

$$DIVI = 1 - \left[\left(\frac{Non\text{-}interest\ income}{Net\ operating\ income} \right)^2 + \left(\frac{Net\ interest\ income}{Net\ operating\ income} \right)^2 \right]$$

where

$$Non\text{-}interest\ income = Fee\ and\ commissions\ income + Trading\ income$$
$$+ Other\ operating\ income$$

$$Net\ operating\ income = Non\text{-}interest\ income + Net\ interest\ income$$

Finally, the effect of diversifying non-credit banking activities is also estimated in the established literature (Sissy et al., 2017; Minh and Thanh, 2019; Ghosh, 2019; Lee et al., 2019; Moudud-Ul-Huq et al., 2020; Edirisuriya et al., 2015). We measure *non-interest income diversification* (*DIVNI*) by employing the same pattern that is, AHHI.

$$DIVNI = 1 - \left[\left(\frac{Fee\ and\ commissions\ income}{Non\text{-}interest\ income} \right)^2 + \left(\frac{Trading\ income}{Non\text{-}interest\ income} \right)^2 + \left(\frac{Other\ operating\ income}{Non\text{-}interest\ income} \right)^2 \right]$$

In our model we control for the bank characteristics that may affect the impact of bank diversification on capital, risk, efficiency and profitability. Consistent with the prior literature (Abuzayed et al., 2018; Paltrinieri et al., 2020; Moudud-Ul-Huq et al., 2019; Meng et al., 2017; Luu et al., 2019; Lee et al., 2019), we account for the bank-specific indicators: size, liquidity, intermediation ratio and lending specialisation.

More specifically, two very important parameters that are mainly employed by the literature and need to be controlled because they impact on capital, risk, efficiency and profitability are bank size and liquidity (Abuzayed et al., 2018; Ferreira et al., 2018; Williams, 2016; Sanya and Wolfe, 2010). In line with these studies, in our survey bank size (SIZE) is estimated as the natural algorithm of the ratio total equity to total assets and the liquidity rate (LIQ) is measured as the ratio of liquid assets to total assets. We also include the intermediation ratio (INT) in our model, which is calculated as the ratio of gross loans to total deposits. Lastly, the ratio of net loans to total assets is employed in our study as it is an indicator of the lending strategy (LEND) of the banks in our sample.

Since macroeconomic conditions influence the effect of diversification on banking institutions, they are included in the bank diversification literature (i.e., Meng et al., 2017; Alkhouri and Arouri, 2018). Thus, the consideration of environmental variables is essential for the purposes of our survey, especially due to the controversy regarding macroeconomic indicators among eurozone countries. More explicitly, our model is comprised of the following macroeconomic indicators: GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment rate (UNE).

5 Empirical results

In this part of our survey, we empirically examine the impact of bank diversification (assets, income and non-interest income diversification) on the profitability, efficiency, capital and risk of eurozone and US banks as well as of their subgroups of commercial, cooperative and savings banks. The results are thoroughly investigated in the following sections of our survey and are shown per reported group in Tables 10–17 (Appendix).

5.1 The effect of bank diversification on profitability

Table 4 and Table 5 depict the impact of bank diversification on the three profitability measures[4] of eurozone and US general samples, and the three subgroups of banks; commercial, cooperative and savings banks. Our findings seem to suggest that the profitability of eurozone savings banks is adversely associated with bank diversification, regardless of the type of diversification. This outcome is in line with the findings of Lee et al. (2014) for Asian savings banks yet it contradicts the findings of Köhler (2015) for European savings banks.

Concerning the impact of asset diversification on profitability, our results provide evidence that for the majority of the US groups examined, as well as eurozone savings banks, the relationship is adverse and statistically highly significant. Additionally, the relationship with the net interest margin is negative and statistically significant in the majority of the reported samples. This outcome is in line with that of Chen et al. (2018) for the conventional banking group. Nevertheless, the coefficient of asset diversification for the ROA and the PROF is favorable for the eurozone general sample, the eurozone cooperative and the eurozone savings banks, which is in line with Alkhouri and Arouri (2018).

Table 4 The effect of bank diversification on the profitability of eurozone banks

VARIABLES	*EUROZONE BANKS*			*EUROZONE BANKS SAVINGS BANKS*			*EUROZONE BANKS COMMERCIAL BANKS*			*EUROZONE BANKS COOPERATIVE BANKS*		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	NIM	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*
LAG	0.851***	0.363***	0.337***	0.894***	0.379***	0.305***	0.856***	0.356***	0.308***	0***	0.315***	0.287***
	(0.00102)	(0.00284)	(0.00249)	(0.00319)	(0.00148)	(0.00114)	(0.000725)	(0.00121)	(0.00148)	0	(0.00704)	(0.00632)
GDP	–0.00578***	0.000275***	0.0198***	–0.0164***	0.000412***	0.0308***	–0.0101***	0.000196***	0.0101***	1.15e-08***	0.000130***	0.00369***
	(0.00142)	(2.15e-05)	(0.00173)	(0.00265)	(2.55e-05)	(0.00141)	(0.00160)	(2.50e-05)	(0.00207)	0	(1.57e-05)	(0.000707)
INFL	0.00128	–0.000234***	–0.0132***	–0.0108***	–0.000255***	–0.00664***	–0.0546***	–0.000810***	–0.0831***	–3.04e-08***	0.000194***	0.0285***
	(0.00146)	(1.94e-05)	(0.00188)	(0.00185)	(2.27e-05)	(0.00129)	(0.00255)	(3.00e-05)	(0.00248)	0	(1.38e-05)	(0.00147)
PUBD	0.000270	–3.07e-05***	–0.00335***	0.000796***	–7.26e-05***	–0.00667***	–0.00164***	–4.54e-05***	–0.00507***	5.05e-10***	1.75e-05***	0.00207***
	(0.000232)	(4.10e-06)	(0.000363)	(0.000259)	(3.18e-06)	(0.000217)	(0.000193)	(3.00e-06)	(0.000298)	0	(4.77e-06)	(0.000392)
UNE	0.0172***	0.000223***	0.0261***	0.00837***	0.000270***	0.0296***	0.00267**	–6.58e-05***	0.00111	–1.85e-08***	0.000218***	0.0308***
	(0.00183)	(2.56e-05)	(0.00251)	(0.00179)	(1.72e-05)	(0.00108)	(0.00109)	(1.66e-05)	(0.00191)	0	(3.67e-05)	(0.00301)
SIZE	–0.0112***	–0.000539***	–0.0384***	–0.0649***	–0.00121***	–0.0883***	0.000591	–0.000930***	–0.0208***	1.54e-07***	9.41e-05	0.0140***
	(0.00233)	(4.83e-05)	(0.00347)	(0.00344)	(3.01e-05)	(0.00197)	(0.00296)	(7.72e-05)	(0.00482)	0	(5.99e-05)	(0.00474)
INT	–0.000251***	5.17e-06***	0.000433***	–0.102***	0.00930***	0.836***	–0.000799***	9.61e-06***	0.00120***	–1.02e-07***	0.00169***	0.0722***
	(7.24e-06)	(5.89e-08)	(6.10e-06)	(0.00769)	(7.74e-05)	(0.00442)	(8.48e-06)	(1.46e-07)	(1.64e-05)	0	(0.000107)	(0.00982)
LEND	0.344***	–0.00381***	–0.133**	0.301***	–0.0148***	–1.103***	0.340***	–0.00920***	–1.255***	5.14e-07***	–0.0136***	–0.937***
	(0.0296)	(0.000692)	(0.0542)	(0.0310)	(0.000623)	(0.0378)	(0.0228)	(0.000494)	(0.0453)	(2.42e-10)	(0.000445)	(0.0405)
LIQ	–0.00483***	–6.65e-06	0.00196***	–0.000971*	–4.48e-05***	–0.00168***	–0.00938***	7.32e-07	0.000451	2.67e-09***	–0.000130***	–0.00966***
	(0.000358)	(8.36e-06)	(0.000604)	(0.000511)	(5.65e-06)	(0.000342)	(0.000360)	(3.86e-06)	(0.000340)	0	(6.46e-06)	(0.000469)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM), the ratio of profit before tax to total assets (PROF), the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 4 The effect of bank diversification on the profitability of eurozone banks (continued)

VARIABLES	*EUROZONE BANKS*			*EUROZONE BANKS SAVINGS BANKS*			*EUROZONE BANKS COMMERCIAL BANKS*			*EUROZONE BANKS COOPERATIVE BANKS*		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	NIM	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*
DIVA	–0.285***	0.00149***	0.0769***	–0.322***	–0.000214	–0.0421***	–0.105***	0.00338***	0.157***	–5.63e-08***	0.00143***	0.0386*
	(0.0150)	(0.000224)	(0.0186)	(0.0170)	(0.000180)	(0.0109)	(0.00892)	(0.000146)	(0.0111)	0	(0.000125)	(0.0200)
DIVI	–3.36e-05***	4.42e-06***	0.000434***	–0.0956***	–0.0112***	–0.967***	0.000150***	2.77e-05***	0.00216***	1.08e-07***	–0.000884***	–0.119***
	(2.51e-06)	(2.97e-08)	(2.58e-06)	(0.0102)	(0.000144)	(0.00870)	(1.29e-05)	(3.34e-07)	(2.98e-05)	0	(5.16e-05)	(0.00482)
DIVIN	5.53e-06***	1.65e-07***	1.25e-05***	–0.0298***	–0.000977***	–0.0667***	–0.0228***	0.000151**	0.00798	1***	1.02e-07***	7.51e-06***
	(1.02e-06)	(8.12e-09)	(6.53e-07)	(0.00117)	(7.78e-06)	(0.000481)	(0.00381)	(5.93e-05)	(0.00529)	0	(3.31e-09)	(3.11e-07)
AR(1)	–2.97	–3.16	–2.33	–5.72	–3.02	–2.27	–2.63	–2.5	–1.88	–0.80	–5.46	–5.39
(p-val AR(1))	0.003	0.002	0.020	0.00	0.003	0.023	0.09	0.013	0.060	0.426	0.00	0.00
AR(2)	1.91	1.30	1.09	1.88	0.99	–0.15	0.83	1.15	1.01	0.45	1.93	1.97
(p-val AR(1))	0.057	0.194	0.276	0.060	0.321	0.877	0.404	0.251	0.312	0.655	0.054	0.049
Hansen	406.3	264.75	327.45	184.05	696.62	216.99	163.51	173.20	174.97	2.8e+10	277.74	282.26
p-hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.002	0.002	0.00	0.00	0.00
Constant	0.153***	0.0141***	0.886***	1.015***	0.0315***	2.204***	0.583***	0.0279***	1.821***	–2.02e-06***	0.00816***	0.345***
	(0.0441)	(0.000859)	(0.0649)	(0.0570)	(0.000693)	(0.0478)	(0.0547)	(0.00149)	(0.0954)	(7.87e-10)	(0.000786)	(0.0682)
Observations	7,915	7,915	7,915	2,04	2,04	2,04	1,365	1,365	1,365	4,19	4,19	4,19
Number of bank	1,584	1,584	1,584	408	408	408	273	273	273	838	838	838

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM), the ratio of profit before tax to total assets (PROF), the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 5 The effect of bank diversification on the profitability of US banks

VARIABLES	*US BANKS*			*US SAVINGS BANKS*			*US COMMERCIAL BANKS*			*US COOPERATIVE BANKS*		
	PROFITABILITY			*PROFITABILITY*			*PROFITABILITY*			*PROFITABILITY*		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	NIM	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*
LAG	0.860***	0.864***	0.899***	0.813***	0.713***	0.671***	0.947***	1.045***	0.893***	0.825***	0.616***	0.642***
	(0.00135)	(0.00121)	(0.00120)	(0.0120)	(0.0118)	(0.0154)	(0.00153)	(0.000351)	(0.00136)	(0.00935)	(0.0111)	(0.0112)
GDP	0.0241*	0.000241**	0.359***	0.148***	0.00131***	0.523***	0.0341**	40,929***	0.482***	–0.0132*	0.000642***	0.0658***
	(0.0129)	(0.000103)	(0.0165)	(0.0194)	(0.000260)	(0.0141)	(0.0136)	–1,398	(0.0162)	(0.00728)	(7.30e-05)	(0.00767)
INFL	0.0228***	0.000408***	–0.163***	–0.0789***	–0.00181***	–0.363***	0.000934	–15,709***	–0.205***	0.0894***	–0.000211***	–0.0243***
	(0.00699)	(8.91e-05)	(0.0114)	(0.0128)	(0.000148)	(0.00909)	(0.00783)	(832.7)	(0.0127)	(0.00437)	(5.92e-05)	(0.00607)
PUBD	0.0158***	–0.000114*	0.126***	0.0864***	0.000991***	0.233***	0.0275***	12,757***	0.157***	–0.0152***	0.000251***	0.0270***
	(0.00463)	(6.13e-05)	(0.00794)	(0.00854)	(9.89e-05)	(0.00609)	(0.00470)	(398.3)	(0.00805)	(0.00318)	(3.32e-05)	(0.00348)
UNE	–0.000798	–0.000719***	0.0276**	0.0292***	0.000386***	0.130***	–0.0123	1,327	–0.0144	–0.0271***	–6.28e-05	–0.00201
	(0.00809)	(0.000111)	(0.0123)	(0.0105)	(0.000113)	(0.00686)	(0.0106)	(993.1)	(0.0129)	(0.00423)	(5.59e-05)	(0.00587)
SIZE	0.101***	–0.00153***	–0.142***	0.00870	3.33e-05	–0.00995	0.117***	30,578***	–0.289***	0.0616***	0.000113	0.00829
	(0.0109)	(0.000218)	(0.00618)	(0.0150)	(0.000210)	(0.0137)	(0.0120)	–1,295	(0.0203)	(0.00550)	(8.66e-05)	(0.00853)
INT	0.000166***	–1.50e-06***	–0.000118***	–0.0105	0.00291***	0.311***	–0.000135***	3.731***	0.000354***	–0.0207***	0.000211***	0.0224***
	(5.83e-06)	(9.11e-08)	(8.58e-06)	(0.0391)	(0.000681)	(0.0326)	(6.65e-06)	(0.605)	(7.86e-06)	(0.00298)	(2.04e-05)	(0.00199)
LEND	0.547***	–0.00987***	–2.013***	–0.0726	–0.00588***	–0.570***	1.028***	–649,914***	–4.992***	0.463***	0.000397	0.0612*
	(0.0832)	(0.00172)	(0.163)	(0.121)	(0.00201)	(0.104)	(0.133)	–38,176	(0.203)	(0.0460)	(0.000369)	(0.0359)
LIQ	–0.00581***	6.23e-05***	–0.00685***	–0.00470***	–5.91e-05***	–0.00494***	–0.00417**	–6,288***	–0.0149***	0.00253***	–1.02e-05**	–0.00106**
	(0.000983)	(1.85e-05)	(0.00183)	(0.00108)	(1.75e-05)	(0.000831)	(0.00164)	(370.2)	(0.00221)	(0.000548)	(4.52e-06)	(0.000465)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 5 The effect of bank diversification on the profitability of US banks (continued)

VARIABLES	*US BANKS*			*US SAVINGS BANKS*			*US COMMERCIAL BANKS*			*US COOPERATIVE BANKS*		
	PROFITABILITY			*PROFITABILITY*			*PROFITABILITY*			*PROFITABILITY*		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	NIM	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*	*NIM*	*PROF*	*ROA*
DIVA	–0.738***	–0.0212***	–1.595***	0.309**	–0.00477***	–0.259***	–0.207*	–367,386***	–1.268***	0.880***	–0.00341***	–0.382***
	(0.105)	(0.00189)	(0.132)	(0.121)	(0.00168)	(0.0631)	(0.121)	–21,781	(0.192)	(0.0500)	(0.000809)	(0.0895)
DIVI	–0.0708	–0.0227***	–2.008***	0.324***	0.00622***	0.520***	–0.0639	18,725***	–1.107***	0.881***	0.00422***	0.414***
	(0.0647)	(0.000201)	(0.0122)	(0.0389)	(0.000281)	(0.0310)	(0.0655)	–6,195	(0.0176)	(0.0710)	(0.000650)	(0.0747)
DIVIN	–0.00736***	3.39e-05**	0.00568***	–0.0133**	–0.00170***	–0.149***	–0.00805***	441.5***	0.00749***	–0.100***	–0.00127***	–0.0900**
	(0.00112)	(1.37e-05)	(0.00128)	(0.00616)	(6.13e-05)	(0.00920)	(0.000829)	(112.8)	(0.000792)	(0.0323)	(0.000360)	(0.0358)
AR(1)	–5.81	–1.27	–1.88	–2.4	–2.51	–2.41	–5.14	–1.64	–1.78	–4.48	–3.33	–3.36
(p-val AR(1))	0.00	0.205	0.060	0.016	0.012	0.016	0.00	0.100	0.075	0.00	0.001	0.001
AR(2)	0.97	0.89	0.11	1.76	0.43	–0.77	0.55	–0.68	0.14	0.28	–0.10	–0.24
(p-val AR(1))	0.331	0.376	0.914	0.078	0.671	0.441	0.581	0.496	0.887	0.777	0.924	0.811
Hansen	216.90	233.80	209.65	58.59	59.14	52.4	187.36	240.83	161.94	138.98	131.61	130.09
p-hansen	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.013	0.169	0.303	0.336
Constant	–2.886***	0.0565***	–8.988***	–8.861***	–0.0994***	–24.90***	–5.047***	–1.208e+06***	–8.019***	0.461	–0.0265***	–2.863***
	(0.532)	(0.00847)	(0.939)	(0.980)	(0.00957)	(0.677)	(0.502)	–54,658	–1.110	(0.327)	(0.00415)	(0.413)
Observations	3,003	3,003	3,003	315	315	315	1,908	1,908	1,908	770	770	770
Number of bank	601	601	601	63	63	63	382	382	382	154	154	154

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

As regards non-interest income diversification, the results vary depending on the banking union and bank type. More specifically, the profitability of eurozone banks, except for savings banks, is enhanced by a rise in non-interest income diversification. This outcome is in line with the results of Moudud-Ul-Huq et al. (2019), Sissy et al. (2017), Sanya and Wolfe (2010), MostakAhamed (2017) and Baele et al. (2007). However, the majority of the US banking groups is negatively affected by an increase in non-interest income diversification confirming the results of Alkhouri and Arouri (2018) and Laeven and Levine (2007). Interestingly, Stiroh (2006) concludes that there is no relationship between those two variables.

In relation to income diversification, the profitability of the greatest part of the reported groups is positively and statistically significantly affected, providing evidence that the profitability of a diversified bank is possibly enhanced when compared with a bank with lower levels of income diversification, therefore, confirming the results of Moudud-Ul-Huq et al. (2019), Ferreira et al. (2018), Ali and Khattak (2020), Luu et al. (2019), MostakAhamed (2017) as well as Elsas et al. (2009). The results could be linked with operational synergies and/or higher income maximum capacity that are generated because of income diversification (Sanya and Wolfe, 2010; Baele et al., 2007). However, the profitability of eurozone savings banks and the US general sample of banks is adversely related with income diversification.

Finally, Tables 4 and 5 also indicate the impact of the bank-specific and the macroeconomic indicators on profitability measures. As concerns liquidity, the results for the majority of the sample provide evidence that bank profitability is negatively related with liquidity. Moreover, for the lending activity and the intermediation ratio, the outcome is contingent with the profitability measure. More specifically, lending is negatively associated with the net interest margin and positively related both with ROA and the ratio of profit before tax to total assets. The intermediation ratio, however, is positively related for the majority of the sample with net interest margin while negatively related with ROA and the ratio of profit before tax to total assets. Moudud-Ul-Huq et al. (2019) also suggest a positive relationship between net interest margin and the intermediation ratio. Finally, the impact of size on profitability depends on whether the bank is in the eurozone or in the USA. The profitability of eurozone banks, except for eurozone cooperative banks, is negatively affected by an increase in bank size whereas the majority of the US banking institutions is positively affected.

Concerning the macroeconomic variables, the impact of the unemployment rate together with the GDP real growth rate on the profitability of the greatest part of the examined banking institutions is positive. Furthermore, the impact of public debt on profitability depends on the banking union that is the relationship is diverse for the majority of the eurozone banking groups and negative for the greatest part of the US banking groups. Lastly, the relationship between profitability and inflation is adverse and statistically significant for the vast majority of the reported sample. The outcome for inflation is in line with the findings of Sanya and Wolfe (2010).

5.2 The effect of bank diversification on efficiency

As concerns asset, capital and income diversification, the results (Table 6) indicate that the coefficient is negative and statistically highly significant for the efficiency indicators for the vast majority of the reported groups. Thus, we may conclude that the efficiency of

both the eurozone and the US banking systems is negatively related to all the examined types of bank diversification. This outcome confirms the results of Alkhouri and Arouri (2018), conveying that non-interest income diversification is negatively related with bank performance and the results of Nguyen (2018) suggesting that income-diversification is negatively connected with cost efficiency. It is also in line with the results of Wu et al. (2020), suggesting that this is an indirect influence of the increased risk levels that highly diversified banks have and could be attributed to the higher monitoring costs. However, our results seem to conflict with those of Chen et al. (2018) and Moudud-Ul-Huq et al. (2019) which suggest that there is no significant relationship between those two parameters.

Concerning the bank-specific indicators, the impact of the lending strategy on efficiency depends on whether the bank belongs to the eurozone or the US banking group. More precisely, a rise in lending activity may precede an increase in the efficiency of eurozone banks and US cooperative banks, while it negatively affects the efficiency of the other two US banking samples. Regarding the intermediation ratio, it is noteworthy that bank efficiency is positively related with all the reported groups of our sample, while Moudud-Ul-Huq et al. (2019) find no significant relationship. Lastly, efficiency is directly related with bank size for the greater part of the sample, this outcome is in line with Antunes et al. (2022) for Chinese commercial banks during the period 2010–2018.

Our findings also help us to understand how the environmental variables are associated with bank efficiency. The majority of eurozone banks are directly affected by an increase in both the unemployment rate and the inflation rate, whereas the greatest parts of the US banking groups are adversely affected. Moreover, the efficiency of the greatest part of the reported sample is adversely related to an increase in public debt (PUBD). Regarding inflation, we observe that the outcome depends on the bank type; the efficiency of savings banks is directly related with changes in inflation whereas the efficiency of cooperative banks is adversely related.

5.3 The effect of bank diversification on capital

Table 7 presents the impact of bank diversification on capital. A positive relationship between bank diversification and capital may indicate that the non-traditional activities of banks require further capital, whereas a negative association may indicate that the new activities require less capital than the traditional activities (Meng et al., 2017; Landi and Venturelli, 2001). According to our outcome, initially we observe that the US savings banking group is the only examined group whose capital is positively and statistically highly significantly affected by an increase in all types of bank diversification.

Our results convey the following empirical evidence. Firstly, we may conclude that the levels of capital employed by eurozone and US banks are both positively and negatively associated with increases in asset diversification. More analytically, the capital of eurozone and US cooperative banks tend to decrease when asset diversification rises whereas the capital of the other three US banking groups is directly associated with asset diversification. In recent literature, Chen et al. (2018) suggest that an increase in asset diversification may lead to a decrease in capital levels while Meng et al. (2017) provide evidence showing the relationship is direct.

Secondly, with the exception of eurozone cooperative banks, an increase in income diversification of both eurozone and US banks has a favourable effect on bank capital, which is in line with Sissy et al. (2017).

Table 6 The effect of bank diversification on bank efficiency

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(4)	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*
	EFF	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*
LAG	0.554***	0.710***	0.423***	0.792***	0.778***	0.757***	0.706***	0.763***
	(0.00178)	(0.0119)	(0.00173)	(0.00482)	(0.00392)	(0.0148)	(0.00342)	(0.00808)
GDP	0.00619***	–0.00243***	0.00243***	0.00426***	–0.0374***	0.0260***	–0.0139***	–0.0110***
	(0.000213)	(0.000522)	(0.000174)	(0.000198)	(0.00130)	(0.00201)	(0.000770)	(0.00131)
INFL	–0.000342*	0.00548***	0.0156***	–0.00224***	0.0249***	0.0275***	–0.0286***	–0.0169***
	(0.000189)	(0.000471)	(0.000233)	(0.000236)	(0.000833)	(0.00195)	(0.000808)	(0.00110)
PUBD	0.000144***	–0.000260***	–0.000390***	0.000315***	–0.0252***	–0.00541***	–0.00431***	–0.00246***
	(2.85e-05)	(6.28e-05)	(3.61e-05)	(9.20e-05)	(0.000456)	(0.000822)	(0.000442)	(0.000618)
UNE	–0.000229	0.00266***	0.00116***	0.000157	–0.00733***	0.0313***	–0.0105***	–0.0309***
	(0.000240)	(0.000391)	(0.000126)	(0.000687)	(0.000947)	(0.00216)	(0.000861)	(0.000985)
SIZE	0.0114***	–0.000647	0.00157**	–0.00181	–0.00271***	0.0249***	0.00596***	0.00365***
	(0.000442)	(0.000722)	(0.000747)	(0.00123)	(0.000923)	(0.00549)	(0.000591)	(0.00119)
INT	0.000289***	0.0784***	0.000325***	0.0149***	3.25e-05***	0.0893***	4.32e-05***	0.0165***
	(1.08e-06)	(0.00410)	(1.67e-06)	(0.00204)	(5.71e-07)	(0.0141)	(5.96e-07)	(0.000963)
LEND	0.0455***	0.0466***	0.135***	0.169***	–0.0428**	–0.158***	–0.0428***	0.0221***
	(0.00576)	(0.00885)	(0.00638)	(0.00914)	(0.0194)	(0.0291)	(0.0150)	(0.00543)
LIQ	0.000247***	–0.000555***	0.00132***	–0.000493***	–0.00226***	–0.000399	–0.00233***	–0.000107
	(5.66e-05)	(0.000152)	(5.88e-05)	(0.000122)	(0.000235)	(0.000327)	(0.000150)	(9.66e-05)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 6 The effect of bank diversification on bank efficiency (continued)

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(4)	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*
	EFF	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*	*EFF*
DIVA	–0.0144***	–0.0110**	–0.00133**	0.108***	–0.339***	–0.253***	–0.209***	–0.0272**
	(0.000953)	(0.00488)	(0.000596)	(0.00256)	(0.0145)	(0.0244)	(0.0100)	(0.0126)
DIVI	–7.29e-05***	–0.129***	–0.000919***	–0.0478***	0.130***	–0.142***	–0.00664	–0.304***
	(6.62e-07)	(0.00585)	(6.03e-06)	(0.00144)	(0.00732)	(0.00870)	(0.00636)	(0.0157)
DIVIN	–1.84e-06***	–0.00824***	0.0134***	1.70e-06***	–0.000337**	–0.0207***	–7.05e-05	–0.0888***
	(2.48e-07)	(0.000420)	(0.000382)	(4.50e-08)	(0.000170)	(0.00106)	(9.35e-05)	(0.00958)
AR(1)	–2.98	–7.91	–5.92	–3.74	–4.17	–2.62	–4.47	–4.00
(p-val AR(1))	0.003	0.00	0.00	0.00	0.00	0.009	0.00	0.00
AR(2)	–0.13	1.80	–1.86	1.53	–1.72	–0.75	–1.72	–1.38
(p-val AR(1))	0.896	0.071	0.063	0.127	0.086	0.452	0.085	0.167
Hansen	1188.46	286.27	248.22	354.57	283.35	57.21	238.34	129.38
p-hansen	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.352
Constant	–0.167***	0.133***	–0.0265**	0.0127	2.936***	0.150	0.745***	0.678***
	(0.00875)	(0.0121)	(0.0128)	(0.0186)	(0.0548)	(0.148)	(0.0427)	(0.0686)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 7 The effect of bank diversification on bank capital

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(5)	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*
	CAP	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*
LAG	0.900***	1.003***	0.743***	0.888***	0.804***	1.002***	0.742***	1.009***
	(0.00359)	(0.00113)	(0.00226)	(0.00398)	(0.00575)	(0.00724)	(0.00636)	(0.00562)
GDP	0.0599***	0.129***	0.107***	0.0955***	–0.0406	0.0166	–0.188***	0.177***
	(0.00703)	(0.00736)	(0.00763)	(0.00519)	(0.0330)	(0.0441)	(0.0386)	(0.0157)
INFL	–0.0707***	–0.169***	–0.232***	0.0311***	0.330***	0.342***	0.423***	0.215***
	(0.00984)	(0.00645)	(0.00986)	(0.00349)	(0.0215)	(0.0528)	(0.0268)	(0.0137)
PUBD	1.61e-07	–0.00106	0.00169	–0.0113***	–0.0793***	–0.0341	–0.135***	0.0140*
	(0.000841)	(0.000911)	(0.00111)	(0.00168)	(0.0106)	(0.0228)	(0.0127)	(0.00770)
UNE	0.0287***	–0.0119***	–0.0158**	0.0817***	–0.0462*	–0.0994***	–0.184***	0.185***
	(0.00712)	(0.00436)	(0.00733)	(0.0108)	(0.0237)	(0.0183)	(0.0250)	(0.0121)
SIZE	0.159***	0.0341***	–0.183***	–0.410***	0.0796***	0.145***	0.0653**	0.0571***
	(0.0118)	(0.0118)	(0.0144)	(0.0168)	(0.0285)	(0.0406)	(0.0263)	(0.0163)
INT	–8.29e-05***	0.143***	–0.00205***	1.729***	–0.000362***	–1.295***	–0.000124***	–0.0365***
	(2.20e-05)	(0.0218)	(3.24e-05)	(0.0355)	(1.79e-05)	(0.111)	(1.98e-05)	(0.00439)
LEND	–1.738***	–0.530***	–3.438***	–5.281***	–0.446	2.302***	–2.234***	–0.744***
	(0.130)	(0.115)	(0.168)	(0.119)	(0.286)	(0.405)	(0.234)	(0.101)
LIQ	–0.0223***	–0.00274	–0.0774***	–0.0240***	–0.0175***	0.0131***	–0.0603***	0.00170
	(0.00145)	(0.00185)	(0.000973)	(0.00138)	(0.00317)	(0.00421)	(0.00192)	(0.00121)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 7 The effect of bank diversification on bank capital (continued)

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(5)	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*
	CAP	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*	*CAP*
DIVA	–0.811***	–0.381***	–0.371***	–0.809***	2.097***	0.196	3.673***	–0.570***
	(0.0523)	(0.0592)	(0.0439)	(0.0497)	(0.211)	(0.498)	(0.335)	(0.185)
DIVI	0.000342***	0.00842	0.00347***	–0.393***	1.420***	0.730***	1.448***	1.005***
	(1.50e-05)	(0.0382)	(6.41e-05)	(0.0155)	(0.0671)	(0.165)	(0.165)	(0.132)
DIVIN	1.99e-05***	–0.0729***	–0.141***	1.10e-05***	–0.00777**	0.0719***	–0.0135***	–0.760***
	(1.64e-06)	(0.00305)	(0.0187)	(6.49e-07)	(0.00320)	(0.0210)	(0.00241)	(0.0926)
AR(1)	–2.52	–6.01	–2.11	–4.11	–2.34	–4.13	–2.23	–4.08
(p-val AR(1))	0.012	0.00	0.035	0.00	0.019	0.00	0.026	0.00
AR(2)	0.85	0.80	0.53	–0.82	–0.40	–0.54	–0.13	0.47
(p-val AR(1))	0.394	0.426	0.594	0.415	0.686	0.591	0.896	0.640
Hansen	396.69	235.87	169.98	1568.46	207.37	47.46	183.58	132.78
p-hansen	0.00	0.00	0.004	0.00	0.00	1.00	0.00	0.279
Constant	0.151	0.113	10.01***	9.455***	8.959***	0.356	18.40***	–3.408***
	(0.219)	(0.207)	(0.301)	(0.284)	–1.367	–2.325	–1.560	(0.869)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Thirdly, the impact of non-interest income diversification on capital is negative for the greatest part of the reported sample. This outcome is also consistent with Sissy et al. (2017). More specifically, the coefficient is negative for the US general sample of banks, US cooperative and commercial banks as well as for eurozone savings and commercial banks. On the other hand, it is only positive for the eurozone general sample, eurozone cooperative and US savings banks.

As regards bank-specific indicators, our results provide evidence that an increase in bank liquidity and lending strategy tend to negatively affect bank capital for the vast majority of the reported sample and the outcome is statistically highly significant. The only exception is the US savings banks' capital which is positively related with both liquidity and lending strategy indicators. In addition, bank capital for the majority of the reported groups is adversely related with the bank intermediation ratio and directly related with bank size.

Furthermore, we observe that bank capital in most samples is adversely related with an increase in public debt. The results also show that the type of banks and the banking union (the eurozone or the USA) in which a bank belongs to, are very important parameters affecting the impact of macroeconomic conditions on bank capital. Moreover, as concerns the unemployment rate, we see that cooperative banks react differently (positively) than the rest of the samples. Also, an increase in inflation precedes an increase in capital levels of US banks and eurozone cooperative banks, while it negatively affects capital levels of the remaining three groups of eurozone banks. Finally, the US banks' capital decreases after a rise in the real GDP growth rate, in contrast to eurozone banks where an adverse relationship appears to prevail.

5.4 The effect of bank diversification on risk

For the purposes of our survey, we separately examine the effect of bank diversification on the default and credit risk of the eurozone and US banking systems. The results are reported in Tables 8 and 9 as well as in the in columns 6 and 7 of Tables 10–17 (Appendix).

Our findings suggest that the coefficient of z-score for income diversification is positive for the majority of the examined banking institutions. As a result of this, an increase in income diversification leads to a rise in bank stability. This outcome could be attributed to economies of scope and concurs with Sanya and Wolfe (2010). Yet, Paltrinieri et al. (2020), Köhler (2015), Lee et al. (2014), Moudud-Ul-Huq et al. (2019), Meng et al. (2017), Demirgüç-Kunt and Huizinga (2010) and Lepetit et al. (2008) conclude that the relationship between stability and income diversification is negative. However, Kim et al. (2020) provide evidence that income diversification is directly related with bank stability until an optimal level of income diversification, and beyond that level, the relationship is adverse.

The outcome is unfavorable for non-interest income and asset diversification, though, it seems that an increase in those two types of diversification negatively influences bank stability by increasing default risk. Confirming the findings of Lepetit et al. (2008), Alkhouri and Arouri (2018) as well as DeYoung and Torna (2013), the results can be

explained if we take into consideration the increased risk of non-traditional banking activities of highly diversified banks (Stiroh, 2006; Abuzayed et al., 2018). However, Alkhouri and Arouri (2018) suggest that asset diversification and bank stability are directly associated while Edirisuriya et al. (2015) suggest that there is no significant connection.

Moreover, bank-specific indicators (liquidity, lending strategy and size) negatively affect the stability of the vast majority of the investigated banking institutions. This finding is in accordance with Abuzayed et al. (2018), indicating that "larger banks are more stable" while it contradicts the findings of Alkhouri and Arouri (2018). Our outcome is also in line with that of Tan and Floros (2018) suggesting that "liquidity risk and capital risk are significantly and negatively related". As regards banks' lending strategy, one potential explanation of the negative relationship could be that the higher lending activity is, the higher bank profitability and risk will be (Paltrinieri et al., 2020). However, the the relationship between default risk and the intermediation ratio are mixed and therefore cannot lead to definitive conclusions. Similarly, Moudud-Ul-Huq et al. (2019) suggest that there is no significant relationship between stability and net interest income.

It is also very interesting to note that eurozone and US banks react differently to an increase in the unemployment rate; eurozone banks' default risk is negatively affected whilst US banks' default risk is positively influenced. In addition, the risk of the vast majority of the reported banks is positively influenced when public debt and real GDP growth rate rise[5], while it is negatively affected when the inflation rate increases. This empirical evidence is in line with Alkhouri and Arouri (2018).

Regarding credit risk, initially we observe that the coefficient of income diversification is positive for the majority of the sample indicating a greater ability for banks to absorb the cost of non-performing loans. A bank with highly diversified activities also has greater ability to collect information, which may help in avoiding lending to clients with poor credit history and as a result lower credit risk (Wu et al., 2020). Conversely, non-interest income diversification is directly related with credit risk for most banking samples under investigation. Finally, concerning the effect of asset diversification, we may conclude that it depends on whether the bank belongs to the eurozone or the US banking group. More precisely, the credit risk of the US banks and of the eurozone general sample of banks is negatively linked with an increase in asset diversification, yet the risk of the three other eurozone banking groups is positively related with increases in asset diversification.

Regarding the bank-specific indicators, we observe that the credit risk of the majority of banking institutions is negatively affected by an increase in liquidity, size and lending strategy. On the other hand, the bank intermediation ratio positively affects the stability of US banking groups and the eurozone general sample while it negatively affects the stability of the other three eurozone banking groups. We also observe that the credit risk of the majority of the reported sample is directly affected by changes in public debt and real GDP growth rate. For the other two macroeconomic indicators (inflation and unemployment rate) the outcome is mixed, hence we may not draw any conclusions.

Table 8 The effect of bank diversification on the default risk

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(6)	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*
	Z	*Z*	*Z*	*Z*	*Z*	*Z*	*Z*	*Z*
LAG	0.299***	0.449***	0.461***	0.648***	0.837***	0.947***	0.807***	0.973***
	(0.00476)	(0.00576)	(0.00180)	(0.00535)	(0.00589)	(0.0172)	(0.00522)	(0.00599)
GDP	–0.00102	–0.195***	–0.00137	0.0301***	–2.106***	–0.176***	–2.117***	–0.106***
	(0.00121)	(0.00200)	(0.000842)	(0.000615)	(0.0134)	(0.00547)	(0.0127)	(0.00179)
INFL	0.0290***	–0.0606***	0.0159***	0.0958***	1.825***	0.0720***	1.892***	0.0658***
	(0.00138)	(0.00165)	(0.00143)	(0.00108)	(0.00538)	(0.00515)	(0.00505)	(0.00152)
PUBD	–0.000373**	–0.00839***	–0.00113***	0.000698***	–0.914***	–0.0858***	–0.936***	–0.0642***
	(0.000183)	(0.000275)	(0.000140)	(0.000220)	(0.00416)	(0.00268)	(0.00396)	(0.000821)
UNE	0.00391**	0.00631***	0.00814***	0.0167***	–1.045***	–0.149***	–1.100***	–0.0896***
	(0.00189)	(0.00103)	(0.00101)	(0.00168)	(0.00366)	(0.00277)	(0.00386)	(0.00134)
SIZE	–0.0110***	–0.0287***	–0.0279***	–0.0159***	0.00668**	0.00778	–0.00499	–0.00480***
	(0.00289)	(0.00316)	(0.00172)	(0.00259)	(0.00307)	(0.00496)	(0.00352)	(0.00130)
INT	–0.000261***	0.441***	–0.000198***	0.116***	–2.94e-05***	–0.0636***	6.30e-06***	–0.00211***
	(3.74e-06)	(0.00548)	(4.67e-06)	(0.00512)	(1.47e-06)	(0.0207)	(1.46e-06)	(0.000506)
LEND	–0.160***	–0.548***	–0.429***	–0.862***	–0.0235	0.179***	–0.303***	–0.0385***
	(0.0398)	(0.0375)	(0.0126)	(0.0156)	(0.0251)	(0.0492)	(0.0283)	(0.00703)
LIQ	–0.000939**	–0.00292***	–0.00640***	–0.00485***	–0.000939***	0.000660	–0.00405***	0.000403***
	(0.000419)	(0.000506)	(8.69e-05)	(0.000123)	(0.000297)	(0.000580)	(0.000349)	(9.32e-05)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 8 The effect of bank diversification on the default risk (continued)

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(6)	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*	*(6)*
	Z	Z	Z	Z	Z	Z	Z	Z
DIVA	–0.212***	0.919***	–0.0827***	–0.458***	–0.0755***	–0.0129	–0.110***	–0.0175
	(0.0135)	(0.00892)	(0.00580)	(0.00803)	(0.0250)	(0.0537)	(0.0247)	(0.0174)
DIVI	0.000190***	–0.358***	0.00226***	–0.0386***	–0.0514***	0.0649***	0.0743***	0.00180
	(2.23e-06)	(0.0138)	(1.27e-05)	(0.00199)	(0.00435)	(0.00940)	(0.00452)	(0.0103)
DIVIN	4.33e-06***	–0.000825	–0.0411***	4.59e-06***	–0.000210	–0.00830***	–0.000266	–0.0628***
	(2.91e-07)	(0.00119)	(0.00287)	(1.21e-07)	(0.000284)	(0.00163)	(0.000215)	(0.00787)
AR(1)	–10.74	–13.67	–6.49	–5.28	–7.00	–4.44	–5.99	–5.02
(p-val AR(1))	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AR(2)	12.32	4.45	5.59	1.31	–0.5	–0.21	–0.67	0.99
(p-val AR(1))	0.00	0.00	0.00	0.189	0.614	0.831	0.500	0.323
Hansen	1396.98	388.83	260.44	1369.22	187.39	46.97	149.98	130.32
p-hansen	0.00	0.00	0.00	0.00	0.00	1.00	0.056	0.331
Constant	2.062***	3.527***	1.905***	1.689***	102.7***	9.942***	105.6***	7.516***
	(0.0701)	(0.0656)	(0.0383)	(0.0443)	(0.481)	(0.296)	(0.458)	(0.0946)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 9 The effect of bank diversification on the credit risk

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(7)	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*
	CR	*CR*	*CR*	*CR*	*CR*	*CR*	*CR*	*CR*
LAG	0.116***	0.0555***	0.260***	0.376***	0.776***	0.740***	0.769***	0.643***
	(0.000956)	(0.00502)	(0.00190)	(0.00731)	(0.00313)	(0.00505)	(0.00326)	(0.00657)
GDP	0.000300*	–0.00149***	–0.000958***	–0.00226***	–0.000727***	0.000872***	–0.000996***	–0.00100***
	(0.000173)	(9.11e-05)	(3.70e-05)	(0.000120)	(3.41e-05)	(6.22e-05)	(4.04e-05)	(5.78e-05)
INFL	0.00960***	0.000877***	–0.00193***	0.000187***	–7.28e-05	–0.000251***	–0.000366***	0.000787***
	(0.000272)	(7.60e-05)	(3.40e-05)	(2.77e-05)	(5.33e-05)	(6.94e-05)	(4.88e-05)	(3.94e-05)
PUBD	–9.37e-05**	9.23e-05***	–5.86e-05***	–0.000113***	–0.000169***	0.000383***	–0.000208***	–0.000373***
	(4.31e-05)	(1.27e-05)	(4.26e-06)	(9.57e-06)	(1.76e-05)	(3.94e-05)	(2.07e-05)	(2.14e-05)
UNE	0.00824***	7.53e-05	0.000607***	0.000105	–0.000542***	0.000574***	–0.000494***	–0.000235***
	(0.000316)	(6.30e-05)	(2.45e-05)	(7.85e-05)	(5.32e-05)	(8.78e-05)	(5.23e-05)	(3.87e-05)
SIZE	–0.0215***	0.000741***	0.000356***	0.000436***	–0.000307***	–0.000612***	0.000791***	0.000411***
	(0.000447)	(8.99e-05)	(8.16e-05)	(0.000108)	(4.49e-05)	(0.000130)	(7.28e-05)	(7.89e-05)
INT	0.000109***	–0.00611***	–1.54e-05***	–0.00706***	2.70e-06***	0.00231***	6.74e-07***	–9.78e-05***
	(2.42e-06)	(0.000312)	(2.17e-07)	(0.000233)	(3.15e-08)	(0.000351)	(2.92e-08)	(3.71e-05)
LEND	–0.485***	0.0159***	0.0780***	0.0231***	0.0135***	0.0152***	0.00923***	0.00267***
	(0.00969)	(0.00153)	(0.00155)	(0.000758)	(0.000885)	(0.00102)	(0.000927)	(0.000414)
LIQ	–0.00302***	7.78e-05***	0.000799***	0.000408***	7.17e-05***	0.000191***	3.96e-05***	1.33e-06
	(9.81e-05)	(2.03e-05)	(1.44e-05)	(1.51e-05)	(1.01e-05)	(1.33e-05)	(1.07e-05)	(5.00e-06)

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

Table 9 The effect of bank diversification on the credit risk (continued)

VARIABLES	*EUROZONE BANKS*	*EUROZONE BANKS SAVINGS BANKS*	*EUROZONE BANKS COMMERCIAL BANKS*	*EUROZONE BANKS COOPERATIVE BANKS*	*US BANKS*	*US SAVINGS BANKS*	*US COMMERCIAL BANKS*	*US COOPERATIVE BANKS*
	(7)	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*	*(7)*
	CR	*CR*	*CR*	*CR*	*CR*	*CR*	*CR*	*CR*
DIVA	0.00339**	–0.00181***	–0.00463***	–0.0136***	0.00753***	0.00939***	0.00354***	0.00742***
	(0.00141)	(0.000674)	(0.000267)	(0.000396)	(0.000599)	(0.000936)	(0.000679)	(0.000590)
DIVI	–3.00e-05***	0.00897***	–1.75e-05***	0.00288***	0.00290***	0.00154***	–0.0118***	8.96e-05
	(1.26e-06)	(0.000503)	(5.50e-07)	(0.000170)	(9.18e-05)	(0.000227)	(9.36e-05)	(0.000552)
DIVIN	2.02e-06***	–0.000305***	–0.00221***	–7.10e-08***	–2.92e-05***	0.00276***	–1.10e-05**	–0.00243***
	(1.04e-07)	(3.46e-05)	(0.000139)	(2.71e-09)	(9.07e-06)	(3.64e-05)	(5.18e-06)	(0.000367)
AR(1)	–1.02	–4.13	–2.05	–5.65	–1.95	–1.52	–1.70	–1.52
(p-val AR(1))	0.308	0.00	0.040	0.00	0.051	0.127	0.090	0.128
AR(2)	1	–1.27	1.39	1.11	–0.98	–1.13	–0.83	0.82
(p-val AR(1))	0.316	0.0204	0.164	0.267	0.327	0.260	0.406	0.411
Hansen	618.01	182.03	193.46	329.04	197.26	56.18	188.84	133.91
p-hansen	0.00	0.01	0.00	0.00	0.00	1.00	0.00	0.256
Constant	0.624***	–0.0251***	–0.0674***	–0.00621***	0.0143***	–0.0539***	0.0111***	0.0352***
	(0.0114)	(0.00193)	(0.00178)	(0.00149)	(0.00233)	(0.00626)	(0.00225)	(0.00301)
Observations	7,915	2,04	1,365	4,19	3,003	315	1,908	770
Number of bank	1,584	408	273	838	601	63	382	154

Notes: The table indicates the system-GMM results for the eurozone sample of banks and its subgroups (commercial, cooperative and savings banks). The estimated model is the XTABOND2 developed by Roodman (2009). The dependent variables are the measures of profitability [the net interest margin (NIM); the ratio of profit before tax to total assets (PROF); the return on average assets (ROA)], the measure of efficiency (EFF) estimated by the D.E.A. methodology, the measure of capital (CAP) estimated as the ratio of total equity to total assets and the measures of risk [insolvency risk (Z) and credit risk (CR)]. LAG is the one period lagged of dependent variables. The independent variables are: the measures of diversification; asset diversification (DIVA), income diversification (DIVI) and non-interest income diversification (DIVNI), the bank-specific indicators; SIZE (the natural logarithm of total assets), LIQ (the ratio of liquid assets to total assets), INT (the ratio of gross loans to total deposits), LEND (the ratio of gross loans to total assets) and the environmental variables; GDP real growth rate (GDP), inflation rate (INFL), public debt (PUBD) and unemployment (UNE). AR(1) and AR(2) indicate the first-order and the second-order autocorrelation (Arellano-Bond tests). Hansen-J variable tests over-identification. Standard errors are in parentheses. ***Significant at 1%, **significant at 5%, *significant at 10%.

6 Conclusions

In this study, we investigate the influence of bank diversification on bank capital, risk, profitability and efficiency in a dynamic panel estimator. We also reveal how the influence differs depending on three specific parameters, that is:

1 the type of diversification (asset, income, non-interest income diversification)

2 the type of bank (commercial, cooperative and savings banks)

3 the country union (the USA and the eurozone).

As regards bank diversification and profitability, initially we observe that the impact of income diversification on profitability is direct for the majority of the reported groups and that asset diversification negatively affects the net interest margin of most of the reported banks. Our review of the empirical literature leads to the conclusion that the banking union to which a bank belongs and the type of bank are significant parameters that need to be taken into consideration when investigating the effect of diversification on bank profitability. This happens because:

1 the profitability of eurozone savings banks is the only examined banking group which is negatively affected by an increase in any type of diversification

2 the effect of asset diversification and non-interest income diversification on profitability depends on the banking union for the majority of the reported sample, as it is negative for US banks and positive for eurozone banking groups with the exception of eurozone savings banks.

A similar pattern is observed with the relationship between capital and diversification, highlighting the fact that the outcome depends on the type of bank and whether the bank belongs to the eurozone or the USA. Our findings show that the US savings banking group is the only examined group whose capital is positively affected by an increase in all the three types of bank diversification. We also conclude that, except for the eurozone cooperative banks, an increase in the income diversification of both eurozone and US banks has a favourable effect on bank capital. Also, with the exception of US cooperative banks, US banking groups are directly associated with asset diversification, whereas the capital of eurozone and US cooperative banks tend to decrease when asset diversification rises. Finally, the impact of non-interest income diversification on capital is negative for the greatest part of the reported sample.

Furthermore, our results indicate that the impact of assets, capital and income diversification on bank efficiency is negative and statistically significant for the vast majority of the eurozone and the US banking institutions.

Our results indicate that income diversification precedes a decrease in both the credit and default risk for the vast majority of the reported sample. Thus, we may conclude that income diversification enhances bank stability. While non-interest income diversification is directly related with default and credit risk for the greatest part of the sample and asset diversification negatively influences bank stability by increasing default risk. Finally, the effect of asset diversification on credit risk depends on whether the bank belongs to the eurozone or the USA. The reason being is that the credit risk of US banks and the eurozone general sample of banks is negatively related with an increase in asset

diversification, while the risk of the three other eurozone banking groups is positively related with an increase in asset diversification.

Overall, we find consistent evidence that income diversification has substantial benefits when compared to other types of diversification since it positively affects stability, profitability as well as the capital of the majority of the reported banks, yet these benefits are not so great for eurozone savings banks. By contrast, non-interest income diversification has the most unfavourable results for the reported groups. This occurs because non-interest income diversification decreases for all four dependent variables (efficiency, capital, stability and profitability), for the majority of the reported sample. Finally, the impact of asset diversification is mixed and is determined by whether a bank belongs to the eurozone or the USA. Our conclusion is consistent with Moudud-Ul-Huq et al. (2019) for Asian countries after the global financial crisis, indicating that the impact of income diversification on performance and bank stability is positive and that of asset diversification varies across the reported countries.

It is also very important to note that some of the results diverge depending on the type of banking institution (commercial, cooperative or savings banks). This outcome is in line with Köhler (2015) and emphasises the importance of the incorporation of different bank types in the examined sample when investigating the effect of diversification on risk, capital, efficiency and profitability of banking institutions.

Our findings have substantial implications for shareholders, regulators and bank managers. Firstly, our results suggest that non-interest income diversification creates more threats than opportunities. In this regard, the supervision of non-traditional banking activities need to be reviewed and improved. Secondly, income diversification offers additional benefits for banks in comparison to asset diversification, which causes a mixed outcome. It is therefore advisable that bank managers ought to consider that various diversification strategies differently influence banking institutions when setting risk management policies, prioritising banking activities and taking investment decisions. Thirdly, the efficiency of banking institutions is negatively affected by bank diversification and this outcome affects shareholders' interests. Fourthly, the impact of bank diversification on capital, risk, efficiency and profitability is dissimilar across different types of banks. Therefore, bank managers should consider following different strategies for each category in order to be more benefited by diversification and supervisors ought to separately analyse the impact of new regulations on each category of banks. Fifth, the country union (the eurozone or the USA) to which a bank belongs affects the examined relationship and needs to be taken into consideration.

Lastly, the limitation of our survey is that it does not provide evidence regarding which type of non-interest income is more beneficial for banks. Thus, our survey could be extended and enriched by employing:

1 a dataset covering more years after the global financial crisis

2 more capital indicators such as capital buffers and coco bonds

3 a number of market-based variables for example stock prices and their volatility.

Appendices/Supplementary materials are available on request by emailing the corresponding author.

References

Abuzayed, B., Al-Fayoumi, N. and Molyneux, P. (2018) 'Diversification and bank stability in the GCC', *Journal of International Financial Markets, Institutions & Money*, DOI: 10.1016/j.intfin.2018.04.005.

Ackermann, J. (2019) 'Europe suffers from the sorry state of its banks', *The Financial Times* [online] https://www.ft.com/content/497d4d9e-0f3a-11e9-b2f2-f4c566a4fc5f.

Alfadli, A. and Rjoub, H. (2019) 'The impacts of bank-specific, industry-specific and macroeconomic variables on commercial bank financial performance: evidence from the Gulf Cooperation Council countries', *Applied Economics Letters*, Vol. 27, No. 15, pp.1284–1288, DOI: 10.1080/13504851.2019.1676870.

Ali, M. and Khattak, M.A. (2020) 'Income structure and performance: an empirical analysis of Islamic and conventional banks in Indonesia', *Bulletin of Monetary Economics and Banking*, Vol. 23, pp.87–108, DOI: 10.21098/bemp.v23i0.1193.

Alkhouri, R. and Arouri, H. (2018) 'The effect of diversification on risk and return in banking sector', *International Journal of Managerial Finance*, Vol. 15, No. 1, pp.100–128, DOI: 10.1108/ijmf-01-2018-0024.

Antunes, J., Vencheh, A.H., Jamshidi, A., Tan, Y., and Wanke, P. (2022) 'Bank efficiency estimation in China: DEA.RENNA approach', *Annals of Operations Research*, Vol. 315, pp.1373–1398.

Arellano, M. and Bond, S. (1991) 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations', *The Review of Economic Studies*, Vol. 58, No. 2, p.277, DOI: 10.2307/2297968.

Arellano, M. and Bover, O. (1995) 'Another look at the instrumental variable estimation of error-components models', *Journal of Econometrics*, Vol. 68, No. 1, pp.29–51, DOI: 10.1016/0304-4076 (94)01642-d.

Ashraf, D., Ramady, M. and Albinali, K. (2016) 'Financial fragility of banks, ownership structure and income diversification: empirical evidence from the GCC region', *Research in International Business and Finance*, Vol. 38, pp.56–68, DOI: 10.1016/j.ribaf.2016.03.010.

Baele, L., De Jonghe, O. and vander Vennet, R. (2007) 'Does the stock market value bank diversification?', *SSRN Electronic Journal*, DOI: 10.2139/ssrn.883593.

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, Vol. 87, No. 1, pp.115–143, DOI: 10.1016/s0304-4076 (98)00009-8.

Charnes, A., Cooper, W. and Rhodes, E. (1978) 'Measuring the efficiency of decision making units', *European Journal of Operational Research*, Vol. 2, No. 6, pp.429–444, DOI: 10.1016/0377-2217 (78)90138-8.

Chen, N., Liang, H. and Yu, M. (2018) 'Asset diversification and bank performance: evidence from three Asian countries with a dual banking system', *Pacific-Basin Finance Journal*, Vol. 52, pp.40–53, DOI: 10.1016/j.pacfin.2018.02.007.

Clark, E., Mitra, S. and Jokung, O. (2019) 'Post global financial crisis modelling: credit risk for firms that are too big to fail', *International Journal of Financial Markets and Derivatives*, Vol. 7, No. 1, p.15, DOI: 10.1504/ijfmd.2019.101235.

Daradkah, D. and Al-Sayyah, M. (2020) 'The effect of financing and non-financing income on Islamic banks' risk: evidence from Gulf Cooperation Council countries', *International Journal of Economics and Business Administration*, Vol. 8, No. 1, pp.180–192, DOI: 10.35808/ijeba/417.

Deelchand, T. and Padgett, C. (2009) 'The relationship between risk, capital and efficiency: evidence from Japanese cooperative banks', *SSRN Electronic Journal*, DOI: 10.2139/ssrn.1525423.

Demirgüç-Kunt, A. and Huizinga, H. (2010) 'Bank activity and funding strategies: the impact on risk and returns', *Journal of Financial Economics*, Vol. 98, No. 3, pp.626–650, DOI: 10.1016/j.jfineco.2010.06.004.

DeYoung, R. and Torna, G. (2013) 'Nontraditional banking activities and bank failures during the financial crisis', *SSRN Electronic Journal*, DOI: 10.2139/ssrn.2032246.

Edirisuriya, P., Gunasekarage, A. and Dempsey, M. (2015) 'Bank diversification, performance and stock market response: evidence from listed public banks in South Asian countries', *Journal of Asian Economics*, DOI: 10.1016/j.asieco.2015.09.003.

Elsas, R., Hackethal, A. and Holzhäuser, M. (2009) 'The anatomy of bank diversification', *Journal of Banking & Finance*, Vol. 34, No. 6, pp.1274–1287, DOI: 10.1016/j.jbankfin.2009.11.024.

Elyasiani, E. and Jia, J. (2019) 'Relative performance and systemic risk contributions of small and large banks during the financial crisis', *The Quarterly Review of Economics and Finance*, Vol. 74, pp.220–241, DOI: 10.1016/j.qref.2019.01.010.

Ferreira, J.H., Zanini, F.A. and Alves, T.W. (2018) 'Bank revenue diversification: its impact on risk and return in Brazilian banks', *RevistaContabilidade&Finanças*, Vol. 30, No. 79, pp.91–106, DOI: 10.1590/1808-057x201805810.

Ghosh, A. (2019) 'Discerning the impact of disaggregated non-interest income activities on bank risk and profits in the post-gramm-Leach-Bliley act era', *Journal of Economics and Business*, Vol. 108, p.105874, DOI: 10.1016/j.jeconbus.2019.105874.

Heid, B., Langer, J. and Larch, M. (2011) 'Income and democracy: evidence from system GMM estimates', *Economics Letters*, Vol. 116, No. 2, pp.166–169, DOI: 10.1016/j.econlet. 2012.02.009.

Kabir, M.N. and Worthington, A.C. (2017) 'The 'competition–stability/fragility' nexus: a comparative analysis of Islamic and conventional banks', *International Review of Financial Analysis*, Vol. 50, pp.111–128, DOI: 10.1016/j.irfa.2017.02.006.

Kim, H., Batten, J.A. and Ryu, D. (2020) 'Financial crisis, bank diversification, and financial stability: OECD countries', *International Review of Economics & Finance*, Vol. 65, pp.94–104, DOI: 10.1016/j.iref.2019.08.009.

Köhler, M. (2015) 'Which banks are more risky? The impact of business models on bank stability', *Journal of Financial Stability*, Vol. 16, pp.195–212, DOI: 10.1016/j.jfs.2014.02.005.

Kolia, D.L. and Papadopoulos, S. (2020a) 'A comparative analysis of the relationship among capital, risk and efficiency in the eurozone and the U.S. banking institutions', *Risk Governance and Control: Financial Markets and Institutions*, Vol. 10, No. 2, pp.8–20, DOI: 10.22495/rgcv10i2p1.

Kolia, D.L. and Papadopoulos, S. (2020b) 'The levels of bank capital, risk and efficiency in the eurozone and the U.S. in the aftermath of the financial crisis', *Quantitative Finance and Economics*, Vol. 4, No. 1, pp.66–90, DOI: 10.3934/qfe.2020004.

Laeven, L. and Levine, R. (2007) *Is There a Diversification Discount in Financial Conglomerates?*, DOI: 10.3386/w11499.

Lakhani, K., Heid, J. and Templeman, L. (2019) *How to Fix European Banking… and Why it Matters*, Deutsche Bank.

Landi, A. and Venturelli, V. (2001) 'The diversification strategy of European banks: determinants and effects on efficiency and profitability', *SSRN Electronic Journal*, DOI: 10.2139/ ssrn.269841.

Le, T. (2018) 'Bank risk, capitalisation and technical efficiency in the Vietnamese banking system', *Australasian Accounting, Business and Finance Journal*, Vol. 12, No. 3, pp.41–61, DOI: 10.14453/aabfj.v12i3.4.

Lee, C., Chen, P. and Zeng, J. (2019) 'Bank income diversification, asset correlation and systemic risk', *South African Journal of Economics*, Vol. 88, No. 1, pp.71–89, DOI: 10.1111/ saje.12235.

Lee, C., Yang, S. and Chang, C. (2014) 'Non-interest income, profitability, and risk in banking industry: a cross-country analysis', *The North American Journal of Economics and Finance*, Vol. 27, pp.48–67, DOI: 10.1016/j.najef.2013.11.002.

Lepetit, L., Nys, E., Rous, P. and Tarazi, A. (2008) 'Bank income structure and risk: an empirical analysis of European banks', *Journal of Banking & Finance*, Vol. 32, No. 8, pp.1452–1467, DOI: 10.1016/j.jbankfin.2007.12.002.

Luu, H.N., Nguyen, L.Q., Vu, Q.H. and Tuan, L.Q. (2019) 'Income diversification and financial performance of commercial banks in Vietnam', *Review of Behavioral Finance*, Vol. 12, No. 3, pp.185–199, DOI: 10.1108/rbf-05-2019-0066.

Mahdi, I.B.S. and Abbes, M.B. (2018) 'Relationship between capital, risk and liquidity: a comparative study between Islamic and conventional banks in MENA region', *Research in International Business and Finance*, Vol. 45, pp.588–596, DOI: 10.1016/j.ribaf.2017.07.113.

Maudos, J. (2017) 'Income structure, profitability and risk in the European banking sector: the impact of the crisis', *Research in International Business and Finance*, Vol. 39, pp.85–101, DOI: 10.1016/j.ribaf.2016.07.034.

Meng, X., Cavoli, T. and Deng, X. (2017) 'Determinants of income diversification: evidence from Chinese banks', *Applied Economics*, Vol. 50, No. 17, pp.1934–1951, DOI: 10.1080/00036846.2017.1383594.

Mercieca, S., Schaeck, K. and Wolfe, S. (2007) 'Small European banks: Benefits from diversification?', *Journal of Banking & Finance*, Vol. 31, No. 7, pp.1975–1998, DOI: 10.1016/j.jbankfin.2007.01.004.

Minh, S.N. and Thanh, T.T. (2019) 'Analysis of the impact from non-interest income to the operational efficiency of commercial banks in Vietnam', *Management Science Letters*, pp.455–462, DOI: 10.5267/j.msl.2019.8.025.

MostakAhamed, M. (2017) 'Asset quality, non-interest income, and bank profitability: evidence from Indian banks', *Economic Modelling*, Vol. 63, pp.1–14, DOI: 10.1016/j.econmod.2017.01.016.

Moudud-Ul-Huq, S., Ashraf, B.N., Gupta, A.D. and Zheng, C. (2019) 'Does bank diversification heterogeneously affect performance and risk-taking in ASEAN emerging economies?', *Research in International Business and Finance*, Vol. 46, pp.342–362, DOI: 10.1016/j.ribaf.2018.04.007.

Moudud-Ul-Huq, S., Zheng, C., Gupta, A.D., Hossain, S.A. and Biswas, T. (2020) 'Risk and performance in emerging economies: do bank diversification and financial crisis matter?', *Global Business Review*, p.097215092091530, DOI: 10.1177/0972150920915301.

Nguyen, N. (2019) 'Revenue diversification, risk and bank performance of Vietnamese commercial banks', *Journal of Risk and Financial Management*, Vol. 12, No. 3, p.138, DOI: 10.3390/jrfm12030138.

Nguyen, T.L.A. (2018) 'Diversification and bank efficiency in six ASEAN countries', *Global Finance Journal*, Vol. 37, pp.57–78, DOI: 10.1016/j.gfj.2018.04.004.

Nguyen, T.P. and Nghiem, S.H. (2015) 'The interrelationships among default risk, capital ratio and efficiency', *Managerial Finance*, Vol. 41, No. 5, pp.507–525, DOI: 10.1108/mf-12-2013-0354.

Paltrinieri, A., Dreassi, A., Rossi, S. and Khan, A. (2020) 'Risk-adjusted profitability and stability of Islamic and conventional banks: does revenue diversification matter?', *Global Finance Journal*, p.100517, DOI: 10.1016/j.gfj.2020.100517.

Roodman, D. (2009) 'How to do Xtabond2: an introduction to difference and system GMM in Stata', *The Stata Journal: Promoting communications on statistics and Stata*, Vol. 9, No. 1, pp.86–136, DOI: 10.1177/1536867x0900900106.

Sanya, S.O. and Wolfe, S. (2010) 'Can banks in emerging economies benefit from revenue diversification?', *SSRN Electronic Journal*, DOI: 10.2139/ssrn.1077842.

Sissy, A.M., Amidu, M. and Abor, J.Y. (2017) 'The effects of revenue diversification and cross border banking on risk and return of banks in Africa', *Research in International Business and Finance*, Vol. 40, pp.1–18, DOI: 10.1016/j.ribaf.2016.09.017.

Stiroh, K.J. (2006) 'New evidence on the determinants of bank risk', *Journal of Financial Services Research*, Vol. 30, No. 3, pp.237–263, DOI: 10.1007/s10693-006-0418-5.

Tan, Y. (2017) 'The impacts of competition and shadow banking on profitability: evidence from the Chinese banking industry', *The North American Journal of Economics and Finance*, Vol. 42, pp.89–106.

Tan, Y. and Anchor, J. (2017) 'The impacts of risk-taking behaviour and competition on technical efficiency: evidence from the Chinese banking industry', *Research in International Business and Finance*, Vol. 41, pp.90–104, DOI: 10.1016/j.ribaf.2017.04.026.

Tan, Y. and Floros, C. (2013) 'Risk, capital and efficiency in Chinese banking', *Journal of International Financial Markets, Institutions and Money*, Vol. 26, pp.378–393, DOI: 10.1016/j.intfin.2013.07.009.

Tan, Y. and Floros, C. (2018) 'Risk, competition and efficiency in banking: evidence from China', *Global Finance Journal*, Vol. 35, pp.223–236, DOI: 10.1016/j.gfj.2017.12.001.

Trabelsi, M.A. and Trad, N. (2017) 'Profitability and risk in interest-free banking industries: a dynamic panel data analysis', *International Journal of Islamic and Middle Eastern Finance and Management*, Vol. 10, No. 4, pp.454–469, DOI: 10.1108/imefm-05-2016-0070.

Tran, V.T., Lin, C. and Nguyen, H. (2016) 'Liquidity creation, regulatory capital, and bank profitability', *International Review of Financial Analysis*, Vol. 48, pp.98–109, DOI: 10.1016/j.irfa.2016.09.010.

Triki, M.B. and Maktouf, S. (2019) 'Concentration measures in emerging banking', *Int. J. Financial Markets and Derivatives*, Vol. 7, No. 1, pp.54–67.

Trujillo-Ponce, A. (2012) 'What determines the profitability of banks? Evidence from Spain', *Accounting & Finance*, Vol. 53, No. 2, pp.561–586, DOI: 10.1111/j.1467-629x.2011.00466.x.

Williams, B. (2016) 'The impact of non-interest income on bank risk in Australia', *Journal of Banking & Finance*, Vol. 73, pp.16–37, DOI: 10.1016/j.jbankfin.2016.07.019.

Windmeijer, F. (2005) 'A finite sample correction for the variance of linear efficient two-step GMM estimators', *Journal of Econometrics*, Vol. 126, No. 1, pp.25–51, DOI: 10.1016/j.jeconom.2004.02.005.

Wu, J., Chen, L., Chen, M. and Jeon, B.N. (2020) 'Diversification, efficiency and risk of banks: evidence from emerging economies', *SSRN Electronic Journal*, DOI: 10.2139/ssrn.3419935.

Zhang, J., Jiang, C., Qu, B. and Wang, P. (2013) 'Market concentration, risk-taking, and bank performance: evidence from emerging economies', *International Review of Financial Analysis*, Vol. 30, pp.149–157, DOI: 10.1016/j.irfa.2013.07.016.

Notes

1 Such as, investments, securities trading, clearing services, insurance, asset management etc.

2 Concerning the methodology, we should also mention that the dependent indicator is lagged by one period ($Y_{i,\ t-1}$) because bank profitability, risk, capital as well as efficiency may be persistent.

3 For the estimation of the system-GMM we employed the module 'xtabond2' in Stata, developed by Roodman (2009).

4 Profitability measures : the net interest margin (NIM [1]), the ratio of profit before tax to total assets (PROF [2]) and the return on average assets (ROA [3]).

5 According to Sanya and Wolfe (2010), GDP and bank risk are positively related because "banks take on higher risk during periods of high economic growth. This is because economic booms can fuel credit expansion and undiscriminating diversification strategies".