Determinants of banks' profitability: the case of constituents of the Euro STOXX banks index

Francesco Guidi[1]

Abstract

The Euro STOXX banks index includes the largest European banks in terms of market capitalisation. The aim of this study is to investigate the determinants of their profitability over the period 2008-2022 by using linear regressions and dynamic panel data models. In accordance with relevant literature, accounting-based indicators are used in this study as internal determinants of banks' profitability, whereas industry- and macroeconomic-based indicators are used as external determinants. By measuring banks' profitability via alternative indicators, such as return on assets (ROA), return on equity (ROE) and net interest margin (NIM), our empirical findings suggest that factors such as total assets and loan loss provisions have a more prominent effect on banks' profitability than other accounting-based indicators. An increase of bank credit risk, measured by the loans-to-assets ratio, is found to lower bank profitability. Furthermore, the effect of the capital-asset ratio on the banks' profitability indicates that over-capitalised banks may have ignored profitable investment opportunities. Managerial efficiency, measured by the cost-to-income ratio, is found to increase the banks' profitability. The robustness of our findings are then checked by using alternative measure of bank risk as well as competition. The sensitive analysis conforms the robustness of our findings.

JEL classifications: G21

Keywords: banking profitability, accounting-based measures, panel GMM.

[1] School of Accounting, Economics and Finance, Greenwich Business School, University of Greenwich, Old Royal Naval College, 30 Park Row, London, SE10 9LS, United Kingdom.

Email: f.guidi@greenwich.ac.uk

1. Introduction

Over the last two decades, the European Union's (EU) banking sector has experienced a period of consistent change owing mainly to the 2008-2009 Global Financial Crisis (GFC) and subsequent European sovereign debt crisis in 2010. One of the measures taken by the EU to break the link between sovereign debt and bank debt, that led to over €4.5 trillion of taxpayers' money being used to rescue banks in the EU, was to call for a banking union (EU Commission, 2012). A key part of this process was to shift the supervision of banks to European level. In the first half of the 2010s, EU institutions managed to establish the first two pillars of the banking union: a Single Supervisory Mechanism (SSM) and a Single Resolution Mechanism (SRM) (EU Commission, 2022). Even though the first two pillars are now in place and fully operational, the proposal for a European deposit protection scheme has not yet been implemented. Furthermore, the other two measures proposed by EU institutions that would complete the proposed banking union and tackle the remaining risks of the banking sector – that is, the management of nonperforming loans as well as initiative to help banks diversify their investment – are still far from being implemented (EU Commission, 2022). This changing regulatory landscape in which European banks have operated over the 2010s raises questions in relation to their performance. These initiatives have shown, on one hand, how important financial stability is to the EU banking system. On the other hand, the delay in implementing and adopting the EU measures that would complete the creation of the banking union highlights the level of concern shown by European banks in relation to the effects of these measures – particularly on their profitability. Bank profitability and their determinants have been a growing area of study given the increasing financialization of advanced economies. In this context, the role played by larger banks in this process of increasing financialization has led to constant scrutiny on how they operate and what factors impact the most on their profitability. The recent empirical literature on European banks' profitability either focuses on individual European countries (Athanasoglou et al., 2008; Pasiouras and Kosmidou, 2007; Garcia and Guerrieiro, 2009; Dietrich and Wanzenried, 2011) or looks at banking performance in the whole European region (see, for instance, Goddard et al., 2004; Bucevska and Misheva, 2004; Goddard et al., 2011, Menicucci and Paolucci, 2016). None of them, however, analyse banks' profitability by focusing to the largest European banks as defined by their market capitalisation. The aim of our study is to fill this gap in the empirical literature by looking at the determinants of the profitability of the largest European banks as identified as constituents of the EURO STOXX Bank Index that tracks the equity prices of the 21 largest European banks. The elements of novelty our study add to the current literature are as follows. First, we use a dataset covering a period from 2008 to the end of 2022 and therefore including also the COVID-19 pandemic period. Second, all banks included in this study, are listed in one or more European stock exchanges. Third, we check the robustness of our results by using alternative measure of market power as well as financial stability.

The rest of the paper is structured as follows. Section 2 provides a review of the literature on the determinants of profitability. Section 3 describes the methodology and Section 4 defines the variables used to construct the determinants of profitability. Section 5 describes the data and Section 6 outlines the methodology. Section 7 reports the estimation results. Finally, Section 8 concludes the paper.

2. Literature review on banking profitability

The empirical literature on banks' profitability has focused the analysis either on cross-country analysis or on single countries. The cross-country analysis includes studies focusing on the Middle East and North African countries (Ben Naceur and Omran, 2011; Olson and Zoubi, 2011; Caporale et al., 2017), Sub-Saharan African countries (Flamini et al., 2009), European countries (Menicucci and Paolucci) Central and Eastern Europe (Djalilov and Piesse, 2016), Southeastern Europe (Bucevska and Misheva, 2017; Guidi, 2021) and Asian countries (Faisal et al., 2020). On the other hand, other studies focus on single countries such as China (García-Herrero et al., 2009; Sufian, 2009), Greece (Pasiouras and Kosmidou, 2007; Athanasoglou et al., 2008), India (Almaqtari et al. 2018), Japan (Liu and Wilson, 2010), Jordan (Saleh and Afifa, 2020), Korea (Lee and Kim, 2013), Portugal (Garcia and Guerreiro, 2016), Serbia (Knezevic and Dobromirov, 2016), Switzerland (Dietrich and Wanzenried, 2011), the USA (Hannan and Prager, 2009; Chronopoulos et al., 2015) and Vietnam (Batten and Vo, 2019; Le, 2020).

Although there are substantial differences among these studies in terms of the periods of analysis, typologies of banks and sources of data, there are also some elements that invite comparison between their findings. A starting point is that alternative measures of profitability, such as return on equity (ROE), return on assets (ROA) and net interest margin (NIM), were used across many of these empirical studies. Secondly, these studies used both internal and external determinants of profitability: the former are usually bank-specific variables, whereas the latter are macroeconomic variables and other variables related to the environment in which the banks under analysis were operating in.

For instance, in most of these studies, internal determinants of banks' profitability include cost to income ratio, equity, total assets, loans and income diversification: their effects on banks profitability is either consistent across these studies or mixed up in other. For instance, the effect of operational efficiency, measured as cost to income ratio is found to have a negative effect on profitability of banks (see, for instance, Liu and Wilson, 2010; Dietrich and Wanzenried, 2011; Garcia and Guerreiro, 2016; Knezevic and Dobromirov, 2016), thereby implying that an increase of operational costs lowers the profitability of banks. Chronopoulos et al. (2015) find a positive relation between bank size (proxied by total assets) and profitability. Conversely, the same relationship is found to be negative in other studies (see, for instance, Pasiouras and Kosmidou, 2007; Caporale et al., 2017). The relation between capital strength, which is proxied by equity divided by total assets, and bank profitability is found to be positive in many studies (see, for instance, Pasiouras and Kosmidou, 2007; Athanasoglou et al., 2008; Liu and Wilson, 2010; Sufian and Habibullah, 2012; Bucevska and Misheva; 2017), while other studies show mixed results (see, for instance, Garcia and Guerreiro, 2016; Batten and Vo, 2019). Previous studies also include the effect of credit risk (proxied by loan loss provision over total assets) on banks' profitability, reporting a negative impact of the former on the latter (see, for instance, Jeon and Miller, 2005; Athanasoglou et al., 2008; Chronopoulos et al., 2015; Garcia and Guerreiro, 2016, Djalilov and Piesse, 2016).

Previous studies also include the effect of external determinants of banks' profitability: these are usually represented by macroeconomic variables (such as inflation rate and Gross Domestic Product) as well as other indicators that describe specific aspects of the environment in which banks operate (that is, for instance, market concentration in terms of either bank deposits or bank loans). By focusing on the effect of macroeconomic variable on banks' profitability, many studies have found a positive relationship between Gross Domestic Product (GDP) growth and financial sector performance (see, for instance, Pasiouras and Kosmidou, 2007; Chronopoulos et al., 2015; Caporale et al., 2017), whereas others (see, for instance, Liu and Wilson, 2010; Goddard et al., 2011; Garcia and Guerreiro, 2014) found the same relationship to be negative. Inflation, an additional external determinant of banks' profitability, is found to positively affect the performance of banks' profitability the banking sector (see, for instance, Athanasoglou et al., 2008; Caporale et al., 2017; Batten and Vo, 2019; Pasiouras and Kosmidou, 2007). Alongside macroeconomic variables, external determinants of banks' profitability include industry-specific characteristics such as the market structure in which banks operate in. A very popular indicator to control for the effect of market structure on banks' profitability is the Herfindahl-Hirschman-Index (*HHI*). Some studies found that the impact of *HHI* was positive during pre-crisis periods such as that which preceded the recent 2007-2009 global financial crisis (see, for instance, Dietrich and Wanzenried, 2011). Other studies (see, for instance, Chronopoulos et al, 2015) found a positive effect on the profitability of small banks, whereas the effect was negative in the case of medium- and large-sized banks.

Overall, the prior empirical literature suggests that bank-specific, industry-specific and macroeconomic factors affect banks' profitability. However, the direction of these effects (either in terms of positive or negative effects on banks' profitability) might depends on the period of analysis considered and the stage of economic development a country is currently in, as well as the methodology used to perform the empirical analysis.

Table 1 - Recent empirical literature on determinants of bank profitability

Author(s)	Country(s)	Dataset	Methodology	Profitability measure(s)	Period	Results
Garcia-Herrero et al. (2009)	China	87 banks	Pooled cross-sectional time series model using generalised method of moments (GMM) estimator technique		1997-2004	banks' profitability is influenced mainly by capitalisation, concentration, real interest rates and inflation.
Liu and Wilson (2010)	Japan	685 banks (including regional, credit cooperatives, city and trust banks)	Pooled cross-sectional time series model using generalised method of moments (GMM) estimator technique	ROA, ROE and NIM	2000-2007	Revenue diversification, credit risk, capitalisation and economic growth have significant impact on bank profitability.
Dietrich & Wanzenried (2011)	Switzerland	372 commercial banks	System GMM estimator	ROAA, ROAE, NIM	1999-2009	Operational efficiency, the growth of total loans, funding costs and the business model are the main determinants of bank profitability.
Garcia and Guerreiro (2014)	Portugal	4 Public banks and 23 private banks	Pooled cross-sectional time series model using ordinary least squares (OLS)		2002-2011	Operational efficiency, lending growth, economic growth and household disposable income growth are the main factors affecting bank profitability.
Chronopoulos et al. (2015)	US	Over 17,500 commercial banks	Two-step GMM estimator technique	ROA and ROE	1984-2010	Bank size, income diversification liquidity, credit risk and asset growth affect bank profitability.

3. Methodology

To estimate the impact of bank-specific, industry-specific, and macroeconomic variables on banks' profitability, we use both panel data linear regression models (either Fixed or Random Effects) as well as a dynamic panel data model. The former as well as the latter regression models been widely used in the empirical literature (see, for instance, Liu and Wilson, 2010).

The panel linear regression model is defined as follows:

$$\pi_{i,t} = \alpha_0 + +\beta X'_{i,t} + \lambda Y'_t + \gamma Z'_t + \varepsilon_t \quad (1)$$

where $\boldsymbol{\pi_{i,t}}$ is the profitability of bank *i* in country *j* at time *t*, with $i = 1, \dots, N$ and $t = 1, \dots, T$. $X'_{i,t}$ is a vector of bank-specific variables, $\boldsymbol{Y'_t}$ is a vector of industry-specific variables and $\boldsymbol{Z'_t}$ is a vector of macroeconomic variables. The term $\boldsymbol{\varepsilon_t}$ denotes the disturbance term made up of the unobserved specific effect $v_{i,t}$ and the idiosyncratic error $u_{i,t}$. Eq. (1) is estimated through random and fixed effect regressions. Further, the Hausman test is applied to determine whether to select fixed effect or random effect estimates.

We then depart from the linear regression model by assuming that lagged dependent variable might have a statistically significant effect on the dependent variable. We thus model this hypothesis by augmenting Eq.(1) with a lagged profitability as an additional regressor, that is:

$$\pi_{i,t} = \alpha_0 + \alpha_1 \pi_{i,t-1} + \beta X'_{i,t} + \lambda Y'_t + \gamma Z'_t + \varepsilon_t \quad (2)$$

where $\boldsymbol{\pi_{i,t-1}}$ is the one-period lagged profitability. By construction, the unobserved bank-specific effect v_i is correlated with the lagged dependant variable $\pi_{i,t-1}$ making panel either fixed or random effects estimator inconsistent. To overcome this problem, Arellano and Bond (1991) proposed a consistent GMM dynamic panel estimator. This estimator is based on the following assumptions: a) datasets with many panels *N* and few periods *T*, (that is $N > T$), meaning many individuals and few time periods; b) a linear functional relationship between dependent and independent variables; c) independent variables that are not meant to be strictly exogenous; d) fixed individual effects and e) heteroskedasticity and autocorrelation within individual but not across them. The Arellano-Bond dynamic panel estimator technique is called *difference GMM* since it starts by transforming all regressors by differencing and then uses the *GMM* technique (Hansen, 1982). The distinctive aspect of the *difference GMM* is then to transform the data by removing the fixed effects. For consistent estimation, the Arellano-Bond estimator requires that the error ε_t be serially uncorrelated. This assumption is testable by using the Arellano-Bond test for serial correlation in the first-differenced errors at order m. If ε_t are serially uncorrelated, we expect to reject at order 1 but not at higher orders. The validity of additionally included instruments is tested by means of the Sargan-Hansen test for overidentifying restrictions. The null hypothesis is that the instruments are valid, that is they are uncorrelated with the error term and the excluded instruments are correctly excluded from the estimated equation. A rejection of the null hypothesis case doubt on the validity of the instruments.

4. Variable selections

Table 2 lists the variables used in our empirical study. Panel A) shows the three alternative profitability measures that we use in our empirical analysis as dependent variables, whereas Panel B) shows the independent variables grouped into three types that is Bank-specific variables, Industry-specific variables and macroeconomics variables. A thorough description of these independent variables is provided in the following sub-sections.

Table 2 – Definition of variables

	(1)	(2)	(3)	(4)
	Symbol	Unit of measurement	Measure	Expected sign
Panel A: Dependent Variables				
Return-on-Assets	ROA	Percent	Profitability	NA
Return-on-Equity	ROE	Percent	Profitability	NA
Net Interest Margin	NIM	Percent	Profitability	NA
Panel B: Independent variables				
Bank-specific variables				
Total assets	TA		Size	+/-
Equity-to-assets	EQTA	Percent	Capital strength	+/-
Loan Loss Provision-to-total gross loans	LLPTL	Ratio	Credit risk	
Cost-to-income ratio	CI	Ratio	Efficiency	-
Loans-to-assets ratio	LA	Ratio	Liquidity	+/-
Capital-to-asset ratio	CA	Ratio	Leverage	+/-
Tier 1 'core capital'	Tier 1	Percent	Solvency	+/-
Tier 2 'supplement capital'	Tier 2	Percent	Solvency	+/-
Industry-specific variables				
Herfindahl-Hirschman-Index	HHI	Score	Market share	-
Macroeconomics variables				
GDP growth rate	GDPGR	Percent	Economic growth	+
Inflation rate	INF	Percent	Changes in Consumer Prices Index	+/-

Notes. The data used to calculate bank-specific and industry-specific variables is from *Refinitiv DataStream*. The data for macroeconomic variables is from the World Bank – World Development Indicator database. The *Herfindahl-Hirschman Index* was calculated by using the deposits market.

4.1 Profitability measures

Three alternative measures of banks' profitability are used in this study. The first one, *ROA,* indicates, in terms of earnings, how effectively a bank is managing its bases of assets which are usually financed via both equity- as well as debt-financing. On the other hand, *ROE* indicates, in terms of earnings, how effectively a bank is using its shareholders' capital. NIM indicates how much net interest income a bank generates for each unit of assets invested in. Similar measures of profitability have been widely used in the empirical literature investigating the determinants of banks' profitability (see, for instance, Liu and Wilson, 2010; Dietrich and Wanzenried, 2011; Olson and Zoubi, 2011; Chronopoulos et al., 2015; Garcia and Guerreiro, 2016; Caporale et al., 2017; Almaqtari et al., 2018; Batten and Vo, 2019).

4.2 Bank-specific variables

Bank size is widely used as one of the determinants of banks' profitability. In our study, following the recent empirical literature (see, for instance, Bucevska and Misheva, 2017; Caporale et al., 2017; Kohlscheen et al., 2018), we proxy bank size by *Total Assets* (*TA*). The effect of *TA* on banks' profitability might be either negative or positive. It has been pointed out (see, for instance, Goddard et al., 2004) that largest banks by assets may benefit from economies of scale or scope that would result in lower costs and higher profits, while small banks may encounter diseconomies of scale that would lead to higher costs and lower profitability. On the other hand, it is also possible that large banks might encounter significant issues in organising their activities as they increase in size, leading to diseconomies of scale (Lee and Kim, 2013).

As a measure of capital adequacy, we use ratio of *Equity to Total Assets* (*EQTA*). The direction of the impact of this possible determinant of banks' profitability might be either positive or negative. Dietrich and Wanzenried (2011) point out that the higher EQTA ratio values imply a reduced need for external funding which means than lower costs and higher profitability. On the other hand, the effect of higher *EQTA* ratio values on profitability could be also negative as overcapitalised banks very often operate over-cautiously and might ignore profitable opportunities (Goddard et al,2010).

As a measure of solvency, we consider Basel Tier 1 as well as Base Tier 2 ratios. The 1998 Basel Capital Accord established a minimum amount of capital that banks were required to operate with. The definition of capital was made up of two elements that is core capital (defined as 'Tier 1') and supplement capital (Tier 2). The effect of these solvency ratios on bank profitability depends on whether banks either meets, exceed or fall below the minimum ratio calculated by regulatory authorities. In our study we aggregate the Basel Tier 1 as well as Base Tier 2 ratios by constructing a new variable named Total Capital Adequacy (TCA).

To capture the impact of credit risk on banks' profitability, the ratio of *Loan Loss Provisions to Total Loans* (*LLPTL*) was used. The *LLPTL* ratio is expected to be negatively related to banks' profitability since a deterioration of a bank's loans portfolio might result in a further increase of provisions held for loan losses, which then leads to lower profitability. According to similar studies (see, for instance, Liu and Wilson, 2010; Garcia and Guerreiro, 2016), the relation between banks' profitability and the *LLPTL* ratio is expected to be negative.

To measure the effect of operating efficiency on banks' profitability, we use in this study the CI ratio. The CI ratio measures a bank's efficiency in holding down its costs (i.e. administrative and fixed costs) relative to income. A decrease (increase) in the *CI* ratio is expected to increase (decrease) banks' profitability (Liu and Wilson, 2010; Dietrich and Wanzenried, 2011), so we expect to see a negative relationship between banks' profitability and the *CI* ratio.

As a measure of bank stability, we also include the *Z-score* which is calculated on a yearly basis at bank level by summing the current period values of ROA and EQTA ratios at bank level and then dividing that sum by the standard deviation of ROA a as a measure of banks' stability.

4.3 Industry-specific variables

Like other studies (see, for instance, Dietrich and Wanzenried, 2011), we also measure the effects of market structure on bank profitability. We use the *HHI* to test for the existence of the *structure-conduct-performance* (*SCP*) paradigm which asserts that the larger the market share of a bank is, the greater the market power that bank can exercise in pricing its product/services – therefore gaining larger profits. If a positive relationship between market concentration (measured by *HHI*) and banks' performance (measured by either *ROA*, *ROE or NIM*) is found, then this provides evidence for the existence of the *SCP* paradigm. Many studies have found a negative and statistically significant effect of *HHI* on banks' profitability (see, for instance, Liu and Wilson, 2010; Chronopoulos et al., 2015; Batten and Vo, 2019), therefore challenging the relevance of the *SCP* hypothesis

4.4 Macroeconomic variables

To control for the effect of macroeconomic environment on banks' profitability, this study uses two variables: *Real GDP growth* (*GDPGR*) and *rate of inflation* (*INF*). The findings of many empirical banking studies (see, for instance, Sufian, 2009; Liu and Wilson, 2010; Dietrich and Wanzenried, 2011; Lee and Kim, 2013; Chronopoulos et al., 2015; Garcia and Guerreiro, 2016) show that economic growth has a positive effect on banks' profitability as banks are likely to lend more when economies are going throughout an expansion and it therefore follows that they are likely to be able to generate larger profits. The additional macroeconomic variable included in our study is the inflation rate. It has been pointed out (see, for instance, Flamini et al., 2009; Bucevska and Misheva, 2017) that the effect of inflation rate on banks' profitability depends on whether banks are able to anticipate future movements in prices. If that is the case, an increase in the rate of inflation results in an increase of banks' profitability. Some other studies (see, for instance, Athanasoglou et al., 2008) point out that the relationship between banks' profitability and inflation is ambiguous and that it is quite difficult to establish an *a priori* effect.

5. Data and summary of statistics

Our sample consists of all banks that are constituents of the Euro STOXX Banks Index which is one of the STOXX Supersector indices that tracks supersectors of the relevant benchmark index (in this case, the Euro STOXX index). The number of European banks constituting the Euro STOXX bank index is 21 as of 31 December 2022. Four banks were from Italy, five from Spain, three banks from Spain, two from Germany, two from Austria, one from Belgium, one from The Netherlands and one from Ireland, respectively. Our sample is therefore based on these banks and the related bank-accounting data have been gathered from *Refinitiv DataStream*. The sample is an unbalanced time-series and cross-sectional dataset with bank-year observations, as well as bank-industry and macroeconomic data.

Table 3 reports descriptive statistics for accounts data at bank level. These are the original data gathered from *Refinitiv DataStream* which were then used to build bank-level and bank-industry variables for the econometrics analysis. In total we use 9 bank-level data variables. On average the size of European banks in terms of total assets was € 693,145mln over the period 2008-2022 with a median of €462,918 mln. Over the same period of time, the annual total gross loan per bank was on average €347,449 mln with a median of €342,691 mln. It is also worthwhile to note that non-interest income was on average much larger (€ 12,484 mln) relative to net interest income (€8,883 mln), therefore pointing out the importance of income generated by assets beyond the traditional loan ones. The profitability of European bank in terms of Net income was on average €1,736 mln. Total operating income was on average €21,105 mln.

Furthermore, Table 4 presents the descriptive statistics of the variables built by using the original data as per Table 2. Table 3 reports the mean, standard deviation (SD), minimum (Min), median and maximum (Max) of the measures of banks' profitability variables, as well as additional bank specific and bank-industry variables plus macroeconomic variables. *ROA* was calculated as net income divided by total assets with an average value of 0.346% over the period of analysis. *ROE* was calculated as net income divided by total equity. On average, European banks reported a ROE of 5.127% over the period 2012-2022. *NIM* was calculated as the difference between interest income and interest expenses which was then divided by total assets: on average its value was 0.379%. The LLPTL was calculated dividing loans Loss Provision by total loans: the LLPTL was on average 4.034%. The total capital adequacy, which was calculated by adding Tier 1 capital to Tier 2 capital, was 16.39%. The *CI* ratio was calculated as total operating expenses divided by total operating income ad its value was 73.45% on average during the period 2012-2022. The *HHI* was calculated by squaring the market share of each bank with respect to the loans' market and then summing the resulting numbers: its value was on average 1084.06 indicating therefore a competitive marketplace. The *GDPGR* and *INF* are the rate of growth of real *GDP* and the rate of growth of prices respectively. These macroeconomic data were gathered from World Bank – World Development Indicators database. On average the annual economic growth of the countries these European banks have their headquarter in, was 0.67%, whereas the average annual rate of inflation was 1.85%.

Table 5 presents pairwise correlation statistics among variables used in this study. Correlation values are found to be positive in a larger number of cases (31 out of 54 values) relative to negative values (23 out of 54). Further, there is no evidence of collinearity between the independent variables as their correlations are well below to the absolute value 0.8 which is the rule of thumb in spotting a strong correlation between independent variables.

Panel A of Figure 1 shows the trend overtime of the profitability indicators used in this study. Their growth was particularly robust since the beginning of the 2010s and up the second half of the decade. Panel B illustrate efforts made by banks in the 2010s to use equity financing to invest into assets: up to the end of 2019, European banks had been increasing the percentage of equity used to funds asset. That trend started to decline in the late 2010s although it reverted to an upward trend in the after math of the Covid-19 pandemic period in the late 2020s. Panel C of Figure 1 shows that cost to income ratio values tend to decline over period of economic growth: therefore banks, tend to be more efficient in terms of holding down costs in a context where economies tend to expand. Panel D of Figure 1 shows that European banks increased substantially loan loss provision with respect to total loan up to the end of the first half of the 2010s, whereas the following period saw a substantial reduction. Panel E clearly show that since 2008, European banks increased substantially their capital adequacy ratio from an average of 8% in 2008 to 18% in 2022. Panel F show that the HHI started to decline since 2010 to reach the lowest level in 2015 therefore showing a high level of market competitiveness: after that we observe an upward trend leading to a moderately concentrated market. Panel G shows a trend of economic growth in the aftermath of the 2008-09 GFC: despite a decline in the period following the European sovereign debt crisis, a positive trend continued with an additional interruption due to the Covid-19 events. Panel H shows a downward trend in the level of inflation up to the period leading to the Covid-19 pandemic: the following period saw an abrupt increase of prices.

Table 3 – Descriptive statistics: bank-level data before their transformation for regression analysis, values are in Euro million

	Mean	Std. dev.	Min	Max	25th	50th	75th	Obs
Total assets	693,154	634,215	43,501	2,663,748	152,303	462,918	1,130,003	290
Total equity	34,579	27,325	1,965	121,23	11,013	25,307	54,001	290
Total gross loans	347,449	243,165	40,715	1,019,188	131,928	342,691	466,168	205
Net loans	301,298	230,825	1,348	996,504	95,350	261,910	430,319	289
Total operating expenses	16,164	17,110	496	81,024	3,959	8,525	24,019	275
Net interest income	8,833	7,776	43	38,619	3,203	5,999	12,685	290
Non-interest income	12,584	15,132	461	77,968	2,503	5,601	17,108	290
Total operating income	21,105	20,667	1,172	87,996	5,821	10,649	30,384	290
Net income	1,736	3,126	-13,965	13,023	317	1,1157	3,248	290

Notes. Values are in Million Euro.

Table 4 – Descriptive statistics: variables used in the regression analysis

	Mean	Std. dev.	Min	Max	25th	50th	75th	Obs
ROA	0.346	0.574	-1.691	4.059	0.148	0.343	0.525	286
ROE	5.127	8.538	-29.973	71.764	2.725	6.022	8.798	286
NIM	0.379	1.182	-6.187	10.48	-0.101	0.357	0.9	274
EQTA	6.171	2.947	1.394	28.819	4.742	5.997	6.745	290
LLPTL	4.034	5.134	0.554	25.203	0.684	1.825	5.146	186
CI	73.45	25.056	7.101	206.84	62.912	70.866	81.627	275
TCA	0.169	0.026	0.11	0.26	0.15	0.17	0.19	165
GDP growth	0.67	3.449	-11.167	8.314	-0.005	1.293	2.284	300
Inflation	1.85	1.996	-0.5	10.001	0.581	1.519	2.486	300

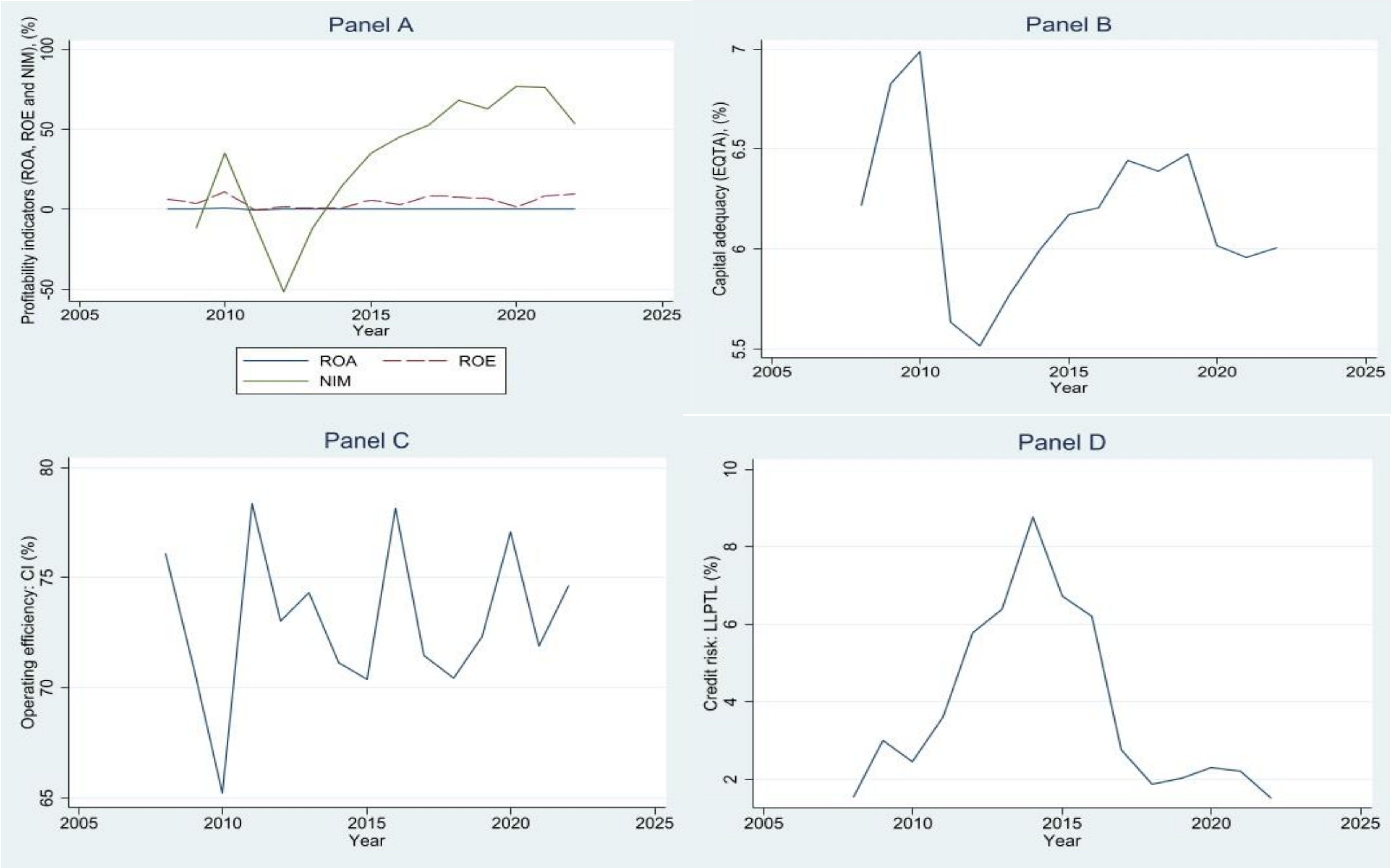
Notes. Values of figures presented in this tale are in percent. or the notion of the variables presented in this table see Table 1. All variables are in percentage value.

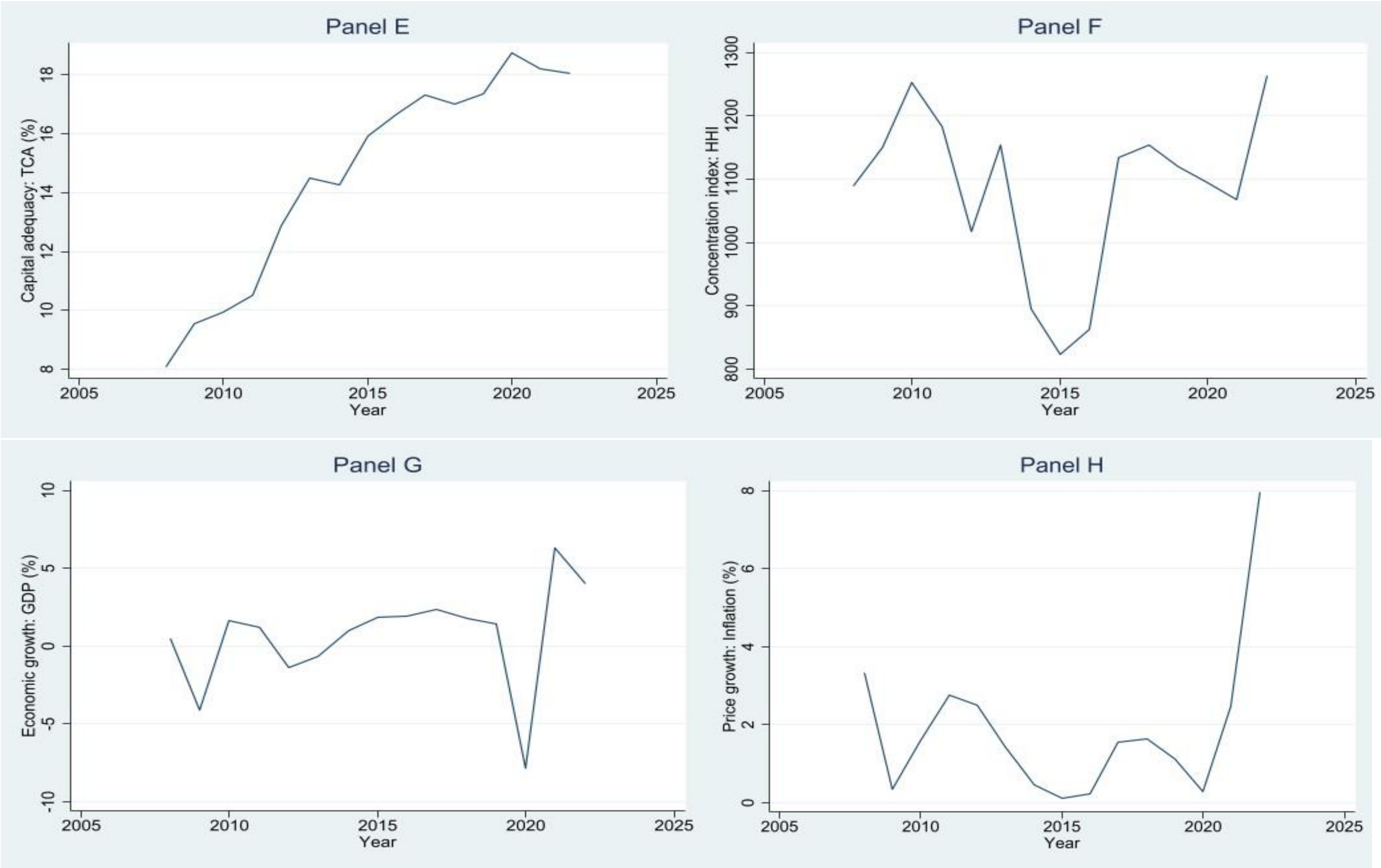
Table 5 - Pairwise correlations

	ROA	ROE	NIM	EQTA	LLPTL	CI	TCA	HHI	GDP	Inflation
ROA	1									
ROE	0.983	1								
NIM	0.544	0.599	1							
EQTA	0.735	0.613	0.347	1						
LLPTL	-0.610	-0.605	-0.518	-0.389	1					
CI	-0.670	-0.615	-0.054	-0.645	0.095	1				
TCA	0.147	0.269	0.741	-0.199	-0.194	0.276	1			
HHI	0.375	0.355	0.051	0.239	-0.757	-0.136	-0.202	1		
GDP	0.447	0.553	0.271	-0.012	-0.058	-0.218	0.216	-0.02	1	
Inflation	0.269	0.355	0.035	-0.273	-0.408	0.137	0.156	0.548	0.424	1

Notes. This Table shows pairwise correlation coefficients for the full sample of variables used in the profitability regression model, covering the period 2008-2009. Variable descriptions as in Table 1 he table presents pairwise correlations. GDP and inflation vary cross-sectionally by country, all other variables bu bank.

Figure 1 – Trend overtime of bank-ratio value





Panel E
Capital adequacy: TCA (%)
8
10
12
14
16
18
2005
2010
2015
2020
2025
Year
Panel F
Concentration index: HHI
800
900
1000
1100
1200
1300
2005
2010
2015
2020
2025
Year
Panel G
Economic growth: GDP (%)
-10
-5
0
5
10
2005
2010
2015
2020
2025
Year
Panel H
Price growth: Inflation (%)
0
2
4
6
8
2005
2010
2015
2020
2025
Year

6. Empirical findings

Table 6 reports the regression results by using ROA as a proxy of banks' profitability through three alternative panel econometric techniques, that is the FE, RE and GMM models. The Fixed Effects model (column 1) is preferred to the Random Effects model (column 2): in other words, the probability value of the Hausman test is very large therefore we fail to reject the null hypothesis that the coefficient estimates of the Random- and Fixed-Effect model are equal. Therefore, the difference in coefficients between Fixed-Effect and Random-Effect models is not systematic, providing evidence in favour of a Random-effect model. The coefficient on the *ROA(-1)* is found to be negative although it is not statistically significant, thereby indicating the absence of any degree of persistence on our profitability measure *ROA when using the GMM technique (column 3 of Table 3)*. The coefficient on *TA* is found to be positive and statistically significant in the GMM model only: this gives some indication that the larger banks are in terms of assets, the larger the positive effect is on their profitability. The coefficients on *LLPTL* are found to be negative and statistically significant across all the three alternative econometric models presented in Table 3 thus, as loan loss provisions increase relative to total assets, the profitability of banks tends to decline: this outcome is consistent with the view that banks with higher credit risks are less profitable (Athanasoglou et al., 2008). The coefficients of the *CI* ratio are negative and statistically significant implying that banks with more efficient management are more able to reduce costs, which drives increased profitability: this result is consistent with prior studies (see, for instance, Pasiouras and Kosmidou, 2007; Liu et al., 2010), suggesting efficiency is likely to be an important determinant of performance. The impact of the market structure, approximated by the *HHI*, does not show any significant effect to bank profitability irrespective to the econometrics techniques used. accordingly, we did not find any support for the SCP hypothesis although previous studies focusing on European banks are in agreement with the SCP hypothesis (see, for instance, Molyneux and Thornton, 1992). The effect of economic growth (*GDPGR*) to bank profitability is positive and statistically significant irrespective of the model used in the regression analysis. On the other hand, the coefficient on inflation is negative and statistically significant on banks' profitability in the case of GMM model only. By using the GMM estimator technique, we should find evidence for first – but not for second – order serial correlation. Testing the specification for the absence of serial correlation, the AR(1) and AR(2) statistics have P-values of 0.00 and 0.589 respectively. As a result, we cannot reject the null hypothesis of no second order serial correlation but do so for first order serial correlation as required by the specification and therefore the condition for the consistency of the GMM estimator is satisfied. The statistic of the Sargan test for overidentifying restriction has a *P-value* of 0.514, this means that we do not reject the null hypothesis that the overidentifying restrictions are valid.

Table 7 shows our results using ROE as a proxy for bank performance. In this case also, the Random Effects model (column 2) is preferred to the Fixed Effects model (column 2) as per the Hausman test results. The effect of the TA on banks' profitability is found to be positive and statistically significant in the case of the GMM models: this result is consistent with the findings of several previous studies (see, for instance, De Young et al., 2004; Tregenna, 2009: Chronopoulos et al., 2015) in which ROE is used as a measure of profitability. Our results also show that the coefficient of the capital variable (EQTA) is positive and statistically significant in both FE and GMM models, therefore that well capitalised bank tend to have a higher profitability. As expected, credit risk (proxied by LLPTL) has a negative and statistically significant effect to bank profitability: this is consistent with studies focusing on using ROE a measure of profitability as well as those focusing on European banks (see, for instance, Liu and Wilson, 2010; Garcia and Guerreiro, 2016). The coefficient on *CI* ratio is found to be negative and statistically significant to the ROE irrespective of the model used: similar results are found in several studies focusing on European banks (see, for instance, Dietrich and Wanzenried 2011; Garcia and Guerreiro, 2016). The effect of the market structure, proxied by *HHI*, to ROE is not statistically significant irrespective to the model used. Finally, GDP growth has a statistically significant effect on *ROE* irrespective to the model used.

Table 8 shows our results using *NIM* as a proxy for bank performance. The results of the Hausman test show that the null hypothesis that the difference in coefficients is not systematic is rejected providing evidence in favour of a Fixed Effects model. The coefficient on *ROA(-1)* of the GMM specification (column 3) is found to be positive and statistically significant at the 1% level. This means that, until 2021, banks' profits were not instantaneously eliminated by the competitive process: therefore, banks were able to retain a significant portion of their profit from year to year. The coefficient on *TA* is found to be negative and statistically significant in the case of the FE specification. The coefficient of the *CI* ratio is positive and highly significant in the case of both Fixed Effects and Random Effects models: these results are consistent with some studies (see, for instance, Batten and Vo, 2019) although opposite findings are found in other studies (see, for instance, Garcia and Guerreiro, 2016). The interpretation of the effect of *CI* on the *NIM* reveals that bank profits are achieved via higher operating costs. The coefficient estimates on GDP growth is positive and statistically significant, therefore suggesting that economic growth positively affects NIM of the largest European banks. The coefficient on Inflation is negative and statistically significant in both Fixed Effects and Random Effects models: this implies that the largest European banks were not able to pass the costs of inflation over the period of study onto their customers.

Table 6 - Determinants of returns on bank assets (ROA)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
ROA(-1)	-	-	-0.079
			(0.133)
TA	-0.00	0.00	0.00***
	(0.00)	(0.00)	(0.00)
EQTA	0.117**	0.098***	0.262***
	(0.052)	(0.033)	(0.059)
LLPTL	-0.045***	-0.039***	-0.074**
	(0.016)	(0.008)	(0.031)
CI	-0.009***	-0.009***	-0.011***
	(0.001)	(0.001)	(0.002)
TCA	5.724***	4.224***	0.043*
	(1.796)	(1.526)	(0.022)
HHI	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)
GDP growth	0.027***	0.027***	0.024***
	(0.007)	(0.007)	(0.00)
Inflation	0.001	-0.012	-0.00*
	(0.018)	(0.018)	(0.01)
_cons	-0.3	-0.214	-
	(0.670)	(0.464)	
Number of Obs	126	126	75
F-statistics	F(8,100)=12.36	-	-
Prob (F-statistic)	0.00	-	-
Wald chi2	-	127.20	228.67
Prob (Wald)	-	0.00	0.00
R-squared Whitin	0.497	0.489	-
Hausman Test	-	4.13	-
Prob (Hausman Test)	-	(0.765)	-
Sargan test	-	-	56.953
Prob (Sargan Test)	-	-	(0.514)
AR(1)	-	-	-3.286
Prob AR(1)	-	-	(0.00)
AR(2)	-	-	-0.539
Prob AR(2)	-	-	(0.589)

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2). The dependent variable is ROA for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

Table 7 - Determinants of returns on bank equity (ROE)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
ROE(-1)	-	-	-0.024
			(0.131)
TA	-0.00	0.00	0.00***
	(0.00)	(0.00)	(0.00)
EQTA	0.834**	0.274	3.093***
	(0.933)	(0.549)	(1.073)
LLPTL	-0.653**	-0.565***	-1.453**
	(0.301)	(0.136)	(0.570)
CI	-0.205***	-0.194***	-0.267***
	(0.035)	(0.029)	(0.044)
TCA	1.125***	0.732***	0.751*
	(0.321)	(0.261)	(0.411)
HHI	-0.00	0.001	0.007
	(0.004)	(0.004)	(0.005)
GDP growth	0.5***	0.509**	0.391**
	(0.134)	(0.135)	(0.156)
Inflation	-0.097	-0.170	-0.011**
	(0.330)	(0.327)	(0.343)
_cons	0.866	4.857**	-
	(12.001)	(7.932)	
Number of Obs	126	126	75
F-statistics	F(8,100)=11.9	-	-
Prob (F-statistic)	0.00	-	-
Wald chi2(8)	-	116.67	223.77
Prob (Wald)	-	0.001	0.00
R-squared Within	0.487	0.473	-
Hausman Test	-	8.22	-
Prob (Hausman Test)	-	0.314	-
Sargan test	-	-	54.035
Prob (Sargan Test)	-	-	(0.623)
AR(1)	-	-	-3.998
Prob AR(1)	-	-	0.00
AR(2)	-	-	-0.687
Prob AR(2)	-	-	0.491

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2). The dependent variable is ROE for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

Table 8 - Determinants of Net Interest Margins (NIM)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
NIM(-1)	-	-	0.656***
			(0.093)
TA	-0.005**	-0.002**	0.00
	(0.002)	(0.001)	(0.00)
EQTA	-0.002	-0.001	-3.179
	(0.001)	(0.001)	(10.133)
LLPTL	-0.00	0.00	0.810
	(0.00)	(0.00)	(5.409)
CI	0.003***	0.003***	0.224
	(0.001)	(0.001)	(0.36)
TCA	0.001	0.003	1.328
	(0.002)	(0.002)	(4.053)
HHI	0.00	0.00	0.012
	(0.00)	(0.00)	(0.047)
GDP growth	0.00**	0.00***	0.401
	(0.00)	(0.00)	(1.396)
Inflation	-0.00**	-0.00**	-0.986
	(0.00)	(0.00)	(3.159)
_cons	0.081***	0.049***	-
	(0.027)	(0.016)	
Number of Obs	110	110	75
F-statistics	F(8,87)=5.52	-	-
Prob (F-statistic)	0.00	-	-
Wald statistic	-	45.9	99.91
Prob (wald)	-	0.00	0.00
R-squared Within	0.336	0.322	-
Hausman Test	-	29.96	-
Prob (Hausman Test)	-	0.00	-
Sargan test	-	-	50.761
Prob (Sargan Test)	-	-	(0.738)
AR(1)	-	-	-3.736
Prob AR(1)	-	-	0.00
AR(2)	-	-	1.539
Prob AR(2)	-	-	0.123

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2).The dependent variable is NIM for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

7. Sensitivity analysis

7.1 Market competition and credit risk

To check the robustness of our empirical results, we estimate again Eqs.(1) and (2) by replacing credit risk and market power variables with alternative indicators. Firstly, in relation to credit risk, we replaced *LLPTL* ratio by using a *Z-score* which is a broad measure of bank risk whereas *LLPTL* ratio focus on credit-risk only (Kick and Prieto, 2015). The *Z-score* has been widely used in the empirical banking literature (see, for instance, Boyd et al., 2006; Uhde and Heimeshoff, 2009; Houston et al., 2010; Beck et al., 2012; Liu et al., 2012; Schaeck and Cihák, 2014; Fu et al., 2014; Fernández et al., 2016. Guidi, 2021). A variety of options to calculate a *Z-score* have been recently surveyed by Lapetit and Stobel (2013). In our study we calculated *Z-score* for bank *i* in year *t* as follows:

$$Z_{it} = \frac{Profitability_{it} + EQTA_{it}}{StDevProfitability_{it}} \quad (3)$$

where $Profitability_{it}$ stands for a measure of profitability (either ROA, ROE, or NIM) at bank level. $EQTA_{it}$ is the ratio of equity over total assets, and $SdDevProfitability_{it}$ is the standard deviation of profitability measure. By following similar studies, we use a three consecutive-year to calculate the $StDevProfitability_{it}$, rather than the full sample period. The *Z-score* can be viewed as the inverse of the probability of bank failure. The higher the value of the *Z-score* is, the higher the financial stability of a bank is or put differently, the lower is the exposure of a bank to insolvency risk. The evolution of the *Z-score*, as calculated in Eq.(3) for our sample of banks, is shown in Figure A1 – Appendix A via the aggregation at year level of *Z-score* values calculated at bank level. The plot shows an upward trend of the *Z-score* values since the first half of the 2010, therefore indicating an increase of the financial stability of the European banks. A reverting trend is observed by the end of the 2010s when a declining *Z-score* is observed, suggesting a decline in the financial stability of European banks.

To make our sensitivity analysis even more robust, we replaced the variable *HHI* by the *Lerner Index* as the former is used as a measure of market concentration and the latter as a measure of competition. The *Lerner index* represents the mark-up over marginal costs and, as a measure of competition, that index has been widely used in recent empirical literature (see, for instance, Berger et al., 2009). We calculated the *Lerner index* at bank level as follows:

$$Lerner_{it} = \frac{P_{i,t} - mc_{i,t}}{P_{i,t}} \quad (4)$$

where P_{it} is the price of total assets proxied by the ratio of total revenue (interest and non-interest income) to total assets of a bank *i* at a specific time *t*, while $mc_{i,t}$ is the marginal cost of total assets of bank *i* at a specified time *t*. Lerner index values ranges from 0 to 1, the closer the value of the index to 1, the more a bank's market power is. In contrast, the close the value is to 0, the lower a bank's market power is. *Lerner index* can also take negative value if $P_{i,t} < mc_{i,t}$, which is not sustainable in the longrun (Delis et al. 2017). To calculate the *Lerner index*, the first step is to estimate a translog cost function modelled as follows:

$$lnTC_{it} = \alpha_0 + \alpha_1 lnQ_{it} + \frac{1}{2}\alpha_2 (lnQ_{it})^2 + \sum_{k=1}^{3} \gamma_{kt} lnW_{k,it} + \frac{1}{2}\sum_{k=1}^{3} \phi_k \left(lnW_{k,it}\right)^2 + \beta_1 ln\omega_{1,it} ln\omega_{2it} + \beta_2 ln\omega_{1,it} ln\omega_{3,it} + ln\omega_{2,it} ln\omega_{3,it} + \varepsilon_t \quad (5)$$

where TC_{it} represents total costs of bank *i* at a specified time *t*; Q_{it} represents bank output which is proxied by total assets for bank *i* at a specified time *t*; $W_{k,it}$ are the three input prices, that is $W_{1,it}$, $W_{2,it}$, $W_{3,it}$ which indicate the prices of labour, funds, and fixed capital and are calculated as the ratios of personnel expenses to total assets, interest expenses to total deposits, and other operating and administrative expenses to total assets, respectively. In this study, we rearrange the translog cost function as defined in Eq.(5) as follows:

$$\begin{aligned} lnTC_{it} = {} & constant + \alpha_1 (lnTA_{it}) + \alpha_2 \frac{1}{2} (lnTA_{it})^2 + \beta_1 (lnACL_{it}) + \beta_2 (lnACC_{it}) + \beta_3 (lnACD_{it}) \\ & + \gamma_1 (lnTA_{it} \times LnACL_{it}) + \gamma_2 (lnTA_{it} \times LnACC_{it}) + \gamma_3 (lnTA_{it} \times LnACD_{it}) \\ & + \phi_1 \frac{1}{2} (lnACL_{it})^2 + \phi_2 \frac{1}{2} (lnACC_{it})^2 + \phi_3 \frac{1}{2} (lnACD_{it})^2 \\ & + \omega_1 (lnACL_{it} \times LnACC_{it}) + \omega_2 (lnACL_{it} \times LnACD_{it}) \\ & + \omega_3 (lnACC_{it} \times LnACD_{it}) \\ & + \varepsilon_t \end{aligned} \quad (6)$$

The estimated coefficients calculated thorough Eq.(6) are then used to calculate the marginal costs, as defined in Eq.(7), with respect to the three input prices which are labour, funds, and fixed capital, that is:

$$mc_{it} = \frac{\partial lnTC_{it}}{\partial lnQ_{it}} = \frac{TC_{it}}{Q_{it}} \left[\alpha_1 + 0.5\alpha_2 lnQ_{it} + \sum_{k=1}^{3} \theta_k lnW_{k,it}\right] \quad (7)$$

The Lerner index is then calculated at bank level in accordance with Eq.(4) by using the marginal costs of bank *i* calculated in year *t* as in Eq.(6) and the price of total assets for bank *i* in year *t* as indicated previously.

Following the procedure outlined above in order to calculate the *Lerner index*, after estimating the translog function as defined in Eq.(6), we used Eq.(7) in order to estimate marginal costs at bank level. We then entered these results in Eq.(4) in order to calculate the *Lerner Index* for Bank *i* in year *t*. Figure 2 shows the evolution over time of the *Lerner Index* for our sample of banks. The evolution of the *Lerner index* shows that up to 2017, on average banks managed to increase their market power: in the late part of the 2010s, however, we observe a decrease of the *Lerner index* and therefore an indication that banks were losing their market power. The period following the events associated with the Covid-

19 pandemic shows an upward trend of the *Lerner index* therefore highlighting that European banks were able to restore their market power.

Figure 2 –Lerner index values during the period 2008-2022

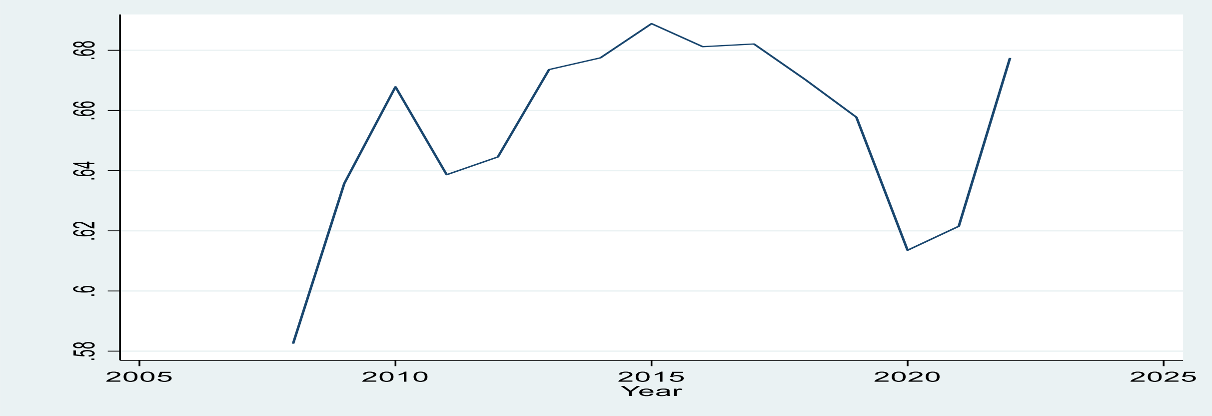
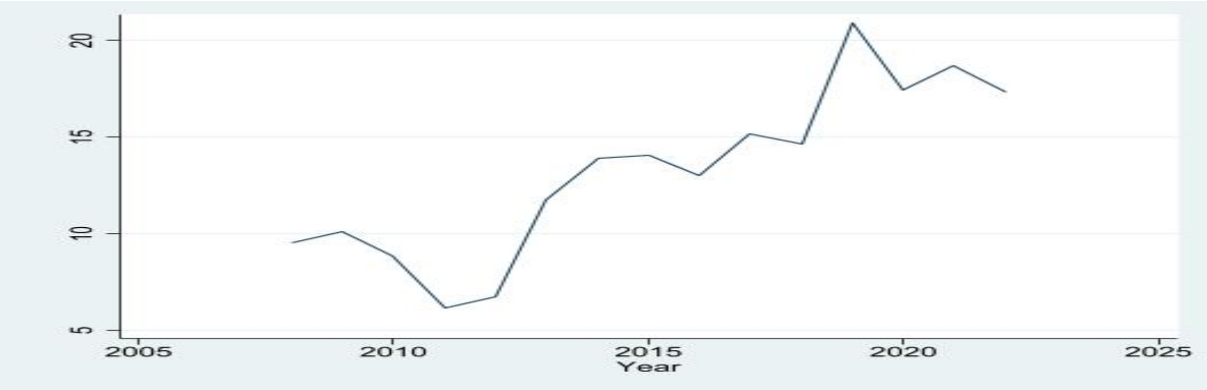


Figure 3 – Z-score values during the period 2008-2022



After replacing *LLPTL* by *Z-score* as well as *HHI* by *Lerner index*, we ran Eqs.(1) and (2) and reported the findings in Tables 9, 10 and 11. Table 9 reports the results of the Eq. (1) when the dependent variables is *ROA*, Table 10 when the dependent variables is *ROE*, while Table 11 shows the results of the regression analysis when *NIM* is used as dependent variable.

The results presented in Table 9, show that the effect of *Z-score* on *ROA*, irrespective to the model used, is positive and statistically significant. In other words, an increase in the *Z-score* results in rise of *ROA*: this result is robust with the findings of Table 3, where the effect of *LLPTL* on *ROA* was negative and statistically significant for all models used. In relation to the market power measure, column 2 of Table 9 shows that the effect of *Lerner Index* on *ROA* is positive and statistically significant just only in the case of the Random Effect model: conversely, when the *HHI* was used as a measure of market power (Table 3), the effect of *HHI* on *ROA* was not statistically significant in any of the models used in Table 3.

If we move to Table 10, the variable *Z-score* is found to have a positive and statistically significant effect on ROE irrespective to the model used: this result is consistent with the findings of Table 4 when *LLPTL* is used as a proxy of the credit risks. Therefore, either *LLPTL* or *Z-score* show that lower credit risk (measured by the former) or higher financial soundness (measured by the latter) contribute to lower ROE at bank level showing consistency in terms of results irrespective to the measure of risk used. By looking at the effect of *Lerner Index* on *ROE*, Table 10 does show a negative effect on bank profitability when the GMM model is used (column 3 of Table 10): if we compare that result with the findings of Table 7, we observe that when using *HHI* as a measure of market power, there is no evidence of any statistically significant effect of the *HHI* on the *ROE* irrespective to the model used.

Columns (1) and (2) of Table 11 show that the effect of *Lerner Index* to *NIM* is positive and statistically significant in the case of the FE and RE models. As the *Lerner index* measures the ability of banks to price their products above marginal costs, our findings show that an increase of the *Lerner index* has the effect of increasing the NIM. In relation to the effect of *Z-score* on *NIM*, column (1) and (2) of Table 11 show a positive and statistically significant effect in the case of the FE and RE models.

Table 9 - Determinants of returns on bank assets (ROA)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
ROA(-1)	-	-	-0.041
			(0.122)
TA	0.00	0.00	0.00***
	(0.00)	(0.00)	(0.00)
EQTA	0.111*	0.010	0.263***
	(0.057)	(0.038)	(0.067)
Z-score	0.028**	0.033***	0.026***
	(0.009)	(0.008)	(0.01)
CI	-0.006***	-0.005***	-0.009***
	(0.001)	(0.001)	(0.002)
TCA	0.053***	0.050***	0.010
	(0.018)	(0.014)	(0.024)
Lerner Index	0.594	0.929**	-1.198
	(0.681)	(0.457)	(0.817)
GDP growth	0.021***	0.022***	0.021***
	(0.007)	(0.007)	(0.008)
Inflation	0.017	0.017	0.021
	(0.014)	(0.014)	(0.021)
_cons	-1.724***	-1.426***	-
	(0.643)	(0.445)	
Number of Obs	154	154	91
F-statistics	F(8,126)=15.81	-	-
Prob (F-statistic)	0.00		-
Wald chi2	-	134.75	242.72
Prob (Wald)	-	0.00	0.00
R-squared Whitin	0.501	0.485	-
Hausman Test	-	8.67	-
Prob (Hausman Test)	-	0.277	-
Sargan test	-	-	73.346
Prob (Sargan Test)	-	-	(0.496)

AR(1)	-	-	-4.263
Prob AR(1)	-	-	(0.00)
AR(2)	-	-	-0.741
Prob AR(2)	-		(0.458)

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2). The dependent variable is ROA for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

Table 10 - Determinants of returns on bank equity (ROE)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
ROE(-1)	-	-	-0.077
			(0.125)
TA	0.00	0.00	0.00***
	(0.00)	(0.00)	(0.00)
EQTA	0.784	-0.996	3.410***
	(1.003)	(0.664)	(1.227)
Z-score	0.415**	0.521***	0.408**
	(0.161)	(0.152)	(0.194)
CI	-0.133***	-0.117***	-0.215***
	(0.029)	(0.024)	(0.041)
TCA	1.02***	0.905***	0.265
	(0.33)	(0.254)	(0.45)
Lerner Index	1.49	11.637	-27.986*
	(11.892)	(7.866)	(14.734)
GDP growth	0.376***	0.391***	0.383**
	(0.123)	(0.122)	(0.156)
Inflation	0.262	0.260	0.329
	(0.26)	(0.248)	(0.380)
_cons	-15.092	-12.738*	-
	(11.233)	(7.683)	
Number of Obs	154	154	91
F-statistics	F(8,126)=12.71	-	-
Prob (F-statistic)	0.00	-	-
Wald chi2(8)	-	104.44	226.26
Prob (Wald)	-	0.00	0.00
R-squared Within	0.446	0.427	-
Hausman Test	-	9.79	-
Prob (Hausman Test)	-	0.201	-
Sargan test	-	-	69.504
Prob (Sargan Test)	-	-	0.626
AR(1)	-	-	-4.782
Prob AR(1)	-	-	0.00
AR(2)	-	-	-0.787
Prob AR(2)	-	-	0.431

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2). The dependent variable is ROE for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

Table 11 - Determinants of Net Interest Margins (NIM)

	(1)	(2)	(3)
	Fixed effects	Random effects	GMM
NIM(-1)	-	-	0.619***
			XXX
TA	0.00	-0.00**	-0.00
	(0.00)	(0.00)	(0.00)
EQTA	-19.64**	-15.766***	-6.557
	(8.806)	(5.871)	(9.788)
Z-score	5.911***	8.011***	-1.648
	(1.418)	(1.433)	(1.521)
CI	0.029	0.135	0.026
	(0.260)	(0.218)	(0.265)
TCA	9.521***	0.951	1.184
	(2.899)	(2.264)	(3.640)
Lerner Index	187.78*	176.23**	72.727
	(104.38)	(69.413)	(112.91)
GDP growth	1.257	0.310	0.63
	(1.086)	(1.169)	(1.213)
Inflation	-5.072**	-1.491	-3.106
	(2.283)	(2.353)	(3.001)
_cons	-232.29	-98.592	-
	(98.609)	(68.85)	
Number of Obs	154	154	91
F-statistics	F(8,126)=7.95	-	-
Prob (F-statistic)	0.00	-	-
Wald statistic	-	61.65	122.13
Prob (wald)	-	0.00	0.00
R-squared Within	0.335	0.256	-
Hausman Test	-	19.59	-
Prob (Hausman Test)	-	0.006	-
Sargan test	-	-	69.076
Prob (Sargan Test)	-	-	0.407
AR(1)	-	-	-3.460
Prob AR(1)	-	-	0.00
AR(2)	-	-	0.937
Prob AR(2)	-		0.348

Notes. This Table shows regression results in column (1) and (2) on the basis of the econometric mode as specified in equation (1), whereas column (3) show results based on the econometric model as specified in equation (2). The dependent variable is NIM for each of the models estimated in column(1) to (3). In particular Fixed-Effects and Random-Effects estimators are applied to Eq.(1). The Hausmann Test statistic was used to test for the presence of random effects: if the null hypothesis $H_0: \sigma_u^2 = 0$, then there are no random effects. Standard errors are between brackets. ***, ** and * indicate statistical significance at 1%, 5% and 10 % level, respectively.

8. Conclusions

In this study we investigated the determinants of profitability for the largest European banks during the period 2012-2022. An unbalanced panel dataset of 21 banks provided the basis for the empirical analysis. We used three alternative measures of bank profitability: ROE, ROA and NIM. The results of the econometric analysis highlight interesting aspects in relation to banks profitability and its determinants, as well as demonstrating that our findings are quite robust across alternative measures of profitability and model specifications.

We found that total assets were positively related to banks' profitability irrespective of the metrics used to measure it. Furthermore, the relationship between capital adequacy was found to be positive when using either *ROA* or *ROE* as a measure of profitability: therefore, higher levels of capital adequacy tend to increase banks' profitability. The impact of credit risk (proxied by loan loss provisions on total loans) on both *ROA* and *ROE* (but not on *NIM*) is statistically significant: the relationship is found to be negative and therefore European banks should carefully monitor the quality of their loans portfolio to minimise the negative impact of loan delinquency on their profitability. A negative and statistically significant relationship is found between the *CI* ratio in two out of the three measures of profitability investigated. In fact, this relationship turns out to be positive when NIM is used as an indicator of banks' profitability. The coefficient on the concentration measure *HHI* is not statistically significant: this shows that the *SCP* hypothesis does not hold irrespective to the measures of profitability and therefore demonstrates that market concentration does not have any significant effect to banks' profitability. The positive and statistically significant effect of economic growth (GDP growth) on our profitability measures show that large European banks are able to seize the opportunity to increase their profitability during periods of economic expansion. Finally, we found that the coefficient on inflation is negative and, in most cases, statistically significant irrespective of the measure of profitability used. This result could be interpreted as the banks' inability to pass higher costs associated with banks' management onto their customers.

Finally, our findings have impactful implications for bankers and policymakers. The former would need to pay considerable attention to the costs associated with the management of banks as well as making sure that economies of scale are maintained as the size of their banks continues to expand. On the other hand, policymakers would need to make sure that economic growth continues to be achieved in tandem with low levels of inflation as both these economic indicators play a very important role in determining banks' profitability.

Bibliography

Almaqtari, F.A., Al-Homaidi, E.A., Tabash, M.I., Farhan, N.H. (2018). The determinants of profitability of Indian commercial banks: a panel data approach. *International Journal of Finance and Economics* 24(1), 168-185.

Athanasoglou, P.P., Brissimis, S.M., Delis, M.D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of International Financial Markets, Institutions and Money* 18(2), 121-136.

Arellano, M., Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies* 58, 277-297.

Batten, J., Vo, X.V. (2019). Determinants of Bank Profitability - Evidence from Vietnam. *Emerging Markets Finance and Trade* 55(6), 1417-1428.

Beck, T., Demirgüç-Kunt, A., & Merrouche, O. (2012). Islamic vs. conventional banking: business model, efficiency and stability. *Journal of Banking & Finance*, 37, 433–447.

Ben Naceur, S., Omran, M. (2011). The effects of bank regulations, competition, and financial reforms on banks' performance. *Emerging Markets Review* 12(1), 1-20.

Boyd, J.H., De Nicoló, G., & Jalal, A.M. (2006). Bank risk-taking and competition revisited: new theory and new evidence, Working Paper No. WP/06/297, IMF.

Bucevska, V., Misheva, H. (2017). The determinants of profitability in the banking industry: empirical research on selected Balkan countries. *Eastern European Economics* 2(4). 146-167.

Caporale, G.M., Lodh, S., Nandy, M. (2017). The performance of banks in the MENA region during the global financial crisis. *Research in International Business and Finance*, 42, 583-590.

Chronopoulos, D.K., Liu, H., McMillan, F.J., Wilson, J.O.S. (2015). The dynamics of US bank profitability. *The European Journal of Finance* 21(5), 426-443.

Dietrich, A., Wanzenried, G., (2011). Determinants of bank profitability before and during the crisis: Evidence from Switzerland. *Journal of International Financial Markets, Institutions & Money* 21, 307-327.

Delis, D.M., Kokas, S., Ongena, S. (2017). Bank market power and firm performance. *Review of Finance*, 21(1), 299-326.

Djalilov, K., Piesse, J. (2016). Determinants of bank profitability on transition countries: What matters most? *Research in International Business and Finance* 38, 69-82.

Flamini, V., Mc Donald, C., Schumacher, L. (2009). The determinants of commercial bank profitability in Sub-Saharan Africa, Working Paper No 09/15, 1-29, International Monetary Fund, Washington, DC.

EU Commission, (2012). Communication from the Commission to the European Parliament and the Council: A Roadmap towards a Banking Union. Available at EUR-Lex - 52012DC0510 - EN - EUR-Lex (europa.eu)

EU Commission, (2022). A rulebook for the EU financial sector. Available at What is the banking union (europa.eu)

Fernández, A.I., González, F., & Suárez, N. (2016). Banking stability, competition, and economic volatility. *Journal of Financial Stability*, 22, 101-120.

Fu, X., Lin, Y., & Molyneux, P. (2014). Bank competition and financial stability in Asia Pacific. *Journal of Banking and Finance*. 38, 64–77.

Garcia, M.T.M., Guerreiro, J.P.S.M. (2016). Internal and external determinants of banks' profitability: the Portuguese case. *Journal of Economic Studies*, 43(1), 90-107.

García-Herrero, A., Gavilá, S., Santabárbara, D. (2009). What explains the low profitability of Chinese banks? *Journal of Banking and Finance*, 33, 2080-2092.

Goddard, J., Molyneux, P., Wilson, J.O.S (2004). The profitability of European Banks: a cross-sectional and dynamic panel analysis. *The Manchester School*, 72(3), 363-381.

Goddard, J., Liu, H, Molyneux, P., Wilson, J.O.S. (2011). The persistence of bank profit. *Journal of Banking and Finance,* 35, 2881-2890.

Guidi, F. (2021). Concentration, competition, and financial stability in the South-East Europe banking context. *International Review of Economics and Finance*, 76, 639-670.

Hannan, T.H., Prager, R.A. (2009). The profitability of small single-market banks in an era of multi-market banking. *Journal of Banking and Finance,* 33(2), 263-271.

Houston, J.F., Lin, C., & Ma, Y. (2010). Creditor rights, information sharing, and bank risk taking. *Journal of Financial Economics*, 96, 485–-512.

Jeon, Y., Miller S.M. (2005). Performance of domestic and foreign banks: the case of Korea and the Asian Financial Crisis. *Global Economic Review*, 34(2), 145-165.

Kick, T., Prieto, E. (2015). Bank risk and competition: evidence from regional banking markets. Review

of Finance, 10, 1185-1222.

Knezevic, A., Dobromirov, D. (2016). The determinants of Serbian banking industry profitability. *Economic Research,* 29(1), 459-474.

Kohlscheen, E., Murcia, A., Contreras, j. (2018). Determinants of bank profitability in emerging markets. BIS - Working Paper 686, 1-36.

Lamers, M., Present, T., Vennet, R.V. (2022). European bank profitability: The great convergence. *Finance Research Letters*, 49, 1-8.

Lee, J.Y., Kim, D. (2013). Bank performance and its determinants in Korea. *Japan and the World Economy*, 27, 83-94.

Liu, H., Wilson, J.O.S. (2010). The profitability of banks in Japan. *Applied Financial Economics*, 20, 1851-1866.

Menicucci, E., Paolucci, G. (2016). The determinants of bank profitability: empirical evidence from European banking sector. *Journal of Financial Reporting and Accounting*, 14(1), 86-115.

Molyneux, P., Thornton, J. (1992). Determinants of European bank profitability: A note. *Journal of Banking and Finance*, 16, 1173-1178.

Olson, D., Zoubi, T.A. (2011). Efficiency and bank profitability in MENA countries. *Emerging Markets Review,* 12, 94-110.

Pasiouras, F., Kosmidou, K. (2007). Factors influencing the profitability of domestic and foreign commercial banks in European Union. *Research in International Business and Finance*, 21, 222-237.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86-136.

Saleh. I., Afifa, M.A., (2020). The effect of credit risk, liquidity risk and bank capital on bank profitability: Evidence from an emerging market. *Cogent Economics & Finance*, 8, 1-13.

Schaeck, K., & Cihák, M. (2014). Competition, efficiency, and stability in banking. *Financial Management*, 43(1), 215–241.

Sufian, F. (2009). Determinants of bank profitability in a developing economy: empirical evidence from the China banking sector. *Journal of Asia-Pacific Business*, 10, 281-307.

Sufian, F., Habibullah, M.S. (2012). Globalizations and Bank performance in China. *Research in International Business and Finance*, 26, 221-239.

Tregenna, F. (2009). The fat years: the structure and profitability of the US banking sector in the pre-crisis period. *Cambridge Journal of Economics*, 33, 609-632.

Uhde, A., & Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: empirical evidence*. Journal of Banking & Finance*, 33, 1299–1311.

Yuanita, N. (2019). Competition and bank profitability. *Journal of Economic Structures*, 8(31), 1-15.

Appendix A

Table A – Constituents of the Euro STOXX banks index

Company	Country
ABN Amro	The Netherlands
Banco BPM	Italy
Banco de Sabadell	Spain
Bank Ireland	Ireland
Bankinter	Spain
Banco Bilbao Vizcaya Argentari	Spain
BNP Paribas	France
Bper Banca	Italy
Caixabank	Spain
Commerzbank	Germany
Credit Agricole	France
Deutsche Bank AG	Germany
Erste Group Bank AG	Austria
ING Groep	The Netherlands
Intesa Sanpaolo	Italy
KBC Grep	Belgium
Mediobanca	Italy
Raiffeisen bank	Austria
Santander	Spain
Société General	France
Unicredit	Italy