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THE IMPACT OF FINTECH IN THE PERFORMANCE OF EUROPEAN COMMERCIAL AND COOPERATIVE BANKS

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The Impact of FinTech in the Performance of European Commercial and Cooperative Banks

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Biographic note

Catarina dos Santos Rua was born on August 6, 1996, in Coimbra, Portugal. In 2014, she enrolled in Economics in the Faculty of Economics, University of Coimbra.
In 2017, she moved to Switzerland, where she worked in a restaurant and studied in a French Language School, having sat the DELF Exam in Besançon, France, and received the B2 level in French.

She returned to Portugal two years later to begin her Master's degree in Finance in the Faculty of Economics, University of Porto. In 2020, she returned to Switzerland under the ERASMUS+ program at the University of Lausanne.

She has signed up for a short-term internship with Natixis in 2021, and in October of last year, she has began the Trainee Program in the same company.

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Abstract

In recent years technology has expanded immensely, and its application to the financial industry has been exponential. Therefore, the word FinTech (Financial Technology) was coined to broadly identify the application of new technology in the financial industry. Accordingly, the implications of FinTech in the financial industry are motivating a considerable amount of research.

In recent years we have witnessed immense technological development, and its application to the financial industry has been exponential. Therefore, the expression Financial Technology, more commonly referred to as FinTech was coined to broadly identify the application of new technologies in the financial industry. Accordingly, the implications of FinTech in the financial industry are motivating a considerable amount of research.

This dissertation aims to contribute to such a stream of literature. Specifically, its primary goal is to understand the impact of the emergence of new FinTech companies in the traditional banking industry. Analogous studies have focused on a single country analysis, such as Indonesia, China and the United States. Instead, the present study aims to quantify the impact of FinTech firms on the performance of European banks, assessing performance with several measures.

The sample consists of 342 Financial Technology companies and 3215 European Banks, including 1362 commercial banks and 1853 cooperative banks. The study period runs from 2011 to 2020 and for 25 European countries. Methodologically, the study relies on two-step GMM (Generalized Method of Moments) estimations.

The analysis shows that FinTech firms have a negative sign on the performance of European banks for ROA and ROE. The opposite occurs for NIM, where a positive relationship was found. However, it is not statistically significant on neither performance measure.

Key-words: Financial Technology, Bank Performance, Panel Data, Generalized Method of Moments (GMM)

Resumo

Na era de desenvolvimento tecnológico, o uso de tecnologia financeira (*Financial Technology)* encontra-se em expansão, ao ponto em que influencia o sistema bancário tradicional. De uma forma geral, *Financial Technology* é definida como o uso de novas tecnologias na indústria financeira, de forma a impulsionar o seu desenvolvimento e a facilitar o fornecimento de serviços financeiros.

Com esta investigação, pretende-se compreender a relação entre estas novas empresas e a indústria bancária tradicional. Visto que este é um tema relativamente recente, a literatura existente é escassa. A maioria dos estudos passados analisaram um país isoladamente, tais como Indonésia, China ou os Estado Unidos da América. A presente presquisa irá debruçar-se sobre o impacto do surgimento de empresas consideradas *FinTech,* no desempenho de bancos Europeus, e ainda analisar se os resultados obtidos diferem quando utilizada uma medida de profitabilidade alternativa, incluindo ROA (*Return on Assets*), ROE (*Return on Equity*), and NIM (*Net Interest Margin*).

A amostra consiste em 342 empresas do ramo de tecnologia financeira, e um total de 3215 bancos europeus, dos quais, 1362 bancos comerciais e 1853 bancos cooperativos. O período de estudo vai de 2011 a 2020, para um total de 25 países europeus, nos quais foram fundadas empresas *FinTech*, na última década.

O modelo foi estimado por GMM (*Generalized Method of Moments*). A análise mostra que empresas *FinTech* impactam negativamente o desempenho de bancos europeus para o ROA e ROE, como esperado. O oposto ocorre para o NIM, onde uma relação positiva foi encontrada. Embora a variável FinTech não seja estatisticamente significativa para nenhuma das medidas de desempenho.

Palavras-chave: Tecnologia Financeira, Desempenho Bancário, Dados em painel, Generalized Method of Moments (GMM)

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Acronyms

BE: Belgium

CAMEL: C - Capital Adequacy; A - Asset Quality; M - Management quality; E – Earnings ability; L – Liquidity.

CAP: Capital Ratio

CTI: Cost to Income

DE: Germany

DEA: Data Envelopment Analysis

DG: Deposits Growth

DK: Denmark

EACB: European Association of Cooperative Banks

ES: Spain

FC: Funding Cost

FE: Fixed Effects

FI: Finland

FR: France

GDP: Gross Domestic Product

GMM: Generalized Method of Moments

GR: Greece

IE: Ireland

IIS: Interest Income Share

IMF: International Monetary Fund

IT: Italy

LLP: Loan Loss Provision

MDA: Multiple Discriminant Analysis

NIM: Net Interest Margin

NL: Netherlands

OLS: Ordinary Least Squares

PHP Programming:

PT: Portugal

ROA: Return on Assets

ROAA: Return on Average Assets

ROAE: Return on Average Equity

ROE: Return on Equity

SE: Sweden

UK: United Kingdom

1. Introduction

The main role of a bank is to oversee financial intermediation. This process consists of the transfer of funds between those who have a surplus to those who have a deficit. Banks also provide a huge array of services to both individual customers and corporations. Therefore, the role of banks is vital in the overall growth of the economy. Throughout the years, this development has been materialized in a growing number of financial organisations, and it is responsible for an increase in the quantity of money circulating in these organizations and for a significant increase in the range of activities (Adam, 2014).

Two types of banks become relevant in this discussion, commercial and cooperative banks. On the one hand, commercial banks are focused on maximizing profits and are shareholder-oriented (Salas & Saurina, 2002; Alves, 2020). On the other hand, cooperative banks enable financing at a regional level and are more focused on their stakeholders (EACB).

The financial health of banks and related institutions constitutes a matter of great concern, especially since the global 2008 financial crisis. Therefore, regulators and governments must ensure that the appropriate systems are in place to prevent a new crisis. Over the years, the pressure on banks has increased immensely. For instance, banks face new post-crisis requirements and challenges and are subject to several changes in the banking system, such as deregulation, financial innovation, globalization, competition from other financial institutions, and a volatile market (Casu et al., 2006). These pressures have a direct impact on the banks' profitability (Goddard et al., 2004). Hence, it is critical to comprehend the banks' financial health and the factors that influence it.

The strength of an economic system can be evaluated by investigating the performance of its banks. Several profitability ratios can be used as proxies for banks performance, such as Return on Assets, Return on Equity and/or Net Interest Margin. Return on Assets and Return on Equity result from management accounting decisions, therefore, based on shareholders' value (Bergendahl and Lindblom, 2006). On the contrary, Net Interest Margin focuses on the profit earned on interest activities (Nasserinia et al., 2014).

Moreover, it is of the utmost interest to identify the determinants that influence banks performance. Financial ratios are commonly employed as determinants of banks performance (Yue, 1992). These determinants can be expressed as a function of internal and external factors. The internal determinants comprise bank-specific variables, whereas the external variables reflect macroeconomic factors (Dietrich & Wanzenried, 2011; Lelissa, 2014).

Internal determinants include bank size; bank diversification; different ratios (quality, liquidity, bank's strength, indebtedness, efficiency); the attitude of the bank concerning risk (risk-adjusted measures); and the level of competition. On the other hand, macro-economic variables comprise income diversification; industry concentration; economic growth; inflation; interest rates; and business cycle.

Recent technological development might represent a source of pressure for the traditional banking industry, seeing as they provide greater opportunities for economies of scale and scope (Pasiouras & Kosmidou, 2007). Technological development is materialized in the financial industry in the form of Financial Technology (FinTech) companies. FinTech refers to the application of technology to create innovative and better-quality financial services (Thakor, 2019).

Financial Technology is a relatively recent concept. Over the last decade, digital and technological innovation has grown substantially, and the Financial Technology setting is no exception (Phan *et al.,* 2019). The acknowledgement of FinTech in some economic and/or financial institutions is, therefore, new. For instance, World Bank states that "Financial Technology is creating new opportunities and challenges for the financial sector – from consumers to financial institutions, to regulators". Furthermore, jointly with the International Monetary Fund (IMF), it has recently written a document– Bali FinTech Agenda (2018) – which includes 12 policy proposals that aim to help countries incorporate FinTech at a national level.

FinTech is present in everyone's daily life, even if not noticed. For example, the most common payments systems nowadays, such as Apple payment, contactless systems, virtual credit cards, mobile applications such as Revolut or Twint, all rely on Financial Technology. Moreover, FinTech is also present in other activities such as Peer-to-Peer lending, Stock Trading mobile applications, Blockchain and Cryptocurrencies, Equity Crowdfunding, and helping to process large-scale databases.

As mentioned, Financial Technology firms are a recent reality. Therefore, the number of available studies that have investigated its impact on the traditional banking industry is limited. Nonetheless, the following authors should be highlighted: Wang and Sui (2020) studied the impact of FinTech on the efficiency of banks in China. The impact on banks performance was studied by Phan et al. (2019) for Indonesia and by Wu and Yuan (2021) for China.

The existing body of literature has focused solely on a single-country analysis and mainly for non-European countries. This investigation intends to fill the geographic literature gap, assessing the impact of Financial Technology on European Banks performance. The purpose of such study is to answer the following two questions: (i) Do Financial Technology companies

decrease banks performance?; and (ii) Which determinants of bank profitability justify the negative impact of FinTech in banks performance?

This study is inspired by Dietrich and Wanzenried, 2011, and is based on the publication of Phan et al. (2019), with the exception that various European countries are being investigated. The estimation was based on the two-step GMM by Arellano and Bover (1995) and Blundell and Bond (1998). To ensure the efficient use of this estimation method, the validation of the instruments chosen is key. Therefore, the Hansen-J statistic test (Hansen, 1982) is required for the validation of instruments. Univariate and multivariate analyses were performed, as well as robustness tests.

FinTech reveals to have no statistical significance for either measure of performance. In addition, it was found that FinTech has a negative sign on ROA and ROE. When the estimation is performed using the Net Interest Margin metric, FinTech appears to have a positive impact on banks performance.

This dissertation is organized into six chapters.

Chapter one presents the introduction. Chapter 2 covers the literature review and is divided as follows: banks performance; what is FinTech; theoretical framework; competition with commercial banks; and concluded studies and their primary conclusions. Chapter 3 contains the research hypothesis. Chapter 4 presents the data sample, the variables description and the methodology used. Chapter 5 covers the regression results and the robustness tests. Finally, chapter 6 is reserved for the conclusions and limitations.

2. Literature Review

2.1. Banks Performance

Banks are financial intermediary that transfer funds from those who have a surplus to those who have a deficit. In addition, banks offer a wide range of services to individuals and businesses. However, finding information on borrowing and saving opportunities seems to be difficult and costly. Consequently, banks play a key role in solving "asymmetric information problems, therefore, reducing the associated costs (Sharma et al., 2016).

The importance of this intermediation in investment and the growth of the economy is undeniable and has been highlighted by numerous scholars such as Demirguç-Kunt and Huizinga (1999) and Lelissa (2014). In recent years, players of the financial sector have witnessed a substantial increase not only in the number of organisations, but also in the amount of money managed by these institutions and the range of activities on offer (Adam, 2014).

Over the previous two decades, the banking industry has undergone remarkable shifts in its operating environment worldwide. Its structure and performance have been influenced by internal and external causes (Athanasoglou et al., 2006). Despite the growing tendency towards bank disintermediation and increased competition from non-financial institutions, banks remain pivotal in the economy for various reasons. First, profitability is required for a bank to continue operating and provide reasonable returns to its shareholders, this is particularly crucial for supervisors seeing as it ensures that capital ratios are more flexible, even in a risky economic situation (Trujillo-Pounce, 2012). Second, when a bank collapses, the entire payment system of a country is threatened (Lelissa, 2014). Last but not least, a healthy and prosperous banking industry can better resist adverse shocks and contribute to the stability of the financial system (Athanasoglou et al., 2006). As a result, all financial players, namely academic researchers, financial markets, bank management, and supervisors are highly concerned with the factors that influence bank performance.

As predicted, the 2008 financial crisis left an indelible impression on the global economy. As a result, the financial status of banks and financial institutions, in general, has become increasingly important. Therefore, it is mandatory for both regulators and governments to ensure the necessary mechanisms to minimize the occurrence of a future crisis (Sharma et al., 2016). In addition to some regulatory post-crisis requirements, several forces that drive change in the banking system, such as deregulation, financial innovation, globalization, competition from other financial institutions, and a volatile market, have put pressure on banks (Casu et al., 2006). These

demands directly impact the bank's profitability (Goddard et al., 2004). As a result, it is imperative to comprehend which factors influence the financial health of a bank, to what extent do they do so and how these factors can be measured.

A bank's solid financial health benefits its depositors, its shareholders, its staff, and the entire economy. Consequently, the assessment of the financial status of a bank must be performed periodically (Mohi-ud-Din & Tabassum, 2010). Seemingly, the strength of an economic system can be evaluated by investigating the performance of its banks (Adam, 2014; Sharma et al., 2016). Numerous studies in the literature have sought to identify the determinants that influence banks performance in Europe and worldwide (Sharma et al., 2016; Trujillo-Ponce, 2012).

Prior studies have investigated both internal and external determinants of banks profitability, focusing their analysis on the banking system of individual countries (Adam, 2014; Athanasoglou et al., 2006; Dietrich & Wanzenried, 2011; Lelissa, 2014; Nasserinia et al., 2014; Sharma et al., 2016; Trujillo-Ponce, 2012; Wirnkar & Tanko, 2008) as well as cross-country comparisons (Dietrich & Wanzenried, 2014; Goddard et al., 2004; Pasiouras & Kosmidou, 2007; Staikouras & Wood, 2004).

2.1.1. Measures of Banks Performance

Bank success has been closely linked to profitability indicators such as Return on Total Assets (ROA), Return on Total Equity (ROE) and Net Interest Margin (NIM), in the research on the determinants of bank performance. Moreover, analysts and bank regulators have used these metrics to evaluate the financial industry and/or to predict economic/financial shocks (Gilbert and Wheelock, 2007).

Essentially, performance and efficiency are determined by defining the share of return in a particular category, such as Return on Capital (ROC), Return on Equity (ROE), and Return on Assets (ROA) measures (Sharma et al., 2016). According to Lelissa (2014), bank success has been intricately linked to the profitability measures mentioned.

Bergendahl and Lindblom (2006) stated that a corporation might be evaluated using measures such as Return on Assets and Return on Equity. These ratios represent a bank's management aptitude for creating profits from the assets or equity, respectively.

Built on the previous definition by Dietrich and Wanzenried (2011), Pasiouras and Kosmidou (2007) employed ROAA and ROEA to measure bank profitability. The difference is that in these ratios, the average assets are utilized to account for any variations in assets over the fiscal year.

An additional performance measure was introduced by Nasserinia et al. (2014). This study demonstrated that in contrast with ROA and ROE, which are results from management accounting decisions, the Net Interest Margin (NIM) concentrates on the profit earned on interest activities. As a result, NIM is a valuable performance metric in intermediation efficiency and industry competition.

2.1.2. Internal and External Determinants of Banks Performance

Several studies have been conducted over the previous few decades to determine what drives a bank's performance. Since most authors return to financial ratios analysis, this section will summarize the most common ratios.

Wirnkar and Tanko (2008) reported that Beaver (1966) was the first author to resort to financial ratios to evaluate performance. However, his investigation was rudimental since it only tested one ratio at a time. Alternatively, Altman (1968) used a multiple discriminant analysis (MDA).

Bank performance can be proxied by the Return on Assets (ROA), Return on Equity (ROE) and Net Interest Margin (NIM) and expressed as a function of internal and external factors. The internal determinants comprise bank-specific variables, whereas the external variables reflect macroeconomic factors (Dietrich & Wanzenried, 2011; Lelissa, 2014).

Internal determinants include bank size; bank diversification; different ratios (quality, liquidity, bank's strength, indebtedness, efficiency); the attitude of the bank concerning risk (risk-adjusted measures); and the level of competition (Adam, 2014; Athanasoglou et al., 2006; Dietrich & Wanzenried, 2011, 2014; Fiordelisi & Mare, 2013; Goddard et al., 2004; Lelissa, 2014; Pasiouras & Kosmidou, 2007; Phan et al., 2019; Sharma et al., 2016; Staikouras & Wood, 2004; Wirnkar & Tanko, 2008).

On the other hand, macro-economic variables comprise income diversification; industry concentration; economic growth; inflation; interest rates; and the business cycle (Dietrich & Wanzenried, 2011, 2014; Lelissa, 2014; Ly, 2015; Nasserinia et al., 2014; Phan et al., 2019; Staikouras & Wood, 2004; Trujillo-Ponce, 2012).

Table 1 - Main Studies on Banks Performance Determinants

Author / Year	Period	Sample	Method	Variables	Results
Single Country Analysis					
Athanasoglou et al. (2006)	1985 - 2001	Greek Commercial Banks	GMM	ROA; ROE; capital ratio; credit risk; productivity; expenses; size; economic cycle; concentration; inflation; ownership.	Found evidence of profitability persistency. All bank-specific determinants are significant, except for size. Cost to income and business cycle has a positive relationship with performance, while the size is negatively related.
Wirnkar and Tanko (2008)	1997 - 2005	11 Nigeria Commercial Banks	DEA	ROA; ROE; CAMEL	The study demonstrated that each CAMEL component is unable to capture a bank's overall performance.
Dietrich and Wanzenried (2011)	1999 - 2009	372 Swiss Commercial Banks	GMM	ROAA; ROAE; NIM; CAP; CTI; deposits growth; size; IIS; FC; GDP; Herfindahl index; tax rate; interest rate.	Profitability is explained by efficiency, the growth of total loans, funding costs, the business model and the effective tax rate.
Trujillo-Ponce (2012)	1999 - 2009	89 Spanish Commercial, Savings and cooperative banks	GMM	ROA; ROE; liquidity ratio; capital ratio; capital structure; deposits growth; cost to income; size; Herfindahl index; GDP; inflation; interest rate.	Raised loans to total assets, customer deposits, CAP, good efficiency and low credit risk, increase the bank's return (using ROA). All macroeconomic factors affect bank profitability except for interest rate. There are differences in the performance of commercial and savings banks
Adam (2014)	2009 - 2013	Erbil Bank - Iraq	Regression model	ROA; ROE; ROD; size; capital; loans over total assets.	The study found that size positively influences bank performance, while the capital and the ratio loans/total assets have a negative impact.
Lelissa (2014)	1990 - 2012	8 Ethiopian Commercial Banks	Multiple Linear Regression	ROA; CAP; SIZE; provision to loans; non-interest expense/gross expense; liquidity ratio; GDP; inflation.	The study concludes that bank-specific variables explain changes in profitability. High performance is related to the ability of banks to control their credit risk; diversification non-traditional services and expenses. In addition, the bank's capital, size, and GDP growth rates have no statistical significance, opposite to the inflation rate.

Nasserinia et al. (2014)	2002 - 2012	115 Japanese Commercial Banks	GMM	Dependent: NIM Independent:	Size and income are not significant in driving bank performance. Variables as credit risk and CAP have a negative relationship with performance, while liquidity risk, asset quality and management efficiency, have a positive effect.
Sharma et al. (2016)	2000 – 2010	1279 Russian Banks	PHP Programming	Current ratio; D/E ratio; ROA; ROE; RAROC; total assets; total equity; net loans; net income.	By using the selected ratios, the authors were able to prove the performance of Russian Banks. Therefore, the chosen variables are drivers of banks profitability.
Multiple Country Analysis					
Goddard et al. (2004)	1992 - 1998	665 European banks (DK, FR, DE, IT & ES)	GMM	ROE; assets; capital assets ratio; Off balance sheets assets.	Some of the results are the following: size and ownership type have a modest impact on performance; diversifications have a negative impact and CAR showed a positive relation with profits.
Staikouras and Wood (2004)	1994 - 1998	685 European Banks (BE, DK, GR, FR, UK, IE, SE, IT, DE, PT, ES, FI & NL)	OLS & Fixed Model Effects	ROA; loans to assets; equity to assets; total assets; loan loss provision ratio; Herfindahl index; interest rate; GDP.	Results suggest that size, capital ratio, CTI, and interest rate levels positively impact profits, while GDP negatively impacts performance.
Pasiouras and Kosmidou (2007)	1995 - 2001	15 European Union Countries	Fixed effects regression	ROAA; capital adequacy; CTI; liquidity ratio; size; inflation; GDP; market capitalization.	The findings show that both bank specific and macroeconomic variables influence commercial bank profitability.
Dietrich and Wanzenried (2014)	1998 - 2012	10000 banks from 118 countries	GMM	ROAA; ROAE; NIM; CAP; CTI; Loan loss provision; deposits growth; size; IIS; FC; GDP; bank ownership; nationality; tax rate; stock market; bank concentration.	The higher development of a country goes with higher competition and efficiency in the capital allocation but also with a lower profitability.
Marques and Alves, (2021)	2005 - 2016	524 European Banks	Clustering Ensemble	ROA; loans to assets; customers deposits to assets; derivative instruments to total assets; total assets; equity to total assets.	The custumer deposits and equity have a positive impact in the profitability, while size (i.e. total assets) show a negative influence.

2.2. FinTech Concept

The financial sector is in the vanguard of technological innovation compared with other service industries (Iman, 2019). This is evidence that FinTech is already recognized by several economic and/or financial institutions such as the World Bank, the Financial Stability Board or "Banco de Portugal".

According to the Financial Stability Board (FSB), FinTech is defined as "technologically enabled financial innovation that could result in new business models[1], applications, processes, or products with an associated material effect on financial markets and institutions, and the provision of financial services". The Basel Committee on Banking Supervision (BCBS) has later assumed this definition.

"Banco de Portugal" has a similar definition, i.e., FinTech "refers to entities that operate in the financial sector and that have business models based on innovative technologies", however, it complements by stating that FinTech can include "the technologies themselves" when incorporated in "entities or traditional financial system participants such as banks and payment institutions".

In a broad sense, FinTech consists in applying new technologies to the financial industry to enhance its development and facilitate the provision of financial services. It encompasses a broad range of technological innovations that have revolutionized the way financial services are provided.

The term FinTech appeared in the 1990s when Citigroup named a project "Financial Services Technology". In recent years a growing body of research considering the implications of FinTech has become increasingly relevant, and its importance is growing exponentially.

A simplistic definition was anticipated by Navaretti et al. (2017), which stated that FinTech is a merge of the terms and concepts "Financial" and "Technology". FinTech is a commonly used term, although the same does not apply for the definition, which is not precise. Most authors define it as the application of advanced technologies in the finance industry to sustain its development (Dranev et al., 2019).

[1] For a discussion about the business model concept see Marques & Alves (2020).

The contribution of FinTech in the innovation and improvement of financial services is illustrated by Thankor (2019). Financial Technology companies use innovative technology to conduct activities that belong to traditional banking, such as conceding credit, payment systems or funds application (Navaretti et al., 2017).

Navaretti et al. (2017) explored some advantages of FinTech, such as the possibility of accomplishing economies of scale by recurring to large data samples. These authors were the first to mention possible cost-advantages, including lesser costs when matching individuals, decreased the cost of transmitting secure information and a more cost-effective process of verification. Thakor (2019) supported the stated advantages. Moreover, Zhang et al. (2020), emphasised the importance of FinTech in helping banks with a more efficient and accurate processing of data.

FinTech applies digital products and/or processes and advanced technological innovations to financial services. Admittedly, FinTech can facilitate access to financial services, thus promoting competition (Navaretti et al., 2017).

Technological innovation is increasingly present in the financial industry and can be found in four different areas: (i) commercial banking activities such as credits, deposits and loan activities; (ii) digital payment systems and virtual currencies; (iii) investment services; and (iv) insurance activities (Navaretti et al., 2017).

Bazot (2013) reports that the application of FinTech systems can replace manual intervention when deciding to concede a loan. In other words, the system will automatically attribute or not a certain loan. This is one practical example of how FinTech can be applied to a traditional activity of a bank– provide loans.

Likewise, Philippon (2015) found benefits when using Financial Technology in peer-to-peer lending, given the facility in which it processes data. In addition, Financial Technology was found significant when analyzing the creditworthiness of individuals, and the improvement in the relationship between clients and bank employees was highlighted by Vives (2017). Furthermore, Vives (2017) found a significant advantage of the use of FinTech, which consists in the easiness of processing large databases when evaluating borrowers or pricing mortgage risk.

Financial Technology is probably mostly noticeable in all the digital payments systems available today. Examples are the mobile payment systems (Darolles, 2016), the contactless function (Phan et al., 2019), and finally, Apple and Google pay (Vives, 2017). Similarly, a less known example, nonetheless still relevant, Blockchain employs Financial Technology and,

by definition, combines computer technologies and encryption algorithms, which reveal to be advantageous to store data and to spread information (Guo & Liang, 2016). A diverse group of authors, such as Dranev et al. (2019); Thakor (2019); Vives (2017), acknowledge the importance of blockchain technology in the finance industry. Namely, they found it essential to manage cryptocurrencies such as bitcoin.

Philippon (2015) further reports that Financial Technology is becoming a digital advisor or a robot-advisor, as Vives (2017) named it, collecting financial information on clients.

FinTech was found relevant in the trading system by Thankor (2019), considering that Financial trading is at the distance of a click or of a mobile application. The trading volume carried out through mobile applications has increased (Kim et al., 2020).

A further sector affected by the use of Financial Technology is insurance activities (Thankor, 2019), especially considering the effectiveness of data processing that this technology allows. InsurTech – Insurance Technology - is starting to be studied (Stoeckli et al., 2018).

In the different sectors mentioned previously, FinTech can help reduce intermediation costs and increase efficiency, which translates into a higher innovation rate when compared with the traditional banking industry (Vives, 2017).

2.3. Theoretical Framework

The relevant theories to consider when evaluating the interaction between FinTech and banks are the following: (i) consumer theory, since more efficient services can be offered; (ii) theory of information, given that the primary purpose of retail banks is financial intermediation; and (iii) innovation diffusion theory to evaluate how new technologies propagate.

2.3.1. Consumer Theory

Individual taste is the centre of the Consumer Theory, a complex variable to measure, meaning we can only infer individuals' preferences based on their choices (McAfee, 2012). The Consumer Theory aims at assessing the impact of alternative hypotheses on goals, laws and limitations of consumers when deciding their demand for goods (Barten & Bohm, 1993).

According to the Consumer Theory, when consumer demand and supply are matched, traditional services can be replaced by new ones (Aaker & Keller, 1990). An analogy can be made with Financial Technology, representing the new services created and the traditional services corresponding to traditional banking operations.

Buskens (2020) states that to attract consumers to new technology or innovation in general, it is important that they receive the information about the product so as to perceive its (dis)advantages. Finally, consumers must trust the innovation proposed.

When joining a new product, especially in the technological field, data protection and privacy are the major concerns for clients. Therefore, companies must provide data protection and transparency when developing a new FinTech product (Stewartand & Jürjens, 2018).

2.3.2. Theory of Information Production

Information asymmetry is based on the fact that different economic agents detain different types of information and try to take advantage of it economically (Bhattacharya & Thakor, 1993). Therefore, asymmetric information can create two problems, adverse selection and moral hazard. Adverse selection is a problem that occurs previously to the transaction when the one-party detains more information. The second problem is moral hazard. It occurs after the transaction when one party takes advantage of the information against the other party (Freixas & Rochet, 1998).

Financial institutions such as commercial banks possess advanced knowledge to process borrowers' information. Therefore, they are in a privileged position in terms of information, which allows them to better attribute funds to their customers, consequently mitigating the asymmetry of information problem (Diamond & Dybvig, 1983).

Information asymmetry is especially relevant in a lending/borrowing situation, where it is clear that the lender detains more information than the borrower. This problem can be mitigated by recurring to large databases provided by FinTech instruments. For instance, in peer-to-peer lending platforms, large databases can reduce the search costs on the buyers' side and decrease the signalling costs from the sellers' perspective (Yan et al., 2015). Therefore, through the reduction of both these costs, the information asymmetry problem can be mitigated.

2.3.3. Innovation Diffusion Theory

The concept of innovation diffusion was introduced in 1962 by Rogers, who aimed to acknowledge "how, why and at what velocity" technological innovations diffuse in the community (Wani & Ali, 2015). The expected outcome is that people belonging to this community adopt the new idea and/or product. To succeed, it is crucial that individuals understand the concept and/or product as an innovation. Peres et al. (2010) defined innovation diffusion as the entry of new products and services in the market due to social effects. He considers two sorts of social effects: network externalities and social signals. Network externalities consider that an individual's utility will grow as the number of consumers of that specific product increases (McGee & Sammut-Bonnici, 2015). As reported by Poggi et al. (2010), social signals englobe any stimulus that translates into information concerning social facts such as: "social interactions, social attitudes, social relations and social emotions" (Poggi & D'Errico, 2011, p. 18).

Globalization can be considered a significant driver for the diffusion of innovations such as Financial Technology (Saksonova & Kuzmina-Merlino, 2017). For instance, globalization was the crucial factor for the development of FinTech without the help of the banking industry, by allowing small companies to merge the financial industry with a well-known innovation, Information Technology.

Buskens (2020) claims that social media is one of the quickest mechanisms to spread information and encourage trust. Nonetheless, this diffusion must be performed according to the phase of the innovation process and its objective.

New companies appear in the market daily with the promise of innovative products and especially less costly products. This is when competition emerges (Christensen, 1997).

2.4. Competition with Commercial Banks

Banks have reacted to increased competition by expanding their product and service offerings and doing a significant percentage of their activity off-balance sheet (Goddard et al., 2004).

The effects on competition between Financial Technology and traditional banks can be found in three main sectors, (i) credit and liquidity risk, (ii) payment system; and (iii) information (Navaretti et al., 2017).

2.4.1. Credit and Liquidity Risk

Pear-to-pear (P2P) platforms are another example of innovations in the financial world. P2P attributes a risk classification to borrowers by performing a primary analysis. However, the replacement of banks by this new form of lending is not straightforward. Banks will continue to lead when it comes to insurance deposits or safe assets, but they will lose some power in riskier and more costly lending (Thakor, 2019).

Commercial banks competitive advantages, such as the possibility of cheaper borrowing or the privileged access to customers databases (Vives, 2017), can be affected by the entry of FinTech companies.

Zhang et al. (2020) emphasize the benefits of the use of FinTech insofar it helps to mitigate errors when processing information on a particular borrower since it is a more computerized process. Therefore, conceding loans becomes a more efficient process.

The impact of FinTech is not so relevant when considering liquidity, since from the point they start raising deposits funds and undertaking maturity transformation, by definition, FinTech becomes a bank. When performing maturity transformation, banks earn interest on each customer, which permits a higher portfolio diversification, and therefore, less risk (Navaretti et al., 2017). The opposite happens for FinTech, which will tend to hold riskier portfolios.

2.4.2. Payment System

An important challenge for retail banks is in the payment sector (Wang & Sui, 2020).

The major contribution of FinTech in payment platforms is the easiness with which it is possible to transfer money between individuals, using, for example, the "Apple Pay" platform. The technological world is in constant change. Therefore, innovations are especially relevant. As long as banks can incorporate emergent technologies rapidly enough, FinTech competition will not become a problem (Navaretti et al., 2017).

Iman (2019) identified payment services as a source of competition, particularly when considering startup companies that use web or mobile application payments.

2.4.3. Information

The major revolution brought about by Financial Technology was in data processing and availability (Zhuo et al., 2020), resorting to the use of algorithms from artificial intelligence (Vives, 2017; Zhang et al., 2020).

Another major challenge for traditional banking is the intermediary process since, through FinTech, data processing becomes more efficient (Vives, 2017). Traditional banks tend to gather a huge array of information on a client, which grants them a monopolistic position. These financial/commercial advantages are diminished by the impact of Financial Technology (Wang & Sui, 2020).

Navaretti et al. (2017) recognize that technological innovation allows the storage of client data in online platforms, and financial services distribution will become customized and more flexible. Seemingly, they also identify the ability of large banks to incorporate innovation.

2.4.4. Additional Considerations

The dimension of competition effects on commercial banks is limited given the strict regulations under which they operate (Iman, 2019).

Christine Lagarde (2018), President of the European Central Bank, has analyzed the possible relationship between FinTech and the Central Bank. The emergence of Financial Technology can replace some activities that commercial banks traditionally assured. Consequently, additional counterparties will be required when providing liquidity through open-market operation, which is an important role of Central Banks. Ultimately, Lagarde believes that communication between these two competitors is of the utmost importance, and in addition, the International Monetary Fund (IMF) is the perfect place to do so.

Retail banks will not disappear since FinTech cannot replace certain operations performed by them, and vice-versa, studies suggest that they may complement each other (Navaretti et al., 2017).

Furthermore, the FinTech segment is small compared to a traditional financial institution, even when considering the largest FinTech markets such as China and United States (Vives, 2017).

2.5. Concluded studies and Primary Conclusions

The academic Mansilla-Fernández (2017) has compiled a list of four stylized facts about Financial Technology by examining data such as the investment in FinTech or the use of electronic payments for European countries.

The following main conclusions can be drawn: (i) developed countries invest more in FinTech companies; (ii) in countries where the majority of individuals hold a bank account, higher use of digital payments is noted; (iii) countries where there is less bank competition invest more in FinTech firms; and (iv) countries that pay lower interest rates on deposits and charge higher interest rates when lending funds will invest more in FinTech corporations.

In conclusion, countries with higher financial development are more open to financial innovation (Thakor, 2019).

The concept of Financial Technology has existed for over a decade, although there is a relative dearth of studies in this area. Therefore, the conclusions of the impact of FinTech on banks, insurance companies and other financial institutions are not clear. Moreover, FinTech data is scarce, and some geographical areas are not covered by the existing studies.

Two Spanish authors, Hernando and Nieto (2006), wrote one of the first studies analyzing the new form of commercial banks operations with access to the internet. This research comprehends 72 Spanish commercial banks from 1995 to the first semester of 2002 from the "Banco de España" database. A multivariate analysis was the method chosen, where different models were estimated by using various regressions, IV estimates (instrument variables) and GLS (generalized least squares).

In particular, they explored how the performance of banks would change when using websites in banks transactions in order to fully understand if the internet can substitute banks operation, or instead if they mutually complement.

The use of the internet and technology-enabled innovations in bank operations complements the traditional activities instead of substituting them. The impact of the internet on the banks' performance takes time to appear, and the repercussions of internet implementation on, for example, ROE and ROA are visible after three years. An additional conclusion arises from the reduction of expenses brought about by the use of new technologies.

Okiro and Ndungu (2013) analyzed "the impact of mobile and internet banking on the performance of financial institutions in Kenya", investigated through a survey of 30 financial institutions.

The study intended to explore both the impact and extent of mobile and internet banking on the performance of financial institutions (SACCOS, commercial banks and micro institutions) in Kenya. They concluded that from all the financial institutions considered, the commercial sector that most applies internet banking followed by SACCOS (Savings and Credit Cooperative Societies), only micro finance institutions are delayed in this process.

Another study was conducted by Iman (2019), and it aimed to understand the determinant characteristics that individuals have or need to have and how they react to FinTech startups. This study encompasses 521 questionnaires from both clients and employees of STB (Small Town Bank - Indonesia).

The main purpose was to answer the two following questions: what role FinTech plays in Indonesia and what type of response STB should adopt. Descriptive exploratory research was performed, including desk research (journals or newspapers), interviews and direct observation of FinTech customers.

Finally, they concluded that banks already apply innovation. The easiest way for Indonesian incumbent banks to enter the FinTech industry is through the payment and financing sectors. Nonetheless, when considering regional banks such as STB, FinTech revealed to have little to no impact.

Phan et al. (2019), also studied the influence of financial technology firms in Banks PerformancePhan et al. (2019), authors of "Do Financial Technology firms influence Banks Performance?", focused on 41 Indonesian banks (emergent country) in the time period of 20 years (from 1998 to 2017). Therefore, they evaluated the impact on the net interest income to total assets (NIM), net income to total equities (ROE), net income to total assets (ROA), and the yield on earning assets (YEA), as well as the impact on bank features as market value (MV) or the age of the firm (FA). The chosen estimation method was the generalized two-step method of moments (GMM).

The main findings were the following: (i) FinTech has a negative impact on the most relevant variables considered: NIM, ROE, ROA and YEA; (ii) FinTech negatively predicts these ratios for each new FinTech firm entering the market and (iii) FinTech effect is more accentuated in larger and older banks. This study is recent (2019), but it is still the first to

evaluate the hypotheses that FinTechs can negatively influence banks performance.

In March 2020, Zhang et al. (2020) published their empirical study on "how FinTech impacts pre- and post-loan risk in Chinese commercial banks". The research was based on 28 listed commercial banks from 2014 until 2018, and the methodology used was the two-step generalized method of moments (GMM).

During the empirical study, two hypotheses were explored. Hypothesis one is intended to understand if the integration of FinTech in banks would decrease the "positive impact of credit activities on pre-loan risk" (Zhang et al., 2020, pp. 4). The second hypothesis assessed was if the mentioned impact is more pronounced in banks "with higher level of managerial ownership".

The main conclusions in accordance with the studied hypothesis are that FinTech mitigates the impact of credit activities on pre-loan risk. This effect is more noticeable in banks with a more elevated level of management ownership. Nevertheless, the authors were unable to find a positive impact of FinTech on post-loan risk.

Wang and Sui (2020) studied the impact of FinTech on the efficiency of Chinese commercial banks, more precisely, in the bank's total factor productivity (TFP). This analysis was performed by focusing on a large data sample, specifically 113 domestic, commercial banks from 2009 to 2018.

Their first hypothesis was to see if FinTech increases the TFF of commercial banks in China, and the second was to understand if that would diverge when considering the level at which banks apply the technologies.

After applying two different regression methods, SYS-GMM (systematic generalized moment estimation) and DFF-GMM (differential generalized moment estimation), they concluded that FinTech increases bank' profitability and improves risk control, service efficiency and competitiveness. Their study also confirmed that Financial Technology incorporation reduces operating and intermediation costs and has led to innovation in business models, services and products. On the other hand, it generates regulatory problems.

The most recent study was written by Wo and Yuan (2021). Their objective was to investigate FinTech and other determinants of banks´ profitability. They applied the OLS estimation, the FGLS estimation, the Prais-Winsten estimation and the FE estimation to six Chinese state-owned commercial banks. The results undoubtedly show that FinTech negatively influences banks' profitability.

Table 2: Relevant Studies in Financial Technology

Author / Year	Period	Sample	Method	Results
Hernando and Nieto (2006)	1995 - 2002	72 Spanish Commercial Banks	IV estimates and GLS	The use of internet in banks operations complements the traditionalactivities instead of substituting them.
(Okiro & Ndungu, 2013)	2012 - 2013	30 Financial Institutions in Kenya	Excel and SPSS	They concluded that commercial banking is the sector that most applies internet banking (sign of complementarity) from all the financial institutions considered.
Iman (2019)	2018	521 Indonesian Small Town Banks	Descriptive exploratory research	The writer concluded that banks already incorporate Financial Technology.
Phan et al. (2019)	1998 - 2017	41 Indonesian Banks	GMM	They concluded that FinTech negatively influences banks performance.
Zhang et al. (2020)	2014 - 2018	28 Chinese Listed Commercial Banks	Dynamic GMM	FinTech reduces the influence of credit activities on pre-loan risk, and this effect is more noticeable in banks with a higher level of management ownership. However, the authors did not discover a positive influence of FinTech.
Wang and Sui (2020)	2009 - 2018	113 Chinese Commercial Banks	SYS-GMM DFF-GMM	They concluded that FinTech increases the bank's profitability, risk control, service efficiency, competitiveness and reduces operating and innovation costs.
Wo and Yuan (2021)	2014 - 2019	6 State-owned Chinese Commercial Banks	OLS, FGLS, FE estimation & Prais-Winsten	These authors concluded that the development of FinTech companies negatively influences bank performance.

3. Research Hypothesis

The study hypothesis will be described in this section. This study adds to the existing literature since there have been no analogous studies for Europe. Furthermore, the variables used have been derived from a few earlier studies.

The Financial Technology business is rapidly evolving around the world, its impact on bank performance necessitates a detailed examination. As a result, the primary goal of this study is to determine the effect of Financial Technology firms on the performance of commercial and cooperative banks. It is also relevant to understand what determinants cause the negative relationship between FinTech and banks performance.

The research hypothesis that will be tested are described below.

H1: FinTech companies reduce the traditional banks' performance.

H2: Larger banks are more impacted by FinTech growth.

Larger banks possess a higher organizational structure, higher number of branches with a high number of employees. Therefore, it is expected that larger banks will be more susceptible to an increase in Financial Technology companies.

H3: Banks with higher capital ratios are less impacted by FinTech growth.

The capital ratio is used as a measure of a bank's financial strength. Therefore, it is expected that banks with higher capital ratios, meaning safer and more resilient to economic shocks such as an increase in competition, are less affected by the increasing number of FinTech companies.

H4: Banks with higher cost-to-income ratios are more impacted by FinTech growth.

Cost to income is a proxy for banks efficiency. An increase in the cost to income is normally associated with a decrease in banks efficiency. Consequently, banks are more vulnerable to an increase in the number of Financial Technology firms.

4. Data and Methodology

4.1 Sample and Data

This research aims to explore the impact of FinTech companies on the performance of European banks and compare commercial and cooperative banks. The data was gathered from two independent sources: SNL Financials[2] and BankScope[3] for a ten-year period, from 2011 until 2020.

SNL Financials database was used to compile all information related to European FinTech companies. For this analysis, the number of operating FinTech companies founded each year was considered for this study. Therefore, private and public enterprises in the following industries were classified as FinTech companies: Banking Technology; Digital Lending; Financial Media and Data Solutions; Insurance Technology; and Investment and Capital Markets Technology. The final list comprises a total of 342 FinTech companies founded during the study period.

The banks' related data was exported from BankFocus for commercial and cooperative banks for European countries (Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Lithuania, Luxemburg, Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, Ukraine, United Kingdom). These countries were chosen based on where FinTech firms were funded over the ten-year study period. For the remaining variables, the tool used was Orbis Bank Focus, which contains information of consolidated and non-consolidated accounts, utilising the consolidation code C1, U1 and U2, as suggested by Duprey and Lé (2016) and Marques and Alves (2020, 2021), to avoid data duplication. All data was gathered in absolute years, throughout ten years, from 2011 to 2020. All figures are in thousands of Euros, and for the countries outside the Eurozone, all data was converted using the exchange rate on the closing date.

The final sample includes 342 FinTech companies (Attachment 1), 3215 European banks 1362 commercial banks and 1853 cooperative banks. Table 3 displays the total number of banks, their distribution by country and type of bank, listed and non-listed banks.

[2] Part of S&P Global Market Intelligence database (SNL Financials has joined forces with S&P Capital IQ)
[3] BankSocpe's data provider is Bureau Van Dijk

Table 3: Sample Distribution by Country and Bank Type

Country	Number of Banks				
	Total	Commercial Banks	Cooperative Banks	Listed Total	Non-Listed Total
Austria	442	52	390	5	437
Belgium	33	30	3	0	33
Bulgaria	19	18	1	4	15
Croatia	22	21	1	5	17
Czech Republic	21	19	2	3	18
Denmark	33	28	5	19	14
Estonia	6	6	0	0	6
Finland	147	22	125	4	143
France	168	99	69	15	153
Germany	883	63	820	4	879
Iceland	5	5	0	2	3
Ireland	31	13	18	3	28
Italy	338	67	271	18	320
Lithuania	5	5	0	1	4
Luxemburg	52	50	2	0	52
Netherlands	29	27	2	1	28
Norway	23	23	0	4	19
Poland	140	75	65	10	130
Portugal	28	23	5	2	26
Russia	352	352	0	29	323
Spain	98	41	57	5	93
Sweden	29	29	0	3	26
Switzerland	118	103	15	5	113
Ukraine	81	81	0	28	53
United Kingdom	112	110	2	2	110
Total	3215	1362	1853	172	3043

4.2 Variables Description

This chapter describes the three dependent variables used in this study and the explanatory variables, in this case, bank-specific factors. This section will be summarized in Table 4.

4.2.1 Dependent Variables

The dependent variable will be the measure of performance. Three alternative measures can express the profitability variable: the Return on Assets (ROA), the Return on Equity (ROE) and the Net Interest Margin (NIM).

ROA and ROE are fundamental performance ratios and commonly used metrics in the literature (Adam, 2014; Marques & Alves, 2021; Walsh, 2008). Analysts and bank regulators have been using these ratios to assess the industry performance and predict changes in the market structure (Gilbert & Wheelock, 2007).

ROA and ROE are indicators focusing on shareholder value and reflect the financial performance and the managerial efficiency of a bank, revealing how well the bank management uses the bank's real investment resources. On the other hand, NIM focuses on the profit earned on interest activities.

a) Return on Assets - ROA

The ratio of net income to total assets is known as ROA. This ratio measures the capacity of a bank's management to generate profits from the bank's assets. Thus, it is a measure of management efficiency, and it indicates the profit earned per euro of assets. Thus, in theory, ROA suggests the capacity of a bank's management to generate profits from its assets, albeit it may be biased due to off-balance-sheet activities.

b) Return on Equity - ROE

ROE is defined as the net income over total equity. The return to shareholders on their equity is translated from this ratio. Broadly, ROE is a metric for determining a company's profitability by disclosing how much profit is generated with the shareholders' money.

c) Net Interest Margin - NIM

NIM is defined as the net interest income divided by total assets, and it measures the average yield of the banks' assets. As Nasserinia et al. (2014) concluded, NIM is an important performance variable. As a result, NIM is a valuable performance indicator for intermediation efficacy, and it can be used as a proxy for industry competition.

4.2.2 Independent Variables

This section will focus on the explanatory variables of the model. Bank-specific determinants/internal factors, such as FinTech, size, and several ratios, will be used as independent variables since the literature found they are the main drivers of profitability (Lelissa, 2014). In addition, two dummies were added in the model to control for macroeconomic/external factors, one to capture time effects and the second to capture country-specific effects.

a) FinTech

FinTech corresponds to the number of FinTech companies founded each year during the ten-year period. The intention of this independent variable is to perceive the impact of the growth of Financial Technology companies. This is a time-series variable, as opposite the remaining explanatory variables.

The growing number of FinTech companies is seen as a source of innovation and competition for traditional banking. However, the opinions differ. Some authors believe it is a source of high competition (Wang & Sui, 2020; Zhang et al., 2020), low competition (Iman, 2019; Navaretti et al., 2017; Thakor, 2019; Vives, 2017; Wang & Sui, 2020) and some writers who believe Financial Technology companies and banks can complement each other (Hernando & Nieto, 2006; Iman, 2019; Navaretti et al., 2017).

FinTech firms might be viewed as a new competitor. Hence, it is expected that it will negatively influence banks performance. This hypothesis is corroborated by Iman (2019); Phan et al. (2019); Wo & Yuan (2021).

b) Dimension - Size

The size variable is related to the bank's dimension. The logarithm of the total assets is used as a proxy for the bank size (Athanasoglou et al., 2006; Goddard et al., 2004; Ly, 2015; Phan et al., 2019; Staikouras et al., 2004). However, the literature has not reached a consensus, and some authors discovered a positive impact of size on bank performance. In contrast, others have found a negative effect, and others have not reached a decisive conclusion.

This variable is considered to have a positive relation with banks performance by Adam (2014), Dietrich and Wanzenried (2014); Nasserinia et al. (2014); Phan et al. (2019) (when using ROA). In theory, when compared to small banks, large banks are expected to benefit from economies of scale (increase in efficiency), economies of scope (higher product diversification) and advantages on funding costs. Moreover, there is still the "too big to fail" argument that safeguards large banks. From a market point of view, larger banks are expected to have higher market power and sturdier brands.

Conversely, authors such as Athanasoglou et al. (2006), Dietrich and Wanzenried (2011), Lelissa (2014), Ly (2015), Passiouras and Kosmidou (2007), Phan et al. (2019) (for NIM and ROE cases) and Staikouras and Wood (2004) found that bank size can negatively impact the performance. This effect might be explained by the presence of diseconomies of scale, agency conflicts, and bureaucratic costs in larger banks could explain this conclusion.

Since the literature is not clear, no assumption is postulated concerning the sign of the size effect.

c) Strength - CAP

In line with other researchers such as Athanasoglou et al. (2006), Dietrich and Wanzenried (2011, 2014), Phan et al. (2019), capital ratio is used as a measure of strength. This study measures capital strength using a risk-based approach suggested in the Basel II and Basel III frameworks. The impact of this ratio on the bank's profitability is not clear in previous literature.

In theory, banks with high capitalization levels are considered safer and more resilient when facing economic or external shocks. Moreover, these banks have the cheapest access to funding, lowering their interest expenses on uninsured debt and thus increasing profits. This theory is backed up by Goddard et al. (2004); Lelissa (2014); Ly (2015); Pasiouras and Kosmidou (2007); Phan et al. (2019), (when using ROA and NIM); Trujillo-Ponce (2012). As referred, there is no consensus. Therefore, some scholars have concluded that high capital levels can negatively influence banks performance. This is the opinion of Fiordelisi and Mare (2013); Nasserinia et al.

(2014); Phan et al. (2019) (when working with ROE); Staikouras et al. (2004). The reason being that due to market inefficiencies, capital is considered more expensive than debt.

Furthermore, some authors Dietrich and Wanzenried (2011, 2014), could not conclude and found an ambiguous association between CAP and profit measurements. Consequently, the sign of this variable cannot be theoretically anticipated.

d) Efficiency - CTI

The cost to income ratio, computed as expenses over total revenues, was used as a proxy for measuring the bank's efficiency (Dietrich & Wanzenried, 2011, 2014; Passiouras & Kosmidou, 2007; Phan et al., 2019).

A negative effect of CTI in the banks' profit is expected since as the cost of income increases, meaning lower bank efficiency, hence the performance should decrease. Previous empirical studies have proved this negative association: Athanasoglou et al. (2006); Dietrich and Wanzenried (2011, 2014); Ly (2015); Passiouras and Kosmidou (2007); Phan et al. (2019); Staikouras et al. (2004).

Following the previously mentioned studies, a negative effect of CTI is expected in the profitability measures.

e) Credit Quality - LLP

The loan loss provision ratio was chosen as a proxy for credit risk (Dietrich & Wanzenried, 2011, 2014; Phan et al., 2019). This variable is expected to cover potential loan losses, therefore, protecting the bank's position in terms of capital and profitability.

Banks that face high exposure to risky loans become fragile, meaning that a higher ratio will translate into lower credit quality, consequently, a decrease in the performance of banks. This negative relationship is documented in previous empirical studies: Athanasoglou et al. (2006); Dietrich and Wanzenried (2011, 2014); Lelissa (2014); Phan et al. (2019). Lacking oppositive arguments, it is anticipated a negative effect of LLP on bank performance.

f) Yearly Growth - DG

The variable DG represents the deposit banks' growth, and is computed yearly. A bank that grows annually suggests a business expansion. Therefore, it is expected that higher profits will be generated. This argument can be refuted since the rise of deposits will not directly translate into an increase in profitability unless deposits can be converted into productive investments. Moreover, a growing industry is likely to attract new competitors, therefore, reducing banks profitability. So, the effect of deposits growth on the performance of banks is unclear.

The literature evidence is mixed. While Ly (2015) and Naceur and Goiaied (2001) found a positive relationship between deposit growth and profits, Demirguç-Kunt and Huizinga (1999) came across a negative effect. Moreover, Dietrich and Wanzenried (2011) and Phan et al. (2019) found mixed conclusions: the measure is chosen depending on the country's income and performance.

As a result, it is not possible to predict the sign of this variable based on the literature.

g) Income Diversification - IIS

The interest income share ratio is calculated by dividing total interest income over total income. Traditional banking activities (e.g. interest operations) account for a considerable portion of total income, whereas expenses such as fees and commission income and trading operations represent a smaller part. Predictably, banks with a higher share of interest revenue in relation to total income will have lower profitability since margins in fees, commissions and in trading activities are typically higher than those in interest operations (Dietrich & Wanzenried, 2011, 2014; Ly, 2015; Phan et al. 2019). Thus, a negative influence of IIS on banks performance is expected.

h) Funding - FC

The ratio of interest expenses over average total deposits is known as funding cost, and it is primarily influenced by the banks' credit rating, competition, and the nature of funds. Since this ratio represents a cost, it is expected that it will have a negative impact on banks profitability. This theory is verified by Dietrich and Wanzenried (2011, 2014); Phan et al. (2019).

Table 4: Variables Description and Expected Signs

Variables	Definition	Source	
Dependent Variables			
ROA –Return on Assets (%)		BankFocus	
ROE – Return on Equity (%)		BankFocus	
NIM – Net Interest Margin (%)		BankFocus	
Independent Variables			Expected Effect
FINTECH	Number of FinTech companies founded	SNL	-
SIZE	Log of Total Assets (€ Thousands)	BankFocus	+ / -
CAP – Capital Ratio (%)	Ratio of a bank's capital to its assets	BankFocus	+ / -
CTI – Cost to Income (%)	Ratio of total expenses over total revenues	BankFocus	-
LLP – Loan Loss Provision Ratio (%)	Loan loss provisions over total loans	BankFocus	-
DG – Deposits Growth (%)	Annual growth of deposits	BankFocus	+ / -
IIS – Interest Income Share (%)	Total interest income over total income	BankFocus	-
FC – Funding Cost (%)	Interest expenses over average total deposits	BankFocus	-

4.3 Descriptive Statistics

In this section, Table 5 illustrates the descriptive statistics for the all sample, including both commercial and cooperative banks, and Table 6 displays the results for the two groups, separately.

On average, banks NIM corresponds to 2.73%, and ROE to 3.26%, whereas ROA presented a value of 0.38%, all annual results. The disparity between the mean and the median for these dependent variables can be explained by the large variability in banks profitability in this sample, as is seen in the maximum and minimum columns.

In Europe, on average, 36 new Financial Technology firms are founded each year. However, there is a large gap between the maximum and the minimum number of FinTech companies funded. This can be explained by the fact that only eight companies were created in 2020, probably due to the COVID-19 situation.

The measure of market capitalization, CAP, is around 22% per annum. CAP, similar to other variables, presents a high discrepancy between its maximum and minimum values. For instance, the best-capitalized bank in this sample has a CAP of 104%, while the least-capitalized bank displays a CAP of only 10%.

Furthermore, CTI is 69% for the overall bank sample, which is not beneficial seeing as a high CTI ratio indicates lower bank efficiency.

The indicator of loan loss provision over total loans, which is considered as a proxy for the credit quality, was on average 0.78%. A higher ratio would imply that the bank is better prepared to resist unexpected losses, yet besides the wide range of this ratio, this number is considered appropriate across banks.

Deposits grew at a pace of 5.5% a year, on average, which is not as high as some authors claim. One reason could be that this sample consists primarily of developed countries known for a lower growth rate. This is consistent with Dietrich & Wanzenried (2014) discoveries, who found that high-income countries have lower deposit growth rates than low-income countries.

Interest income accounts for 91% of overall income, indicating a significant portion of the banks' earnings. Funding costs are quite high, accounting for 6.6%, implying that interest expenses are substantial compared to the deposits.

Except for the FinTech number, all variables were winsorized[4] at the 1% and 99% levels. Despite this technique, there is still a large variability in the variables, as evidenced by the maximum and minimum values.

Table 5: Descriptive Statistics

Variables	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
ROA (%)	0.383	0.285	5.679	-6.422	1.131	12901
ROE (%)	3.266	2.929	31.083	-43.215	7.663	12901
NIM (%)	2.738	2.034	16.664	-0.038	2.557	12901
FINTECH	36.358	41.500	52.000	8.000	13.297	12901
SIZE	13.195	13.092	19.527	9.057	1.741	12901
CAP (%)	22.125	18.260	104.623	10.275	12.988	12901
CTI (%)	69.164	68.159	199.183	12.943	20.113	12901
LLP (%)	0.780	0.219	19.735	-7.123	2.789	12901
DG (%)	5.500	4.988	91.003	-85.769	18.623	12901
IIS (%)	91.704	75.786	148.289	-21.954	18.317	12901
FC (%)	6.633	0.571	118.795	0.008	12.542	12901

Note: Table 5 shows the descriptive statistics of the variables used in the model. All variables were winsorized at the 1% and 99% levels, except for FinTech variable.

After examining the descriptive statistics for the entire sample, it is interesting to observe if they behave similarly for commercial and cooperative banks. This investigation is accessible in Table 6.

Commercial banks present higher ROA, ROE and NIM, with 0.59%, 4.23% and 4.28%, respectively. On the contrary, cooperative banks demonstrate lower values than the overall average (table 6). For instance, ROA is 0.28%, ROE is 2.79% and finally, NIM is 1.98%. This might be explained because cooperative banks typically operate on a smaller scale and provide higher interest rates on deposits.

[4] As described in the help documents available on Eviews, "with winsorizing, the extreme values are replaced by certain percentile (the trimmed minimum and maximum) of the data. It is known that winsorized estimators are usually more robust to outliers than trimming."

The descriptive statistics for the FinTech variable remain the same since this variable does not depend on the type of bank.

In general, commercial banks had greater values for all explanatory variables, except for lower growth deposits than the overall average. Therefore, they present a higher capital ratio, cost to income, loan loss provision ratio, interest income share, and funding costs compared to the overall average (Table 5). However, when considering cooperative banks, the opposite behaviour is found. Comparing with the overall average (Table 5), cooperative banks present lower capital ratio, cost to income, loan loss provision ratio, interest income share, funding costs but present higher deposits growth rate.

Table 6: Descriptive Statistics by bank type: commercial banks and cooperative banks

	Commercial Banks						Cooperative Banks					
Variables	**Mean**	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Observations**	**Mean**	**Median**	**Maximum**	**Minimum**	**Std. Dev.**	**Observations**
ROA (%)	0.593	0.553	5.679	-6.422	1.874	4259	0.279	0.247	4.400	-6.422	0.381	8642
ROE (%)	4.231	4.921	31.083	-43.215	12.006	4259	2.791	2.626	30.495	-43.215	3.993	8642
NIM (%)	4.287	2.816	16.664	-0.038	3.945	4259	1.975	1.952	7.987	-0.038	0.574	8642
FINTECH	36.358	41.500	52.000	8.000	13.297	4259	36.358	41.500	52.000	8.000	13.055	8642
SIZE	13.353	13.261	19.527	9.057	2.334	4259	13.117	13.038	19.527	9.649	1.349	8642
CAP (%)	25.506	19.400	104.623	10.275	17.780	4259	20.458	17.960	104.623	10.275	9.363	8642
CTI (%)	70.530	66.784	199.183	12.943	30.486	4259	68.491	68.390	199.183	12.943	12.023	8642
LLP (%)	1.668	0.447	19.735	-7.123	4.534	4259	0.343	0.170	19.735	-7.123	0.953	8642
DG (%)	2.499	4.118	91.003	-85.769	28.557	4259	6.979	5.113	91.003	-85.769	10.455	8642
IIS (%)	96.803	39.767	148.289	-21.954	24.303	4259	95.904	91.541	148.289	-21.954	14.429	8642
FC (%)	6.501	1.718	118.795	0.008	211.861	4259	6.747	4.949	68.728	0.081	59.985	8642

Note: Table 6 shows the descriptive statistics of the variables used in the model per bank type. All variables were winsorized at the 1% and 99% levels, except for FinTech variable.

Table 7 compares the three determinants of performance: ROA, ROE and NIM, by country, for commercial and cooperative banks.

It is verified that commercial banks present higher profitability ratios for all countries except for Bulgaria, France, Ireland and Netherlands, when ROA expresses profitability. This can be expected since commercial banks aim to maximise shareholder value, showing a more profit-oriented view. In contrast, cooperative banks tend to focus more on creating value for their costumer-owners.

Table 7: International Comparison of ROA, ROE and NIM by business model

Country	Commercial Banks			Cooperative Banks		
	ROA	ROE	NIM	ROA	ROE	NIM
Austria	0.399	5.179	4.311	0.343	3.277	1.913
Belgium	0.384	5.128	**0.970**	0.311	3.010	1.876
Bulgaria	**0.186**	4.916	4.756	0.395	4.462	2.845
Croatia	0.343	5.011	4.684	-0.571	-9.543	2.348
Czech Republic	0.463	6.359	3.412	0.287	3.431	1.144
Denmark	0.475	6.116	3.219	0.335	3.130	1.978
Finland	0.472	5.691	3.608	0.344	3.280	1.905
France	**0.221**	4.905	4.321	0.343	3.283	1.905
Germany	0.386	4.934	4.307	0.345	3.287	1.909
Ireland	**0.385**	4.989	4.351	0.399	3.677	2.035
Italy	0.461	5.224	3.974	0.343	3.277	1.912
Luxemburg	0.363	5.034	4.377	0.302	2.928	1.946
Netherlands	**0.221**	4.918	4.344	0.276	3.028	1.605
Poland	0.463	5.343	4.143	0.345	3.270	1.922
Portugal	0.413	5.073	4.166	0.331	3.173	1.890
Spain	0.462	5.247	3.977	0.344	3.272	1.921
Switzerland	0.466	5.517	3.629	0.301	2.956	1.816
United Kingdom	0.221	4.903	4.329	0.381	3.920	0.427

Note: This table excludes Estonia, Iceland, Lithuania, Norway, Russia, Sweden, and Ukraine are not included in this table since BankFocus reports that these countries have no cooperative banks.

Table 8 represents the correlation matrix for the explanatory variables present in the regression. Although there were no concerns with the correlation between the variables, even the higher positive and negative values, 0.3519 and -0.1694, respectively, are not close to serial correlation.

Table 8: Correlation Matrix

	FinTech	SIZE	CAP	CTI	LLP	DG	IIS	FC
FinTech	1.000							
SIZE	-0.072	1.000						
CAP	-0.115	-0.257	1.000					
CTI	-0.043	-0.174	-0.042	1.000				
LLP	0.086	0.048	-0.015	**-0.169**	1.000			
DG	-0.140	0.060	-0.014	-0.022	0.113	1.000		
IIS	0.064	0.045	-0.154	0.089	0.014	-0.007	1.000	
FC	**0.351**	0.134	-0.240	-0.173	0.359	0.049	0.079	1.000

4.4 Model Specification and Methodology

This research aims to assess the impact of Financial Technology companies on the performance of commercial and cooperative banks. The difference in performance between commercial and cooperative banks will also be assessed.

This investigation employs a dynamic linear model with panel data, considering both time series and cross-section data. The econometric model was built based on the studies of Athanasoglou et al. (2006); Dietrich and Wanzenried (2011, 2014); Nasserinia et al. (2014); Sharma et al. (2016); Trujillo-Ponce (2012) for three different performance measures. Moreover, this study includes the FinTech variable, as suggested by Phan et al. (2019).

$$P_{ict} = c + \beta_i FinTech_{ct} + \beta_h P_{ict-1} + \sum_{j=1}^{J} \beta_j X_{ict}^{j} + \sum_{m=1}^{M} \beta_m D_{country_c} + \sum_{p=1}^{P} \beta_p D_{year_t} + \varepsilon_{ict}$$
$$\varepsilon_{ict} = v_{ict} + u_{it} \quad (4.4.1)$$

P_{ict} represents the three performance measures employed, namely Net Interest Margin, Return on Assets and Return on Equity, for bank i, country c and time t, with i = 1,…,N, c = 1,…,N and t = 1,…,T. X it is a vector of bank-specific explanatory variables. P_{ict-1} corresponds to the one-period lagged dependent variable, the need for this variable is justified by the fact that bank profits have a proclivity to persist over time, reflecting market barriers, vulnerability to economic shocks and/or competition (Berger et al., 2000). $D_{country}$ represents a dummy that aims to capture specific characteristics of each country that remain invariant throughout the time, such as banking regulation differences. $D_{country}$ denotes a dummy time that captures particular effects that vary over time, such as economic shocks or crises. C is the constant term, $\beta_h, \beta_j, \beta_m, \beta_p$ represent the coefficients of the variables and ε_{ict} is the error term, which can be decomposed in v_{ict} (the unobserved bank-specific effect) and u_{it} (idiosyncratic risk).

Besides understanding the impact of FinTech on banks performance, by using ROA, ROE and/or NIM, as expressed in equations (4.4.2), (4.4.3), (4.4.4), respectively, it is intended to perform the same study for commercial and cooperative banks, separately.

$$ROA_{ict} = c + \beta_1 ROA_{i,t-1} + \beta_2 FinTech_{ct} + \beta_3 SIZE_{ict} + \beta_4 CAP_{ict} + \beta_5 CTI_{ict} + \beta_6 LLP_{R\,ict} + \beta_7 DG_{ict} + \beta_8 DG_{ict-1} + \beta_{10} IIS_{ict} + \beta_{11} FC_{ict} + \sum \beta_{12} D_{country_c} + \sum \beta_{13} D_{year_t} + \varepsilon_{ict} \quad (4.4.2)$$

$$ROE_{ict} = c + \beta_1 ROE_{i,t-1} + \beta_2 FinTech_{ct} + \beta_3 SIZE_{ict} + \beta_4 CAP_{ict} + \beta_5 CTI_{ict} + \beta_6 LLP\_R_{ict} + \beta_7 DG_{ict} + \beta_8 DG_{ict-1} + \beta_{10} IIS_{ict} + \beta_{11} FC_{ict} + \sum \beta_{12} D_{country_c} + \sum \beta_{13} D_{year_t} + \varepsilon_{ict} \quad (4.4.3)$$

$$NIM_{ict} = c + \beta_1 NIM_{i,t-1} + \beta_2 FinTech_{ct} + \beta_3 SIZE_{ict} + \beta_4 CAP_{ict} + \beta_5 CTI_{ict} + \beta_6 LLP\_R_{ict} + \beta_7 DG_{ict} + \beta_8 DG_{ict-1} + \beta_{10} IIS_{ict} + \beta_{11} FC_{ict} + \sum \beta_{12} D_{country_c} + \sum \beta_{13} D_{year_t} + \varepsilon_{ict}$$

This research is based on unbalanced panel data since BankFocus did not have all the values of the financial statements available for each bank for the complete time period. This occurs due to banks entering and/or exiting the market over the sample period for various reasons such as mergers or bankruptcy. However, investigations must include data for at least five years, according to Trujillo-Ponce (2012), to ensure models consistency. Accordingly, by employing a 10-year sample, the consistency of the models present in this study is assured.

To estimate a bank's performance using unbalanced panel data can be problematic. First, the factors that affect banks performance might be endogenous to the model, resulting in causality problems. Second, some of the factors that influence banks performance can be difficult to measure. For instance, bank-specific variables are often the result of management decisions, which may be difficult to consider in the model. Finally, bank-specific features can be linked to omitted variables, resulting in a correlation between independent variables and the error term. Additionally, the existence of unobserved heterogeneity across bank-specific variables is expected, as specified in the model (4.4.1) by the term v_{ict}.

To overcome the referred obstacles, two GMM approaches could be used for dynamic panel data, the first Arellano and Bond (1991) and the second, Arellano and Bover (1995) and Blundell and Bond (1998). Both methods are useful when dealing with cases of a large number

of individuals with a limited number of periods and for when the dependent variables are correlated with the past (Roodman, 2009). Arellano and Bond (1991) developed an estimator which converts all regressors to differences, and it is known as difference GMM. The estimator of Arellano and Bover (1995) and Blundell and Bond (1998), also known as system GMM, is an update to the difference GMM, and it assumes that the first differences of instrument variables are uncorrelated with the fixed effects. By proceeding as mentioned, it is possible to include more instruments, consequently increasing efficiency.

In the case of the present research, the system GMM (Generalized Method of Moments) by Arellano and Bover (1995) and Blundell and Bond (1998). The 2-step estimation was chosen. The efficiency of this estimation highly depends on the validation of the instruments, which should be uncorrelated with the error term. The instruments' validation and the number is measured using the Hansen-J statistic test (Hansen, 1982).

There is evidence that banks profits tend to persist over time and tend to be correlated with previous performance. To capture this effect, the regression model incorporates the one-period lagged dependent variable as explanatory. This study instrument for the endogenous variables with the one-period lag. An additional instrument variable was inserted, corresponds to the two-period lag of the deposits growth variable since it is a growth rate that depends on the previous period.

5. Results and Discussion

5.1 Univariate Analysis

To evaluate possible differences between commercial and cooperative banks, the differences in the averages and medians were tested for the three main performance measures. Two tests were performed, the parametrized t-test of Welch and the non-parametrized z-test of Wilcoxon.

Table 9 reveals that on average and in the median, commercial banks present higher ROA, ROE and NIM, compared to cooperative banks, thus indicating that commercial banks are more profitable in general. Again, both tests are significant at a 1% level for all performance measures.

Table 9: Performance measures comparison between commercial and cooperative banks

	Test t Welch (Average Comparison)			**Test z Wilcoxon (Median Comparison)**		
	ROA	ROE	NIM	ROA	ROE	NIM
Commercial Banks	0.5346	4.0787	3.8384	0.4884	4.6553	2.3446
Cooperative Banks	0.3462	3.3723	1.9686	0.3025	3.1757	1.9290
Test Result	-11.3461***	-6.4016***	-55.9957***	24.8213***	21.3282***	21.6050***

Note: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1% respectively.

The results are considered limited because the univariate analysis does not account for various elements that influence performance. Moreover, this analysis is based on tight assumptions since it undermines econometric problems such as heteroscedasticity and endogeneity and ignores the distribution and variance of the variables. Consequently, the multivariate analysis will provide the most reliable results.

5.2 Multivariate Analysis

5.2.1 Regression Results

As previously stated, this study is inspired in Dietrich and Wanzenried (2011) and is based on the publication of Phan et al. (2019), except that various European countries are being studied.

Table 10 corresponds to the central estimation of the traditional determinants of banking performance, using the GMM estimator. The same regression is applied to three performance proxies, ROA (Return on Assets), ROE (Return on Equity) and NIM (Net Interest Margin).

Table 10: Regression results for ROA, ROE and NIM with GMM estimator

Variables	ROA	ROE	NIM
C	0.229	-7.718	-0.154
	(2.577)	(20.843)	(0.482)
P (-1)	0.998***	1.037***	0.818***
	(0.193)	(0.168)	(0.077)
FINTECH	-0.024	-0.017	0.013
	(0.045)	(0.480)	(0.017)
SIZE	0.020	0.174	-0.015
	(0.012)	(0.113)	(0.011)
CAP	-0.003*	-0.057***	-0.000
	(0.002)	(0.022)	(0.000)
CTI	0.015***	0.153*	-0.001
	(0.004)	(0.079)	(0.002)
LLP Ratio	0.414*	4.983***	-0.005
	(0.221)	(1.205)	(0.055)
DG	-0.027	0.023	0.022
	(0.087)	(0.921)	(0.038)
DG (-1)	0.004**	0.028	0.002*
	(0.002)	(0.026)	(0.001)
IIS	-0.000***	-0.002***	0.000*
	(0.000)	(0.000)	(0.000)
FC	-0.197	-3.068	-0.019
	(0.239)	(1.994)	(0.115)
Hansen Test (p-value)	0.134	0.138	0.696
Durbin-Watson	2.245	2.336	2.152
Year Dummies	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes
Instrument No.	29	29	29

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM.

The first phase is to determine which proxy is statistically more reliable. The less significant model has the dependent variable net interest income (NIM), with only three out of ten variables being significant. On the contrary, six out of ten factors are significant when employing Return on Assets (ROA). These are encouraging findings given the research has highlighted ROA as the key criterion for evaluating banks performance.

The lagged dependent variable and IIS are significant regardless of the dependent variable used, as for CAP, CTI, LLP ratio, and DG lagged were statistically significant in two of the three regressions. FinTech, SIZE, DG, and FC, on the other hand, have no explanatory power.

Despite increased competition in Europe, the lagged dependent variable, which measures performance persistence, is statistically significant transversely to all models, indicating that bank profits are persistent from year to year. In general, if a bank makes anomalous profits in one year, future profits are expected to include a major portion of the prior year's profits. Previous research such as Athanasoglou et al. (2006), Dietrich and Wanzenried (2011), Goddard et al. (2004) and Nasserinia et al. (2014) came to similar conclusions. Furthermore, the evidence of this persistence supports the validity of the dynamic model chosen, the GMM estimator.

FinTech was determined to be non-significant for all performance indicators in this study. The sign is consistent with assumptions and past research for the ROA and ROE models (Phan et al., 2019; Wu & Yuan, 2021). The same does not occur when NIM is included as a dependent variable. Financial Technology companies can be seen as new entrants in the financial industry, therefore representing an increasing competition and consequent profit decrease (Iman, 2019; Thakor, 2019; Vives, 2017; Wang & Sui, 2020; Zhang et al., 2020).

The impact of bank size on profitability is questionable. It has a favourable impact on ROA and ROE but a negative impact on NIM, consistent with earlier research. Adam (2014); Athanasoglou et al. (2006); Trujillo-Ponce (2012); Lelissa (2014); Nasserinia et al. (2014); all agree that size is immaterial in explaining bank profitability.

In accordance with Adam (2014), Nasserinia et al. (2014), and Phan et al. (2019), the present study discovered a positive association between size and performance (ROA and ROE), implying that in general larger banks are more profitable.

As described by Dietrich and Wanzenried (2011), Lelissa (2014), Pasiouras and Kosmidou (2007) and Phan et al. (2019), when NIM is used as a performance ratio, the relationship becomes negative. According to Pasiouras and Kosmidou (2007), this can suggest the presence of scale diseconomies or a symptom of excess bureaucracies in large institutions.

The capital ratio was statistically significant for ROE and ROA and positively related to bank performance for all performance metrics, in accordance with Fiordelisi and Mare (2013);

Nasserinia et al. (2014); Phan et al. (2019) (in case of ROE); and Staikouras et al. (2004). In general, banks holding high capital levels are thought to be safer and more resilient in the face of adverse economic or external shocks.

Typically, when the cost of income rises, the bank's efficiency falls, and as a result, the bank's profitability will reduce, ceteris paribus. However, this negative relation described in the literature by Dietrich and Wanzenried (2011, 2014); Ly (2015); Phan et al. (2019) only occurs with NIM, and it is not statistically significant.

This study encountered a positive and significant association between the cost to income and ROA and ROE, contradicting earlier research. Conversely, a negative association is found with NIM, as expected since an increase in the CTI implies lower bank efficiency and a consequent decrease in performance. This last conclusion is aligned with Lelissa (2014) and Dietrich and Wanzenried (2011, 2014).

The loan loss provision ratio is a proxy for a bank's credit quality. As underlined by Athanasoglou et al. (2006), Dietrich and Wanzenried (2011, 2014), Lelissa (2014) and Phan et al. (2019), a greater ratio would imply lower credit quality and, as a result, lesser profitability. Therefore, this study satisfies expectations only when the performance measure is NIM, even though the variable has no significance in this situation.

This ratio has shown a positive and substantial association with performance in the more robust models, those using ROA and ROE, which contradicts earlier results.

Deposit growth, a proxy for bank growth, does not appear to impact banks' profitability, as this variable is statistically insignificant for all profitability indicators.

The findings are mixed. Nonetheless, a positive relationship between ROE and NIM was discovered, validating the idea that a corporation in expansion should earn larger profits. Dietrich and Wanzenried (2014); Ly (2015); and Phan et al. (2019), all support these findings.

When the parameter is ROA, the results diverge, and it was found that deposit growth negatively influences profitability, which is consistent with Dietrich and Wanzenried (2011); and Phan et al. (2019) findings. This is because if deposits are not efficiently utilized, an increase in deposits may have little influence on profitability.

Predictably, banks with a higher share of interest revenue as a percentage of overall income will be less profitable. The results are consistent with Adam (2014); Dietrich and Wanzenried (2011, 2014); Ly (2015); and Phan et al. (2019) discovered a substantial negative relationship between IIS and ROA and ROE, which is consistent with the expectations.

Funding costs are a cost to any bank. They are a burden as they constitute all losses, costs and expenses incurred by banks as a result of the borrower's failure to pay. Consequently, a

negative impact of this variable was expected and founded for all three-performance measures, although not statistically significant. This is corroborated by Dietrich and Wanzenried (2011, 2014); and Phan et al. (2019).

5.2.2 Results with the Interactions of FINTECH with SIZE, CAP and CTI

Table 11 shows the results of the two-step GMM regression, as in the previous section, but now includes the interaction between three explanatory variables and the FinTech variable. This estimation aims to understand the main drivers of the negative relationship between Financial Technology companies and banks performance.

Table 11: Results of the interaction of FinTech with SIZE, CAP and CTI

Variables	ROA	ROE	NIM	ROA	ROA	ROA
C	-5.713***	-69.552***	-1.388***	-1.988*	-1.3	-0.852***
	(1.260)	(15.186)	(0.252)	(1.086)	(0.821)	(0.27)
P (-1)	0.822***	0.962***	0.880***	1.040***	1.064***	0.880***
	(0.131)	(0.14)	(0.014)	(0.166)	(0.177)	(0.013)
FINTECH	0.147***	1.714***	0.043***	0.025	0.002	0.027***
	(0.023)	(0.295)	(0.005)	(0.018)	(0.008)	(0.005)
SIZE	0.133***	1.408***	0.030***	0.073	0.023*	-0.005
	(0.039)	(0.417)	(0.008)	(0.047)	(0.012)	(0.003)
CAP	-0.005	-0.138**	0.003	-0.003	-0.01	-0.001
	(0.005)	(0.062)	(0.002)	(0.002)	(0.007)	(0.001)
CTI	0.058***	0.732***	0.014***	0.014***	0.015***	0.014***
	(0.01)	(0.138)	(0.003)	(0.004)	(0.005)	(0.003)
LLP Ratio	0.346***	4.608***	-0.045***	0.510***	0.526***	-0.046***
	(0.112)	(1.147)	(0.013)	(0.137)	(0.146)	(0.013)
DG	0.024	0.217	-0.006	0.027	0.03	-0.006
	(0.018)	(0.194)	(0.005)	(0.019)	(0.021)	(0.005)
DG(-1)	0.002**	0.02	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.012)	(0.000)	(0.001)	(0.001)	(0.000)
IIS	0.000***	-0.003***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FC	-0.324***	-3.931***	0.050***	-0.327***	-0.342***	0.049***
	(0.075)	(0.814)	(0.018)	(0.085)	(0.093)	(0.018)
FINTECH*SIZE	-0.003***	-0.035***	-0.001***	-0.002		
	(0.001)	(0.011)	(0.000)	(0.001)		
FINTECH*CAP	0.000	0.003	0.000**		0.000	
	(0.000)	(0.002)	(0.000)		(0.000)	
FINTECH*CTI	-0.001***	-0.017***	0.000***			0.000***
	(0.000)	(0.003)	(0.000)			(0.000)
Hansen Test (p-value)	0.117	0.207	0.634	0.252	0.301	0.515
Durbin-Watson	2.012	2.112	2.129	2.189	2.183	2.121
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Instrument No.	32	32	32	30	30	30

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM. The evaluation of the interceptions individually, is only presented for ROA, due to space purposes. The results for ROE and NIM can be found in the appendix.

The results show a negative and significant effect of the FinTech*Size variable. This means that larger banks are more sensible to the (negative) impact of FinTech in banks performance. This result is consistent throughout all performance measures studied and findings are as expected. Therefore, hypothesis two is accepted.

The variable FinTech*CAP appears to be to be non-significant for the main proxies of banks profitability, ROA and ROE. In addition, this variable does not seem to be responsible for the negative impact of FinTech in banks performance. The latter conclusion can be extended to the Net Interest Margin, although it presents statistical significance at 5%. Then, hypothesis three is rejected.

When considering the interaction of FinTech and the cost to income, the results suggest a negative and significant effect at 1% level. Meaning that less efficient banks (banks with higher CTI), would be more susceptible to the negative impact of FinTech in banks performance. This result is consistent with the hypothesis four.

When considering the effect of the interactions individually, the statistical significance disappears, except for the interaction between FinTech and cost to income.

5.3 Robustness Tests

Estimating bank performance poses several difficulties. The fixed effect estimate model implies that the variables between banks remain constant throughout time. When using OLS, variables are supposed to be random and unpredictable. Theoretically, OLS unsuitable for the model used in this investigation since the inclusion of individual bank effects in the error term causes non-zero covariance between the latter and the lagged dependent variable. In general, when using least-squares techniques (fixed or random effects), we encounter bias and inconsistent estimates, especially when dealing with small-time windows.

Table 12: Robustness Tests – OLS and Fixed Effects Estimation

Variables	OLS			Fixed Effects		
	ROA	ROE	NIM	ROA	ROE	NIM
c	3.791***	35.013***	2.683***	0.149	11.599***	4.294***
	(0.406)	(4.894)	(0.326)	(0.329)	(3.994)	(0.300)
P (-1)	0.308***	0.294***	0.829***	0.030***	0.006***	0.516***
	(0.008)	(0.009)	(0.005)	(0.009)	(0.010)	(0.010)
FinTech	-0.048***	-0.430***	-0.044***	0.001***	0.011	0.003***
	(0.009)	(0.111)	(0.007)	(0.000)	(0.003)	(0.000)
SIZE	-0.023***	-0.183***	-0.016***	0.100***	0.302	-0.238***
	(0.002)	(0.028)	(0.002)	(0.024)	(0.291)	(0.021)
CAP	0.002***	-0.006	-0.002***	0.003***	0.054***	-0.003***
	(0.001)	(0.005)	(0.000)	(0.000)	(0.010)	(0.000)
CTI	-0.012***	-0.127***	-0.001***	-0.018***	-0.202***	-0.004***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.004)	(0.000)
LLP	-0.204***	-2.052***	0.002	-0.245***	-2.498***	-0.013***
	(0.003)	(0.044)	(0.002)	(0.004)	(0.048)	(0.003)
DG	0.000	0.015***	-0.006***	-0.000	0.007*	-0.005***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.003)	(0.000)
DG (-1)	0.000**	0.004	0.002***	0.000	0.002	0.001***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.003)	(0.000)
IIS	0.000***	-0.000***	0.000	0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FC	-0.009	0.014	-0.028***	0.033***	0.269***	-0.016**
	(0.009)	(0.110)	(0.007)	(0.008)	(0.102)	(0.007)
Durbin-Watson stat	1.927	1.961	1.753	2.160	2.149	1.880
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM.

To verify the robustness of the econometric model applied, the same estimation was done using two different methods, the OLS (Ordinary Least Squares) and fixed effects, as detailed in Table 12. In order to find the best method to apply, the Hausman test was performed. In this test, the null hypothesis represents the random effects. This hypothesis was rejected because the p-value found was lower than 0.05. Therefore, it was concluded that the estimation through the fixed effects method is the most appropriate.

FinTech is statistically significant for all performance indicators and for the two estimation methodologies, as shown in table 12. When applying OLS, similar to GMM, the sign is the expected (negative). The same does not apply to the fixed effects estimator.

Concerning the signs of the explanatory variables, the findings were the following: a) Fixed effects are the closest technique for Return on Assets; b) OLS is the closest method for Return on Equity; and c) while using Net Interest Income, the results signs are equal, except for the deposit's growth variable.

When estimating the model through OLS or fixed effects, a slight increase in statistically significant variables is visible. Despite this, neither of these models is correct for the endogeneity problems of the model. Therefore, OLS and fixed effects estimators would be considered non-consistent.

6. Conclusions and Limitations

In this section, the main conclusion and limitations resulting from this study will be presented.

6.1 Conclusions

. This research evaluates the impact of the growing number of Financial Technology companies in the performance of European commercial and cooperative banks. In addition, this study aimds to understand what the drivers of this negative relationship between FinTech and banks performance are. To achieve this purpose, an unbalanced panel data was used. The data was gathered from two independent sources: SNL Financials for all the FinTech related data and BankScope for bank's related data, for a period of ten years, from 2011 to 2020. The sample comprises 342 FinTech companies and 3215 listed and non-listed European banks, including, 1362 commercial banks and 1853 cooperative banks.

Different performance measures were tested, namely, Return on Assets, Return on Equity and Net Interest Income.

Starting with the univariate analysis, the differences on the averages and median of commercial and cooperative banks were evaluated. Two tests were performed: the parametrized t-test of Welch and the non-parametrized z-test of Wilcoxon. Both tests are significant at a 1% level for all performance measures. The results reveal that commercial banks present higher profitability ratios for all performance measures (ROA, ROE and NIM), both on average and on medians.

The multivariate analysis demonstrated that the model with the net interest income metric is the weakest of the three. In addition, this analysis shows a high level of profits' persistence over time for all performance metrics. This result is corroborated by Athanasoglou et al. (2006); Dietrich and Wanzenried (2011); Goddard et al. (2004); Nasserinia et al. (2014).

Generally, all bank-specific determinants of bank performance present the expected sign, at least in one of the three performance measure. Considering ROA and ROE as measures of performance, the following variables presented the expected sign: size, CAP, DG, IIS and FC. On the contrary, cost to income and loan loss provisions present a positive sign. Bearing in mind Net Interest Income as an independent variable, all bank-specific determinants of banks performance correspond to the expectations.

The most relevant variable of this study, FinTech, showed a negative impact on banks performance, as expected, but only for two of the three measures, ROA and ROE. As mentioned

in section 2, these new technological companies can be seen as new entrants in the financial industry, therefore representing an increasing competition and consequent decrease in profits.

The contrary occurs when using NIM, where a positive impact of FinTech in banks performance was found. As stated in the literature, there is a possible complementarity between Financial Technology firms and traditional banks.

FinTech reveals to have no statistical significance for either measure of performance. Therefore, hypothesis one is rejected for all performance measures.

Concerning the study of the main drivers of the theoretical negative relation between FinTech and banks performance, the results were the following: hypothesis two is verified, as larger banks are expected to be more susceptible to the innovations brought about by Financial Technology companies. Therefore, bank performance becomes more vulnerable to the negative impact of FinTech.

As for the interaction of FinTech with the bank's capital ratio, the results are not the expected. The results show that this variable is hardly even statistically significant, meaning that CAP is not a driver of the negative impact of FinTech in banks performance. Therefore, hypothesis three is not verified for either of the performance measures.

Finally, when evaluating the interaction of FinTech and the cost to income, this relation proves to be negative and statistically significant at 1% level, for all proxies of performance. Theoretically, by applying digital technology to the financial industry traditional banking services become more efficient. Hypothesis four is verified, since the results demonstrate that banks with higher CTI are more vulnerable to the negative impact of FinTech in banks performance.

The robustness analysis consisted in the estimation through OLS and fixed effects, since random effects estimation was excluded by the Hausman test. The results in terms of sign were similar to those obtained with GMM. The main difference was a slight increase in the number of variables statistically significant. Despite, neither OLS nor fixed effects correct the endogeneity problems of the model, therefore, OLS and fixed effects estimators would be considered non-consistent.

6.2 Limitations

The main limitations of this research are related with the data availability and with the estimation method chosen.

Technology applied to the financial industry is a recent subject, therefore, FinTech related data is scarce and difficult to obtain. Additionally, all variables described, except for FinTech were winsorized at the 1% and 99% level, with the objective of reducing the impact of outliers without losing observations. In spite of this procedure, in general, a large dispersion in the variables was found, as indicated by the maximum and minimum values. Moreover, when including unlisted banks in the sample, some potential estimation bias can be expected.

In view of the estimation method used – GMM estimator – it highly depends on the choice of instrument variables. This problem is mitigated by the Hansen test, which is responsible for the validation of the instruments. Nonetheless, this method is new, and it has recently become popular among researchers.

Appendix

The following three appendixes show the computations of the interactions of FINTECH with SIZE, CAP and CTI, individually. The same regression was performed by multiplying FINTECH for the dummy variables. The conclusions were the same.

Appendix 1: Interaction of FINTECH and SIZE, for ROA, ROE and NIM

Variables	ROA	ROE	NIM
C	-1.988*	-14.872*	0.076
	1.086	9.015	0.133
P (-1)	1.040***	1.015***	0.878***
	0.166	0.138	0.013
FINTECH	0.025	0.181	0.003
	0.018	0.172	0.004
SIZE	0.073	0.473	0.002
	0.047	0.443	0.01
CAP	-0.003	-0.055***	-0.001
	0.002	0.021	0.001
CTI	0.014***	0.141***	0.001
	0.004	0.039	0.000
LLP Ratio	0.510***	4.996***	-0.046***
	0.137	1.12	0.012
DG	0.027	0.156	-0.007
	0.019	0.186	0.005
DG (-1)	0.003***	0.024**	0.003***
	0.001	0.012	0.000
IIS	0.000***	-0.003*	0.000***
	0.000	0.000	0.000
FC	-0.327***	-3.278*	0.069***
	0.085	0.774	0.018
FINTECH*SIZE	-0.002	-0.009	0.000
	0.001	0.013	0.000
Hansen Test (p-value)	0.252	0.312	0.335
Durbin-Watson	2.189	2.321	2.297
Year Dummies	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes
Instrument No.	30	30	30

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM.

Appendix 2: Interaction of FINTECH and CAP, for ROA, ROE and NIM

Variables	ROA	ROE	NIM
C	-1.300	-9.073	0.134
	0.821	7.082	0.150
P (-1)	1.064***	1.015***	0.881***
	0.177	0.139	0.013
FINTECH	0.002	0.002	0.001
	0.008	0.081	0.002
SIZE	0.023*	0.161	-0.007**
	0.012	0.105	0.003
CAP	-0.010	-0.150**	0.002
	0.007	0.067	0.002
CTI	0.015***	0.140***	0.001
	0.005	0.039	0.000
LLP Ratio	0.526***	4.963***	-0.046***
	0.146	1.128	0.012
DG	0.030	0.181	-0.008
	0.021	0.196	0.005
DG (-1)	0.003***	0.026**	0.003***
	0.001	0.012	0.000
IIS	0.000***	-0.003***	0.000***
	0.000	0.000	0.000
FC	-0.342***	-3.296***	0.068***
	0.093	0.801	0.019
FINTECH*CAP	0.000	0.003	0.000
	0.000	0.002	0.000
Hansen Test (p-value)	0.301	0.337	0.299
Durbin-Watson	2.183	2.315	2.298
Year Dummies	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes
Instrument No.	30	30	30

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM.

Appendix 3: Interaction of FINTECH and CTI, for ROA, ROE and NIM

Variables	ROA	ROE	NIM
C	-4.484***	-56.273***	-0.852***
	1.133	13.741	0.270
P (-1)	0.875***	0.991***	0.880***
	0.149	0.147	0.013
FINTECH	0.105***	1.304***	0.027***
	0.019	0.254	0.005
SIZE	0.022*	0.251**	-0.005
	0.011	0.120	0.003
CAP	-0.002	-0.055**	-0.001
	0.002	0.022	0.001
CTI	0.060***	0.733***	0.014***
	0.011	0.142	0.003
LLP Ratio	0.390***	4.882***	-0.046***
	0.128	1.213	0.013
DG	0.029	0.245	-0.006
	0.020	0.204	0.005
DG (-1)	0.002**	0.020	0.003***
	0.001	0.013	0.000
IIS	0.000***	-0.003***	0.000***
	0.000	0.000	0.000
FC	-0.364***	-4.270***	0.049***
	0.089	0.897	0.018
FINTECH*CTI	-0.001***	-0.017***	0.000***
	0.000	0.003	0.000
Hansen Test (p-value)	0.204	0.287	0.515
Durbin-Watson	2.019	2.119	2.121
Year Dummies	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes
Instrument No.	30	30	30

Notes: (*), (**) and (***), represent the statistical significance at 10%, 5% and 1%, respectively, and P represents the three performance measures, ROA, ROE and NIM.

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Attachments

Attachment 1: FinTech Sample Distribution by Country and Industry

Country	Total	Banking Technology	Digital Lending	Financial Media and Data Solutions	Insurance Technology	Investment and Capital Markets Technology	Private Companies	Public Companies
Austria	6	2	0	2	0	2	6	0
Belgium	3	0	1	0	1	1	3	0
Bulgaria	2	0	2	0	0	0	2	0
Croatia	2	0	1	0	1	0	2	0
Czech Republic	1	0	0	0	1	0	1	0
Denmark	5	2	2	0	0	1	5	0
Estonia	6	2	2	1	1	0	6	0
Finland	6	2	2	2	0	0	5	1
France	23	4	3	3	8	5	23	0
Germany	56	10	10	3	21	12	55	1
Iceland	1	1	0	0	0	0	1	0
Ireland	9	3	1	1	1	3	9	0
Italy	10	3	1	1	2	3	10	0
Lithuania	3	1	2	0	0	0	2	1
Luxemburg	2	1	1	0	0	0	1	1
Netherlands	9	3	2	0	3	1	9	0
Norway	3	1	0	0	1	1	3	0
Poland	4	1	2	0	1	0	4	0
Portugal	1	1	0	0	0	0	1	0
Russia	8	4	1	1	1	1	8	0
Spain	12	3	4	1	2	2	12	0
Sweden	16	4	7	2	1	2	16	0
Switzerland	17	4	3	1	3	6	17	0
Ukraine	1	0	1	0	0	0	1	0
United Kingdom	136	23	24	18	29	42	134	2
Total	342	75	72	36	77	82	336	6