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The Impact of Fintech in the Performance of European Commercial Banks

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Declaration of Authorship

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Abstract

In the last decade, the financial sector has witnessed a constant evolution in the services it provides due to digitalization. Therefore, terminology financial technology, or Fintech, has become a common presence in the day-to-day of most population. With the emergence of these new financial technology companies, traditional institutions such as banks felt the pressure of competition through many outlines. Thus, the aim of this research is to comprehensively investigate and analyse the impact of Fintech on the performance of commercial banks, with a focus on key performance indicators such as profitability and efficiency. A total of 816 commercial banks from 20 European countries make up the study's sample. The period of analysis was from 2012 to 2021 and 202 Fintech companies founded during this period the number were considered relevant for the analysis. The study was performed using the GMM (Generalized Method of Moments) estimator and the main results show that the formation of fintech companies has a significant negative impact on bank's profitability. Also, results show that returns of larger banks are more susceptible to the unfavourable effects of fintech creation, considering the size of the banks.

Key words

Bank Performance, Dynamic Panel Data, Financial Technology (Fintech), Generalized Method of Moments (GMM), Profitability

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Introduction

The role of banks is essential to the functioning of the general economy since they act as financial intermediaries (Demirgüç-Kunt & Huizinga, 1999). Therefore, a bank's function is to raise savings from those who experience a surplus to those who have a deficit, in order to fund activities. The role of the banking industry has immense significance to the economy since there is a great dependence on the services they provide. Taking this into consideration, any failure of the banking industry would cause economic consequences at a worldwide scale, meaning that the way that banks operate their businesses is crucial. (Sharma et al. 2016).

In fact, the banking industry is considered to be the vital component of the economy, since it provides credit and enables individuals and companies to save, invest, and spend more, all of which contributes to economic growth. The economy cannot function without banks, but it would be paralyzed without access to credit. (Naili & Lahrichi, 2020). Bank's business models are the result of managerial decisions regarding the type of activities it provides, funding sources, diversification in products and size (Marques & Alves, 2020).

In any economy, commercial banks are the main source of financial intermediaries. They run the payment system and are the primary lenders to the private and business sectors. Globalization, rivalry from nonbanking financial organizations, and pressures from fluctuating market dynamics have all been directed towards commercial banks (Casu et al, 2006). As a result, commercial banks have to deal with a variety of macroeconomic environments, as well as explicit and implicit tax regulations, deposit insurance policies, the status of the financial markets, and international institutional and legal realities (Demirgüc-Kunt & Huizinga, 1999). Thus, commercial banks are for-profit organizations that operate under their shareholders control, performing universal banking services according to efficiency standards (Salas & Saurina, 2002).

Confronted with the financial crisis of 2008, the banking industry and main financial institutions showed their vulnerability towards any disruption in the

economy. This came to prove that governments, regulators, and market participants needed to adjust their strategies of response and ensure that the next financial crisis would create minimal consequences (Sharma et al. 2016).

Analysing the financial performance of an economy's banks is essential to determining its overall financial health (Adam, 2014). Academic researchers, bank management, and financial markets have all expressed interest in learning more about the factors that influence bank performance (Athanasoglou et al., 2008). Nevertheless, managers' basic reliance on financial performance metrics shapes organization strategy, especially in the short term. Furthermore, financial metrics have been used for many years, and managers usually feel comfortable using them (Adam, 2014).

Over the years, Return on Equity, Net Interest Margins, and Return on Assets have been the main dependent variables in studies on bank profitability. (Dietrich & Wanzenried, 2011). Studies that analyse bank performance in the literature currently in publication categorize the control variables into three groups: macroeconomic indicators, industry-specific factors, and bank-specific factors (Alfadli & Rjoub, 2020). Nevertheless, it is also possible to separate the internal and external components that affect bank profitability. Internal determinants are the management choices that have an impact on the bank's operational results (Staikouras & Wood, 2004). The external determinants are factors unrelated to bank management that have an impact on the operation and performance of financial institutions. These factors include the legal and economic environments (Athanasoglou et al., 2008).

A number of authors, including Goddard et al. (2004), Staikouras & Wood (2004), Athanasoglou et al. (2008), Adam (2014), Sharma et al. (2016), Menicucci & Paolucci (2016), Dietrich & Wanzenried (2011, 2014) have employed ROE and ROA for the analysis of bank profitability. Since its introduction by Nasserinia et al. (2014), the performance metric of NIM has been widely utilized in the analysis of bank profitability by a number of authors.

The assessment of the determinants of bank profitability has now become more critical since the relentless advance of digitalization. The financial world has

undergone a profound and transforming evolution and this paradigm shift affects financial institutions' back-office operations as well as their user interface.

Fintech is a relatively new concept of Financial Technology and has become one of the world's largest sectors since its inception. As a result, the banking sector is made up of both banks and other conventional financial institutions as well as technology start-ups that are beginning to control the majority of the market (Iman, 2019). The financial industry now offers a new stream of financial services as a result of this creative combination. The new stream has shown to be more successful and efficient in this industry than the conventional method of delivering financial services by traditional institutions, since the general population resorts to services provided by fintech companies on a daily basis, being payments systems like Apple Pay or Google Pay, contactless systems or even mobile banking systems (Kumar, 2020).

Financial Technology companies are able to upend established industries by creating new big data-driven business models and regulations must change to allow these companies to function without jeopardizing the stability of traditional banks and financial institutions. These new competitors are able to utilize hard information to spread the traditional relationship between banks and consumers, which is based solely on soft information. (Vives, 2017).

Given the novelty of these new companies, few studies have been conducted to understand the real impact of these companies on the performance of traditional banks. Authors like Phan et al. (2020) and Chen et al. (2021), studied the impact of fintech companies on the profitability of banks on a single country analysis. Considering this, the purpose of this study is to add to existing literature by providing a multiple country analysis.

Based on the studies conducted by Dietrich & Wanzenried (2011, 2014), Phan et al. (2020) and Rua (2022), this research aims to investigate the impact of fintech companies on the performance of European commercial banks, with a focus on key performance indicators such as profitability and efficiency and new fintech related variables such as number of mobile subscriptions and venture capital investment to assess the impact of the drivers of fintech in the actual performance measures of banks.

The sample used in the study consists of a total of 816 commercial banks, listed and non-listed from 20 European countries. The period of analysis considered was from 2012 to 2021 and during this period the number of Fintech companies founded and relevant to the study were 202 Fintech companies. The study was performed using the GMM (Generalized Method of Moments).

The Final Thesis contributes to a better understanding of the dynamics between the traditional banking sector and innovative financial technologies, which is crucial for navigating the rapidly changing financial landscape.

Thus, the following is the order in which this dissertation is structured: Chapter one presents the determinants of bank performance. The theoretical foundation for fintech, its rivalry with traditional banks, and the primary findings of academic research are presented in Chapter 2. Insights on fintech integration and European financial markets are given in Chapter 3. The data sample, variable descriptions, and methodology are presented in Chapter 4. Regression model results and key discoveries are covered in Chapter 5, and all study conclusions and key limitations are covered in Chapter 6.

1 Determinants of Bank Performance

In this section it will be covered theoretical framework on bank performance, as well as its measures, focusing on different approaches made by authors over the years to access the impact of operational performance and balance sheet structure on overall performance, as well as assessing for macroeconomic variables. Adding to this, a literature review of the main studies will be made, as well as main conclusions regarding the subject.

1.1 Overview of Bank Performance

A bank is an intermediary that transfers savings from those with excess money to people who are short on cash for productive endeavours. As a result, banks offer a variety of financial services to the general public and address asymmetric information issues. (Sharma et al., 2016). It is commonly known that by transforming deposits into profitable investments, the banking industry contributes significantly to economic acceleration and financial intermediation, meaning that those financial institutions are crucial for the general population (Hajková, 2020). By consequence their stability is critical for the well function of the entire financial system (Menicucci & Paolucci, 2016).

Traditional banks are facing a heavy level of competition from the new companies that are entering the market. To stay competitive, traditional banks are diversifying in transformation initiatives, as mobile banking apps and portals. Even though traditional banks are facing this fierce competition, core services are still being provided to the general population. Furthermore, traditional commercial banking dominates the market, showing a projected market value of US$2.50 trillion in 2024. Nevertheless, also Net Interest Income is expected to grow at the annual rate of 0.95% until 2028 (Statista, 2024).

Thus, in order to finance economic activity in general, the role of banks continues to be crucial. It is then agreed that a stable baking sector is a requirement for sustainable economic development (Menicucci & Paolucci, 2016) and can better

endure unfavourable shocks and support the stability of the financial system (Athanasoglou et al., 2008).

An efficient financial system should show increased profitability, a rise in the amount of funds flowing from savers to borrowers, as well as high-quality consumer services (Menicucci & Paolucci, 2016).

The 2008 financial crisis showed that banks and financial institutions are very volatile and that a single deviation from efficiency would drastically affect the economic system of the entire world. In accordance, it is necessary that both governments and market participants adjust their strategies to ensure minimum impact on a possible next crisis, which means that the way that banks operate became an important area of study around the financial markets (Sharma et al., 2016).

In addition, facing the Covid-19 pandemic, the banking sector all over Europe faced an uncertainty period in which drastic disruptions were caused. Therefore, central banks and European Governments implemented several policies to migrate the impact of the pandemic on the general economy such as subsidies and business loans, as well as the policy of near zero interest rates which made it difficult for banks to operate in profitable environment with smaller lending margins and poorer investment returns (Jílková & Kotěšovcová, 2022).

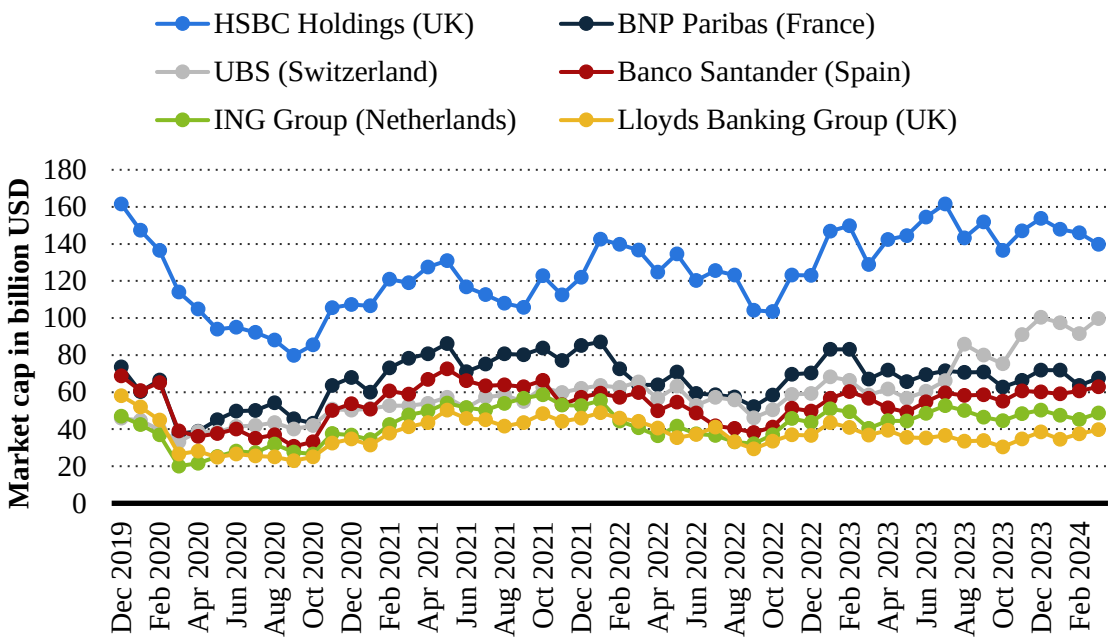
While some policies attempted to lessen the immediate tightening of financial conditions, others supported the flow of credit to businesses by easing bank restrictions on the use of capital buffers or directly intervening in the credit markets through government-sponsored credit lines and liability guarantees, among other means. Therefore, lenders saw a decline in asset quality, endangering the stability of the systems (Demirgüç-Kunt et al., 2021).

In accordance, the financial markets were severely impacted by the Covid-19 outbreak in 2020. As evidenced in Figure 1, between December 31, 2019, and October 31, 2020, the market capitalization values of several of the biggest banks in Europe, including Hong Kong and Shanghai Banking Corporation (HSBC) and Banco Santander, nearly dropped. After October 2020, the market capitalization of the biggest

European banks rose, but a new downward trend was initiated by the economic uncertainty of 2022 (Statista, 2024).

Therefore, to assess the financial health of an economy it is necessary to study the financial performance of its banks (Adam, 2014) and the determinants of bank performance have attracted many interests on behalf of academic researchers, bank management and financial markets (Athanasoglou et al., 2008)

Figure 1 - Monthly market capitalization of Europe's largest banks since the coronavirus from December 2019 to March 2024



Source: Statista, 2024

1.2 Factors Influencing Banks Performance

Over the past years, several studies have been conducted in order to analyse the determinants of bank's performance. Most of the studies have been focused on the relationship between bank's earnings and operational performance (Athanasoglou et al., 2008; Wirnkar & Tanko, 2008) as some other studies explore the tie between performance and balance sheet structure, with regards of macroeconomic determinants (Staikouras & Wood, 2004; Sharma et. al, 2016).

The performance of banks can be determined by internal factors and external factors. As highlighted by Staikouras & Wood (2004), bank performance determinants

can be divided in internal and external determinants. Therefore, decisions made by management and reflected in the bank's operating outcomes are known as internal factors (Staikouras & Wood, 2004). Since it is commonly believed that an analysis of financial ratios pertaining to profitability has a bearing on a bank's performance, this one is determined by Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM), all of which are seen to be metrics exclusively related to each bank individually (Dietrich & Wanzenried, 2011).

Goddard et al. (2004), Staikouras & Wood (2004), Athanasoglou et al. (2008), Adam (2014), Sharma et al. (2016), Menicucci & Paolucci (2016) used return on equity and return on assets for the analysis of bank profitability. While Dietrich & Wanzenried (2011) and Pasiouras & Kosmidou (2007) instead of ROA and ROE, used return on average assets and return on average equity to measure profitability with regards for variations in assets along the fiscal year. The performance measure of NIM was introduced by Nasserinia et al. (2014) that stated that this indicator can be used as a performance factor of effectiveness in intermediation and can also be a proxy for industry competition, since high margins can create constrains to financial intermediation by lowering deposit rates with a result in less deposits and high lending rates.

Different authors consider different internal factors. Such ratios are related to liquidity, bank’s strength, loans, efficiency, and level of competition. For example, when considering multiple country analysis, Goddard et al. (2004), examined the relationship between profitability and growth using commercial, savings, and cooperative banks from five EU member states. Internal metrics including the capital to asset ratio and bank size were utilized in the analysis to assess bank performance. The outcomes demonstrated that while the capital to asset ratio has a beneficial effect on earnings, size has almost no effect on performance. Staikouras & Wood (2004) performed an analysis using also countries from the EU to examine how both external and internal factors affect the banking industry's performance. Several metrics were used as control variables such as equity to assets ratio, total assets, loans to assets ratio and loan loss provision. The data was also divided according to bank size. The results provided an overall understanding of profitability being positively influenced by size

and capital ratio, considering also that GDP presents a negative impact. Pasiouras & Kosmidou (2007), studied how bank's specific determinants such as bank's total assets, cost to income ratio, equity to assets and loans to short funding ratio, and also banking environment affects the profitability of commercial banks in 15 EU countries, with a focus on nationality, with distinction between national and foreign banks. The results suggest that equity to assets is positively related to profitability, while cost to income and size showed a negative impact. Also, Dietrich & Wanzenried (2014) investigated the impact on profitability in a multiple country analysis using capital ratio, cost to income ratio, loss loan provision, growth deposits, interest income and funding costs.

Turning to authors that performed their studies using only one country in the analysis, Athanasoglou et al. (2008) studied the impact of bank-specific, industry-specific, and macroeconomic determinants of bank profitability on Greek banks. The findings showed that all bank-specific determinants impacted bank profitability, with the exception of size. Wirnkar & Tanko (2008), carried out a study to find the adequacy of CAMEL factors in capturing the performance of a bank. The CAMEL system consists in five parts, capital adequacy, asset quality, management quality, earnings ability, and liquidity and each of the factors is scored from 1 to 5, 1 being the strongest. In a sample of commercial banks from Nigeria, the authors concluded that there is inability in each factor of the CAMEL to capture the overall performance of a bank.

Dietrich & Wanzenried (2011), performed an analysis on the profitability of commercial banks in Switzerland, considering the impact of the financial crisis. Thus, it was used cost to income ratio, equity over total assets, bank size, loan loss provision and interest income share as control variables in the model. Accordingly, bank profitability is mainly explained by operational efficiency, growth of total loans, funding costs and bank business model.

By employing a study on a single bank, the Erbil Bank for Investment and Finance in Iraq, Adam (2014) based his research on financial ratios, bank size and overall capital. Conclusions demonstrated that the size of the bank is positively related to performance while the level of capitalization showed a negative impact. Nasserinia et al. (2014) used NIM as dependent variable to examine the impact of bank-specific

determinants and external macroeconomic factors on profitability. To account for control variables, it was used measures of liquidity risk, credit risk, capital adequacy, managerial efficiency, income diversification and size. Thus, NIM is negatively correlated with credit risk and capital adequacy, and there is a positive relation of the dependent variable with liquidity risk and management efficiency. Sharma et al. (2016) performed an analysis of Russian banking sector, using ratios such as debt to equity ratio and current ratio, as well as total assets, total equity, net loans, and net income to assess bank's profitability.

The external determinants which are mainly reflections of the legal and economic contexts that will affects the bank's operations are completely unrelated to bank management (Athanasoglou et al., 2008). Therefore, macroeconomic variables such as inflation, interest rates, GDP, industry concentration and business cycles with focuses on the last financial crisis, are considered in several studies mentioned above (Staikouras & Wood (2004); Athanasoglou et al. (2008); Pasioras & Kosmidou (2007); Dietrich & Wanzenried (2011, 2014); Nasserinia et al. (2014)).

2 Theoretical Framework on Fintech

This chapter will present the overall knowledge on Fintech by covering Fintech emergency and digital transformation in recent years. Further it will cover the competition between fintech companies and commercial banks and how commercial banks are starting to modify their business models in order to compete with emerging companies. Lastly it will be presented a literature review comprising the main studies and main conclusions of the impact of these financial technology companies on the performance of banks, using different approaches to evaluate the impact.

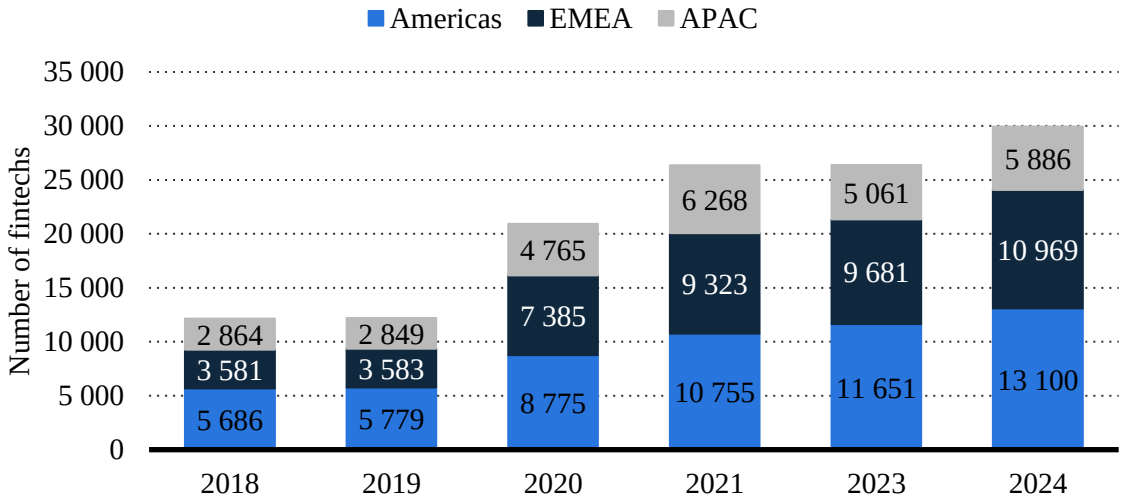
2.1 Fintech and Digital Transformation

The banking sector has experienced significant changes due to advancements in FinTech, as noted by Zhao et al. (2022) and Chen et al. (2021). The world is undergoing an unprecedented transformation driven by rapidly evolving technologies, influencing various aspects such as smart cities, transportation, green energy, e-commerce, public administration, e-learning, information inclusion, health, and culture. This rapid evolution is fuelled by a range of technologies, including big data, social media, cloud computing, blockchain, augmented reality, virtual artificial intelligence, and machine learning.

Fintech is a recent concept of financial technology and since it first emerged has grown into one of the biggest industries in the world. Thus, the banking industry is composed not only of banks and traditional financial institutions, but also of technology start-up companies that are starting to dominate most of the industry (Iman, 2019).

According to Figure 2, the Americas have the highest number of fintech startups worldwide as of May 2023, with 11,651 startups in this area. Comparatively, there were 5,061 fintech startups in the Asia Pacific region and 9,681 in the EMEA (Europe, the Middle East, and Africa) region. When it comes to the number of fintech unicorns worldwide in 2023, the United States led the pack with almost five times as many as the United Kingdom, which came in second (Statista, 2024).

Figure 2 - Number of fintech startups worldwide from 2018 to 2023 by region.



Source: Statista, 2024

The terminology of "fintech" emerged in the 90's when a group called Citigroup initiated a project called "Financial Services Technology Consortium" with the intention of unifying technology and financial services. Since 2014, this concept has turned into a new influx of technology and platforms that have made products in the financial industry more accessible and more efficient to the general public (Iman, 2019).

When considering the technological innovation that fintech brought into the market, one must look further than just the payment method. In this way, fintech penetrated into fields like funding, financing, asset management, banking services, insurance, and cryptocurrency (Iman, 2019).

Therefore, fintech is known for the use of innovation and automation technology in financial services (Vives, 2017) and refers to the processes and products that are available for financial services thanks to digital transformation in new technologies (Navaretti et al. 2017). The Financial Stability Board defines digital transformation as the adoption of technologies that enhance the transparency and quality of financial services, encompassing new applications, products, business models, and processes (Financial Stability Board, 2017). The concept involves the utilization of digital technologies and platforms to streamline financial services, transactions, and management, as articulated by the European Commission (2022).

It is known that fintech has the capability to disrupt a well-established industry, with the generation of new business models based on big data, therefore regulations need to adapt so that these technological firms can deliver results without compromising the financial stability of traditional banks and financial institutions (Vives, 2017).

Nevertheless, the true impact of these firms is beginning to be felt in the banking sector and capital markets. As already mentioned, fintech emerged in various fields, but the main developments have occurred in lending, payment systems, financial advising and insurance. These late developments allowed fintech companies to lower the cost of intermediation and provide a broader access to financial services, which means that this new function of financial services allowed most people that previous wouldn't have access them to now have an open door into the financial industry (Vives, 2017).

Fintech companies can fill in the problem of information asymmetries, which most of the times are in the core of the banking industry, therefore the tension between stability and competition is an ongoing debate on how to regulate these companies (Navaretti et al. 2017).

It is clear that financial technology firms boost competition in financial markets and most of the times provide services more broadly and efficiently than traditional banks. These companies provide the same services as banks, but they do it in a different way, with the advantage of technological advances on their side. It is discussed that these companies provide decentralized financial services through internet platforms, and the business model of fintech companies is likely to gradually converge into the same model as banks (Navaretti et al. 2017).

2.2 Competition with traditional banks

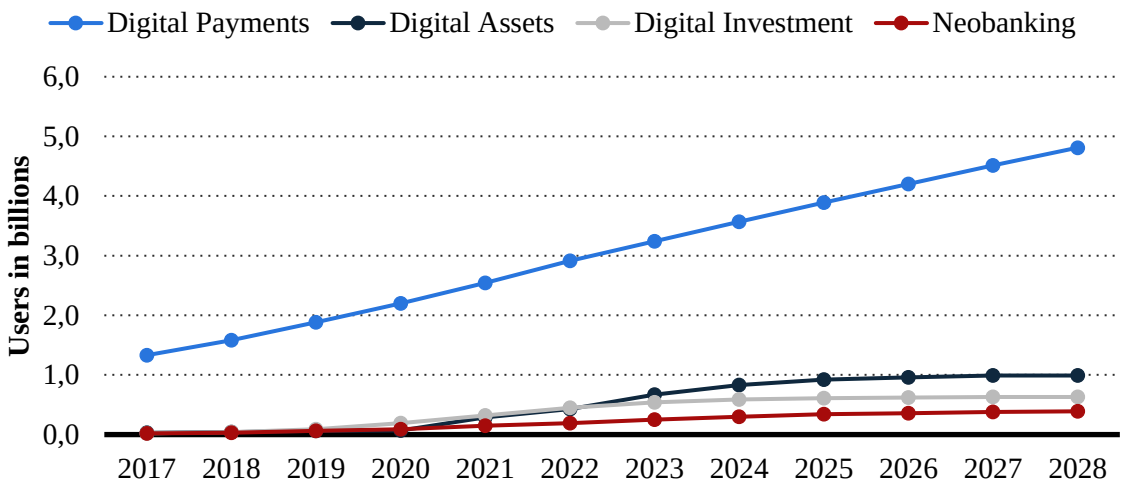
As already mentioned, fintech companies have the ability to impact all services that are usually offered by traditional banks through cost reductions that arise from digitalization and technological advances. More specifically, fintech users benefit from economies of scale in collecting large amounts of data and also from cheaper and

more secure transmission of information as well as lower costs of verification (Navaretti et al. 2017).

According to McKinsey (2023), in July 2023 publicly traded fintech companies represented a market capitalization of $550 billion, which represents a two-times increase since 2019. Also, it is suggested that the revenues in the fintech industry are expected to grow almost three times faster than the revenues in traditional banking between 2022 and 2028. Furthermore, retail customers are now demonstrating towards fintech the same degree of involvement and trust as they do with banks. According to a McKinsey survey, 41% of retail consumers desired to learn more about fintech products. Similarly, in 2022, about 800 million mobile accounts - nearly half of all accounts worldwide - were recorded in Africa (McKinsey, 2023).

Additionally, and also highlighted by McKinsey (2023), in 2022, 35% of small and medium-sized businesses (SMEs) in the US looked into using fintech for services like loans, which had previously been provided by traditional banks. This thought came about as a result of their quest for more affordable costs and platform integration. In Asia, 20% of SMEs employed fintech businesses for lending and payments (McKinsey, 2023).

Figure 3 - Number of fintech users worldwide from 2017 to 2023, with forecasts from 2024 to 2028, by segment (in billions)Source: Statista, 2024



Source: Statista, 2024

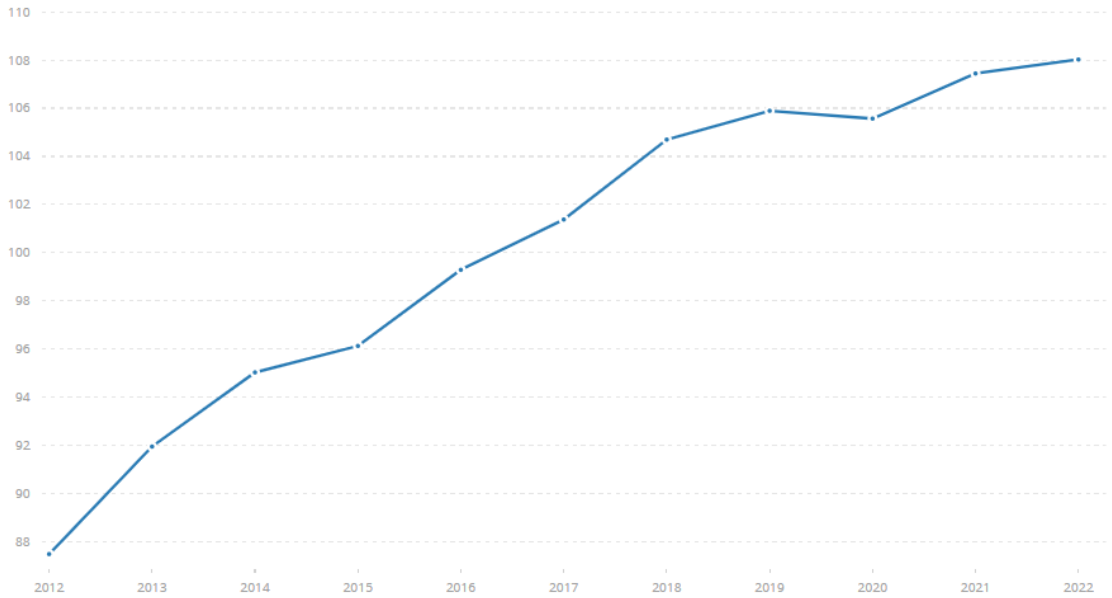
Furthermore, according to Statista, 2024 and evidenced in Figure 3 global fintech user numbers are expected to rise yearly between 2023 and 2027 across all industry segments.

In face of this, it is necessary to analyse the perspective of key services of banks in order to really understand the impact of fintech on performance and competition. Looking at credit and liquidity risk, traditional banks have the ability to execute maturity transformation and earn interest margins, thus they have an advantage in providing liquidity services to their depositors. When it comes to liquidity, fintech's influence is less significant because by definition, when they begin to raise deposits and carry out maturity transformation, they essentially become banks, and therefore be under a bank charter. Banks can achieve lower risk by increasing portfolio diversification and earning income on each customer when they undertake maturity transformation fintech, on the other hand, typically maintains riskier portfolios. (Navaretti et al., 2017).

Smartphones are one tool that fintech companies are employing to reach out to its clientele. Not only has smartphone use and mobile subscriptions increased recently as shown in Figure 4 that indicates the evolution of mobile subscriptions around the world per 100 people, between 2012 and 2022, but it appears that smartphones are starting to become necessities for humans (Kumar, 2020).

Mobile payment is an online financial banking service that banks have built up to facilitate clients' access to the financial products and services they have to offer. Customers in particular are able to do financial transactions around-the-clock on their smartphones. As a result, transactions can now take place not just between banks and clients, but also between customers and other businesses (Kumar, 2020). The ease with which money may be transferred between individuals using platforms like "Apple Pay" or “Google Pay” is the primary addition of fintech to payment platforms. Innovations are particularly important and fintech rivalry won't become an issue as long as banks can quickly adopt emerging technologies (Navaretti et al., 2017).

Figure 4 - Mobile Phone Subscriptions (per 100 people)



Source: The World Bank, 2024

Considering that most of the impact of fintech is related to the use of new business models based on big data, these new competitors are able to use hard information to disseminate the traditional relationship between banks and customers, that are based only on soft information (Vives, 2017). The whole financial sector builds on information and how that information is treated. Thus, according to Navaretti et al. (2017), technological advancements will enable the storage of customer data on online platforms and lead to a more flexible and tailored delivery of financial services. The authors, therefore, also recognize that banks have the capacity for innovation, and to compete with these types of financial technological companies.

In order to acquire a competitive edge over traditional businesses, banks are collaborating and developing alliances with big data and artificial intelligence platforms, all the while considering their clients' best interests. Nowadays, traditional institutions are mainly performing routine tasks, such lending money and managing accounts (Bouyala (2018); Fernandez and Gallardo-Gallardo (2021)). Given this, as noted by Harb et al. (2022) and Zhao et al. (2022), banks are innovating to restructure their operations and gain a competitive advantage in a new, difficult market. As

stressed by Gai et al. (2018), all banks have as their shared goal the promotion of digital technologies to enable different banking operations and services, such deposits, and withdrawals, through computers or smartphones.

2.3 Main Studies and Conclusions

Financial technology has been around for a few years, yet there aren't many studies in this field. As a result, it is unclear how FinTech will affect banks, insurance providers, and other financial organizations. Furthermore, there is an absence of FinTech data, and the studies that are currently available do not cover all geographic locations.

Iman (2019) conducted a study to examine how traditional banks are competing against emerging fintech startups. The author analysed Small Town Bank (STB), a regional bank in Indonesia and its ability to innovate. Therefore, the study focuses on two main questions in an effort to gather information that policymakers and industry participants may use: "*What are the current dynamics of the fintech industry in Indonesia?*" And also, in response to these dynamics, "*What action should STB take*?"

Thus, data was obtained from primary sources through internal and external questionnaires, which total a number of 521.The bulk of responders were married and between the ages of 26 and 30, followed by those between the ages of 21 and 25 and 31 to 35. The majority of the respondents are civil servants, private employees, and employees of state or regional enterprises. The study's findings show that the bank is generally already fairly prepared for innovation, but there are a few things to keep in mind, including internal restructuring, consolidation, and service optimization, which means that payment and finance industries provide the bank with the most convenient entry points into the fintech space. Fintech has a huge and wide-ranging technical and managerial impact, but this does not mean that established banks and other financial institutions cannot compete.

Phan et al. (2020) also studied the influence of technology firms on the performance of banks and developed a hypothesis that the growth of these firms negatively impacts bank performance. In a study of the Indonesia market and using a

sample of 41 banks and data on the number of fintech firms registered to the Fintech Indonesia Association. Indonesia is country where many fintech have emerged over the last few years. The variables chosen to assess the impact of emerging fintech companies were NIM, ROE, ROA, and yield on earning assets, as well as evaluating the impact on overall market value. The results of the study show that fintech negatively and significantly impacts performance measures. More so, the results also suggest that banks with higher value, more mature and state-owned are more impacted by fintech, compared with lower valued, younger, and private owned banks. The findings were considered robust.

Facing the impacts of Covid-19, the banking industry was deeply affected, leaving opportunity for the growth of fintech companies. In light of this and contributing to existing literature, Chen et al. (2021), conducted a study to examine the impact of fintech products on the performance of Chinese commercial banks. For the research method, the authors designed two questionnaires, one for bank employees and other for bank customers. For the customers questionnaire, the main questions were related to fintech products characteristics, bank performance and customer satisfaction, demographic information such as customer's age, gender, the number of years holding a bank account and overall knowledge about fintech products in the bank. As for the employee's questionnaire, the questions were also about fintech products characteristics, bank performance, efficiency and quality, and demographic information. It was conducted a total of 400 questionnaires. The main conclusions lie on the fact that fintech products can have an advantage of survival due to the overall acceptance by customers and employees, for some years now, these products are more present in the financial industry due to the growth of digital services, more so doing the Covid-19 crisis Chen et al. (2021).

Zhang et al. (2020) investigated how pre- and post-loan risk in credit activities, caused by information asymmetries, are impacted by fintech companies. Therefore, to assess whether these risks can be eased by fintech the study was performed in a sample of fintech subsidiaries in Chinese banks, based on 28 listed commercial banks. The main hypothesis were related to the understanding of whether the fintech integration in banks would actually decrease the pre-loan risk, and if banks with higher level of

managerial ownership are more affected by the influence that was described. After conducting the analysis, the authors concluded that the influence of credit activities on pre-loan risk is lessened by fintech integration in banks. Indeed, this effect is more pronounced in institutions where management ownership is higher. However, no positive impact was found on post-loan risk.

More recently, Zhao et al. (2022), investigated the impact of financial technology innovation on Chinese banks' performance, using patent data and fintech development index, by applying GMM (generalized method of moments) model. The data used in the analysis consists in a sample of 120 banks and indicators such as capital ratio, non-performing loans to gross loans ratio, cost to income ratio, ROA, and liquid assets to total deposits ratio were used as control variables to measure performance. A fintech development index was constructed by compiling fintech data, and the authors also considered GDP, consumer price index, and the degree of market competition. The findings demonstrated that fintech innovation lowers asset quality and bank profitability, measured by ROA. These findings were more pronounced in larger and state-owned commercial banks. Additionally, fintech innovation also improves capital adequacy and management efficiency. In light of this, main conclusions provide insight on the fact that banks should focus on rising their technological capabilities in order to keep competing with emerging companies.

3 European Financial Markets and Fintech Integration

As highlighted by Ketterer (2017), the emergence of new firms poses a challenge to the established norms of the traditional financial services sector, prompting resistance from incumbent banks and other financial institutions who may perceive it as a threat to their positions. A second impediment is the lack of appropriate and timely regulation. In the last few years, the industry has seen an emerging number of fintech companies, not only in Europe but also around the world (Ketterer, 2017).

The large preexisting banking presence and financial inclusion, stringent regulations, and, in certain countries, a strong preference for cash-based transactions can all contribute to the low penetration. Fintech payment instruments and financing, however, are expanding quickly and the users of these kinds of platforms are also increasing at an exponential level. Thus, even while transaction volumes and client counts are rising inside nations, new laws and guidelines should level the playing field for new competitors and promote the expansion of businesses internationally (Baba et al., 2020).

Despite efforts by lawmakers and regulators to foster increased competition in the financial services industry, the regulatory process may lag behind the swift pace of technological developments in digital finance. Ketterer (2017) also discusses the potential challenge posed by the lack of access to good-quality and affordable digital connectivity, particularly broadband access. He notes that insufficient access to such connectivity might impede the adoption of digital financial technologies, slowing down their integration into the financial landscape (Ketterer, 2017).

Therefore, it is clear that inside the European Financial Market, from the perspective of regulations, it might come down to the trade-off between competition and financial stability. Thus, Navaretti et al. (2017), argues that fostering competition in financial markets should result in a lighter regulatory framework than for traditional financial services, although this may seem a little controversial. The rapid growth of fintech threatens financial stability and it has been this way since the 80’s, when money

market funds started to challenge traditional banking. During those years, a steady pattern of deregulation, exactly meant to boost competition and efficiency in the financial market, caused shadow banking to grow, banks to engage in riskier off-balance sheet operations, and ultimately, the 2008 financial catastrophe (Bofondi et al., 2017). Considering this, it is argued that also relating fintech companies, if it is allowed an excessively light approach in terms of regulation, the outcome may be the same as in 2008. The argument isn't only that fintech is risky, but banks may also take advantage of regulatory arbitrage opportunities to raise the riskiness of their operations due to competitive pressure from fintech companies (Navaretti et al., 2017).

The regulatory framework should create a balanced environment for fintech and traditional providers offering similar services, particularly now, in light of the convergence between banks and fintech companies. Therefore, regulation needs to focus on the service being rendered rather than the entity delivering it. Innovative payment services are one example of an activity that is somewhat unknown and raises new regulatory obligations. Peer to peer lending is one example of a new product that should be made completely transparent to its users (Navaretti et al., 2017).

Therefore, since many economic activities readily fit within the current legal framework, the majority of regulatory adjustments and clarifications have been made in the areas of payments, capital raising, and investment management. There were only a few regulatory mentions that included fintech developments in market assistance and insurance (Financial Stability Board, 2017).

According to the Financial Stability Board, 2017, through the introduction of a customized regulatory framework for payment institutions in 2007, the European Union opened the market for payment services to non-bank companies. The legal framework for keeping or transferring value in relation to digital currencies is being clarified in order to mitigate the dangers of fraud, money laundering, and terrorism funding. The European Union has also updated its payment services directive in 2015 in an effort to control emerging fintech companies including payment data aggregators and payment initiation service providers. Nevertheless, changes related to the rules for equity crowdfunding were also implemented in relation to new license requirements and the application of existing rules (Financial Stability Board, 2017).

Certain banking licenses may be viewed by fintech companies as a significant expense, even though their business model may involve less activities. Fintech credit platforms might be seen as profiting from regulatory arbitrage to the extent that these companies organize their operations in essentially the same way as banks (Financial Stability Board, 2017).

Ultimately, the aims that governments and politicians pursue as well as the relative importance of the various interest groups engaged will determine the policy interventions pertaining to fintech. Nevertheless, fintech companies and regulations for them are relatively new, such as most of the governments and national regulations are still fragmented around Europe (Ferrarini, 2017).

4 Methodology and Data

In this section it will be presented the data and methodology used in the analysis to understand the impact of fintech formation on the performance of European commercial banks. Also, it will be presented the research hypothesis. Adding to existent literature in order to analyse the impact of fintech companies in more than one country. The variables used for the analysis will be described further in detail.

4.1 Research Hypothesis

As already mentioned, the sector of Financial Technology is growing and entering into a well-established industry, therefore, the purpose of this study is to comprehend and thoroughly investigate how Fintech has affected European commercial banks' performance, with an emphasis on important performance metrics like profitability and efficiency. Additionally, the study aims to identify the causes contributing to the negative association which is pertinent given the projected detrimental impact of Fintech on bank performance.

Based on previous studies already mentioned above, research hypothesis are described below in this section. The research question is “What is the impact of Fintech formation on the financial performance (profitability/efficiency) of financial institutions, as measured by metrics such as Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM)”.

Hypothesis 1: Fintech companies reduce commercial bank’s performance.

Hypothesis 2: High Investment in Venture Capital reduce commercial bank’s performance.

As mentioned by Cumming & Schwienbacher (2018), the emergence of fintech companies is also driven by ventures, therefore their growth depends on the amount of venture capital investment made. If high investment in venture capital translates into more emerging fintech companies, bank performance will be negatively impacted.

Hypothesis 3: Larger banks are more impacted by Fintech formation.

According to Dietrich & Wanzenried (2014) larger banks are more likely to have more operational efficiency and higher product diversification, which is positively related to bank profitability. Therefore, larger banks are more susceptible to be negatively impacted by Fintech formation. This is measured by the number of fintech, the number of mobile phone users and the investment in venture capital in different countries, which are positively related with fintech formation.

4.2 Sample and Data

In order to perform the analysis, all the data was gathered from different sources. All bank related data was gathered from BankFocus as well as the number of Fintech founded. The data regarding venture capital investment was retrieved from OECD Statistics and macroeconomic data was retrieved from The World Bank.

The bank related data was compiled and exported from BankFocus, comprising data of commercial banks from the following countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and United Kingdom. The selection of these countries was based on the of the number of fintech companies founded, and considering the period of the analysis, these were the countries that revealed the highest number of fintech emergence. To avoid data duplication and according to Duprey & Lé (2016), it was used the consolidation code C1, U1 and U2. The period of analysis considered was from 2012 to 2021 and all figures are presented in thousands of dollars. Therefore, the final sample after a careful analysis comprises a total of 816 commercial banks, listed and non-listed.

For the analysis on Fintech, it was compiled the number of companies founded in each country of the analysis, being that this comprises all private and public companies. Also, it was compiled the total venture capital investment in each country in each year of the analysis, as well as the number of mobile phone subscriptions per 100 people, in each year, in each country. These variables are all related to fintech formation. There were 202 active fintech businesses that were taken into consideration.

4.3 Variables Description

In this section it will be presented a detailed description of all variables considered in the analysis, as well as the expected effect of independent variables on the dependent ones. The analysis takes into account macroeconomic factors, specific fintech industry characteristics, and bank-specific variables.

4.3.1 Dependent Variables

The selected dependent variables will measure bank performance. Therefore, these variables are: Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM). As already mentioned before, both ROA and ROE are key indicators of bank profitability used by many authors such as Athanasoglou et al. (2008), Adam (2014), Menicucci & Paolucci (2016) and Phan et al. (2020). As for NIM, it was vastly used by authors such as Nasserinia et al. (2014), Menicucci & Paolucci (2016), Phan et al., (2020) and Jílková & Kotěšovcová (2022).

Thus, ROA, which is return on assets, is the ratio of net profits to total assets and reflects the ability of banks to generate profits from their assets. Thus, this indicator measures how efficiently banks are managing their resources to generate profits (Menicucci & Paolucci, 2016).

The indicator ROE which represents return on equity, is the ratio of net profits over total equity and measures the return to shareholders on their equity and how efficiently the management of the bank is using shareholders' investment. Therefore, ROE measures how effectively a company uses investment funds to create earnings growth (Menicucci & Paolucci, 2016).

NIM represents net interest margin and is the net interest income over total assets, where net interest income represents the difference between interest income generated by banks and the interest that banks have to pay for borrowed funds. This indicator measures the average yield of the bank's assets and the profit earned on interest activities. Thus, this represents bank's efficiency on investments (Menicucci & Paolucci, 2016), (Dietrich & Wanzenried, 2011).

4.3.2 Independent Variables

The independent variables considered in this analysis are divided into three parts. The first part represents the bank-specific variables, the second part represents the industry-specific variables related to fintech companies and the third part represents the macroeconomic variables. All of these are considered to be the explanatory variables of the model. The selection of variables was based on previous studies from authors such as Dietrich & Wanzenried (2011, 2014), (Menicucci & Paolucci, 2016) and Phan et al. (2020).

Bank-specific variables measure the internal determinants of bank profitability. Therefore, the following variables were selected as control variables for the study: Cost-to-Income ratio, Capital ratio, Loan Loss Provision ratio, Equity to Total Assets ratio, Total Assets, Interest Income Share and Funding Costs.

The cost-to-income ratio represents total expenses over total generated revenues, and it is a measure of bank's efficiency (Phan et al., 2020). Since this ratio, as noted by Pasiouras & Kosmidou (2007), shows the efficacy of expense management related to revenue production, higher ratios imply a less efficient management (Hajková, 2020), thus, it is expected a negative effect of this ratio on bank profitability indicators.

A measure of capital adequacy, or more particularly, bank risk and strength, is the capital ratio, which is equal to equity over total assets (Hajková, 2020). Therefore, the lesser the bank's risk, the greater this ratio (Dietrich & Wanzenried, 2014). However, among the existing literature, the effect of this ratio on bank profitability is not clear (Hajková, 2020). Given their increased risk, banks with lower capital ratios ought to yield higher returns than those with higher capitalization. However, considering that banks with higher capitalization thought to be safer, it is anticipated that they will continue to be profitable for an extended length of time, even during uncertain times. Additionally, these banks are anticipated to have lower funding costs, which will boost their profitability. Thus, is not theoretically viable to forecast the influence of this ratio on profitability, according to scholars like Dietrich & Wanzenried (2014) and Phan et al. (2020), given the lack of agreement in the research.

Loan Loss Provision is a metric used to assess the credit quality of banks. It is defined as the ratio of loan loss provisions to total loans (Hajková, 2020). It is anticipated that this ratio will have a negative influence on bank profitability since a larger ratio will signal a lower credit quality and have an adverse effect on profitability (Dietrich & Wanzenried, 2011, 2014); (Menicucci & Paolucci, 2016); (Phan et al., 2020).

The logarithm of the bank's total assets is used to represent the variable size, which is a measurement of the bank's dimensions. Regarding the effect of this variable on bank profitability, there isn't a unanimous agreement in the literature that currently exists (Hajková, 2020). Some authors like Dietrich & Wanzenried (2014), Menicucci & Paolucci (2016) and Phan et al. (2020) (using ROA) consider that larger banks have a positive effect on profitability, since when compared to small banks, these can increase efficiency by taking advantage of economies of scale and economies of scope in terms of product diversification. On the other hand, Dietrich & Wanzenried (2011) and Phan et al. (2020) (using ROE and NIM) found a negative impact on profitability. This can be explained by a number of reasons, being that it is commonly associated that banks that are too large can have agency conflicts and be negatively impacted by bureaucratic reasons. However, it is expected a positive effect of this variable on the profitability measures.

The interest income ratio represents total interest income over total income. Generally speaking, asset management activities like trading operations yield larger margins for commercial banks than interest operations. If interest income makes up a substantial portion of total income, banks should expect to be less lucrative. In other words, it is expected that interest income share will have a negative impact on bank performance (Phan et al., 2020).

The last variable related to internal bank performance is funding costs, which represent interest expenses over average total deposits. Thus, it is expected that as funding costs increase, the bank’s profits are consequentially lower. According to Dietrich & Wanzenried (2011, 2014) and Phan et al. (2020), it is expected that this variable is going to impact bank profitability negatively.

As already mentioned, there are three industry-specific variables related to fintech. The first one is the number of fintech companies founded in each country during the time of the analysis, the second one is the number of mobile subscriptions per year and country and the third one is the venture capital investment per year and country.

Based on the literature review performed, the growth of fintech companies is a source of competition for commercial banks. Associated with the growing number of financial technology companies there is also the number of mobile subscriptions, since the business model of these companies is online, and this can be used as a proxy for infrastructure strength (EIB Institute, 2016). According to Cumming & Schwienbacher (2018), the emergence of fintech companies is also driven by ventures and no longer just investments in internal projects. Therefore, venture capital investment became crucial for the growth and emergence of fintech companies. Consequentially and according to EIB Institute (2016), these last two variables are positively related to the number of fintech companies founded in each country and will therefore be negatively related to the profitability of banks. The negative relation between Fintech and bank profitability is evidenced by authors such as Iman (2019) and Phan et al. (2020).

Table 1 - Description of Variables

Dependent Variables		**Source**
ROA – Return on Assets (%)		BankFocus
ROE – Return on Equity (%)		BankFocus
NIM – Net Interest Margin (%)		BankFocus
Independent Variables	**Description**	**Source**
CTI – Cost to Income (%)	Measures bank's operational efficiency	BankFocus
CAP – Equity to Total Assets Ratio	Capital adequacy measures capital strength	BankFocus
SIZE- Total Assets (log)	Log of total Assets to measure bank size	BankFocus
LLP – Loan Loss Provision Ratio	Measures the quality of a bank's assets	BankFocus
IIS – Interest Income Share (%)	Total interest income over total income	BankFocus
FC – Funding Cost	Interest Expenses over Total Average Deposits	BankFocus
FINTECH – Number of Fintech	Number of fintech companies founded	BankFocus
MOBILE – Number of Mobile Subscriptions	Number of mobile subscriptions per 100 people	The World Bank
INVEST – Venture Capital Investment	Total venture capital investment (All rounds)	OECD Statistics
INF – Inflation	Inflation per consumer prices	The World Bank
GDP – GDP per Consumer Prices	GDP per capita	The World Bank

Source: own presentation based on BankFocus, The World Bank, OECD Statistics

Table 2 - Studied and Expected Effects of Variables

Variables	Author	Studied Effect	Expected Effect
CTI	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(-)	(-)
CAP	Staikouras & Wood (2004); Pasiouras & Kosmidou (2007); Athanasoglou et al. (2008); Menicucci & Paolucci, (2016) and Phan et al. (2020)	(+) ROA, NIM (-) ROE	(+/-)
LLP	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(-)	(-)
SIZE	(Dietrich & Wanzenried, 2011 2014); Nasserinia et al. (2014); Phan et al. (2020)	(+) ROA (-) ROE, NIM	(+/-)
FC	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(-)	(-)
IIS	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(-)	(-)
FINTECH	Phan et al. (2020)	(-)	(-)
MOBILE	EIB Institute (2016)	(+) on Fintech	(-)
INVEST	EIB Institute (2016)	(+) on Fintech	(-)
INF	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(+/-)	(+/-)
GDP	(Dietrich & Wanzenried, 2011 2014); Phan et al. (2020)	(+)	(+)

Source: own presentation based on BankFocus, The World Bank, OECD Statistics

4.4 Descriptive Statistics

This section aims to present descriptive statistics for the analysis, as presented in Table 3, as well as a comprehensive explanation of the statistics presented.

Looking at Table 3, it is possible to verify that the mean value for ROA is 0.607%, for ROE it is presented a mean value of 5.219% and for NIM the mean value corresponds to 2.105%, considering that these values are annual.

For ROA, the mean annual value of 0.607% can suggest a relatively low average profitability to the bank's assets. The standard deviation shows a relatively high divergence between bank's ROA, which can point out different efficiencies and business models. Considering ROE, the mean annual value of 5.219% shows a relatively high profitability when compared to ROA, meaning that profitability is higher when it is considered the shareholder's equity. The standard deviation also shows some variability in terms of values. When looking at NIM, the mean annual value of 2.105% represents the average difference between interest income and interest paid in relation to a bank's interest-earning assets.

Regarding CTI, the mean value for the overall sample corresponds to 68.95% and as already mentioned before this is a ratio of efficiency and higher ratios imply less bank efficiency. The mean value presented is quite high, which may suggest that most banks reflect low efficiency in management. Not different from other variables, the standard deviation also reflects that some banks reflect more efficiency than others. Looking at minimum and maximum values it is also possible to report that some banks report almost no operating costs relative to income, that can arise due to reporting differences or some specific financial structuring.

For CAP, a measure of capital adequacy and risk, the mean value among observations corresponds to 13.33%, and just like the variable CTI also shows great dispersion of observations among maximum and minimum values, which can indicate that some banks are almost entirely financed by equity, while others show almost no equity.

Looking at the variable SIZE, which is the logarithm of total assets as a proxy to measure the size of each bank, the value corresponds to 14.57, with the minimum value of 4.13 and maximum of 21.59, which shows that some banks are quite larger than others within the overall sample. As for LLP, the mean value is 3.82%, which indicates that most banks within the sample show a high ratio of loan loss provision, which is a proxy to measure credit quality. Regarding IIS, the mean value corresponds to 0.092% which shows that within the sample interest is not a big part of income for most of the banks, considering a maximum value of 232% and a minimum value of -61%. Funding costs (FC) have a mean value of 0.107%, which represents the part of interest expenses in average total deposits, and looking at the standard deviation, the variable also presents great dispersion among maximum and minimum values.

Considering the industry-specific variables related to fintech formation, the first variable to look is the number of fintech companies founded in each country during the period of analysis with an average value of 14 fintech companies founded annually. As already mentioned, the fintech concept started to emerge heavily in the markets in the last few years, nevertheless, it is shown that a relatively low level of new companies emerges each year. One explanation for this can be the effects of the Covid-19 pandemic, which were felt mainly in the last 2 years of the analysis. As for the variable Invest, the mean value of 739 million shows a high average on the overall countries of the analysis, and the variable mobile, which represents the natural logarithm of the total mobile subscriptions per 100 people in each country per year of the analysis, has a mean value of 17. By taking the natural logarithm of the number of mobile subscriptions per 100 people, the variable's scale is compressed, which makes it easier to analyse in this context.

For macroeconomic variables, the mean value of GDP corresponds to 48117, which is the number per capita in each country, with values ranging from 7079 to 133772 per capita, and the mean value of Inflation corresponds to 1.21%, where some countries report values of -1% to values of 5%.

Table 3 - Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	6479	.607	2.731	-42	99
ROE	6381	5.219	11.044	-114	106
NIM	6368	2.105	3.911	-41	142
CTI	6453	68.946	27.254	0	307
CAP	6673	13.333	15.077	0	100
SIZE	6768	14.564	2.377	4.127	21.594
LLP	4785	3.819	7.508	0	100
IIS	6393	.092	4.044	-61	232
FC	5317	.107	5.685	0	404
FINTECH	8160	14.184	20.406	1	66
MOBILE	8160	16.99	1.242	13.543	18.513
INVEST	8007	739.14	1070.732	0	6156
INF	8160	1.21	1.228	-1	5
GDP	8160	48117.287	25885.727	7079	133712

Source: own presentation based on Stata

In Table 4, it is presented the correlation matrix, which shows the correlation between the explanatory variables of the model. Although it is possible to see some high values when it comes to the variable MOBILE, there is no evidence of serial correlation in the model, and the explanatory variables are not correlated.

Table 4 - Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) CTI	1.000										
(2) CAP	0.013	1.000									
(3) SIZE	-0.200	-0.405	1.000								
(4) LLP	0.083	0.334	-0.175	1.000							
(5) IIS	-0.042	-0.001	-0.019	-0.017	1.000						
(6) FC	0.015	-0.006	-0.011	0	-0.020	1.000					
(7) FINTECH	-0.087	-0.162	-0.026	-0.050	-0.003	0.010	1.000				
(8) MOBILE	0.070	0.067	-0.016	0.087	-0.017	-0.010	-0.474	1.000			
(9) INVEST	0.106	0.121	0.044	0.010	-0.004	-0.007	-0.501	**0.468**	1.000		
(10) INF	-0.001	0.045	-0.018	0.012	0.012	0.010	-0.191	0.060	0.201	1.000	
(11) GDP	0.022	-0.034	0.104	-0.229	0.024	-0.002	0.100	**-0.546**	-0.045	-0.167	1.000

Source: own presentation based on Stata

4.5 Methodology

In this section it will be presented the aim of the research and described the methodology used in the analysis. Furthermore, it will be presented the regression model and the specification of the model used.

The aim of this research is to comprehensively investigate and analyse the impact of Fintech on the performance of commercial banks, with a focus on key performance indicators such as profitability and efficiency. Accordingly, this analysis applies a linear model with panel data, considering both time series and cross-section data. Therefore, the model was developed having in consideration and base the studies of Athanasoglou et al. (2008), Dietrich & Wanzenried (2011, 2014) and Nasserinia et al. (2014) on bank profitability for the regards of the determinants of bank performance, as well as bank-specific control variables. To an extent, the fintech variable is included in this analysis according to the research of Phan et al. (2020). Nevertheless, it was added to the model two more control variables related to fintech formation that are expected to have a negative impact on bank performance.

Thus, the following equations represent the linear regressions studied in this research.

$$ROA_{ict} = c + \beta_1 ROA_{i,t-1} + \beta_2 CTI_{ict} + \beta_3 CAD_{ict} + \beta_4 SIZE_{ict} + \beta_5 LLP_{ict} + \beta_6 IIS_{ict} + \beta_7 FC_{ict} + \beta_8 FINTECH_{ct} + \beta_9 MOBILE_{ct} + \beta_{10} INVEST_{ct} + \beta_{12} INF_{ct} + \beta_{13} GDP_{ct} + \varepsilon_{ict}$$

$$ROE_{ict} = c + \beta_1 ROE_{i,t-1} + \beta_2 CTI_{ict} + \beta_3 CAD_{ict} + \beta_4 SIZE_{ict} + \beta_5 LLP_{ict} + \beta_6 IIS_{ict} + \beta_7 FC_{ict} + \beta_8 FINTECH_{ct} + \beta_9 MOBILE_{ct} + \beta_{10} INVEST_{ct} + \beta_{12} INF_{ct} + \beta_{13} GDP_{ct} + \varepsilon_{ict}$$

$$NIM_{ict} = c + \beta_1 NIM_{i,t-1} + \beta_2 CTI_{ict} + \beta_3 CAD_{ict} + \beta_4 SIZE_{ict} + \beta_5 LLP_{ict} + \beta_6 IIS_{ict} + \beta_7 FC_{ict} + \beta_8 FINTECH_{ct} + \beta_9 MOBILE_{ct} + \beta_{10} INVEST_{ct} + \beta_{12} INF_{ct} + \beta_{13} GDP_{ct} + \varepsilon_{ict}$$

Where i represents the bank, c represents the country and t represents the time, with i = 1,…,N; c = 1,…,N; t = 1,…,T.

Thus, the research is based on an unbalanced panel data, which means that some data retrieved from BankFocus was incomplete, and some values of the financial statements for some years were missing. This could have happened because during the period of analysis, banks could have exited the markets, resulting in no records for those years. Nevertheless, this would not impose a biased result since the period of the analysis is 10 years, which is considered a reasonable analysis period, having in consideration the best method and estimator for the analysis of an unbalanced panel data.

When analysing factors that affect banks' performance those might be endogenous to the model. The endogeneity problem occurs in a model when an explanatory variable is correlated with the error term, and can be caused by omitted variables, this means that sometimes some explanatory variables are not included in the model and end up in the error term, which can occur since some performance indicators regarding banks can be difficult to measure. Thus, endogeneity bias can cause inconsistent estimates which will lead to various problems such as wrong inferences resulting in in inaccurate conclusions (Ullah & Akhtar, 2018).

Therefore, the choice of the appropriate model to be used is crucial and for this analysis it was chosen to apply the GMM (Generalized Method of Moments), having in consideration the analysis of a dynamic panel data and past studies performed by Dietrich & Wanzenried (2011, 2014) and Phan et al. (2020). The cause-and-effect relationship for an underlying phenomenon in dynamic panel data is typically changeable across time. Dynamic panel data estimation techniques apply the lags of the dependent variables as explanatory factors to capture this. For this reason, the dependent variables' lag values serve as controls over this endogenous connection (Ullah & Akhtar, 2018).

Thus, the two-step GMM model approached by Arellano & Bover (1995) and Blundell & Bond (1998) addresses the exposed problems and is intended for scenarios of large number of individuals against a smaller number of periods of analysis. This

method addresses endogeneity by employing instrumental variables and considering fixed effects in the model, as well as autocorrelation and heteroskedasticity (Roodman, 2009).

Taking this into account and considering the high dependence of banks' profits in previous years results and according to Dietrich & Wanzenried (2011, 2014), it was necessary to consider instrumental variables that corresponds to one-period lagged dependent variable to control for this effect. It was also considered the need to apply lagged variables as instruments to other variables that might show endogeneity problems. Accordingly, to account for the time dependence of variables, which is managed by instruments designed for the dependent variables as indicated by the regression equations, the GMM estimator was employed in the regression model. Tests were performed to reach the final results of the regression models and three regressions were performed, one for each dependent variable presented.

5 Results and Discussion

In this section it will be presented and discussed the analysis results based on the regressions presented earlier. It will also be presented the results for the interaction between Fintech Formation and the three measures of bank performance, as well as robustness checks to confirm the validity of the results provided.

As already mentioned, the analysis is based on the past work of authors such as Dietrich & Wanzenried (2011, 2014); Menicucci & Paolucci (2016) and Phan et al. (2020), research conducted on Fintech drivers by the EIB Institute (2016) and also the study conducted by Rua (2022). It was used the GMM estimator to obtain the following results.

Table 5 presents the first results with ROA as dependent variable. When considering the first performance measure, it can be said that most of the explanatory variables are statistically significant to explain the model. Looking first at bank-specific measures such as CTI and LLP, it is presented a negative effect of both variables on ROA, going in accordance with what was expected and authors like Dietrich & Wanzenried (2011, 2014) and Phan et al. (2020), since when considering CTI, higher ratios imply a less efficient management, as highlighted also by Pasiouras & Kosmidou (2007). For LLP, the measure of a bank's credit quality, higher ratios imply lower credit quality, therefore a negative impact on profitability, also emphasized by Dietrich & Wanzenried (2011, 2014) and Phan et al. (2020).

The variable CAP, which measures capital adequacy presents a positive relation with ROA. Given that scholars did not reach a theoretical consensus the positive relation between variables go in accordance with the studies performed by Staikouras & Wood (2004); Pasiouras & Kosmidou (2007); Athanasoglou et al. (2008); Menicucci & Paolucci, (2016) and Phan et al. (2020), which bolsters the claim that banks with adequate capital face higher returns and lower funding costs.

The variable SIZE, is positively related to ROA, meaning that larger banks are more likely to be more profitable, even though for this dependent variable the result is not statistically significant, the finding goes in accordance with Dietrich & Wanzenried

(2014), Menicucci & Paolucci (2016) and Phan et al. (2020), when considering ROA.

For IIS, the results go against what was expected and studied by other authors, since for ROA it shows a positive impact of this variable and higher ratios imply less income diversification what it is expected to decrease bank profitability (Dietrich & Wanzenried, 2014). Looking at FC, the negative impact on ROA goes as expected, since this represents costs to any bank, and as funding costs increase, profits are consequentially lower, going in accordance with the studies of Dietrich & Wanzenried (2011, 2014) and Phan et al. (2020).

When considering the industry-specific variables, the number of fintech companies founded during the period of the analysis in each country have a negative and statistically significant impact on ROA, which means that the entrance of these new financial technology companies in the market presents a threat to the profits of commercial banks, as evidenced by Iman (2019) and Phan et al. (2020). The control variables measuring the number of mobile subscriptions (MOBILE) and the venture capital investment (INVEST) also present a negative impact on ROA, as expected since these variables are positively related with the number of fintech companies founded, as evidenced by EIB Institute (2016).

For the macroeconomic variables, in the case of INF, which measures the inflation rate in each country in each year of the analysis, it is shown that there is a negative but not statistically significant impact on ROA. According to Phan et al. (2020), the pace at which inflation rises relative to operating expenses determines how inflation affects banks' profits. If banks are unable to anticipate inflation, this can have a significant effect on their bottom line. For GDP per capita, this shows a negative and small effect on ROA, as evidenced by Dietrich & Wanzenried (2014).

Table 5 - Regression Results for ROA

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.015	.002	-6.79	0	-.02	-.011	***
CAP	.026	.007	3.52	0	.011	.04	***
SIZE	.016	.015	1.08	.281	-.013	.045	
LLP	-.021	.005	-4.04	0	-.032	-.011	***
IIS	.039	.011	3.57	0	.018	.061	***
FC	-.045	.006	-7.03	0	-.058	-.033	***
FINTECH	-.009	.003	-3.12	.002	-.015	-.003	***
MOBILE	-.117	.055	-2.11	.035	-.226	-.008	**
INVEST	-.00022	0	-2.54	.011	0	0	**
INF	-.005	.022	-0.24	.813	-.048	.038	
GDP	0	0	-3.25	.001	0	0	***
Constant	3.408	1.039	3.28	.001	1.371	5.444	***

Mean dependent var	**0.468**	**SD dependent var**	**1.090**
Number of obs	**3430**	**Chi-square**	**512.671**

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

Source: own presentation based on Stata

Table 6 presents the results with ROE as dependent variable. Looking at the results it is evident that most of the independent variables are not statistically significant and therefore do not explain the model. Considering CTI, and in accordance with the results obtained for ROA, there is a negative impact of this variable on ROE, which was expected, since higher ratios reflect lower efficiency as demonstrated by Dietrich & Wanzenried (2011, 2014) and Phan et. al (2020).

Contrarily to the effect observed on ROA, the variable CAP shows a negative impact on ROE, although not statistically significant, goes in accordance with Dietrich & Wanzenried (2011, 2014) and Phan et. al (2020).

When considering bank size, it is observed a positive effect on ROE, while not significant to explain this performance measure, goes against Dietrich & Wanzenried (2014) and Phan et al. (2020). However, Menicucci & Paolucci (2016) discovered a positive correlation between bank profitability and size, suggesting that bigger banks provide higher returns.

As for loan loss provision, it is observed a negative relation with this measure of performance, the same as for ROA, which was expected based on the studies of Dietrich & Wanzenried (2011, 2014); Menicucci & Paolucci (2016) and Phan et al. (2020). Considering the mentioned studies but looking now at FC, only Dietrich & Wanzenried (2011) found a negative relation between this variable and ROE, as presented in the results on Table 6.

IIS, INVEST and INF have no explanatory power when considering ROE as dependent variable. Although some variables reflect the expected effect, they cannot be considered to explain this performance measure.

For the fintech related variables, the number of fintech companies negatively impact ROE, in accordance with Phan et al. (2020), although the significance of this explanatory variable is quite low, since it is only statistically significant at the 10% level. The same is verified for the variable MOBILE, considering a negative impact on ROE.

Table 6 - Regression Results for ROE

ROE	**Coef.**	**St.Err.**	**t-value**	**p-value**	**[95% Conf**	**Interval]**	**Sig**
CTI	-.14	.019	-7.45	0	-.176	-.103	***
CAP	-.018	.028	-0.63	.53	-.073	.037	
SIZE	.154	.188	0.82	.411	-.214	.522	
LLP	-.146	.074	-1.96	.05	-.291	0	**
IIS	-.147	.357	-0.41	.68	-.846	.552	
FC	-.449	.053	-8.50	0	-.552	-.345	***
FINTECH	-.034	.02	-1.73	.083	-.072	.004	*
MOBILE	-.997	.565	-1.77	.077	-2.105	.11	*
INVEST	0	.001	-0.34	.736	-.001	.001	
INF	-.157	.19	-0.82	.41	-.53	.216	
GDP	0	0	-1.90	.058	0	0	*
Constant	31.627	10.917	2.90	.004	10.229	53.024	***

Mean dependent var	**5.194**	**SD dependent var**	**9.418**
Number of obs	**3426**	**Chi-square**	**2161.684**

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

Source: own presentation based on Stata

The third regression has NIM as dependent variable, and the results are displayed on Table 7. Therefore, it is also possible to see that most of the explanatory variables are not statistically significant and cannot be considered to explain the regression model. Considering CTI, and in accordance with the other performance measures, this has a negative impact on NIM, as highlighted by Dietrich & Wanzenried (2011, 2014) and Phan et. al (2020). Capital adequacy, measured by the variable CAP, presents a positive impact on NIM, in accordance with Dietrich & Wanzenried (2011, 2014); Menicucci & Paolucci (2016) and Phan et al. (2020), showing once again the claim that banks with higher capital ratios yield higher interest margins.

The variable SIZE presents a positive effect, meaning that larger banks have better margins (Dietrich & Wanzenried (2014); Menicucci & Paolucci (2016)). In contrast, authors such as Dietrich & Wanzenried (2011) and Nasserinia et al. (2014) found that larger banks have lower interest margins resulting in less profits. IIS presents a negative sign which goes according to the findings of Dietrich & Wanzenried (2011) that state that banks with higher interest income share have lower net interest margins than banks with a better income diversification.

Different from the other two performance measures, when NIM is considered as dependent variable, it is observed a positive impact of the number of fintech companies founded in each country, although not statistically significant, goes against the findings of Phan et al (2020). The emergence of fintech companies might compromise the profitability of traditional banks, as already evidenced by Phan et al (2020) and Iman (2019). Considering this, the variable mobile impacts NIM negatively, while the variable INVEST has no statistical significance in this model.

Macroeconomic variables present a negative relation with net interest margin, which in the case of net interest margin was not the expect effect, as inflation increase, interest rates tend to increase too, therefore banks might have to pay more for borrowing, which could reduce their net interest margins if they can't charge more for loans.

Table 7 - Regression Results for NIM

NIM	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.005	.003	-1.50	.133	-.011	.001	
CAP	.008	.009	0.94	.349	-.009	.026	
SIZE	.054	.048	1.13	.26	-.04	.147	
LLP	.003	.01	0.32	.75	-.016	.022	
IIS	-.019	.033	-0.58	.564	-.085	.046	
FC	0	.012	0.03	.98	-.024	.024	
FINTECH	.005	.005	1.02	.309	-.005	.015	
MOBILE	-.864	.316	-2.74	.006	-1.483	-.245	***
INVEST	0	0	1.63	.104	0	.001	
INF	-.129	.039	-3.35	.001	-.205	-.054	***
GDP	0	0	-2.89	.004	0	0	***
Constant	17.891	6.003	2.98	.003	6.125	29.656	***

Mean dependent var	**2.000**	**SD dependent var**	**2.481**
Number of obs	**2900**	**Chi-square**	**202.037**

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

Source: own presentation based on Stata

5.1 Results for Fintech Formation

In order to further investigate the impact of the three variables related to Fintech formation, this section will present the results of the interaction between the variable "Fintech_Formation", which aggregates the number of fintech companies founded, the number of mobile subscriptions and the venture capital investment, and the three performance measures.

Therefore, the same analysis was made for the three performance measures using the GMM estimator and the new variable Fintech_Formation instead of the three separate industry-specific fintech variables.

The results of each regression are displayed in Table 8. From these results, the discussion will focus only on the impact of Fintech_Formation on each performance measure. Thus, it is possible to see that for the first performance measure, ROA, the variable Fintech_Formation has a negative impact with statistical significance at the 5% level. Although the results display a small coefficient, it is possible to see that financial technology firms and the drivers of their appearance impact the bank's return on assets. Looking at the second performance measure, it is evident that this one is also negatively

impacted by Fintech_Formation, but with no statistical significance to explain the hypothesis. Even though it is known from previous study from Phan et al. (2020) that the number of fintech companies negatively impact ROE, it is not possible to infer that the aggregated variable, which also considers fintech drivers, have a negative impact on return on shareholders' equity. Lastly, for NIM, it is demonstrated a negative and significant relation with Fintech_Formation, meaning that the formation of fintech companies, associated with the drivers mobile subscriptions and venture capital investment have a negative impact on bank's interest margins.

Overall, from this analysis it is clear that not only the number of fintech companies founded in each country, but also the number of mobile subscriptions and the amount of venture capital investment, highly contribute to reduce commercial bank's profitability, in this study measured by Return on Assets, Return on Equity and Net Interest Margin.

Table 8 - Regression Results for Fintech_Formation

	ROA		**ROE**		**NIM**	
CTI	-.016	***	-.142	***	-.005	
CAP	.028	***	-.002		.018	*
SIZE	.007		.108		-.044	
LLP	-.022	***	-.153	**	-.011	
IIS	-.034	***	-.148		.002	
FC	-.035	***	-.423	***	-.021	***
Fintech_Formation	**-.025**	****	**-.136**		**-.189**	****
INF	-.016		0		.053	**
GDP	0	****	.108		0	***
Constant	1.459	****	14.433	****	2.279	****
Mean dependent var	0.469		5.194		2.004	
Number of obs	3444		3440		2912	
SD dependent var	1.089		9.400		2.477	
Chi-square	487.737		2031.831		208.459	

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

Source: own presentation based on Stata

5.2 Results for Fintech Formation and Bank Size

Adding to the results obtained, it was studied the effect of the interaction of Fintech Formation and bank size on each performance measure.

As already stated in above results, bank size influences the three performance measures, therefore, and taking into consideration that, Table 9 presents the results between the interaction of Fintech Formation and bank size on the performance measures.

Considering that size is positively related to ROA, ROE and NIM, one might say that larger banks yield higher returns and better margins. Taking also into account that all three measures of performance are negatively impacted by Fintech Formation, when looking at the results of the interaction between these two variables it is possible to conclude that both the returns and margins of larger banks are more likely to be affected by the negative impact of Fintech Formation. The results are only statistically significant for the measures ROA and NIM, nevertheless it is interesting to observe that the negative impact on larger banks is consistent among the three performance measures.

Table 9 – Regression Results for Fintech_Formation and Bank Size

	ROA		**ROE**		**NIM**	
CTI	-.016	***	-.142	***	-.005	
CAP	.028	***	-.002		.017	*
SIZE	.024		.201		-.176	**
LLP	-.022	***	-.154	**	-.011	
IIS	.03	***	-.149		.001	
FC	-.034	***	-.425	***	-.023	***
Fintech_Formation*Size	**-.002**	****	**-.009**		**-.013**	****
INF	-.017		-.031		.049	****
GDP	0	****	0		0	***
Constant	1.443	****	14.372	****	2.166	****
Mean dependent var	0.469		5.194		2.004	
Number of obs	3444		3440		2912	
SD dependent var	1.089		9.400		2.477	
Chi-square	487.737		2031.831		208.459	

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

Source: own presentation based on Stata

5.3 Robustness Checks

In order to properly analyse panel data, there are many models and estimators that one can use in order to achieve the right results. Considering this, apart from the GMM estimator used in this study, it can be used a pooled OLS (Ordinary Least Squares) model, a Random Effect model, or Fixed Effects model. The pooled OLS model specifies constant coefficients, ignoring the cross-section and time series nature of the presented data, which in the case of this study is not ideal. On the other hand, the fixed effects model will control for time-invariant differences between observations, in that way the estimated coefficients cannot be biased because of omitted time-invariant characteristics. The random effects model assumes that the individual-specific effect over the observations is assumed to be a random variable that is uncorrelated with the independent variables, which means that the error term is not correlated with the predictors (Nwakuya & Ijomah, 2017).

To understand if the results of the analysis are robust or not and if the estimator used is providing the most valid results, it was applied two different models for the estimation of the results. Therefore, to obtain the right estimation for the model it was conducted the Hausman test (Sheytanova, 2015). Accordingly, the result showed a p-value below 0.05, which means that the right estimator is Fixed Effects.

Results for the estimation with Fixed Effects are displayed on Table 10. From this, it is possible to say that the Fintech variable with this estimator suffers from omitted values, resulting in no impact on the performance measures. Apart from this, all other fintech related variables display the expected effect on each measure of performance, the same verified when applying the GMM estimator. For the bank-specific variables, the statistical significance of all explanatory variables on NIM drops, as no variable can explain this regression model. For ROA it is observed the same effects of the explanatory variables and as for ROE, it is observed a slight increase in statistical significance of variables, and the same impact as verified above.

Table 10 - Results for Fixed Effects Model

	ROA		ROE		NIM
CTI	-.005	**	-.054	***	-.002
CAP	.03	***	.027		.01
SIZE	.209	**	1.514	*	-.031
LLP	-.024	**	-.214	*	-.002
IIS	-.001		-.561	*	-.009
FC	0		0		0
FINTECH	0		0		0
MOBILE	-1.77	***	-14.876	***	-.314
INVEST	0	**	-.001	**	0
INF	-.061	***	-.391	**	-.033
GDP	0		0		0
Constant	27.73	***	242.109	***	7.914
Mean dependent var	0.469		5.193		2.004
R-squared	0.047		0.042		0.003
F-test	7.982		9.698		0.630
Akaike crit. (AIC)	7880.803		22577.110		8291.998
SD dependent var	1.088		9.399		2.477
Number of obs	3445		3441		2913
Prob > F	0.000		0.000		0.753
Bayesian crit. (BIC)	7936.105		22632.401		8345.790

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

Source: own presentation based on Stata

Considering now the OLS estimator, one can say that this one presents better results than when using Fixed Effects, since in this case the model does not specify obvious omitted variables that directly comprise the analysis of coefficients.

When looking at the results it is clear that in this case the variable Fintech presents the expected negative effect for ROA and ROE, while for NIM, the impact presented is positive, although not statistically significant. The variable MOBILE also shows the expected effect among the three performance measures. As for INVEST, this one shows no specific impact on any of the measures. For the bank-specific variables, the impact and coefficient reveal basically the same effect as when used the GMM estimator. The significance levels demonstrated with the OLS estimator are slightly higher, as more variables are statistically significant to explain the regression models.

Overall, the OLS model is the closest to the model used in this study. Nevertheless, the use of either of the two models presented in this section might not be the correct step into the analysis of bank profitability, since neither the OLS nor the Fixed Effects model considers the persistence of bank's profits over the years and do not that into account endogeneity problems in the regression model. Therefore, their use would provide non-consistent and biased results.

Table 11 - Results for OLS Model

	ROA		ROE		NIM	
CTI	-.014	***	-.133	***	-.004	**
CAP	.023	***	-.023		.008	
SIZE	.013		.15		.05	**
LLP	-.019	***	-.138	***	0	
IIS	.036	***	-.128		-.01	
FC	-.035	***	-.431	***	-.014	**
FINTECH	-.005	***	-.025	***	.003	
MOBILE	-.141	***	-.814	***	-.564	***
INVEST	0	***	0		0	
INF	-.033	*	-.151		-.049	
GDP	0	***	0	***	0	***
Constant	3.808	***	27.896	***	12.466	***
Mean dependent var	0.469		5.193		2.004	
R-squared	0.172		0.154		0.064	
F-test	.		.		.	
Akaike crit. (AIC)	9729.713		24628.810		13378.741	
SD dependent var	1.088		9.399		2.477	
Number of obs	3445		3441		2913	
Prob > F	.		.		.	
Bayesian crit. (BIC)	9797.305		24696.389		13444.488	

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

Source: own presentation based on Stata

Conclusions

This research assesses the impact of new Financial Technology companies on the performance of European commercial banks. Therefore, and to fully understand the impact of these companies in a well-established industry, it is important to consider the factors that might drive the growth of the technology industry. Having this in mind and considering past studies, this research introduces two control variables related to the formation of fintech companies. The analysis was based on an unbalanced panel data that gathers information from various sources, like BankFocus, The World Bank and OECD Statistics. The period of analysis was from 2012 to 2021, comprising the crucial years where the emergence of fintech companies was more accentuated. The final sample after a careful analysis comprises a total of 816 commercial banks, listed and non-listed and 202 fintech companies from 20 European countries.

Return on Equity, Return on Assets, and Net Interest Margin were the metrics used to gauge bank profitability; a number of macroeconomic, fintech drivers and bank-specific were chosen as control variables.

In light of the overall analysis and the results that have been presented it is possible to evidence that the most reliable proxy in terms of statistical significance is the model with Return on Assets as dependent variable, where 9 out of 11 variables are revealed to have explanatory power. On the other hand, the model with Net Interest Margin as dependent variable reveals to be the least significant model with only 3 out of 11 variables with explanatory power.

Looking at the results obtained it is possible to say that most of the variables evidenced the expected effects on the models. When considering the model with Return on Assets as dependent variable, all bank-specific variables showed the expected effect with the exception of Interest Income Share. Related to this variable, the observed effect was positive thus the findings were quite surprising, since it was expected that higher ratios would imply less income diversification, resulting in less profitability. Interestingly, only 6 of the 11 factors in the regression model with ROE as the dependent variable had explanatory power. Regarding the variables related to bank management, the expected effect was obtained in accordance with the literature

review performed. For the regression model with NIM as dependent variable none of the bank-specific variables revealed to have explanatory power in the model. The overall model shows that Cost-to-Income, Loan Loss Provision ratio and Funding Costs have a negative and significant impact on profitability, while Size and Equity to Total Assets ratio have a significant positive effect on bank profitability.

Nevertheless, when analysing the effect of the variable Fintech it is possible to say that this one showed a negative and significant impact on Return on Assets and Return on Equity. When considering Net Interest Margin, it was observed a positive impact, although not statistically significant to explain the model, it can be considered a mutually beneficial connection between traditional banks and financial technology companies. The negative impact of the number of fintech companies is statistically significant for at least two performance measures, proving the veracity of hypothesis 1.

For the assessment of the real impact of financial technology on the banking industry, two variables related to fintech were incorporated in the analysis. Thus, the number of mobile subscriptions has a negative and significant effect on all three performance measures. As for the investment in venture capital, it is also observed a negative impact on Return on Assets, which corroborates hypothesis 2, as high venture capital investment reduces bank performance, verified only for ROA.

Considering the overall paradigm of fintech formation composed of the aggregation of the three fintech related variables, the results showed that this variable has a negative impact on all three measures of performance. The results comprising this variable are quite interesting, as the three variables in separate showed different explanatory power in the models, but when put together it is evident the negative effect of the overall bank performance measures. Within the findings, the relation between bank size and fintech formation also revealed that the performance of larger banks is more affected by the negative impact of fintech formation, which validates hypothesis 3 of the research.

Therefore, the existence of financial technology companies exerts a negative impact on banks' performance indicating that traditional banks are facing challenges keeping up with the disruptive innovations that fintech companies are introducing.

Additionally, the study highlights the importance of considering the drivers of fintech companies when assessing the impact of this new industry on bank performance.

The study's conclusions provide important new perspectives on how the banking sector is changing in response to technological disruption. In order to maintain their long-term survival and competitiveness, traditional banks must carefully manage the challenges posed by fintech, which is rapidly changing the financial landscape.

Despite the fact that this thesis has improved knowledge of how fintech companies affect European commercial banks' performance, there are a number of limitations that should be noted and acknowledged. Firstly, the limited availability of specific data on the performance and operational metrics of banks and fintech companies may have influenced the scope and detail of the analysis. Related to the bank-specific variables, it was found an exceptionally large dispersion in the sample, as a high number of outliers was presented in data and had to be taken off, which could compromise the remaining data.

Secondly, the rapid pace of technological advancements and the dynamic nature of the financial environment could have constrained the timeliness of the findings and recommendations. The industry of financial technology is recent, therefore accurate data regarding this subject is quite hard to access. Additionally, a lot of companies do not present public records of their operations, making it difficult to consider all the fintech companies founded in each country during the period analysed.

Based on the findings of this study several avenues for further research emerge. Firstly, further studies could delve deeper into the adaptation strategies of traditional banks to fintech innovations and their efficacy in various contexts. Secondly, it is important to conduct a more thorough analysis of customer attitudes and preferences towards fintech and traditional banking services to better understand market dynamics. Thirdly, future research should emphasize the evolution of the regulatory environment and the impact on innovation and competitiveness in the financial sector.

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List of Abbreviations

B2B: Business to Business

CAMEL: Capital Adequacy; Asset Quality; Management quality; Earnings ability; Liquidity.

CAP: Capital Ratio

CTI: Cost to Income

DEA: Data Envelopment Analysis

EIB: European Investment Bank

EMEA: Europe, the Middle East, and Africa

FC: Funding Cost

FSB: Financial Stability Board

GDP: Gross Domestic Product

GMM: Generalized Method of Moments

HSBC: Hong Kong and Shanghai Banking Corporation

IIS: Interest Income Share

LLP: Loan Loss Provision

NIM: Net Interest Margin

OECD: Organization for Economic Co-operation and Development

OLS: Ordinary Least Squares

ROA: Return on Assets

ROAA: Return on Average Assets

ROAE: Return on Average Equity

ROE: Return on Equity

SMEs: Small and Medium Enterprises

STB: Small Town Bank

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Annex F – Regression Results for NIM and Fintech_Formation and Size

Annex A – Regression Results for ROA and Fintech_Formation

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.016	.002	-7.31	0	-.021	-.012	***
CAD	.028	.007	3.77	0	.014	.043	***
LLP	-.022	.005	-4.08	0	-.032	-.011	***
IIS	.034	.009	3.93	0	.017	.052	***
FC	-.035	.004	-9.49	0	-.043	-.028	***
FintechFormation	-.025	0	-2.20	.028	0	0	**
INFLATION	-.016	.014	-0.90	.368	-.039	.015	
GDP	0	0	-3.22	.001	0	0	***
SIZE	.007	.015	0.43	.665	-.022	.035	
Constant	1.459	.324	4.51	0	.825	2.093	***

Mean dependent var	**0.469**	**SD dependent var**	**1.089**
Number of obs	**3444**	**Chi-square**	**487.737**

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

Source: own presentation based on Stata

Annex B – Regression Results for ROE and Fintech_Formation

ROE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.142	.019	-7.59	0	-.181	-.107	***
CAD	-.002	.029	-0.09	.928	-.06	.055	
LLP	-.153	.075	-2.00	.045	-.299	-.003	**
IIS	-.148	.357	-0.39	.694	-.84	.559	
FC	-.423	.035	-12.46	0	-.504	-.367	***
FintechFormation	-.136	0	-0.87	.387	0	0	
INFLATION	-.031	.14	-0.22	.825	-.305	.243	
GDP	0	0	-0.84	.403	0	0	
SIZE	.108	.186	0.58	.564	-.258	.473	
Constant	14.433	3.54	4.08	0	7.496	21.371	***

Mean dependent var	**5.194**	**SD dependent var**	**9.400**
Number of obs	**3440**	**Chi-square**	**2031.831**

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

Source: own presentation based on Stata

Annex C – Regression Results for NIM and Fintech_Formation

NIM	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.005	.004	-1.88	.06	-.014	0	*
CAD	.018	.011	1.51	.132	-.005	.037	
LLP	-.011	.012	-0.50	.62	-.029	.017	
IIS	.002	.021	0.25	.804	-.036	.047	
FC	-.021	.009	-4.50	0	-.058	-.023	***
FintechFormation	-.189	0	-2.75	.006	0	0	***
INFLATION	.053	.05	1.11	.268	-.042	.153	
GDP	0	0	-2.46	.014	0	0	**
SIZE	-.044	.045	0.88	.38	-.049	.128	
Constant	2.279	.769	2.97	.003	.772	3.785	***

Mean dependent var	**2.004**	**SD dependent var**	**2.477**
Number of obs	**2912**	**Chi-square**	**208.459**

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

Source: own presentation based on Stata

Annex D – Regression Results for ROA and Fintech_Formation and Size

ROA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.016	.002	-7.19	0	-.021	-.012	***
CAD	.028	.007	3.78	0	.013	.042	***
LLP	-.022	.005	-4.09	0	-.032	-.011	***
IIS	.03	.009	3.45	.001	.013	.047	***
FC	-.034	.004	-8.56	0	-.041	-.026	***
Fintech_Formation *SIZE	-.002	.001	-2.29	.022	-.003	0	**
INFLATION	-.017	.014	-1.25	.213	-.044	.01	
GDP	0	0	-3.45	.001	0	0	***
SIZE	.024	.016	1.46	.143	-.008	.056	
Constant	1.443	.321	4.49	0	.813	2.073	***

Mean dependent var	**0.469**	**SD dependent var**	**1.089**
Number of obs	**3444**	**Chi-square**	**487.805**

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

Source: own presentation based on Stata

Annex E – Regression Results for ROE and Fintech_Formation and Size

ROE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.142	.019	-7.49	0	-.18	-.105	***
CAD	-.002	.029	-0.09	.932	-.059	.054	
LLP	-.154	.076	-2.02	.043	-.303	-.005	**
IIS	-.149	.355	-0.42	.674	-.845	.546	
FC	-.425	.038	-11.19	0	-.499	-.35	***
Fintech_Formatin* SIZE	-.009	.007	-1.20	.23	-.023	.006	
INFLATION	-.031	.14	-0.22	.824	-.306	.244	
GDP	0	0	-1.01	.311	0	0	
SIZE	.201	.218	0.92	.358	-.227	.628	
Constant	14.372	3.545	4.05	0	7.425	21.32	***

Mean dependent var	**5.194**	**SD dependent var**	**9.400**
Number of obs	**3440**	**Chi-square**	**2030.374**

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

Source: own presentation based on Stata

Annex F – Regression Results for NIM and Fintech_Formation and Size

NIM	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CTI	-.005	.003	-1.52	.127	-.01	.001	
CAD	.017	.01	1.68	.092	-.003	.037	*
LLP	-.011	.013	-0.88	.38	-.036	.014	
IIS	.001	.018	0.07	.943	-.035	.037	
FC	-.023	.006	-3.63	0	-.036	-.011	***
Fintech_Formatin* SIZE	-.013	.005	-2.70	.007	-.022	-.003	***
INFLATION	.049	.05	0.99	.32	-.048	.146	
GDP	0	0	-2.69	.007	0	0	***
SIZE	.176	.071	2.49	.013	.038	.315	**
Constant	2.166	.762	2.84	.004	.672	3.66	***

Mean dependent var	**2.004**	**SD dependent var**	**2.477**
Number of obs	**2912**	**Chi-square**	**209.258**

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

Source: own presentation based on Stata