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TRABAJO FIN DE GRADO EN

**THE EFFECTS OF INVESTING IN FINTECH ON
FINANCIAL STABILITY AND BANKING
CONCENTRATION: EVIDENCE FROM EUROPEAN
MARKETS**

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Abstract

This study examines the Fintech phenomenon in Europe. By employing econometric techniques, the consequences of Fintech presence on financial stability and banking concentration are analysed. Through a time series and panel data approach, multiple factors directly impacting financial stability (Z-score and NPL) and banking concentration (variables related to asset concentration) are taken into account.

The results obtained suggest a positive relationship between the presence of Fintech and financial stability, indicating that the absorption of higher-risk debt by these new actors may be the underlying cause. Additionally, an inverse relationship is observed between the presence of Fintech and banking concentration, implying an increase in competition with traditional banking institutions.

These findings have implications for understanding the financial dynamics in Europe, underscoring the crucial role of Fintech companies in risk management and fostering a more stable environment within the banking sector.

Keywords: *Fintech; financial stability; banking concentration*

JEL Classification: D40, G21, G28, L10

Resumen

Este trabajo examina el fenómeno Fintech en Europa. Mediante la aplicación de técnicas econométricas se analiza las consecuencias que tiene la presencia de Fintech en la estabilidad financiera y en la concentración bancaria.

A través de un enfoque de series temporales y datos de panel, se examinan múltiples factores con impacto directo en la estabilidad financiera (Z-score y NPL) y en concentración bancaria (variables de concentración de activos bancarios).

Los resultados obtenidos sugieren que hay una relación positiva entre la presencia de Fintech y la estabilidad financiera, sugiriendo que la absorción de deuda de mayor riesgo por parte de estos nuevos actores podría ser la causa subyacente. Adicionalmente, se observa una relación inversa entre la presencia de Fintech y la concentración bancaria, lo que implica un aumento de la competencia con las instituciones bancarias tradicionales.

Este hallazgo tiene implicaciones para la comprensión de la dinámica financiera en Europa y destaca el papel crucial de las empresas Fintech en la gestión de riesgos y la promoción de un entorno más estable en el sector bancario.

Palabras clave: *Fintech; estabilidad financiera; concentración bancaria*

Clasificación JEL: D40, G21, G28, L10

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1. INTRODUCTION TO FINTECH

In recent years the phenomenon of FinTech has arrived to our everyday life. We see it on the news, we talk about them and we use them maybe without being aware. Grammatically, the term FinTech does not need a deep explanation, it is just the contraction of “Financial Technology”. However, the concept FinTech does not seem to be clear, and a proper definition may be needed.

The motivation of this project is to shed light over this phenomenon which has changed the financial and banking landscape in the main global economies. Beyond merely exploring the key factors that explain its blossoming, this paper will focus on the effects that this transformation poses to the financial industry. This research will meticulously dissect through econometric methodologies the relationship between the presence of Fintech in a market and two aspects that are central to the financial sector: financial stability and banking concentration.

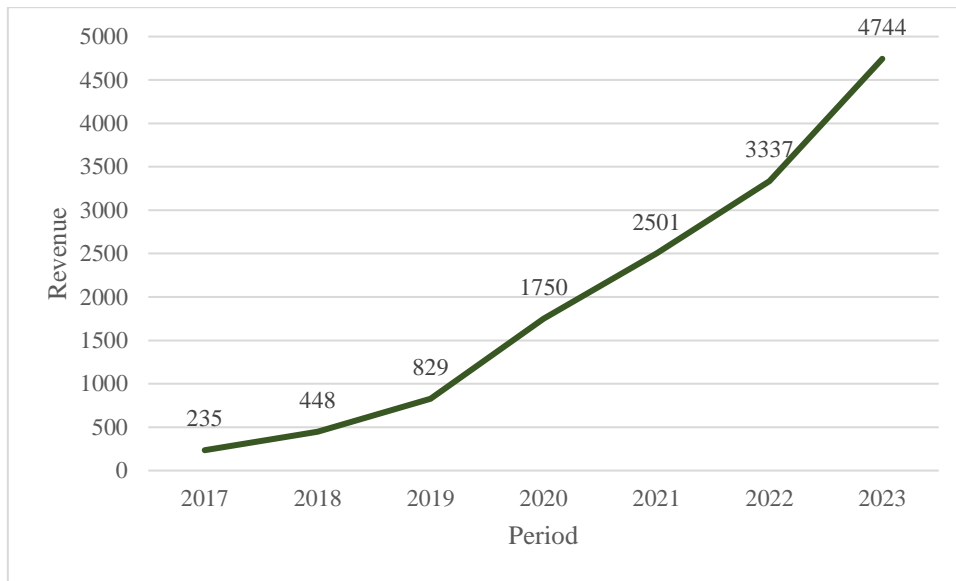
FinTech refers to the “novel processes and products that become available for financial services thanks to digital technological advancements” (Barba, Calzolari, & Pozzolo, 2017). Other institutions, such as the Financial Stability Board defines the term as “technologically enabled financial innovation that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services” (Barba, Calzolari, & Pozzolo, 2017).

The concept of FinTech can be seen as an umbrella term as it may include the financial sector as a whole. Classifying the areas that currently comprise FinTech allows to better understand its potential. Nevertheless, there is not a single classification and every author suggests slight differences.

Last but not least, Arner et al. (2015) categorise Fintech areas as Finance and investment, Financial operations and risk management, payments and infrastructure, data security and consumer interface.

As can be seen in Figure 1, Fintech activity is growing at a steady pace, as it has multiplied by 20 its revenues in the last 6 years. Taking this growth and its importance for the economy, it is worth analysing the consequences that Fintech can pose to the financial industry.

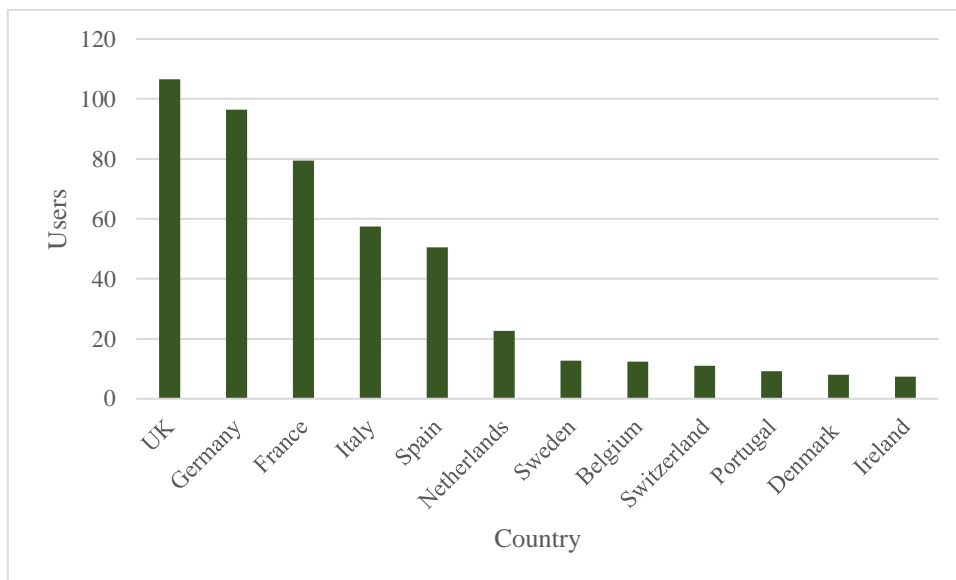
Figure 1: Revenue of Fintech industry worldwide (\$ billion)



Source: Statista

In Europe, the Fintech companies have found a prosperous ecosystem to develop their activities. One of the key factor behind the blossoming of Fintech in Europe is Open Banking, which will be discussed in the next section. Figure 2 shows the main European markets for Fintech through the number of users.

Figure 2: Number of Fintech users in selected European countries in 2023 (million users)



Source: Statista

Therefore, the scope of the empirical test that will be performed will be focused on the main countries that hold the user's pool, namely United Kingdom, Germany, France, Italy and Spain.

Once provided a holistic review of the Fintech services it is necessary to address the objectives of this paper in relation to this companies.

The remainder of the paper is organized in three sections. Section two discusses the related literature. Section three refers to the Institutional Framework, focusing on the licenses and regulations that comprise the Fintech activity. Section four presents the hypotheses, defines the database and describes the empirical model and study variables, then proceeds with the discussion of the results and the concluding section.

2. LITERATURE REVIEW

In order to understand the reality of Fintech in Europe it is worth mentioning the reasons behind the spectacular bloom of Fintech services to later focus on its effects on financial stability and banking concentration.

The European financial landscape has undergone a profound metamorphosis which has two central elements as all great changes in a sector: the factors that explain it and its consequences. This paper will focus mainly on the European markets for a variety of reasons. First of all, the EU has adopted an uniform regulation across all its member states which makes it easier for comparison and analysis of the outcomes in different national markets. Parallely, in the EU we can find a wide diversity in terms of market size, degree of financial development and banking concentration. This allows us to have a more holistic approach of the consequences of Open Banking. On top of that, the EU is a leader in Open Banking, while other countries are starting to imitate the framework applied in Europe.

Therefore, the first thing to consider is that the emergence of Fintech companies can be explained by the environmental circumstances paired with a beneficial regulatory framework called Open Banking. The wave of technological change itself does not explain the change that the sector has undertaken, as it needs to be contextualised with all the factors relating to the 2008 Global Financial Crisis that are still present in today's banking reality.

The literature reflects that the factors which explain the development of FinTech are found in the consequences of the Financial Crisis of 2008. This episode is central to the development, not only of the financial sector as a whole, but also of the Fintech ecosystem.

The first factor to consider is the public perception of banks, as it severely deteriorated. Their image suffered as it was shown that their risk management was not optimal. The banking sector showed an image of instability, both with the risk measurement of the products commercialised and their own financial structure. In a report published by Forbes in 2015 it was stated that Americans trusted more tech firms than banks for financing¹.

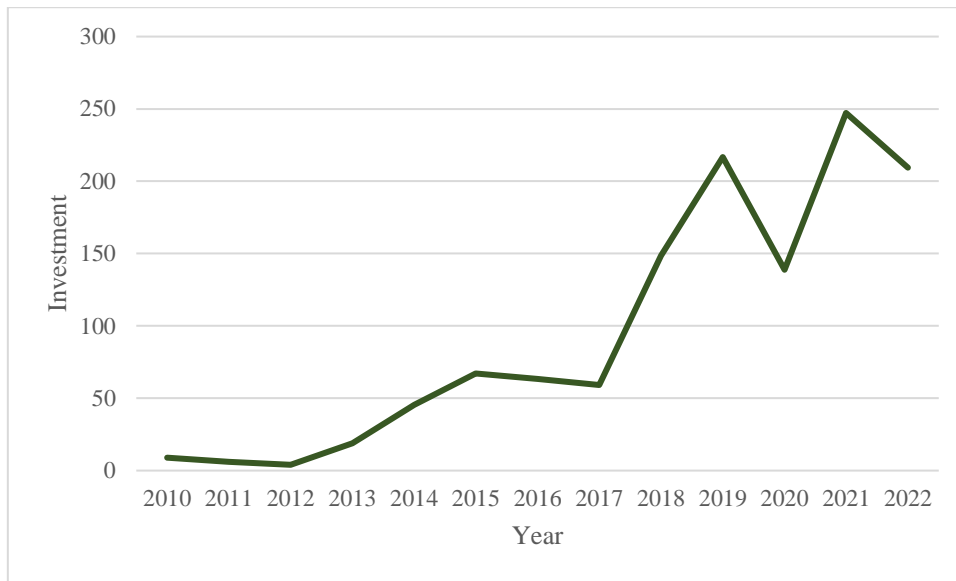
In Spain, this situation was worsened by the need of restructuring in the banking sector. This can be seen in the reduction of banks (by mergers and acquisitions) and the reduction of overall banking branches. The perception of banks and financial institutions was severely damaged, so there was an opportunity for the appearance of new actors with a new way of approaching the customers. Hence, the marketing strategy of some of this new entrants is focused on presenting themselves as an opportunity or way to avoid traditional banks.

The second factor to consider is the increase in regulatory scrutiny by the public institutions. As the 2008 Financial Crisis showed, the lack of legal measures in the sector regarding some financial products led to the subprime mortgage bubble burst. Additionally, regulators aimed to reinforce the banking system in order to avoid bankruptcy. These regulations affected heavily the banks, having to focus on complying with the new norms and constraints. Parallely, this allowed some technological players to enter a market in which the traditional banks had some limitations.

The third factor are the economic conditions that enabled a beneficial environment for FinTech companies. Among these factors, the exceptionally low interest rates should be highlighted. The attractive conditions for financing allowed not only the FinTech, but also Venture Capital and other investors, to fund projects very capital intensive, as the technological ones.

¹ <https://www.forbes.com/sites/niallmccarthy/2015/06/24/americans-trust-tech-firms-more-than-banks-for-finance-infographic/>

Figure 3: Total value of investments into fintech companies worldwide (\$ billion)



Source: Statista

It is also worth mentioning among the economic factors that after the 2008 Financial Crisis, a large number of employees from financial institutions were dismissed due to the restructuring. This allowed some of them to create projects with the know-how of the sector. FinTech companies had a great opportunity to recruit valuable workers. Additionally, a new generation of graduates with technological skills faced a difficult job market in which FinTech companies could hire the best talents.

On top of that, the demographic response should be noted, as the democratization of internet services and smartphone penetration increased in the general population. This trend has been significantly accelerated by COVID-19, as the circumstances imposed the general public to embrace the digital services. This situation benefited FinTech companies which aim mainly for clients that are technology savvy, but with a focus on creating an effortless experience for the user. A study from EY estimated that in 2019 worldwide 6 out of 10 people used actively FinTech services (Ernst&Young, 2019). That figure is likely obsolete and probably has increased, as it does not take into account the COVID-19 social response in which digitalisation grew significantly.

Those elements, complemented by the technological innovations seen in recent years, created a breeding ground for the blossoming of the FinTech sector. A study from the Department of International Trade stated that in the UK in 2019 there were over 1600 FinTech firms (Bowden, King, Kotmos, Loncan, & Stentella, 2021).

However, there is a concrete element that has direct impact on the blossoming of Fintech which is Open Banking. This regulatory movement finds its force within the European Union in two Directives, the first and second Payment Services Directive (PSD and PSD2). These directives laid the groundwork for the changes in the financial sector, redefining roles and responsibilities of financial institutions, customers, data and third-party providers (TTPs) in the payment ecosystem.

These regulatory bodies aimed to create a financial ecosystem that empowers consumers with more control over their financial data through informed consent, while providing them with a broader range of financial services through the promotion of competition and innovation. However, as with any regulatory change of such magnitude and ambition, the extent to which these objectives have been met remains a topic of ongoing research and debate.

Once reviewed the literature about the factors that affect the Fintech ecosystem, the consequences of this reality must be examined. This will be the aim of this project, through two main topics which hold a central importance for a national economy and, more specifically, for the financial sector of a region. The topics which will be examined under the light of Fintech are the financial stability and the banking concentration.

The first hypothesis this paper poses is related to the objective of Open Banking, as it will be subject to analysis whether it has affected the concentration of the European financial sector. It is crucial to delve into existing literature to examine if the entrance of new players, specially Fintech companies, has changed the existing market balance. To do so, we will analyse the market concentration in relation with the emergence of Fintech companies to assess the competitive landscape and evaluate the success that Open Banking has had in increasing competition and its effects on consumers. Research has shown that in markets where the sector is subject to a higher market concentration, traditional banks are wield more power and influence, leading to reduced incentives for innovation and competition. This can be translated into a more scarce offering of products and services at the same time that the prices tend to be higher. This harms the position of the customer in the market and poses threats to the integrity of the system. Therefore, it is central to know if the objectives aimed with Open Banking (which encouraged data sharing, customer empowerment) have indeed materialized. To do so, the role of Fintech is very relevant as they appear as disruptors who can potentially divert customers from

traditional commercial banks as their position can weaken in the presence of new competition.

The second hypothesis of this paper is that the proliferation of electronic payment methods through Fintech, as a result of Open Banking, has contributed to the stability of the financial system. Traditionally, financial stability has been directly related with the resilience of established banks as a secure infrastructure in which customers could build trust. Open Banking can reshape the dynamics in the financial sector, hence damaging (or strengthening) the established position of traditional institutions which has a consequence in the stability of the system. At the same time, Fintech companies appear to have business models that are yet to be considered stable, the majority of them not being profitable while providing services to millions of users. This statement breaks the traditional concept by which a significant number of clients can be associated with the success of a company, and at the same time poses potential threats and risks to the financial systems. Having a company directly dependent on external financing while offering a financial service to a wide pool of clients can be a risk to be considered seriously as it can damage the stability of the sector. On top of that, the new services allowed by Open Banking are subject to other potential risks that need to be addressed as the cybersecurity threats.

Therefore, we will review the literature and analyse our own data to assess how financial stability depends on the resilience of banks and the stability of payment systems. The majority of the literature asserts that the presence of Fintech companies enhances financial services, reducing risks, and addressing systemic vulnerabilities while other experts may doubt it. It is vital to know the risks that the banking sector face in relation to FinTech as it would be a stepping stone for the public institutions and regulators (European Systemic Risk Board, 2022).

The risks detailed are related to financial issues, but it is worth noting that there are also many risks associated with the use of technology and cyber attacks.

As said previously, there is a vast array of services that a FinTech company may offer. Therefore, the risks presented may be applicable only to certain FinTech companies.

Firstly, FinTech are not different from other financial institutions in the liquidity risk. When presented as financial intermediaries, FinTech companies need to carry the necessary due diligence to prevent those risks. They need to match their cash inflow to stay in a cash positive position to face their liabilities. To do so, they need also to manage

credit risk and to consider the interest and exchange rates as traditional financial institutions do.

The matter is that most FinTech companies have not gone through a complete economic cycle to test its robustness. Meanwhile, their users pool continues growing as they are attracting new customers to their business. Thus, the risk entailed grows as well in a situation in which the regulation for FinTech is not completely set as this paper will discuss over the next chapters.

In addition, there are other consequences which are embodied in traditional banks. Traditional commercial banks may need to employ high-risk services, products or behaviours to re-attract clients to respond to the FinTech phenomenon (Baomin Chen, 2022). Banks might increase their risk tolerance to maintain a certain profit level like lowering loan requirements or increase loan services to riskier clients. Moreover, the innovations required to keep the pace of FinTech brings hidden technological risks.

On top of that, as the regulation on some FinTech companies is not suited yet for their activity, some companies have unclear business models which lead to murky financial statements. This fact can be utilized by some actors to commit fraud.

There are other risks to consider in relation with FinTech. The volatility of the price of cryptocurrencies and other crypto-assets may create credit risks in the financial markets, not only because of the potential loss for the investors, but also because many FinTech companies have crypto-assets as collateral for certain obligations.

The popularity of algorithmic trading (and high-frequency trading) by FinTech companies may pose risks translated in volatility of the stock market as it can magnify negative (and positive) consequences and produce information asymmetry between players.

Reviewing the existing literature related on the effects of Fintech activity in Europe, it is clear that there are still gaps in our understanding. These gaps relate to the extent of regulatory success in achieving their goals in concentration and stability, through the variations in the impact of Open Banking in relation with other international markets. Therefore this paper aims to shed light in those areas of uncertainty which will be addressed in the subsequent sections of this document.

3. INSTITUTIONAL FRAMEWORK

The banking and financial sector is one of the most regulated industries in the world.. Given the financial impact in the global economy, it has been always subject to strict regulations.

The scope of this chapter is to focus on the EU framework, as it is one of the most complete yet pioneer systems. In this matter, when referring to the EU, normally it covers the EEA (European Economic Area) which includes not only the EU Member States but also Iceland, Liechtenstein and Norway.

The first topic to mention when referring to providing financial services is the licenses. FinTech companies should take this into account as it is an essential requirement to provide certain products and services.

3.1. Licenses

Licenses can be seen as entry barriers to operate that regulators pose in order to maintain potential fraudulent actors and risks away from financial operations. Therefore it is central to understand both the concentration of financial institutions and the stability that it gives to the system as they usually have strict requirements.

In general terms the following licenses are considered: the banking license, the electronic money license, participatory financing platform license and the payment institution license. All of them are very important for FinTech companies. However, two of these licenses will attract most of our attention, which are the banking licenses and the payment institution license.

3.1.1. The banking license

The banking license is a very important authorisation in the banking industry, therefore it directly affects those Fintech companies which want to act as banks (neobanks) in its activities. The trust in the financial system is backed by these licenses, which ensure the enforcement of good practices and supervision of its operations. Thus, licensing must prevent unsafe institutions with high operational and financial risk, that can pose a threat to the financial system, from entering the banking market.

Since 2014, only the European Central Bank (ECB) has been competent to grant the banking licenses for the credit institutions based on Member States under the Single

Supervisory Mechanism (SSM)². The main topics that the ECB assess in order to grant the authorisation are the applicant's capital levels, its operations programme, structural organisation and the suitability of managers and relevant shareholders.

The spectrum of activities that a bank can perform is very wide, hence, it is vital to delimit its concept in order to regulate it. The key activity of a bank³ is “undertaking the business of which is to take deposits or other repayable funds from the public and to grant credits for its own account”. Therefore, in order to perform these core activities the institution must be granted a banking license. It is worth mentioning that with the definition given, some FinTech services would be based directly or indirectly on the granting of small or big credits.

Consequently, as will be shown, some FinTech companies will need a banking license in order to perform their services or partner with a credit institution. However, this affirmation is controversial as there is a figure named by authors as “shadow banks”. As defined by Buiters⁴ “The shadow banking sector consists of the many highly leveraged non-deposit-taking institutions that lend long and illiquid and borrow short in markets that are liquid during normal or orderly times but can become very illiquid when markets become disorderly. They are functionally very similar to banks but are barely supervised or regulated. They hold very little capital, are not subject to any meaningful prudential requirements as regards liquidity, leverage or any other feature of their assets and liabilities” (Buiters, 2008). This means that these companies fund themselves through credits which later lend to individuals and companies. The business model is similar to a licensed commercial bank but without the pertinent regulatory framework and with the origin of its funds not being subsidized deposits.

This situation poses some threats not only to the banking sector but also to a domestic economy depending on the size of the shadow bank. The systemic risks associated with maturity transformations, leverage and credit risk are applicable to these companies similarly to a bank, but with the difference that licensed banks are obliged to hold certain guarantees over the credits and deposits they take. The risk increases exponentially as

² This topic is regulated in the Council Regulation (EU) No 1024/2013 of 15 October 2013 conferring specific tasks on the European Central Bank concerning policies relating to the prudential supervision of credit institutions.

³ Defined in Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms

they tend to be highly leveraged. On top of that, shadow banks can pose regulatory arbitrage concerns because of their special position, as they are not regulated, which is translated in an advantageous spot. This harms the position of licensed banks, which have compliance and operational requirements which pose a disadvantage.

Shadow bank debt is much more concentrated than bank deposits and is provided primarily by, potentially informed, large banks in the form of credit lines (Erica Jiang, 2020). This might be contradictory as the licensed banks are harmed by the existence of shadow banks but, at the same time, they provide them with liquidity. Banks seem to calculate that the expected value they receive of the credit lines is higher than the specific harm they receive by each shadow bank.

3.1.2. The Electronic Money License

This license does not hold the scope and importance of the banking license, although it is relevant for some FinTech companies.

This license is meant to be used by those firms which offer intermediary services with electronic money. It is regulated by the Electronic Money Directive II (EMD2)⁵ and somewhat in the Payment Service Directive (PSD2).

The definition of electronic money that can be found in EMD2 is: “*electronically, including magnetically, stored monetary value as represented by a claim on the issuer which is issued on receipt of funds for the purpose of making payment transactions [...] and which is accepted by a natural or legal person other than the electronic money issuer*”.

However, in order to guarantee that the Electronic Money Institutions (EMIs) do not take over the banking services (for the reasons stated before), the EMD2 set certain limitations such as the prohibition of taking deposits or other repayable funds from the public. Therefore, EMIs are meant to be intermediaries, which cannot hold the funds. The operation should be carried immediately and cannot be considered a deposit or a repayable fund, therefore no interest shall be yielded. On the contrary, the Banking License may allow the credit institutions to make payments or issue electronic money. However, as will be seen, the Electronic Money License will be closely related to the

⁵ Directive 2009/110/EC of the European Parliament and of the Council of 16 September 2009 on the taking up, pursuit and prudential supervision of the business of electronic money institutions

Payment Institution License, which will allow a wider range of services and information to be exchanged.

3.1.3. The Participatory Financing Platform License

The Participatory Financing Platform License (PFP) refers to activities in which there is an intermediation between the public and the investment project, facilitated by electronic platforms. This license is meant just to a specific activity within the FinTech ecosystem, which is the Crowdfunding model.

Crowdfunding is a way of funding projects and businesses by collecting money from a large number of small investors via an online platform. It is usually used by entrepreneurial startups that face financial constraints when asking for funds as it allows to access financing, at the same time that gives the opportunity to individuals to invest in big projects. The lending platform usually has not a direct exposure to the risk of the operations and its business model is based on servicing fees.

3.1.4. The Payment Institution License

The Payment Institution License is a license that allows an institution to process certain payments between parties. In the European Union its regulation began in 2007 with the Payment Service Providers Directive (PSD). This was the first step to create a single payments market in the EU. At that time the technology was much simpler and incumbent banks were the only financial institutions.

Therefore, as the situation developed, it was necessary an amendment, which came with the PSD2. The importance of this Directive is central to the current situation. The PSD2 is the cornerstone of the revolution that allowed FinTech companies to offer services and products that could not be possible before. That revolution is named Open Banking and has changed the model in the whole banking industry as it allowed the entrance of new comers, creating a completely different environment.

Open Banking is a change in paradigm in the banking industry. The most valuable asset for banks nowadays is information as with the latest technologies it can base a competitive advantage. With Open Banking that valuable asset is being opened and shared with certain institutions that can be considered competitors for the incumbent bank. Therefore, this movement is changing the rules and the business approach of the banking sector as a whole.

Open Banking allows the clients of the financial service to transfer the payment information to other financial institutions of their choice. That gives to a certain extent power to the customer to choose other financial intermediaries, a power that the bank loses. Therefore, Open Banking may have the direct effect of changing the financial stability of the market, as the power is shared between several players.

4. EMPIRICAL EXPERIMENT

4.1. Hypotheses, data and methodology

4.1.1. Hypotheses

The purpose of this research is to analyse the effect of the investment in FinTech on the stability on the financial sector and the banking concentration. Based on the reviewed literature, the following hypotheses are proposed:

Topic 1.—Financial stability

Null Hypothesis (H_0) – Fintech investment does not affect the financial stability

Hypothesis (H_1) - Fintech investment does affect the financial stability

Topic 2.—Banking concentration

Null Hypothesis (H_0) – Fintech investment does not affect the banking concentration

Hypothesis (H_1) - Fintech investment does affect the banking concentration

4.1.2. Data

The data gathered for this paper has been gathered from different sources. The sample consists of data from the main European markets, namely Italy, UK, France, Germany and Spain. Due to the characteristics of the Fintech ecosystem, private entities that are not publicly traded and with a short track record, the availability of data is very scarce. That is the reason why the time series is constrained to the period from 2013 to 2017.

There are two arrays of data which will be used in this paper: figures referring to funding in Fintech and macroeconomic indicators. The figures of Fintech funding are drawn from CB Insights, whereas the macroeconomic indicators are drawn from the World Bank Data Base.

TABLE 1
VARIABLE DEFINITION

Variable	Acronym	Definition
<i>Banking variables</i>		
Bank credit to bank deposits	CTD	Ratio of loans extended to the amount of deposits held in a banking institution
Bank non interest income to total income	NII	Proportion of the banking income generated from non-interest sources (namely fees, commissions and trading) in relation to the total income
Bank regulatory capital to risk-weighted assets	RCAP	Proportion of regulatory capital (protected against losses) to its risk-weighted assets
Bank cost to income ratio	EFF	Efficiency, it compares the operating expenses to total income
Bank Return On Assets	BROA	Net income as a percentage of the total assets
<i>Macroeconomic variables</i>		
Gross Domestic Product	GDP	Gross Domestic Product of each country
<i>Explanatory variables</i>		
Investment in Fintech	INV	Investment in Fintech in each country
Investment in Fintech to GDP	INVGDP	Investment in Fintech in each country in relation to its GDP
<i>Dependent variables</i>		
Banking Z-score	Z	Inverse probability of banking failure
Ln Z-score	LNZ	The natural logarithm of the Banking Z-score
Non Performing Loans	NPL	Probability of Total Loans granted that are potential financial distress
3-bank asset concentration	TCONC	Concentration of assets of the 3 biggest commercial banks of an economy
5-bank asset concentration	FCONC	Concentration of assets of the 5 biggest commercial banks of an economy

4.1.3. Measures of financial stability

This study uses three measures of risk exposure: the *Z-score*, the natural logarithm of *Z-score* and, as a robust-ness check, the NPL ratio ($NPL_{i,t}$).

The *Z-score* is calculated as follows:

$$Z_{i,t} = \frac{ROA_{i,t} + CAR_{i,t}}{\sigma(ROA_{i,t})} \quad (1)$$

Where:

- $ROA_{i,t}$ is the profitability ratio measured as earnings before tax over total assets
- $CAR_{i,t}$ is the capitalization ratio measured as equity capital over total assets
- $\sigma(ROA_{i,t})$ is the standard deviation of ROA computed for a three-year rolling time window. A moving standard deviation is used to allow for time variability of the denominator.

The *Z-score* is interpreted as the reduction in the standard deviation of its Return On Assets (*ROA*) that would be required to absorb the entire equity capital of the bank. Thus, it serves as a measure of the distance between a bank's current financial position and its solvency. It is widely used by regulators, policymakers and investors as an early warning signal, especially during periods of economic stress or financial turbulence.

A higher *Z-score* generally indicates a greater distance from insolvency, and is associated with a lower probability of bank failure. In other words, the *Z-score* is the inverse probability of bank failure. That is why it will be used to reflect banking stability.

The natural logarithm of *Z-score* is also used in this study. It is computed as follows:

$$LZ_{i,t} = \ln(Z_{i,t}) \quad (2)$$

By transforming the *Z score* through the natural logarithm, the results are normalized, with the variance stabilized, which helps with the interpretation. On top of that, the indicator will beneficiate from more robustness.

The Non Performing Loan ratio is calculated taking the volume of NPLs and dividing it by the total value of customer loans. This ratio serves as an indicator of the asset quality

and credit risk within the banking industry. Non Performing Loans are loans where the borrower has failed to pay some of the pre-established quotas for a specified period, indicating potential financial distress.

A rising NPL ratio may be indicative of economic downturns or increased default risks, while a declining NPL would mean economic recovery, improved credit conditions or financial stability. Researches have associated Non Performing Loans with a negative impact on GDP growth, productivity and unemployment, due to unaddressed vulnerabilities in the financial and corporate sectors (Ardhi, Bahri, & Artha, 2021). A high proportion of Non Performing Loans has a detrimental effect on banks, as they will generate low profits, require higher provisions and need larger resources to be managed (Aiyar, y otros, 2015). Consequently, Non Performing Loans have a direct effect on financial stability.

Therefore, this figure is used to assess the financial stability, risk assessment and economic health of either a financial institution or the financial sector of a region (the latter is the use given in this project).

4.1.4. Measures of banking concentration

This study uses two measures of banking concentration that are somewhat related: the 3-bank asset concentration and the 5-bank asset concentration.

The 3 and 5 bank asset concentration reflects the congregation of assets in the three (and five) largest commercial banks of an economy, expressed as a proportion of total commercial banking assets. This metric is a reflection of the dominance of a few key players in the market and is often used to assess the level of competition and potential vulnerabilities.

A higher concentration ratio implies that a substantial portion of the market is controlled by a limited number of banks. Therefore, this figure assesses the structure and stability of the banking sector.

4.1.5. Empirical specification

This section presents a discussion on strategies for identifying and testing hypotheses regarding the effects of NPLs on lending market structure.

The empirical methodology for this study is based on the following Ordinary Least Squares (OLS) estimator with fixed effects for panel data:

$$Y_{it} = \gamma_0 + \gamma_1 F_{i,t-1} + X'_{i,t-1} \Gamma + v_i + v_t + \epsilon_{it} \quad (3)$$

Where Y_{it} is the dependent variable for the following indicators. The first is the banking Z-score, defined by the expression (1). The second, used as a robustness check is the natural logarithm of the Z-score, calculated using the formula (2). The third is the Non Performing Loans ratio, computed as the proportion of the volume of NPLs out of the total value of customer loans. The fourth and fifth are the banking concentration, both the 3 and 5 banking asset concentration.

For the **explanatory variables**, the indicators of interest ($F_{i,t-1}$) are the investment in Fintech to measure the dimension of the investment in each country; and the investment in Fintech in relation to the country's GDP, in order to have a relative scope taking into account the dimension of the domestic economy. Both of these indicators are lagged one period and have been transformed by applying a natural logarithm.

The **matrix** $X'_{i,t-1}$ captures the following control variables lagged by one period. The first is bank credit to bank deposits ($CTD_{i,t-1}$). It reflects the ratio of loans extended to the amount of deposits held. It provides assessment on the financial banking lending in a country relative to its deposit base, indicating its reliance on deposits for funding its loan portfolio. The second is bank non interest income to total income ($NII_{i,t-1}$). It represents the proportion of the banking income generated from non-interest sources (namely fees, commissions and trading) in relation to the total income generated by the banking sector. The third is bank regulatory capital to risk-weighted assets ($RCAP_{i,t-1}$). It indicates the capital adequacy of the banking sector by measuring the proportion of regulatory capital (protected against losses) to its risk-weighted assets. It reflects the ability of the banking sector to absorb potential losses and in which degree it may compromise its solvency. The fourth is bank cost to income ratio ($EFF_{i,t-1}$), which is the efficiency. It compares the operating expenses to total income. It assesses the banking sector's operational effectiveness. The fifth is bank Return On Assets ($BROA_{i,t-1}$). It measures the profitability of the banking industry by expressing the net income as a percentage of the total assets. It reflects the capacity of generating earnings provided its assets.

The **macroeconomic variable** used is the natural logarithm of each country's Gross Domestic Product lagged by one period.

4.2. Results

4.2.1. Descriptive statistics and parametric tests

A description of the sample distribution and the values registered is summarised in Table 2. Concerning the dependent variables, the Bank Z Score reflects an average of 15.955, with a standard deviation of 3.265. The values range from a minimum of 8.717 to a maximum of 20.355. Moving to Ln Z, the natural logarithm of the Z Score, it maintains an average of 2.747, with a standard deviation of 0.226. The values oscillate between 2.165 and 3.013. Non-Performing Loans reveal an average of 6.247, accompanied by a standard deviation of 5.577. The range extends from a minimum of 0.735 to a maximum of 18.064.

Moving on to the 3-Bank Asset Concentration, it records a mean of 77.866 with a standard deviation of 5.295. The values fluctuate between a minimum of 70.024 and a maximum of 87.816. Similarly, the 5-Bank Concentration presents an average of 63.449, with a standard deviation of 7.084. The values range from a minimum of 51.623 to a maximum of 79.017.

TABLE 2
DESCRIPTIVE STATISTICS

DEPENDENT VARIABLES	Mean	SD	Min	Perc.5%	Median	Perc.95%	Max
Bank Z-score ($Z_{i,t}$)	15.955	3.265	8.717	9.218	16.612	20.176	20.355
Ln Bank Z-score ($LnZ_{i,t}$)	2.747	0.226	2.165	2.220	2.810	3.005	3.013
Non Performing Loans ($NPL_{i,t}$)	6.247	5.577	0.735	0.848	4.104	18.047	18.064
3-Bank Asset Concentration ($TCON_{i,t}$)	77.866	5.295	70.024	70.036	76.479	87.584	87.816
5-Bank Asset Concentration ($FCON_{i,t}$)	63.449	7.084	51.623	53.427	61.808	78.049	79.017
REGRESSORS	Mean	SD	Min	Perc.5%	Median	Perc.95%	Max
Investment in Fintech ($INV_{i,t}$)	-6.513	1.156	-8.889	-8.606	-6.680	-4.400	-4.382
Investment in Fintech to GDP ($INVGDP_{i,t}$)	7.919	1.282	5.431	5.458	7.949	10.106	10.169
Bank credit to deposits ($CTD_{i,t}$)	115.800	17.639	91.495	91.696	116.210	161.100	163.900
Non-Interest Income to Total Income ($NII_{i,t}$)	50.521	11.164	21.294	27.240	51.262	67.103	68.058
Bank regulatory capital ($RCAP_{i,t}$)	16.574	2.488	11.586	12.517	18.891	20.633	20.801
Bank ROA before tax ($BROA_{i,t}$)	0.062	0.548	-1.843	-1.628	0.188	0.613	0.615
Bank cost to income ratio ($EFF_{i,t}$)	70.205	8.393	57.173	57.928	67.897	86.095	88.629
Gross Domestic Product ($GDP_{i,t}$)	28.252	0.347	27.655	27.662	28.272	28.772	28.787

Turning to the regressors, Investment in Fintech ($INV_{i,t}$) displays an average of -6.513, accompanied by a standard deviation of 1.156. The values range from a minimum of -8.889 to a maximum of -4.382. Investment in Fintech to GDP ($INVGDP_{i,t}$) maintains an average of 7.919, with a standard deviation of 1.282. The values oscillate between a minimum of 5.431 and a maximum of 10.169. Bank Credit to Bank Deposits ($CTD_{i,t}$) exhibits an average of 115.800, accompanied by a standard deviation of 17.639. The values range from a minimum of 91.495 to a maximum of 163.900. Bank Non-Interest Income to Total Income ($NII_{i,t}$) displays an average of 50.521, with a standard deviation of 11.164. The values fluctuate between a minimum of 21.294 and a maximum of 68.058. Continuing, Bank Regulatory Capital to Risk-weighted assets ($RCAP_{i,t}$) displays an average of 16.574, with a standard deviation of 2.488. The values oscillate between a minimum of 11.586 and a maximum of 20.801. Bank Return On Assets before tax ($BROA_{i,t}$) showcases an average of 0.062, accompanied by a standard deviation of 0.548. The values range from a minimum of -1.843 to a maximum of 0.615. Bank Cost to Income ($EFF_{i,t}$) records an average of 70.205, with a standard deviation of 8.393. The values fluctuate between a minimum of 57.173 and a maximum of 88.629. Lastly, the Gross Domestic Product ($GDP_{i,t}$) maintains an average of 28.252, with a standard deviation of 0.347. The values oscillate between a minimum of 27.655 and a maximum of 28.787.

4.2.2. Testing the first Hypothesis: financial stability

This section discusses the econometric results which prove hypothesis 1. The topic of this hypothesis was focused on the effects of the investment in Fintech over the financial stability of an economy.

Table 3 gives the regression coefficients for the expression (3). The hypotheses for this study are tested using OLS regression analysis with fixed effects for panel data.

Financial stability will be assessed through the effect that the Funding of Fintech has over the Bank Z-score, the natural logarithm of the Z-score and Non Performing Loans. The change in those indicators would reflect the effect in a financial economy due to the existence of Fintech companies.

TABLE 3

THE EFFECT OF INVESTMENT IN FINTECH ON STABILITY

This table shows the results when financial stability, defined through the dependent variables as the NPL ratio, the Z-score and the natural logarithm of the *Z-score*, is regressed against the investment in Fintech, the bank credit to bank deposits ratio, the bank non interest income to total income, the bank regulatory capital to risk-weighted assets and the efficiency. The specifications are estimated using the OLS estimator for panel data with fixed effects for the period 2013-2017. All the regressions contain individual fixed effects, and the standard errors are clustered by countries. *, **, ***, denote minimum 10 %, 5 %, 1 % significance, respectively.

	OLS with fixed effect					
	Investment in Fintech			Investment in Fintech to GDP		
	<i>Z score</i>	<i>LnZ</i>	<i>Bank NPL</i>	<i>Z score</i>	<i>LnZ</i>	<i>Bank NPL</i>
<i>const</i>	2286.140*** (429.862)	153.680*** (27.809)	283.474 (824.560)	2236.92*** (424.786)	150.857*** (27.427)	268.024 (815.553)
<i>INV_{i,t-1}</i>	3.081*** (0.575)	0.179*** (0.037)	0.524 (1.104)	3.111*** (0.581)	0.180*** (0.038)	0.512 (1.116)
<i>CTD_{i,t-1}</i>	-0.061* (0.027)	-0.005** (0.002)	0.048 (0.052)	-0.059* (0.027)	-0.004* (0.002)	0.048 (0.052)
<i>NII_{i,t-1}</i>	-0.228* (0.105)	-0.011 (0.007)	-0.051 (0.201)	-0.232* (0.106)	-0.01 (0.007)	-0.049 (0.203)
<i>RCAP_{i,t-1}</i>	1.258* (0.548)	0.054 (0.035)	0.327 (1.051)	1.248* (0.547)	0.053 (0.035)	0.313 (1.050)
<i>EFF_{i,t-1}</i>	0.155** (0.537)	0.008* (0.003)	-0.001 (0.103)	0.157** (0.054)	0.008* (0.003)	-0.011 (0.103)
<i>BROA_{i,t-1}</i>	0.4798 (0.559)	-0.003 (0.036)	-0.532 (1.073)	0.504 (0.562)	-0.002 (0.036)	-0.537 (1.080)
<i>GDP_{i,t-1}</i>	-81.732*** (15.421)	-5.413*** (0.998)	-9.864 (29.580)	0.480*** (15.068)	-5.221*** (0.973)	-9.048 (28.929)
Country	Yes	Yes	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes	Yes	Yes
N	24	24	24	24	24	24
Wald test (<i>p-value</i>)	0.000	0.000	0.000	0.000	0.000	0.000

The results indicate that the null hypothesis can be rejected, therefore suggesting that there is a relationship between Fintech investment and financial stability.

The nature of that relationship is positive, as it shows that an increase in Fintech investment produces an increase in financial stability (drawn by the positive sign in the coefficient between the stability and Fintech funding). All the coefficients between Fintech Investment and the financial stability ratios are positive, thus, consistent.

A possible reason behind this relationship may be that, as presented in the literature review, an increment in the Fintech activity can attract some banking clients that are in an underbanked situation. The regulations enforced after the 2008 Global Financial Crisis obliged the banking entities to have a tighter risk control over its credit. As a result, the structure of banks is rewarded when safer credits are loaned. Therefore, banking institutions have a tendency to favor safer credit lending practices, thereby creating a void that Fintech companies could opportunistically fill by targeting riskier clients and offering innovative financial products.

This hypothesis is reinforced by the fact that the relationship between Fintech investment and credit to deposit ratios in the banking institutions is inversely proportional. The data suggests that as Fintech investment increases, credit-to-deposit ratios in banks decrease, implying that Fintech companies might be catering to a target customer that conventional banks, constrained by regulatory pressures, are less inclined to serve. In less concentrated, liquid and stable banking sectors, such as the countries under analysis in this paper, the bank credit and Fintech credit are more likely to act as complementary, where Fintech platforms tend to serve borrowers that are not serviced by traditional banks (Hodula, 2022). This dynamic not only contributes to the diversification of financial services but also supports the notion that Fintech plays a pivotal role in meeting the financial needs of individuals and businesses overlooked by traditional banking entities.

There is a secondary factor which may contribute to financial stability derived from the presence of Fintech. As mentioned previously, one of the areas where Fintech companies have found a way to satisfy a need of improvement, is risk management. This subsector has been subject to an important development with the evolution of Big Data and Machine Learning, some of which has been directly due to FinTech's solutions. Fintech companies have focused on specific parts of the banking value chain in terms of design, development and execution more cheaply, quickly and conveniently than incumbent banks were offering (European Banking Authority, 2018). Commercial banks have opted to internally

develop technologies mainly oriented towards enhancing customers' experience in an attempt to attract new customers (Bowden, King, Kotmos, Loncan, & Stentella, 2021). Nevertheless, in some areas such as risk management, banks have benefited from fostering partnerships or pursuing acquisitions with Fintech entities. Clearly, a development in risk management has a direct positive impact on financial stability.

However, some studies alert of financial stability risks that can materialize due to the concentration of banking dependency in the service certain critical Third Party Providers (Joint European Supervisory Authority, 2022). Nevertheless, those are potential risks that can potentially affect the financial stability but which have not impacted yet, hence, they have not impacted the model.

While the focus of this study revolves around the relationship between Fintech investment and financial stability, it is worth acknowledging the significance of the control variables. The expected levels of significance exhibited by these control variables lend credibility to the robustness of the research design, further validating the study's findings.

4.2.3. Testing the second Hypothesis: banking concentration

This section discusses the econometric results which prove hypothesis 2. The topic of this hypothesis was focused on the effects of the investment in Fintech over the banking concentration in an economy.

Table 4 displays the regression coefficients for the expression (3). The hypotheses for this study are tested using OLS regression analysis with fixed effects for panel data.

Banking concentration will be assessed through the effect that the Funding of Fintech has over the 3 and 5 banking asset concentration. The change in those indicators would reflect the effect in a financial economy due to the existence of Fintech companies.

TABLE 4

THE EFFECT OF INVESTMENT IN FINTECH ON BANKING CONCENTRATION

This table shows the results when banking concentration, defined through the dependent variables as the 3 and 5 banking asset concentration, is regressed against the investment in Fintech, the bank credit to bank deposits ratio, the bank non interest income to total income, the bank regulatory capital to risk-weighted assets and the efficiency. The specifications are estimated using the OLS estimator for panel data with fixed effects for the period 2013-2017. All the regressions contain individual fixed effects, and the standard errors are clustered by countries. *, **, ***, denote minimum 10 %, 5 %, 1 % significance, respectively.

	OLS with fixed effect			
	Investment in Fintech		Investment in Fintech to GDP	
	TCONC	FCONC	TCONC	FCONC
const	-1054.230 (1061.380)	-1418.160 (1054.130)	-1017.090 (1045.170)	-1341.850 (1035.820)
<i>INV_{i,t-1}</i>	-2.632 (1.420)	-5.053** (1.411)	-2.668 (1.430)	-5.112** (1.417)
<i>CTD_{i,t-1}</i>	0.255** (0.067)	0.212** (0.067)	0.253** (0.067)	0.209** (0.066)
<i>NII_{i,t-1}</i>	0.412 (0.259)	0.779** (0.257)	0.417 (0.260)	0.787** (0.257)
<i>RCAP_{i,t-1}</i>	-1.921 (1.353)	-1.939 (1.344)	-1.921 (1.346)	-1.930 (1.334)
<i>EFF_{i,t-1}</i>	0.050 (0.133)	-0.097 (0.132)	0.048 (0.133)	-0.100 (0.131)
<i>BROA_{i,t-1}</i>	-0.853 (1.381)	-3.059* (1.372)	-0.881 (1.384)	-3.105* (1.371)
<i>GDP_{i,t-1}</i>	39.663 (38.076)	52.504 (37.816)	36.994 (37.073)	47.203 (36.742)
Country	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes
N	24	24	24	24
Wald test (p-value)	0.001	0.001	0.001	0.001

The results indicate that the null hypothesis can be rejected, therefore suggesting that there is a relationship between Fintech investment and banking concentration.

The nature of that relationship is negative, as it shows that an increase in Fintech investment produces a decrease in banking concentration (drawn by the negative sign in the coefficient between the concentration and Fintech funding). All the coefficients between Fintech Investment and concentration are negative, thus, consistent.

This result is coherent with the aim of Open Banking. In the EU and UK, the introduction of the Payment Services Directive and moreover with its second version, aimed at increasing the financial competition by opening the payment services to new entrants.

Furthermore, the coherency of these results with the aim of Open Banking emphasizes the role of Fintech in promoting innovation and dismantling traditional barriers in the financial industry. The negative coefficients consistently observed in the relationship between Fintech investment and banking concentration reflect a shift in which traditional banking models are faced with a much more competitive landscape. Open Banking intends to condensate the increment in competition in a beneficial situation for customers, benefiting through a wider arrange of choices, improved services and lower prices. If Open Banking has achieved those goals would be subject to a whole paper.

However, there is a tendency that must not be overlooked. As stated before, banks have incentives to acquire or pursue partnerships with Fintech companies due to efficiencies in the development of technological solutions. In its working papers, the IMF (International Monetary Fund) claims that it seems inevitable that there will be a further concentration and consolidation within the banking sector by acquisition of Fintech companies (Baba, et al., 2020). Therefore, it is logical to wonder if the presence of Fintech companies can turn into a concentration mechanism in subsequent years due to the competitive advantage that the acquisitor (and more solvent) banks can obtain as a result of the merger.

While focusing on the primary relationship between Fintech investment and banking concentration, it is worth noting the reliability of the study's methodology through control variables. The expected levels of significance demonstrated by the variables utilized enhance the robustness of the research design, reinforcing the credibility of the outcomes.

4.3. Conclusions

This paper analyses the sensitivity of the financial stability and banking concentration in the financial sector in relation to the Fintech activity. A unique database is constructed for this purpose by combining CBInsights Fintech investment data with World Data Bank macroeconomic and market data for each country under study.

The main finding of this study is that a higher Fintech activity (represented by the variable of Fintech funding) increases the financial stability while lowering the banking concentration.

The results of this study also suggest that the reason behind the positive relation between Fintech activity and financial stability is that the Fintech companies absorb the riskier products and clients from traditional banking institutions.

Similarly, the study seem to point that the inverse relation between Fintech activity and banking concentration can have a cause in Open Banking.

The outcomes of this study may hold importance for both practitioners and scholars. For Fintech, banks and investors it may have implications in risk management and strategic decisions, as understanding the impact of Fintechs can leverage the risk models and business operations. It is also important for them because having a holistic understanding of the competitive landscape can be translated into competitive advantages.

Regulators may find the outcomes of this study relevant as they need to be aware of all the implications that the new entrants produce in order to direct their regulatory policies. If Fintech is found to contribute positively to financial stability (as this study states), regulators may consider policies that support and encourage responsible Fintech growth.

Scholars can find this study insightful as it contributes to the academic understanding of the interplay between Fintech, financial stability and banking concentration. Scholars can build on this research to refine existing theories or propose new frameworks for understanding the dynamics of the financial industry.

Nevertheless, the depth of the analysis required to fully understand this field surpasses the scope of the current paper due to the inherent limitations of the format and content of the research. If deemed necessary, further research would be essential to fully elucidate the implications that Fintech has in the complex ecosystem of financial markets.

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