Erasmus University Rotterdam

Erasmus School of Economics

International Bachelor Economics and Business Economics

Bachelor’s Thesis in Strategy Economics

The Impact of Fintech Competition on Bank Risk-Taking in the EU27: A Focus on Digital Lending and Capital Raising

António Urbano Ferreira Alves Freixo

608174

Supervisor: Víctor González-Jiménez

Second Assessor:

Date final version: 19/08/2024

Table of Contents

Abstract

This thesis explores the impact of fintech competition on the risk-taking behavior of large and medium-sized banks within the European Union (EU27) between 2011 and 2020, focusing on digital lending and capital raising. Utilizing a panel dataset and random effects models, the study investigates whether fintech activities influence the stability of legacy banks, as measured by the Z-Score and the Non-Performing Loans (NPL) ratio. Contrary to the competition-stability and competition-fragility hypotheses prevalent in the literature, the findings indicate no significant direct relationship between fintech competition and bank risk-taking. However, the analysis reveals that larger banks exhibit lower risk-taking compared to smaller banks when faced with fintech competition, suggesting that bank size plays a crucial role in moderating the impact of fintech. The study contributes to the ongoing debate on financial stability in the digital age and highlights the need for further research to fully understand the dynamics between fintech and traditional banking, particularly in regulated environments like the EU27.

Introduction

The influence of competition on bank risk-taking has been a subject of extensive debate in the literature, with contrasting views on whether it fosters stability or fragility within the banking system (Boyd & De Nicoló, 2005). Recently, a new form of competitor entered the banking industry – financial technology (fintech) companies. Fintechs are usually made up of various offerings, namely digital capital raising and digital lending (CCAF, 2024). Over the past decade, the banking industry has undergone a big transformation fueled by rapid technological advancements and the growing influence of fintech (Brandl & Hornuf, 2017). The industry is changing to offer "true customer centricity", where offerings are increasingly personalized (PWC, 2024). Traditional, or legacy, banks typically offer conventional financial services, such as checking accounts and loans, and have physical branches (Chase Bank, 2024). Fintech has effectively reshaped the expectations clients have of legacy banks, who increasingly copy their fintech competitors with a mobile-first approach (PWC, 2024). More specifically, consumer banking has undergone big changes, and 73% of financial sector executives believe consumer banking is the most likely to be completely disrupted by fintech within the financial services industry (PWC, 2024).

Studies such as Hermuningsih, Sari & Rahmawati (2023) have shown that banks of different sizes are affected differently by fintech. Nonetheless, banks of all sizes face significant challenges in responding to fintech competition as (Phan et al., 2020). The existing literature, while acknowledging the potential benefits of fintech for consumers, is far from a consensus on whether fintech positively or negatively impacts legacy banks in terms of performance and offers limited insights into its impact on the risk-taking behavior of legacy banks. Various studies, such as Demirgüç-Kunt, Feyen & Levine (2013), have underscored the importance of the banking industry for a well-functioning economy, making the study of its competitive dynamics increasingly important. This is especially true under the new form of competition fintech is bringing upon the industry.

Fintech competitive pressure is also strongly felt in the European Union (EU), which makes up 27% of the global cumulative valuation of the fintech industry (EuroDev, 2024). According to Statista (2024), within the EU's 27 member countries (EU27), fintech keeps pushing records related to its penetration and market position. The impact of fintech hon traditional banking has thus become operations a critical area of interest for business leaders and policymakers alike.

Therefore, given the established need for research and importance of the topic, the research question guiding this study is:

To what extent does fintech competition influence the risk-taking behavior of large and medium-sized legacy banks in the EU27, and how do these effects differ between the two types of banks?

To investigate the impact of fintech competition on bank risk-taking, I employ a panel dataset encompassing large and medium-sized banks within the EU27 countries between 2011 and 2020. I make use of a random effects model and variables to proxy risk-taking and fintech competition to ascertain the impact the latter has on the former, while also accounting for and investigating the moderating effect of bank size on this relationship. I use robustness checks with alternative measures of risk-taking and different econometric specifications to ensure the validity of findings.

The main regression results show no statistically significant relationship between the measures of fintech competition (digital lending, digital capital raising, and the combined fintech activity) and bank risk-taking. This finding contradicts the prevailing literature, which generally posits a relationship between competition and bank risk-taking, either through the competition-stability or competition-fragility hypotheses. Some evidence is found that for larger banks, an increase in fintech activity is associated with a decrease in risk-taking compared to smaller banks.

I explore the potential reasons behind the main regressor's statistical insignificance. The robustness check replicating the main regression analysis using a different econometric model confirmed the initial results. However, when an alternative dependent variable – the non-performing loans (NPL) ratio – was employed, the results showed that bank size no longer moderated the relationship between fintech competition and risk-taking. These mixed findings highlight the complexity of the relationship between these variables and underscore the need for further investigation.

This thesis starts with its theoretical framework surrounding bank competition and risk-taking. I review existing research on banking competition, risk-taking, fintech's influence, and the role of bank size. The empirical methodology details data sources, variables, and models. Results are presented and discussed, followed by a conclusion summarizing findings, evaluating implications, and suggesting future research directions.

Theoretical Framework

Given the established motivation for the research question, the subsequent theoretical framework will explore the relevant theories and existing academic discourse, serving as the foundation for formulating the research hypotheses.

Firstly, it is crucial to understand the theory surrounding bank competition and risk-taking, specifically, the impact of competition on risk-taking. This is important because banks, like most businesses, operate in a competitive landscape where they strive to attract customers and maximize profits (Vives & Ye, 2024). Understanding how competition influences legacy bank's risk-taking behavior is thus key to assessing the stability of the financial system (Boyd & De Nicoló, 2005).

Banks, as in most industries, compete between each other for customers and their business in the form of deposits, credit, and other financial products (Freixas & Rochet, 1997). The competition among banks can lead to increased bank risk-taking, referring to the actions and strategies that banks undertake which expose them to various other risks, such as credit risk (Freixas & Rochet, 1997). The degree of risk-taking is influenced by various factors, some of which are not easily measurable, such as corporate governance structures. Bank risk-taking then impacts the entire sector's stability (Schaeck & Martin Cihák, 2014; Carlson & Mitchener, 2006). Given the large importance the banking industry has on an economy, it is important to understand how to minimize the likelihood of disturbances, which can come in the form of bank closures, so that the economy's welfare is not put in jeopardy, and at the same time make it so that banks continue operating efficiently.

There is a long-standing debate on the impact of competition in the banking sector's stability (Allen & Gale, 2004). One of the sides of this debate is that outlined in the competition-stability hypothesis (Boyd & De Nicoló, 2005). This hypothesis posits that competition within the banking system creates stability because competitive pressure forces banks to operate more efficiently and adopt better risk management practices, ultimately leading to financial stability. Banks operate more efficiently through various mechanisms, such as diversification of risk to decrease the likelihood of being overly negatively impacted by local economic downturns (Ferreira, 2023).

The other side of the debate puts forward the competition-fragility hypothesis, which posits that increased competition leads to instability by eroding profit margins, prompting banks to take on risks to maintain profitability (Martinez-Miera & Repullo, 2010). The mechanisms explained can then lead to increased likelihood of financial distress through, for example, credit risk – where banks engage in riskier lending practices, or liquidity risk – where banks reduce their liquidity buffers and are more vulnerable to financial shocks (Ferreira, 2023; Freixas & Rochet, 1997; Feng, 2018). Banks find themselves in need of changing their risk profile due to a deterioration in its franchise value – the value of future profits a bank can expect to earn. Through a decreased franchise value, banks lose the incentive to behave prudently, as the cost of losing the franchise is reduced (Berger, Klapper, and Turk-Ariss, 2008). These hypotheses are further explored below.

Literature Review

This section is dedicated to exploring the literature surrounding the theory put forward above, as well as the themes surrounding the research question in focus. To this effect, the analysis of existing literature will be divided into four main areas. Firstly, the literature on competition within the banking sector, secondly, the literature surrounding bank risk-taking, thirdly, the specific literature on financial technology and its interaction with legacy banks, and finally, the literature on the impact of size with respect to the reaction to fintech competition is explored.

Banking sector

This section will explore the impacts that competition has on banks' strategic behavior mostly through the lenses of the competition fragility and stability hypotheses.

The findings regarding the effect of competition on risk-taking are dichotomous – evidence exists for both the competition-stability and -fragility hypotheses. The competition-fragility hypothesis is supported by Keeley (1990), who found that deposit insurance, which intensifies competition, leads to increased risk-taking by banks. Similarly, Jiménez, Lopes, and Saurina (2013) found a non-linear relationship between bank competition and risk-taking, suggesting that competition initially reduces risk but only up to a certain point, after which further competition can lead to increased risk-taking. This inverted-U relationship is mirrored in the EU-specific study by López-Penabad, Iglesias-Casal & Neto (2021), but only in countries with a less stable banking system. In countries with a stable banking system no relationship is found, which contradicts the overall findings in the literature. Ferreira (2023) studies the EU27 banking sector. The findings indicate that increased competition leads to lower stability, specifically suggesting that policy measures aimed at increasing competition may not necessarily enhance stability.

In contrast, Boyd and De Nicoló (2005) provide theoretical support for the competition-stability hypothesis, demonstrating that lower lending rates due to competition can increase the success rate of borrowers' investments, leading to lower credit risk for banks. Empirical studies have also lent credence to this view. For example, Schaeck, Čihák & Wolfe (2006) found that more competitive banking systems are associated with a lower likelihood of bank failures. This result is mirrored in Goetz (2018), Kabir & Worthington (2017), and Anginer, Demirguc-Kunt & Zhu (2014). Sarkar and Sensarma (2015) empirically analyze the competition-stability relationship in the Indian banking sector and show that increased competition leads to higher stability concerning default, market, and asset risks. These results are, however, qualified by the findings that competition also adversely affects banks’ capital and liquidity ratios, such as loan loss provisions, which act as critical safety buffers. This may therefore indicate that findings depend on how risk is measured, and that there may be a trade-off where competition can enhance certain part of bank stability while undermining others.

Results in Europe diverge as well. For example, Uhde & Heimeshoff (2009) mention that the lack of competition in the EU banking market has a significant negative effect on financial stability primarily due to higher returns volatility in concentrated markets.

Berger et al. (2009), in a study of 23 countries, some of which European, find that the two hypotheses can coexist, whereby even if market power results in riskier loan portfolios, the overall risks of banks need not increase if their franchise value is protected through risk-mitigating techniques, such as increasing their equity capital.

The impact of fintechs in the banking sector

There is a growing body of literature addressing the impact financial technology firms have on the banking sector, some of which is covered here.

First, however, it may be useful to understand the change fintech has caused. Fintech benefits from a multitude of advantages over legacy banks. Frost et al. (2019) show that fintech have an information advantage in credit assessments relative to a traditional credit bureau. Jagtiani and Lemieux (2018) find that fintech lenders successfully penetrate areas that are underserved by legacy banks, showing once again fintech's ability to address gaps in the legacy banking landscape. These findings are mirrored in Yang & Zhang (2022) and Aduba, Asgari & Izawa (2023)

Shifting the focus to the impact that fintech has had on legacy banking institutions, studies find that fintech competition negatively affects the banking sector's profitability and risk-taking. Hodula (2024) examines the relationship between FinTech credit growth and traditional banking sector profitability, finding a robust negative relationship, thus supporting the view that fintech credit is a substitute to credit from legacy financial institutions. These findings are mirrored in the results from Gopal & Schnabl (2022) and Naceur (2023).

With relation to risk taking, various papers, such as Jia (2024) and Ndwiga (2024) investigate the impact that increased fintech penetration and entry have on bank risk-taking. They both find that fintech presence increases bank risk-taking by legacy banks, relating to the competition-fragility hypothesis discussed previously. Similarly, Elekdag (2024), analyzing over 10 thousand financial institutions from around the globe, finds that fintech presence generally increases risk-taking. Conversely to the aforementioned findings, Haddad and Hornuf (2023) report that fintech start-ups improve traditional banks' performance and reduce systemic risk, suggesting support for the competition-stability hypothesis. Tang (2019) asserts that fintech can be a complement to bank credit.

Risk-taking by banks

The following papers show banking risk is influenced by factors such as market power, regional differences in regulation, and income diversification. Berger, Klapper, and Turk-Ariss (2009) find that banks with greater market power tend to have less overall risk exposure, though this higher market power increases their loan portfolio risk. Altunbas (2007) makes an interesting contrast between banks in Europe and those in the U.S., where inefficient European banks hold more capital and take on less risk. These findings underscore the regional differences in legislation and approaches to banking, and how these are translated into bank outcomes. Lepetit et al. (2008) in a study of European banks, find that banks that diversify into non-interest income activities increase their risk, especially small banks.

The impact of being large in the presence of fintech

The literature shows that bank size significantly influences how banks respond to fintech innovations and manage risk, with larger, well-capitalized banks generally being better equipped to adapt and maintain stability (Hermuningsih, Sari & Rahmawati, 2023; Phan et al., 2020). Wang et al. (2020) highlight that larger banks, given their substantial market share, are often the primary targets of fintech innovations, necessitating robust adaptive strategies. Studies such as those by Altunbas (2007) and Berger, Klapper, and Turk-Ariss (2009) have shown that well-capitalized banks are better positioned to manage risk and maintain stability. Elekdag (2024), in a study of over 10,000 financial institutions worldwide, 10% of which not banks, finds that risk-taking decreases on bank size. While a more comprehensive sample, it does not account for the specificities of the common European banking system. For example, all European banks are subject to the same legislation regarding various measures, such as capital requirements (ECB, 2017). The topic of the effect of bank size in response to the presence of fintech remains very understudied and is however, the effects of bank size in relation to fintech remain underexplored and not well-defined. The mixed evidence on the impact of competition on stability in the banking sector, particularly regarding fintech, remains open for further empirical validation. Given this gap, I formulate three hypotheses to address the research question:

Hypothesis 1: The competition of fintech increases bank risk-taking.

Hypothesis 2 The relationship between fintech competition and bank risk-taking varies with the size of the bank, with the impact being different for large banks compared to smaller.

Methodology

To investigate the effects of fintech competition on bank risk-taking a regression is run. Given that the data is panel data, a random effects model is generally preferred over a Pooled Ordinary Least Squares regression. To account for within-group heteroskedasticity, I estimate the parameters using clustered standard errors.

Random effects models estimate the effect of specific variables on an outcome by considering both within-group and between-group variations over time. The model makes the important assumptions that individual-specific effects are random and uncorrelated with the independent variables. The extent to which these are met is further discussed in the model assumption section. Pooled Ordinary Least Squares (POLS) estimates the effect of specific variables on an outcome by pooling all observations across both cross-sectional units (in this case, banks) and time periods into a single regression model. While POLS recognizes the panel structure of the data by combining these observations, it does not account for potential individual-specific or time-specific effects, meaning it treats all observations as independent. POLS also relies on a set of assumptions, which are further discussed in the model assumptions section.

Therefore, following the specifications, methodologies, and variables in previous studies, the following baseline specification is proposed:

$$Ln\ Risk_{it} = \beta_0 + \beta_1 fintech_{it} + \beta_2 Big_i + \beta_3 (fintech_{it} \times Big_i) + \beta_Z Z_{it} + \mu_i + \omega_t + \varepsilon_{it}$$

As supported in the literature (Kabir & Worthington, 2017; Goetz, 2018; Ferreira, 2023; Tan, 2016, between many others) the Z-Score variable used as a proxy to risk-taking. The ways in which the Z-Score variable is calculated vary across studies. We take the most used formula as our main analysis variable. The formula can be seen below.

$$Z - Score_{i,t} = \frac{ROAA_{i,t} + E/A_{i,t}}{\sigma ROAA_{i,t}}$$

Here, ROAA stands for Return on Average Assets provides a measure of profitability by averaging total assets over a period, smoothing out fluctuations, and E/A stands for Equity to Assets ratio (E/A), and it indicates the proportion of a company's assets financed by shareholders' equity. A higher E/A suggests greater financial stability and lower reliance on debt. The timeframe used to the standard deviation of ROAA is set at three years, following Elekdag (2024) and Kabir and Worthington (2017).

The Z-score is taken as a proxy of risk-taking by a bank, and is interpreted as the number of standard deviations that a bank's ROA can fall before the bank becomes insolvent (e.g., Laeven & Levine, 2009; Demirgüç-Kunt & Huizinga, 2010). Thus, it can be inferred that the higher the Z-Score, the safer, or less risky, a bank is. Upon plotting the Z-Score in a histogram, it became clear that it is highly skewed to the left. To counteract this, the natural logarithm of the Z-Score is taken. This follows other studies, such as Laeven & Levine (2009) and Elekdag (2024).

To measure fintech competition, I use three different measurements: Digital lending, digital capital raising, and the sum of these variables, which are referred to as total fintech. These measurements are taken per year. The fintech transactions all took place outside the legacy banking system. These variables are in USD and are used to understand the competitive pressure that legacy banks in various countries are under by fintech entrants. Elekdag (2024) and Naceur (2023) have used this database to the same effect that it will be used in this analysis.

An additional dimension is entered into the analysis by including an interaction term for whether a bank is considered large or medium with the independent variable of interest. Following the literature, large banks are those with over USD$50 billion in assets. This was cemented as general regulatory standards in legal documents such as the Dodd-Franks act, with banks who had more than USD$50 billion being subject to more stringent regulations (CRS, 2017). Medium-sized banks are those with over USD$2 billion in assets and less than USD$50 billion, which were banks small enough to escape to the Dodd-Franks act's more stringent requirements but big enough to meet their customer's needs (Kline, 2016). For this study the size distinction is made with the dummy variable “big”, which equals zero if the bank has assets between $USD2 and 50 billion and equals 1 if its assets are over USD$50 billion. The rationale for this is multifaceted. First, the impact of the difference in bank sizes on the relationship between fintech competition and risk-taking has not been thoroughly explored in existing research. Examining the role of bank size also has significant policy implications. For instance, it can inform discussions on how regulations might need to be tailored for banks of different sizes.

Following the literature, both bank- and country-specific controls are considered. For bank-specific controls, I include the natural logarithm of assets, as well as the non-interest income over average total assets. As for country specific variables, and following the literature, I include the banking industry concentration, inflation, unemployment rates, as well as the natural logarithm of gross domestic product per capita.

I carry out various robustness checks to the investigation’s main findings. Firstly, the results from POLS regressions using the same model as the main regression are reported. Secondly, I run additional random effects regressions with a different measure of risk-taking which is also used in literature, in this case, the ratio of non-performing loans (Kabir and Worthington, 2017). The formula for this measure can be found below:

$$NPL\ \% = \frac{Total\ consumer\ non-performing\ loans}{Total\ consumer\ loans} \times 100$$

NPL stands for non-performing loans and is the ratio of the non-performing loans in a bank’s portfolio. It can be perceived to measure bank risk because as the bank takes riskier loans, the probability that these will become non-performing, which means their payments are made back in time, increases. Therefore, a bank’s risk profile should be reflected in this ratio.

A second set of hypotheses is thus added to account for this different way of measuring risk-taking:

Hypothesis 3: The competition of fintech increases bank risk-taking, as measured by the NPL ratio, in the EU27 countries.

Hypothesis 4: The relationship between fintech competition and bank risk-taking, as measured by the NPL ratio varies with the size of the bank, with the impact being different for large banks compared to smaller banks in the EU27 countries.

Model assumptions

The random effects model assumes that the individual-specific random effects are uncorrelated with the explanatory variables across all time periods. This assumption is crucial for producing unbiased and consistent estimates. Additionally, the model assumes no perfect collinearity among the explanatory variables, homoskedasticity (constant variance of the error term across all observations), and that the error terms are independently and identically distributed with no autocorrelation.

The first assumption is critical but challenging to validate. This assumption is plausible in contexts where unobserved individual-specific effects (such as management quality or corporate culture) do not systematically correlate with observed explanatory variables (like fintech competition or bank size). Given the harmonized regulatory environment across the EU27, which reduces variability in external regulatory influences, it is more plausible that the assumption holds (ECB, 2017). These regulations include the Capital Requirements Regulations (CRR), for example, established under the Basel framework (ECB, 2017). However, inherent differences in bank-specific factors might still lead to some correlation. Given the inability to definitively test the assumption, robustness checks and alternative modeling approaches become crucial.

The random effects model also assumes no perfect collinearity between explanatory variables. As can be seen in Table 1 below, the correlation between variables is low, which satisfies this assumption.

Table 1: Correlation matrix for main variables in regressions

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Z Score	1.000											
(2) NPL	0.023	1.000										
(3) DCR	0.004	-0.151	1.000									
(4) DL	0.052	-0.141	0.659	1.000								
(5) Fintech	0.043	-0.162	0.820	0.930	1.000							
(6) Big	-0.141	0.015	0.124	0.024	0.042	1.000						
(7) BC	0.040	-0.201	0.102	0.163	0.166	-0.012	1.000					

(8) NII/ATA	0.140	0.038	-0.019	0.003	0.004	-0.399	0.049	1.000				
(9) ROA	0.032	-0.027	-0.090	-0.035	-0.050	-0.054	-0.034	-0.046	1.000			
(10) GDP	-0.013	-0.250	0.330	0.132	0.218	0.105	0.186	0.032	-0.091	1.000		
(11) Inf	0.086	-0.081	-0.156	-0.004	-0.024	-0.052	-0.013	0.054	0.047	-0.018	1.000	
(12) Unem	-0.061	0.111	0.089	-0.105	-0.075	0.080	-0.119	-0.104	-0.024	-0.220	-0.277	1.000

Note: DCR refers to digital capital raising, DL to digital lending, and Fintech to the sum of both, all three measured in USD. BC refers to bank concentration, and NII/ATA is referent to non-interest income over average total assets. Unem is referent to the unemployment measure, and Inf to inflation

The table above shows the correlation matrix between all the variables used. Interestingly, the Z-Score has a very low correlation with most variables, indicating it is relatively independent of other variables, including the other risk-taking variable NPL. To minimize the likelihood of computing biased estimates, explanatory variables should not be highly correlated with each other. Following Yoon, Lee & Oh (2023) and Tchuigouaa, Soumaré & Hessou (2020), correlations between explanatory variables are established to be sufficiently low to ease concerns of multicollinearity.

To tackle potential heteroskedasticity, the model makes use of clustered standard errors. Addressing the assumption of normality of errors, the central limit theorem should work

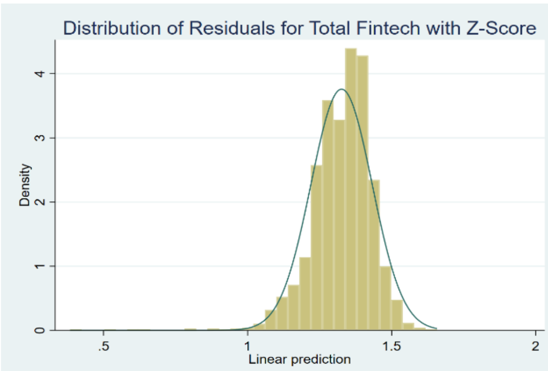

Figure 1: Distribution of Residuals for Total Fintech with Z-Score

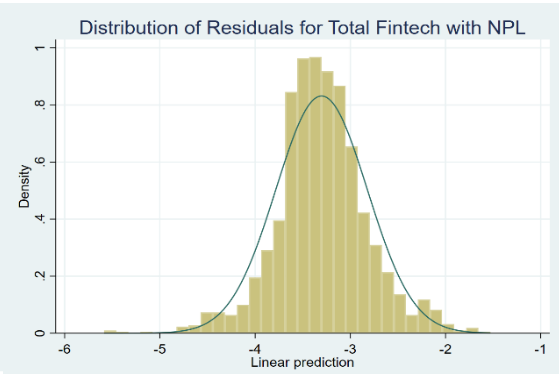

Figure 2: Distribution of Residuals for Total Fintech with NPL

to eliminate that concern, as, due to the large size of the sample, the distribution of the error terms approximates normality. Moreover, figures 1 and 2 show histograms of the residuals from the regression of total fintech expenditure and the two different methods of risk-taking overlayed with a normal distribution curve. In both cases, the residuals closely follow a normal distribution curve. Finally, the assumption of linearity is made. Given the established relationship in the literature between the variables I focus on the assumption is likely the hold.

Secondly, the pooled ordinary least squares regression is carried out as a robustness check, relying on various assumptions. Firstly, the assumption of linearity is made, whereby a linear relationship between the independent and dependent variables is assumed. Given the theoretical framework and the established relationships in the literature, the assumption of linearity is likely reasonable. Secondly, the assumption of independence of errors is made, which implies that the residuals of the regression model are not correlated with each other. This means that the error term for one observation should not predict the error term for another observation. Again, the use of clustered standard errors helps mitigate this issue by accounting for potential correlations within clusters. Fourthly, the assumption of no perfect multicollinearity is considered. This assumes that the independent variables are not perfectly correlated with each other. The correlation table, Table 1, shows low correlations between these variables in analysis, which works to fulfill this assumption. Lastly, the assumption of normality of errors is made. Again, the central limit theorem provides some assurance of normality in large samples.

While difficult to check assumptions are met, steps have been taken to minimize the impact that errors could have on the estimators calculated. There are, however, some problems. For example, accounting for omitted variable bias, an assumption made in both models, is necessary but likely impossible to accomplish and verify.

Data

Throughout the investigation, data is retrieved from various sources. All data is collected for the EU27 countries, a list of which can be found in Appendix 1. Furthermore, all data is collected from the years 2011 to 2020.

Fintech measures

This data is extracted from the Cambridge Center for Alternative Finance's Benchmarks. Digital capital raising comprises of investment-based crowdfunding and non-investment-based crowdfunding. Digital lending is comprised of balance sheet lending, P2P/Marketplace lending, debt-based securities and invoice trading. These measures are, as described in the literature and by the researchers responsible for their collection, a reliable way to gauge the fintech activity (Elekdag, 2024; Naceur, 2023). This variable is measured in USD. Due to data collection limitations, there are some missing values, making it an unbalanced panel dataset.

Bank-level measures

All bank-level measures were retrieved from the Orbis/Bureau Van Dijk BankFocus database. The sample consists of 394 commercial banks in the 27 countries of the European Union (EU27) listed in Appendix 1. These banks all have over USD$2 billion in assets as of the last available data. For each bank several variables are considered per year of analysis (2011 – 2020). Total assets are used to determine whether a bank is big or small. Total loans are used as a control variable. Lastly, three ratios are considered, all as control variables: Return on assets (ROA), the capital adequacy ratio (CAR), and the non-interest income over average total assets. Finally, the return on average assets (ROAA), and the equity-to-assets ratio, are used to calculate the Z-Score for each bank.

My study considers banks over USD$2 billion in assets. The banks with over USD$2 billion and under USD$50 billion in assets are widely considered to be medium-sized banks. Banks with over USD$50 billion in assets are large. The reasons for this study to consider only these two subsets are multiple. Firstly, big and medium-sized banks typically hold a substantial share of the banking market (ILSR, 2019). Their behavior, especially in terms of risk-taking, can have significant implications for the overall financial system, making analysis more pertinent. Secondly, larger banks might respond differently to fintech competition compared to smaller banks. This may be due to their structure or their ability to innovate. Wang et al. (2020) showed that fintech competition tends to impact these larger institutions more significantly because they are often the primary targets of fintech innovations. In that same study, Wang et al. (2020) look at small and medium-sized banks in China in a similar framework to my own, leaving a gap in the literature's analysis of large banks and their reaction to increasing fintech competition.

Country-level measures

Finally, I use two databases to calculate country-level measures. One of them is the World Bank Global Financial Development Database, from which country-level data on bank concentration is taken. From the IMF's World Economic Outlook dataset, data for GDP, inflation, and unemployment is gathered. All these controls are standard in similar literature, such as Elekdag (2024), Naceur (2023), and Berger, Klapper, and Turk-Ariss (2009)

To address the presence of outliers in the digital capital raising, digital lending, the sum of both, and Z-Score variables, these variables were winsorized at the 1st and 99th percentiles, a method also employed by Elekdag (2024) in a similar context.

Results

The descriptive statistics for each variable of interest can be found below. Table 2 is referent to big banks, and table 3 is to banks considered medium-sized.

Descriptive statistics

Table 2: Descriptive statistics for big banks

Descriptive Statistics – Big banks

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99
Z-Score	708	1.255	0.359	-0.567	2.095	0.092	1.991
NPL	767	-3.148	1.003	-6.21	-0.323	-5.577	-0.486
DCR	725	16.541	2.255	7.885	20.157	11.541	20.157
DL	652	17.965	2.334	9.125	21.77	10.222	21.355
Fintech	644	18.524	1.888	13.034	21.412	13.034	21.412
Concentration	870	68.047	13.844	33.17	98.228	33.583	98.185
NII/ATA	809	1.045	0.671	-0.422	6.039	0.019	3.674
ROA	809	0.369	1.084	-13.41	3.965	-2.517	1.985
GDP	870	10.744	.31	9.84	11.678	9.976	11.654
Inflation	870	1.355	1.181	-1.541	5.795	-1.217	3.728
Unemp	870	9.936	5.604	1.96	27.475	2.89	26.095

Note: DCR refers to the natural logarithm of digital capital raising, DL to the natural logarithm of digital lending, and Fintech to the natural logarithm of the sum of both. Concentration refers to bank concentration, and NII/ATA is referent to non-interest income over average total assets. Unemp refers to unemployment.

Table 3: Descriptive statistics for medium-sized banks

Descriptive Statistics- Medium banks

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99
Z-Score	2274	1.344	0.36	-1.724	2.095	0.355	2.095
NPL	1815	-3.072	1.746	-8.119	2.52	-8.119	2.52
DCR	2354	15.972	2.489	7.24	20.157	8.584	20.157
DL	2069	17.744	2.373	9.125	21.77	9.271	21.355
Fintech	2011	18.342	1.863	13.034	21.412	13.655	21.412
Concentration	3070	66.436	15.105	33.17	98.588	33.525	96.009
NII/ATA	2732	65.24	15.054	33.17	98.588	33.525	95.876
ROA	2673	1.575	2.379	-2.066	38.312	-.342	13.126
GDP	2419	10.719	.404	9.84	11.678	9.909	11.669
Inflation	2870	1.355	1.298	-2	6	-1	5
Unemp	2870	8.534	4.165	2	27	3	25

Note: DCR refers to the natural logarithm of digital capital raising, DL to the natural logarithm of digital lending, and Fintech to the natural logarithm of the sum of both. Concentration refers to bank concentration, and NII/ATA is referent to non-interest income over average total assets. Unemp refers to unemployment.

For medium banks, the mean Z-Score is 1.344, while for big banks, it is slightly lower at 1.255, indicating somewhat lower stability among big banks compared to medium banks. The NPL have a mean of -3.072 for medium banks, whereas for big banks, the mean is slightly lower at -3.148, suggesting that big banks experience slightly more defaults than medium banks. The total presence of fintech is similar for both large and medium banks, with values of 18.524 and 18.342, respectively. It is also important to note that, for medium-sized banks, the number of observations for NPL is significantly lower than those for the Z-Score. This disparity in observations may undermine the analysis.

I now move to present the results of the main analysis, visible in table 4.

Table 4: Main regression result

Variable name	Z-Score (log units)	Z-Score (log units)	Z-Score (log units)
Constant	4.82 ***	5.714 ***	5.95 ***
	(1.33)	(1.34)	(1.38)
DCR	-0.00494		
	(0.0192)		
DL		-0.0167	
		(0.0196)	
FINTECH			-0.0287
			(.0277)

Big	-1.22 **	-1.683 ***	-1.887
	(0.486)	(0.516)	(0.685)
Independent	0.0527	0.0766 **	0.0855 **
Variable x Big	(0.0297)	(0.0287)	(0.037)
ROA	0.157	0.00782	0.00878
	(0.0215)	(0.0188)	(0.0192)
Capital adequacy	-0.956 **	-0.921 **	-0.919 **
ratio	(0.313)	(0.311)	(0.312)
Total loans	5.12e-13	4.32e-13 (2.52e-13)	4.31e-13
	(2.63e-13)		2.48e-13
NII/ATA	0.00172	0.00838	0.000384
	(0.014)	(0.0169)	(0.014)
GDP	-0.106	-0.192	-0.201
	(0.127)	(0.116)	(0.115)
Bank Concentration	0.000406	0.00274	0.0034
	(0.000407)	(0.00289)	(0.00295)
Inflation	0.0418	0.0569	0.0639
	(0.0377)	(0.0421)	(0.0435)
Unemployment	-0.00498	0.00252	0.00396
	(0.0105)	(0.0117)	(0.0121)
Year fixed effects	YES	YES	YES
N	1945	1731	1694
rho	0.241	0.204	0.198
Breusch-Pagan Lagrange Multiplier	0.000	0.000	0.000

*Note: * Significant at the 5% level, ** significant at the 1% level. *** significant at the 0.1% level. DCR refers to the natural logarithm of digital capital raising, DL to the natural logarithm of digital lending, and Fintech to the natural logarithm of the sum of both. BC refers to bank concentration, and NII/ATA is referent to non-interest income over average total assets.*

Table 4 outlines the results from the regressions relating the measures of risk-taking to the independent variables of interest, which in this case are the total amounts in the digital lending and digital capital raising categories. In the table, these measures are captured with the natural logs of DCR, DL, and FINTECH as independent variables. The coefficients for these digital financial activities are consistently negative but not statistically significant across all models, indicating that these activities do not have a significant impact on banks' Z-Score.

This dummy "Big" shows a significant negative relationship with the Z-Score across all models, with coefficients ranging from -1.22 to -1.88. This suggests that larger banks tend to have higher risk, following the findings from studies such as Ratnovski, Tong & Laeven (2014). Looking at the interaction term, a positive and significant relationship is found in the models encompassing Digital Lending and Total Fintech. The interaction terms indicate how the effect of competition on the Z-Score differs between large and medium-sized banks. Specifically, a 1% increase in digital lending is associated with a 0.0766% increase in the Z-Score for large banks, while a 1% increase in total fintech activity is associated with a 0.0855% increase in the Z-Score for those same banks. In other words, for larger banks, an increase in fintech activity is associated with lower risk-taking compared to smaller banks.

These results make intuitive sense and follow the general pattern noticed in the literature. The larger a bank is, the more resources it has, and thus, the better it can weather competitive pressure. This may be because larger banks benefit from economies of scale and can thus allocate more capital to fight competition without changing their risk profile, as Hughes & Mester (2013) show possible. Furthermore, studies such as Altunbas (2007) and Berger, Klapper, and Turk-Ariss (2009) show that in legacy banking systems, larger and well-capitalized banks have more substantial financial and technological resources, which can allow them to better manage risk.

Regarding the control variables, the most notable pattern in that in the capital adequacy ratio, which is consistently negative and significant, indicating that banks with higher capital adequacy ratios tend to have higher risk, as measured by a lower Z-Score.

Robustness checks

The first robustness check consists of calculating the same model but using a Pooled Ordinary Least Squares (POLS) specification to assess the consistency of the results obtained in the main regression.

Table 5: First robustness check using POLS specification

Variable name	Z-Score (log units)	Z-Score (log units)	Z-Score (log units)
Constant	4.184 **	5.434 ***	5.48 ***
	(1.307)	(1.31)	(1.35)
DCR	-0.00388		
	(0.198)		
DL		-0.0261	
		(0.188)	
FINTECH			-0.0397
			(0.0268)
Big	-1.01 **	-1.57 ***	-1.73 **
	(0.03)	(0.486)	(0.659)
Independent Variable x Big	0.0391	0.0683 **	0.075 *
	(0.03)	(0.0275)	(0.036)
ROA	0.0257	0.0134	0.0139
	(0.0256)	(0.021)	(0.0213)
Capital adequacy ratio	-0.984 ***	-0.982 **	-0.979 **
	(0.302)	(0.316)	(0.319)
Total loans	5.33e-13 *	4.68e-13	4.71e-13
	(2.62e-13)	(2.55e-13)	(2.54e-13)
NII / ATA	0.00535	0.000816	0.00568
	(0.0202)	(0.0215)	(0.0202)
GDP	-0.0627	-0.169	-0.158
	(0.124)	(0.112)	(0.112)
Bank Concentration	.00173	0.005	0.00527
	(0.00249)	(0.00275)	(0.00282)
Inflation	0.0764 *	0.0874 *	0.0963 *
	(0.0384)	(0.042)	(0.432)
Unemployment	-0.00363	0.00504	0.00611
	(0.00967)	(0.0104)	(0.0107)
N	1945	1731	1694
Year fixed effects	YES	YES	YES

*Note: * Significant at the 5% level, ** significant at the 1% level. *** significant at the 0.1% level. DCR refers to the natural logarithm of digital capital raising, DL to the natural* *logarithm of digital lending, and Fintech to the natural logarithm of the sum of both. BC refers to bank concentration, and NII/ATA is referent to non-interest income over average total assets.*

Table 5 presents the results of the first robustness check. Similarly to the main regression, the coefficients for the natural logarithm of fintech measures are insignificant. Also similarly to the first regression, the coefficient of the dummy for bank size is consistently negative, and significant in two of the three regressions, indicating large banks riskier profiles than smaller banks. The interaction term confirms that fintech competition's effect on risk-taking is moderated by bank size. The coefficients for the interaction term match in significance and sign to the main regression, adding confidence to the results obtained.

Table 6: Second robustness check using NPL as a risk-taking measure

Variable name	NPL (%)	NPL (%)	NPL (%)
Constant	8.89 **	6.12 *	5.19
	(3.03)	(3.08)	(3.15)
DCR	-0.0134		
	(0.0218)		
DL		-0.0189	
		(0.0193)	
FINTECH			-0.017
			(0.0297)
Big	0.659	0.0407	0.817
	(0.509)	(0.46)	(0.62)
Independent Variable x Big	-0.0291	-0.0116	-0.035
	(0.028)	(0.0223)	(0.0312)
ROA	-0.0325 ***	-0.0262 ***	-0.0257 ***
	(0.00859)	(0.00619)	(0.00619)
Capital adequacy ratio	-0.788	-0.719	-0.728
	(0.41)	(0.384)	(0.392)
Total loans	-2.20e-13	-3.16e-13	-1.84e-13
	(3.69e-13)	(3.78e-13)	(3.81e-13)

NII /ATA	0.00172	0.0084	0.000384
	(0.014)	(0.0169)	(0.014)
GDP	-1.15 ***	-0.912 **	-0.824 ***
	(0.295)	(0.294)	(0.307)
Bank Concentration	0.00112	0.003	0.00193
	(0.00334)	(0.00348)	(0.00375)
Inflation	-0.00371	0.0243	0.0235
	(0.0215)	(0.0235)	(0.0243)
Unemployment	0.0339 *	0.0509 ***	0.0522 ***
	(0.0147)	(0.0157)	(0.0161)
N	1777	1582	1544
rho	0.856	0.866	0.871
Year fixed effects	YES	YES	YES
Breusch-Pagan Lagrange Multiplier	0.000	0.000	0.000

*Note: * Significant at the 5% level, ** significant at the 1% level. *** significant at the 0.1% level. DCR refers to the natural logarithm of digital capital raising, DL to the natural logarithm of digital lending, and Fintech to the natural logarithm of the sum of both. BC refers to bank concentration, and NII/ATT is referent to non-interest income over average total assets.*

The final robustness check, presented in Table 6, utilizes the natural logarithm of the non-performing loans ratio (NPL%) as the dependent variable, offering an alternative measure of bank risk-taking.

The coefficients for the measures of competition are, similarly to the previous regression estimates, negative and not statistically significant. There are, however, differences with respect to the models in Tables 4 and 5. The coefficient for the dummy variable for bank size is positive but not statistically significant in any of the models. This contrasts with the previous results where larger banks were found to be significantly riskier. Furthermore, the interaction terms are negative but not statistically significant. This contrasts with the other analyses, where these interactions were positive and significant, thus suggesting that the impact of fintech competition on risk-taking, as measured by NPLs, does not appear to be significantly different between large and small banks.

The second robustness check thus presents a very contrasting picture compared to the main regression and the first robustness check. These results can, however, be reconciled with those prior.

The NPL ratio and Z-Score are inherently different, capturing different dimensions of bank risk. Thus, fintech competition affects them differently. The Z-Score focuses on profitability, leverage, and return volatility, while the NPL ratio reflects credit risk specifically – an arguably narrower measure, as credit is not the only source of risk (Berger, Klapper & Turk-Ariss (2009)). This distinction aligns with the findings of Sarkar and Sensarma (2015) who observed a trade-off in the Indian banking sector, where increased competition improved certain aspects of stability (like default risk, captured by NPLs), while potentially undermining others (like capital adequacy, reflected in the Z-score's components). Fintech competition might similarly impact various risk dimensions unevenly, leading to contrasting results depending on the chosen risk measure.

Discussion

The main regression’s results in Table 4 indicate no significant relationship is found between the measure of fintech competition and bank risk-taking. This finding does not match the findings in the literature or either of the two hypotheses generally discussed in papers – the competition stability and -fragility hypotheses. This could be for a variety of reasons which fall into two broad categories – either the effect exists but analysis carried out is not econometrically valid or the results found are valid and just do not match the findings in the literature.

One possible reason for the insignificant results is that the data period from the CCAF database (2011–2020) might be too short to capture changes in risk-taking. Given that the banks in this study are large organizations, systemic shifts in risk-taking could take longer than the years covered by this analysis. Additionally, banks may have anticipated the competitive pressures from fintech companies before 2011 and adjusted their risk behaviors earlier, which would not be reflected in this analysis. It’s also possible that the data does not fully capture the competitive pressures fintech exerts on traditional banks in the EU27. While these measures were significant in predicting risk-taking in Elekdag

(2024) with a larger and more geographically diverse sample, there could be omitted variables, like bank management quality, influencing both fintech competition and risk-taking, leading to biased results.

Addressing the second possibility, it is useful considering that the market structure, mostly set by the EU27 regulatory framework, might mitigate some of the competitive pressures from fintech, where, for example, banks are under less freedom to adjust their risk-profile compared to their counterparts elsewhere. For example, the EU27 regulatory framework imposes rigorous capital requirements, stress testing, and risk management standards on banks (ECB, 2017). As a result, banks in the EU27 have less flexibility to modify their risk-taking behaviors in response to competitive pressures from fintech firms. This is noted by Altunbas (2007), who shows that European banks take on less risk.

Another possibility is that the fintech offerings in the EU27 do not yet directly compete with legacy banks, perhaps even acting as a complement rather than a substitute, as noted by Tang (2019), thus not significantly reducing legacy banks' main source of income. This is evident when looking at industry statistics. For example, in the North America region, digital payments are the most popular category of fintech by transaction value (Statista, 2024). However, in Europe, neo-banking – banks with a pure online presence – are the most popular category of fintech, with almost $1 billion more in transaction value than the second most popular category – digital payments (Statista, 2024). Finally, it may be that banks see fintech as a threat but are able to pivot and address that threat without increasing their bankruptcy risk. For example, and as explained in further detail in the literature review section, Berger et al. (2009) show that competition-fragility and -stability can coexist, and thus banks need not increase their risk taking.

Regarding the second robustness check, the insignificant impact of fintech competition on bank risk-taking can be reconciled with the existing literature by considering the strict and uniform regulatory framework within the EU27. This was already discussed above, and suggests that the EU27's regulatory environment, as highlighted in Altunbas (2017), can mitigate the influence of competition on bank risk-taking.

Conclusion

The growth of fintech has undeniably transformed the financial landscape, posing both challenges and opportunities for traditional banks. The primary objective of this thesis was to examine the impact of fintech competition, specifically in the areas of digital lending and capital raising, on the risk-taking behavior of large and medium-sized legacy banks in the EU27. The study aimed to contribute to the ongoing debate in the literature regarding the relationship between competition and bank risk-taking, particularly in the context of the evolving fintech landscape.

The empirical analysis yielded mixed results regarding the hypotheses. The main regressions, using both the Z-Score and NPL ratio as risk measures, found no significant relationship between fintech competition and bank risk-taking, thus not supporting Hypotheses 1 and 3. However, the interaction term was significant in the Z-Score analysis, supporting Hypothesis 2, which suggested that the impact of fintech competition on risk-taking varies with bank size, with larger banks being less prone to increase risk. In contrast, the NPL regressions did not support Hypothesis 4, as the interaction term indicated no significant difference in the impact of fintech competition on risk-taking between large and small banks when measured by NPLs.

In conclusion, the research question, "To what extent does fintech competition influence the risk-taking behavior of large and medium-sized legacy banks in the EU27, and how do these effects differ between the two types of banks?", can be answered as follows. Fintech competition, as measured by digital lending and capital raising activities, does not appear to have a direct and significant impact on the risk-taking behavior of legacy banks in the EU27. However, the impact of fintech competition on risk-taking is moderated by bank size, with larger banks experiencing a decrease in risk-taking relative to smaller banks in response to fintech competition, as measured by the Z-Score. Results regarding the NPL ratio as a risk measure are less conclusive and suggest that the relationship may be contingent on how risk is measured, and what factors are important when considering a bank’s health.

Implications

The primary implication of this study's findings is that the impact of fintech competition on bank risk-taking in the EU27 appears to be more nuanced than previously suggested in the literature. The results indicate that fintech competition does not have a direct and significant impact on bank risk-taking. The insignificant results suggest that the competitive pressures from fintech might not be translating into increased risk-taking behavior by banks, potentially due to the harmonized regulatory environment in the EU27 that limits banks' flexibility to adjust their risk profiles. Results, however, do appear to show that an increase in fintech activity is associated with a larger decrease in risk-taking for large banks than smaller banks. This implies that larger banks, with their greater resources and capabilities, might be better equipped to adapt to the challenges presented by fintech. The contrasting results obtained when using the non-performing loans ratio as a risk measure highlight the complexity of the relationship and suggest that the impact of fintech competition might vary depending on the specific risk dimension being considered.

The possibility that harmonized regulatory environment in the EU27 may be mitigating the impact of fintech competition on bank risk-taking brings implications for policymakers. These may need to consider whether existing regulations sufficiently address the potential risks posed by fintech competition. Regulation must not strangle fintech initiatives but must not leave a very important part of the economy unprotected and subject to unfair competition. At the same time, not allowing banks to take risks may also be detrimental to their ability to innovate and compete effectively. This is especially important due to the big changes expected, as well as banks' intention to move to "digital-first" (PWC, 2024). This relates to a further implication for legacy banks, which is the necessity of innovation and technology adoption.

Regarding implications for bank-strategy, results suggest that larger banks, despite their inherently higher baseline risk, might possess a competitive advantage in adapting to the fintech landscape. This advantage could potentially drive further consolidation within the banking sector. Smaller banks, on the other hand, must be careful and mindfully adapt their strategy when facing a comparatively safer competitor and a growing competitor threat in the form of fintech. This finding may become a rationale for mergers and acquisitions, as there appears to be an inherent advantage to being a larger size. This is especially true when considering the expected increase in fintech over the foreseeable future.

As fintech carves out niches within the financial services industry, which the literature and my results corroborate, banks may be forced to specialize or focus on segments where they have a competitive advantage, perhaps leveraging their size. This has an implication for the industry, where the observed lack of increased risk-taking could thus develop into an increasingly segmented market where legacy banks and fintechs occupy complementary roles.

Independently of whether legacy banks and fintechs act complementarily or compete, consumers stand to benefit, at least in the short term. This is because legacy banks reinvent their offerings to match fintechs' "customer-centricity" while fintechs keep growing and themselves developing their offerings (PWC, 2024). While in the short-term this is likely to reduce costs to consumers, either through competition or specialization, in the long-term the overall effect – of fragility or stability – remains to be seen. While my study does not find any significant effect of fintech on legacy bank risk taking within the EU27, it may be that legislative or industry developments change this.

Limitations

As previously mentioned, fintech is a relatively new phenomenon, so the data collected is limited to recent years. This short time frame poses challenges, such as potentially missing the long-term effects of fintech competition on bank risk-taking. Additionally, the unbalanced nature of the panel dataset may affect the reliability and robustness of the estimates; for example, the number of observations for the NPL ratio is much lower than the number of observations for the Z-Score, which illustrates how the dataset's limitations could impact the analysis.

The study's exclusive focus on banks with over USD$2 billion and in the EU27 may limit the generalizability of the findings to smaller banks and regions with different regulatory environments. However, the study still offers valuable insights into the relationship between fintech competition and bank risk-taking within the specific context of the EU27.

Thirdly, also as mentioned, it may be that the methodology is not econometrically correct, and that, for example, the relationship between bank size and risk-taking is not appropriately measured with either the Z-Score or the NPL ratio. Furthermore, there may be other factors influencing both fintech competition and bank risk-taking that were not included in the analysis. These omitted variables can lead to biased estimates, potentially distorting the interpretation of the results.

Directions for future research

The inconclusive results suggest further research is needed on the relationship between fintech competition and bank risk-taking, considering factors like bank size and regulatory changes. Future studies could incorporate a wider range of fintech activities, include banks of all sizes, and explore the impact of neobanks, which are increasingly popular in Europe (Statista, 2024). Finally, expanding the use of alternative risk measures and comparing their characteristics and subsequent results to understand the dynamics of bank response to fintech competition.

Bibliography

Aduba, J. Jr., Asgari, B., & Izawa, H. (2023). Does FinTech penetration drive financial development? Evidence from panel analysis of emerging and developing economies. *Borsa Istanbul Review, 23*(5), 1078-1097. https://doi.org/10.1016/j.bir.2023.06.001

Allen, F., & Gale, D. (2004). Competition and Financial Stability. *Journal of Money, Credit and Banking*, *36*(3), 453–480. http://www.jstor.org/stable/3838946

Anginer, D., Demirguc-Kunt, A., & Zhu, M. (2014). How does competition affect bank systemic risk? *Journal of Financial Intermediation, 23*(1), 1-26. https://doi.org/10.1016/j.jfi.2013.11.001

Banya, R. M., & Biekpe, N. (2017). Bank competition and economic growth: Empirical evidence from selected frontier African countries. *Journal of Economic Studies, 44*(2), 245-265. https://doi.org/10.1108/JES-09-2015-0169

Ben Naceur, S., Candelon, B., Elekdag, S., & Emrullahu, D. (2023). *Is FinTech eating the bank's lunch?* (IMF Working Paper No. WP/23/239). International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2023/11/18/Is-FinTech-Eating-the-Bank-s-Lunch-540817

Berger, A. N., Klapper, L. F., & Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research*, *35*(2), 99-118. https://doi.org/10.1007/s10693-008-0050-7

Berger, A., Klapper, L., & Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research, 35*(2), 99-118. https://doi.org/10.1007/s10693-008-0050-7

Boyd, J. H., & De Nicoló, G. (2005). The Theory of Bank Risk Taking and Competition Revisited. *The Journal of Finance*, *60*(3), 1329–1343. http://www.jstor.org/stable/3694928

Brandl, B., & Hornuf, L. (2017). Where did fintechs come from, and where do they go? The transformation of the financial industry in Germany after digitalization. *SSRN*. https://dx.doi.org/10.2139/ssrn.3036555

Carlson, M., & Mitchener, K. J. (2006). Branch Banking, Bank Competition, and Financial Stability. *Journal of Money, Credit and Banking*, *38*(5), 1293–1328. http://www.jstor.org/stable/3839007

Chase. (n.d.). *Online banking vs. traditional banking: Exploring the differences*. Chase. Retrieved 2024, August 13, from https://www.chase.com/personal/banking/education/basics/banking-traditional-vs-online-banking

Congressional Research Service. (2017, December 14). *The $50 billion threshold in the Dodd-Frank Act: Key findings*. https://crsreports.congress.gov/product/pdf/IN/IN10840/4na

Corbae, D., & Levine, R. (2019). *Competition, stability, and efficiency in the banking industry*. University of Wisconsin - Madison, University of California, Berkeley, and NBER. https://www.ecb.europa.eu/press/conferences/shared/pdf/20191216_4th_macroprud_conf/2019.12.16_Competition_stability_and_efficiency_in_the_banking_industry_Dean_Corbae.pdf

Corporate Finance Institute (CFI). (n.d.). *Major Risks for Banks*. Retrieved August 13, 2024, from https://corporatefinanceinstitute.com/resources/career-map/sell-side/risk-management/major-risks-for-banks/

Demirgüç-Kunt, A., Feyen, E., & Levine, R. (2013). The Evolving Importance of Banks and Securities Markets. *The World Bank Economic Review*, *27*(3), 476–490. http://www.jstor.org/stable/43774118

Elekdag, S., Emrullahu, D., & Ben Naceur, S. (2024). *Does FinTech increase bank risk taking?* (IMF Working Paper No. WP/24/17). International Monetary Fund.

European Central Bank. (2017, June 28). *Harmonisation paves the way for a European banking market*. Retrieved from https://www.ecb.europa.eu/press/key/date/2017/html/ecb.sp170628.en.html

Feng, A. X. (2018). *Bank competition, risk taking, and their consequences: Evidence from the U.S. mortgage and labor markets* (IMF Working Paper No. WP/18/157). International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2018/07/06/Bank-Competition-Risk-Taking-and-their-Consequences-Evidence-from-the-U-S-46034

Ferreira, C. (2024). *The impact of bank market competition and stability on bank total factor productivity changes: Evidence from a panel of European Union banks* (REM Working Paper). ISEG – REM (Research in Economics and Mathematics). http://hdl.handle.net/10400.5/30478

Freixas, X., & Rochet, J.-C. (2008). *Microeconomics of banking* (2nd ed.). MIT Press.

Frost, J., Gambacorta, L., Huang, Y., Shin, H. S., & Zbinden, P. (2019). *BigTech and the changing structure of financial intermediation* (BIS Working Paper No. 779). Monetary and Economic Department, Bank for International Settlements. https://www.bis.org/publ/work779.pdf

Goetz, M. R. (2018). Competition and bank stability. *Journal of Financial Intermediation, 35*(Part A), 57-69. https://doi.org/10.1016/j.jfi.2017.06.001

Gopal, M., & Schnabl, P. (2022). The rise of finance companies and FinTech lenders in small business lending. *The Review of Financial Studies, 35*(11), 4859-4901. https://doi.org/10.1093/rfs/hhac034

Haddad, C., & Hornuf, L. (2023). How do fintech start-ups affect financial institutions' performance and default risk? *The European Journal of Finance, 29*(15), 1761-1792. https://doi.org/10.1080/1351847X.2022.2151371

Hermuningsih, S., Rahmawati, A. D., & Sari, P. P. (2023). The moderating role of bank size: Influence of fintech, liquidity on financial performance. *Jurnal Siasat Bisnis, 27*(1). https://doi.org/10.20885/jsb.vol27.iss1.art8

Hughes, J. P., & Mester, L. J. (2013). Who said large banks don't experience scale economies? Evidence from a risk-return-driven cost function. *Journal of Financial Intermediation, 22*(4), 559-585. https://doi.org/10.1016/j.jfi.2013.06.004

Jagtiani, J., & Lemieux, C. (2018). Do fintech lenders penetrate areas that are underserved by traditional banks? *Journal of Economics and Business, 100*, 43-54. https://doi.org/10.1016/j.jeconbus.2018.03.001

Jia, X. (2024). *FinTech penetration, charter value, and bank risk-taking*. Journal of Banking & Finance, 161, 107111. https://doi.org/10.1016/j.jbankfin.2024.107111

Jiménez, G., Lopez, J. A., & Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability, 9*(2), 185-195. https://doi.org/10.1016/j.jfs.2013.02.004

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

Keeley, M. C. (1990). Deposit Insurance, Risk, and Market Power in Banking. *The American Economic Review*, *80*(5), 1183–1200. http://www.jstor.org/stable/2006769

Kline, A. (2016, May 26). Why midsize banks rule right now. *American Banker*. Retrieved from https://www.americanbanker.com/news/best-mid-size-banks

Laeven, L., Ratnovski, L., & Tong, H. (2014). *Bank size and systemic risk* (IMF Staff Discussion Note No. SDN/14/04). International Monetary Fund. https://www.imf.org/external/pubs/ft/sdn/2014/sdn1404.pdf

Lautenschläger, S. (2017, June 28). *Harmonisation paves the way for a European banking market* [Press release]. European Central Bank. https://www.ecb.europa.eu/press/key/date/2017/html/ecb.sp170628.en.html

Lepetit, L., Nys, E., Rous, P., & Tarazi, A. (2013). Bank income structure and risk: An empirical analysis of European banks. *Journal of Banking & Finance, 32*(8), 1452-1467. https://doi.org/10.1016/j.jbankfin.2007.12.002

Liebersohn, J., & Rothstein, J. (2024). *Household mobility and mortgage rate lock* (NBER Working Paper No. w32781). National Bureau of Economic Research. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4915967

López-Penabad, M. C., Iglesias-Casal, A., & Silva Neto, J. F. (2021). Competition and financial stability in the European listed banks. *SAGE Open*. https://doi.org/10.1177/21582440211032645

Malovaná, S., Hodula, M., Bajzík, J., & Gric, Z. (2024). Bank capital, lending, and regulation: A meta-analysis. *Journal of Economic Surveys, 38*(3), 823-851. https://doi.org/10.1111/joes.12560

Martínez-Miera, D., & Repullo, R. (2010). Does competition reduce the risk of bank failure? *The Review of Financial Studies, 23*(10), 3638-3664. https://doi.org/10.1093/rfs/hhq057

Ndwiga, D. (2024). *Monetary policy risk-taking transmission channel: A case of banking industry in Kenya* (KBA Centre for Research on Financial Markets and Policy® Working Paper Series No. 78). Kenya Bankers Association. https://www.kba.co.ke/wp-content/uploads/2024/06/Monetary-policy-risk-taking-transmission-channel-A-case-of-banking-industry-in-Kenya-David-Ndwiga.pdf

Paulsen, C. (2024, March 28). *Fintech in Europe: A Comprehensive Overview*. EuroDev. Retrieved August 13, 2024, from https://eurodev.com/blog/fintech-in-europe

Phan, D. H. B., Narayan, P. K., Rahman, R. E., & Hutabarat, A. R. (2020). Do financial technology firms influence bank performance? *Pacific-Basin Finance Journal, 62,* 101210. https://doi.org/10.1016/j.pacfin.2019.101210

Pruteanu-Podpiera, A., Weill, L., & Schobert, F. (2008). Banking competition and efficiency: A micro-data analysis on the Czech banking industry. *Comparative Economic Studies, 50*(2), 253-273. https://doi.org/10.1057/palgrave.ces.8100248

PwC. (n.d.). *Blurred lines: How FinTech is shaping financial services*. PwC. Retrieved 2024, August 13, from https://www.pwc.com/gx/en/industries/financial-services/fintech-survey/blurred-lines.html

PwC. (n.d.). *Customers in the spotlight: How FinTech is reshaping banking*. PwC. Retrieved 2024, August 13, from https://www.pwc.com/gx/en/industries/financial-services/publications/fintech-is-reshaping-banking.html

Sarkar, S., & Sensarma, R. (2016). The relationship between competition and risk-taking behaviour of Indian banks. *Journal of Financial Economic Policy, 8*(1), 95-119. https://doi.org/10.1108/JFEP-05-2015-0030

Schaeck, K., & Cihák, M. (2014). Competition, Efficiency, and Stability in Banking. *Financial Management*, *43*(1), 215–241. http://www.jstor.org/stable/43280177

Schaeck, K., Čihák, M., & Wolfe, S. (2006). *Are more competitive banking systems more stable?* (IMF Working Paper No. WP/06/143). International Monetary Fund. https://www.imf.org/external/pubs/ft/wp/2006/wp06143.pdf

Statista. (2024). Transaction value in the FinTech market in Europe (2017-2028). *Statista.* Retrieved from https://statista.com/outlook/dmo/fintech/europe#transaction-value

Statista. (2024). Transaction value in the FinTech market in North America (2017-2028). *Statista.* Retrieved from https://www.statista.com/outlook/dmo/fintech/north-america#transaction-value

Tang, H. (2019). *Peer-to-peer lenders versus banks: Substitutes or complements?* The Review of Financial Studies, 32(5), 1900–1938. https://doi.org/10.1093/rfs/hhy137

Uhde, A., & Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: Empirical evidence. *FAU Discussion Papers in Economics, 02/2009.* Friedrich-Alexander University Erlangen-Nuremberg, Institute for Economics.

Vives, X. (2019). Digital disruption in banking. *Annual Review of Financial Economics, 11*, 243-272. https://doi.org/10.1146/annurev-financial-102710-144900

Vives, X., & Ye, Z. (2024). *Information technology and lender competition* (IESE Business School Working Paper). University of Navarra. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3863988

Yang, T., & Zhang, X. (2022). FinTech adoption and financial inclusion: Evidence from household consumption in China. *Journal of Banking & Finance, 145*, Article 106668. https://doi.org/10.1016/j.jbankfin.2022.106668

Yoon, Soon Suk, Hongbok Lee, and Ingyu Oh. 2023. Differential Impact of Fintech and GDP on Bank Performance: Global Evidence. Journal of Risk and Financial Management 16: 304. https:// doi.org/10.3390/jrfm16070304

Ziegler, T., Shneor, R., Wenzlaff, K., Suresh, K., Paes, F. F. de C., Mammadova, L., Wanga, C., Kekre, N., Mutinda, S., Wang, B., Closs, C. L., Zhang, B., Forbes, H., Soki, E., Alam, N., & Knaup, C. (2021). *The 2nd global alternative finance market benchmarking report*. SSRN. http://dx.doi.org/10.2139/ssrn.3957488

Appendices

Appendix 1 – List of EU27 countries

1. Austria
2. Belgium
3. Bulgaria
4. Croatia
5. Cyprus
6. Czech Republic
7. Denmark
8. Estonia
9. Finland
10. France
11. Germany
12. Greece
13. Hungary
14. Ireland
15. Italy
16. Latvia
17. Lithuania
18. Luxembourg
19. Malta
20. Netherlands
21. Poland
22. Portugal
23. Romania
24. Slovakia
25. Slovenia
26. Spain
27. Sweden