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Does FinTech Increase Bank Risk Taking?

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ABSTRACT: Motivated by its rapid growth, this paper investigates how FinTech activities influence risk taking by financial intermediaries (FIs). In this context, this paper revisits an ongoing debate on the impact of competition on financial stability: on one side, it is argued that greater competition encourages greater risk taking (competition-fragility hypothesis), while the other side of the debate asserts that more competition can increase financial stability (competition-stability hypothesis). Using a curated databased covering over 10,000 FIs and global FinTech activities, we find a robust relationship whereby greater FinTech presence is associated with heightened risk taking by FIs, offering support for the competition-fragility hypothesis. However, the inclusion of bank-, industry-, and country-specific characteristics can alter this relationship. Importantly, there is suggestive evidence indicating that in certain cases, greater FinTech presence may be associated with *less* FI risk taking amid stronger domestic institutions. Notwithstanding the relevance for policy, this paper presents a novel framework that may help reconcile some of the conflicting results in the literature which have found supportive evidence for each of the two competing hypotheses.

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WORKING PAPERS

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I. Introduction

Technology-enabled innovations in the financial sector, known as FinTech, have experienced rapid growth in recent years. While the current share of FinTech finance in major markets remains relatively low, estimated at around 2 percent of total credit, the average growth rate of FinTech volumes over 2012-2020, excluding China, has been a remarkable 70 percent (CCAF, 2021). Importantly, this upwards trend is expected to continue (World Bank, 2022).

The rise of FinTech brings both opportunities and challenges to the financial services industry. Technological innovation holds the promise of expanding access to financial services, increasing the variety of product offerings, enhancing convenience, and reducing costs for clients. However, it also has implications for market concentration, competition, and contestability in financial services, with both potential benefits and risks. On the one hand, increased FinTech activities can promote greater competition and diversity in lending, payments, trading, and other financial services, leading to broader financial inclusion and an expanded customer base. This can result in improved revenue streams, enhanced efficiency, and increased resilience in the banking system. On the other hand, heightened competition can put pressure on the profitability of traditional financial institutions (FIs), which may respond by taking on additional risks to maintain their margins.

The rapid emergence of Fintech is related to an ongoing debate among policymakers and academics on the impact of greater competition on financial system stability. According to the traditional “competition-fragility” view, increased competition among banks leads to heightened financial instability. This occurs as heightened competition erodes market power, reduces profit margins, and undercuts franchise value. Consequently, banks face greater incentives to engage in excessive risk taking (see, for example, Allen and Gale, 2004, or, more recently, Carvallo, Valencia, and Ortiz Bolaños, 2018). On the other side of the debate, the “competition-stability” view argues that more competitive bank systems result in more stability. Boyd and De Nicoló (2005) show that lower lending rates reduce the entrepreneurs’ cost of borrowing which increases the success rate of entrepreneurs’ investments (see also Bülbül, Hakenes, and Lambert, 2019). Therefore, banks will face lower credit risk on their loan portfolio in more competitive markets which should lead to increased banking sector stability.

The growing role of FinTech activities in the financial sector adds a new dimension to this debate. Yet, to date, the few studies that have explored the interplay between FinTech and bank risk taking have typically focused on China (Deng and others, 2021; Hu, Zhao, and Yang, 2022; Fung and others, 2020). This paper aims to address this gap in the literature and provide insights into how the growing presence of FinTech influences risk taking activities across traditional FIs worldwide. Our study focuses on assessing these two competing hypotheses noted above by inquiring whether the presence of FinTech contributes to more risk taking among traditional financial institutions (competition-fragility) or not (competition-stability).

We assess the relative merits of these two hypotheses by utilizing a cross-country database that encompasses over 10,000 traditional FIs and data on FinTech activities such as digital lending and digital capital raising activities across 57 countries. Using this comprehensive data base, we quantify the impact of growing FinTech activities on a measure of risk taking by traditional FIs. Moreover, we aim to understand the mechanisms driving risk taking by examining the role of profitability and capitalization ratios. We also explore the heterogeneous risk-taking response of different types of FIs (banks vs non-banks) to the impact of different

FinTech business models. In addition, we investigate whether the impact of FinTech on FI risk taking differs with respect to the different bank-, industry-, and country-specific characteristics.

Our baseline specification indicates that greater FinTech presence is associated with heightened risk taking, offering support for the traditional competition-fragility hypothesis. Our findings remain robust when we consider alternative ways to measure FinTech, include extra control variables, and use various statistical approaches like Two-Stage Least Squares (2SLS) and the Generalized Methods of Moments (GMM) estimation.

Furthermore, our analysis reveals differential effects of selected FinTech business models on different types of traditional FIs. For example, whereas commercial bank risk taking is adversely affected by a greater presence of FinTechs operating a balance sheet lending model, an analogous result is found in the case of cooperative banks with respect to FinTechs leveraging a peer-to-peer (P2P) business model. In both cases, the change in risk taking appears to be associated primarily with a deterioration in profitability.

We then explore how the relationship between FinTech growth and FI risk taking changes depending on selected bank-, industry-, and country-specific characteristics. The results indicate that higher capital and liquidity ratios as well as greater income diversification can reduce the influence of growth FinTech activities on risk taking across FIs. Likewise, there is suggestive evidence indicating that in some cases greater FinTech presence may be associated with *less* FI risk taking amid stronger institutions. These results are relevant in the policy context, but also contribute to the literature by helping to reconcile some of the conflicting results from previous studies that have found supportive evidence for each of the two competing hypotheses. Indeed, by highlighting the role of country specificities—including the role of institutions and policy frameworks—our paper rationalizes both hypothesis in a unified framework.

The remainder of the article proceeds as follows. Section II presents the literature review. Section III outlines the econometric approach. Section IV describes the data and provides summary statistics. Section V discusses the main findings and section VI presents the conclusions and policy implications.

II. Literature

The impact of FinTech growth on financial stability is related to an ongoing debate on the relationship between competition and stability of the banking system. One side of the debate—the traditional "competition-fragility" hypothesis—argues that greater bank competition leads to more bank risk taking. Specifically, more competition erodes banks' market power, decreases profit margins, and thereby reduces their charter (or franchise) value (Marcus, 1984; Keeley, 1990; Allen and Gale, 2004).[1] Lower charter values reduce the penalty for failure and thus encourage greater risk taking in the pursuit of higher returns. In addition to funding riskier projects, banks might seek to generate income through new lines of noninterest generating activities that also raise their risk profiles (DeYoung and Roland, 2001; Stiroh, 2004). Likewise, lower charter values could reduce efforts to screen potential borrowers rigorously, thus deteriorating credit quality and raising overall fragility (Allen and Gale, 2000; Allen and Gale, 2004; Boot and Thakor, 1993; Dell'Ariccia and Marquez, 2006).[2] In extremis, acutely distressed banks, with little remaining equity value (including because of persistently weak profitability) are more inclined to gamble for resurrection (Jensen and Meckling, 1976; IMF, 2014).[3] Empirically, Beck, De Jonghe, and Schepens (2013) document that greater competition not only increases bank fragility but does so to a greater extent as activity restrictions become more stringent. Further, Uhde and Heimeshoff (2009) show that higher bank concentration reveals higher risk taking among banks across the EU. More recently, Carvallo Valencia and Ortiz Bolaños (2018) provide evidence that suggests that in banking markets characterized by increased competition, banks typically maintain lower capital buffers, as suggested by theories related to the "charter value" of banks and the negative impact of competition on banks' risk attitudes.

On the other side of the debate, the "competition-stability" hypothesis contends that competition can enhance financial stability by lowering loan rates, decreasing borrower credit risk, and reduce the likelihood of bank failures (Boyd and De Nicoló, 2005). Put differently, accordingly to this hypothesis, greater market power would result in higher bank risk because higher lending rates render it more difficult for customers to repay their loans, exacerbating the moral hazard incentives of borrowers to shift into riskier projects. At the same time, higher lending rates may also attract riskier borrowers owing to adverse selection. In particular, borrowers who are most desperate for funds, including those with poor credit histories, may be more willing to accept higher lending rates as they might not have access to cheaper alternatives. Likewise, if lower competition is characterized by a greater degree of bank concentration, this can lead to more risk taking if the institutions believe that they are too big to fail and are more likely to be explicitly or implicitly protected by the government safety net (IMF, 2014; BCBS, 2016). Empirical evidence supporting this hypothesis indicates that the risk of bank failure rises in more concentrated markets (Boyd, De Nicoló and Jalal, 2006), whereas more competitive banking systems are characterized by lower likelihoods of bank failure (Schaeck, Čihák and Wolfe, 2006). Likewise, a more recent study by Bülbül, Hakenes and Lambert (2019) show that heightened competition, improves the probability of banks for implementing advanced risk management instruments.

[1] The charter value can be thought of the present value of expected future profits (Demsetz, Saidenberg and Strahan, 1996) or the market value of the bank beyond its book value (Berger, Klapper, and Turk-Ariss, 2008).

[2] Competitive banking systems with many small banks- more difficult to monitor and supervise (Anginer, Demirgüç-Kunt and Zhu, 2014). Also note that by making it easier for borrowers to switch banks, competition might impede banks from earning information rents (see for instance, Boot and Greenbaum, 1993; Berger and Udell, 1995; Berger and others, 2005; and Dell'Ariccia and Marquez 2006).

[3] Gambling for resurrection refers to a situation when shareholders and managers become more willing to engage in riskier strategies as their firms approach the brink of financial failure. This willingness arises because they have less to lose if the firm fails and more to gain if their efforts are successful, given that their ownership stake in the company has already lost significant value.

The greater presence of FinTech in the financial landscape has also sparked debates concerning its impact on financial stability. One strand of research is in line with the traditional competition-fragility hypothesis. For instance, Fang and others (2023) argue that the growth in FinTech has been associated with greater bank risk taking.[4] Through partnerships with FinTech firms or the development of in-house expertise, improvements in risk identification and management capabilities may increase banks' risk tolerance. Moreover, despite the benefits stemming from the reduced cost of loans, greater online presence, and broadened access to previously underserved borrowers, and an over-reliance on developing technologies and business practices could be a concern. For example, Liberti and Petersen (2019), Jakšič and Marinč (2018), as well as, Mild, Waitz and Wöckl (2015) argue that important qualitative information is not efficiently used in non-traditional credit assessment methods that are typically employed by FinTech firms. At the same time, banks have a strong incentive to invest in higher-yield products (which can raise their risk profiles) to help defray the R&D costs needed to develop in-house capabilities (including, possibly in the context of partnering with FinTech firms). Ben Naceur and others (2023) present a conceptual framework where growing FinTech presence in a financial system could be either complementary (via partnerships) thereby broadening lending base (and/or increasing revenues) or could result in greater competition which erodes bank profits. They conclude that increased FinTech presence results in a negative impact on profitability, primarily driven by reduced interest income and increased costs, which is in line with the competition-fragility hypothesis. Similarly, Bakker and others (2023) find that FinTech competition is associated with a reduction in net interest margin of banks in EMDEs and Latin America and the Caribbean.

On the other hand, several studies support the competition-stability perspective. For instance, Grennan and Michaely (2021), Deng and their colleagues (2021), FSB (2017), and Yeo and Jun (2020) argue that FinTech lending reduces information asymmetry in credit markets, leading to a decrease in bank risk taking, and as a result, enhances the overall resilience of the banking system. Through partnerships with FinTech firms or the development of in-house capabilities, banks have effectively reduced risk taking by improving efficiency, transparency, and diversification. This notion is echoed by Daud and their team (2022), Murinde, Rizopoulos, and Zachariadis (2022), Campanella, Della Peruta, and Del Giudice (2017), as well as Hu, Zhao, and Yang (2022). Furthermore, Fung and others (2020) highlight three crucial aspects in this context: first, the potential to enhance profitability when banks invest in FinTech start-ups with expanded market access; second, the operational efficiency gains resulting from FinTech partnerships; and third, the complementary services offered by FinTech partners that not only enhance profitability but also reduce the incentive for risk taking. Simultaneously, Deng and others (2021) underscore how partnerships with FinTech companies can broaden a bank's business horizons, increase profitability, and, in the process, promote regional diversification, ultimately lowering overall bank risk.

Expanding upon the extensive theoretical and empirical literature, our contribution to this research agenda involves revisiting the longstanding debate regarding the impact of competition on financial stability. We do so by taking a novel approach: we explore how FinTech may be (indirectly) influencing competition and therefore risk taking by traditional FIs. We use a curated cross-country database that includes over 10,000 FIs, including banks and non-bank financial institutions and FinTech activities across 57 countries over the 2012-2020 period. In this way, our paper builds on the existing literature in several ways: we consider a recent global sample in

[4] Using country-level data, Cevik (2023) shows a negative—albeit not statistically significant—impact of FinTech on financial stability.

contrast to many single country studies (that have typically focused on China). Our paper covers Non-Bank Financial Institutions (NBFIs) in addition to banks, and we explore the differentiated impact of FinTech on risk taking by these different types of FIs. In addition, we investigate how the leading FinTech business models may have a differential impact. Additionally, our research aims to uncover the underlying factors driving risk taking, particularly in relation to profitability and capitalization ratios. Lastly, we assess how bank-, industry-, and country-specific characteristics alter the link between the growing FinTech activities and FI risk taking. Through this multifaceted analysis, we strive to provide insights that can inform policymakers, industry practitioners, and researchers in understanding the evolving landscape of financial markets and the implications of increasing FinTech integration for the stability of the financial system.

III. Econometric Approach

Our empirical research is motivated by recent research assessing the relationship between competition and bank risk taking (Beck, De Jonghe, and Schepens, 2013; Schaeck and Čihák, 2010; Boyd, De Nicoló and Jalal 2006; Boyd and De Nicoló, 2005). In line with earlier studies, we use the z-score as a measure of risk taking (a measure of the distance from insolvency which can be traced back to Roy, 1952). Then, while controlling for the degree of bank concentration—a standard measure of financial system competition used in the literature—we use Fintech transactions as the main proxy to gauge how potential competitive pressures stemming from the growth of Fintech may be influencing risk taking across traditional FIs.

Therefore, guided by recent empirical studies, we initially propose the following baseline specification:

$$Z_{b,c,t} = \beta * Fintech_{c,t} + \gamma * X_{b,c,t-1} + \delta * W_{c,t} + Other_{b,c,t} \qquad (1)$$

where $Z_{b,c,t}$, $Fintech_{c,t}$, $X_{b,c,t-1}$, $W_{c,t}$, and $Other_{b,c,t}$, denote the z-score—our measure of risk taking, the natural logarithm of country-level FinTech transactions, bank-level controls, industry- and country-specific controls, as well as bank and time fixed effects terms and a residual, respectively. The z-score is calculated as:

$$Z_{b,c,t} = \frac{ROA_{b,c,t} + (E/A)_{b,c,t}}{\sigma(ROA_{b,c,t})}$$

where $ROA_{b,c,t}$, $(E/A)_{b,c,t}$, and $\sigma(ROA_{b,c,t})$, denote bank-specific return on assets (ROA), the equity-to-asset ratio, and the 3-year rolling average of standard deviation of ROA. A higher z-score indicates a lower probability of insolvency since it suggests the bank can withstand a greater amount of volatility in its returns before its equity is wiped out. Specifically, the z-score represents the number of standard deviations by which returns would have to fall to deplete equity. More intuitively, a higher z-score indicates that the bank is more stable. The z-score is an important measure in the assessment of the stability of financial institutions and has been widely used in empirical banking studies to gauge the risk of failure or distress of a bank because it encompasses both profitability and capitalization, as well as the volatility of earnings. Because the z-score is highly skewed, following Laeven and Levine (2009), we use the natural logarithm of the raw z-score which is normally distributed.[5] Importantly, are empirical strategy (implicitly) presumes that risk taking by an individual

[5] Nevertheless, henceforth, when we use z-score we are really referring to the log(z-score), unless noted otherwise.

financial institution does not influence aggregate FinTech activities at the country level. Although this is a plausible assumption, we assess its validity in the section covering the empirical results.

To get insights on the underlying channels influencing our risk taking measure, we decompose the z-score into two additive components following Lepetit and others (2008): the risk-adjusted profitability (return on assets, ROA) and capitalization (equity-to-assets) ratios. The first component is the risk-adjusted ROA whereby the level of profits (as captured by ROA) is scaled by its volatility ($ROA_{b,c,t}/\sigma_{ROA_{b,c,t}}$). This ratio is sometimes interpreted as capturing portfolio risk. The second component divides the leverage ratio (the equity-to-asset ratio) by the standard deviation of ROA ($(E/A)_{b,c,t}/\sigma_{ROA_{b,c,t}}$). In this way, it recognizes that the expected loss absorbing capacity of two identical capital ratios will differ depending on the volatility of the portfolio (as proxied by the standard deviation of ROA). More simply, the decomposition will shed light on whether changes in the z-score are primarily driven by changes in (risk-adjusted) profits or capitalization.

Our measure of $Fintech_{c,t}$ encompasses transactions such as digital lending and digital capital raising activities that have emerged outside of the incumbent banking systems and traditional capital markets and occur online (CCAF, 2021).[6] We also consider alternative measures of the FinTech variable: we either scale it by GDP (to assess the relative importance relative to the size of the economy) or combined with BigTech transactions (based on the work by Cornelli and others, 2023).

Regarding the other variables, we initially include bank-level controls such as size expressed as the natural logarithm of total assets and capitalization as the equity-to-asset ratio.[7] At the country level, we control for cyclical and structural determinants such as GDP growth, inflation, policy rate, log of GDP per capita and 5-bank asset concentration. For more on the definitions of the variables please refer to Annex Table 1.

Against the background, the baseline specification can be interpreted as follows: A statistically significant estimate whereby $\beta < 0$ would be supportive of the competition-fragility hypothesis because greater FinTech presence is associated with an increase in risk taking. In contrast, a positive value would be in line with the competition-stability hypothesis.

We also explore how different FinTech models and bank business models interact in line with the approach of Ben Naceur and others (2023). In this case, the dependent variable would be the z-score associated with a type of FI (e.g., commercial versus cooperative banks) and the FinTech variable would be classified according to the activities of the main business models in our sample.

We augment the baseline specification to consider the role of bank-, industry-, and country -specific characteristics. In this case, the specification would be modified as follows:

$$Z_{b,c,t} = \beta_1 * Fintech_{c,t} + \beta_2 * Fintech_{c,t} * CHAR_{b,c,t-1} + \gamma * X_{b,c,t-1} + \delta * W_{c,t} + Other_{b,c,t} \qquad (2)$$

[6] For brevity, we use the label ‘‘FinTech’’ in referring to the natural logarithm of the FinTech in the remainder of the paper.
[7] We also winsorize both control variables at the 2 percent level (1 percent in each tail) to mitigate the impact of outliers.

where $CHAR_{b,c,t-1}$ denotes a bank-, industry-, or country-level indicator variable that equals unity if its value is above the sample median (Annex Table 1).[8] The coefficient β_2 gauges the impact of the different characteristics on the relationship between Fintech and risk taking:

$$\frac{\partial Z_{b,c,t}}{\partial Fintech_{c,t}} = \beta_1 + \beta_2 * CHAR_{b,c,t-1}$$

[8] These indicator variables are constructed as dummy variables that enable the differentiation of observations based on whether they fall below or above their median value. For instance, in the case of low bank concentration, a value of 1 indicates values below the median, and 0 represents values above the median. By splitting the observations into two groups based on their median, the model can account for potential nonlinearities and differing relationships that exist between FinTech and Bank risk taking.

IV. Data and summary statistics

To investigate the relationship between FinTech competition and the profitability of financial institutions, our analysis integrates three distinct datasets. First, we source data on FinTech transactions from the Global Alternative Finance data repository, administered by the Cambridge Center for Alternative Finance (CCAF), encompassing a sample of 57 countries. Second, we compile balance sheet and income statement details for over 10,000 financial institutions, leveraging the Bureau van Dijk Orbis database, a comprehensive global resource drawing from publicly accessible data. This database encompasses both banks and non-banks worldwide. Third, we assemble country-level macroeconomic data and a range of structural indicators from publicly available sources to further enrich our analysis. Details on these datasets and descriptive statistics are presented below.

A. FinTech

FinTech transactions are collected from the Global Alternative Finance data depository hosted by the CCAF for a sample of 57 countries of yearly data over 2012-2020. FinTech transactions include country-level digital finance activities such as digital lending and digital capital raising models that have emerged outside of the incumbent banking systems and traditional capital markets and occur online (CCAF, 2021).

After rapid growth from 2013-2017, FinTech transaction volumes declined globally owing to a more stringent regulatory regime in China (Figure 1). However, excluding China, the data displays an upward trend, but current volumes remain relatively modest, estimated at around 2 percent of the total credit in major FinTech markets (Figure 2). Nevertheless, there is a strong expectation of continued rapid growth (World Bank, 2022).

Among the various FinTech business models, P2P (marketplace) lending and Balance Sheet lending have gained significant traction. P2P lending platform offer a matching service between borrowers and investors. They provide services including the verification of borrower information and the assignment of credit ratings, and in some cases, referring the loan applications to partner banks. Depending on the exact business, this could imply that the risk of financial loss in case of loan default lies with the partnering bank rather than the platform itself (CCAF, 2021; FSB, 2017; FDIC, 2015).[9]

The Balance Sheet lending platform is the closest model to a traditional non-bank credit intermediary (which can provide loans but is not legally permitted to take deposits). This type of platform manages the entire loan process, from collecting applications to servicing payments, and therefore assumes the financial risk if loans go unpaid (CCAF, 2021; FSB, 2017). These platforms compete more directly with traditional FIs and so may foster greater risk taking, by inter alia, incumbent banks owing to intensified competition.[10]

[9] An example of such model is Mintos, one of the biggest P2P lending platforms in Europe with €8.7 billion invested in loans and €394 million of loans sold on the secondary market since its creation in 2015 (Mintos, 2023). Mintos collaborates with 61 lending companies from 33 countries and generates income from commissions earned when these companies fund loans through their platform.

[10] An example of such a FinTech business model is *Credibly*, a prominent SME-focused FinTech platform, which has provided over $2 billion in funding to U.S. small and medium-sized businesses since 2010 (Credibly, 2023). *Credibly* partners with borrowers through underwriting, funding, and servicing stages, relying on venture capital firms and institutional investors for funding.

Figure 1. FinTech finance volumes by model (including China, in US$ billions)

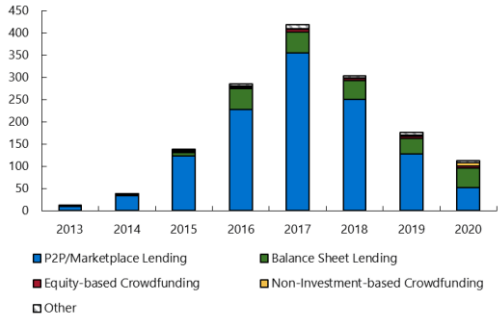
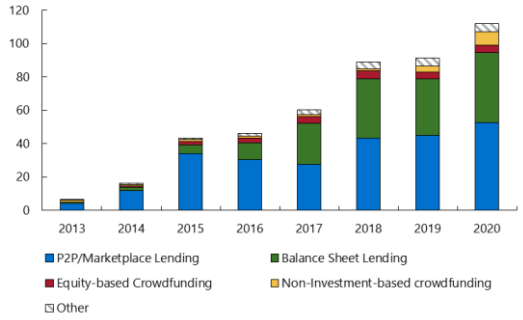


Figure 2. FinTech finance volumes by model (without China, in US$ billions)



Source: Authors calculations using CCAF (2021) Database.

B. Financial Institutions

The balance sheet and income statement data for over 10,000 traditional financial institutions are sourced from the Bureau van Dijk Orbis database. This database provides information on banks and non-banks globally, based on publicly available data sources. To capture domestic effects, we primarily use unconsolidated statements (95 percent of our observations) as they provide a more detailed view of financial activities and performance of individual banks within their respective markets. Unconsolidated statements are preferred as they exclude other activities and sources of income from parent companies or subsidiaries from the analysis (Albertazzi and Gambacorta, 2009; García-Herrero, Gavilá and Santabárbara, 2009; Valverde and Rodríguez Fernández, 2007). However, in some cases, certain banks only have consolidated statements, while others have only unconsolidated statements. To avoid information loss, following Ben Naceur and others (2023), we use the consolidated statement when an unconsolidated statement is unavailable (Micco, Panizza, and Yañez, 2007).

Our sample of financial institutions consists of two broad groups: banks and non-banks, representing 90 percent and 10 percent of the observations, respectively. Among banks, approximately 80 percent are cooperative banks. However, while larger in number, they are smaller in size (with average assets of $373 million) relative to the commercial banks (with average asset of over $10 billion). Commercial banks appear to maintain higher level of capitalization (with an average equity-to-assets ratios of 18 percent) and are more profitable when compared to cooperative banks (both in terms of ROA and ROE).

Table 1: Bank-specific characteristics 1/

Financial Institution	Institutions	Total Assets (in billions, US$)	E/A (percent)	ROE (percent)	ROA (percent)	z-score (log units)
All	10,167	2.8	16.2	4.9	0.8	4.2
Banks	9,198	2.0	15.3	4.7	0.7	4.2
Commercial Bank	1,409	10.2	17.7	7.1	1.0	3.8
Cooperative Bank	7,151	0.4	14.9	4.2	0.7	4.3
Non-Banks	969	10.7	25.4	7.5	1.7	3.8

Source: Authors calculations using Bureau van Dijk Orbis database.

1/ This table reports the averages of key variables for different FI groupings.

C. Risk taking

Recall that our risk taking indicator is the z-score which measures the distance from insolvency (or default) and represents the number of standard deviations by which ROA would have to fall to deplete equity.[11] The z-score, displays large variation within financial systems and across countries. When examining the z-score across different FI's, there are notable differences across banks and non-banks, with banks displaying higher values (Table 1). Among banks, cooperative banks have higher average z-scores relative to commercial banks. When examining the z-score components, cooperative banks appear to have lower (risk-adjusted) returns than commercial banks but a higher (risk-adjusted) capitalization ratio. There is also significant cross-country variation in the z-score (see Annex Table 2). For instance, while profits in Germany would have to fall by over 300 times their standard deviation to deplete bank equity on average, in Argentina profits would need to fall by a factor of 14. The components of the z-score also differ across countries. For instance, risk adjusted profitability varies from 0.3 percent in Nigeria to 47 percent in Germany against a sample average of 9 percent.

D. Macroeconomic and other control variables

Country-level macroeconomic data and various structural indicators are collected from publicly available sources, including the International Monetary Fund (IMF) WEO, World Bank Governance Indicators, Haver, and the Global Financial Development Database. These data encompass factors such as GDP growth, GDP per capita, policy rate, inflation, bank concentration, and rule of law. Other indicators such as Central Bank Independence Index is sourced from Romelli (2022) and data on policy frameworks are collected from Anginer and others (2019). For more on the definitions, please refer to Annex Table 1.

[11] We also winsorize the (log(Z-score) at the 2 percent level (1 percent in each tail) to mitigate the impact of outliers.

Table 2: Summary Statistics of Main Regression Variables

Variable	Number of Observations	Mean	Median	Standard Deviation	Minimum	Maximum
z-score						
z-score (log units)	74,052	4.2	4.2	1.3	0.9	7.8
Risk-adjusted ROA (standardized)	75,265	0.0	-0.3	1.0	-0.4	6.8
Risk-adjusted E/A (standardized)	75,265	0.0	-0.3	1.0	-0.4	6.9
FinTech						
FinTech (in billions, US$)	87,384	22.4	4.4	33.3	0.0	356.8
FinBigTech (in billions, US$)	87,840	25.9	4.5	54.7	0.0	600.2
P2P lending (in billions, US$)	75,738	15.0	8.7	25.9	0.0	327.3
Balance Sheet lending (in billions, US$)	60,791	11.7	5.3	12.5	0.0	36.7
Other FinTech (in billions, US$)	87,263	1.2	0.6	1.3	0.0	7.1
FinTech-to-GDP (percent)	87,384	0.1	0.1	0.2	0.0	3.4
FinTech (log units)	87,384	20.9	22.2	4.1	7.2	26.6
FinBigTech (log units)	87,840	21.1	22.2	4.1	7.2	27.1
P2P lending (log units)	75,738	21.3	22.9	3.2	9.3	26.5
Balance Sheet lending (log units)	60,791	21.5	22.4	2.8	6.2	24.3
Other FinTech (log units)	87,263	18.9	20.3	3.2	6.5	22.7
Bank-controls						
Total assets (in billions, US$)	84,897	2.8	0.1	11.3	0.0	88.9
Total assets (log units)	84,897	11.6	11.4	2.6	5.6	18.3
Equity-to-Asset ratio (percent)	84,831	16.2	11.6	15.7	2.2	94.1
Non-Interest Income-to Average Assets (percent)	84,530	1.8	1.0	3.5	-0.2	27.5
Total Capital Ratio (percent)	21,628	26.4	18.2	29.1	6.7	221.1
Net Loans to Total Deposits and Borrowing (percen	72,381	67.6	66.7	31.6	2.6	226.3
Macro-controls						
GDP growth (percent)	91,503	1.5	2.2	2.7	-11.1	25.3
GDP per capita (log units)	91,503	10.6	10.9	0.6	7.7	11.5
Inflation (percent)	91,335	2.4	1.8	3.0	-2.1	53.5
Policy rate (percent)	88,663	2.3	0.6	4.3	-0.8	59.3
Concentration (percent)	90,992	59.3	47.6	18.1	31.9	100.0
Institutions						
Central Bank Independence (index)	60,618	0.6	0.6	0.2	0.2	0.9
Rule of Law (index)	91,503	79.4	89.9	21.3	11.3	100.0
Policy frameworks						
Supervision (index)	91,035	0.6	0.7	0.1	0.2	0.8
Regulatory capital requirements (percent)	91,035	8.3	8.0	0.9	8.0	16.0
Activity Restriction Index (index)	91,035	0.4	0.5	0.2	0.0	0.9
Multiple Supervisors (index)	91,503	0.6	1.0	0.5	0.0	1.0

Source: Authors calculations.

V. Empirical Results

We now present our main results beginning with a discussion of our baseline specification along with several robustness exercises. The next sub-section then explores how risk taking by different types of FIs (for example, banks versus NBFIs) are differentially influenced by selected FinTech business models. The effects of bank-, industry- and country-level characteristics on the interplay between the growing FinTech presence and risk-taking is considered in the following sub-section.

A. Baseline specification

Overall, our initial results indicate that greater FinTech presence is associated with heightened risk taking across the financial system. Specifically, as shown in Table 3 (column 1), using the baseline specification, we find a negative, and statistically significant, relationship between the FinTech variable and the z-score. That is, as the presence of FinTech activities increases (as captured by the total volume of transactions), risk taking (as measured by the z-score) by traditional FIs tends to rise. This finding provide support for the "competition-fragility" hypothesis, which assets that greater competition within the financial system leads to more risk taking by individual FIs (see for instance, Allen and Gale, 2004). Of note, our cross-country findings differ from other studies, which typically consider single country cases (primarily China), arguing that the expansion of FinTech firms is linked with lower bank risk taking (which is more in line with the "competition-stability" hypothesis).[12]

1) Robustness Analysis

This inverse relationship by FinTech presence and risk taking appears robust. In particular, we consider alternative measures of the FinTech variable: we either scale it by GDP (to assess the relative importance relative to the size of the economy) or combined with BigTech transactions (based on the work by Cornelli and others, 2023).[13] Following Beck, De Jonghe, and Schepens (2013) we also augment our baseline regressions by including variables that capture the revenue mix (share of non-interest income-to-total-income), provisioning ratio (loan loss provisions-to-assets) and loan-to- asset ratio to help better account for differences in business models given the comprehensive nature of our dataset, which includes over 10,000 different FIs of varying types. As shown in Table 3 (columns 2-6), the relationship between risk taking and FinTech remains intact.

2) What about endogeneity?

We recognize the possible occurrence of endogeneity concerns, such as situations associated with omitted variable bias and reverse causation. Recall that our empirical strategy surmised that risk taking by an individual financial institution could not materially influence country-level Fintech activities. Nevertheless, to address potential endogeneity issues we conduct additional robustness checks. We begin by tackling the possibility of omitted variable bias which could stem from not adequately controlling for the structure of the financial system or variations in policy frameworks across countries that could influence the relationship between Fintech activities and FI risk taking. We therefore consider several additional control variables including the Financial Development Index (see Annex Table 1 for details), reflecting countries' rankings based on financial institutions and market depth, access, and efficiency (Sahay and others, 2015). Investment Freedom measures investor protection, treatment of foreign investment, and expropriation risks, among others (Heritage Foundation, 2023). Government Effectiveness gauges public service quality, civil service independence, policy formulation and

[12] See, for example, Hu, Zhao, and Yang (2022) as well as Fung and others (2020).

[13] Note that BigTech data is not granular (that is, there is no breakdown according to business models) and so not used extensively in our study.

implementation effectiveness, and government commitment credibility (Kaufmann and Kraay, 2023). Financial Freedom (Heritage Foundation, 2023) captures state intervention in the financial system, including the extent of government ownership, which is relevant for many countries given the prevalence of, for example, state-owned banks across countries (World Bank, 2012). Additionally, we consider tightening and loosening actions of various macroprudential policy instruments (Alam and others, 2019). The results in Table 4 include the baseline specification (column 1) and the alternative specifications which include these variables (columns 2-7). Importantly, note the robustness of the main result: the statistically significant negative relationship between Fintech activities and FI risk taking.

To address reserve causality concerns, we employ two complementary approaches[14]. First, we re-estimate the relationship using instrumental variables estimation (for instance using 2SLS). We consider two distinct instruments: (1) mobile cellular subscriptions and (2) the total volume of FinTech transactions in all countries except the one under consideration ($FinTech_{-c,t}$). The mobile cellular subscriptions instrument is useful in its own right, but also serves as a proxy for internet penetration and can capture variations in internet accessibility across countries. Our assumption is that a higher proportion of the population with mobile telephone usage and/or internet access correlates with increased FinTech transactions, and vice versa. The results from this regression closely align with our baseline model (Table 4, column 8). Moreover, the inclusion of $FinTech{-}c,t$ as an instrument enables us to construct a FinTech variable that would not be (directly) influenced by domestic factors. This approach aims to better examine the impact of FinTech transactions beyond a specific country's borders, mitigating potential biases from factors like mergers, acquisitions, or partnerships between FinTech entities and established institutions within the country. The result of this specification is presented in Table 4 under column 9. In fact, the coefficient determining the impact of greater FinTech presence on risk taking (–0.48) suggests an economically significant relationship. In particular, a one percentage point increase in (log) FinTech transactions is associated with a decrease in the z-score of 0.5, where the median and standard deviation of the z-score is 4.2 and 1.3, respectively. At the same time, estimates from the other regressions are smaller, but noteworthy given the rapid growth of FinTech over the past decade.

Second, to tackle the challenges posed by endogeneity in the context of unobserved differences among a diverse set of FIs, we utilize GMM estimation following the approach of Arellano and Bover (1995) as well as Blundell and Bond (1998). This method addresses potential biases originating from dissimilar, for example, corporate governance structures, and other latent variables in addition, GMM estimation helps account for the limited number of time periods amid a substantial number of individual financial institutions. The results of this approach are presented in Table 4 (column 10) and underscore the robustness of our baseline results.

3) **Decomposing the z-score**

As in Lepetit and others (2008), we decompose the z-score into two additive components to shed some light on the relative importance of each. Specifically, instead of the z-score, we concentrate on its two additive components: the risk-adjusted profitability (return on assets, ROA) and capitalization (equity-to-assets) ratios. The z-score is replaced by each component using the baseline specification and the results are shown in Table 5 (columns 2-5). To facilitate interpretation, the components on the FinTech variable are also standardized (so the units are now standard deviations). Corroborating our earlier findings, we find a negative correlation with each component (and with roughly the same magnitudes).

[14] In the penultimate section of the paper, we explore the role of institutions, regulatory environment, and supervisory frameworks in greater detail.

Table 3: Baseline and Robustness Regressions

Variable	(1) **z-score** (log units)	(2) **z-score** (log units)	(3) **z-score** (log units)	(4) **z-score** (log units)	(5) **z-score** (log units)	(6) **z-score** (log units)
FinTech (log units)	-0.0139**			-0.0254***	-0.0136**	-0.0133**
	(0.00639)			(0.00656)	(0.00648)	(0.00638)
FinTech to GDP		-0.0882***				
		(0.0299)				
FinBigTech (log units)			-0.0150***			
			(0.00572)			
FinTech (standardized)						
Loan Loss Provisions to Net Int. Revenue				-0.00627***		
				(0.000297)		
Loan-to-Assets ratio					0.000737	
					(0.000669)	
Revenue mix						-0.00218***
						(0.000649)
Size (log assets)	0.246***	0.247***	0.259***	0.268***	0.248***	0.244***
	(0.0315)	(0.0315)	(0.0307)	(0.0309)	(0.0311)	(0.0304)
Equity-to-assets	0.00980***	0.00989***	0.00986***	0.0101***	0.0106***	0.00971***
	(0.00149)	(0.00149)	(0.00146)	(0.00163)	(0.00162)	(0.00152)
GDP growth	-0.0110**	-0.00841	-0.0101*	-0.00737	-0.00970*	-0.0110**
	(0.00539)	(0.00546)	(0.00538)	(0.00549)	(0.00543)	(0.00538)
Inflation	-0.00735**	-0.00660*	-0.00755**	-0.00454	-0.00669*	-0.00714**
	(0.00357)	(0.00357)	(0.00347)	(0.00357)	(0.00362)	(0.00356)
GDP per capita	1.311***	1.160***	1.345***	1.264***	1.308***	1.316***
	(0.277)	(0.29)	(0.273)	(0.281)	(0.28)	(0.277)
Policy rate	-0.00365	-0.00019	-0.00178	-0.00519	-0.00331	-0.00408
	(0.00384)	(0.00383)	(0.00348)	(0.00389)	(0.00385)	(0.00384)
Concentration	-0.000829	-0.00147	-0.000764	-0.00309**	-0.00109	-0.000908
	(0.00122)	(0.00121)	(0.00122)	(0.00123)	(0.00123)	(0.00122)
N	70,578	70,578	70,864	67,977	69,849	70,536
rho	0.64	0.63	0.65	0.63	0.64	0.64
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 4: Baseline and Robustness Regressions

Variable	(1) z-score (log units)	(2) z-score (log units)	(3) z-score (log units)	(4) z-score (log units)	(5) z-score (log units)	(6) z-score (log units)	(7) z-score (log units)	(8) 2SLS 1/ z-score (log units)	(9) 2SLS 2/ z-score (log units)	(10) GMM z-score (log units)
FinTech (log units)	-0.0139**	-0.0126**	-0.0194***	-0.0189***	-0.0237***	-0.0139**	-0.0173**	-0.0922***	-0.480***	-0.0752***
	(0.00639)	(0.00637)	(0.00714)	(0.00637)	(0.00647)	(0.00638)	(0.00714)	(0.0175)	(0.0386)	(0.0118)
Government Effectiveness		0.00757***					0.00482**			
		(0.00209)					(0.00220)			
Financial Development			0.507				0.428			
			(0.464)				(0.469)			
Investment Freedom				-0.00594***						
				(0.00124)						
Financial Freedom					-0.0143***					
					(0.00172)					
Macroprudential Policy						0.000156	-0.000892			
						(0.00309)	(0.00402)			
Size (log assets)	0.246***	0.244***	0.276***	0.245***	0.237***	0.246***	0.275***	0.252***	0.280***	0.322***
	(0.0315)	(0.0315)	(0.0356)	(0.0314)	(0.0313)	(0.0315)	(0.0357)	(0.0184)	(0.0199)	(0.0479)
Equity-to-assets	0.00980***	0.00967***	0.0107***	0.00980***	0.00979***	0.00980***	0.0106***	0.00953***	0.00818***	0.0425***
	(0.00149)	(0.00149)	(0.00157)	(0.00149)	(0.00149)	(0.00149)	(0.00156)	(0.00100)	(0.00109)	(0.00978)
GDP growth	-0.0110**	-0.00851	-0.0274***	-0.00444	-0.00223	-0.0110**	-0.0266***	-0.0192***	-0.0601***	0.0225***
	(0.00539)	(0.00545)	(0.00743)	(0.00540)	(0.00539)	(0.00539)	(0.00745)	(0.00477)	(0.00625)	(0.00309)
Inflation	-0.00735**	-0.00599*	-0.0122***	-0.00722**	-0.00561	-0.00737**	-0.0116***	-0.0145***	-0.0502***	-0.0278***
	(0.00357)	(0.00354)	(0.00397)	(0.00357)	(0.00357)	(0.00357)	(0.00395)	(0.00324)	(0.00467)	(0.00485)
GDP per capita	1.311***	0.927***	1.505***	1.332***	1.491***	1.311***	1.247***	1.012***	-0.470*	0.951***
	(0.277)	(0.297)	(0.342)	(0.276)	(0.275)	(0.277)	(0.364)	(0.196)	(0.247)	(0.0784)
Policy rate	-0.00365	-0.00501	-0.00615	0.00211	0.00868**	-0.00364	-0.00731*	-0.0194***	-0.0974***	-0.0171***
	(0.00384)	(0.00383)	(0.00426)	(0.00389)	(0.00392)	(0.00383)	(0.00428)	(0.00466)	(0.00843)	(0.00456)
Concentration	-0.000829	-0.00113	-0.00167	-0.00212*	-0.00237*	-0.000844	-0.00178	0.000835	0.00908***	-0.00664***
	(0.00122)	-0.00123	-0.00131	-0.00123	-0.00122	-0.00126	-0.00133	-0.00096	(0.00126)	(0.00255)
N	70,578	70,578	61,729	70,578	70,578	70,578	61,729	70,578	70,578	70,687
rho	0.64	0.62	0.69	0.63	0.64	0.64	0.68	0.63	0.85	
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

1/ Instrumental Variable = Mobile Subscriptions

2/ Instrumental Variable = Total volume of FinTech transactions in all countries except the country under consideration.

Table 5: Baseline and Robustness Regressions

Variable	(1) **z-score** (log units)	(2) **Risk-adjusted ROA**	(3) **Risk-adjusted ROA** (standardized)	(4) **Risk-adjusted E/A**	(5) **Risk-adjusted E/A** (standardized)
FinTech (log units)	-0.0139**	-0.313***		-4.996**	
	(0.00639)	(0.110)		(2.144)	
FinTech (standardized)			-0.0604***		-0.0453**
			(0.0212)		(0.0195)
Size (log assets)	0.246***	1.344***	0.0635***	33.03***	0.0733***
	(0.0315)	(0.497)	(0.0235)	(10.14)	(0.0225)
Equity-to-assets	0.00980***	-0.0196	-0.000927	-0.254	-0.000564
	(0.00149)	(0.0152)	(0.00072)	(0.299)	(0.000665)
GDP growth	-0.0110**	-0.346***	-0.0163***	-3.561**	-0.00791**
	(0.00539)	(0.0902)	(0.00426)	(1.749)	(0.00388)
Inflation	-0.00735**	16.68***	-0.00845***	-2.422***	-0.00538***
	(0.00357)	(4.728)	(0.00167)	(0.711)	(0.00158)
GDP per capita	1.311***	0.211***	0.788***	289.6***	0.643***
	(0.277)	(0.0554)	(0.223)	(86.64)	(0.192)
Policy rate	-0.00365	0.0696***	0.00995***	1.101	0.00244
	(0.00384)	(0.0265)	(0.00262)	(1.079)	(0.00239)
Concentration	-0.000829		0.00328***	0.0627	0.000139
	(0.00122)		(0.00125)	-0.513	(0.00114)
N	70,578	71,672	71,672	71,672	71,672
rho	0.64	0.58	0.58	0.55	0.55
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

B. FinTech business models and risk taking across types of FIs

We now investigate the differential effect of selected FinTech business models on different types of traditional FIs. Given their prevalence, we focus on the P2P and Balance Sheet (lending) FinTech business models. As for traditional FIs, we have NBFIs and banks, the latter of which is further split into cooperative and commercial banks. The results are summarized in Table 6 (Panel A). For detailed results, refer to Annex Table 5, Sub table 1- 5.

Two key results stand out. First, commercial bank risk taking is more adversely affected by a greater presence of FinTechs operating a balance sheet lending model. Second, and interestingly, risk taking by cooperative banks is only influenced by FinTech focusing on the P2P model. Notice that in both cases, the results are highly statistically significant. These findings present novel evidence that favors the competition-fragility hypothesis which argues that greater competition—in this case associated with greater FinTech activity—leads to more bank risk taking. Moreover, we show that this is the case for NBFI too, a noteworthy contribution to the literature primarily focused on banks.

1) Decomposing the z-score

To shed further light on these results, we again decompose the risk-taking measure. Table 6 (Panel B) displays the relationship between these components and the same FinTech business models. (For detailed results, refer to Annex Table 5, Sub table 6-10). This decomposition reveals a noteworthy pattern: There is a negative (and statistically significant) relationship between the prevalence of FinTechs operating balance sheet models and risk-adjusted profits for all traditional FIs considered in aggregate (notice the coefficient of -0.0866). Similar results hold for the different types of FIs: NBFIs as well as cooperative and commercial banks.

Table 6 (Panel B) points to additional granular insights. Recall that using the z-score did not reveal a statistically significant relationship between cooperative bank risk taking and the balance sheet lending business model (Table 6, Panel A). However, the z-score decomposition uncovers a negative correlation between this aforementioned business model and risk-adjusted cooperative bank profitability (with a coefficient of -0.097), pointing to an important channel. This finding is likely related to the fact that the balance sheet lending model is the closest to the business model pursued by traditional banks, competing directly with cooperative banks, and so may foster greater risk taking by these FIs. These results are consistent with the competition-fragility hypothesis, whereby greater competition from FinTech operating the balance sheet business model could be eroding the market power of traditional banks, their profit margins, and hence, their franchise values, which would then potentially encourage greater risk taking (Demsetz, Saidenberg and Strahan, 1996; Berger, Klapper and Rima Turk-Ariss, 2008). In fact, some of the most weakly capitalized banks (possibly as a result of persistent weak profitability), would be more inclined to gamble for resurrection (IMF, 2014).

Commercial banks seem to come under pressure primarily from the activities of FinTech operating balance sheet lending models (both profits and capitalization are adversely affected). In contrast, while not statistically significant, the positive correlation (gauged with the coefficient 0.0145) between commercial bank (risk-adjusted) profits and P2P FinTech activities may suggest that these (larger) banks may be benefitting from partnerships with these types of Fintech firms. In contrast, cooperative bank profitability is adversely affected by

the emergence of P2P models. Such FinTechs may be able to better target underserved and/or less creditworthy borrowers, including via effective online marketing, and thereby undercutting the market share of cooperative banks. Likewise, many (smaller, possibly regional) cooperative banks may find it difficult to afford the necessary IT investments to meet customer expectations, particularly among younger generations who are more inclined to use digital banking services and may not have strong attachments to community-oriented institutions (Coelho and others, 2019).

In summary, we find evidence that suggests a robust relationship between greater FinTech presence and elevated risk taking across the financial system. These results are further reinforced by a more detailed inspection focusing on selected business models employed by FinTech firms and various types of traditional FIs. Taken together, we present novel evidence supporting the competition-fragility hypothesis. However, previous research has emphasized the possibility of non-linear relationships. Motivated by these studies, we build on the literature by exploring how bank-, industry- and country-characteristics may influence the link between FinTech and risk taking.

Table 6.A: Summary: Effect of FinTech Business Models and Risk Taking Across Types of FIs 1/

Financial Institution	FinTech	P2P	B/S	Other
All	-0.0139**	-0.0105**	-0.00121	-0.0281***
Banks	-0.0108	-0.00741	0.00325	-0.0305***
Commercial Banks	-0.00459	0.000537	-0.0301***	-0.0233**
Cooperative Banks	-0.00766	-0.0436***	0.0143	-0.0284
Non-Banks	-0.0420**	-0.0304**	-0.0208	-0.0296*

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

1/ Both risk taking and business model variables are expressed in log units.

Table 6.B: Summary: Effect of FinTech Business Models and Risk Taking Across Types of FIs 1/

Financial Institution	Variable	FinTech	P2P	B/S	Other
All	ROA /2	-0.0604***	-0.0590***	-0.0866***	-0.0746***
	E/A /3	-0.0453**	-0.0640***	-0.0153	-0.0593***
Banks	ROA	-0.0535**	-0.0631***	-0.0986***	-0.0888***
	E/A	-0.0344	-0.0686***	-0.0188	-0.0675***
Commercial Banks	ROA	-0.027	0.0145	-0.0843***	-0.0616**
	E/A	-0.0672**	-0.0108	-0.0561***	-0.0661***
Cooperative Banks	ROA	-0.0944	-0.251***	-0.0970**	-0.0726
	E/A	0.107	-0.233***	-0.0156	-0.0224
Non-Banks	ROA	-0.101*	-0.0485	-0.0460*	-0.0336
	E/A	-0.137***	-0.0827**	-0.017	-0.0544

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

1/ Both risk taking and business model variables are standardized.

2/ Refers to risk-adjusted ROA.

3/ Refers to risk-adjusted E/A.

C. Effect of FinTech on Risk Taking Based on Selected Country and Bank-Specific Characteristics

In this section, we consider how the relationship between growing FinTech presence and risk taking across FIs changes depending on selected bank-, industry-, and country-specific characteristics.

1) The Role of Bank and Industry-Specific Characteristics

With the need to recognize data limitations, at the bank level, we consider capitalization levels, a liquidity ratio, and the share of non-interest income (see Table 7 for details). Higher capital buffers, while capable of absorbing losses, might influence risk taking behavior- either by encouraging it to leverage the greater loss absorbing capacity or by promoting a more conservative approach to protect franchise value, aligning with the insights of Demsetz, Saidenberg, and Strahan (1996). Similarly, a lower liquidity ratio, reflected in the loan-to-deposit ratio, may signal heightened risk exposure due to increased non-performing loans resulting from riskier lending practices, or it might denote a more selective approach to lending, reducing risk by choosing borrowers more cautiously[15]. A greater share of non-interest income could be a sign of an increased appetite for risk as banks venture into areas where they have little expertise in the search for new revenue streams, or, again, more selective lending, and thus more conservative income from a more prudent lending practice.

We also consider the degree of bank concentration in the domestic financial system. This is a classic measure associated with competition and has been used in earlier studies to discern between the competition-fragility and competition-stability hypotheses. Boyd and De Nicoló (2005) argue that concentrated banking systems enhance market power, which allows banks to boost the interest rate they charge to firms. These higher interest rates may induce firms to assume greater risk. Further, highly concentrated markets may lead to more risk taking if the institutions believe that they are too big to fail and are more likely to be explicitly or implicitly protected by the government safety net (Berger, Klapper and Rima Turk-Ariss, 2008). On the other hand, more competition can enhance financial stability by lowering loan rates, decreasing borrower credit risk, and reducing bank failure risk.

The results indicate that raising banks' liquidity and capitalization ratios, as well as their share of non-interest income, results in a lower degree of less risk taking. As shown in Table 5, the interaction terms involving the liquidity, capital, and noninterest-to-total income ratios are all positive and statistically significant. This means that changing these bank-specific indicators can attenuate the impact of FinTech presence on risk taking. Interestingly, a similar result is found in the case of the concentration variable: the interaction term is positive and statistically significant as well (Table 7). This result echoes the reasoning put forth by Martinez-Miera and Repullo (2010). They note that in less concentrated financial systems—which tend to be more competitive—the entrance of new financial institutions could lead to an erosion of margins and buffers to cover loans losses, resulting in riskier banks (consistent with the competition-fragility hypothesis). However, in highly concentrated markets, greater competition, through the entry of new FIs—including FinTechs—can lower loan rates, reduce credit risk, and foster stability (in line with the competition-stability hypothesis). In summary, our results suggest a novel non-linear relationship between competition and financial stability depending on bank-specific characteristics and the degree of competition in the financial system.

[15] Owing to data limitations, the loan-to-deposit ratio was used as the liquidity indicator.

2) The Role of Institutions

At the country level, we use two indicators to gauge the quality of domestic institutions. The first is the rule of law index by Kaufmann and Kraay (2023), which captures, inter alia, property rights and the quality of contract enforcements. The second is the central bank independence index (Romelli, 2022) which measures the degree to which a country's central bank can make monetary policy decisions without interference from the government or political pressures. Focusing on the latter, a more independent central bank could imply more effective supervision, which could result in less risk taking, or it may encourage some financial operations to creep outside of the regulatory perimeter thus resulting in more risk taking.

The results indicate that greater FinTech presence may result in *less* risk taking amid stronger institutions. As displayed in Table 7, the interaction terms related to the rule of law and central bank independence indicators are positive, statistically significant. In the context of the rule of law measure, we get a positive and statistically significant *net* effect[16]. Although the baseline results indicate that growing FinTech activities are associated with more risk taking, in some instances, the sign of this relationship may switch depending on the strength of domestic institutions. In terms of contributions to the literature, this finding introduces a new angle on the debate between the competition-fragility versus the competition-stability hypotheses: the validity of the hypothesis depends on country-specific institutional features. More generally, these results tend to support to policy recommendations pointing to the importance of enhancing domestic institutions. In this case, the importance of the rule of law (and accordingly property rights and contract enforcement) and the independence of the central bank. While role of the latter may not be immediately apparent, recall that for many countries, the mandate for bank regulation and supervision lies with the central bank. Hence, central bank independence is not just critical for effective monetary policy, but also for safeguarding financial stability.

[16] Although not shown for brevity, these results are available upon request.

Table 7: Summary: Effect of FinTech on Risk Taking based on selected bank and country-specific characteristics

Variable	(1) z-score (log units)	(2) z-score (log units)	(3) z-score (log units)	(4) z-score (log units)	(5) z-score (log units)	(6) z-score (log units)
FinTech (log units)	-0.0191***	-0.0226***	-0.0172***	-0.0176***	-0.0308***	-0.0556***
	(0.00691)	(0.00803)	(0.00664)	(0.0065)	(0.00681)	(0.0107)
aboveMedian_nonic	-0.231**					
	(0.103)					
Fin*aboveMediannonic	0.00861*					
	(0.00479)					
aboveMedian_capital		-0.172				
		(0.142)				
Fin*aboveMediancapital		0.0127*				
		(0.00732)				
lessMedian_loantodep			-0.215**			
			(0.104)			
Fin*lessMedianloantodep			0.0101**			
			(0.00461)			
lessMedian_concentration				-0.492***		
				(0.166)		
Fin*lessMedianconcentration				0.0159**		
				(0.007)		
aboveMedian_ruleoflaw					-0.858***	
					(0.287)	
Fin*aboveMedianruleoflaw					0.0557***	
					(0.0136)	
aboveMedian_centralbankindependence						-0.568***
						(0.197)
Fin*aboveMediancentralbankindependence						0.0322***
						(0.0102)
Size (log assets)	0.242***	0.251***	0.249***	0.250***	0.252***	0.208***
	(0.0315)	(0.0316)	(0.0315)	(0.0316)	(0.034)	(0.0371)
Equity-to-assets	0.00977***	0.00976***	0.00981***	0.00986***	0.00908***	0.00574***
	(0.00149)	(0.00149)	(0.0015)	(0.00149)	(0.00151)	(0.00156)
GDP growth	-0.0109**	-0.0121**	-0.0106**	-0.0167***	-0.00103	0.00642
	(0.00538)	(0.00541)	(0.00539)	(0.0055)	(0.005530	(0.00574)
Inflation	-0.00739**	-0.00734**	-0.00737**	-0.00142	-0.00653*	-0.00519
	(0.00357)	(0.00357)	(0.00356)	(0.00361)	(0.00367)	(0.00376)
GDP per capita	1.295***	1.315***	1.315***	1.424***	1.627***	1.364***
	(0.277)	(0.277)	(0.278)	(0.278)	(0.278)	(0.282)
Policy rate	-0.00358	-0.00342	-0.00375	-0.00822**	0.00108	0.00864**
	(0.00384)	(0.00384)	(0.00384)	(0.00386)	(0.00389)	(0.00416)
Concentration	-0.000962	-0.000745	-0.00086	-0.00103	-0.00282**	-0.00102
	(0.00122)	(0.00122)	(0.00122)	(0.00121)	(0.00125)	(0.00129)
N	70,578	70,578	70,578	70,578	54,424	38,197
rho	0.64	0.65	0.64	0.65	0.70	0.67
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

3) Policy Frameworks

Motivated by the previous findings, we now investigate the role of policy frameworks. Following the work of Barth, Caprio, and Levine (2002); Barth, Caprio and Levine (2013); Beck, De Jonghe, and Schepens (2013); as well as Anginer and others (2019), we consider how capital requirements, regulatory restrictions, and the supervisory framework influence the relationship between FinTech presence and risk taking. The data is from the World Bank Regulation and Supervision Survey (BRSS) and based on the most recent 2019 survey. The capital requirements indicator is defined as the minimum capital requirement in a country and ranges from 8 percent to 16 percent in our sample of countries. Similar to the case of bank-specific capital ratios, higher requirements could be the result of the supervisor responding to riskier behavior, or it could be associated with less risk taking as banks want to preserve their franchise values. The activity restriction index measures regulatory impediments to banks engaging in securities markets, insurance, and real estate activities, along with engaging in nonfinancial businesses. The supervisory stringency index attempts to quantify the rigor of banking oversight and regulation. For these two indicators, a higher value could be a regulatory response to excessive risk taking, or it may be associated with lower risk taking as a result of, inter alia, effective supervision. The multiple supervisory agencies indicator variable takes on the value of unity if there are multiple supervisory agencies operating in a country. Multiple supervisory agencies could reduce risk taking as different supervisory approaches can result in complementary information (which would otherwise be neglected, Llewellyn, 1999), or, conversely, through regulatory arbitrage, could result in greater risk taking. Further, Agur (2013) shows that the negative impact of competition among multiple bank regulators arises only in the presence of a generally weak regulatory environment.

Because policy frameworks tend not change materially over time, these four indicator variables tend to be inertial. While the BRSS database has been updated recently, at the same time, these time series have not been updated since 2016. Hence, with the goal of distilling more granular insights, we use a complementary empirical approach. Namely, we split the sample of countries depending on whether they are above or below the median value of each indicator in 2012, and then run regressions for each group (“above” and “below”) for the years starting in 2013.

The results presented in Table 8 (for details, refer to Annex Table 5, Table 11), suggest that in the presence of stronger policy frameworks, growing FinTech activity may, in certain instances, be associated with *lower* risk taking. We consider four main takeaways. First, and interestingly, we find that countries with more stringent activity restrictions (with values above the sample median) are associated with greater risk taking. A similar finding is noted by Beck, De Jonghe, and Schepens (2013). A reason for this could be that excessively restrictive regulations may result in the migration of selected financial services outside of the regulatory perimeter, including, possibly, via partnerships with FinTechs. Second, amid lower minimum capital requirements, FinTech transactions and the z-score are inversely related, suggesting that increasing the regulatory capital ratios may curtain risk taking (including as franchise value increases). Indeed, Anginer and others (2021) found that an increase in capital requirements and regulatory capital holdings at financial institutions after the Global Financial Crisis coincided with a transition towards asset categories with reduced risk weights. Third, there is also a negative and statistically significant relationship between Fintech activities and risk taking in countries with a more lenient supervisory regime. A similar finding is found by Kandrac and Schlusche (2020) and Chronopoulos, Wilson, and Yilmaz (2023). This again hints that a more intrusive supervisory approach could be mitigating excessive risk taking. Fourth, in countries with multiple supervisory agencies, greater FinTech presence is characterized with *less* risk taking by traditional financial institutions.

These results suggest a policy trade-off: amid some regulatory and supervisory measures, more FinTech activity is associated with less risk taking. However, other measures (restrictions on bank activities) may result in more risk taking as FinTech activities expand. Therefore, striking the right balance between the extent of regulatory stringency and the degree of supervisory intrusiveness is key. In this context, benefitting from multiple supervisory approaches could help manage this trade-off. Overall, in countries with more robust regulatory and supervisory regimes, an expansion of FinTech activities need not result in heightened risk taking across FIs.

Table 8: Summary: Effect of FinTech on Risk Taking based on selected policy frameworks

Policy Framework	βFinTech (Below median)	βFinTech (Above median)
Supervisory Index	-0.0227**	0.00313
	(0.00958)	(0.0101)
Regulatory Capital	-0.0226**	-0.00865
	(0.00961)	(0.0167)
Activity Restriction	-0.0287**	-0.0209***
	(0.0152)	(0.00791)
Multiple Supervisory Agencies	-0.0227***	0.0781***
	(0.0075)	(0.0328)

Source: Authors calculations
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

VI. Conclusions and Policy Implications

Motivated by its rapid growth, this paper investigates how FinTech activities influence risk taking in the financial system. Notwithstanding the potential benefits, expanding FinTech activities will have implications for market structure and competition within the financial system.

Against the backdrop of the emergence of FinTech, this paper revisits the issue of competition and stability within a financial system. Two hypotheses have underpinned an ongoing debate: On one side, the competition-fragility hypothesis argues that greater competition results in the loss of market power and reduced profit margins, which encourages more risk taking by financial intermediaries, and therefore an increase in financial system fragility. On the other side of the debate, the competition-stability hypothesis argues that more competition can lower lending rates, and thereby credit risk, which subsequently supports financial system stability.

By investigating how the growth of FinTech influences risk taking across traditional FIs, we take a novel approach at assessing these two competing hypotheses. We do so by using a curated cross-country database, where we assess to what extent, and under what conditions, greater FinTech activities—and possibility the associated increase in competitive pressures within the financial system—results in more elevated financial sector risk taking.

We find a robust relationship whereby greater FinTech presence is associated with heightened risk taking by FIs, offering support for the competition-fragility hypothesis. We conducted several robustness checks, and the significance of our results remained consistent relative to the baseline estimates.

Leveraging the granularity of our database, we also uncover differential effects of selected FinTech business models on the different types of traditional FIs. For instance, whereas commercial bank risk taking is adversely affected by a greater presence of FinTechs operating a balance sheet lending model, cooperative banks are disproportionately influenced by P2P FinTechs. In both cases, a deterioration in profitability seems to be a key factor linked to increase in risk taking.

We then investigate how selected bank-, industry-, and country-specific characteristics affect the relationship between FinTech growth and FI risk taking. The results suggest that higher capitalization and liquidity ratios as well as greater income diversification can reduce the influence of growth FinTech activities on FI risk. Importantly, there is suggestive evidence indicating that in certain cases, greater FinTech presence may be associated with *less* FI risk taking amid stronger domestic institutions. These results help to reconcile some of the conflicting results in the literature which have found supportive evidence for each of the two competing hypotheses. Indeed, by highlighting the role of country specificities—including the role of institutions and policy frameworks—our paper provides a framework to rationalize both hypotheses in a unified manner.

These findings have notable policy implications. In general, robust institutions combined with strong policy frameworks can help reap the benefits of growing FinTech activities while safeguarding financial stability. In particular, regulatory frameworks should be underpinned by strong legal foundations, appropriately calibrated to country-specific conditions, and updated to encompass emerging FinTech activities. Additionally, rigorous supervision should be carried out by autonomous institutions, which in some countries may involve the central bank. These institutions should closely monitor financial institutions' risk taking behavior, especially in the

context of increasing FinTech activities. The presence of multiple supervisory agencies and/or approaches could be beneficial in ensuring comprehensive and effective oversight of the financial system.

VII. Annex Tables

Annex Table 1. Variable Names, Definition and Sources

Table 1: Variable Names, Definition and Sources

Variable	Description	Source
Dependent variables		
z-score	Log of ((Return on Assets + Equity-to-Assets)/s.d. Return on Assets)	Authors calculations using Bureau van Dijk Orbis database
Risk-adjusted ROA	Return on Assets/s.d. Return on Assets	Authors calculations using Bureau van Dijk Orbis database
Risk-adjusted E/A	Equity to Assets/s.d. Return on Assets	Authors calculations using Bureau van Dijk Orbis database
Explanatory variables		
FinTech	Log of (Total volume of digital lending and capital raising activities in US$)	Cambridge Center for Alternative Finance (2021)
P2P Lending	Log of (Total volume of P2P lending activities in US$)	Cambridge Center for Alternative Finance (2021)
Balance Sheet Lending	Log of (Total volume of Balance Sheet lending activities in US$)	Cambridge Center for Alternative Finance (2021)
Bank-controls		
Total assets	Log of (Total Assets)	Bureau van Dijk Orbis
Equity-to-Asset ratio	Equity to Total Assets (%)	Bureau van Dijk Orbis
Non-Interest Income-to Average Assets	Non-Interest Income-to Average Assets (%)	Bureau van Dijk Orbis
Total Capital Ratio	Total Capital Ratio (%)	Bureau van Dijk Orbis
Net Loans to Total Deposits and Borrowing	Net Loans to Total Deposits and Borrowing (%)	Bureau van Dijk Orbis
Macro-controls		
GDP growth	GDP, at constant prices, percent change (%)	IMF WEO Database (2023)
GDP per capita	Gross domestic product per capita, constant prices	IMF WEO Database (2023)
Inflation	Annual percentage of average consumer prices (%)	IMF WEO Database (2023)
Policy rate	Central Bank Policy rate (%)	Haver Database
Bank concentration	Assets of five largest banks to total bank assets (%)	Global Financial Development Database (2022)
Other Robustness Controls		
Government Effectiveness (index)	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	Kaufmann and Kraay (2023)
Financial Development (index)	A relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets.	Sahay and others (2023)
Investment Freedom (index)	National treatment of foreign investment, Foreign investment code, Restrictions on land ownership, Sectoral investment restrictions, Expropriation of investments without fair compensation, Foreign exchange controls, Capital controls.	Heritage Foundation (2023)
Financial Freedom (index)	The extent of government regulation of financial services, The degree of state intervention in banks and other financial firms through direct and indirect ownership, Government influence on the allocation of credit, The extent of financial and capital market development, and Openness to foreign competition.	Heritage Foundation (2023)
Macroprudential Policies	The sum of Macorprudential policy action indicators - Each tightening event is coded as +1, each loosening event is coded as -1 and no or neutral action is coded as a zero.	Alam and others (2019)
Instrumental Variables		
Mobile Subscriptions	Log of (Mobile cellular subscriptions (per 100 people))	World Development Indicators (2023)
Sum of all FinTech transactions leaving out the Country under consideration.	Log of (Total volume of FinTech transactions in all countries except the country under consideration).	Authors calculations using CCAF (2021)
Institutions		
Central Bank Independence (index)	A comprehensive index that captures a number central bank characteristics: governor and central bank board; monetary policy and conflicts resolution; objectives; limitations on lending to the government; financial independence; reporting and disclosure.	Romelli (2022)
Rule of Law (index)	Perceptions on the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	Kaufmann and Kraay (2023)
Policy frameworks		
Supervision (index)	Quality of supervision based on a number of questions: 12.1, 12.5, 12.10, 12.11, 12.12.2, 12.13, 12.14, 12.20, 12.27.	Authors calculations using Anginer and others (2019)
Regulatory capital requirements	Minimum required risk-based regulatory capital ratio (%)	Anginer and others (2019)
Activity Restriction Index (index)	Conditiions under which banks can engage in securities activities, insurance and real estate activities, along with engaging in nonfinancial businesses.	Authors calculations using Anginer and others (2019)
Multiple Supervisors (index)	Single or multiple body/agencies supervising banks for prudential purposes	Authors calculations using Anginer and others (2019)

Annex Table 2. Descriptive Statistics

Country	z-score (log units)	Risk-adjusted ROA	Risk-adjusted E/A	FinTech (log units)	FinTech (in billions, $US)	Total Assets (in billions, $US)	Total Capital ratio (percent)	Number of FIs
Albania	3.4	1.6	64.9	14.4	0.03	1.3	18.9	11
Argentina	2.6	4.5	32.3	16.7	0.04	2.1	24.8	56
Armenia	3.5	5.5	69.1	16.3	0.13	0.5	21.2	17
Australia	4.4	4.2	318.6	19.9	0.72	7.2	24.0	52
Austria	4.5	16.7	246.1	16.4	0.02	0.7	37.2	332
Belgium	3.6	24.1	230.1	16.6	0.05	5.5	18.5	35
Brazil	3.6	8.1	110.9	18.7	0.96	0.5	28.9	889
Bulgaria	3.6	3.0	56.0	16.3	0.03	1.5	19.0	4
Canada	4.1	16.9	253.2	19.4	0.39	16.8	35.9	81
Chile	4.0	12.4	128.6	18.6	0.24	11.0	28.7	29
China	4.5	25.0	291.2	24.5	127.12	28.0	23.0	211
Colombia	3.7	8.4	153.5	16.1	0.13	0.7	25.5	26
Czech Republic	3.8	9.6	136.8	16.3	0.04	3.2	23.3	18
Denmark	4.1	7.7	139.5	16.3	0.06	6.6	21.8	44
Estonia	3.5	6.2	56.2	17.5	0.08	0.7	21.7	5
Finland	4.9	8.1	239.6	18.4	0.19	1.0	47.6	121
France	4.0	18.0	295.5	19.7	0.64	6.1	29.2	160
Georgia	3.3	4.0	65.9	15.8	0.07	0.7	30.7	12
Germany	5.9	47.3	1036.2	19.7	0.64	3.3	20.7	525
Ghana	3.3	7.4	53.6	16.2	0.19	0.4	33.6	18
Hong Kong	4.3	17.6	281.7	16.7	0.16	18.9	35.4	43
India	4.0	5.5	143.7	18.8	0.68	5.9	22.9	68
Indonesia	4.0	9.4	149.4	17.9	0.58	1.7	27.7	109
Ireland	3.6	3.8	95.3	16.3	0.06	17.6	46.0	8
Israel	4.7	17.4	248.6	19.1	0.32	63.0	14.5	4
Italy	4.2	6.0	185.8	18.5	0.55	2.1	21.2	287
Japan	4.8	9.7	341.6	19.7	0.51	5.7	22.5	189
Kazakhstan	3.4	3.3	63.5	16.5	0.11	0.8	48.6	24
Kenya	3.4	1.6	50.4	17.0	0.03	0.9	25.7	16
Latvia	2.8	3.2	16.2	18.5	0.17	0.2	21.2	1
Malaysia	4.2	7.7	133.9	16.2	0.04	6.3	30.6	22
Mexico	3.2	3.2	73.2	17.8	0.20	0.8	40.5	234
Netherlands	4.0	8.8	236.3	19.4	0.67	11.6	31.8	22
New Zealand	4.2	15.0	385.1	18.5	0.20	9.0	27.6	17
Nigeria	3.3	0.3	53.5	15.9	0.01	1.2	45.3	13
Norway	4.5	10.8	161.2	14.7	0.02	3.5	20.6	86
Peru	3.6	5.7	108.0	15.2	0.04	1.3	21.0	44
Philippines	3.9	5.2	153.9	15.0	0.04	0.7	30.7	43
Poland	4.2	6.9	138.7	17.5	0.16	0.8	16.7	56
Republic of Korea	4.1	8.8	137.2	18.8	0.65	21.1	18.3	47
Republic of Moldova	3.7	3.3	61.9	14.8	0.06	0.4	42.5	9
Romania	3.4	0.5	126.5	13.9	0.01	1.8	30.0	12
Russian Federation	3.2	3.1	70.2	17.7	0.12	0.3	36.8	228
Singapore	4.3	12.3	127.5	18.6	0.29	19.0	18.8	4
Slovenia	3.0	1.5	46.9	16.8	0.04	1.0	15.1	6
South Africa	3.7	5.6	107.4	16.3	0.02	9.2	23.8	14
Spain	5.1	11.1	381.0	18.6	0.26	1.0	33.7	61
Sweden	4.7	11.4	191.5	18.5	0.14	6.2	23.7	74
Switzerland	5.3	21.8	555.2	17.1	0.04	15.5	24.4	18
Uganda	3.4	2.8	53.7	16.1	0.03	0.2	27.4	18
Ukraine	3.0	1.5	97.3	16.5	0.24	0.2	53.7	50
United Arab Emirates	3.8	9.4	103.8	16.7	0.04	26.1	20.2	15
United Kingdom	3.7	6.9	151.6	22.3	6.40	7.9	32.4	137
United Republic of Tanzania	3.6	4.7	91.2	15.7	0.03	0.2	19.4	21
United States of America	4.2	4.8	137.8	22.8	35.05	1.4	24.0	5436
Vietnam	3.9	9.7	138.5	13.5	0.02	1.2	15.6	72
Zambia	3.4	8.0	116.6	16.0	0.09	0.4	28.9	13
Average	**3.9**	**8.9**	**170.1**	**17.4**	**3.2**	**6.4**	**27.6**	**10,167 /1**

Source: Authors calculations using the Bureau van Dijk Orbis database and CCAF(2021) database

1/ Total Number of FIs

Annex Table 3. List of Countries included in the Sample.

Number	Country	Total Alternative Finance Volume 2012-2020 (in billions, $US)	Total Alternative Finance Volume 20120-2020 (% of GDP)
1	China	1,018.00	6.9
2	United States	315.7	1.5
3	United Kingdom	58	2.2
4	Brazil	7.7	0.5
5	Netherlands	6.1	0.7
6	France	5.8	0.2
7	Germany	5.8	0.2
8	Australia	5.7	0.4
9	India	5.6	0.2
10	Korea, Rep.	5.2	0.3
11	Indonesia	4.5	0.4
12	Italy	4.4	0.2
13	Japan	4.1	0.1
14	Canada	3.1	0.2
15	Israel	2.6	0.6
16	Singapore	2.4	0.7
17	Spain	2.2	0.2
18	Chile	1.9	0.8
19	Finland	1.7	0.6
20	Mexico	1.6	0.1
21	New Zealand	1.6	0.8
22	Sweden	1.5	0.3
23	Poland	1.5	0.2
24	Ghana	1.1	1.7
25	Colombia	1.1	0.4
26	Latvia	1	3
27	Ukraine	1	0.6
28	Hong Kong	0.8	0.2
29	Armenia	0.8	6.4
30	Estonia	0.7	2.4
31	Russian Federation	0.7	0
32	Georgia	0.6	3.7
33	Kazakhstan	0.5	0.3
34	Denmark	0.5	0.2
35	Zambia	0.5	2.8
36	Ireland	0.4	0.1
37	Belgium	0.4	0.1
38	Switzerland	0.4	0.1
39	Peru	0.4	0.2
40	Czech Republic	0.3	0.1
41	Philippines	0.3	0.1
42	Moldova	0.3	2.9
43	Malaysia	0.3	0.1
44	Argentina	0.3	0.1
45	United Arab Emirates	0.3	0.1
46	Kenya	0.3	0.3
47	Slovenia	0.3	0.5
48	Uganda	0.2	0.6
49	Norway	0.2	0.1
50	Tanzania	0.2	0.3
51	Austria	0.2	0
52	Vietnam	0.2	0.1
53	Bulgaria	0.2	0.3
54	Albania	0.2	1.1
55	South Africa	0.1	0
56	Romania	0.1	0
57	Nigeria	0.1	0

Source: Authors calculations using CCAF(2021) database.

Annex Table 4. Digital Lending and Capital Raising Activities Models and Definitions

Digital Lending Business Models	
P2P/Marketplace Lending	Individuals or institutional funders provide a loan to a consumer borrower, business borrower, or secured against a property, commonly ascribed to off-balance sheet lending.
Balance Sheet Lending	The platform entity provides a loan directly to the consumer borrower, business borrower, or secured against a property, ascribed to on-balance sheet nonbank lending.
Invoice Trading	Individuals or institutional funders purchase invoices or receivables from a business at a discount.
Securities	Debt-based: Individuals or institutional funders purchase debt-based securities, typically a bond or debenture, at a fixed interest rate. Mini-bonds: Individuals or institutions purchase securities from companies in the form of an unsecured bond which is 'mini' because the issue size is much smaller than the minimum issue amount needed for a bond issued in institutional capital markets.
Consumer Purchase Finance/BNPL	A buy now/pay later payment facilitator or Store Credit solution.
Digital Capital Raising Business Models	
Equity-based	Individuals or institutional funders purchase equity issued by a company; provide equity or subordinated debt financing for real estate; purchase securities from a company, such as shares or bonds, and share in the profits or royalties of the business.
Non-Investment based	Backers provide funding to individuals, projects or companies in exchange for non-monetary rewards or products. Donors provide funding to individuals, projects or companies based on philanthropic or civic motivations with no expectation of monetary or material. Interests and/or other profits are re-invested (forgoing the interest by donating) or provides microcredit at lower rates.
Source: CCAF (2021).	

Annex Table 5. Detailed Regression Output Tables

Table 1: Effect of FinTech Business Models and Risk Taking Across All FIs

Variable	(1) z-score (log units)	(2) z-score (log units)	(3) z-score (log units)	(4) z-score (log units)
FinTech (log units)	-0.0139**			
	(0.00639)			
P2P Lending (log units)		-0.0105**		
		(0.00524)		
Balance Sheet Lending (log units)			-0.00121	
			(0.00578)	
Other FinTech (log units)				-0.0281***
				(0.00739)
Size (log assets)	0.246***	0.245***	0.236***	0.245***
	(0.0315)	(0.0334)	(0.0369)	(0.0316)
Equity-to-assets	0.00980***	0.00954***	0.0112***	0.00974***
	(0.00149)	(0.00160)	(0.00202)	(0.00149)
GDP growth	-0.0110**	-0.0124**	-0.0349***	-0.0122**
	(0.00539)	(0.00575)	(0.00734)	(0.00540)
Inflation	-0.00735**	0.00231	-0.00171	-0.00664*
	(0.00357)	(0.00486)	(0.00524)	(0.00357)
GDP per capita	1.311***	1.652***	2.196***	1.094***
	(0.277)	(0.299)	(0.391)	(0.285)
Policy rate	-0.00365	-0.0104**	-0.0230***	-0.00268
	(0.00384)	(0.00407)	(0.00468)	(0.00382)
Concentration	-0.000829	0.00426**	0.00232	-0.000596
	(0.00122)	(0.00170)	(0.00275)	(0.00122)
N	70,578	67,454	57,013	70,551
rho	0.64	0.68	0.77	0.62
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 2: Effect of FinTech Business Models and Risk Taking Across Banks

Variable	(1) z-score (log units)	(2) z-score (log units)	(3) z-score (log units)	(4) z-score (log units)
FinTech (log units)	-0.0108			
	(0.00704)			
P2P Lending (log units)		-0.00741		
		(0.00565)		
Balance Sheet Lending (log units)			0.00325	
			(0.00659)	
Other FinTech (log units)				-0.0305***
				(0.00828)
Size (log assets)	0.240***	0.243***	0.251***	0.238***
	(0.0353)	(0.0371)	(0.0425)	(0.0354)
Equity-to-assets	0.0121***	0.0118***	0.0152***	0.0120***
	(0.00185)	(0.00197)	(0.00256)	(0.00186)
GDP growth	-0.00854	-0.0106*	-0.0371***	-0.0100*
	(0.00599)	(0.00642)	(0.00819)	(0.00600)
Inflation	-0.00757*	0.00014	-0.00538	-0.00697*
	(0.00399)	(0.00599)	(0.00651)	(0.00399)
GDP per capita	1.678***	2.112***	2.658***	1.411***
	(0.302)	(0.327)	(0.438)	(0.312)
Policy rate	-0.00443	-0.0112**	-0.0264***	-0.00423
	(0.00458)	(0.00486)	(0.00571)	(0.00449)
Concentration	-0.00113	0.00360*	0.00164	-0.000696
	(0.00129)	(0.00184)	(0.00294)	(0.00129)
N	64,957	62,291	54,017	64,937
rho	0.66	0.71	0.80	0.62
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 3: Effect of FinTech Business Models and Risk Taking Across Commercial Banks

Variable	(1) **z-score** (log units)	(2) **z-score** (log units)	(3) **z-score** (log units)	(4) **z-score** (log units)
FinTech (log units)	-0.00459			
	(0.00936)			
P2P Lending (log units)		0.000537		
		(0.00731)		
Balance Sheet Lending (log units)			-0.0301***	
			(0.0101)	
Other FinTech (log units)				-0.0233**
				(0.0101)
Size (log assets)	0.117**	0.102*	0.208**	0.117**
	(0.0493)	(0.0522)	(0.0883)	(0.0493)
Equity-to-assets	0.00261	-0.000336	0.00051	0.00249
	(0.00251)	(0.00288)	(0.00387)	(0.00251)
GDP growth	0.0206**	0.015	-0.0168	0.0181*
	(0.0101)	(0.0119)	(0.0160)	(0.0100)
Inflation	0.0032	0.00895	-0.00515	0.00312
	(0.00508)	(0.00763)	(0.00833)	(0.00504)
GDP per capita	1.692***	2.419***	3.244***	1.508***
	(0.444)	(0.503)	(0.583)	(0.452)
Policy rate	-0.00343	-0.00807	-0.00645	-0.00305
	(0.00601)	(0.00605)	(0.00641)	(0.00602)
Concentration	0.00238	0.00882***	0.00377	0.0025
	(0.00262)	(0.00328)	(0.00503)	(0.00259)
N	8,370	7,380	4,153	8,350
rho	0.77	0.86	0.93	0.73
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 4: Effect of FinTech Business Models and Risk Taking Across Cooperative Banks

Variable	(1) z-score (log units)	(2) z-score (log units)	(3) z-score (log units)	(4) z-score (log units)
FinTech (log units)	-0.00766			
	(0.0202)			
P2P Lending (log units)		-0.0436***		
		(0.0147)		
Balance Sheet Lending (log units)			0.0143	
			(0.0164)	
Other FinTech (log units)				-0.0284
				(0.0195)
Size (log assets)	0.269***	0.262***	0.237***	0.267***
	(0.0475)	(0.0482)	(0.0515)	(0.0473)
Equity-to-assets	0.0217***	0.0215***	0.0250***	0.0216***
	(0.00336)	(0.00337)	(0.00382)	(0.00335)
GDP growth	-0.0383***	-0.0392***	-0.0395*	-0.0401***
	(0.0107)	(0.0108)	(0.0214)	(0.0105)
Inflation	-0.0128	-0.0248	-0.00287	-0.0163
	(0.0140)	(0.0157)	(0.0214)	(0.0126)
GDP per capita	2.418***	2.320***	0.746	2.177***
	(0.784)	(0.629)	(1.676)	(0.654)
Policy rate	-0.0215**	-0.0202**	-0.0318***	-0.0203**
	(0.00982)	(0.00834)	(0.0120)	(0.00816)
Concentration	-0.00265	0.00199	0.00234	-0.00171
	(0.00170)	(0.00249)	(0.00429)	(0.00178)
N	52,593	51,357	47,807	52,593
rho	0.69	0.65	0.51	0.65
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 5: Effect of FinTech Business Models and Risk Taking Across Non-Banks

Variable	(1) **z-score** (log units)	(2) **z-score** (log units)	(3) **z-score** (log units)	(4) **z-score** (log units)
FinTech (log units)	-0.0420**			
	(0.0165)			
P2P Lending (log units)		-0.0304**		
		(0.015)		
Balance Sheet Lending (log units)			-0.0208	
			(0.0133)	
Other FinTech (log units)				-0.0296*
				(0.0166)
Size (log assets)	0.276***	0.261***	0.176**	0.272***
	(0.0595)	(0.0679)	(0.0690)	(0.0600)
Equity-to-assets	0.00654**	0.00626**	0.00388	0.00654**
	(0.00256)	(0.00271)	(0.00289)	(0.00255)
GDP growth	-0.00802	-0.00786	-0.0152	-0.00891
	(0.0147)	(0.0154)	(0.0192)	(0.0149)
Inflation	-0.00025	0.00656	-0.0000349	0.00235
	(0.00752)	(0.00817)	(0.00906)	(0.00757)
GDP per capita	0.266	0.403	1.995**	0.207
	(0.737)	(0.835)	(0.893)	(0.746)
Policy rate	-0.0015	-0.00583	-0.00562	0.000611
	(0.00741)	(0.00763)	(0.00875)	(0.00749)
Concentration	-0.000909	0.00523	0.00153	-0.00158
	(0.00367)	(0.00441)	(0.00728)	(0.00364)
N	5,621	5,163	2,996	5,614
rho	0.65	0.66	0.83	0.64
Bank Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes

Source: Authors calculations.

Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 6: Effect of FinTech Business Models and Risk Taking Across ALL FIs

Variable	(1) Risk-adjusted ROA (standardized)	(2) Risk-adjusted E/A (standardized)	(3) Risk-adjusted ROA (standardized)	(4) Risk-adjusted E/A (standardized)	(5) Risk-adjusted ROA (standardized)	(6) Risk-adjusted E/A (standardized)	(7) Risk-adjusted ROA (standardized)	(8) Risk-adjusted E/A (standardized)
FinTech (standardized)	-0.0604***	-0.0453**						
	(0.0212)	(-0.0195)						
P2P Lending (standardized)			-0.0590***	-0.0640***				
			(-0.0156)	(-0.0137)				
Balance Sheet Lending (standardized)					-0.0866***	-0.0153		
					(-0.0132)	(0.0119)		
Other FinTech (standardized)							-0.0746***	-0.0593***
							(0.019)	(0.0171)
Size (log assets)	0.0635***	0.0733***	0.0678***	0.0776***	0.0663***	0.0551**	0.0625***	0.0726***
	(0.0235)	(0.0225)	(0.0236)	(0.0229)	(0.0218)	(0.0221)	(0.0235)	(0.0226)
Equity-to-assets	-0.000927	-0.000564	-0.000939	-0.000867	-0.000691	-0.000894	-0.000987	-0.000608
	(0.000720)	(0.000665)	(0.000734)	(0.000682)	(0.000766)	(0.000716)	(0.000724)	(0.000668)
GDP growth	-0.0163***	-0.00791**	-0.0248***	-0.0141***	-0.0341***	-0.0178***	-0.0171***	-0.00857**
	(0.00426)	(0.00388)	(0.00461)	(0.00418)	(0.00590)	(0.00532)	(0.00426)	(0.00387)
Inflation	-0.00845***	-0.00538***	0.00627*	-0.00317	0.00313	0.00743***	-0.00761***	-0.00475***
	(0.00167)	(0.00158)	(0.00340)	(0.00315)	(0.00297)	(0.00261)	(0.00165)	(0.00156)
GDP per capita	0.788***	0.643***	0.804***	0.870***	1.428***	1.049***	0.633***	0.516***
	(0.223)	(0.192)	(0.242)	(0.207)	(0.367)	(0.304)	(0.227)	(0.196)
Policy rate	0.00995***	0.00244	-0.00217	-0.0036	-0.0157***	-0.0172***	0.0115***	0.00349
	(0.00262)	(0.00239)	(0.00323)	(0.00302)	(0.00387)	(0.00356)	(0.00256)	(0.00232)
Concentration	0.00328***	0.000139	0.00704***	0.00049	0.0028	0.00179	0.00347***	0.000308
	(0.00125)	(0.00114)	(0.00155)	(0.00156)	(0.00198)	(0.00201)	(0.00124)	(0.00112)
N	71,672	71,672	68,446	68,446	57,565	57,565	71,645	71,645
rho	0.58	0.55	0.59	0.59	0.79	0.71	0.55	0.53
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 7: Effect of FinTech Business Models and Risk Taking Across Banks

Variable	(1) Risk-adjusted ROA (standardized)	(2) Risk-adjusted E/A (standardized)	(3) Risk-adjusted ROA (standardized)	(4) Risk-adjusted E/A (standardized)	(5) Risk-adjusted ROA (standardized)	(6) Risk-adjusted E/A (standardized)	(7) Risk-adjusted ROA (standardized)	(8) Risk-adjusted E/A (standardized)
FinTech (standardized)	-0.0535**	-0.0344						
	(0.0243)	(0.0223)						
P2P Lending (standardized)			-0.0631***	-0.0686***				
			(0.0174)	(0.0153)				
Balance Sheet Lending (standardized)					-0.0986***	-0.0188		
					(0.0159)	(0.0143)		
Other FinTech (standardized)							-0.0888***	-0.0675***
							(0.023)	(0.0207)
Size (log assets)	0.0452*	0.0655**	0.0550**	0.0737***	0.0591**	0.0499*	0.0437*	0.0643**
	(0.0260)	(0.0266)	(0.0256)	(0.0267)	(0.0253)	(0.0257)	(0.026)	(0.0266)
Equity-to-assets	-0.000784	-0.000516	-0.00112	-0.00106	-0.000837	-0.000916	-0.000956	-0.000652
	(0.00102)	(0.000951)	(0.00107)	(0.000991)	(0.00103)	(0.000983)	(0.00103)	(0.000957)
GDP growth	-0.0205***	-0.00869*	-0.0310***	-0.0168***	-0.0448***	-0.0221***	-0.0216***	-0.00970**
	(0.00504)	(0.00460)	(0.00547)	(0.00498)	(0.00703)	(0.00632)	(0.00501)	(0.00455)
Inflation	-0.0104***	-0.00681***	0.00578	-0.00948**	0.00436	0.00996***	-0.00966***	-0.00632***
	(0.00189)	(0.00180)	(0.00464)	(0.00435)	(0.0042)	(0.00369)	(0.00188)	(0.00177)
GDP per capita	0.768***	0.744***	0.787***	1.070***	1.398***	1.235***	0.552**	0.573**
	(0.249)	(0.217)	(0.273)	(0.236)	(0.428)	(0.349)	(0.256)	(0.225)
Policy rate	0.0103***	0.00321	-0.00422	-0.0027	-0.0226***	-0.0231***	0.0113***	0.00357
	(0.00330)	(0.00304)	(0.00423)	(0.00398)	(0.00523)	(0.00485)	(0.0031)	(0.00285)
Concentration	0.00239*	-0.000597	0.00553***	-0.00145	0.000973	0.000351	0.00280**	-0.000249
	(0.00140)	(0.00128)	(0.00179)	(0.00184)	(0.00222)	(0.00238)	(0.0014)	(0.00127)
N	65,880	65,880	63,121	63,121	54,457	54,457	65,860	65,860
rho	0.57	0.56	0.58	0.63	0.78	0.74	0.53	0.52
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 8: Effect of FinTech Business Models and Risk Taking Across Commercial Banks

Variable	(1) Risk-adjusted ROA (standardized)	(2) Risk-adjusted E/A (standardized)	(3) Risk-adjusted ROA (standardized)	(4) Risk-adjusted E/A (standardized)	(5) Risk-adjusted ROA (standardized)	(6) Risk-adjusted E/A (standardized)	(7) Risk-adjusted ROA (standardized)	(8) Risk-adjusted E/A (standardized)
FinTech (standardized)	-0.027	-0.0672**						
	(0.0323)	(0.0274)						
P2P Lending (standardized)			0.0145	-0.0108				
			(0.0196)	(0.0157)				
Balance Sheet Lending (standardized)					-0.0843***	-0.0561***		
					(0.0241)	(0.0207)		
Other FinTech (standardized)							-0.0616**	-0.0661***
							(0.0288)	(0.0234)
Size (log assets)	0.04	0.0419	0.062	0.068	0.0839	0.0837	0.0378	0.0393
	(0.0411)	(0.0407)	(0.0433)	(0.0434)	(0.0584)	(0.0578)	(0.0412)	(0.0407)
Equity-to-assets	-0.0000858	-0.0000826	-0.000107	-0.0000773	-0.000573	0.000132	-0.000241	-0.000213
	(0.00140)	(0.00129)	(0.00158)	(0.00143)	(0.0018)	(0.0015)	(0.00141)	(0.00129)
GDP growth	0.0108	0.0048	-0.000108	-0.0049	-0.0279**	-0.0229***	0.00914	0.00516
	(0.00688)	(0.00564)	(0.00756)	(0.00581)	(0.0114)	(0.00875)	(0.00704)	(0.0058)
Inflation	-0.00167	-0.000156	0.0133***	0.0142***	0.00527	0.0045	-0.00152	0.000924
	(0.00240)	(0.00207)	(0.00414)	(0.00346)	(0.00402)	(0.00323)	(0.00236)	(0.00203)
GDP per capita	0.604*	0.722**	0.699*	0.886***	1.701***	1.338***	0.485	0.595*
	(0.351)	(0.307)	(0.388)	(0.301)	(0.523)	(0.404)	(0.347)	(0.313)
Policy rate	0.00224	-0.00247	-0.00773*	-0.0109***	-0.0111**	-0.00912***	0.00321	-0.000142
	(0.00338)	(0.00281)	(0.00404)	(0.00324)	(0.00473)	(0.00329)	(0.00337)	(0.00281)
Concentration	0.00489***	0.00326**	0.00995***	0.00729***	0.00758***	0.00497*	0.00506***	0.00301*
	(0.00182)	(0.00159)	(0.00225)	(0.00185)	(0.0029)	(0.00281)	(0.00183)	(0.00161)
N	8,568	8,568	7,559	7,559	4,261	4,261	8,548	8,548
rho	0.53	0.57	0.61	0.69	0.85	0.84	0.49	0.50
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 9: Effect of FinTech Business Models and Risk Taking Across Cooperative Banks

Variable	(1) Risk-adjusted ROA (standardized)	(2) Risk-adjusted E/A (standardized)	(3) Risk-adjusted ROA (standardized)	(4) Risk-adjusted E/A (standardized)	(5) Risk-adjusted ROA (standardized)	(6) Risk-adjusted E/A (standardized)	(7) Risk-adjusted ROA (standardized)	(8) Risk-adjusted E/A (standardized)
FinTech (standardized)	-0.0944	0.107						
	(0.0660)	-0.0726						
P2P Lending (standardized)			-0.251***	-0.233***				
			(0.0373)	(0.035)				
Balance Sheet Lending (standardized)					-0.0970**	-0.0156		
					(0.0433)	(0.0378)		
Other FinTech (standardized)							-0.0726	-0.0224
							(0.054)	(0.058)
Size (log assets)	0.0668**	0.0798***	0.0295	0.0401	0.0607**	0.034	0.0676**	0.0759**
	(0.0295)	(0.0304)	(0.0299)	(0.0312)	(0.0254)	(0.0284)	(0.0293)	(0.0301)
Equity-to-assets	-0.00165	-0.000999	-0.00239	-0.00235	-0.000435	-0.000711	-0.0016	-0.00123
	(0.00192)	(0.00174)	(0.00194)	(0.00176)	(0.00154)	(0.00154)	(0.00193)	(0.00174)
GDP growth	-0.0588***	-0.0444***	-0.0675***	-0.0571***	-0.0683***	-0.0315*	-0.0614***	-0.0433***
	(0.0107)	(0.0109)	(0.0116)	(0.0121)	(0.0194)	(0.0179)	(0.0108)	(0.0108)
Inflation	-0.0196	-0.0417***	-0.0448***	-0.0665***	0.00634	0.0146	-0.0271**	-0.0349***
	(0.0129)	(0.0125)	(0.0139)	(0.0137)	(0.0189)	(0.0173)	(0.0119)	(0.0108)
GDP per capita	1.116*	2.076***	2.291***	2.565***	2.695**	1.145	1.282**	1.443**
	(0.656)	(0.690)	(0.593)	(0.636)	(1.362)	(1.112)	(0.579)	(0.587)
Policy rate	-0.00539	0.00837	-0.0104	-0.00842	-0.0423***	-0.0348**	0.00096	-0.000323
	(0.00943)	(0.00996)	(0.00759)	(0.00789)	(0.0153)	(0.016)	(0.00742)	(0.00766)
Concentration	0.00247	-0.000452	0.00569**	-0.00287	0.00185	-0.000461	0.00309	-0.000047
	(0.00207)	(0.00189)	(0.00288)	(0.00324)	(0.00366)	(0.0041)	(0.00217)	(0.00201)
N	53,237	53,237	51,930	51,930	48,086	48,086	53,237	53,237
rho	0.57	0.75	0.75	0.79	0.87	0.64	0.60	0.63
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 10: Effect of FinTech Business Models and Risk Taking Across Non-Banks

Variable	(1) Risk-adjusted ROA (standardized)	(2) Risk-adjusted E/A (standardized)	(3) Risk-adjusted ROA (standardized)	(4) Risk-adjusted E/A (standardized)	(5) Risk-adjusted ROA (standardized)	(6) Risk-adjusted E/A (standardized)	(7) Risk-adjusted ROA (standardized)	(8) Risk-adjusted E/A (standardized)
FinTech (standardized)	-0.101*	-0.137***						
	(0.0539)	(0.0495)						
P2P Lending (standardized)			-0.0485	-0.0827**				
			(0.0401)	(0.0359)				
Balance Sheet Lending (standardized)					-0.0460*	-0.017		
					(0.0237)	(0.0215)		
Other FinTech (standardized)							-0.0336	-0.0544
							(0.0371)	(0.0339)
Size (log assets)	0.126***	0.106***	0.113**	0.0920**	0.0904**	0.0676	0.124***	0.103**
	(0.0459)	(0.0395)	(0.0524)	(0.0453)	(0.0416)	(0.042)	(0.0463)	(0.0401)
Equity-to-assets	-0.000392	-0.0000823	-0.000271	-0.000339	0.0000287	-0.000169	-0.000374	-0.0000471
	(0.000921)	(0.000786)	(0.000847)	(0.000714)	(0.000979)	(0.000817)	(0.000915)	(0.00078)
GDP growth	-0.000894	-0.00328	-0.00491	-0.00893	0.00198	-0.00255	-0.00069	-0.00325
	(0.00932)	(0.00802)	(0.0102)	(0.00822)	(0.0113)	(0.00939)	(0.00948)	(0.00819)
Inflation	-0.00155	0.00102	0.00664*	0.00852**	0.0013	0.000515	0.000204	0.00332
	(0.00371)	(0.00333)	(0.00387)	(0.00350)	(0.00381)	(0.00349)	(0.00365)	(0.00331)
GDP per capita	0.696	0.31	0.706	0.417	1.423*	0.976	0.68	0.28
	(0.567)	(0.457)	(0.628)	(0.488)	(0.825)	(0.719)	(0.565)	(0.457)
Policy rate	0.00733*	-0.000324	0.00117	-0.00558	0.00188	-0.00174	0.00855**	0.00138
	(0.00389)	(0.00349)	(0.00378)	(0.00340)	(0.00399)	(0.00375)	(0.00403)	(0.00348)
Concentration	0.00757***	0.00382*	0.0115***	0.00702***	0.00658	0.00409	0.00711***	0.00319
	(0.00234)	(0.00219)	(0.00307)	(0.00252)	(0.00426)	(0.00349)	(0.00231)	(0.00213)
N	5,792	5,792	5,325	5,325	3,108	3,108	5,785	5,785
rho	0.67	0.64	0.69	0.67	0.81	0.78	0.66	0.64
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

Table 11: Effect of FinTech on Risk Taking based on selected policy frameworks

Variable	Supervisory Index		Regulatory Capital		Activity Restriction		Multiple Supervisory Agencies	
	(1) z-score (log units) Below median	(2) z-score (log units) Above Median	(3) z-score (log units) Below median	(4) z-score (log units) Above Median	(5) z-score (log units) Below median	(6) z-score (log units) Above Median	(7) z-score (log units) Below median	(8) z-score (log units) Above Median
FinTech (log units)	-0.0227**	0.00313	-0.0226**	-0.00865	-0.0287**	-0.0209***	-0.0227***	0.0781***
	(0.00930)	(0.0101)	(0.00961)	(0.0167)	(0.0139)	(0.00785)	(0.00747)	(0.0231)
Size (log assets)	0.185***	0.263***	0.236***	0.217***	0.185***	0.230***	0.215***	0.222***
	(0.0454)	(0.0434)	(0.0404)	(0.0492)	(0.0612)	(0.0354)	(0.0366)	(0.0596)
Equity-to-assets	0.00427**	0.0136***	0.0115***	0.00685***	0.00367	0.0122***	0.00656***	0.0167***
	(0.00207)	(0.00213)	(0.00217)	(0.00204)	(0.00268)	(0.00184)	(0.00163)	(0.00364)
GDP growth	-0.0192*	0.00818	-0.0456***	0.0369***	0.0289***	-0.0301***	0.00232	0.0141
	(0.00982)	(0.00912)	(0.00769)	(0.0103)	(0.00955)	(0.00855)	(0.00649)	(0.0182)
Inflation	-0.0042	-0.00490	-0.00863	-0.000387	-0.00257	-0.00680	-0.00526	-0.00544
	(0.00588)	(0.00556)	(0.00571)	(0.00549)	(0.00477)	(0.00526)	(0.00384)	(0.0155)
GDP per capita	1.408***	-0.0578	1.857***	1.133**	1.491**	1.394***	1.272***	-0.761
	(0.354)	(0.653)	(0.410)	(0.559)	(0.641)	(0.363)	(0.283)	(1.851)
Policy rate	-0.00352	0.00517	-0.00104	0.0148	0.00488	-0.0199***	0.00578	0.0385**
	(0.00528)	(0.00945)	(0.00467)	(0.0107)	(0.00422)	(0.00658)	(0.00430)	(0.0173)
Concentration	-0.00336*	0.00301	0.000452	-0.000402	-0.00152	-0.00307	-0.00116	-0.000140
	(0.00174)	(0.00191)	(0.00130)	(0.00367)	(0.00154)	(0.00276)	(0.00137)	(0.00354)
N	14,051	56,527	61,371	8,921	14,657	55,921	21,010	49,568
rho	0.72	0.63	0.63	0.62	0.68	0.63	0.67	0.60
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors calculations.
Note: *, **, and *** denote statistical significance at 10, 5, and 1 percent level, respectively.

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