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Artificial Intelligence, FinTech, Financial Risk, and Macro-Financial Linkages

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Agenda

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- Research Questions, Hypothesis and Methodology
- Basic definitions: AI, FinTech
- Impact of Fintech and AI on Financial Risk
- Artificial Intelligence, Financial Risk, FinTech micro and macro perspective
- Econometric Models and Results: micro and macro perspective
- Conclusions

Motivation

- **Digitalization:** We are observing the ongoing revolution of the financial world.
 - FinTech completely redefine the way consumers meet their financial needs.
 - FinTech credit offers an **alternative funding** source for underserved segments.
- **AI:** the increasing use of AI solutions in all areas of the economy, including the financial sector.
- **Financial Risk:** financial risk is the possibility of losing money on an investment or a business venture.
 - Financial risk increases due to the use of AI for commercial purposes.
 - In particular, operational risk and cybersecurity increase. In parallel, we see an increase in climate risk.
- **Macrofinancial linkages:** financial market imperfections, which affect the demand side of credit, also arise from information asymmetry. Impact on financial sector to real economy

Aim

The aim of this paper is to investigate the role of **digital technology** and **AI** in the context of macro-financial linkages

Despite the growing number of studies on the development of the FinTech and AI, there is still a lack of specific research on how the above changes affect relations between the financial sector and the real economy and how to properly measure this phenomenon; there is still no specific quantitative research on how the above changes (i.e. fintech credit) affect the development of the bank loan market.

Research Questions and Hypothesis

In this paper, we aim to answer the following main research question:

- What is the impact of FinTech and AI on traditional banking performance and lending market in the European countries?

We also examine the question:

- Whether fintech and big tech credit complement or substitute for bank credit in the European countries?

The following research hypotheses were formulated based on the above question.

- H1: Digitalization, FinTech and AI has a positive impact on the bank credit market.
- H2: Digitalization has a positive impact on traditional banks' performance in the European countries.
- H3: FinTech credit is a complement for bank credit.

Methodology

The study consists of two stages.



In the first stage, based on the available literature on the subject (scientific articles and reports of international financial institutions), the channels through which new technologies and AI have an impact on the financial sector and the real sphere, including financial risk and sustainable development, were defined.



In the second stage, an empirical measurement of the analyzed phenomenon was made based on a quantitative study using econometric techniques based on collected panel data.

Tech firms

- **Tech firms**, including Big tech and Fintech, have come to deliver various financial services that are typically provided by traditional banks (access payment, credit or depository services (“banking services”).
- Big techs stand out among tech firms due to their unique “data-network-activities” (DNA) loop.
- Tech firms may operate digital platforms that deliver depository services. This is done through partnerships with banks.
- Additionally, some tech firms have entities in their groups that have obtained a banking license and are therefore allowed to take deposits. The main ways to provide banking services are holding a license or entering into partnerships with banks.
- RegTech, SupTech broadly refer to innovative technologies used by supervisory agencies to support the conduct of bank supervision (BIS 2018).

Development of Digitalization: FinTech & BigTech

FinTech is technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions, and the provision of financial services (The Financial Stability Board, FSB, 2017) FinTech is the use of technology to provide new and improved financial services (Thakor (2020, p. 1) , the essence is to use technology to deliver new or improved financial services.

BigTech offer financial services as part of their activities (BIS, 2019). BigTech companies have many lines of business (cf. Vives, 2017, p. 101). Amazon, Apple, and Google, which operate in the lending market, have great potential for the development of financial services because they have access to a huge amount of customer data. BigTechs invest in AI companies.

FinTech bring both positive and negative factors that may influence bank operations, especially in credit. The positive factors may include chances to increase efficiencies. As a negative factor, FinTech companies deprive banks from clients who seek cheaper and faster solutions for borrowing and investing.

AI-definition

- Artificial Intelligence (AI) broadly refers to computer systems that perform tasks that typically require human intelligence (Russell and Norvig, 2010).
- Alan Turing and John von Neumann laid the theoretical groundwork, delineating principles that would become the cornerstone for subsequent computational and AI advancements (Turing, 1948, 1950).
- When ChatGPT – a gen AI application – was launched in late 2022 that AI became more readily and publicly accessible.
- The concept of AI is constantly developing and covering new areas, but what was once known as AI is no longer so modern. An attempt to identify the definition of AI and AI systems has been made by the OECD(2024).

Fig. 1 The development of Artificial Intelligence from simple calculations to AI System/Agents

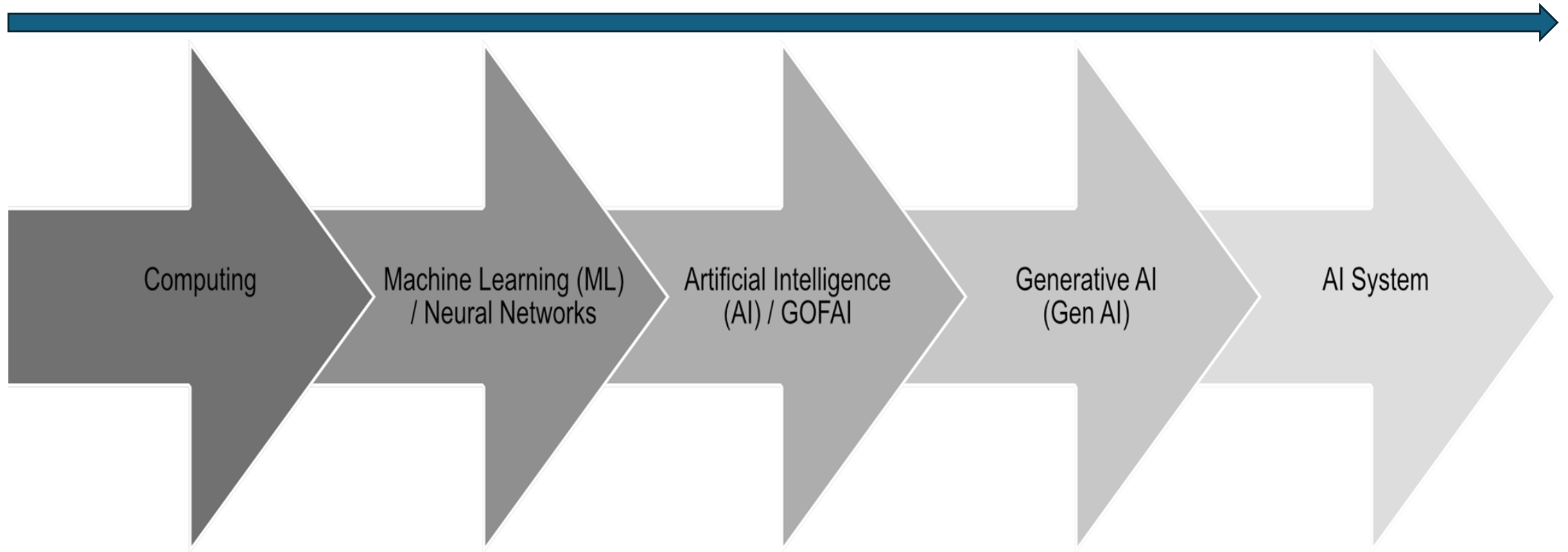


Table 1. BigTech: Bank partnership in Lending

	Bank partnership			Banking licence
	in Payments*	in Deposits	in Lending	
Apple	global	US		
Amazon			EU, IN, US	
Google	global		IN	
Meta	IN		IN	
PayPal	global	US	IN, CN	EU
Meta			IN	
Ant Group/Alibaba			CN	CN, HK, SG(Singapur)
Tencent			CN	CN, HK

BigTech collaborate with banks for granting credit and offering payment-related services such as digital wallet services.

Source: Barakova, Ehrentraud, Leposke, (2024), p. 12.

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AI	BigTech
OpenAI	Microsoft, NVIDIA
Anthropic	Alphabet, Amazon, Salesforce, Zoom
Scale AI	Amazon, Meta, NVIDIA, Intel, AMD
Perplexity	NVIDIA, Amazon
Infection AI	Microsoft, NVIDIA
Hugging Face	Alphabet, AMD, Amazon, IBM, Intel, NVIDIA, Qualcomm, Salesforce
Mistral	Microsoft, NVIDIA, Salesforce, Samsung, IBM
Baichuan	Alibaba, Tencet, Xiaomi
Moonshot	Alibaba, Tencet

AI in finance (1)

Financial institutions have been using artificial intelligence (AI) for many years. Three AI use cases are worth highlighting:

- customer support chatbots;
- fraud detection, including for purposes of anti-money laundering and combating the financing of terrorism (AML/CFT);
- credit and insurance underwriting.

Use of AI for chatbots and fraud detection is not new, but the technology has significantly improved in recent years. Also, credit scoring, valuation of collateral and assessing unstructured information from multiple sources to more accurately predict insurance risks and set premiums.

AI in finance (2)

- GenAI, advanced use cases of AI in financial markets involving full end to end automation without any human intervention remain largely at development phase, if any.
- AI in production and live AI use cases are mostly used for process automation, as a way to enable efficiencies and improve productivity at the back-office (operations) and middle-office (compliance and risk management) of financial service providers and are used in an indirect manner (i.e. without direct interaction with the financial consumer).
- Large language models (LLMs), a type of GenAI, are being used as information points and as a way to simplify data analysis and reporting on the basis of the firm's data.

The risks concerning AI

- The wider use of AI has brought transformative benefits to the financial sector but may also **exacerbate existing risks**.
- The risks AI poses when used by financial institutions are largely the same risks.

These include

- ✓ **microprudential risks**, such as:

credit risk, insurance risk, model risk, operational risks, reputational risks; conduct or consumer protection risks;

- ✓ **macroprudential or financial stability risks**. AI use may heighten some of the existing risks, such as model risk (eg lack of explainability makes it challenging to assess appropriateness of AI models) and data-related risks (eg privacy, security, bias).

Impact of FinTech on Financial sector

- Consumers, in both developed and emerging market economies, are increasingly turning to digital financial services that are cheaper and more convenient. This phenomenon influences the business models of banks and the level of competition in the market (Claessens et al., 2018, pp. 29–49).
- FinTech companies influences **the structure of the banking sector** by changing the borrower-lender relationship. By entering the area of activity previously reserved for banks, FinTech companies exert a huge impact on competition in the financial services sector. **This is the reason for a new approach to the relationship between the financial sector and the real economy.**
- The changing architecture of the financial sector brings new challenges for regulators due to a source of new risks.

The risks concerning FinTech

- **New risks give rise to new threats.** Risks associated with the operations of FinTech and BigTech may be classified on a **micro- and macroeconomic level**.
- **Microeconomic risks involve**, directly or indirectly, possible losses brought on by a loss of funds from financial institutions and operational risk, e.g. as a result of a cyberattack (cyber security).
- **Macroeconomic risks** affect the relations between the financial sector and the real economy.
 - ✓ Systemic risks address the effects of contagion
 - ✓ pro-cyclicality and increasing volatility.
 - ✓ Another risk source may arrive along with so-called systemically important institutions (BigTech).

The Role of FinTech in Macrofinancial linkages

- Financial market imperfections are also of significance to FinTech.
- Traditional banks aiming to relations with their customers used to be considered a factor **lessening information asymmetry** (Akerlof 1970; Stiglitz and Weiss 1981, Leland and Pyle 1977; Diamond 1984).
- FinTech have a comparative advantage with respect to Big Data and analytics (BigTech); internet platforms has enabled the immediate of matching lenders and borrowers thanks to so-called peer-to-peer loans (P2P); the intermediation of financial institutions is not necessary (Herzenstein, Dholakia, Andrews 2011 and Morse 2015).
- For this reason, the new competitors have impact on the existing bank-borrower relations (bank-customer relations business models), as one of the banks' fundamental functions is their ability to mitigate information problems in relations between borrowers and lenders.

Literature Review

- **Claessens et al.** (BIS, 2018) extensive study on competition in the FinTech sector credit market. Findings: FinTech credit is negatively correlated with competition in the banking market and the severity of regulation of that market.
- **Tang**, (Review of Financial Studies, 2019). Findings: concerning Peer-to-Peer lenders versus traditional banks in US.
- **Bao & Huang** (2021) Journal of Financial and Quantitative Analysis. Findings: concerning shadow banking in a Crisis, evidence from Fintech during COVID-19 in China.
- **Cornelli, Frost, Gambacorta, Rau, Wardrop, Ziegler**, (Journal of Banking and Finance, 2023). Fintech and big tech credit: Drivers of the growth of digital lending. Findings confirm that fintech and big tech credit seem to complement other forms of credit, rather than substitute for them.
- **Pawłowska** (Springer, 2022). Bank Lending Procyclicality and Digital Technologies; Does the Structure of the Financial Sector Matter? Finding confirms that Fintech maintain competition in the banking sector.
- **Kouretas and Pawłowska** (Journal of International Development, 2025). Impact of Digital Technology on Traditional Banking: A Case From the Credit Market in the European Union. Findings confirm the dominant role of digital technologies in loans for households during the analysed period.

Research Method

The aim of this paper is to investigate the role of digital technology and AI in bank lending in the context of the relations between the financial sector and the real economy in the EU.

Model:

1. The model concerns the impact of the digital techniques on bank lending and profitability of the EU banks (2 equations).

Data Sources and Variables

- Panel has been constructed from many data sources connected at the national level i.e. Financial Databases, ECB, IMF, McKinsey reports, Statista.
- Macroeconomic data are collected from Eurostat, World Bank, and European Central Bank.
- Data concerning loans are from Centre for European Policy Studies (CEPS);
- FinTech firms data are collected from Cornelli, Doerr, Franco, Frost, (2021);
- FinTech credit data are collected from Cornelli, Frost, Gambacorta, Rau, Wardrop and Ziegler, (2020);
- Data of AI data center are collected from Statista.
- Panel Includes data from: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK, Cyprus, Malta; Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia for 2013-2021.
- Models were estimated in STATA.

Econometric model (eq.1)

In case to check the impact of FinTech and AI on bank loans, we conduct a panel data regression based on the following baseline specification:

$$\Delta Y_{c,t} = \mu_t + \gamma_c + \alpha_1 MS_{c,t} + \alpha_2 BankL_{c,t} + \alpha_3 GDP_{c,t} + \alpha_4 DigTech_{c,t} + \alpha_5 AI + \varepsilon_{c,t} \quad (1)$$

where the explained variable $Y_{c,t}$ is FinTech credit variables in country c in year t .

$GDP_{c,t}$ is a country GDP growth, $MS_{c,t}$ is market structure indicator, in country c in year t .
DigTech are a vectors of variables, in country c in year t .

Econometric model (eq. 2)

In case to check the impact of FinTech and AI on bank loans, we conduct a panel data regression based on the following baseline specification:

$$\Delta Y_{c,t} = \mu_t + \gamma_c + \alpha_1 MS_{c,t} + \alpha_2 GDP_{c,t} + \alpha_3 DigTech_{c,t} + \alpha_4 FinTech_{c,t} + \alpha_5 AI + \varepsilon_{c,t} \quad (2)$$

where the explained variable $Y_{c,t}$ is ROA in country c in year t .

$GDP_{c,t}$ is a country GDP growth, $MS_{c,t}$ is market structure indicator, in country c in year t . ***DigTech*** and ***Fintech*** are a vectors of variables, in country c in year t .

The Explanatory Variables in the model – country level variables

Market structure indicators

- concentration ratio *CR5* and *HHI*

Macro variables

- GDP growth rate, GDP per capita

DigTech variables: As the variables describing the digitalisation for each year t in a given country c we adopted:

- number of ATMs per 1000 km² (*ATM*);
- share of the number of individuals using the Internet for online banking in the population (*Internet1*);
- share of the number of individuals using the Internet in the population (*Internet2*);
- mobile
- number of secure web servers per 1 million people (*server*).

FinTech variables: As variables describing new technology for each year t in a given country c we adopted:

- FinTech equity financing in relation to GDP for country c in year t ; data from the study: Cornelli, Doerr, Franco, Frost, (2021);
- number of transactions in the FinTech sector in relation to GDP for country c in year t ; data from the study: Cornelli, Doerr, Franco, Frost, (2021)
- Fintechcredit: Fintech credit to GDP; data from the study: Cornelli, Frost, Gambacorta, Rau, Wardrop and Ziegler (2020).

Tab.2 Descriptive statistics of panel data

Variable names	Definitions	Nu. of Obs.	Mean	Std. Dev.	MIN	MAX
Banking variables						
CR5	Share of the 5 largest credit institutions in total assets	286	62.0285	18.1816	26.18	97.28
HHI	Herfindahl-Hirschman index is the sum of the squares of the market share of individual banks for assets	286	0.13645	0.156726	0.0245	1.3
ROA	Return on assets	289	0.6116	0.782862	-2.55	3.04
ROE	Return on equity	289	7.1482	8.3403	-29.28	24.07
Credit variables						
T_Loans	%annual change in total loans (in euro)	286	-0.0157	0.0979	-0.4384	0.6125
L_GDP	Loans to GDP %	286	12.90705	12.201	0.522	50.905
L_PC	%annual change in total loans per capita	286	0.065	0.0359	0.0117	0.1802
FinTech variables						
FinTech1	FinTech equity financing in relation to GDP.	266	48.44	10.6071	0	6.69462
FinTech2	Log of number of FinTech companies	280	2.29737	1.5404	0	6.6120
FinTech3	Fintech credit to GDP	147	13329.09	18448.5	0	46054
FinTech4	The value of the KFTX Stock Index was created to track the capitalization of innovative companies in the financial sector	277	1128,053	231,64	849	1434
GDPpc	The gross domestic product per capita	286	35023.6	22098.2	6812.4	118823.6
GDP	The gross domestic product growth rate yoy	286	2.975	2.78129	-1.4	25.1
DigTech variables						
ATM	Number of Automated Teller Machines (ATMs)	224	41915.2	32002.9	196	86767
Internet1	Internet banking (% of individuals)	224	48.44	16.84	2	90
Internet2	Individuals using the Internet	278	78.11876	11.7297	39.93	98.14
Mobile	number of mobile phone subscriptions per 100 people	281	124.375	15.625	91.9	172.12
card	The logarithm of the number of payment cards	270	1.281654	1.381603	0.3225	19.66
Server	Number of secure servers	286	13511.7	29888.65	39.02	277133.7
AI variables						
AI	Number of data centers. A data center includes servers, storage systems, networking equipment, cooling systems, and security controls	224	95.464	145.311	10	529

Tab. 3 Empirical Results of the model for 1 eg. 1

VARIABLES	(1) one FintechCredit	(2) two FintechCredit	(3) tree FintechCredit	(4) four FintechCredit	(5) five FintechCredit
<i>T_lonas</i>		0.751 (0.564)	0.279 (0.673)	0.748 (0.563)	
<i>CR5</i>	-0.005 (0.006)	-0.007 (0.005)	-0.005 (0.003)	-0.007 (0.005)	0.009 (0.006)
<i>ATM</i>		0.000 (0.001)	-0.000 (0.000)		
<i>Mobile</i>	-0.005 (0.004)	-0.002 (0.004)		-0.002 (0.004)	
<i>GDP</i>	-0.194 (0.534)	-0.360 (0.515)	0.045 (0.643)	-0.351 (0.514)	-0.418 (0.710)
<i>INTER2</i>		0.019***	0.013*	0.019***	-0.017**
<i>Alcenter</i>	0.780*** (0.075)	0.804*** (0.074)	0.805*** (0.044)	0.805*** (0.073)	0.792*** (0.082)
<i>FinTech2</i>	1.050*** (0.093)	1.079*** (0.079)	1.010*** (0.109)	1.078*** (0.079)	
<i>L_PC</i>	0.016* (0.008)				0.019** (0.009)
<i>INTER1</i>	0.003 (0.005)		-0.000 (0.003)		
<i>Server</i>			0.115*** (0.043)		0.248*** (0.043)
<i>Card</i>					0.069* (0.041)
Observations	182	183	179	183	174
Number of krajid	26	26	26	26	25
R-squared	0.802	0.802	0.802	0.860	0.8422

VARIABLES	(1) one FintechCredit	(2) two FintechCredit	(3) tree FintechCredit	(4) four FintechCredit	(5) five FintechCre dit
<i>T_lonas</i>		0.462 (0.667)	0.279 (0.673)	0.483 (0.664)	
<i>CR5</i>	-0.004 (0.003)	-0.005* (0.003)	-0.005 (0.003)	-0.005 (0.003)	0.003 (0.004)
<i>ATM</i>		-0.000 (0.000)	-0.000 (0.000)		
<i>Mobile</i>	-0.009*** (0.003)	-0.007** (0.003)		-0.007** (0.003)	
<i>GDP</i>	0.282 (0.647)	0.001 (0.650)	0.045 (0.643)	-0.024 (0.647)	-0.288 (0.777)
<i>INTER1</i>		0.021***	0.013*	0.021***	-0.012
<i>Alcenter</i>	0.756*** (0.044)	0.792*** (0.041)	0.805*** (0.044)	0.790*** (0.041)	0.760*** (0.051)
<i>FinTech4</i>	0.999*** (0.104)	1.041*** (0.098)	1.010*** (0.109)	1.040*** (0.098)	
<i>L_PC</i>	0.015*** (0.005)				0.013** (0.006)
<i>INTER2</i>	0.004 (0.003)		-0.000 (0.003)		
<i>Server</i>			0.115*** (0.043)		0.228*** (0.046)
<i>Card</i>					0.056 (0.042)
Observations	182	183	179	183	174
R-squared	0.780	0.798	0.802	0.798	0.662

Tab. 4 Empirical Results of the model for 1 eg. 2

VARIABLES	(1) one ROA	(2) two ROA	(3) tree ROA	(4) four ROA	(5) five ROA
<i>CR5</i>	-0.005 (0.006)	-0.002 (0.006)	-0.001 (0.005)	-0.005 (0.006)	-0.003 (0.004)
<i>INTER1</i>	0.011** (0.005)		0.014*** (0.004)	0.016*** (0.004)	0.011*** (0.004)
<i>Mobile</i>	0.007 (0.005)			0.003 (0.004)	
<i>GDP</i>	0.738 (0.609)	0.502 (0.614)	0.667 (0.514)	0.243 (0.584)	0.587 (0.541)
<i>FinTech2</i>	0.028 (0.086)	-0.030 (0.074)			
<i>Alcenter</i>	-0.040 (0.111)		-0.062 (0.073)	-0.046 (0.083)	-0.011 (0.067)
<i>FinTech4</i>		0.456*** (0.138)			0.354*** (0.097)
<i>ATM</i>		0.000 (0.001)		0.000 (0.001)	
<i>INTER2</i>		0.019*** (0.006)			
<i>Card</i>		0.018 (0.036)			-0.056 (0.056)
<i>Server</i>			0.116*** (0.025)	0.120*** (0.030)	0.102*** (0.026)
<i>FinTech1</i>			-0.021 (0.020)	-0.021 (0.024)	-0.056*** (0.021)
Observations	182	174	182	159	196
Number of krajid	26	25	26	26	25

VARIABLES	(1) one ROA	(2) two ROA	(3) tree ROA	(4) four ROA	(5) five ROA
<i>CR5</i>	-0.005 (0.004)	-0.001 (0.004)	-0.004 (0.003)	-0.005 (0.004)	-0.004 (0.003)
<i>INTER1</i>	0.012*** (0.003)		0.010*** (0.002)	0.012*** (0.003)	0.010*** (0.003)
<i>Mobile</i>	0.005 (0.004)			0.003 (0.004)	
<i>GDP</i>	1.413* (0.738)	1.319* (0.781)	0.923 (0.593)	0.586 (0.676)	0.781 (0.589)
<i>FinTech2</i>	-0.042 (0.084)	-0.024 (0.056)			
<i>Alcenter</i>	0.020 (0.082)		-0.027 (0.046)	0.003 (0.055)	0.023 (0.049)
<i>FinTech4</i>		0.513*** (0.143)			0.442*** (0.100)
<i>ATM</i>		0.000 (0.000)		0.000 (0.000)	
<i>INTER2</i>		0.019*** (0.006)			
<i>Card</i>		0.028 (0.043)			-0.062 (0.060)
<i>Server</i>			0.119*** (0.027)	0.113*** (0.034)	0.097*** (0.028)
<i>FinTech1</i>			-0.050** (0.020)	-0.050** (0.025)	-0.082*** (0.021)
Observations	182	174	206	159	196
R-squared	0.577	0.456	0.781	0.608	0.694

Conclusions

- The paper fills a research gap in the area of the relationship between the financial sector and the real economy, driven by digitalization and AI in the EU.
- Using a panel data sample for the period 2013–2021 for the EU, we find that new technology affects the bank credit market and profitability of banks and additionally takes into account the role of artificial intelligence in finance.
- Additionally, this paper confirms that in the European countries, fintech credit seems to complement banking credit, rather than substitute for them.
- It should be noted that FinTech and BigTech companies are developing mainly in Asia. In European countries, traditional banks still dominate the financial sector. However, banks are investing in new technologies.
- Furthermore, new players (FinTech, BigTech) are blurring the boundary between the financial sector and the real economy. In the future, GenAI advances are expected to increasingly support banking service at the operational level.

Further Research

- The results confirm that new technology and AI affect the supply of credit.
- Of importance are challenges pertaining to the monitoring of FinTech credit and AI.
- In the future, GenAI advances are expected to increasingly support the financial services.
- A further direction of research should use panel VAR estimation methods with new AI and FinTech variables.

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