Bank financial innovation and SMEs lending: do we experience a transformation in a bank-SME relationship?

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Outline

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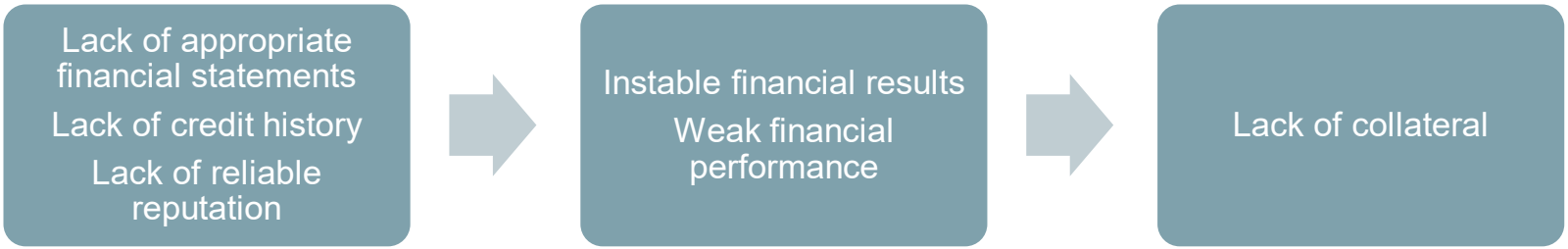
Motivation

- We explore to what extent the advancements in bank digital technology help ease constraints for Small and Medium-sized enterprises (SMEs)
- Why focus on SMEs?
  - In Europe, SMEs account for **99% of the enterprise population**, and account for more than half of its GDP and employment.
  - The availability of lending and cost of finance have been well-documented in the literature as **a major constraint on growth opportunities for small and medium-sized enterprises** (Beck et al., 2006; Gorodnichenko and Schnitzer, 2010; Bottazzi et al., 2014; Berlingieri et al., 2020).
  - Almost 70% of SMEs do not use the external financing from banks, and another 15% are underfinanced (World Bank, 2017).

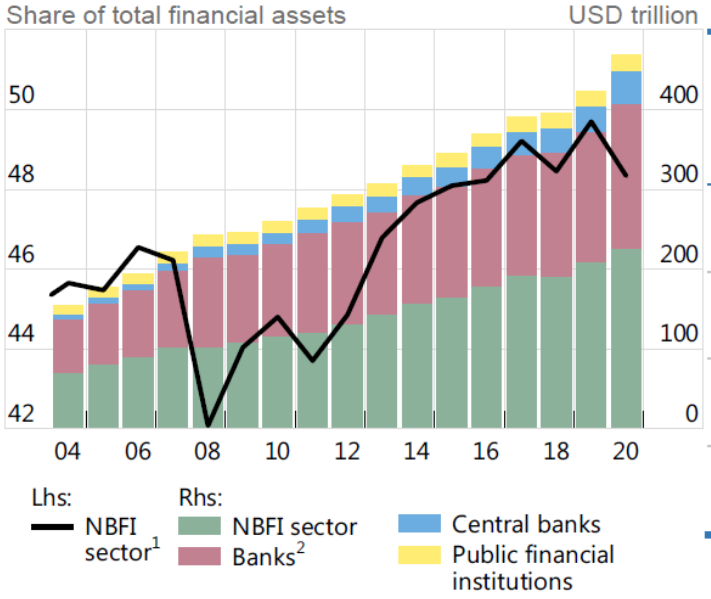
Why do SMEs exhibit higher financial constrains compared to larger firms?



Financial exclusion of SMEs

Financial Sector changes in the era of digital technology

Total global financial assets



Composition of the global financial system

	Total global financial assets	Central banks	Banks[2]	PFIs[3]	NBFI sector
Size at end-2020 (USD trillion)	468.7	41.9	180.4	19.9	226.6
Share of total global financial assets (%)	100.0	8.9	38.5	4.2	48.3
Growth in 2020 (year-over-year, %)	10.9	32.3	11.1	7.7	7.9
Growth 2014-19 (annualised growth, %)	5.0	6.9	3.7	4.5	5.9

Source: Assets of financial intermediaries globally, FSB, 2021

- Share of NBFI assets has increased substantially over the past decades
- OFIs represent the largest share of NBFI, accounting for 30.3% of total global financial assets in 2020 vs. traditional banks, accounting for 38.5% of total global assets

Research sub-questions

- Does bank financial technology increase SMEs' access to credit?
- What is the effect on debt maturity?
- Does it help reducing cost of credit?
- Does it benefit more opaque firms (younger and smaller in size)?
- Does it reduce the need for collateral?
- Does credit market structure matter for explaining these relationships?

Theoretical arguments & empirical evidence

Theory

- Financial technology reduces information frictions **via greater information availability and data sharing**.
- **Machine learning models and AI algorithms** allow for more precise credit assessment.
- Technological development **does not require any physical branches** allowing to access credit in the underbanked and underserved markets.
- **Technology development** should **reduce** the cost of funding and thus extend the credit opportunities for traditionally financially excluded entitites.

Evidence

- **Greater information availability** improves credit risk evaluation & increases lending to previously financially excluded borrowers (Jagtiani & Lemieux, 2018; Berge et al., 2020)
- **More precise algorithms**, **data diversity and real-time monitoring** allows banks to compute the credit risks more precisely, **so eases the collateral requirements** (Bazarbash, 2019; Gambacorta et al., 2019)
- **The application process is faster** (Fuster et. al., 2019) and **less dependent on personal relationships** (Behr et al., 2020).
- This also **optimizes the operational and regulatory costs** at banks, and improve banks' efficiency (Wang et. al., 2021; Lee et al., 2021).

But… due to many limitations regarding the data sharing and regulatory restrictions on the usage of data in the credit scoring models faced by banks, banks may compensate for the loss of relationship by shortening the credit maturity, demand for additional collateral or increase the cost of credit.

Hypotheses

- **Can the access to alternative data alleviate the constraints of financially exclusive entities?**

- **H1a**. Financial innovation at banks stimulates SMEs' access to debt.

  - Traditionally, banks acquire information on customer behaviour through the **relationship** (Diamond, 1991; Rajan, 1992). The reduction of relationship could be perceived by banks as more risky as not all 'soft' information can be easily replaced by the 'hard' information (Petersen & Rajan, 1994).

- **H1b:** The impact of bank financial innovations is stronger on the short-term than long-term debt.

- **Does the financial innovation decrease the cost of funding?**
  - Increase in operational efficiency at banks due to fin. technology **does not translate into reduction in the cost of intermediation** (Philippon, 2017)
  - lack of relationship with the borrowers observed in automated lending procedures **may push borrowers into moral hazard** (Di Maggio et al, 2021), and thus increase the risk for banks.

- **H2:** Financial innovation at banks is likely to increase the cost of debt.

- **Who will be the largest beneficiary of the financial innovation at banks?**

- **H3a.** Financial innovations at banks are more likely to benefit more opaque businesses.
- **H3b.** Financial innovations at banks are more likely to reduce cost of debt for more opaque firms.

Hypotheses (continued)

- **Can the access to big data and alternative credit scoring models make the credit market less collateral dependent?**
  - Access to big data may reduce the collateral needs for SMEs (Gambacorta et al., 2019).
- **H4.** Financial innovations at banks make SMEs less dependent on collateral, i.e., the effect of alleviated access to bank debt from innovative banks is more pronounced for SMEs with relatively low value of tangible assets in total assets.

- **Will the effect of financial technology be the same across all economies?**
  - The effect is conditional on credit market characteristics

- **H5a:** The role of banks' financial innovations will be **less pronounced in economies** with **more developed traditional banking model**, and more important, where **the FinTech market is more developed**.

- **H5b.** Financial innovations at banks play more important role in **decreasing SMEs' debt cost** in environments where **the traditional banking model** is better developed, and **increasing the cost of intermediation** where **the FinTech market is more developed**.

Sample

Year	Countries	Observations	% of observations
2009	10	7,395	0.7
2010	12	30,061	3.0
2011	12	74,473	7.4
2012	12	68,994	6.9
2013	13	103,770	10.3
2014	13	116,038	11.6
2015	13	119,877	11.9
2016	14	129,938	12.9
2017	14	133,456	13.3
2018	14	134,228	13.4
2019	15	85,178	8.5
All years	15	1,003,408	100.0

Banks affiliated with a firm	Observations	% of observations
1	717759	71.5
2	202319	20.2
3	63290	6.3
4	16677	1.7
5	3363	0.3
All observations	1,003,408	100.0

179,921 SMEs

54 largest European banks

Austria, Croatia, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Latvia, Poland, Portugal, Slovenia, Spain, and the UK.

Period: 2008 - 2019

Banks' financial innovation

- automation software (AUT.SOFT)
- blockchain technology (BLOCKCHAIN)
- data analytics (ANALYTICS)
- lending solutions (LENDING)
- payments (PAYMENTS)
- personal finance (PERSON.FIN)
- regulatory technology (REGULAT)
- sum of the seven abovementioned variables (INNOV.ALL)

Sources: Crunchbase, CBInsights, banks' financial statements & public announcements

Methodology

$$DEP_{i,t} = f\begin{pmatrix} FIRM_{t-1} \\ MAIN.BANK_{t-1} \\ COUNTRY_t \\ BANK.INNOV_t \\ \text{firm fixed effects} \\ \text{year fixed effects} \end{pmatrix},$$

Dependent variables:

DEBT.GR
ST.DEBT (ratio)
ST.DEBT.GR
LT.DEBT.GR
INT.COST

Control variables:
Firm's control variables:

- Profitability ratio (EBIT to sales ratio)
- FIXED.ASSET (value of fixed asset to total asset)
- EQUITY (Equity to firm total asset)
- ASSET.TURN (sales to total assets)
- FIRM.SIZE (ln firm's turnover)
- LN.FIRM.AGE (ln years in operation)

Bank control variables:

- BANK.SIZE (ln of assets)
- BANK.LOANS (loans to asset ratio)
- Bank equity ratio (BANK.EQUITY)
- Bank deposit growth (BANK.DEPO.GR)

Methodology

$$DEP_{i,t} = f\begin{pmatrix} FIRM_{t-1} \\ MAIN.BANK_{t-1} \\ COUNTRY_t \\ BANK.INNOV_t \\ \text{firm fixed effects} \\ \text{year fixed effects} \end{pmatrix},$$

Control variables:

Country's control variables:

- GDP.GROWTH (GDP growth rate)
- UNEMPL (unemployment rate)
- GDP.PC (GDP per capita)
- PRI.CREDIT (domestic credit to private sector by banks to a country's GDP)
- BRANCHES (number of commercial bank branches per 100,000 adults)
- FINTECH.CRED (FinTech credit per capita)

Results – Credit growth (H1a and H1b)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
A. Financial innovations at bank								
$BANK.INNOV_t$	0.00360***	0.00364***	0.00412***	0.00225***	0.00403***	0.00393***	0.00219***	0.00172***
	(0.000639)	(0.000568)	(0.000781)	(0.000760)	(0.000524)	(0.000636)	(0.000694)	(0.000175)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$	$ST.DEBT_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
A. Financial innovations at bank								
$BANK.INNOV_t$	0.00357**	0.0161***	0.0114***	0.0143***	0.0143***	0.0129***	0.0181***	0.00654***
	(0.00178)	(0.00167)	(0.00221)	(0.00238)	(0.00146)	(0.00189)	(0.00209)	(0.000536)

Bank financial innovations is positively correlated with the credit growth at SMEs, however the effect is significant only on the short-term credit for SMEs.

Results – Cost of debt (H2)

Dependent variable:	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$	$\widehat{INT.COST_t}$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
A. Financial innovations at bank								
$BANK.INNOV_t$	-0.00207	-0.000347	0.00526**	-0.00146	-0.000883	-0.000555	-0.00299	-0.000397
	(0.00166)	(0.00157)	(0.00221)	(0.00232)	(0.00139)	(0.00186)	(0.00224)	(0.000511)

The bank financial innovations do not change the cost of credit to SMEs.

Results – impact on the opaque SMEs (H3a)

Panel A. Moderating role of firm size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$FIRM.SIZE_{t-1}$	-0.0108***	-0.0103***	-0.0103***	-0.0102***	-0.0102***	-0.0103***	-0.0103***	-0.0102***
	(0.000625)	(0.000470)	(0.000467)	(0.000465)	(0.000472)	(0.000472)	(0.000465)	(0.000471)
$BANK.INNOV_t$	0.00322***	0.00299***	0.00343***	0.00184**	0.00391***	0.00297***	0.00210***	0.00154***
	(0.000646)	(0.000573)	(0.000799)	(0.000763)	(0.000525)	(0.000651)	(0.000696)	(0.000180)
$BANK.INNOV_t$ x $FIRM.SIZE_{t-1}$	0.00130***	0.00143***	0.00178***	0.00106**	0.000703***	0.00179***	0.000461	0.000239***
	(0.000323)	(0.000274)	(0.000481)	(0.000441)	(0.000231)	(0.000344)	(0.000352)	(6.79e-05)
Observations	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408
Firms	179,921	179,921	179,921	179,921	179,921	179,921	179,921	179,921

Panel B. Moderating role of firm age

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$YOUNG.FIRM_{t-1}$	0.00858***	0.00776***	0.00759***	0.00835***	0.00851***	0.00744***	0.00835***	0.00951***
	(0.00100)	(0.000960)	(0.000977)	(0.00101)	(0.000975)	(0.000956)	(0.00105)	(0.00104)
$BANK.INNOV_t$	0.00448***	0.00425***	0.00463***	0.00272***	0.00498***	0.00465***	0.00301***	0.00195***
	(0.000637)	(0.000566)	(0.000780)	(0.000757)	(0.000522)	(0.000633)	(0.000692)	(0.000174)
$BANK.INNOV_t$ x $YOUNG.FIRM_{t-1}$	-0.0137***	-0.0168***	-0.00646*	-0.0102***	-0.0172***	-0.0172***	-0.00579***	-0.00422***
	(0.00287)	(0.00370)	(0.00388)	(0.00312)	(0.00260)	(0.00466)	(0.00218)	(0.000709)
Observations	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408	1,003,408
Firms	179,921	179,921	179,921	179,921	179,921	179,921	179,921	179,921

The financial innovations do not help the most opaque SMEs to eliminate the market frictions.

Results – cost of debt (H3b)

Panel A. Moderating role of firm size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$FIRM.SIZE_{t-1}$	-0.0101***	-0.00994***	-0.00951***	-0.00992***	-0.00955***	-0.0101***	-0.0100***	-0.00966***
	(0.00130)	(0.00130)	(0.00130)	(0.00132)	(0.00132)	(0.00129)	(0.00132)	(0.00134)
$BANK.INNOV_t$	-0.00207	9.60e-06	0.00724***	-0.00107	-0.000458	-0.000460	-0.00279	-0.000163
	(0.00171)	(0.00164)	(0.00220)	(0.00244)	(0.00140)	(0.00197)	(0.00247)	(0.000553)
$BANK.INNOV_t$ x $FIRM.SIZE_{t-1}$	8.80e-06	-0.000645	-0.00420***	-0.000790	-0.00125*	-0.000150	-0.000273	-0.000246
	(0.000910)	(0.000864)	(0.00127)	(0.00133)	(0.000702)	(0.00107)	(0.00120)	(0.000219)
Observations	634,770	634,770	634,770	634,770	634,770	634,770	634,770	634,770
Firms	129,387	129,387	129,387	129,387	129,387	129,387	129,387	129,387

Panel B. Moderating role of firm age

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$YOUNG.FIRM_{t-1}$	0.0122***	0.0114***	0.0106***	0.0129***	0.0125***	0.0105***	0.0125***	0.0144***
	(0.00328)	(0.00304)	(0.00316)	(0.00335)	(0.00312)	(0.00300)	(0.00333)	(0.00338)
$BANK.INNOV_t$	-0.00131	0.000382	0.00538**	-0.000837	-0.000113	-9.56e-06	-0.00228	-0.000208
	(0.00168)	(0.00158)	(0.00222)	(0.00232)	(0.00140)	(0.00188)	(0.00224)	(0.000511)
$BANK.INNOV_t$ x $YOUNG.FIRM_{t-1}$	-0.0124**	-0.0246***	-0.00502	-0.0168**	-0.0176***	-0.0161**	-0.0155**	-0.00538***
	(0.00601)	(0.00612)	(0.00785)	(0.00708)	(0.00485)	(0.00712)	(0.00708)	(0.00147)
Observations	634,770	634,770	634,770	634,770	634,770	634,770	634,770	634,770
Firms	129,387	129,387	129,387	129,387	129,387	129,387	129,387	129,387

The financial innovations help younger SMEs to decrease the cost of credit.

Results - the role of collateral (H4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$LOW.COLLAT_{t-1}$	0.0134***	0.0138***	0.0138***	0.0139***	0.0133***	0.0138***	0.0135***	0.0131***
	(0.000614)	(0.000593)	(0.000599)	(0.000615)	(0.000605)	(0.000588)	(0.000626)	(0.000626)
$BANK.INNOV_t$	0.00172**	0.00283***	0.00272***	0.00163*	0.00278***	0.00245***	0.000638	0.00139***
	(0.000824)	(0.000707)	(0.00105)	(0.000953)	(0.000636)	(0.000845)	(0.000900)	(0.000207)
$BANK.INNOV_t$ x $LOW.COLLAT_{t-1}$	0.00351***	0.00198**	0.00320**	0.00101	0.00321***	0.00355***	0.00275***	0.000776***
	(0.000914)	(0.000771)	(0.00127)	(0.00112)	(0.000641)	(0.000980)	(0.00102)	(0.000185)
Observations	977,732	977,732	977,732	977,732	977,732	977,732	977,732	977,732
Firms	176,327	176,327	176,327	176,327	176,327	176,327	176,327	176,327

The financial innovations help SMEs with lower collateral to obtain credit.

Results – the credit market structure & credit access (H5a)

Panel A. Moderating role of a the development of the traditional banking model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$
Regressor used as BANK.INNOV:	AUT.SOFT$_t$	BLOCKCHAIN$_t$	ANALYTICS$_t$	LENDING$_t$	PAYMENTS$_t$	PERSON.FIN$_t$	REGULAT$_t$	INNOV.ALL$_t$
BRANCHES$_{t-1}$	0.000579***	0.000566***	0.000592***	0.000564***	0.000649***	0.000611***	0.000531***	0.000666***
	(6.30e-05)	(6.27e-05)	(6.39e-05)	(6.31e-05)	(6.39e-05)	(6.36e-05)	(6.26e-05)	(6.39e-05)
BANK.INNOV$_t$	0.0212***	0.0292***	0.0188***	0.0171***	0.0108***	0.0281***	0.0119***	0.00604***
	(0.00218)	(0.00301)	(0.00289)	(0.00292)	(0.00171)	(0.00365)	(0.00198)	(0.000552)
BANK.INNOV$_t$ x BRANCHES$_{t-1}$	-0.000354***	-0.000468***	-0.000258***	-0.000258***	-0.000109***	-0.000451***	-0.000202***	-8.21e-05***
	(4.03e-05)	(5.52e-05)	(5.20e-05)	(4.80e-05)	(3.09e-05)	(6.96e-05)	(3.77e-05)	(1.08e-05)
Observations	983,408	983,408	983,408	983,408	983,408	983,408	983,408	983,408
Firms	177,962	177,962	177,962	177,962	177,962	177,962	177,962	177,962

Panel B. Moderating role of the development of the FinTech market

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable:	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$	DEBT.GR$_t$
Regressor used as BANK.INNOV:	AUT.SOFT$_t$	BLOCKCHAIN$_t$	ANALYTICS$_t$	LENDING$_t$	PAYMENTS$_t$	PERSON.FIN$_t$	REGULAT$_t$	INNOV.ALL$_t$
FINTECH.CRED$_{t-1}$	-5.41e-05***	-2.97e-05**	-5.23e-05***	-5.02e-05***	-5.70e-05***	-3.71e-05***	-7.13e-05***	-7.16e-05***
	(1.38e-05)	(1.40e-05)	(1.40e-05)	(1.38e-05)	(2.18e-05)	(1.38e-05)	(1.43e-05)	(1.52e-05)
BANK.INNOV$_t$	-0.000746	0.00374***	0.00151*	0.000566	0.00308***	0.00344***	0.000511	0.00132***
	(0.000728)	(0.000657)	(0.000871)	(0.000837)	(0.000634)	(0.000739)	(0.000791)	(0.000215)
BANK.INNOV$_t$ x FINTECH.CRED$_{t-1}$	0.000167***	0.000157***	0.000118***	0.000132***	1.20e-05	0.000148***	0.000158***	3.44e-05***
	(1.87e-05)	(2.28e-05)	(3.46e-05)	(2.40e-05)	(1.90e-05)	(2.32e-05)	(2.82e-05)	(4.95e-06)
Observations	826,827	826,827	826,827	826,827	826,827	826,827	826,827	826,827
Firms	147,789	147,789	147,789	147,789	147,789	147,789	147,789	147,789

In countries with more developed banking sectors where the relationship-based lending model are dominant, the role of financial technology in removing SMEs' financial constraints is reduced. However, there is some complementarity between FinTechs and banks in augmenting lending provision.

Results – the credit market structure & cost of intermediation (H5b)

Panel A. Moderating role of a the development of the traditional banking model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$BRANCHES_{t-1}$	0.000289**	0.000283**	0.000244*	0.000306**	0.000282**	0.000253**	0.000283**	0.000268**
	(0.000123)	(0.000123)	(0.000125)	(0.000125)	(0.000126)	(0.000124)	(0.000123)	(0.000125)
$BANK.INNOV_t$	0.0166***	-0.00286	-0.00770	0.0273***	-0.00837*	-0.0135	0.0110**	0.00189
	(0.00557)	(0.00650)	(0.00829)	(0.00778)	(0.00494)	(0.0101)	(0.00556)	(0.00173)
$BANK.INNOV_t$ x $BRANCHES_{t-1}$	-0.000381***	5.28e-05	0.000250*	-0.000487***	0.000143	0.000237	-0.000277**	-4.55e-05
	(0.000109)	(0.000120)	(0.000142)	(0.000128)	(9.30e-05)	(0.000192)	(0.000108)	(3.31e-05)
Observations	622,263	622,263	622,263	622,263	622,263	622,263	622,263	622,263
Firms	127,814	127,814	127,814	127,814	127,814	127,814	127,814	127,814

Panel B. Moderating role of the development of the FinTech market

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$FINTECH.CRED_{t-1}$	7.38e-06	1.67e-05	1.90e-05	1.30e-05	6.02e-05	1.47e-05	-2.60e-05	-1.44e-05
	(2.84e-05)	(2.83e-05)	(2.88e-05)	(2.85e-05)	(3.79e-05)	(2.85e-05)	(3.08e-05)	(3.01e-05)
$BANK.INNOV_t$	-0.00316*	-0.000383	0.00658***	-0.00276	-0.00109	-0.00107	-0.00328	-0.000564
	(0.00177)	(0.00172)	(0.00224)	(0.00262)	(0.00153)	(0.00212)	(0.00242)	(0.000586)
$BANK.INNOV_t$ x $FINTECH.CRED_{t-1}$	0.000109***	7.16e-05	0.000105	7.07e-05*	-5.48e-05	8.39e-05*	0.000205***	2.21e-05**
	(3.49e-05)	(4.41e-05)	(8.04e-05)	(3.90e-05)	(3.51e-05)	(4.47e-05)	(5.32e-05)	(9.52e-06)
Observations	607,658	607,658	607,658	607,658	607,658	607,658	607,658	607,658
Firms	125,417	125,417	125,417	125,417	125,417	125,417	125,417	125,417

In countries with more developed banking sectors financial technology helps reducing the cost of intermediation for SMEs, but it increases in countries with higher presence of FinTechs

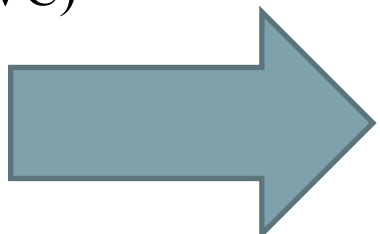
Robustness Check

- Endogeneity check using the GMM-SYS
- Estimations for firms that declared only one main bank
- Growth rate of debt depending on its maturity
- Using alternative measures of bank innovation from GlobalData database from Innovation Scoreboard

(i) a number of filed patents;

(ii) a number of granted patents by a bank; and

(iii) a number of deals a bank has been involved as a Venture Capitalist (VC)



The results do not change except for the cost of credit (H2) when employing endogeneity test.

Endogeneity test

Panel A. Impact on bank debt growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$BANK.INNOV_t$	0.00189***	0.00308***	0.00252***	0.00138*	0.00527***	0.00148**	0.00166**	0.00131***
	(0.000697)	(0.000745)	(0.000793)	(0.000753)	(0.000780)	(0.000727)	(0.000694)	(0.000191)
Observations	726,769	726,769	726,769	726,769	726,769	726,769	726,769	726,769
Firms	150,117	150,117	150,117	150,117	150,117	150,117	150,117	150,117
AR(1)	-90.83***	-90.81***	-90.81***	-90.81***	-90.82***	-90.80***	-90.82***	-90.83***
AR(2)	-0.294	-0.279	-0.292	-0.277	-0.372	-0.310	-0.246	-0.322

Panel B. Impact on cost of debt

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$AUT.SOFT_t$	$BLOCKCHAIN_t$	$ANALYTICS_t$	$LENDING_t$	$PAYMENTS_t$	$PERSON.FIN_t$	$REGULAT_t$	$INNOV.ALL_t$
$BANK.INNOV_t$	0.00909***	0.00415**	0.00750***	0.0117***	0.00293	0.00568***	0.00764***	0.00219***
	(0.00201)	(0.00209)	(0.00268)	(0.00230)	(0.00200)	(0.00204)	(0.00229)	(0.000558)
Observations	410,634	410,634	410,634	410,634	410,634	410,634	410,634	410,634
Firms	98,160	98,160	98,160	98,160	98,160	98,160	98,160	98,160
AR(1)	-24.21***	-24.18***	-24.18***	-24.20***	-24.22***	-24.16***	-24.19***	-24.23***
AR(2)	1.369	1.466	1.436	1.393	1.387	1.474	1.410	1.337

Hypothesis H2 is strongly confirmed after addressing an endogeneity issue

Robustness checks: alternative measures of bank innovativeness

This table presents the results of the estimations for the fixed-effects panel models. For brevity, we do not present coefficients for firm- (PROFIT, FIXED.ASSETS, EQUITY, ASSET.TURN, LN.FIRM.AGE, and FIRM.SIZE), country- (PRI.CREDIT, GDP.GROWTH, GDP.PC, and UNEMPL), and bank-level control variables (BANK.SIZE, BANK.LOANS, BANK.EQUITY, and BANK.DEPO.GR), the constant term, and year dummy variables. Standard errors clustered at the firm-level are shown in parentheses. *, **, *** refer to significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Impact on debt growth

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$	$DEBT.GR_t$
Regressor used as BANK.INNOV:	$FILINGS_t$	$GRANTS_t$	$CVC.DEALS_t$	$SC.FILINGS_t$	$SC.GRANTS_t$	$SC.CVC.DEALS_t$
$BANK.INNOV_t$	8.61e-05**	0.000465***	0.000787**	0.00112**	0.00583**	0.0109**
	(4.03e-05)	(0.000177)	(0.000352)	(0.000537)	(0.00234)	(0.00482)
Observations	228,182	228,182	228,182	228,182	228,182	228,182
Firms	39,145	39,145	39,145	39,145	39,145	39,145

Panel B. Impact on cost of debt

	(9)	(10)	(11)	(12)	(13)	(14)
Dependent variable:	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$	$INT.COST_t$
Regressor used as BANK.INNOV:	$FILINGS_t$	$GRANTS_t$	$CVC.DEALS_t$	$SC.FILINGS_t$	$SC.GRANTS_t$	$SC.CVC.DEALS_t$
$BANK.INNOV_t$	-9.94e-05	0.000103	-0.00107	-0.00136	0.00110	-0.0136
	(0.000135)	(0.000393)	(0.00116)	(0.00180)	(0.00537)	(0.0161)
Observations	176,249	176,249	176,249	176,249	176,249	176,249
Firms	34,126	34,126	34,126	34,126	34,126	34,126

Summary of the results

- Bank digitalisation **increases SMEs' credit access**, benefiting **short-term** vs. long-term credit.
- Bank digitalisation **increases the borrowing costs for SMEs, but younger firms benefit from lower borrowing rates** at more digitalized banks.
- **Collateral** becomes **less important** at financially innovative banks.
- We find that bank digitalisation especially benefits the **markets with lower penetration by traditional banks** but **higher FinTechs presence**, but this pattern reverses when it comes to the cost of intermediation.

Policy recommendations

- All kind of **policy** initiatives regarding the digitalisation of financial services are important to **increase the access to finance** in the context of Europe, though **they are not fully sufficient** to **impact the cost of financial services** which may still provide a hurdle for SMEs on average to access the bank credit.
- It is also important to **emphasize the need** to tailor the policy of further digitalisation of financial services to reflect **peculiarities of the credit market structure.**

THANK YOU

Any questions?

Descriptive statistics

This table presents descriptive statistics for the sample basing on observations employed in regressions from specification 1 in Table 4.

Variable	Observations	Firms	Mean	Std.Dev.	Min.	1st Quart.	2nd Quart.	3rd Quart.	Max.
A. Dependent variables									
DEBT.GR	1,003,408	179,921	-0.004	0.116	-0.547	-0.042	-0.016	0.006	0.856
ST.DEBT	769,199	152,714	0.307	0.372	0.000	0.000	0.114	0.582	1.000
INT.COST	629,578	128,922	0.086	0.274	-0.057	0.007	0.029	0.064	4.003
LT.DEBT.GR	1,001,487	179,830	-0.008	0.098	-0.547	-0.036	-0.016	0.003	0.763
ST.DEBT.GR	1,002,321	179,867	-0.008	0.069	-0.536	-0.024	-0.012	0.003	0.756
B. Other firm-level variables									
PROFIT	1,003,408	179,921	0.026	0.159	-2.000	0.007	0.028	0.070	0.600
FIXED.ASSETS	1,003,408	179,921	0.299	0.259	0.000	0.075	0.231	0.473	1.000
LOW.COLLAT	977,667	176,325	0.499	0.500	0.000	0.000	0.000	1.000	1.000
EQUITY	1,003,408	179,921	0.466	0.264	0.000	0.246	0.450	0.679	1.000
ASSET.TURN	1,003,408	179,921	1.679	1.514	0.000	0.750	1.303	2.102	14.999
FIRM.SIZE	1,003,408	179,921	-0.268	1.688	-10.125	-1.392	-0.229	0.835	3.912
LN.FIRM.AGE	1,003,408	179,921	2.724	0.818	0.000	2.398	2.890	3.219	5.541
YOUNG.FIRM	1,003,408	179,921	0.086	0.280	0.000	0.000	0.000	0.000	1.000
C. Country-level variables									
PRI.CREDIT	1,003,408	179,921	1.081	0.366	0.324	0.937	1.112	1.306	1.921
GDP.GROWTH	1,003,408	179,921	0.017	0.022	-0.143	0.007	0.020	0.029	0.084
GDP.PC	1,003,408	179,921	35.385	5.202	21.024	31.305	35.969	38.906	86.550
UNEMPL	1,003,408	179,921	0.155	0.067	0.031	0.097	0.153	0.214	0.275
BRANCHES	983,408	177,962	52.246	21.305	8.930	35.460	55.110	67.510	99.300
FINTECH.CRED	826,827	147,789	6.853	24.512	0.000	0.080	0.700	3.010	278.530
D. Bank fundamentals									
BANK.SIZE	1,003,408	179,921	12.073	1.502	8.252	10.920	12.301	13.288	14.625
BANK.LOANS	1,003,408	179,921	0.597	0.093	0.131	0.561	0.595	0.655	0.863
BANK.EQUITY	1,003,408	179,921	0.080	0.031	0.011	0.063	0.070	0.081	0.224
BANK.DEPO.GR	1,003,408	179,921	0.055	0.105	-0.424	-0.003	0.034	0.085	1.311
E. Financial innovations at bank									
AUT.SOFT	1,003,408	179,921	0.223	0.375	0.000	0.000	0.000	0.500	1.000
BLOCKCHAIN	1,003,408	179,921	0.153	0.338	0.000	0.000	0.000	0.000	1.000
ANALYTICS	1,003,408	179,921	0.134	0.301	0.000	0.000	0.000	0.000	1.000
LENDING	1,003,408	179,921	0.191	0.348	0.000	0.000	0.000	0.333	1.000
PAYMENTS	1,003,408	179,921	0.266	0.422	0.000	0.000	0.000	0.500	1.000
PERSON.FIN	1,003,408	179,921	0.089	0.260	0.000	0.000	0.000	0.000	1.000
REGULAT	1,003,408	179,921	0.238	0.387	0.000	0.000	0.000	0.500	1.000
INNOV.ALL	1,003,408	179,921	1.294	1.770	0.000	0.000	0.000	2.000	7.000
FILINGS	228,182	39,145	8.902	11.378	0.000	1.000	5.000	9.000	56.000
GRANTS	228,182	39,145	2.554	2.647	0.000	1.000	2.000	4.000	27.000
CVC.DEALS	228,182	39,145	1.850	1.790	0.000	1.000	1.000	3.000	10.000
SC.FILINGS	228,182	39,145	0.663	0.847	0.000	0.071	0.377	0.682	4.013
SC.GRANTS	228,182	39,145	0.190	0.197	0.000	0.071	0.150	0.301	1.935
SC.CVC.DEALS	228,182	39,145	0.137	0.127	0.000	0.071	0.075	0.207	0.694