

The Importance of Technology in Banking during a Crisis

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IMF WP title
“Tech in Fin before FinTech:
Blessing or Curse for Financial Stability?”

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Information Technology in Finance

IT more and more present in finance and lending, e.g.

- machine learning
- more info available (e.g. digital footprint)
- ...

As witnesses by world-wide surge in FinTech and...

- *“We see ourselves as a technology company with a banking license”*
Michael Corbat (Citibank CEO, 2014)
- *“We are a technology company”*
Marianne Lake (JPMorgan Chase CFO, 2016)
- *“We want to be a tech company with a banking license”*
Ralph Hamers (ING CEO, 2017)
- many many more...

Information Technology and Financial Stability

FinTech lit. cannot help too much

- FinTech not exposed yet to large shocks, FinTech lending still small in most countries and not representative

In this paper we

- estimate IT Adoption across US banks *before* the GFC
- look at low- and high- IT adopters *during (and after)* the GFC
- focus on NPLs, mortgage delinquency, and lending

The sign of the relationship between IT and Financial Stability is ambiguous

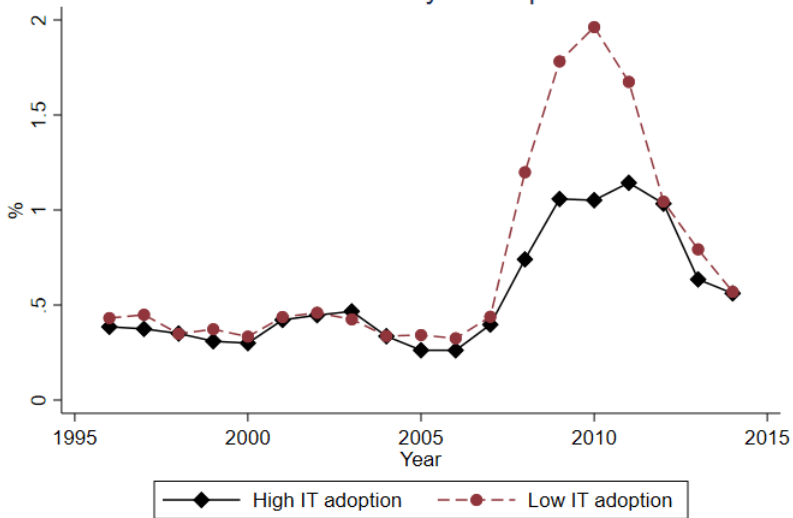
Positive

- IT allows to gather, store, and distribute info (Petersen and Liberti, 2018)
- IT allows the use of more sophisticated statistical models
- \Rightarrow better screening and monitoring

Negative

- might neglect info difficult to quantify , e.g. “soft” info (Rajan, Seru, Vig; 2015)
- statistical models trained during good times may fail during crisis
- IT may encourage moral hazard through securitization and other fin innovation

NPL/Assets by IT adoption



Measuring IT adoption

Survey data from Aberdeen (previously Harte Hanks)

- used in many seminal papers on IT-adoption (non-financial)
 - e.g. Beaudry et al., 2010 JPE; Bloom et al., 2012 AER; Bresnahan et al., 2002 QJE
- plant (branch) level PCs/Employee in the US in 1999, 2003, 2004, 2006, 2016
- highly correlated with IT budget and adoption of new technologies (Cloud Computing) for 2016, 65% (don't have these other measures before)

Map bank branches to the bank-level and

- bank-level IT adoption = average pre-GFC branch IT after controlling for county FEs and branch size (we also standardize)
- merge with regulatory Data on BHC, e.g. NPLs, assets, loans, wholesale funding

NPLs and IT adoption: Panel Regression

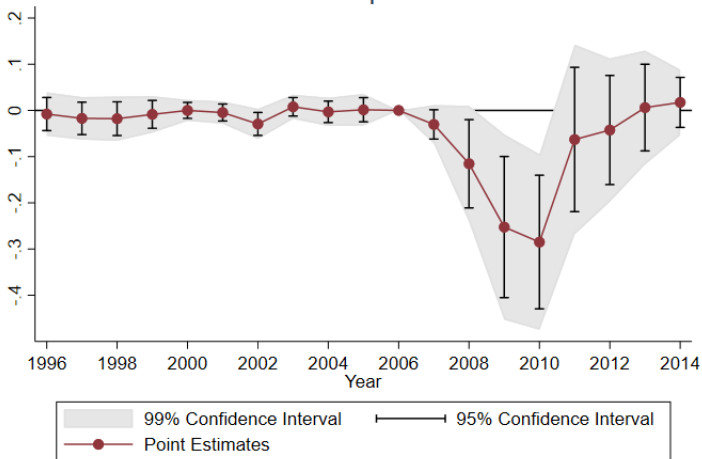
$$NPL_{b,t} = \alpha_b + \delta_t + \beta IT_b \cdot crisis + (X_b \cdot crisis_t)' \gamma + \epsilon_{b,t} \quad (1)$$

Table: Panel Regressions

	(1)	(2)	(3) NPLs	(4)	(5)
IT-adoption	-0.0239 (0.017)		-0.0283 (0.018)		
crisis	0.811** (0.349)	0.793** (0.346)			
IT-adoption × crisis	-0.160** (0.063)	-0.168** (0.065)	-0.157** (0.066)	-0.170** (0.068)	-0.143** (0.063)
N	4608	4608	4608	4608	4608
Bank FE		×		×	×
Year FE			×	×	×
Controls					×

$$NPL_{b,t} = \alpha_b + \delta_t + \sum_{\tau \neq 2006} \beta_{\tau} IT_b \cdot 1[t = \tau] + \epsilon_{b,t}$$

Effect of IT adoption on NPLs



Spurious Correlation?

IT correlated with other predictors of NPLs?

- measures of ex-ante exposure to GFC
 - pre-GFC ratios of loans, capital, and wholesale to assets, ROA, size, wages, and exposure to house-price drop
- **no correlation** with IT adoption \Rightarrow unlikely to be correlated with unobservable characteristics predicting exposure to GFC
- no higher ROA or wages \Rightarrow do not seem better managed or higher human capital
- impact of IT on NPLs unaffected by including important controls
 - \rightarrow coefficient stability to formally test for bias from unobservable variables (Altonji et al.2005, Oster 2019)

Cross Sectional Results + Falsification

	NPLs during GFC (1)	Loans pre-GFC (2)	HP Exposure (3)	Size pre-GFC (4)	Capital pre-GFC (5)	Wholesale pre-GFC (6)	ROA pre-GFC (7)	Log Wage (8)
IT-adoption	-0.183*** (0.061)	-0.648 (0.700)	-0.896 (0.664)	-0.0931 (0.057)	-0.195 (0.420)	-0.0459 (0.372)	-0.0282 (0.049)	-0.0227 (0.018)
R-squared	0.0262	0.00220	0.00550	0.00712	0.000427	0.0000383	0.00107	0.00414
N	337	337	337	337	337	337	337	337
Mean	1.54	62.69	15.83	13.9	13.02	15.92	2.55	4.84
Std.Dev.	1.13	13.8	12.06	1.1	9.43	7.41	.86	.35

▶ Coefficient stability + local spillovers

Roots of IT Adoption: Executives' Backgrounds

Most of the variation in branch-level IT adoption is driven by bank characteristics (60% of explained variation)

- conjecture: top executives with more tech-prone background
⇒ overcome frictions that prevent banks from adopting IT
- text analysis to flag technology background of pre-GFC bank executives:
 - bios of CEO, CFO, COO, President from S&P Global MI before 2007
 - search for tech-related words
 - compute an executives' "tech-orientation" score

$$Y_b = \alpha + \beta \cdot ExecIT_b + \epsilon_b \quad (2)$$

Table: NPLs, IT adoption, and Executives' "tech-orientation"

Dependent Variable:	NPLs during GFC (1)	NPLs during GFC (2)	IT adoption (3)
IT adoption	-0.138* (0.076)		
Executives' "tech-orientation"		-0.155*** (0.047)	0.0900* (0.051)
R-squared	0.0141	0.0210	0.00967
N	249	249	249

▶ Robustness

Just better managers?

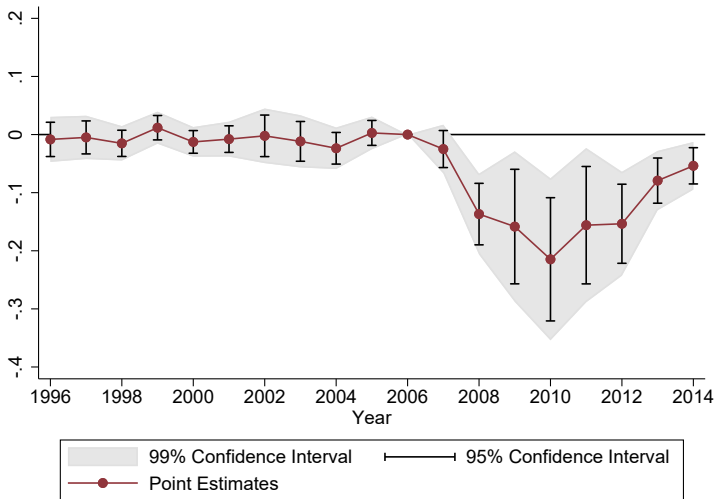
Table: Executives' "tech-orientation" and Compensation

	(1) NPLs	(2) NPLs	(3) IT-adoption	(4) IT-adoption
Executives' "tech-orientation"	-0.173*** (0.062)	-0.168*** (0.062)	0.104* (0.057)	0.104* (0.057)
Log Compensation		-0.0375 (0.060)		-0.00208 (0.053)
R-squared	0.0226	0.0244	0.0136	0.0136
N	237	237	149	149

Use compensation as proxy for human capital

- adding as control doesn't affect results
- more paid executives did not promote IT nor lowered NPLs

Figure: Time-varying Effect of tech-background of executives on NPLs



Roots of IT adoption: The Land-grant colleges

Established in 19th century in all US States to provide technical education

- students more likely to major in technical subjects and less likely to major in business and management sciences
- location of colleges does not predict the presence of BHC headquarters in a county

Conjecture: banks whose headquarters are closer to these colleges have generally a higher level of IT adoption

- \Rightarrow Use as IV
- look at different specifications (many instrument settings \rightarrow LASSO)
- results: qualitatively similar than OLS, larger in magnitude but not statistically different in most cases

▶ Table

How did high IT adopters contain the surge in NPLs?

Risk-shifting or more resilient loans?

- loan-level Data from Freddie Mac
- performance during the crisis of mortgages issued before the crisis and securitized
- detailed loan-level characteristics, such as LTV, DTI, Credit Score, postal code, and origination year

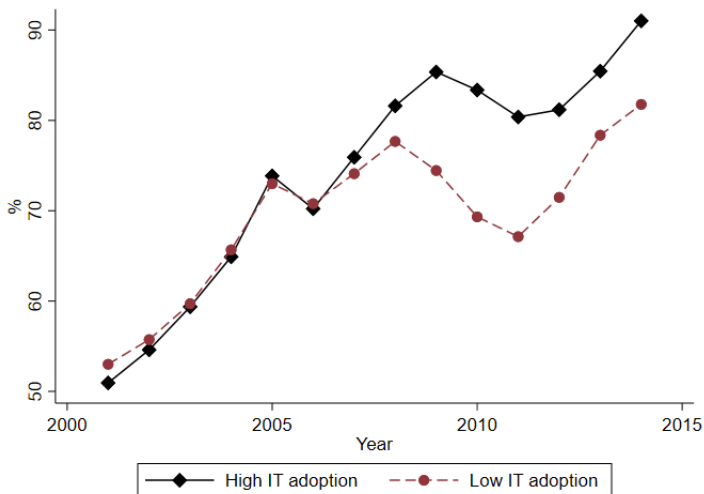
$$Delinquent_l = \alpha_{z(l)} + \delta_{o(l)} + \beta IT_{b(l)} + X_l' \gamma + \eta_l$$

Table: Loan-Level Regressions

Dependent Variable:	Delinquency during GFC				
	Share of months with past due > 90 days				
	(1)	(2)	(3)	(4)	(5)
IT adoption	-0.471** (0.191)	-0.459** (0.169)	-0.348** (0.145)	-0.323** (0.118)	
FICO score				-2.578*** (0.284)	-1.125*** (0.181)
DTI				0.565*** (0.052)	0.248*** (0.022)
LTV				1.075*** (0.129)	0.543*** (0.056)
IT adoption × Low FICO					-0.198*** (0.064)
IT adoption × High FICO					-0.00732 (0.029)
Estimation Method	OLS	OLS	OLS	OLS	OLS
Org. Year FE		Yes	Yes	Yes	Yes
Postal Code FE			Yes	Yes	Yes
N	3,451,671	3,451,671	3,451,671	3,451,671	3,451,671
Mean	3.44	3.44	3.44	3.44	3.44
Std.Dev. of dept. var.	14.32	14.32	14.32	14.32	14.32

Does IT matter for lending?

Figure: Loans over pre-crisis Assets by pre-GFC IT-adoption



Conclusion

In this paper

- we measure the heterogeneous degree of IT-adoption of US commercial banks before the GFC
- high-IT-adopters experienced a significantly smaller increase in NPLs
- also, originated more resilient loans pre-GFC
- several pieces indicating direct role of IT adoption strengthening bank resilience

Why do these findings matter for today's debate? (different technologies...)

- danger of “this time is different” approach
- several commonalities with FinTech in lending
 - machine learning techniques are more powerful versions of the previously available statistical tools
 - digital footprint vs FICO score
- our measure predictive of others IT adoption metrics in 2016 (IT budget, adoption of Cloud Computing)

APPENDIX

Table: Robustness of Main Panel Regression

	Dependent Variable: NPLs							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IT × crisis	-0.165** (0.068)	-0.243* (0.120)	-0.158** (0.069)	-0.161** (0.063)	-0.242** (0.095)	-0.214** (0.080)	-0.380* (0.183)	-0.165*** (0.051)
Exercise	Baseline	PCs per Emp	HW IT	HW NPLs	Loans	Broad def.	As of 2006	Bank Clustering
R-squared	0.00944	0.00376	0.00794	0.0108	0.00867	0.00993	0.00530	0.00944
N	4692	5035	4692	4692	4692	4692	4655	4692
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Tech-related words

technology, engineering, math, computer, machine, system, analytic, technique, method, process, stem, efficiency, efficient, software, hardware, data, informatic

Coefficient Stability

Dependent Variable:	NPLs during GFC	
	(1)	(2)
IT-adoption	-0.183*** (0.061)	-0.157*** (0.058)
R-squared	0.0262	0.243
N		337
Mean		1.54
Std.Dev.		1.13
Other Controls included		Yes

- coefficient is stable although R-squared goes up by 10 times: we perform an omitted variable bias test (Altonji et al.2005, Oster 2019) and find no bias
 - \Rightarrow results point towards IT itself as the cause of the negative relationship

Cross Sectional Results + Local Spillover

Dependent Variable:	NPLs during GFC (1)	IT of local competitors (2)	NPLs during GFC (3)
IT-adoption	-0.183*** (0.061)	0.275*** (0.083)	-0.157*** (0.058)
IT of local competitors			0.0773 (0.047)
R-squared	0.0262	0.0750	0.243
N	337	337	337
Mean	1.54	0	1.54
Std.Dev.	1.13	1	1.13
Other Controls included			Yes

- no statistically significant local spillover

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IV Regressions

Instrument(s)	Dependent Variable: NPLs during GFC					
	OLS (1)	IV 5 closest (2)	IV All (3)	IV LASSO (4)	IV LASSO (5)	IV LASSO (6)
IT adoption	-0.183*** (0.055)	-0.949* (0.489)	-0.301** (0.127)	-0.837** (0.350)	-0.541** (0.230)	-0.546** (0.241)
N	337	337	337	337	337	337
P-value: IV = OLS		0.117	0.353	0.0619*	0.118	0.132
Controls	No	No	No	No	Yes	Yes
State FEs	No	No	No	No	No	Yes
F-stat of First Stage		2.192	9.948	14.06	12.42	10.76
Cragg-Donald Wald F		1.258	1.081	22.959	17.509	5.817
Stock and Yogo's value		10.83	10.99	16.38	16.38	16.38

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Table: Lending Regressions

Dependent Variable :	Loan Growth (crisis)			
NPLs during the GFC	-0.926*** (0.159)	-1.030*** (0.187)		
IT-adoption			0.378** (0.182)	0.331* (0.196)
R-squared	0.0127	0.0928	0.0961	0.175
N	343	336	343	336
Controls	No	Yes	No	Yes

Literature and Contributions

FinTech: e.g. Fuster et al. (2019); Berg et al. (2019); Di Maggio and Yao (2018) and many more...

- Impact of technology adoption on outcomes during systemic crisis

IT adoption in other industries: e.g. Beaudry et al. (2010); Bresnahan et al. (2002); Bloom et al. (2012); McElheran and Forman (2019)

- Focus on financial industry and financial stability

IT in banking before the GFC and the “profitability paradox”: e.g. Beccali (2007); Berger (2003); Koetter and Noth (2013)

- Different methodology, focus on financial stability, provide explanation for “profitability paradox”

Defaults and NPLs in crises: e.g. Mian and Sufi (2009, 2011); Adelino et al. (2016)

- Role of lenders’ technology

Executives and firm outcomes: e.g. Benmelech and Frydman (2015); Bertrand and Schoar (2003)

- Impact of executives’ “tech-orientation” on IT and NPLs

Magnitude

One standard deviation higher IT adoption \Rightarrow 17-13 basis points less NPLs in 2007-2010

- 9 to 11% of mean NPLs (150 bp)
- 12 to 15% of std.dev. (113 bp)

If all banks were at the 75th percentile of IT adoption \Rightarrow

- increase of NPLs lower by 6.5 to 8.5 basis points
- 6 to 8% smaller increase (actual number is 105 bp)