When Broadband Comes to Banks: Credit Supply, Market Structure, and Information Acquisition

Angelo D'Andrea[1] Marco Pelosi[2] and Enrico Sette[3]

FDIC Bank Research Conference
September 29, 2023

The views expressed are solely those of the authors and should not be interpreted as reflecting the view of the Bank of Italy

[1][3]Bank of Italy [2]UBS

Motivation

The arrival of **fast internet** is one of the most disruptive innovations in history, with a wide-ranging impact on economic activity

Fast internet changes the way **information** is acquired, processed and transferred

As an **information-intensive** industry, **banking** is particularly exposed to the effects of internet technologies (ITECs)

ITECs allow **banks** to collect and process more information, potentially reducing **asymmetric information** and agency problems in credit markets

Research question

We study the effects of **fast internet** on **bank credit supply**
We identify the mechanisms behind these effects

Research question

We study the effects of **fast internet** on **bank credit supply**
We identify the mechanisms behind these effects

Focus on **Italy** between 1998 and 2008. **Ideal laboratory**

- Document the causal effect of broadband on bank credit supply

- Shed light on the channels

- Deep mechanism− information channel (screening vs monitoring)

Research question

We study the effects of **fast internet** on **bank credit supply**
We identify the mechanisms behind these effects

Focus on **Italy** between 1998 and 2008. **Ideal laboratory**

- Document the causal effect of broadband on bank credit supply

- Shed light on the channels

- Deep mechanism— information channel (screening vs monitoring)

The paper does NOT

- Study the effect of broadband on firms (isolates credit supply, controlling for demand)
- Study online banking services (limited to households in our sample period)

Challenges

Despite the relevance, difficult to measure the **causal effect** of broadband on bank lending

- **Microdata** on access to broadband and bank loans (main+channels)
- **Endogeneity** of the availability of broadband internet

Challenges

Despite the relevance, difficult to measure the **causal effect** of broadband on bank lending

- **Microdata** on access to broadband and bank loans (main+channels)
- **Endogeneity** of the availability of broadband internet

This paper:

- **Microdata** on broadband, loans (CR), and branches' location
- **Identification**:
  features of the **BB infrastructure** (**pre-determined** -1950s- $\times$ timing of intro)

Preview of the results

- **Bank credit supply**   Extensive margin: ↑ **n. loans**
    Intensive margin: ↑ **amount of credit**
    Price of credit: ↓ **avg. interest rate**

(Intermediate) *Channels*

- Internal efficiency   ↑ **credit per employee**; ↓ **NPLs**

- Geography of loans   ↑ **markets and distance**

- Local competition   ↑ **competitors**; ↓ **concentration**

(Deep) *Mechanisms*

- Information (**monitoring**)

Related Literature

- **Broadband Internet** and the **Economy** (Röller & Waverman, 2001; Czernich et al., 2011; Forman et al, 2012; Kolko, 2012; Akerman et al. 2015; Hjort & Poulsen, 2019)

  Few works on **banking** (Keil & Ongena, 2020; Mazet-Sonilhac, 2021; D'Andrea & Limodio, 2023)

- **Technology** and **banking** (Petersen & Rajan, 2002; Berger, 2003; Hauswald & Marquez, 2003; Vives & Ye, 2021)

- **Information** in financial intermediation (Petersen & Rajan, 2002; Stein, 2002; Berger & Udell, 2004; Einav et al., 2013)

Outline

- Institutional Context

- Data

- Empirical strategy

- Results

- Mechanisms

- Conclusion

Institutional Context

Context - Italian Credit market

Italian **bank credit market**, 1998-2008

○ Bank-dependent economy (limited market-based finance)

○ Similar characteristics wrt other large European countries
  (access to the banking system, banking depth, efficiency, stability, and concentration)

○ No housing bubble

• Active role of branches throughout the process (Mocetti et al., 2017)

• Multiple bank relationships (Gobbi and Sette, 2014)

Context - Access to the ADSL in Italy

○ **Broadband Internet connection** through the asymmetric digital subscriber lines (**ADSL**)
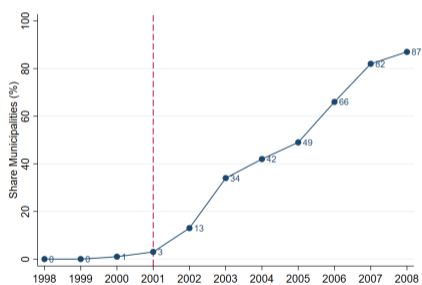
Technical Aspects of the ADSL (identification)
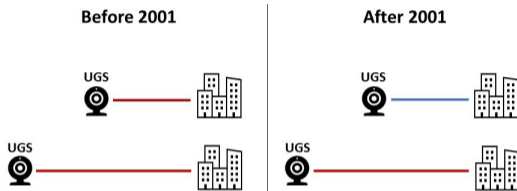
- **BB** deployment via the telephone network: 1950s; capillary; copper lines
- Municipality $\curvearrowright$ Urban Group Stage (**UGS**): fiber optic cable

Technical Aspects of the ADSL (identification)

- **BB** deployment via the telephone network: 1950s; capillary; copper lines

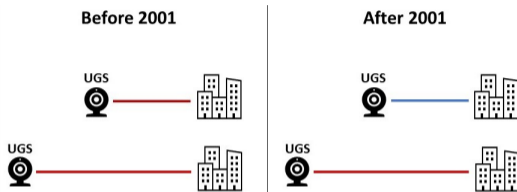- Municipality $\curvearrowright$ Urban Group Stage (**UGS**): fiber optic cable

Distance from UGS:
ER. UGSs position $\sim$ random: **pre-determined** and **irrelevant for telephone purposes**
R. Main determinant of the investment and timing of **ADSL adoption**

Data

Data

• **Location of UGSs**: Sobbrio (thanks!) used in Campante et al. (2018)

• **ADSL availability:** AGCOM. Cross section as of 2009 (just after the end of our sample period) of activable ADSL lines for each municipality

• **Loan-level data:** Bank of Italy, Credit Register. Information on the credit exposures to non-financial firms, for credit lines above 75,000 euro. Information on the municipality of the branch that is responsible for the loan (chosen by the firm)

• **Firm data:** CERVED Group, CADS database. Data on location and balance-sheet indicators of the limited companies in Italy

Table 1: Summary Statistics

	Mean	sd	p50	N
		Panel A: Municipality		
Municipalities				5,258
Years				11
North	0.58	0.49	1.00	5,258
Center	0.15	0.35	0.00	5,258
South	0.27	0.44	0.00	5,258
Number SLs	1.70	3.82	1.00	5,258
Distance SL	0.44	1.29	0.00	5,258
Number UGSs	0.11	1.03	0.00	5,258
Distance UGS	12.84	8.92	11.39	5,258
Distance prov. capital	22.32	13.03	20.35	5,212
		Panel B: Bank-municipality		
Number of loans	26,71	138.77	8	148,197
Extended credit	28,637.35	289,804.10	3,718.56	148,197
Average interest rate	5.96	2.39	5.87	109,419
		Panel C: Loan		
Extended credit	1,072.01	8,132.08	309.86	3,958,884
Average interest rate	6.57	2.90	6.00	2,047,529

Empirical Strategy

Base model

$$Y = \alpha + \beta \textit{Broadband} + X + \varepsilon$$

Endogeneity of broadband adoption

Identification
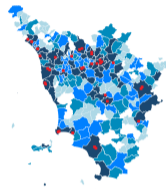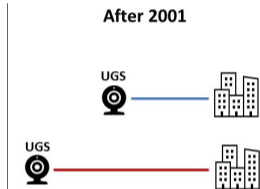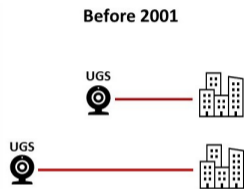
IV: distance from UGS × dummy post-2001 `BT`

Cross-sectional: distance between the municipality of the branch and the closest UGS

Time: before and after the rolling out of broadband internet (post 2001)

Empirical strategy

Reduced Form

$$Y_{(r)bmt} = v + \beta DistanceUGS \times Post2001_{mt} + X_{(r)bmt} + \alpha_{bm} + \phi_{bt} + \varepsilon_{(r)bmt}$$

$DistanceUGS \times Post2001$: instrument for broadband (Campante et al., 2018)

$X_{(r)bmt}$: Time-varying control variables

α_{bm} and ϕ_{bt}: bank-municipality and bank-year fixed effects

Supply: further condition on **firm-time** FEs (control for the effect of broadband on firms)

First-stage

Cross Section: Dep. var is the natural logarithm of ADSL activable lines in municipality m (as of 2009)

Table 2: First Stage regressions

	(1)	(2)
	Ln	Ln
	(Activable BB lines)	(Activable BB lines)
DistanceUGS	-0.437***	
	(0.060)	
DistanceUGS		-0.418***
$\times$ Post2001		(0.059)
Prov FE	X	
Mun FE		X
Year FE		X
F-statistic	53.21	50.15
Mean	5643.85	3099.72
R-squared	0.310	0.985
N	4253	7546

Results

Bank-Mun level: Loans, Amounts, and Interest rates

Dataset: bank-city-year DID graph

Table 4: Number of loans, Extended credit, Average rates

	(1)	(2)	(3)
	Ln	Ln	Avg
	(N. Loans)	(Ext. Credit)	(Rate)
DistanceUGS	-0.024***	-0.040***	0.048**
$\times$ Post2001	(0.008)	(0.011)	(0.023)
Controls	X	X	X
Bank-Mun FE	X	X	X
Bank-Year FE	X	X	X
Mean	28.64	30200612.31	6.02
R-squared	0.928	0.897	0.508
N	126160	126160	88234

Credit expansion

1 std. dev. **increase** in the **distance** (worse access to ADSL) is associated with:

- 2.4% ↓ in the **number of loans** (extensive margin)

- 4% ↓ in **credit granted** (loan volumes, intensive margin)

- 4.8 basis points ↑ in the average **interest rate** charged (smallish effect)

by a bank in the municipality

Focus on Supply

Demand $\rightsquigarrow$ **Credit Expansion** $\leftarrow$ **Supply**

- Demand

    - ↑ firm productivity (Akerman et al., 2015; Hjort & Paulsen, 2019)

    - Credit ↑, but interest rates ↓

- **Supply**

    - Isolate supply by using Degryse et al. (2019) and Khwaja & Mian (2008)

Intensive margin - supply channel

Dataset: firm-bank-city-year

Table 5: Extended credit

	(1)	(2)	(3)
	Ln	Ln	Ln
	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)
DistanceUGS	-0.044***	-0.015***	-0.014**
$\times$ Post2001	(0.006)	(0.004)	(0.007)
Controls	X	X	X
Bank-Mun FE	X	X	X
Bank-Year FE	X	X	X
ILST		X	
Firm-Year FE			X
Mean	1120004.40	1134604.40	1223090.41
R-squared	0.125	0.532	0.862
N	2964696	2910192	2520498

Credit expansion - supply channel

1 std. dev. **increase** in the **distance** leads to:

- 4.4% ↓ in **credit granted**, when not controlling for demand factors

- 1.4 - 1.5 % ↓ in **credit granted** when **controlling for demand** factors (i.e. comparing banks lending to firms in the same industry-location-size-time cluster, or, focusing on multi-bank firms, lending to the same firm)

- Almost **one-third** of the total effect of broadband is due to **credit supply**

Interest rates - supply channel

Dataset: firm-bank-city-year

Table 6: Interest rates

	(1) Avg (Rate)	(2) Avg (Rate)	(3) Avg (Rate)
DistanceUGS $\times$ Post2001	0.065*** (0.014)	0.041*** (0.012)	0.056*** (0.014)
Controls	X	X	X
Bank-Mun FE	X	X	X
Bank-Year FE	X	X	X
ILST FE		X	
Firm-Year FE			X
Mean	6.53	6.50	6.38
R-squared	0.246	0.393	0.681
N	1489136	1435625	1098313

Robustness

- **Adding controls**: several economic and socio-demographic municipal characteristics from the 2001 Census. We interact each variable with a second-order polynomial-time trend to control flexibly for the possibility of differential time trends `check`

- **Exclude metropolis**: exclude cities with more than 1m inhabitants `check`

- **Placebo broadband**: run tests on years from 1998 to 2001, assuming that the year pre-ADSL is 1999 `check`

- **Bank Specialization** (Paravisini et al. 2015): we follow Benetton & Fantino (2021) and include a control variable for bank-industry specialization `check`

Mechanisms

Mechanisms

(Intermediate) **Channels**:

- ✓ Productivity (Petersen & Rajan, 2002)

- ✓ Market Expansion – end the "tyranny of distance" (Berger, 2003; Granja et al., 2022)

- ✓ Local competition (Hauswald & Marquez, 2003; Vives & Ye, 2021)

(Deep) **Mechanisms**

- **Information frictions**
  - information flows (Berger, 2003)
  - screening vs monitoring (Petersen & Rajan, 2002)

Mechanism: internal efficiency

Dataset: bank-city-year

Table 7: Internal efficiency - Productivity and Credit quality

	(1) Ln (Loan/Empl.)	(2) Ln (Ext./Empl.)	(3) Asinh (NPLs/N. Loans)	(4) Asinh (NPLs(2y)/N. Loans)
DistanceUGS	-0.020**	-0.035***	0.001**	0.001*
$\times$ Post2001	(0.008)	(0.012)	(0.000)	(0.001)
Bank-Mun FE	X	X	X	X
Bank-Year FE	X	X	X	X
Mean	1.7	1120163.06	.01	.02
R-squared	0.816	0.803	0.303	0.475
N	124652	124652	124843	145491

Mechanism: Geographical Reach

Dataset: bank-city-year

Table 8: Geography of the loans at origination

	(1) Share (Diff. Prov.)	(2) Asinh (Distance)
DistanceUGS $\times$ Post2001	-0.008*** (0.002)	-0.023* (0.013)
Bank-Mun FE	X	X
Bank-Year FE	X	X
Mean	.16	17.87
R-squared	0.383	0.415
N	98099	94570

Mechanism: Competition

Dataset: bank-city-year

Table 9: Banks' competition

	(1)	(2)	(3)	(4)
	Ln	HHI	Share	Share
	(Competitors)		(Top 3)	(Top 5)
DistanceUGS	-0.028***	0.005***	0.005***	0.005***
× Post2001	(0.004)	(0.001)	(0.001)	(0.001)
Mun FE	X	X	X	X
Year FE	X	X	X	X
Mean	2.90	.68	.96	.99
R-squared	0.936	0.930	0.670	0.331
N	50990	60888	60888	60888

The Information channel

The information channel

- **Information matters**
  - High vs Low info sensitive contracts

- **Internal information flows**
  - Connected firms
  - Distant branches wrt the HQ (Levine et al., 2020)

- **Asymmetric information**: screening vs **monitoring**
  - Price dispersion and queries (**NEW DATA**)
    New borrowers (screening) vs current clients (monitoring)

The information channel

- **Information matters**
  - High vs Low info sensitive contracts

- **Internal information flows**
  - Connected firms
  - Distant branches wrt the HQ (Levine et al., 2020)

- **Asymmetric information**: screening vs **monitoring**
  - Price dispersion and queries (**NEW DATA**)
    New borrowers (screening) vs current clients (monitoring)

Information-sensitive loans

Table 10: Extended credit - Information-sensitive loans

	(1)	(2)	(3)	(4)
	Info-sensitive	Term loans	Credit lines	Loans BbR
	Ln	Ln	Ln	Ln
	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)
DistanceUGS	-0.043***	0.009	-0.015***	-0.040***
× Post2001	(0.005)	(0.011)	(0.004)	(0.006)
Controls	X	X	X	X
Bank-Mun FE	X	X	X	X
Bank-Year FE	X	X	X	X
Firm-Year FE	X	X	X	X
Mean	916266.29	1666857.72	888465.77	939235.79
R-squared	0.788	0.713	0.816	0.754
N	2226234	1132318	2060444	1746719

The information channel

- **Information matters**
  - High vs Low info sensitive contracts

- **Internal information flows**
  - Connected firms
  - Distant branches wrt the HQ (Levine et al., 2020)

- **Asymmetric information**: screening vs **monitoring**
  - Price dispersion and queries (**NEW DATA**)
    New borrowers (screening) vs current clients (monitoring)

Information within banks

Table 11: Extended credit - Branch-borrower vs Branch-HQ

	(1)	(2)	(3)	(4)	(5)
	W/out	W/out	W/out	Diff.	Same
	25th pc	50th pc	75th pc	HQ Prov.	HQ Prov.
	Ln	Ln	Ln	Ln	Ln
	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)
DistanceUGS	-0.016*	-0.014	-0.011	-0.016***	-0.001
$\times$ Post2001	(0.009)	(0.010)	(0.011)	(0.004)	(0.007)
Controls	X	X	X	X	X
Bank-Mun FE	X	X	X	X	X
Bank-Year FE	X	X	X	X	X
ILST FE				X	X
Firm-Year FE	X	X	X		
Mean	961766.52	1000414	1030260.81	1121289.72	1252514.81
R-squared	0.861	0.864	0.867	0.538	0.548
N	949155	510478	180559	2275563	570902

The information channel

- **Information matters**
  - High vs Low info sensitive contracts

- **Internal information flows**
  - Connected firms
  - Distant branches wrt the HQ (Levine et al., 2020)

- **Asymmetric information**: screening vs **monitoring**
  - Price dispersion and queries (**NEW DATA**)
    New borrowers (screening) vs current clients (monitoring)

Asymmetric information - screening

Table 12: Standard deviation of rates and Information queries at origination

	(1) Sd (Rates)	(2) Sd (Rates)	(3) Dummy (Query)
DistanceUGS	0.000	0.023	0.006
$\times$ Post2001	(0.045)	(0.046)	(0.006)
Bank-Mun FE	X		X
Bank-Mun-Score FE		X	
Bank-Year FE	X	X	X
Firm FE			X
Mean	2.07	2.12	.54
R-squared	0.206	0.362	0.529
N	52183	39884	337761

Asymmetric information - monitoring

Table 13: Standard deviation of rates and Information queries during the relationship

	(1)	(2)	(3)	(4)
	Sd	Sd	Dummy	Asinh
	(Rates)	(Rates)	(Query)	(N. Inquiries)
DistanceUGS	-0.029**	-0.035***	-0.003*	-0.049***
$\times$ Post2001	(0.012)	(0.013)	(0.001)	(0.006)
Bank-Mun FE	X		X	X
Bank-Mun-Score FE		X		
Bank-Year FE	X	X	X	X
Firm-Year FE			X	
Mean	2.02	2.03	.05	.92
R-squared	0.182	0.348	0.411	0.730
N	244989	232636	1541280	117412

Conclusion

Conclusion

We study the effect of **broadband internet** on **bank credit**

- **Expansion of credit supply** (↑ loans, ↓ rates)

  ○ Increase in internal efficiency

  ○ Increase in geographical reach

  ○ Increase in local competition

  • **Information channel** (more info at the monitoring stage)

Micro evidence of the effects of ICTs on the industry structure and banks' strategies

THANK YOU!

My research can be found at:

https://sites.google.com/view/angelodandrea

Appendix

Balancing of Covariates

Table 14: Balance Table on Pre-determined municipality characteristics

	(1) Close	(2) Far	(3) Norm. diff.	(4) Obs.
Area (Sq. Km)	33.82	55.16	**(-.27)**	5071
Altitude (meters)	212.24	362.75	**(-.41)**	5071
Coast	.10	.10	(0)	5071
South	.22	.32	(-.17)	5258
Distance prov. capital	17.37	27.26	**(-.58)**	5212
Pop. young	2859.01	976.28	(.16)	5258
Pop. adults	7540.14	2434.46	(.15)	5258
Pop. old	2790.74	1004.22	(.13)	5258
Pop. university	1248.14	243.21	(.11)	5258
Families	5894.16	1944.1	(.14)	5258
Foreigners	380.81	110.72	(.10)	5258
Houses	6844.39	2781.27	(.13)	5258
Buildings	2547.41	1717.6	(.16)	5258
N. firms	1239.12	373.92	(.14)	5258
N. employees	4626.47	1191.72	(.14)	5258
SL per capita	.26	.47	**(-.37)**	5258
UGS per capita	.01	0	(.25)	5258

Aggregate Evidence

DID: `back`

- treatment = distance UGS $\geq$ median
  control   = distance UGS $<$ median

- pre = until 2001; post = after 2001
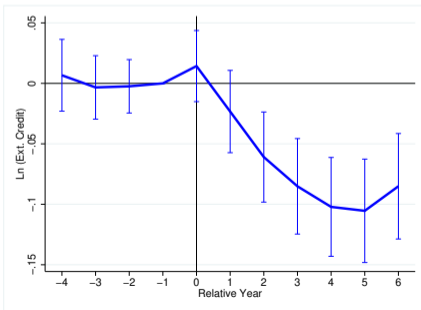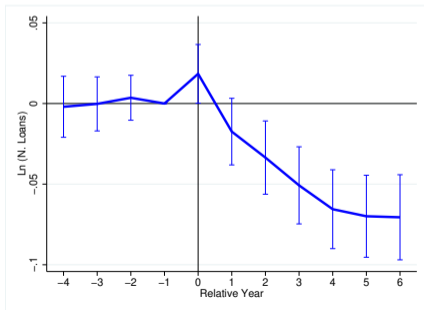
Table 15: Extended credit and Interest rates - with controls

	(1) Ln (Ext. Credit)	(2) Avg (Rate)
DistanceUGS	-0.011**	0.036**
$\times$ Post2001	(0.006)	(0.017)
Controls	X	X
Controls 2	X	X
Bank-Mun FE	X	X
Bank-Year FE	X	X
Firm-Year FE	X	X
Mean	1224550.35	6.38
R-squared	0.862	0.681
N	2511703	1094002

Table 16: Extended credit and Interest rates - without large cities

	(1) Ln (Ext. Credit)	(2) Avg (Rate)
DistanceUGS	-0.024***	0.051***
× Post2001	(0.005)	(0.015)
Controls	X	X
Bank-Mun FE	X	X
Bank-Year FE	X	X
Firm-Year FE	X	X
Mean	1017539.33	6.33
R-squared	0.874	0.682
N	2153678	954705

Table 17: Extended credit and Interest rates - placebo

	(1) Ln (Ext. Credit)	(2) Avg (Rate)
DistanceUGS	0.001	0.028
× Post2001	(0.004)	(0.022)
Controls	X	X
Bank-Mun FE	X	X
Bank-Year FE	X	X
Firm-Year FE	X	X
Mean	1056604.90	6.72
R-squared	0.861	0.710
N	594672	218318

Table 18: Extended credit and Interest rates - bank specialization

	(1) Ln (Ext. Credit)	(2) Avg (Rate)
DistanceUGS	-0.016**	0.039***
× Post2001	(0.007)	(0.014)
Controls	X	X
Bank-Mun FE	X	X
Bank-Year FE	X	X
Firm-Year FE	X	X
Mean	1223090.41	6.38
R-squared	0.862	0.681
N	2520498	1098313

Extensions: Firms' heterogeneity

Table 19: Extended credit - Firms' heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
		Size			Riskiness	
	Micro	Small-Medium	Large	Safe	Vulnerable	Risky
	Ln	Ln	Ln	Ln	Ln	Ln
	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)	(Ext. Credit)
DistanceUGS	-0.001	-0.014**	-0.014	-0.011	-0.013*	-0.018***
× Post2001	(0.006)	(0.007)	(0.013)	(0.009)	(0.007)	(0.005)
Controls	X	X	X	X	X	X
Bank-Mun FE	X	X	X	X	X	X
Bank-Year FE	X	X	X	X	X	X
Firm-Year FE	X	X	X	X	X	X
Mean	327724.23	708302.07	7140432.43	1237072.46	1219495.00	1192879.33
R-squared	0.860	0.849	0.744	0.865	0.858	0.856
N	689344	2316732	201215	1980588	848046	531022