

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

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

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Introduction

Motivation

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

The availability of a massive amount of **information** and the ability to communicate quickly transform industries' size and operations

As an **information-intensive** business, **banking** is particularly exposed to the effects of transformations in information technologies (ITs)

Innovations in ITs 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 the arrival of **fast internet** on bank lending
We identify the effects on **credit supply**

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- Document the causal effect of broadband on bank lending supply
- Shed light on the channels
- Provide first direct evidence on info collection (screening vs monitoring)

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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

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

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This paper:

- Granular administrative **microdata** on branches' loans and location, banks' characteristics, firms' characteristics, information requests by banks on borrowers
- **Identification** strategy for access to broadband: localization of the necessary infrastructure for BB deployment (pre-determined -1950s- × timing of introduction)

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
- Heterogeneity
- Conclusion

Institutional Context

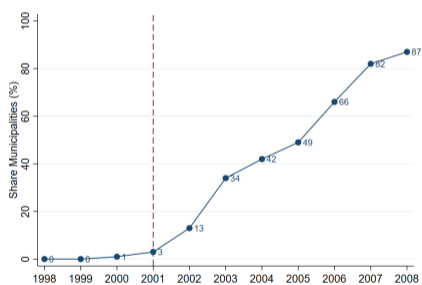
Context - Italian Credit market

Italian bank credit market, 1998-2008

- Bank-dependent economy
- Market-based finance limited to a few larger firms (Pagano et al., 1998)
- 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

- **Distance** between the municipality and the closest higher-order telecommunication exchange (the **UGS**, Urban Group Stage)

The **distance from the UGS**, irrelevant for voice communication purposes, is the main determinant of the investment needed to provide ADSL to a given area and, consequently, of the timing of **ADSL adoption** (Ciapanna and Sabbatini, 2008)

Crucial for identification strategy

Data

Data

- **Location of UGSs:** Sobbrío (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
- **Firm-Bank data:** Bank of Italy, "Centrale dei Rischi". 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)
- **Bank branches:** Bank of Italy, "Lista Succursali". All the branches operating in Italy during the period of analysis
- **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

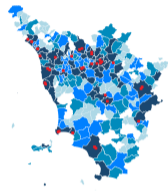
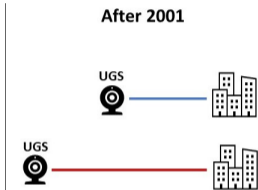
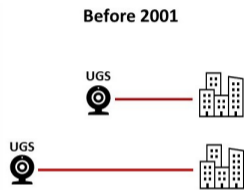
Empirical Strategy

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

$$Y_{(r)bmt} = \nu + \beta \text{DistanceUGS} \times \text{Post2001}_{mt} + X_{(r)bmt} + \alpha_{bm} + \phi_{bt} + \varepsilon_{(r)bmt}$$

DistanceUGS \times *Post2001*: instrument for broadband access (conditional on municipality FEs). See, e.g., Campante et al. (2018); Manacorda & Tesei (2020); Guriev et al. (2021)

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

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

Supply: we further condition on **firm-time** FEs (control for the contemporaneous 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 × Post2001		-0.418*** (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-Town level: Number of Loans and Loan Amounts

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 × Post2001	-0.024*** (0.008)	-0.040*** (0.011)	0.048** (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
 - Indirect evidence \uparrow firm productivity. See, e.g., Akerman et al. (2015), Ciapanna & Colonna (2019), Hjort & Paulsen (2019)
 - Online banking not widespread for firms
 - Credit \uparrow , but interest rates \downarrow
- 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 × Post2001	-0.044*** (0.006)	-0.015*** (0.004)	-0.014** (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)	(2)	(3)
	Avg (Rate)	Avg (Rate)	Avg (Rate)
DistanceUGS × 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** – screening and monitoring (Petersen & Rajan, 2002)
- **Transaction costs** – transfer of information (Berger, 2003)

Mechanism: internal efficiency

Dataset: bank-city-year

Table 7: Internal efficiency - Productivity and Credit quality

	(1)	(2)	(3)	(4)
	Ln	Ln	Asinh	Asinh
	(Loan/Empl.)	(Ext./Empl.)	(NPLs/N. Loans)	(NPLs(2y)/N. Loans)
DistanceUGS	-0.020**	-0.035***	0.001**	0.001*
× 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)	(2)
	Share	Asinh
	(Diff. Prov.)	(Distance)
DistanceUGS	-0.008***	-0.023*
× Post2001	(0.002)	(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 × Post2001	-0.028*** (0.004)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (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 (wrt the HQ) branches (Levine et al., 2020)
- **Asymmetric information, mainly monitoring**
 - Credit scores, price dispersion, and queries
 - Exploit queries on borrowers' credit history (low storage capacity in the 2000s)
 - 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 × Post2001	-0.043*** (0.005)	0.009 (0.011)	-0.015*** (0.004)	-0.040*** (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

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
× 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

**Asymmetric Information:
screening or monitoring?**

Asymmetric information - screening I

Table 12: Screening: Standard deviation of rates at origination

	(1)	(2)
	Sd	Sd
	(Rates)	(Rates)
DistanceUGS	0.000	0.023
× Post2001	(0.045)	(0.046)
Bank-Mun FE	X	
Bank-Mun-Score FE		X
Bank-Year FE	X	X
Mean	2.07	2.12
R-squared	0.206	0.362
N	52183	39884

Asymmetric information - screening II

Table 13: Screening: Information queries at origination

	(1)	(2)	(3)
	Dummy (Query)	Dummy (Synthetic)	Ln (Delta)
DistanceUGS × Post2001	0.006 (0.006)	-0.011 (0.009)	-0.004 (0.009)
Bank-Mun FE	X	X	X
Bank-Year FE	X	X	X
Firm FE	X	X	X
Mean	.54	.23	93.74
R-squared	0.529	0.731	0.506
N	337761	146557	146557

Asymmetric information - monitoring I

Table 14: Monitoring: Standard deviation of rates during the relationship

	(1)	(2)
	Sd	Sd
	(Rates)	(Rates)
DistanceUGS	-0.029**	-0.035***
× Post2001	(0.012)	(0.013)
Bank-Mun FE	X	
Bank-Mun-Score FE		X
Bank-Year FE	X	X
Mean	2.02	2.03
R-squared	0.182	0.348
N	244989	232636

Asymmetric information - monitoring II

Table 15: Monitoring: Number of Inquiries during the credit relationship

	(1)	(2)	(3)	(4)
	Dummy	Asinh	Asinh	Asinh
	(Query)	(N. Inquiries)	(N. Inquiries)	(N. Inquiries)
DistanceUGS	-0.003*	-0.003**	-0.005*	-0.049***
× Post2001	(0.001)	(0.001)	(0.003)	(0.006)
Bank-Mun FE	X	X	X	X
Bank-Year FE	X	X	X	X
Firm FE			X	
Firm-Year FE	X	X		
Mean	.05	.07	.22	.92
R-squared	0.411	0.407	0.386	0.730
N	1541280	1541280	554625	117412

Information acquisition: Wrap-up

- Effect of **broadband Internet** on **information-sensitive** loans
- Effect driven by information flows **within the banks** (info processing)
- No worsening in the observable risk profile of borrowers
- No effect on info acquisition at the **screening** stage (no finer pricing of risk, no increase in queries to the CR)
- More info acquisition at the **monitoring** stage (more likely to lend to firms with no credit history, finer pricing of risk, more queries to the CR on current customers)

More efficient info flow within the bank and gathering of transmittable info on borrowers

Heterogeneity

Conclusion

Conclusion

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

- Expansion of credit supply (\uparrow loans, \downarrow rates)
 - Increase in internal efficiency
 - Increase in geographical reach
 - Increase in local competition
 - Information channel (more info acquisition 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 16: Balance Table on Pre-determined municipality characteristics

	(1)	(2)	(3)	(4)
	Close	Far	Norm. diff.	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

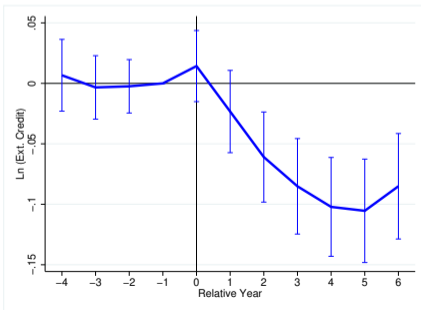
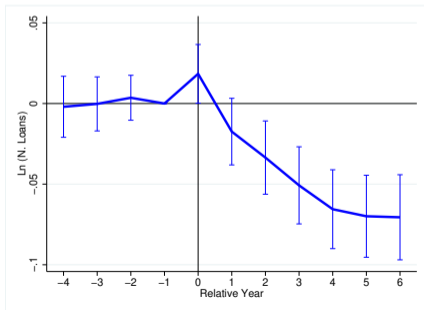


Table 17: Extended credit and Interest rates - with controls

	(1)	(2)
	Ln	Avg
	(Ext. Credit)	(Rate)
DistanceUGS	-0.011**	0.036**
× 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 18: Extended credit and Interest rates - without large cities

	(1)	(2)
	Ln	Avg
	(Ext. Credit)	(Rate)
DistanceUGS × Post2001	-0.024*** (0.005)	0.051*** (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 19: Extended credit and Interest rates - placebo

	(1)	(2)
	Ln	Avg
	(Ext. Credit)	(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 20: Extended credit and Interest rates - bank specialization

	(1)	(2)
	Ln	Avg
	(Ext. Credit)	(Rate)
DistanceUGS × Post2001	-0.016** (0.007)	0.039*** (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

back

Table 21: 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 × Post2001	-0.001 (0.006)	-0.014** (0.007)	-0.014 (0.013)	-0.011 (0.009)	-0.013* (0.007)	-0.018*** (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