

# Broadband and Bank Intermediation

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**3<sup>rd</sup> Biennial Banca d'Italia and Bocconi University Conference  
Financial Stability and Regulation**

18 March 2022

*The views expressed herein are those of the authors and should not be attributed to the Bank of Italy or the Eurosystem.*

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# Technology and Finance

Great interest on how **new technologies** shape the economy

Mobile internet

Ultra-fast broadband

Broadband

FinTech

Artificial Intelligence

Blockchain

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The financial sector is particularly exposed to technological shocks (markets, **intermediation**)

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The financial sector is particularly exposed to technological shocks (markets, **intermediation**)

**Which are the effects of new technologies on financial intermediation?**

**Which are the mechanisms behind these effects?**

**Who are the winners and losers?**



# Broadband and Banking

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**Banking** is an **information-intensive** industry which relies on cutting-edge technologies

- ✓ Deliver innovative products
- ✓ Streamline loan-making processes
- ✓ Improve back-office efficiency





## Research question:

We study the effects of **broadband internet** (BB) on **banking**

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- ✓ **Empirical setting:** Italy, 1998-2008 → **IV** for broadband (ADSL) availability
- 1. Document the causal effect of BB on bank lending to non-financial firms
- 2. Shed light on the mechanisms: focus on the organisational structure of banks
- 3. Highlight possible trade-offs related to BB diffusion

# Preview of Results

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1. **Broadband internet** has a significant effect on:

- ✓ Extensive margin:    ↑ **number of loans**
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- ✓ Price of credit:       ↓ **average interest rate**

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- ✓ Market Expansion
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3. Credit reallocation (geographical)





## **Information** in financial intermediation

- Information and new technologies: Fuster et al. (2018), Liberti and Petersen (2019)

## **Technology** and **banking**

- ITs on banking: Petersen and Rajan (2002), Berger (2003), Hauswald and Marquez (2003), Vives and Ye (2021)
- Broadband internet: D'Andrea and Limodio (2020), Keil and Ongena (2020), Ahnert et al. (2021), He et al. (2021), Mazet-Sonilhac (2021)
- FinTech: Buchack et al. (2018), Di Maggio and Yao (2018), Braggion et al. (2019), Tang (2019)

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## **Contribution:**

Identify and quantify the effect of broadband on bank lending

Focus on credit supply

Information channel

- Data and Empirical Strategy
- Results
- Mechanisms
- Credit Reallocation
- Conclusion

# Outline

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- ✓ Endogeneity of broadband internet availability



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- ✓ Need microdata on broadband and banks
- ✓ Endogeneity of broadband internet availability

## Italy, 1998-2008

- ✓ Microdata on broadband and granular administrative data on bank loans
- ✓ **Identification** strategy for broadband adoption: **IV**
  - Pre-determined broadband infrastructure (built in the 1950s)
  - Time of broadband introduction



# Data on Broadband and Banks

- **Broadband**: share of hh with access to ADSL in a municipality firms vs hh

Asymmetric scale:

0 = 0%

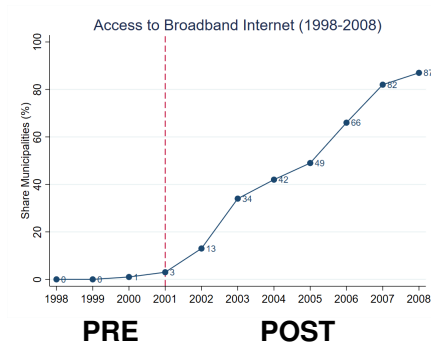
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3 = 76%–85%

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5 = above 95%



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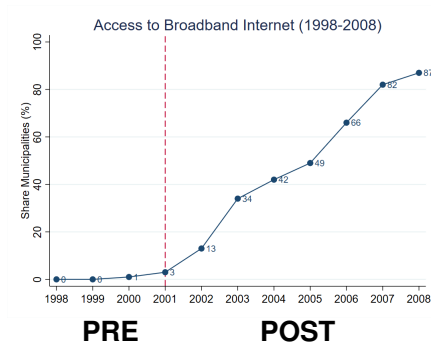
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- **Firm-Bank data:** Bank of Italy, “Centrale dei Rischi”  
**Interest rates:** Taxia, “Centrale dei Rischi”  
**Deposits and employees:** Bank of Italy, Supervisory Reports  
**Bank branches:** Bank of Italy, “Lista Succursali”  
**Firm data:** CERVED Group



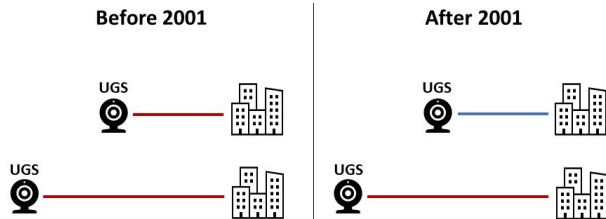
# Summary Statistics

	Mean	sd	p50	N
Panel A: Municipality				
Municipalities				5,271
Years				11
North	0.61	0.49	1.00	51,290
Center	0.15	0.36	0.00	51,290
South	0.24	0.43	0.00	51,290
Internet	2.04	2.35	0.00	42,058
Number SLs	1.79	4.04	1.00	51,290
Distance SL	0.40	1.23	0.00	51,290
Number UGSs	0.13	1.10	0.00	51,290
Distance UGS	12.49	8.87	11.07	51,290
Distance prov. capital	21.96	12.93	20.00	50,859
Panel B: Bank-municipality				
Number of loans	28.23	147.37	8	153,120
Extended credit	29,086.22	282,980.90	3,584.40	153,120
Average interest rate	6.10	1.70	5.98	86,382
Panel C: Loan				
Extended credit	1,028.48	8,159.02	299.32	4,330,369



# Identification

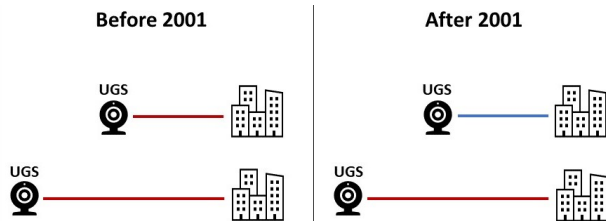
- Pre-determined infrastructure (telephone network)
- Distance from UGS
- Key for BB (fiber-optic cable)
- **Interaction**  
Changes the identification assumption ass





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**IV: distance from BB infrastructure** × **dummy post-2001** mono distr

- ✓ **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)



# Basic Specification

## OLS

$$Y_{(r)bmt} = \nu + \beta \text{Broadband}_{mt} + \gamma X_{(r)bmt} + \alpha_{(r)bm} + \phi_t + \varepsilon_{(r)bmt}$$

$r$  firm-bank,  $b$  bank,  $m$  municipality,  $t$  year

$Y$ : number of loans, loan amount, interest rate, etc.

$\text{Broadband}_{mt}$ : Internet (0-5)

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

$\alpha_{(r)bm}$  and  $\phi_t$ : bank-municipality and year fixed effects; firm-bank-municipality (and firm-year) fixed effects in some specifications

**Endogeneity** of broadband adoption (Comin and Hobijn, 2004)



## 2SLS

$$\begin{aligned} \text{Broadband}_{mt} &= \alpha + \delta Z_{mt} + \omega X_{mt} + \theta_m + \xi_t + \epsilon_{mt} \\ Y_{(r)bmt} &= \nu + \beta \widehat{\text{Broadband}}_{mt} + \gamma X_{(r)bmt} + \alpha_{(r)bm} + \phi_t + \varepsilon_{(r)bmt} \end{aligned}$$

$Z_{mt} \equiv$  IV: distance from UGS  $\times$  *post2001*

Local fixed effects: bank\*municipality or firm\*bank\*municipality FEs, year FEs

BT

parallel trends



	0-5 (Internet)	Dummy (Good access)	Dummy (Some access)	Years since good internet
distance UGS × post 2001	-0.053*** (0.007)	-0.010*** (0.001)	-0.009*** (0.001)	-0.035*** (0.005)
Mun FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Method	OLS	OLS	OLS	OLS
F-statistic	52.6	46.5	46.6	47.2
Mean	2.041	0.437	0.451	1.206
R-squared	0.760	0.750	0.763	0.818
N	41932	41932	41932	41932

# Outline

- Data and Empirical Strategy
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# The Effect of Broadband on Lending

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**Dataset:** bank-city-year

	(1)	(2)	(3)
	Ln	Ln	Avg.
	(N. loans)	(Ext. credit)	Interest Rate
Internet	0.039** (0.016)	0.081*** (0.024)	-0.107** (0.045)
Bank-Mun FE	X	X	X
Year FE	X	X	X
Method	IV	IV	IV
F-statistic	134.9	133.6	318.4
Mean	28.8	30094.4	6.8
N	124243	123762	112834



- Estimates from 2SLS show positive and statistically significant coefficients
- Internet interquartile range = 3 = “high broadband”
- Moving from zero to high broadband coverage is associated with (2SLS estimates):
  - a 12% (0.08 of a s.d.) increase in the number of loans issued
  - a 28% (0.13 of a s.d.) increase in the amount of loans granted
  - a 30 b.p. (0.18 of a s.d.) decrease in the average interest rate



Credit expansion: ↑ **credit** granted and ↓ **interest rate**

- DiD check
- Different measures of broadband coverage check
- Adding controls (differential time trends) BT check
- Placebo broadband check

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# Isolating Supply



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

# Isolating Supply

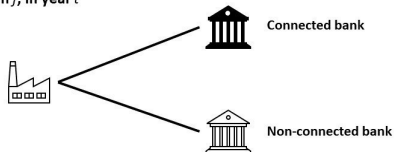
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Demand  $\rightsquigarrow$  **Credit Expansion**  $\leftarrow$  **Supply**

- Khwaja and Mian (2008)

Firm  $f$ , in year  $t$



- Degryse et al. (2019)

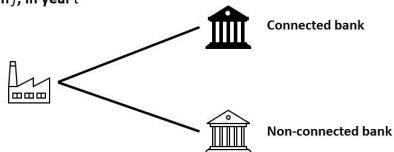
Industry-location-size-time FEs

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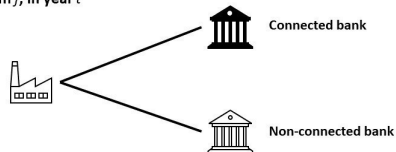
	(1) Ln (Ext. credit)	(2) Ln (Ext. credit)	(3) Ln (Ext. credit)
Internet	0.114*** (0.017)	0.066*** (0.009)	0.040*** (0.009)
Bank-Year FE	X	X	X
Bank-Mun FE	X	X	X
Firm-Year FE		X	
ILST FE			X
Method	IV	IV	IV
F-statistic	259.8	350.8	293.6
Mean	1057.8	1180.7	
N	2115962	1752272	2055783

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	Ln	Ln	Ln
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Internet	0.114*** (0.017)	0.066*** (0.009)	0.040*** (0.009)
Bank-Year FE	X	X	X
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Method	IV	IV	IV
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**Supply** accounts for between 35 and 58% of the total effect



Theoretical literature on how **ICTs** affect **credit supply**

- Increase screening and monitoring capacity (Petersen and Rajan, 2002)
- Reduce communication costs – transfer of information (Berger, 2003)

# Mechanisms

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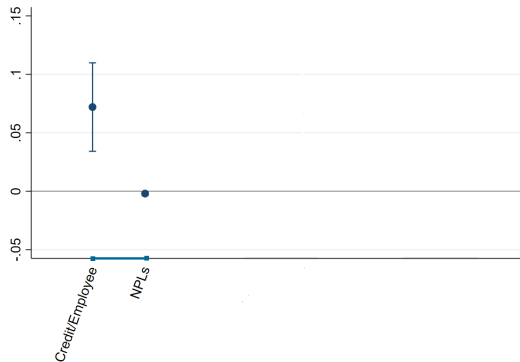
These in turn may raise:

- ✓ Productivity (Petersen and Rajan, 2002)
- ✓ Market Expansion – end the “tyranny of distance” (Berger, 2003)
- ✓ Local competition (Hauswald and Marquez, 2003; Vives and Ye, 2021)



## Mechanisms (cont.)

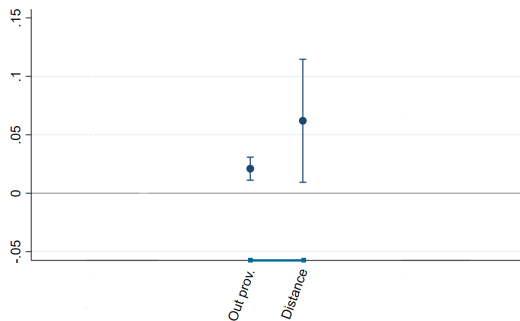
✓ Productivity (↑ Credit per employee by 24%)



	(1) Ln (Ext./Empl.)	(2) Ln (NPLs/N.Loans)
Internet	0.072*** (0.023)	-0.002** (0.001)
Year FE	X	X
Bank-Mun FE	X	X
Method	IV	IV
F-statistic	123.4	134.9
Mean	1487.2	0.02
N	116743	124243

# Mechanisms (cont.)

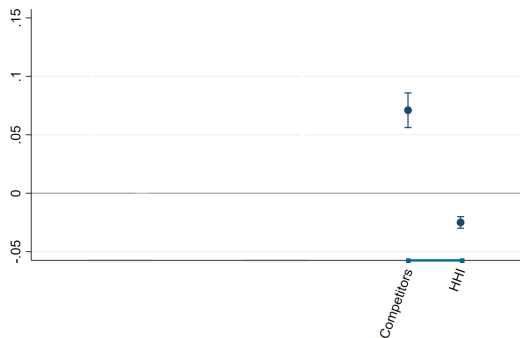
- ✓ Productivity (↑ Credit per employee by 24%)
- ✓ Market Expansion (↑ Pr. Out of Province by 6%; ↑ Avg. Distance by 18%)



	(1) Share (≠ Prov.)	(2) Asinh (Avg. Distance)
Internet	0.021*** (0.006)	0.062* (0.032)
Year FE	X	X
Bank-Mun FE	X	X
Method	IV	IV
F-statistic	94.0	133.5
Mean	0.16	18.17
N	81851	79425

## Mechanisms (cont.)

- ✓ Productivity (↑ Credit per employee by 24%)
- ✓ Market Expansion (↑ Pr. Out of Province by 6%; ↑ Avg. Distance by 18%)
- ✓ Local competition (↑ N. Competitors by 20%; ↓ Conc. Ratios by 6%)



	(1)	(2)
	Ln	
	Competitors	HHI
Internet	0.071*** (0.009)	-0.025*** (0.003)
Year FE	X	X
Mun FE	X	X
Method	IV	IV
F-statistic	52.3	88.4
Mean	3.28	0.68
N	41858	49566

- ✓ **Broadband internet** → **credit expansion**

## Supply channel:

- ✓ Productivity           ↑
- ✓ Market expansion   ↑
- ✓ Local competition   ↑

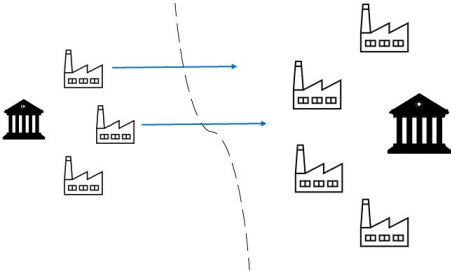
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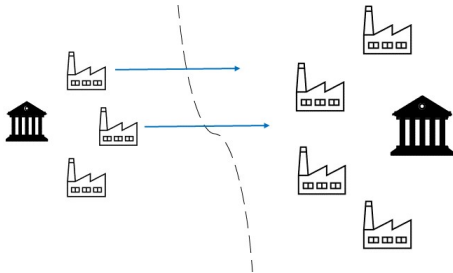




# Digital Highways



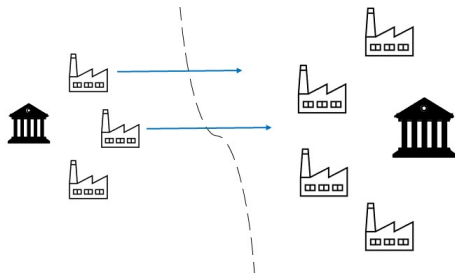
# Digital Highways



Credit flows:

**PERIPHERY** → **CENTER**

# Digital Highways



Credit flows:

**PERIPHERY** → **CENTER**

credit reallocation

- ✓ **Winners and losers** (areas, banks, business sectors) small branches target
- ✓ **Local underdevelopment** (**No** - preliminary evidence) real
- ✓ **Financial stability** (**debate** on bank concentration and fragility of the banking system)

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- ✓ Channels:
  - ✓ Rise in productivity
  - ✓ Market expansion
  - ✓ More intense local competition



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  - ✓ More intense local competition
- ✓ Heterogeneous effects
  - ✓ Credit reallocation → Banks in big cities exploit fast internet the most

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  - ✓ Rise in productivity
  - ✓ Market expansion
  - ✓ More intense local competition
- ✓ Heterogeneous effects
  - ✓ Credit reallocation → Banks in big cities exploit fast internet the most
- ✓ **Next: Reduced form**, direct evidence, heterogeneity, real effects, financial stability

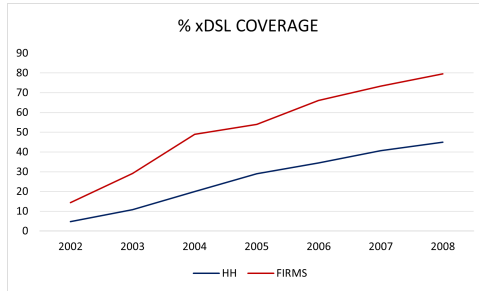
**THANK YOU!**

**Angelo D'Andrea**

angelo.dandrea@unibocconi.it

# **APPENDIX**

# ADSL Firms and HHs



back

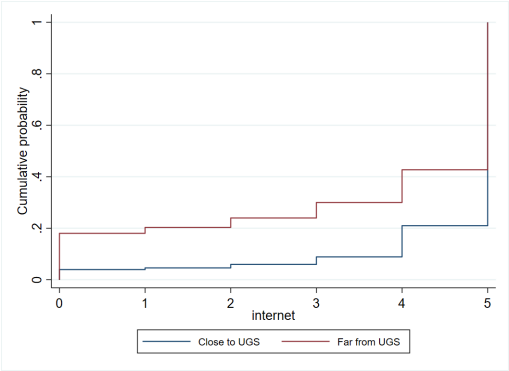
# Identification Assumption

Whatever correlation existed between the distance to the closest UGS and relevant municipality characteristics, this did not change at the time of the introduction of the ADSL (Campante et al., 2018)

We identify the effect of the change in the impact of distance on the outcomes of interest, under the assumption that any change in that impact occurs solely through the intro of Broadband Internet

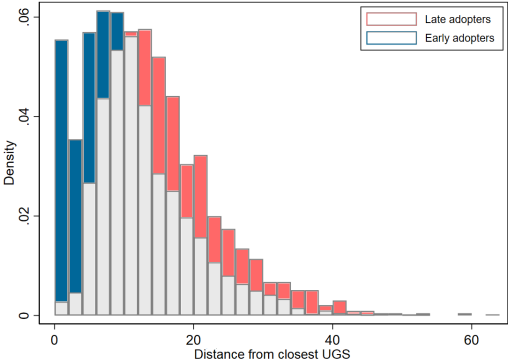
[back](#)

# Monotonicity



back

# Distance from the Closest UGS

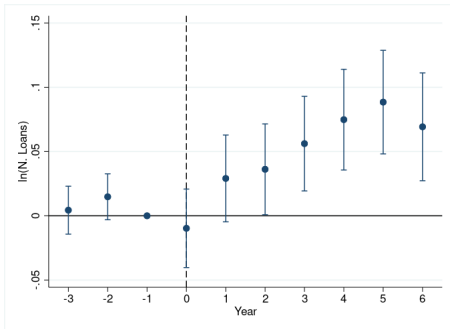




# Parallel trends

## DiD on the extensive margin close vs far

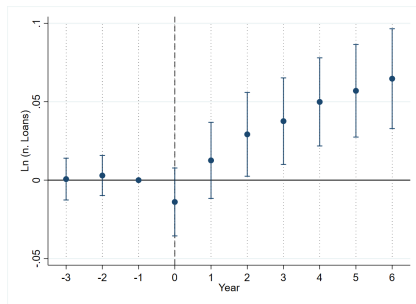
- treatment = early adopters  
control = late adopters
- pre = until 2001; post = after 2001



# Parallel trends (cont.)

## DiD on the extensive margin

- treatment = close to UGS  
control = far from UGS
- pre = until 2001; post = after 2001

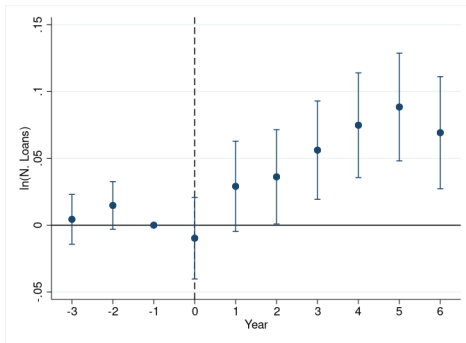


	Close	Far	Norm. diff.	N.
Surface	35.31	55.06	(-.24)	4400
Altitude	205.08	336.16	<b>(-.37)</b>	4400
North	.69	.55	(.21)	4528
SL per capita	.24	.43	<b>(-.39)</b>	4528
Dist. province capital	2.67	3.23	<b>(-.61)</b>	4492
Pop. growth	.07	.04	<b>(.3)</b>	4361
Adults growth	.05	.02	(.21)	4528
Graduate growth	.88	.8	(.15)	4528
Foreigners growth	2.53	2.83	(-.09)	4524
Buildings growth	.13	.1	(.13)	4528
Firms growth	.1	.04	<b>(.31)</b>	4528
Employees growth	.05	.05	(.02)	4528
Income p.c. growth	.19	.17	(.19)	4361

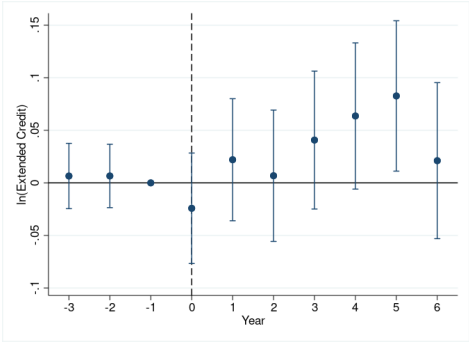
# Robustness: DiD

**DiD:** intensive

- treatment = internet  $\geq 50\%$  in 2006  
control = internet  $< 50\%$  in 2006
- pre = until 2001; post = after 2001



# Robustness: DiD (cont.)



back

# Robustness: Broadband Measures

back

	Ln	Ln	Ln	Ln
	(N. loans)	(N. loans)	(N. loans)	(N. loans)
Internet	0.039** (0.016)			
Years Since Good Internet		0.063** (0.026)		
Good access			0.226** (0.095)	
Some access				0.254** (0.107)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
F-statistic	134.9	121.7	117.9	118.3
N	124243	124243	124243	124243

# Robustness: Controls

Dataset: bank-city-year [back](#)

	(1)	(2)	(3)	(4)
	Ln	Ln	Ln	Ln
	(N. loans)	(Ext. credit)	(N. loans)	(Ext. credit)
Internet	0.006** (0.002)	0.007 (0.004)	0.029* (0.016)	0.064*** (0.023)
Controls	X	X	X	X
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			142.5	141.2
Mean	28.9	30240.062	28.9	30240.062
R-squared	0.902	0.861		
N	123350	122869	123350	122869

# Robustness: Placebo Broadband

Dataset: bank-city-year [back](#)

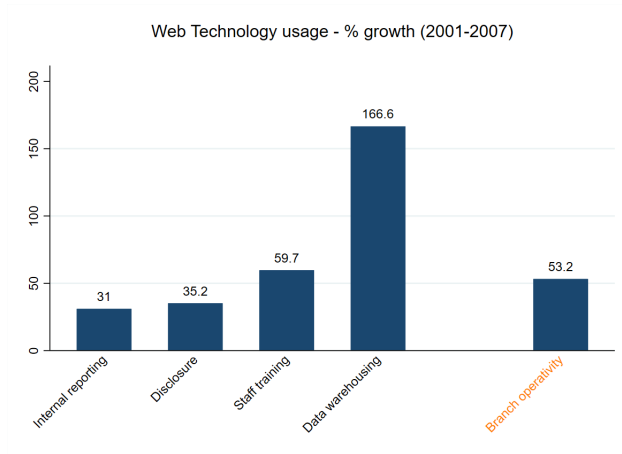
	(1)	(2)	(3)	(4)
	Ln	Ln	Ln	Ln
	(N. loans)	(Ext. Credit)	(N. loans)	(Ext. Credit)
Internet placebo	0.000	-0.005	0.008	0.001
	(0.003)	(0.005)	(0.009)	(0.015)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
Mean	26.12	24395.638	26.12	24395.638
R-squared	0.932	0.906	-0.000	-0.000
N	72277	71905	72277	71905



# Balance Table

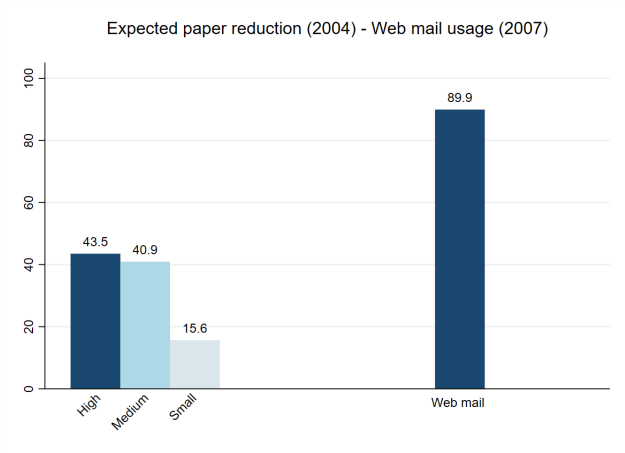
	Close	Far	Norm. diff.	N.
Surface	35.31	55.06	(-.24)	4400
Altitude	205.08	336.16	<b>(-.37)</b>	4400
North	.69	.55	(.21)	4528
SL per capita	.24	.43	<b>(-.39)</b>	4528
Dist. province capital	2.67	3.23	<b>(-.61)</b>	4492
Pop. growth	.07	.04	<b>(.3)</b>	4361
Adults growth	.05	.02	(.21)	4528
Graduate growth	.88	.8	(.15)	4528
Foreigners growth	2.53	2.83	(-.09)	4524
Buildings growth	.13	.1	(.13)	4528
Firms growth	.1	.04	<b>(.31)</b>	4528
Employees growth	.05	.05	(.02)	4528
Income p.c. growth	.19	.17	(.19)	4361

# Use of the Web



Source: Italian Banking Association (ABI). Economic Analysis, 2002-2008

# Use of the Web (cont.)



Source: Italian Banking Association (ABI). Economic Analysis, 2002-2008

# Credit Reallocation

**Dataset:** origination bank-city-year [back](#)

	(1)	(2)
	Share	Share
	(New loans in CR)	(New loans already client)
Internet	0.015** (0.007)	0.012** (0.005)
Year FE	X	X
Bank-Mun FE	X	X
Method	IV	IV
F-statistic	112.0	112.0
Mean	0.86	0.10
N	72951	72951

# Small Municipalities

**Dataset:** firm-bank-city-year [back](#)

	(1)	(2)	(3)	(4)
	Ln	Ln	Ln	Ln
	(Ext. credit)	(Ext. credit)	(Ext. credit)	(Ext. credit)
Internet	0.001	-0.001	-0.031	-0.005
	(0.003)	(0.004)	(0.029)	(0.046)
Controls	X	X	X	X
Bank-Year FE	X	X	X	X
Bank-Mun FE	X		X	
Firm-Year FE		X		X
Firm-Branch FE		X		X
Method	OLS	OLS	IV	IV
F-statistic			22.4	18.9
R-squared	0.243	0.967		
N	130647	47709	130647	47709

# Branches Expansion

Dataset: bank-city-year [back](#)

	(1)	(2)	(3)	(4)
	Ln	Ln	Ln	Ln
	(Branches)	(Branches)	(Branches)	(Branches)
		Small		Small
Internet	0.004*** (0.001)	0.000 (0.000)	0.054*** (0.006)	0.003 (0.002)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			111.9	166.2
Mean	1.88	1.04	1.88	1.04
R-squared	0.950	0.894		
N	137691	45837	137691	45837

# “Easy Target”

**Dataset:** origination firm-bank-city-year [back](#)

	Dummy (Firm in small muni,out prov, with internet)	Dummy (Firm in small muni,out prov, with internet)
Internet	0.007*** (0.002)	0.054*** (0.018)
Bank-Year FE	X	X
Bank-Mun FE	X	X
Firm FE	X	X
Method	OLS	IV
F-statistic		86.2
Mean	0.04	0.04
R-squared	0.598	
N	550197	550197

# Real Effects

Dataset: city-year [back](#)

	All mun.		Small mun.	
	(1)	(2)	(3)	(4)
	ln	ln	ln	ln
	(Income)	(Inc. p.c.)	(Income)	(Inc. p.c.)
Internet	0.040*** (0.003)	0.017*** (0.002)	0.064*** (0.007)	0.021*** (0.004)
Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	IV	IV	IV	IV
F-statistic	52.6	53.7	122.8	122.8
Mean	123.914	10.062	25.125	9.988
N	33268	33268	16630	16630