Broadband and Bank Intermediation *

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Abstract

This paper studies the effects of access to broadband internet on bank credit to non-financial firms. We rely on granular micro-data from Italy and an empirical strategy based on IV. We find that banks with branches in municipalities reached by fast internet increase loan supply, both at the extensive and the intensive margin, and reduce credit price. We document that the expansion of credit goes through three main channels: banks increase productivity; they expand their geographical scope; and competition in municipalities reached by broadband internet intensifies. To increase lending, fast internet also leads banks to make internal credit reallocation by moving credit away from smaller municipalities.

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1 Introduction

The arrival of fast internet has been one of the most disruptive innovations in history, and as such, it had a substantial impact on economic activity. The availability of a massive amount of information and the ability to communicate them quickly transformed many industries' size and operations. As an information-intensive business, banking was particularly prone to this transformation. When information flows are limited, banks face higher information asymmetries, communication costs, and more severe agency problems (Leland and Pyle, 1977). Innovations in information and communication technology, from hardware such as computers to software such as credit scoring and client profitability programs, up to the recent diffusion of internet technologies, mitigate these frictions and can play a crucial role in shaping banking activity (Mishkin and Strahan, 1999). As proof of this, banks have long relied on cutting-edge technologies to deliver innovative products, streamline loan-making processes and improve their back-office efficiency (Frame et al., 2018).

Despite its relevance and the importance of the banking industry for the smooth functioning of the economy (Levine, 1997), the evidence on the effects of fast internet on bank activities, in particular lending, is scant[1] [2]. A key reason for this is the lack of high-quality administrative data and of an identification strategy to deal with the endogeneity of the introduction of the internet[3].

This paper studies the effect of access to broadband internet on bank credit to non-financial firms, and it sheds light on the mechanisms behind this effect. We rely on granular micro-data from Italy and instrument the staggered arrival of broadband through the historical presence of telephone infrastructures, controlling for prior local characteristics. We find that fast internet favors credit expansion and is associated with a reduction in the average price of credit. Then, we separately identify the component of the total effect which is attributable to supply and show that it accounts for half of the total effect[4]. When dealing with the mechanisms behind our results, we document that broadband internet affects the organizational design of banks, with effects on banks' productivity, market geography, and local banking competition.

We resort to a unique dataset from Italy that includes detailed information on the dates of broadband internet arrival and the geographical location of the necessary infrastructure for broadband. This information is matched with loan-level data from the comprehensive Italian credit register and other administrative details on the location of bank branches and banks' assets, liabilities, and employees. We observe these data between 1998 and 2008, which mark the expansion

[1] D'Andrea and Limodio (2019) is an exception. They focus on the effects of high-speed internet in Africa and show that fast internet favored new financial technologies in the interbank market, thus alleviating banks' liquidity risk and promoting lending to the private sector.

[2] By contrast, a large literature studies the effects on the banking industry of regulatory reforms (Bertrand et al., 2007), removals of barriers to entry (Cetorelli and Strahan, 2006), shocks of various nature (financial, real, natural disasters), institutional quality, and even the role of culture and ethnicity (Caprio et al., 2007; Grosjean, 2011; Calomiris and Carlson, 2016; Pascali, 2016; Fisman et al., 2017; D'Acunto et al., 2019).

[3] The latter refers to the fact that local economic conditions can influence the rolling of internet infrastructures.

[4] Indeed, the effect of fast internet on lending is an equilibrium effect determined by supply and demand factors. On the one hand, broadband access may favor credit expansion through a more efficient acquisition and process of information. On the other hand, it may boost credit demand through an increase in firms' productivity and profitability.

of broadband internet in Italy, and perform an econometric analysis based on instrumental variables (IV).

Measuring the impact of access to broadband on credit is challenging. Since high-speed internet is not randomly assigned to municipalities, bank credit could be affected by hidden factors other than (but related to) broadband connection. To deal with this source of endogeneity, we use an instrumental variable strategy and leverage the position of the municipality in the pre-existing voice telecommunications (telephone) infrastructure to instrument for broadband availability (Campante et al., 2018). As fast internet services in Italy could only be offered in municipalities connected to high-order telecommunication exchanges via optic fiber, we use the distance between the municipality centroid and these exchange infrastructures (a proxy for the required investment to connect the municipality with the fiber) as a source of variation for the availability of high-speed internet (Ciapanna and Sabbatini, 2008). Because the pre-existing telecommunication network was not randomly distributed, our instrumental variable relies on the interaction between the abovementioned distance and a dummy variable for the period after broadband internet became available. Our identification assumption is that whatever correlation existed between the distance and relevant municipality characteristics, this did not change at the time of introduction of broadband for reasons other than broadband itself. Results from our 2SLS estimates shed light on the causal effect of fast internet on bank credit.

The main findings of the paper can be summarized as follows. We find a positive and statistically significant effect of broadband internet on the extensive and intensive margin of the credit relationship. Going from zero to high broadband coverage is associated with an increase in the number of loans issued by banks of 12% (0.08 of a standard deviation, s.d.), and an increase in the amount of credit granted of 28% (0.13 of a s.d.)[5]. Then, we find a negative and statistically significant effect of broadband on the price of bank credit. Moving from zero to high coverage of high-speed internet is associated with a decrease in the average interest rate of 30 b.p. (0.18 of a s.d.).

These results represent equilibrium outcomes that take into account both demand and supply. The effect of fast internet on credit demand has been only indirectly documented in the literature by focusing on firm's productivity (Akerman et al., 2015). On the other hand, the evidence on the effect of broadband on bank's internal activity and its organizational design remains scant. However, there is consensus that information technologies have revolutionized the way lending is conducted by traditional banks (He et al., 2021). For that reason, in this paper, we apply a particular lens on how broadband internet affects bank credit supply.

The granularity and the structure of our data help us isolate credit supply from other confounding factors. Similar to Khwaja and Mian (2008), in the most demanding specification, we exploit the panel structure of the data and the diffusion of multiple bank relationships in Italy

[5] ”High” broadband coverage means at least 75% of the population in the municipality connected to fast internet.

(Gobbi and Sette, 2014) to compare the amounts of credit extended to firms that have relationships with banks in municipalities served differently by broadband. In this way, we can isolate credit supply from demand, and we can exclude that total credit variation is driven by firm-specific needs (which may be affected by the availability of fast internet). We use high dimensional fixed-effect regressions that control for time-varying firms' loan demand and for features specific to the firm-bank-municipality relationship. Finally, we add bank-year fixed effects to control for time-varying credit variation that originates from bank-specific policies.

When restricting the analysis on credit supply by controlling for firm-level demand for credit, we find that branches in municipalities reached by fast internet expand their amount of credit 19% more than other branches (0.14 of a s.d.).

To qualify the effect of broadband internet on credit supply, we study how banks' productivity, geographical scope, and local competition are affected by fast internet. As far as the first is concerned, we show that the lending efficiency of banks, measured by banks' labor productivity and credit quality, increases as a consequence of broadband availability. Internet helps increase credit extended per employee by 24%. Standard models suggest that a surge in loan supply may lead to a worse quality distribution (Berger and Udell, 2004; Foos et al., 2010). If anything, in our setting, we find that credit quality improves as the share of non-performing loans (NPLs) per bank decreases. These findings are in line with Petersen and Rajan (2002) and Berger (2003), who argue that richer hard information and more efficient back-office technology helps both ex-ante screening and ex-post monitoring.

Moreover, the geographical reach of banks widens. Banks operating in municipalities reached by fast internet expand their markets beyond standard geographical borders, which typically coincide with provinces. We find that they are more likely to originate loans outside the province where they are located. In addition, the physical distance between banks' municipalities and borrowers increases, too. These results are consistent with the view that improved screening and monitoring, together with a reduction in communication costs, allow banks to reduce the diseconomies of distance and increase "proximity" (Berger, 2003; Felici and Pagnini, 2008).

Finally, municipalities reached by fast internet experience a rise in banking competition. This is confirmed by the increase in the number of available bank brands in the municipality and the dynamics of standard proxies of competition. The concentration ratio of the top 5 and top 3 banks decreases, as well as the Herfindahl–Hirschman Index (HHI) of deposits. Consistently, we find that increased competition pushes down loan prices (in line with Hauswald and Marquez (2003); Vives and Ye (2021)).

The arrival of fast internet has additional effects on banks and borrowers. To this extent, we find that banks tend to implement internal credit reallocation across municipalities, with new loans managed by larger, more distant branches. In the test using granular data, we show that broadband internet does not have any effect on credit supply for branches located in small municipalities[6]. At the same time, banks tend to open new branches in places reached by fast internet, but not if these places are small. Access to high-speed internet creates digital highways that carry bank credit from connected peripheries to the center, (i.e., from smaller municipalities connected to broadband towards bigger municipalities). Yet, this local credit desertification is not accompanied by slower economic growth. Broadband access boosts GDP per capita both in bigger and smaller municipalities, showing off the virtues of the credit flows that broadband contributes to creating.

Our results are robust to several robustness checks, most notably, different measures of broadband coverage and the inclusion of several control variables at the municipality level, aiming to control municipality time trends. We also run placebo IV specifications for the years before fast internet was available and simulate internet availability as if we were in the post broadband period. Reassuringly, we find no impact of broadband internet on bank credit.

This paper builds and extends on different strands of the literature. It contributes to the broad literature on the effects of new telecommunication infrastructures on the economy (Roller and Waverman, 2001; Forman et al., 2009; Czernich et al., 2011; Kolko, 2012; Akerman et al., 2015; Pascali, 2017; DeStefano et al., 2018; Donaldson, 2018; Steinwender, 2018; Hjort and Poulsen, 2019). In this respect, it is one of the few that concentrate on the role of ICTs in banking. D'Andrea and Limodio (2019) exploit the staggered arrival of fiber-optic submarine cables in Africa and show that high-speed internet lifts banking. They highlight one possible mechanism behind this effect that is related to more efficient interbank markets. Lin et al. (2021) study China in the late 19th century and show that the telegraph significantly expanded banks' branch networks. This paper adds to the existing literature by focusing on a specific technology, broadband internet, and a specific instrument, enhanced bank credit to firms, and by showing the channels through which it operates.

The paper also contributes to the literature on information technology and banking. Hauswald and Marquez (2003) provide a theoretical framework on the effects of new information technologies on loan prices and competition. They show that the advent of new information technologies generates ambiguous effects depending on whether these technologies are readily available to all competitors rather than exclusive use to some of them. Using similar arguments, Vives and Ye (2021) show that IT progress involves an increase in competition intensity when it weakens the influence of bank-borrower distance on monitoring costs. Petersen and Rajan (2002) and Berger (2003) provide intuitions and empirical evidence on the effects of new technologies on the distance between lenders and borrowers. New technologies allow financial intermediaries to substitute soft information with hard information, thus increasing the distance between borrowers and lenders. Related to this topic, Felici and Pagnini (2008) find that the geographical reach of entry decisions increases for those banks that resort more to information and communication technolo-

[6] We define a municipality as small if its population is below the in-sample median of 4,639 inhabitants.

gies and that the latter has important pro-competitive effects. Degryse and Ongena (2005) and Keil and Ongena (2020) show the effects of new technologies on bank de-branching, while in a recent paper, Ahnert et al. (2021) show that job creation by young firms in the US is stronger in counties that are more exposed to IT-intensive banks. Our paper adds to this literature by showing the effects of broadband internet on bank lending and the organizational design of banks. The paper is also close to the literature on internet banking and bank performance (DeYoung, 2005; Ciciretti et al., 2009) and that of information technology and financial stability (Pierri and Timmer, 2020). Finally, the paper builds a bridge between the traditional literature on technology and banking and the fast-growing literature on FinTech (De Roure et al., 2016; Buchak et al., 2018; Tang, 2019; Braggion et al., 2020; Di Maggio and Yao, 2020), which documents the economic effects of state-of-the-art financial technologies.

To conclude, our paper contributes to the large literature on information in financial intermediation (Leland and Pyle, 1977; Campbell and Kracaw, 1980). Stiglitz and Weiss (1992) show that despite the richer strategy space available to lenders, market equilibria can be characterized by credit rationing if information asymmetries are relevant. New technologies such as credit scoring (Einav et al., 2013), fax machines, and the internet can help reduce these information asymmetries and improve bank lending (Liberti et al., 2016; Liberti and Petersen, 2019).

The rest of the paper is organized as follows. Section 2 presents the institutional background in Italy. Section 3 describes our data. Section 4 presents the empirical specifications and the identification strategy. Section 5 shows the main results with robustness checks. Section 6 investigates the mechanisms behind our findings. Section 7 discusses the effects of new digital highways on bank credit. Finally, Section 8 concludes.

2 Institutional Background

Italy represents an ideal laboratory for our analysis. First, the long history of human settlement in the country allowed for the existence of several relatively small municipalities located at short distance from one another, often separated by geographical barriers (rivers, lakes, mountains). This creates large variation in the distribution of the infrastructure needed to bring broadband to different municipalities, which often have a very similar level of economic activity and development and are just a few miles away. Second, Italy in our sample period did not experience an especially fast growth in credit, nor it experienced a housing bubble, contrary for example to the US, UK, Ireland or Spain. Third, Italy is a developed economy, mostly bank dependent, with an economic structure similar to that of other major countries. Finally, Italy has very granular administrative micro-data that are crucial to implement our identification strategy.

2.1 Broadband Internet

Broadband internet connection in Italy has been traditionally provided through asymmetric digital subscriber lines (ADSL). ADSL technology is a data communications technology that enables faster data transmission than a conventional voiceband modem, and it was introduced by the Italian telecommunications incumbent operator, Telecom Italia, in 1999. The development of the ADSL infrastructure was relatively slow in the first years. By the end of 2000, only 117 out of 8,100 Italian municipalities had access to the new technology. Instead, it sped up sensibly during the subsequent years. By the end of 2005, about half of all municipalities owned an ADSL line, accounting for approximately 86% of the population. Figure 1 reports the time series of broadband adoption in terms of the number of municipalities with ADSL access, between 2000 and 2008. Given the low access and penetration rates until 2001, we consider this as the last "pre-broadband" year throughout our analysis.

ADSL technology relies on information transmission over conventional copper phone wires. Henceforth, ADSL access depends crucially on the user's position in the pre-existing voice telecommunications infrastructure. Technically, the voice telecommunications infrastructure consists of three levels: the Line Stage (LS), the Urban Group Stage (UGS), and the Transit Group Stage (TGS). The LS is the last structure where all the providers connect with their equipment, after which the famous last mile that reaches the end-users begins. In Italy, the 10,500 LSs are linked to one of the 628 UGS, which are connected to one of the 65 TGS. To complete the physical architecture of the network, some TGSs are tied to the three international gateways (Milan, Rome, and Palermo), which allow for international communications.

Two parameters are of specific importance for ADSL deployment and performance. The first is the distance between the end user's premises and the closest telecommunication exchange (the LS), known as the "local loop". If the length of the local loop is above a certain threshold, the ADSL connection cannot be implemented through traditional copper wires, but it needs fiber optic cables. The second is the distance between the LS and the closest higher-order telecommunication exchange (the UGS). Independently from the length of the local loop, for ADSL to be available, the connection between the LS and the UGS must be through fiber optic cables. In Italy, the length of the local loop has not constituted a limiting factor for the development of the broadband infrastructure. Since the local loop was a key element in the voice telecommunications network, its length was generally short and distribution capillary. Instead, the distance between the LS and the UGS, which was irrelevant for voice communication purposes, has become the primary determinant of the investment needed to provide ADSL to a given area and, consequently, of the timing of ADSL adoption (Ciapanna and Sabbatini, 2008). The latter is behind the choice of our instrumental variable.

To build our instrument, we exploit the fact that the 628 UGSs were inherited from the pre-existing voice telecommunication system, so their location was determined long before the advent of the internet. As a consequence, the position of the telecommunication infrastructures was not influenced by the ADSL technology (Impiglia et al., 2004; AGCOM, 2011). Our IV builds on the assumption that ceteris paribus, the closer a municipality happened to be to a UGS when the ADSL became available, the more likely that municipality had access to high-speed internet earlier in the ADSL diffusion process.

2.2 The Italian Bank Credit Market

During the twenty years between 1980 and 2000, the Italian financial industry has changed substantially, modernizing its operations and performance. Following the implementation of the Second Banking Coordination Directive, Italy enacted a comprehensive banking law (”Testo Unico Bancario”) in 1993, which drastically reduced government ownership of banks. The share of assets in the hands of banks owned by central and local government or foundations accounted for 12%, from the 18% in 1998 and the 58% in 1990, (ABI, 2001). Under the joint effect of deregulation and technological changes, the system became much more ”market-oriented”, and substantial advances occurred in terms of the quantity, productivity and prices of banking services and the diversification, depth and efficiency of the markets (Bank of Italy, 2003; Angelini and Cetorelli, 2003).

In the same period, the Italian banking system has undergone substantial restructuring. At the end of 2000, there were more than 800 banks, one-third of which were part of a banking group. The reorganization of the banking system took place mainly by ways of mergers and acquisitions, increasing the overall degree of concentration. The five largest groups in Italy held more than 50% of total banking assets, up from 35% in 1996. In this regard, Italy lined up with other European economies. However, the extension of individual banks’ branch networks and numerous competitors in the same markets heightened competition. A series of standard indicators confirms that the increasing concentration of the Italian credit system has come within a framework of intensifying competition.

The branch network at the beginning of the 2000s was also very dense. At the end of 2000, there was one branch for every 2,100 inhabitants (ABI, 2001), which means that about four-fifths of the population could choose between (at least) three banks in their town of residence. Similarly, the ATM network was very capillary, with 31,750 ATMs (more than one every 2,000 inhabitants) and POS terminals widespread, about 570,800 (more than one every 110 inhabitants).

The Italian financial system is mostly bank-dependent. In 2000, deposits and money market fund shares were equivalent to 87% of GDP. Loans accounted for about one-third of non-financial companies’ outstanding liabilities, and this share was fast growing. Considering the average annual flows over the period 1998-2000, loans accounted for 55% of the total increase in firms’ liabilities. The majority of these loans were granted by resident banks (Bank of Italy, 2003).

Throughout the 2000s, Italian banks have supported the increasing demand for credit by non-financial firms through loosened supply conditions. Firm leverage has increased conspicuously between 2000 and 2007, moving from 34% to 39%. The available evidence (see Bugamelli et al. (2018) for a detailed review) suggests that the Italian banking system has sustained productivity growth before the great financial crisis by supporting firm-level innovation and exporting and by improving the allocation of capital across firms. These dynamics have been similar in other major European countries.

3 Data

Our final dataset combines information from several sources. It includes details on ADSL coverage and the infrastructural characteristics of the Italian municipalities between 2004 and 2008. It pairs these information with matched firm-bank data related to the period 1998-2008. We have information on the amount of credit granted by bank *b* to firm *f*, and the specific features of the credit relationship (loan type, presence of collateral, interest rate). Then, we also use data on the location and the opening and closing of bank branches during the period of analysis, together with data on bank employees and bank deposits. Finally, we gather information on the balance sheets of Italian non-financial incorporated firms.

Data on ADSL coverage are from the "Osservatorio Banda Larga", backed by the Italian Ministry of Telecommunications (Campante et al., 2018). The data include information on the percentage of households with access to ADSL-based services, for each municipality and year between 2005 and 2008, on an asymmetric six-point scale: 0%, 1%–50%, 51%–75%, 76%–85%, 86%–95%, and above 95%. No data are available for years prior to 2005. We view 2002 as the first year the ADSL technology became available (as discussed in the previous section). Hence, for years prior to 2002, we consider the percentage of households with access to ADSL equal to zero. We then use information from the Annual reports of the Italian Communications Authority (AGCOM) to retrieve data for 2004, whereas we treat 2002 and 2003 as missing.

Throughout the analysis, we use the asymmetric six-point-scale variable as our baseline measure of broadband internet access. However, in robustness checks we also experiment with alternative measures. First, we create dummy variables for *good access* (which takes value 1 if broadband access is above 50%) and *some access* (1 if broadband access is above 0%) to broadband. These measures facilitate the interpretation of the coefficients, as they do not rely on the asymmetric scale. Second, we define a proxy for good internet as the number of years since at least 50% of households in a municipality have had access to the ADSL. The latter has the advantage to provide a dynamic to the broadband effect but comes with the disadvantage of considering 2004 as the first year of ADSL adoption, introducing some noise in the first years of the sample.

Figure 2 reports the distribution of access to broadband across Italian municipalities in 2004, the first year of data availability, and 2008, the last year considered in our sample, with darker colors indicating high or full access. The figure documents the rapid diffusion of high-speed internet throughout the country.

Data on ADSL coverage are complemented with those on the infrastructural features of the internet technology. In particular, we collect information on the number and geographical location of LSs and UGSs. Then, we compute the geodesic distance between the centroid of each municipality and the closest UGS and use this variable, interacted with a dummy post-2001, to instrument access to the broadband[7].

Data on matched firm-bank relationships are from the Italian Credit Register (CR) held by the Bank of Italy. The CR contains information on the universe of loans and guarantees banks and financial companies issued to their customers above 30,000 euros (75,000 euros before 2008). For each credit relationship, we observe data on the bank and the firm involved, the total amount granted, the amount utilized, the composition of the credit (three loan types are distinguished: credit lines, term loans, loans backed by receivables), its status (performing or not) and the timing of the relationship. Moreover, we also observe the municipality of the branch that the borrower selects as the reference for the management of the credit relationship. This feature is essential as it allows to observe the bank's location with which the borrower interacts. It also allows us to match data on the loans issued to a firm by banks in different municipalities, with information on internet access in each municipality.

Data on interest rates are from *Taxia*, which is part of the CR. While a subset of the CR, it provides detailed information on interest rates covering more than 80% of total bank lending (Rodano et al., 2013). Such data include the rates charged on outstanding loans (distinguished into credit lines, term loans, and loans backed by receivables) and newly issued term loans.

Data on bank deposits and bank employees are from the Supervisory Reports that banks submit to the Bank of Italy, the banking supervisor of the country, during our sample period.

Data on bank branches are from the Bank of Italy "Lista succursali". For each bank branch, we observe its name, bank identifier, group to which it belongs (when relevant), location, and period of activity (initial and closing date).

We match data at the bank-level using the unique bank identifier.

Data on firm balance sheets are from the firm register collected by CERVED Group. These data provide balance sheets and income statements for the universe of incorporated firms in Italy from 1998-2008. Firms not covered are mainly small firms (sole proprietorship or small household producers). Throughout our analysis, our sample includes all the firms covered by the CERVED database. We match these data with the credit data using the unique firm tax identifier.

Finally, we collect information on the local economic activity and the social background of different areas by using publicly available data from the Bank of Italy, the Italian national statistical institute (ISTAT), and the Ministry of Economy and Finance (MEF).

[7] Data on the location of LSs and UGSs have been kindly provided by Francesco Sobbrio and are used in Campante et al. (2018).

Table 1 reports summary statistics associated with our final sample. Panel A refers to data at the municipality level and shows municipalities geographical distribution (*North*, *Center*, *South*), as well as statistics on access to broadband (*Internet*) and the ADSL underlying infrastructure (the number of LSs and their average distance from the municipality; the number of UGSs and their average distance from the municipality). Panel B refers to data at the bank-municipality level that we use as our baseline setting throughout the analysis. It shows the number of loans issued by a bank in a given municipality, the amount of credit granted, and the average interest rate charged. Finally, panel C refers to loan-level data and reports statistics on (granted) loan amounts.

4 Empirical Strategy

We test the effects of banks' broadband availability on several outcomes, at the bank-level, at the loan (bank-firm relationship) level, and the municipality level.

The existing literature provides some guidance on what could be the effect of broadband internet on bank credit. First, we expect credit outcomes, both the extensive (loans issued) and the intensive (amount of credit granted) margin, to be positively related to broadband (Petersen and Rajan, 2002; Berger, 2003). The effect of high-speed internet on interest rates, instead, is a priori ambiguous. Following the framework by Hauswald and Marquez (2003), the effect of new information technologies on credit price is negative (an increase in interest rates) when the informational advantage of the intermediary that gathers information leads to less competition in the credit market. On the contrary, the effect is positive (a decrease in interest rates) when access to information makes data much more widely and readily available to all competitors. In this case, an improvement in IT generates spillover effects that erode informational advantages and serve to level the playing field, with a consequent reduction of interest rates.

To estimate the intention-to-treat (ITT) effect of the increased access to broadband internet, we rely on the following specification:

$$Y_{(r)bmt} = \nu + \beta Broadband_{mt} + \gamma X_{(r)bmt} + \text{fixed effects} + \varepsilon_{(r)bmt} \tag{1}$$

where subscripts r, b, m, and t indicate, respectively, relationship, bank, municipality and year (r or b depending on whether the specification refers to credit relationship characteristics or aggregate bank characteristics); Y is the outcome variable; *Broadband* represents the percentage of households that have access to the ADSL in the municipality of the branch, based on the asymmetric six-point scale described in the previous section; X includes time-varying controls at the relationship or bank level; fixed effects are different sets of dummies depending on the outcome variable. The latter may include time (year), branch municipality, and bank-municipality of the branch fixed effects. Furthermore, in the regressions at the loan level, we saturate the model with the inclusion of bank-year, firm-year, and firm-bank-municipality of the branch fixed effects[8], in order to isolate the effect of broadband internet on credit supply. We estimate equation (1) with standard errors clustered at the municipality level.

Our main outcome variables are the following. In the regressions aggregated at the bank level: i. the (log) number of loans issued by bank b, in municipality m, at time t, which measures the effect of broadband internet on the extensive margin of bank credit; ii. the total (log) amount of credit granted by bank b, in municipality m, at time t, which measures the intensive and the extensive margin combined; iii. the average interest rate charged by bank b in municipality m, which proxies for the price of credit[9]. In the regressions at the bank-firm relationship level, when we turn on credit supply: i. the (log) amount of credit commitments by bank b to firm f, at time t, which evaluates the effect of broadband on the intensive margin of the credit relationship.

Next, we further explore the mechanisms through which broadband internet affects lending (section 6). We keep the same econometric specification at the bank level and focus on different outcome variables. We use indicators of bank productivity and credit quality to test the effect of broadband internet on the lending efficiency of the bank. We also study measures of distance and location of the borrowers to test for the geography of the loans once broadband internet is available. Then, we look at outcomes at the municipality level to test for local competition. In that regard, we concentrate on the number of local competitors and standard measures of market concentration. Finally, we use a mix of the above-mentioned specifications to provide evidence on the reallocation effects of broadband internet and the associated real effects.

A major concern with the estimates of a model in which we regress bank credit features on access to ADSL is that broadband availability is unlikely to be randomly allocated across municipalities, potentially generating a bias in the estimates of model parameters (Comin and Hobijn, 2004). We use an instrumental variable approach that exploits exogenous variation in broadband adoption across different geographical areas to deal with this concern.

We take advantage of the geographical distribution of ADSL physical infrastructures and leverage differences across Italian municipalities in the distance between a municipality and the closest UGS, where the latter represents a key determinant of the cost of supplying ADSL services. The underlying assumption is that the distance to the closest UGS affects the pattern of ADSL roll-out, with municipalities located farther away from UGSs getting access to broadband internet later on, ceteris paribus.

Even though the presence and the location of the UGSs precedes the development (and even the existence) of broadband in Italy, the spatial distribution of UGSs is itself non-random. To address this issue, we exploit the panel structure of the data and add bank-municipality (or more

[8] Notice that this is finer than firm-bank fixed effects, since it focuses on the relationship between the firm and the bank in a specific municipality.

[9] In the main analysis, we use a weighted average of bank's interest rates, where credit is not distinguished between different loan types (term loans, loans backed by receivables, credit lines) and weights depend on the amount of firms' utilized credit for each loan type.

granular, i.e., firm-bank-municipality) fixed effects to our specifications. Then, to account for potential time-varying confoundings, we interact the distance of a municipality to the closest UGS with a dummy for the post-2001 period (i.e., after the introduction of high-speed internet). The latter constitutes our instrument to ADSL coverage.

The main identifying assumption behind our IV is that 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 in the municipality. Indeed, 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 because of the availability of broadband internet (Campante et al., 2018)[10].

Hence, our econometric model relies on the following two-stage specification:

$$Broadband_{mt} = \rho + \delta DistanceUGS_m \times Post2001 + \omega X_{(r)bmt} + \text{fixed effects} + \xi_t + \epsilon_{(r)bmt} \quad (2)$$

$$Y_{(r)bmt} = \nu + \beta \widehat{Broadband}_{mt} + \gamma X_{(r)bmt} + \text{fixed effects} + \phi_t + \varepsilon_{(r)bmt} \quad (3)$$

where *Distance UGS* is the (time invariant) distance of the bank's municipality centroid to the closest high-order telecommunication exchange (UGS), and we interact this variable with a dummy *Post2001*, that takes value 1 for the years after 2001, and zero otherwise[11]. We estimate equation (3) via two-stages least squares (2SLS) regressions.

Table 2, reports first stage estimates as presented in equation (2). Column 1 refers to our baseline measure of ADSL coverage. Columns 2 and 3 refer to the dummies *good access* and *some access*, which are equal to 1 if at least 50% or more than 0% of households have access to the internet, respectively. Finally, column 4 focuses on the *years since good internet* (the number of years since at least 50% of the population has ADSL access). As we can see from the table, coefficients are negative and statistically significant, in line with our underlying hypothesis. Moreover, F-statistics are generally high and well above the rule of thumb thresholds.

5 Results

This section shows the main results on the effects of broadband internet on bank credit in Italy. We first present motivating evidence using a difference-in-differences (DiD) setting. Next, we implement our preferred empirical strategy and show estimates from the instrumental variable (IV) analysis.

[10] In the appendix, table A1, we provide a balance table that compares mean values of geographical and socioeconomic indicators for municipalities below and above the median of distance from the closest UGS.

[11] This approach is similar to that in Paravisini et al. (2015), Campante et al. (2018), Manacorda and Tesei (2020) and Guriev et al. (2021).

5.1 Motivating Evidence

To gain intuition, before implementing the two-stage specification as in equations (2) and (3), we run a standard DiD event study on the (log) number of loans and the (log) amount of credit granted by Italian banks.

We simulate a DiD setting and divide the sample into two groups. Treated banks are those in municipalities where at least 50% of the households were connected to the ADSL in 2006. Control banks are those in municipalities where ADSL was unavailable in 2006 or solely to a restricted share of the households. Then, we consider 2001 as the baseline year (in line with the main analysis) and show the heterogeneous effects of broadband internet at the extensive and intensive margin of bank credit.

Figure 3 displays estimated event study coefficients, together with the corresponding 95% confidence interval. The top panel focuses on the number of loans. We consider the semi-dynamic regression proposed by Borusyak and Jaravel (2017), and drop the farthest (negative) relative year from the event, in addition to the baseline category [12]. First, we do not find evidence of pre-trends, meaning that the two groups of banks are on a parallel trend before the arrival of high-speed internet. Second, the treatment dynamics show the positive and statistically significant effect of broadband on bank credit. The effect of fast internet takes one year to materialize and then monotonically increases, with a long-term effect amounting to roughly a 9% increase in the number of loans issued. The bottom panel focuses on the amount of credit extended. While standard errors are somewhat larger, the event study points to similar results. Treated and control banks are on a parallel trend before the treatment, and fast internet is associated with more credit.

Overall, these preliminary findings indicate a positive relationship between access to broadband internet and credit granted by banks.

5.2 The Effects of Broadband on Bank Credit

We now implement the baseline two-stage specification on our main dependent variables, following equations (2) and (3).

We first aggregate data at the bank-municipality-year level and focus on the extensive margin (the number of loans issued by banks to non-financial firms) and the intensive margin (the amount of credit issued) of bank credit. Results are shown in Table 3. Columns 1 and 2 report the basic OLS estimates. The coefficients associated with broadband access are positive and statistically significant, indicating that the advent of high-speed internet is associated with more credit granted by banks. Interestingly, OLS coefficients are lower than the average treatment effect from the event study in section 5.1. As regards the extensive margin, the coefficient *broadband* is 0.007 (meaning that moving from zero to full broadband increases the number of loans granted by

[12] Borusyak and Jaravel (2017) show that this is the minimum number of restrictions for point identification.

3.9%), while the corresponding mean effect implied by the event study is around 6.7%[13].

This difference may signal the short-term bias of the two-way fixed effects estimator when treatment effects take time to materialize[14]. In order to test this hypothesis, we follow De Chaisemartin and d'Haultfoeuille (2020) and compute the weights associated with the OLS estimates. Results are reported in table 4. In line with our hypothesis, more than 60% of the OLS weights are associated with the first years after the treatment, and weights are strongly decreasing over time[15].

Next, we instrument broadband access with the interaction between distance to the closest UGS and the post-2001 dummy and consider this as our preferred specification[16]. Columns 3 and 4 show the main results. We find a positive and statistically significant effect of broadband internet on bank credit. The effect is larger than in the basic OLS specification: moving from zero to high broadband coverage is associated with an increase in the number of loans issued of 12% (0.08 of a s.d.) and an increase in the amount of credit granted of 28% (0.13 of a s.d.)[17]. This result is qualitatively in line with Liberti et al. (2016) that show an improvement in the allocation of credit when more and better information is available.

Then, we test the effects of having access to broadband internet on the price of bank credit. We aggregate data at the bank-municipality-year level and run a specification similar to equations (1) and (3). Results, shown in table 5, indicate that the average effect of high-speed internet on interest rates is negative and statistically significant. Passing from zero to high ADSL coverage is associated with a decrease in the average interest rate of 30 b.p. (0.18 of a s.d.)[18]. The latter is in line with the theoretical argument by Hauswald and Marquez (2003) that, being broadband internet a general purpose information technology whose benefits are widely and easily available among bank competitors, the spillover effects from information dissemination dominate the negative effects from informational rents[19].

[13] Computed on the semi-dynamic model that also excludes 2002 and 2003, for which broadband data are missing in our dataset. Notice that estimates from a standard event study considering the first year of ADSL access provide a mean effect of 7%.

[14] Borusyak and Jaravel (2017) show that the OLS coefficient from two-way fixed effects staggered DiD is a weighted average of the OLS coefficients. When treatment effects are heterogeneous over time, those weights are higher for low values of the relative time from the event and may even become negative in the long run.

[15] The downward bias of the OLS coefficient could also have different sources. First, coverage might be related to unobservable municipality characteristics associated with higher credit. Second, it could be related to the coarseness of the measure of broadband access, especially at the bottom, where going from 1% to 49% access would be entirely missed and yet have the strongest impact (if diminishing returns to broadband are present).

[16] Importantly, when we compute the weights for the reduced form regression of Y on our instrument, we find equal weights. Results are reported in table 4.

[17] "High" broadband coverage means a value of *internet* equal to 3 (at least 75% of the population connected). The latter is also the interquartile range of ADSL coverage for municipalities included in our sample during the period of broadband availability.

[18] This accounts for a reduction of 5% in the average rate, that is in line with Brown and Goolsbee (2002) which find that the growth of the internet has reduced term life prices by 8–15 percent.

[19] Schenone (2010) finds evidence of these spillover effects in initial public offerings (IPOs), using the Securities Data Company (SDC) dataset by Thomson Reuters.

5.3 The Supply Channel

The findings in the previous section represent equilibrium outcomes. Indeed, the effect of broadband internet on bank credit results from two forces acting simultaneously: credit demand (firms that ask for credit) and credit supply (banks that offer credit).

The effect of fast internet on credit demand has been indirectly investigated in the literature by studying firm productivity (Akerman et al., 2015; DeStefano et al., 2018). Although there is consensus on the fact that banks use cutting-edge technologies to deliver innovative products, streamline loan-making processes, and improve back-office efficiency (He et al., 2021), evidence on the direct effect of broadband on banks' productivity is relatively scant[20]. Moreover, the fact that lending increases while interest rates go down is difficult to reconcile with a pure demand-side story.

In this paper, we further contribute to the existing literature by isolating the component of the total effect of broadband on bank credit due to credit supply.

We perform this exercise in table 6, where we exploit the granularity of our dataset to further characterize the effect of broadband on the intensive margin of the credit relationship. We use loan-level data and leverage variation within firm-bank[21]. Columns 1 and 3 report OLS and 2SLS estimates related to this specification. Passing from zero to high broadband coverage is associated with an increase in the amount of credit granted by bank b to firm f of 41% (0.28 of a s.d). Next, following Khwaja and Mian (2008), we saturate the model with the inclusion of firm by year fixed effects that capture the component of the total effect that is related to demand. Importantly, we also add bank-time fixed effects to attenuate the concern that the (exogenous) arrival of broadband internet simultaneously affects both the supply and the demand for credit. Finally, this specification also includes firm-bank-municipality of the branch fixed effects to capture time-invariant characteristics of the credit relationship and possible confounders related to the specialization of different bank branches[22].

Estimates are reported in columns 2 and 4 and refer to the effect of broadband internet on credit supply. As we can see from the table, almost half of the total effect is a pure supply-side effect[23]. Going from zero to high broadband coverage is associated with an increase in bank credit supply of 19% (0.14 of a s.d.).

[20] In the appendix, figures 5 and 6, we report descriptive statistics on the % growth of the use of web technologies within bank branches, during the period 2001-2007. These statistics, obtained from the Economic Analysis of the Italian Banking Association (ABI), suggest a sensible increase in the use of web technologies in the back office activities of banks during the examined period.

[21] These specifications at the firm-bank-municipality-year level always include controls for the loan (one-year lagged) share of revolving loans of the firm, and the loan share of extended credit of the issuing bank

[22] Notice that this specification is more demanding than that used in Paravisini et al. (2015) as we observe the municipality of the specific branch that manages the loan.

[23] These results always have to be interpreted with the caveat that the variation used in these specifications is that of firms that borrow from multiple banks.

5.4 Robustness

We subject our main results to several robustness checks.

First, we verify that our instrument passes the Angrist and Imbens (1995) instrument's monotonicity test. By instrumenting our endogenous variable (D_{mt}, Z=[0,1]) with the distance to the closest UGS interacted with the dummy post-2001 (Z_{mt}), we are implicitly assuming that the effect of distance on access to broadband is monotone, that is, either $D_{mt}^{high} \geq D_{mt}^{low}$ or $D_{mt}^{high} \leq D_{mt}^{low}$, $\forall mt$. The assumption is not verifiable, but has testable implications on the CDFs of internet for municipalities close or far from the UGS, that is, they should never cross. In fact, if $D_{mt}^{high} \geq D_{mt}^{low}$ with probability 1, then $Pr(D^{high} \geq j) \geq Pr(D^{low} \geq j), \forall j \in supp\ D$. Figure 7 plots the CDFs of internet for banks close to the UGS (blue solid line) and far from the UGS (red solid line)[24]. Since the two CDFs never cross, the instrument passes the test.

Second, our basic identification assumption would be violated if there are underlying trends affecting the outcomes of interest that correlate with our instrument. To control for these confounding factors, we augment our specifications in equations (2) and (3) with several economic and socio-demographic municipal characteristics available from the 2001 Census, interacted with a second-order polynomial-time trend. In this way, we control flexibly for the possibility of differential time trends. The baseline group of controls includes the natural logarithm of the total population, elderly population, the number of private firms operating in the municipality, the number of employees, the distance from the provincial capital[25]. Table A2 reports the estimates related to the extensive and the intensive margin of bank credit. All the coefficients keep the same sign as in the baseline specification, and they remain statistically significant at standard levels. Furthermore, the magnitudes are not sensibly affected by the inclusion of these control variables.

Next, we test the robustness of the main results by using different measures of ADSL coverage. Table A3 focuses on the extensive margin of the credit relationship. In column 1, we report our baseline IV estimate for reference. In column 2, we use *Years Since Good Internet* and find a similarly positive effect. One more year of good internet is associated with an increase of 6.3% in the number of loans. Considering an average of four years of good internet, the total effect of broadband on credit is an increase of 25%. In this case, OLS and IV estimates get much closer to one another, showing the importance of considering the treatment effect dynamic in our analysis. In columns 3 and 4, we consider two alternative dummy variables: *good access* and *some access*. The coefficients are close in magnitude to our baseline *Broadband* measure, although they slightly vary between each other.

In table A4, we address the possibility that our results are picking up some underlying trend in credit that happens to be correlated with the diffusion of broadband. We run placebo IV specifications for the years from 1998 to 2003, assuming that the level of ADSL access in 2006 was

[24] Notice that, for this exercise, we use a dummy variable below/above the median of UGS distance to proxy for our instrument (that is a continuous variable).

[25] *Population* is the only variable for which a yearly time series is available.

already present in 2001 (and the following years). Reassuringly, we see no impact of this fictitious introduction of broadband internet, supporting the view that pre-existing trends do not drive our findings.

6 Mechanisms

Results so far show that the arrival of broadband internet leads to an expansion of bank credit. This materializes on the extensive margin (number of loans granted), on the intensive margin, and on the price of credit issued by banks (interest rates go down). Moreover, part of the total effect is due to factors independent of credit demand, as we have seen that loan amounts are affected by access to broadband, which also controls for firm-specific time-varying unobservables. In what follows, we further explore the channels through which all these effects take place.

6.1 Lending Efficiency

It is often argued that IT advances play a substantial role in boosting productivity (Draca et al., 2007). It is thus essential to test whether bank lending efficiency increases as a consequence of broadband internet availability.

We measure bank lending efficiency using two different indicators. First, loans per bank employee, which is a measure of the bank's labor productivity. Second, the share of non-performing loans (NPLs), which proxies banks' credit quality.

Petersen and Rajan (2002) suggest that new technologies allow banks to collect more hard information about borrowers, enabling them to change the nature of lending from an emphasis on strict ex-ante screening and costly ex-post monitoring, to fine-tuned screening and frequent ex-post monitoring. Similarly, Berger (2003) documents the increase in profit productivity due to improvements in ”back-office” technologies, as well as consumer benefits from new ”front-office” technologies. Since high-speed internet enhances screening and monitoring, we expect the effect of broadband on productivity to be positive and significant. On the other hand, the effect of broadband on credit quality is a priori ambiguous. Since marginal borrowers are generally worse than incumbent customers, credit quality could worsen as a consequence of credit expansion. However, hard information on borrowers becomes richer and timely once new technologies are available. Improved screening and monitoring activities can thus offset the negative effect of credit growth.

Table 7 shows the results. Columns 1 and 3 show that bank's access to broadband internet has a positive effect on its labor productivity, measured as the amount of extended credit per bank employee. Going from zero to high broadband coverage is associated with an increase in credit per employee of 24%. On the other hand, columns 2 and 4 show that high-speed internet is associated with a slight decrease in the share of NPLs, meaning that credit quality, on average, improves with the expansion of credit[26].

Taken together, these two findings support the thesis that banks' overall lending efficiency sensibly increases after the introduction of broadband internet[27].

6.2 Banks' Geographical Reach

Lending is traditionally a "local" business, and the distance between lenders and borrowers is a crucial factor shaping credit relationships, especially those that involve SMEs (Degryse and Ongena, 2005). However, Petersen and Rajan (2002) suggest that technology helps break the "tyranny of distance". By improving screening and monitoring activities of banks, new technologies allow for increasing capital intensity of lending and thus lending to more distant borrowers. Along the same lines, Berger (2003) shows that technological progress facilitates the geographic expansion of banking organizations by reducing distance-related dis-economies. New services created by technological progress with higher value added, traditional banking services delivered more efficiently, bank monitoring and the control of risk exposures at longer distances and lower costs, and reduced managerial diseconomies of distance all contribute to ease the way banks find and finance new clients.

On the other hand, Wilhelm (2001) argues that advances in communication technology and increased capacity for information do not imply greater exchange of information inside the bank. This is due to the limited incentives for loan officers to transfer information on which they hold monopoly power. Similarly, advances in communication technology may not lead to more exchange of information between firms and banks (Bhattacharya and Chiesa, 1995) and between different banks (Padilla and Pagano, 1997). In this regard, technological developments may have no effects on the distance between lenders and borrowers[28].

To address these critical issues, we look at the effects of broadband internet on the geography of the credit relationship by focusing on new loans originated by Italian banks during the period of our analysis[29]. We define a dummy variable for the loan being originated outside the province of the branch (*Diff. Province*) to measure the effect of broadband internet on the geographical borders (the market) within which the bank operates[30]. Then, we create a direct measure of the distance between lenders and borrowers by computing the geodesic distance between the centroid of the municipality of the branch that manages the loan and the exact location of the firm.

[26] The latter is in line with Pierri and Timmer (2020), which study the implications of IT in banking for financial stability. The authors find that pre-crisis IT adoption that was higher by one standard deviation led to 10% fewer NPLs during the 2007–2008 financial crisis.

[27] Casolaro and Gobbi (2007) find that banks adopting IT capital intensive techniques are more efficient and interpret the latter as evidence of a catching-up effect consistent with the usual pattern of diffusion of new technologies.

[28] See also Degryse and Ongena (2005) for empirical evidence on the static nature of the relationship between firms and banks in Belgium, between 1973 and 1997.

[29] To substantiate our hypothesis that broadband reduces communication costs and increases "proximity", in table A5 of the appendix, we preliminary show that broadband access is positively associated with the share of loans granted to firms connected themselves to broadband.

[30] In Italy, before the advent of fast internet, provinces defined the borders of bank credit markets (Crawford et al., 2018).

Estimates from model (3), aggregated at the bank-municipality-year, are reported in table 8. Columns 1 and 3 refer to the share of new loans originated out of the province of the branch. Columns 2 and 4 refer to the inverse hyperbolic sine of the geodesic distance between the municipality of the branch and the firm. The table shows that access to high-speed internet increases the probability that the bank extends credit outside its province. At the same time, broadband internet is associated with firm-bank relationships exhibiting longer distances[31]. Findings are in line with the literature and document the shrinking effects of new information technologies on the distance between lenders and borrowers (Petersen and Rajan, 2002; Berger, 2003; Felici and Pagnini, 2008).

These results also suggest that broadband internet can trigger a re-definition of local credit markets, with all the consequences for agents involved in the credit relationship and for regulatory and supervisory authorities.

6.3 Competition

The expansion of credit following the arrival of broadband internet may be driven by tougher local competition. Hauswald and Marquez (2003) find that when the information gap between banks becomes smaller, because of ICT diffusion, there is a softening of the winner's curse that leads to an increase in the intensity of bank competition. Similarly, Vives and Ye (2021) find that when IT progress involves a weakening in the influence of bank-borrower distance on monitoring costs, then banks' competition intensity increases. Finally, Felici and Pagnini (2008) show that new communication and information technologies have significant pro-competitive effects in local banking markets. By increasing the geographical reach of bank entry decisions, these new technologies augment local credit market contestability.

The effects of broadband internet, and more efficient information technologies in general, on banking competition, is an interesting question in itself. We explore this question in what follows, focusing on two measures of competition: the number of (physical) bank competitors in the municipality; and measures of concentration of the local credit market.

Vesala (2000) shows that loan mark-ups were decreasing in Finland, in lock-step with the rapid development of the internet. On the other hand, Gropp et al. (2009) find only a small increase in contestability in the European loan markets despite the impressive technological advances experienced in many countries.

Our results on the effects of broadband on local competition are shown in tables 9 and 10. In table 9, the main dependent variable is the (log) number of bank competitors in a municipality. Estimates from table 9 show a significant increase in local competition[32]. Indeed, the number of banks competing in the market increases when the municipality is reached by fast internet.

[31] In table A6 of the appendix we propose the same exercise at the firm level, where we can control for firm fixed effects (that capture time-invariant firm characteristics). As we can see, results are qualitatively in line with those just presented.

[32] Competition within the municipality.

In table 10, the main dependent variables are standard indicators of concentration of the local (municipality) credit market: the concentration ratio of the top 5 and 3 banks, and the Herfindahl–Hirschman Index (HHI), computed using data on bank deposits[33]. As we can see from the table, all the coefficients are negative and statistically significant at the 99% level.

Overall, high-speed internet is associated with an increase in competition in the local credit markets. Results are in line with Frame et al. (2018) on the effects of new technologies on banking.

7 Extensions: Digital Highways, Credit, and the Real Effects of Broadband

In this section, we present additional results associated with the arrival of broadband internet on the activity of banks, with a focus on credit allocation and the spatial distribution of the effects.

7.1 Credit Reallocation

An extension that helps characterize our main results relates to the effects of access to broadband internet on credit allocation. The expansion of credit documented in the previous sections may coincide with an enlargement of the set of borrowers served by the banking industry. Otherwise, it can result from an increased amount of credit granted to borrowers that already benefited from banking services. The latter is particularly likely to occur in the case of credit flows from branches of the same bank, where transaction and operating costs are relatively lower (Cetorelli and Goldberg, 2012a,b).

We analyze these possibilities in table 11. Columns 1 and 3 test whether new loans originated by banks reached by fast internet are issued to firms already having a credit relationship. Columns 2 and 4 focus on new loans originated towards firms that already have a credit relationship with the same bank (in a different municipality). Results show that banks connected to high-speed internet have a higher probability of granting a loan to firms out of the credit market before. Moreover, they also have a higher probability of serving firms with a relationship with the same bank.

These findings provide evidence on the complementary effects of broadband on bank credit allocation. First, access to broadband internet determines an expansion in the set of borrowers served. Second, it allows banks to implement internal capital reallocation.

[33] As robustness, we replicate the same estimates by computing standard indicators of competition using data on extended credit. Results are similar to those in table 10.

7.2 The Spatial Distribution of the Effects: Does Broadband Internet Create Banking Deserts?

The previous sections show that fast internet leads banks to expand their geographical reach (outside of their province) and reallocate part of their credit within their internal organization. These dynamics may lead to a movement away from small municipalities, typically in the countryside, towards larger municipalities.

Physical infrastructures as highways and railroads, for example, are known to have affected the spatial allocation of economic activities. The direction of their effects has been heterogeneous between rural and urban areas, the periphery and the center, places crossed by the facility and adjacent areas (Rephann and Isserman, 1994; Chandra and Thompson, 2000; Baum-Snow, 2007; Michaels, 2008; Atack et al., 2010; Banerjee et al., 2012; Duranton and Turner, 2012; Donaldson, 2018). Digital infrastructures, sharing some of the underlying features, may have similar effects.

To explore this issue, in this section, we focus on the heterogeneity that distinguishes between small and bigger municipalities and show the existence of potential winners and losers from the process of broadband diffusion (Akerman et al., 2015). This heterogeneity is of particular interest because it assesses whether technological progress can determine credit desertification and, eventually, local economic stagnation. Furthermore, it is relevant in the political economy literature as the internet has been identified as a potential driver of polarization of the political spectrum and behind the recent rise of populist parties.

Table 12 replicates the analysis in table 6 for small municipalities. We exploit the granularity of our dataset and test the effect of broadband internet on the intensive margin of the credit relationship. We use loan-level data and leverage variation within firm-bank. Columns 1 and 3 report OLS and 2SLS estimates related to this specification. Then, we follow Khwaja and Mian (2008) and concentrate on the supply of loans by saturating the model with the inclusion of firm-year fixed effects, which capture demand-side confounders. The coefficients associated with this specification are reported in columns 2 and 4 and isolate the effect of broadband internet on credit supply. As we can see from the table, there seems to be no effect of fast internet on the amount of credit granted to non-financial firms in small municipalities[34].

In the appendix, tables A8 to A12, we also replicate the analysis on the mechanisms behind our results and show that for banks in small municipalities: lending efficiency goes down (in particular, productivity goes down), competition increases[35], and banks do not react in terms of loans geographical expansion and credit reallocation.

The test in table 12 highlights how broadband does not have any positive effect on credit

[34] In table A7 of the appendix, we report the results based on the specification on interest rates. Our results show that access to broadband internet is associated with an increase in the price of credit (contrary to the specification that refers to the entire sample). The increase in the average rate in small municipalities connected to high-speed internet can be explained, in part, by the nature of the credit relationships that remain anchored in those municipalities. These credit relationships usually rely on soft information and are less sensitive to credit price (Ioannidou and Ongena, 2010).

[35] Even if some of the IV coefficients are not statistically significant at standard levels.

supply for branches located in small municipalities. In this section, we argue that a reshaping can explain part of this null effect in the markets served by banks in different municipalities.

As we have argued in the introduction, broadband internet is a multi-dimensional information technology that reduces information asymmetries, communication costs, and agency problems in the banking industry. To work properly and activate a cheaper and timely communication channel between lenders and borrowers, both agents need to be connected. One possible explanation behind the null effect of broadband on credit in small municipalities is that firms in such places get access to larger credit markets. Firms in small municipalities reached by fast internet may become the "easiest target" for banks in bigger municipalities connected to broadband. As a result, they can exploit this situation to borrow a larger amount of money from outside the municipality and rip better credit prices.

We test this hypothesis in table 13. Columns 1 and 2 report OLS and IV estimates where the dependent variable is a dummy equal to one when the loan is from a bank in a bigger municipality to a firm in a small municipality, out of the province of the bank, and connected to fast internet.

The results from table 13 provide supporting evidence that improved lender-borrower communication increases the probability of credit relationship formation. Firms in small municipalities reached by fast internet face new (and broader) investment opportunities and reallocate part of their borrowing out of the municipality towards banks that operate in larger cities (which offer higher amounts of credit, at a lower cost). Consequently, both borrowers in small municipalities and banks in bigger municipalities benefit from the arrival of broadband internet. The former, as they face higher credit supply at a lower price. The latter can reach borrowers that were previously out of their market and can expand their customer base.

This phenomenon of credit centralization has the potential to create local banking deserts. In the same direction, it is interesting to analyze whether banks react to the new technological advancements with a change in their geographical location. We investigate this aspect by looking at the evolution of bank branches.

Italy was in a phase of sensible expansion of the number of branches since the beginning of the 90s. Figure 4 provides evidence in this direction. Furthermore, although we are used to associate informatization with de-branching, following the idea that automatic lending diminishes the value of geographical proximity and so the relevance of local branch presence (Kroszner and Strahan, 1999; Berger and DeYoung, 2001; Petersen and Rajan, 2002), the substitution of a brick-and-mortar model with a click-and-mortar model of banking is a very recent phenomenon[36] [37]. Therefore, during the period of our analysis, the choice that Italian banks faced was not whether to open or close branches but rather whether and where to open new branches.

[36] The latter is probably due to the limited diffusion of smartphones and software allowing for sufficient cyber-security, until recent times.

[37] Different studies have attempted to measure the impact of technology on branching empirically. Degryse and Ongena (2004) argue that new technologies may have only a limited impact on branch presence because of the importance of bank branch proximity for customers. Keil and Ongena (2020) show that broadband and mobile internet access explain well the recent de-branching of banks at the country level, but not that at the US county or bank branch level.

In table 14 we test the (heterogeneous) effects of having broadband internet on the number of branches in a municipality. Columns 1 and 3 refer to the whole sample, and columns 2 and 4 focus on the sample of small municipalities. Results from the table show that banks tend to increase their branch presence in places reached by broadband, where they can exploit the potential of fast internet. However, this does not happen in small municipalities, in which the effect of broadband is null. Indeed, we consider the latter as another sign of credit centralization from the perspective of the bank.

To conclude our analysis, we check whether these developments, credit flows towards bigger municipalities that lead to local credit desertification, are accompanied by economic underdevelopment in small areas.

Tables 15 and 16 replicate the analysis in equations (2) and (3), where the dependent variables are: the natural logarithm of population, the natural logarithm of income, and the natural logarithm of income per capita in the municipality[38]. Table 15 accounts for the entire sample. Table 16 focuses on the restricted sample of small municipalities. As we can see from the tables, the effect of broadband internet on the real economy is generally positive and more pronounced in small municipalities. Even if not conclusive, these findings suggest that new credit flows allowed by high-speed internet are the expression of broader investment opportunities and alleviated financial frictions, rather than bank desertification followed by local economic underdevelopment.

8 Conclusion

In this research, we provide empirical evidence on the effects of broadband internet on bank credit to non-financial firms. To address this point, we combine data on access to the ADSL technology in Italy with firm-bank matched data from the Bank of Italy. We follow 901 banks in 5271 municipalities, during the period 1998-2008, and show the effects of broadband at the extensive and at the intensive margin of the credit relationship and on credit price.

Our quasi-experimental design relies on the staggered adoption of the ADSL technology across Italian municipalities and an instrumental variable strategy that exploits the municipality's position in the pre-existing voice telecommunications infrastructure.

To explore our research question, we implement two-stages least squares analysis and focus on the effects of broadband on credit by isolating the effects on credit supply, on interest rates, and the underlying mechanisms that elucidate our main results.

Our findings highlight that high-speed internet fosters bank credit towards non-financial firms. The total amount of credit increases with broadband availability, while the average interest rate goes down. Many channels contribute to this aggregate effect. The internal efficiency of banks goes up as a consequence of broadband access. Banks reached by fast internet expand their mar-

[38] Data on income are from the publicly available dataset of the Italian Ministry of Economy and Finance (MEF). The time series starts in 2000, meaning that we have no information for the period 1998-1999.

kets and increase the distance towards their borrowers. At the same time, local competition increases, as reflected by the growth in the number of physical branches and competitors and by standard indicators of competition. Finally, banks connected to broadband internet tend to reach new borrowers and implement internal credit reallocation.

The effect of broadband, however, is heterogeneous. Access to high-speed internet creates digital highways that carry bank credit from the periphery to the center (i.e., from small municipalities to bigger municipalities). Nevertheless, credit desertification in small municipalities does not lead to economic underdevelopment, showing off the virtues of the credit flows generated by internet technologies.

Overall, our results are consistent with high-speed internet promoting bank credit and creating new credit opportunities for non-financial firms.

To conclude, our paper directly speaks to policymakers as we document the multifaceted effects of investments in new hi-tech infrastructures. The latter can serve as a guide for the introduction of future technologies, as the ultra-high-speed internet and the 5G mobile technology. Moreover, the issue of the effects of technological innovation on the operativity and the structure of the banking system is of utmost importance for central banks, both as monetary policy authorities (since it involves banks' lending activity) and as micro and macroprudential supervisors (since it involves banks' risk profiling).

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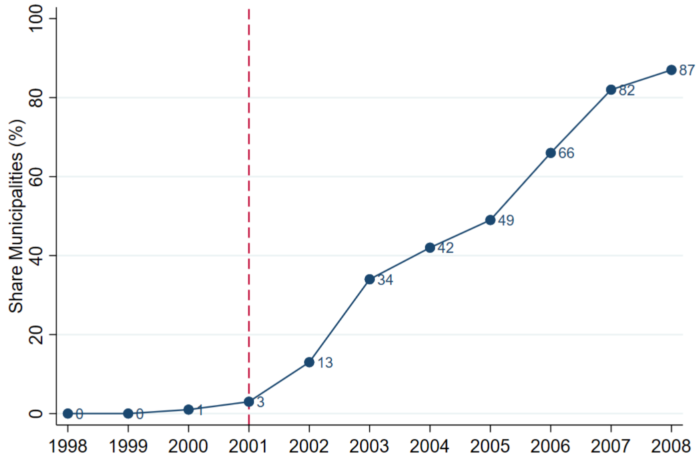
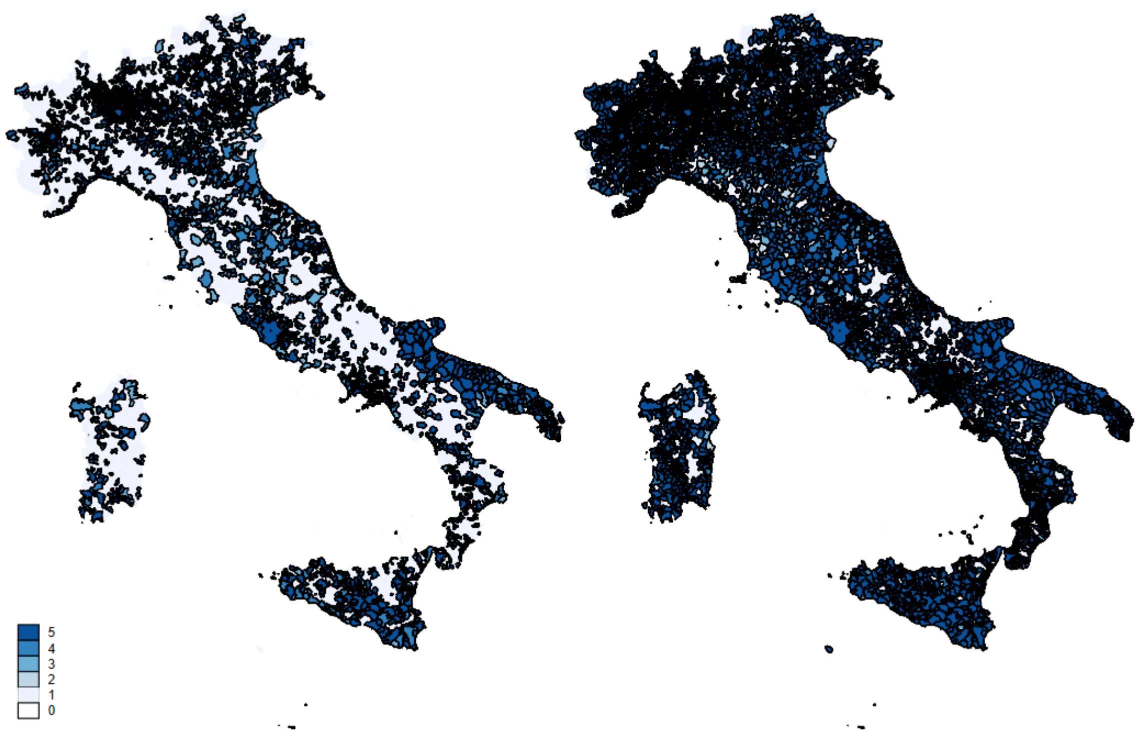
Figures

Figure 1: Broadband internet in Italy



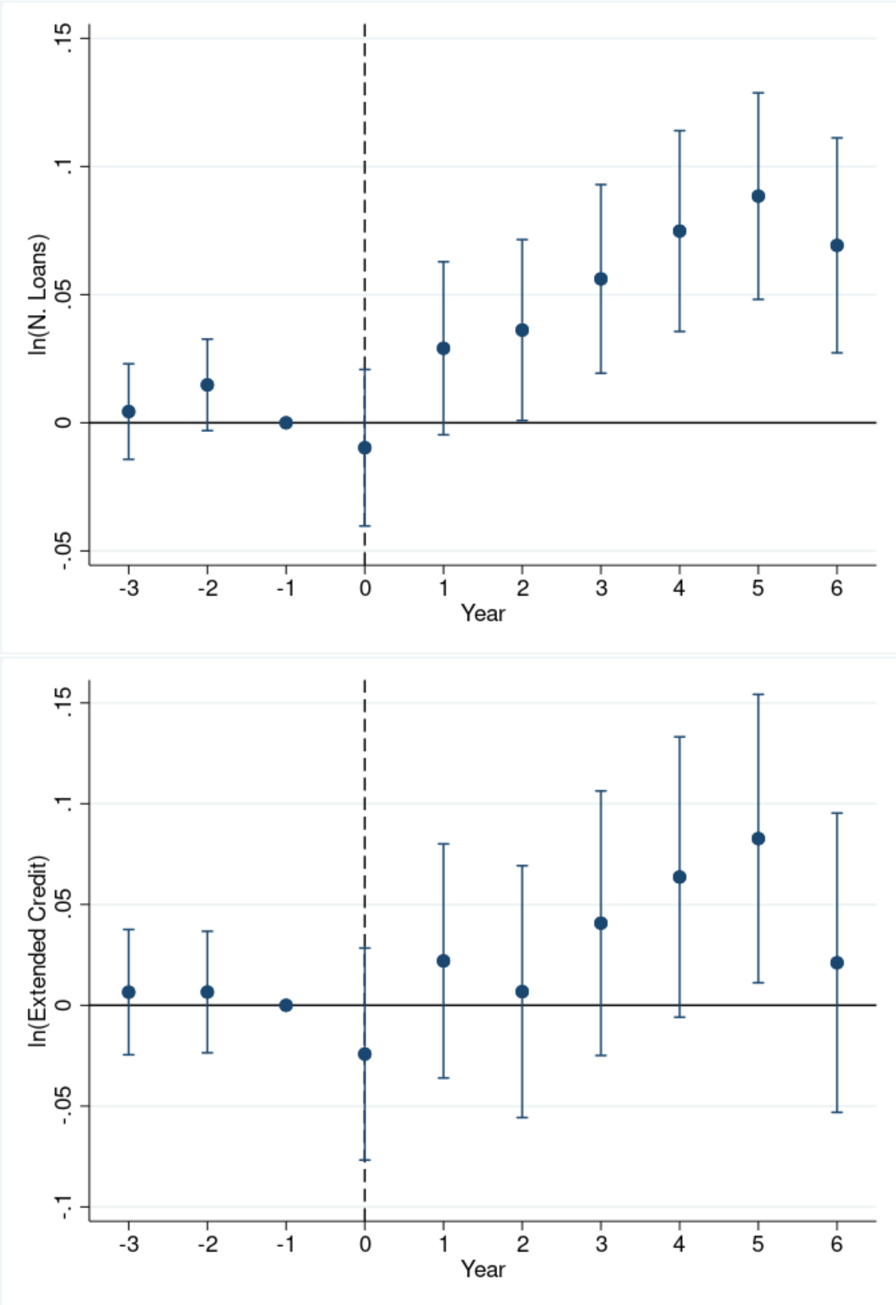
Notes: Broadband diffusion in Italy between 2000 and 2008. On the y-axis, we report the share of municipality with access to the ADSL technology. On the x-axis, the years. The dashed vertical line indicates the separation between the pre-broadband and the post-broadband period, that we make coincide with 2001.

Figure 2: Geographical distribution of Broadband internet



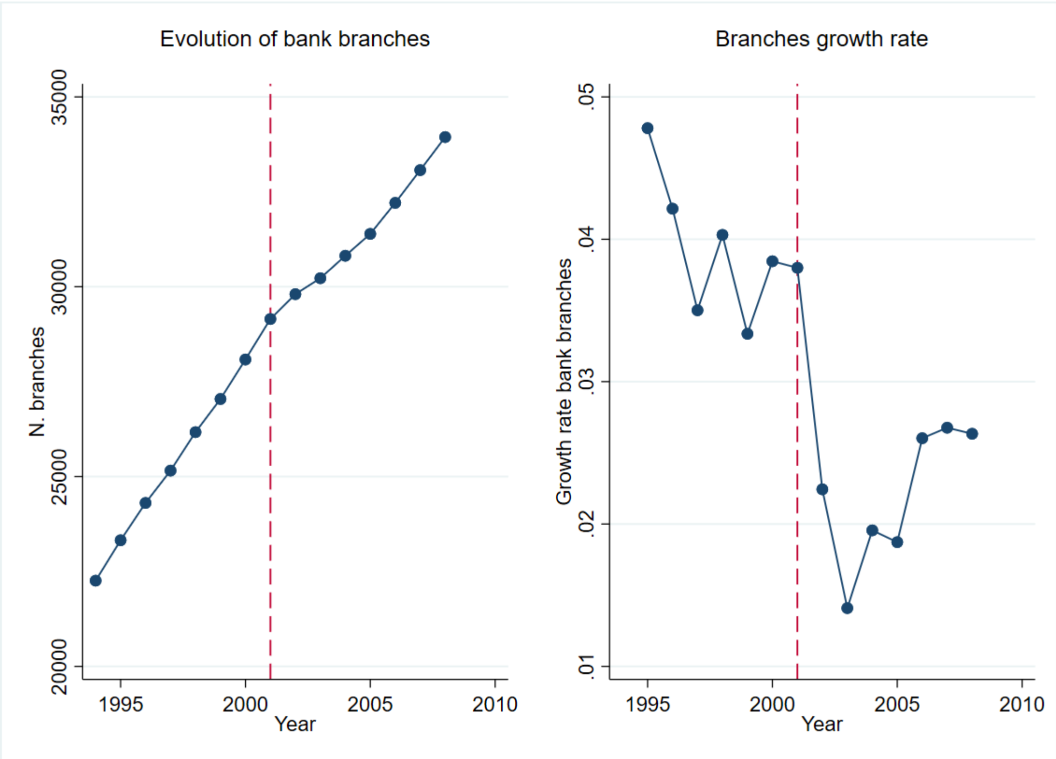
Notes: Geographical distribution of ADSL access in Italian municipalities. The left panel refers to 2004, the first year for which data on ADSL are available. The right panel refers to 2008, the last year in our sample. The measure of broadband internet is the baseline six-point asymmetric scale of ADSL coverage. Lighter colors indicate no or low access. Darker colors indicate high or full access.

Figure 3: DiD Event study: number of loans and credit amount



Notes: DiD setting. The treatment group is made by banks in municipalities with access to ADSL in 2006 (early adopters). The control group is made by banks in municipalities with no access to ADSL in 2006 (late adopters). Year 0 corresponds to 2002, the first year in which broadband internet is available. In the top panel, on the y-axis is $ln(N.\ loans)$, the natural logarithm of the number of loans issued by each bank. In the bottom panel, on the y-axis is $ln(Ext.\ credit)$, the natural logarithm of the total amount of credit granted by each bank. Both panels follow the indications of Borusyak and Jaravel (2017) and drop 1998, in addition to the baseline year (2001), from the computations.

Figure 4: Bank Branches in Italy, 1995-2010



Notes: This figure plots the evolution of bank branches in Italy during our sample period. On the left is reported the time series of the total number of branches. On the right is the growth rate of branches by year.

Tables

Table 1: 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

Notes: This table reports summary statistics for our final dataset. Panel A refers to data at the municipality level. We provide information on the municipality geographical distribution, as well as on access to broadband and the ADSL underlying infrastructure. Panel B refers to data at the bank-municipality level, that we use quite intensively throughout our analysis. We provide information on the number of loans issued by a bank in a given municipality, the amount of credit granted (in thousands of euros), and the average interest rate charged. Finally, panel C refers to loan level data and reports the credit amount.

Table 2: First stage regressions

	0-5 (Internet)	Dummy (Good access)	Dummy (Some access)	Years since good internet
distance UGS	-0.053***	-0.010***	-0.009***	-0.035***
× post 2001	(0.007)	(0.001)	(0.001)	(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

Notes: This table reports estimates from OLS as presented in equation (2). The dataset is at the municipality-year level. The dependent variables are: *Internet*, the percentage of households with access to ADSL-based services, in municipality m and year t, on an asymmetric six-point scale; *Good access*, a dummy variable that takes value 1 if broadband access is above 50%, and zero otherwise; *Some access*, a dummy variable that takes value 1 if broadband access is above 0%, and zero otherwise; and *Years since good internet*, a variable that counts the number of years since the percentage of households with access to the ADSL was above 50%. The main predictor is our instrument: the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the F-statistic from the regression; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 3: Regressions of Internet on Banks' Number of Loans and Extended Credit

	(1) Ln (N. loans)	(2) Ln (Ext. credit)	(3) Ln (N. loans)	(4) Ln (Ext. credit)
Internet	0.007***	0.009***	0.039**	0.081***
	(0.002)	(0.004)	(0.016)	(0.024)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			134.9	133.6
Mean	28.79	30094.456	28.79	30094.456
R-squared	0.901	0.860		
N	124243	123762	124243	123762

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variables are: *Ln(N. loans)*, the natural logarithm of the number of loans issued by bank b in year t; and *Ln(Ext. Credit)*, the natural logarithm of the amount of loans granted by bank b in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 4: Weights OLS estimates on the extensive margin of the credit relationship

Internet		Instrument	
Year	weight	Year	weight
2004	0.34	2004	0.20
2005	0.27	2005	0.20
2006	0.19	2006	0.20
2007	0.11	2007	0.20
2008	0.08	2008	0.20

Notes: This table reports the weights associated with OLS estimates from equation (1). Estimates are reported for years from 2004 to 2008 only (post broadband). The left panel accounts for the regression of the number of loans (extensive margin of the credit relationship) on *Internet*. The right panel reports weights for the reduced form regression of the number of loans on the instrument, *Distance from UGS* $\times$ *post2001*. The weights associated with the coefficients of *Internet* are decreasing over time. Those associated with the coefficients of the instrument are, instead, constant.

Table 5: Regressions of Internet on Average Interest Rates

	(1)	(2)
	Average Rate	Average Rate
Internet	-0.018***	-0.107**
	(0.007)	(0.045)
Controls	X	X
Bank-Mun FE	X	X
Year FE	X	X
Method	OLS	IV
F-statistic		318.4
Mean	6.81	6.81
R-squared	0.678	
N	112834	112834

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variable is *Average Rate*, the (weighted) average interest rate on loans issued by bank *b* in year *t*. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to the basic OLS estimate. Column 2 and refers to the 2SLS estimate, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 6: Regressions of Internet on Firms' Extended Credit

	(1) Ln (Ext. Credit)	(2) Ln (Ext. Credit)	(3) Ln (Ext. Credit)	(4) Ln (Ext. Credit)
Internet	0.007***	0.004***	0.114***	0.058***
	(0.002)	(0.001)	(0.017)	(0.009)
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			259.8	335.9
Mean	1057.814	1180.751	1057.814	1180.751
R-squared	0.153	0.948		
N	2115962	1643157	2115962	1643157

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level. The dependent variable is *Ln(Ext. Credit)*, the natural logarithm of the amount of loans granted by bank b to firm f, in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Controls* refer to the loan (one-year lagged) share of revolving loans of the firm, and the loan share of extended credit of the issuing bank. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and bank-year level, in columns 1 and 3. The model is saturated with firm-bank-municipality fixed effects and firm-year fixed effects in columns 2 and 4. The latter aims at isolating the supply effect. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 7: Regressions of Internet on Banks' Lending efficiency (productivity and quality)

	(1) Ln (Ext./Empl.)	(2) Asinh (NPLs/N. loans)	(3) Ln (Ext./Empl.)	(4) Asinh (NPLs/N. loans)
Internet	0.010**	-0.000	0.072***	-0.002**
	(0.004)	(0.000)	(0.023)	(0.001)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			123.4	134.9
Mean	1487.241	0.020	1487.241	0.020
R-squared	0.759	0.597		
N	116743	124243	116743	124243

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variables are: *Ln(Ext./Empl.)*, the natural logarithm of the amount of credit issued by bank employee; and *Asinh(NPLs/N. loans)*, the inverse hyperbolic sine of the share of non performing loans on total loans. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 8: Regressions of Internet on Loan Geography

	(1) Share ($\neq$ Prov.)	(2) Asinh (Avg. Distance)	(3) Share ($\neq$ Prov.)	(4) Asinh (Avg. Distance)
Internet	0.001	0.003	0.021***	0.062*
	(0.001)	(0.006)	(0.006)	(0.032)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			94.0	133.5
Mean			0.16	18.17
R-squared	0.292	0.324		
N	81851	79425	81851	79425

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level, and focuses on new loans. The dependent variables are: *Share(Diff. Province)*, the share of the loans originated outside the province of the bank; and *Asinh(Avg. Distance)*, the inverse hyperbolic sine of the average geodesic distance between the centroid of the municipality of the bank and the location of the firm. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 9: Regressions of Internet on Bank Competitors in the municipality

	(1) Ln (Competitors)	(2) Ln (Competitors)
Internet	0.010***	0.071***
	(0.001)	(0.009)
Mun FE	X	X
Year FE	X	X
Method	OLS	IV
F-statistic		52.3
Mean	3.28	3.28
R-squared	0.962	
N	41858	41858

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level. The dependent variables is *Ln(competitors)*, the natural logarithm of the number of bank (physical) competitors in municipality m, in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to basic OLS estimates. Column 2 refers to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 10: Regressions of Internet on Competition (Deposits)

	(1) HHI	(2) Top 3 Share	(3) Top 5 Share	(4) HHI	(5) Top 3 Share	(6) Top 5 Share
Internet	-0.004***	-0.005***	-0.003***	-0.025***	-0.026***	-0.022***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.002)	(0.002)
Mun FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Method	OLS	OLS	OLS	IV	IV	IV
F-statistic				88.4	88.4	88.4
Mean	0.68	0.96	0.99	0.68	0.96	0.99
R-squared	0.924	0.651	0.326			
N	49566	49566	49566	49566	49566	49566

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level. The dependent variables are: *HHI*, the Herfindahl–Hirschman Index of bank deposits in municipality m and year t; *Top 3 share*, the share of deposits owned by top 3 banks in the municipality; and *Top 5 share*, the share of deposits owned by top 5 banks in the municipality. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 to 3 refer to basic OLS estimates. Columns 4 to 6 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 11: Regressions of Internet on Existing Relationships

	(1) Dummy (Multiple)	(2) Dummy (Multiple Bank)	(3) Dummy (Multiple)	(4) Dummy (Multiple Bank)
Internet	0.001	0.001	-0.031***	0.034**
	(0.001)	(0.002)	(0.009)	(0.014)
Bank-Year FE	X	X	X	X
Bank-Mun FE	X	X	X	X
Firm FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			191.5	191.5
Mean	0.91	0.18	0.91	0.18
R-squared	0.650	0.525		
N	633732	633732	633732	633732

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level, and focuses on new loans. The dependent variables are: *Dummy(Multiple)*, a dummy variable for the loan issued to a firm already having a credit relationship; and *Dummy(Multiple Bank)*, a dummy variable for the loan issued to a firm already having a credit relationship with the same bank (in a different place). The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality, firm and bank-year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 12: Regressions of Internet on Firms' Ext. Credit - Small Municipalities

	(1) Ln (Ext. Credit)	(2) Ln (Ext. Credit)	(3) Ln (Ext. Credit)	(4) Ln (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
Mean	665.857	746.809	665.857	746.809
R-squared	0.243	0.967		
N	130647	47709	130647	47709

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variable is *Ln(Ext. Credit)*, the natural logarithm of the amount of loans granted by bank b to firm f, in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Controls* refer to the loan (one-year lagged) share of revolving loans of the firm, and the loan share of extended credit of the issuing bank. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and bank-year level, in columns 1 and 3. The model is saturated with firm-bank-municipality fixed effects and firm-year fixed effects in columns 2 and 4. The latter aims at isolating the supply effect. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 13: Regressions of Internet on the Easiest Target

	Dummy (Firm in small muni,out prov, with internet)	Dummy (Firm in small muni,out prov, with internet)
Internet	0.007***	0.054***
	(0.002)	(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

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level, and focuses on new loans. The dependent variable is a dummy that identifies loans to firms in small municipalities connected to fast internet, out of the province of the bank, granted by banks in municipalities with at least 10,000 inhabitants. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to basic OLS estimates. Column 2 refers to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality, firm and bank-year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 14: Internet on Bank Branches in the municipality

	(1) Ln (Branches)	(2) Ln (Branches) Small	(3) Ln (Branches)	(4) Ln (Branches) Small
Internet	0.004***	0.000	0.054***	0.003
	(0.001)	(0.000)	(0.006)	(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

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variables is *Ln(branches)*, the natural logarithm of the number of branches of bank b in municipality m, in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. Columns 1 and 3 refer to the all sample. Columns 2 and 4 refer to the sample of small municipalities. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality (or municipality) and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table 15: Regressions of Internet on Income and Population

	(1) ln (Income)	(2) ln (Pop.)	(3) ln (Income p.c.)	(4) ln (Income)	(5) ln (Pop.)	(6) ln (Income p.c.)
Internet	0.003***	0.002***	0.002***	0.040***	0.028***	0.017***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.002)	(0.002)
Mun FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Method	OLS	OLS	OLS	IV	IV	IV
F-statistic				52.6	53.7	53.7
Mean	123.914	11318	10.062	123.914	11318	10.062
R-squared	0.998	0.999	0.986			
N	33268	41932	33268	33268	41932	33268

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level. The dependent variables are: *Ln(Income)*, the natural logarithm of income; *Ln(Pop.)*, the natural logarithm of population; and *Ln(Income p.c.)*, the natural logarithm of income per capita. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 to 3 refer to basic OLS estimates. Columns 4 to 6 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

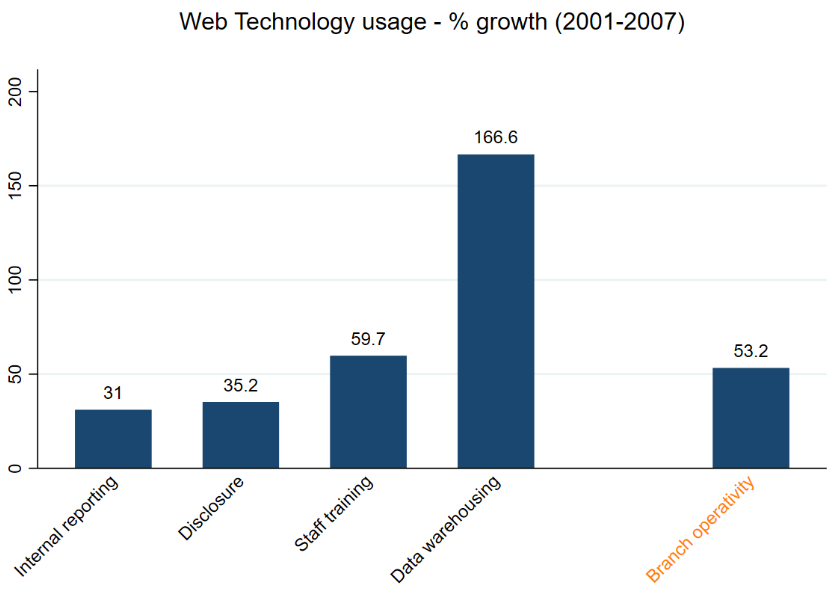
Table 16: Regressions of Internet on Income and Population - Small municipalities

	(1) ln (Income)	(2) ln (Pop.)	(3) ln (Income p.c.)	(4) ln (Income)	(5) ln (Pop.)	(6) ln (Income p.c.)
Internet	0.004***	0.002***	0.002***	0.064***	0.053***	0.021***
	(0.000)	(0.000)	(0.000)	(0.007)	(0.005)	(0.004)
Mun FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Method	OLS	OLS	OLS	IV	IV	IV
F-statistic				122.8	126.4	122.8
Mean	25.125	2517	9.988	25.125	2517	9.988
R-squared	0.992	0.995	0.979			
N	16630	20913	16630	16630	20913	16630

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variables are: *Ln(Income)*, the natural logarithm of income; *Ln(Pop.)*, the natural logarithm of population; and *Ln(Income p.c.)*, the natural logarithm of income per capita. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 to 3 refer to basic OLS estimates. Columns 4 to 6 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

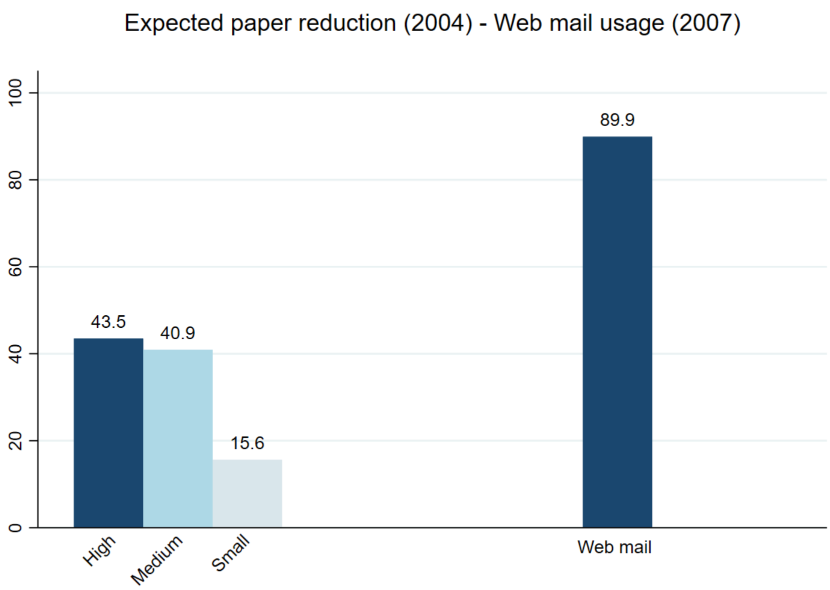
Appendix A Additional Figures

Figure 5: Usage of web technologies



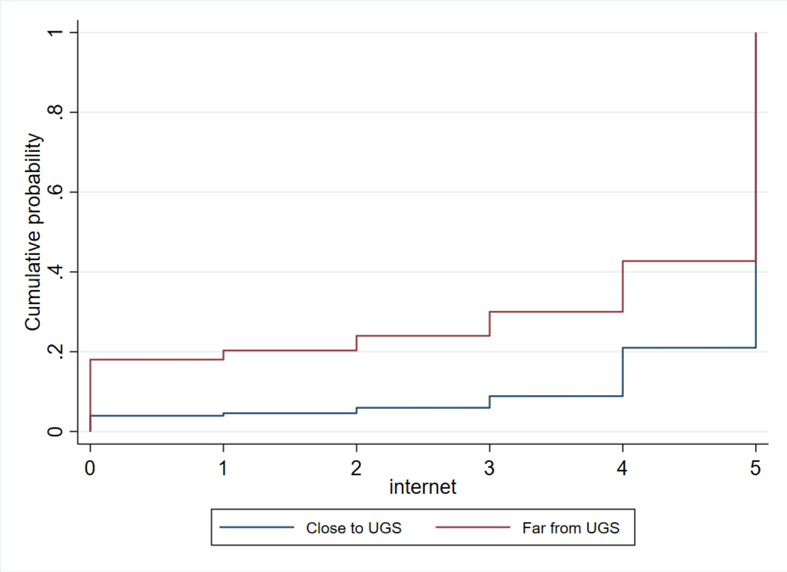
Notes: This figure reports the % growth of the use of web technologies, during the period 2001-2007, for different functions within Italian banks. The source is the Economic Analysis, 2002-2008, from the Italian Banking Association (ABI). Notice that for *Branch operativity*, we do not have the % growth but simply the % usage of web technology in 2007.

Figure 6: Web e-mails



Notes: This figure reports expectations about paper reduction, in 2004, within bank branches. Much of the banks included in the survey expected a high or medium reduction of paper. At the same time and for the same unit of analysis, the figure reports the % usage of web e-mails in 2007. The source is the Economic Analysis, 2002-2008, from the Italian Banking Association (ABI).

Figure 7: Instrument Monotonicity Test



Notes: Angrist and Imbens (1995) instrument's monotonicity test. The assumption of monotonicity of the LATE is not verifiable, but has testable implications on the CDFs of internet for municipalities close or far from the UGS. That is, they should never cross. Here, we plot the CDFs of internet for banks close to the UGS (blue solid line) and far from the UGS (red solid line). In order to separate the two groups, we use a dummy variable below/above the median of UGS distance, that proxy well for our continuous instrument. Values of the CDFs refer to the post broadband period. Since the two CDFs never cross, the instrument passes the test.

Appendix B Additional Tables

Table A1: Balance Table

	Close	Far	Norm. diff.	N.
Surface	35.31	55.06	(-.24)	4400
Altitude	205.08	336.16	**(-.37)**	4400
North	.69	.55	(.21)	4528
SL per capita	.24	.43	**(-.39)**	4528
Dist. province capital	2.67	3.23	**(-.61)**	4492
Pop. growth	.07	.04	**(.3)**	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	**(.31)**	4528
Employees growth	.05	.05	(.02)	4528
Income p.c. growth	.19	.17	(.19)	4361

Notes: balance table. This table compares several geographical and socioeconomic indicators, for municipalities that are at different distances from the necessary infrastructure for broadband. We distinguish between municipalities close (below the median of distance) and far (above the median of distance) from the closest UGS. Column 1 reports the average value of each variable for municipalities close to the UGS. Column 2 reports the average value of each variable for municipalities far from the UGS. Column 3 reports the normalized difference as in Imbens and Wooldridge (2009). Values above 0.25 can be considered problematic. Finally, column 4 reports the total number of observations (municipalities).

Table A2: Regressions of Internet on Banks' Number of Loans and Extended Credit with Controls

	(1) Ln (N. loans)	(2) Ln (Ext. credit)	(3) Ln (N. loans)	(4) Ln (Ext. credit)
Internet	0.006**	0.007	0.029*	0.064***
	(0.002)	(0.004)	(0.016)	(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

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variables are: *Ln(N. loans)*, the natural logarithm of the number of loans issued by bank b in year t; and *Ln(Ext. Credit)*, the natural logarithm of the amount of loans granted by bank b in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Controls* refers to municipality-level variables: the natural logarithm of total population; elderly population, number of private firms, number of employees, distance from the provincial capital, interacted with a second-order polynomial-time trend. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A3: Regressions of Internet on Banks' Number of Loans

	Ln (N. loans)	Ln (N. loans)	Ln (N. loans)	Ln (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
Method	IV	IV	IV	IV
F-statistic	134.9	121.7	117.9	118.3
Mean	28.79	28.79	28.79	28.79
R-squared				
N	124243	124243	124243	124243

Notes: This table reports estimates from 2SLS as presented in equation (3). The dataset is at the bank-municipality-year level. The dependent variable is *Ln(N. loans)*, the natural logarithm of the number of loans issued by bank b in year t. The main predictors are: *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale; *Years since good internet*, a variable that counts the number of years since the percentage of households with access to the ADSL was above 50%; *Good access*, a dummy variable that takes value 1 if broadband access is above 50%, and zero otherwise; and *Some access*, a dummy variable that takes value 1 if broadband access is above 0%, and zero otherwise. All our predictors are instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A4: Regressions of Internet Placebo on Banks' Number of Lines and Firm's Extended Credit

	(1) Ln (N. loans)	(2) Ln (Ext. Credit)	(3) Ln (N. loans)	(4) Ln (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
F-statistic			100.4	99.6
Mean	26.12	24395.638	26.12	24395.638
R-squared	0.932	0.906		
N	72277	71905	72277	71905

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level. The dependent variables are: *Ln(N. loans)*, the natural logarithm of the number of loans issued by bank b in year t; and *Ln(Ext. Credit)*, the natural logarithm of the amount of loans granted by bank b in year t. The main predictor is *Internet placebo*, a fake measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. The sample includes years from 1998 to 2003, where we assign ADSL data of 2006 to years from 2001 to 2003. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A5: Regressions of Internet on the Share of Connected Firms out of the municipality

	(1) Share (Connected firms)	(2) Share (Connected firms)
Internet	0.021***	0.116***
	(0.002)	(0.010)
Bank-Mun FE	X	X
Year FE	X	X
Method	OLS	IV
F-statistic		132.2
Mean	0.31	0.31
R-squared	0.515	
N	92654	92654

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level, and focuses on new loans. The dependent variables is the *Share(Connected firms)*, the share of the loans originated with firms connected to broadband. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to basic OLS estimates. Column 2 refers to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A6: Regressions of Internet on Loan Geography

	(1) Dummy (Diff. Province)	(2) Asinh (Distance)	(3) Dummy (Diff. Province)	(4) Asinh (Distance)
Internet	0.001	0.003	0.033***	0.074**
	(0.002)	(0.007)	(0.011)	(0.037)
Bank-Year FE	X	X	X	X
Bank-Mun FE	X	X	X	X
Firm FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			191.5	215.4
Mean	0.42	77.35	0.42	77.35
R-squared	0.672	0.756		
N	633732	567594	633732	567594

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level, and focuses on new loans. The dependent variables are: *Dummy(Diff. Province)*, a dummy variable for the loan being originated outside the province of the bank; and *Asinh(Distance)*, the inverse hyperbolic sine of the geodesic distance between the centroid of the municipality of the bank and the location of the firm. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality, firm and bank-year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A7: Regressions of Internet on Average Interest Rates - Small Municipalities

	(1) Average Rate	(2) Average Rate
Internet	0.009	0.309**
	(0.012)	(0.139)
Bank-Mun FE	X	X
Year FE	X	X
Method	OLS	IV
F-statistic		43.0
Mean	6.25	6.25
R-squared	0.546	
N	16637	16637

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variable is *Average Rate*, the (weighted) average interest rate on loans issued by bank b in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to the basic OLS estimate. Column 2 and refers to the 2SLS estimate, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A8: Regressions of Internet on Banks' Internal efficiency (productivity and quality) - Small Municipalities

	(1) Ln (Ext./Empl.)	(2) Asinh (NPLs/N. loans)	(3) Ln (Ext./Empl.)	(4) Asinh (NPLs/N. loans)
Internet	-0.014**	0.000	-0.165***	-0.002
	(0.006)	(0.000)	(0.055)	(0.003)
Bank-Mun FE	X	X	X	X
Year FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			81.6	90.6
Mean	750.624	0.01	750.624	0.01
R-squared	0.720	0.337		
N	29465	31045	29465	31045

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the bank-municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variables are: *Ln(Ext./Empl.)*, the natural logarithm of the amount of credit issued by bank employee; and *Asinh(NPLs/N. loans)*, the inverse hyperbolic sine of the share of non performing loans on total loans. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A9: Regressions of Internet on Bank Competitors in the municipality - Small Municipalities

	(1) Ln (Competitors)	(2) Ln (Competitors)
Internet	0.002**	-0.007
	(0.001)	(0.010)
Mun FE	X	X
Year FE	X	X
Method	OLS	IV
F statistic		125.4
Mean	2.03	2.03
R-squared	0.908	
N	20839	20839

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variable is *Ln(competitors)*, the natural logarithm of the number of bank (physical) competitors in municipality m, in year t. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Column 1 refers to basic OLS estimates. Column 2 refers to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A10: Regressions of Internet on Competition (Deposits) - Small Municipalities

	(1) HHI	(2) Top 3 Share	(3) Top 5 Share	(4) HHI	(5) Top 3 Share	(6) Top 5 Share
Internet	-0.003***	-0.002***	-0.002***	-0.032***	-0.023***	-0.023***
	(0.001)	(0.000)	(0.000)	(0.005)	(0.003)	(0.003)
Mun FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Method	OLS	OLS	OLS	IV	IV	IV
F-statistic				215.0	215.0	215.0
Mean	0.84	0.99	0.99	0.84	0.99	0.99
R-squared	0.824	0.192	0.180			
N	28161	28161	28161	28161	28161	28161

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the municipality-year level, and includes information on small municipalities (below the median of population) only. The dependent variables are: *HHI*, the Herfindahl–Hirschman Index of bank deposits in municipality m and year t; *Top 3 share*, the share of deposits owned by top 3 banks in the municipality; and *Top 5 share*, the share of deposits owned by top 5 banks in the municipality. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 to 3 refer to basic OLS estimates. Columns 4 to 6 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the municipality and year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A11: Regressions of Internet on Loan Geography - Small Municipalities

	(1) Dummy (Diff. Province)	(2) Asinh (Distance)	(3) Dummy (Diff. Province)	(4) Asinh (Distance)
Internet	0.004**	-0.008	0.019	0.039
	(0.002)	(0.009)	(0.021)	(0.068)
Bank-Year FE	X	X	X	X
Bank-Mun FE	X	X	X	X
Firm FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			4.7	4.0
Mean	0.15	14.61	0.15	14.61
R-squared	0.948	0.955		
N	9572	8120	9572	8120

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level. It focuses on new loans, and includes information on small municipalities (below the median of population) only. The dependent variables are: *Dummy(Diff. Province)*, a dummy variable for the loan being originated outside the province of the bank; and *Asinh(Distance)*, the inverse hyperbolic sine of the geodesic distance between the centroid of the municipality of the bank and the location of the firm. The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality, firm and bank-year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Table A12: Regressions of Internet on Existing Relationships - Small Municipalities

	(1) Dummy (Multiple)	(2) Dummy (Multiple Bank)	(3) Dummy (Multiple)	(4) Dummy (Multiple Bank)
Internet	0.011*	0.002	-0.014	-0.059
	(0.006)	(0.005)	(0.057)	(0.047)
Bank-Year FE	X	X	X	X
Bank-Mun FE	X	X	X	X
Firm FE	X	X	X	X
Method	OLS	OLS	IV	IV
F-statistic			4.7	4.7
Mean	0.86	0.1	0.86	0.1
R-squared	0.836	0.793		
N	9572	9572	9572	9572

Notes: This table reports estimates from OLS and 2SLS as presented in equations (1) and (3). The dataset is at the firm-bank-municipality-year level. It focuses on new loans, and includes information on small municipalities (below the median of population) only. The dependent variables are: *Dummy(Multiple)*, a dummy variable for the loan issued to a firm already having a credit relationship; and *Dummy(Multiple Bank)*, a dummy variable for the loan issued to a firm already having a credit relationship with the same bank (in a different place). The main predictor is *Internet*, a measure of ADSL coverage in the municipality, based on a six-point asymmetric scale. Columns 1 and 2 refer to basic OLS estimates. Columns 3 and 4 refer to 2SLS estimates, where the variable *Internet* is instrumented by the interaction between *Distance from UGS* and a dummy variable *post2001*. *Method* reports the used estimator; *F-statistic* reports the Sanderson-Windmeijer multivariate F-statistic, when the 2SLS methodology is adopted; *Mean* refers to the mean of the dependent variable; *R-squared* is the adjusted R^2; and *N.* refers to the number of observations. Fixed effects are at the bank-municipality, firm and bank-year level. Standard errors, in parentheses, are clustered at the municipality level. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.