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Local banking markets and barriers to entrepreneurship in minority and other areas

Does broadband availability help?

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Abstract

This empirical study investigates the linkages among entrepreneurship in the form of establishment entry, local banking markets, and broadband availability, focusing on minority areas in the US. Lack of access to banks and lack of competition in the market for small business loans can make it more difficult for an entrepreneur to overcome the liquidity constraint to starting a new business. Broadband internet access can facilitate startups directly by enhancing firm profitability and indirectly by stimulating competition in the loan market, lowering the cost of access to finance, and enabling access to financial capital from fintech lenders. The barriers to new business creation erected by local banking markets are hypothesized to be even higher in minority areas, given the greater difficulty minority entrepreneurs face in raising financial capital. The empirical results show that broadband availability, local bank density, and competition in small business loans all facilitate startups. Broadband lowers barriers for entrepreneurs as hypothesized through both the direct and indirect channels. Broadband availability attenuates the barriers from insufficient access to local banks and lack of competition in small business loans from banks. For some industries, higher bank density and greater loan competition facilitate startups more in minority areas than in mostly white areas. Given that minority areas have many fewer banks per capita and much less loan competition than mostly white counties, the results imply that minority areas face even higher barriers to entrepreneurship from insufficient local formal financial resources. The moderating effect of broadband on local financial constraints applies even more so to Black communities; thus while the barriers for Black entrepreneurs may be higher, access to broadband has a greater alleviating effect on those barriers. Business creation in Hispanic areas also faces obstacles from the local banking environment, but broadband does not appear to help reduce them, although it still has a positive direct effect on entry. Additional evidence shows that broadband helped small businesses in minority areas procure more bank loans. Broadband access can thus help entrepreneurs in general, Blacks in particular, and to a lesser extent Hispanics surmount the liquidity constraint to starting a business. The implications of the results are discussed with reference to current and proposed policy to promote broadband availability, usage, and digital equity.

I. Introduction

The recent economic downturn in 2020 brought on by COVID-19 hit small businesses hard in the US. From February to April 2020 there was a 22% decline in active business ownership, with 3.3 million small businesses shuttered at least temporarily—the largest drop on record (Fairlie, 2020). The damage the pandemic wrought on the small business environment follows many years of decline. The birth rate of establishments, a key measure of small business dynamism, plummeted almost 30 percent during the Great Recession and since then has remained much lower than in any period at least since the late 1970s.[1] The pandemic hit minority entrepreneurs particularly hard. More than two in five Black entrepreneurs, the hardest-hit group, closed their small businesses, and almost one-third of Hispanic small business owners shut down (Fairlie, 2020). Six months after the pandemic began, small businesses owned by minorities were most likely to report experiencing "financial and operational challenges" (Federal Reserve Bank of Atlanta et al., 2021).

It is concerning that small business numbers and new firm entry are declining. Large negative shocks to and steady declines in small business formation can create a "missing generation" of future employers, generating deeper recessions and slower recoveries (Clementi & Palazzo, 2016). Decline in the health of small businesses and startups in minority areas is of heightened concern, given that most employment is by small business,[2] small high-impact businesses account for most employment growth, and minority-owned businesses tend to hire more minorities than other businesses (Bates, 1994).

Given the importance of small businesses for local economies, especially for minority communities, understanding the hindrances to new business formation is important. One of the greatest obstacles that entrepreneurs face is raising financial capital to start and continue young ventures (Kerr & Nanda, 2009; Braggion et al., 2018). Insufficient access to local banks and lack of competition in small business loans from banks hinders small businesses (Degryse & Ongena, 2005; Nguyen, 2019), and the results here extend that detrimental impact to starting new businesses. The focus of the present research is on whether broadband internet access can lower

[1] The statistics for the Great Recession compare the establishment birth rate in the US in 2009 to 2006 using data for establishments with employment from the Business Dynamics Statistics (BDS) from the US Census Bureau.
[2] Per BDS data, over half of employment in 2018 was from establishments with fewer than 100 employees, and about one-quarter of employment was from establishments with fewer than 20 employees.

financial barriers to entrepreneurship, expressed in the birth rate of establishments. There are fewer banks in minority areas, which could constrain would-be entrepreneurs. With broadband internet access, however, the importance of local banks may be diminished, since online lending from out of area banks, lending platforms, crowdfunding, and providers of other forms of financial technology (fintech) become available. Fintech is promising for minority entrepreneurs because it may replace the high access costs, poor service, and low prospects for obtaining loans from local banks, which may be why fintech is disproportionately used in areas with fewer bank branches and larger minority residents (Erel & Liebersohn, 2020). Thus exploring the nexus among local bank presence, competition, broadband, and new business formation appears to be both promising and important.

The empirical investigation is conducted for all startups and also comparatively for areas in which a substantial number of blacks and Hispanics live. The Poisson regressions for establishment births in various industries advance the literature by including county-year fixed effects, which control for the plethora of possible county-level control variables used in past regional studies of entrepreneurship as well as any unobserved confounders at the county level that evolve over time. The findings indicate that local bank presence, competition in the market for small business loans, and broadband availability all facilitate startups. A finding new to the literature—and potentially important for policy related to broadband internet access or small business lending—is that broadband availability lowers barriers for entrepreneurs posed by lack of local banks and bank concentration. The comparative results are also novel. Broadband availability has a greater effect on new businesses formation in black areas, and to a lesser extent in Hispanic areas during some years. The ability of broadband to moderate the startup barriers caused by sparser or less competitive local banking environments applies to black areas, but not Hispanic areas. Supplementary evidence shows that broadband helped small businesses in minority areas procure more loans from banks. In contrast, in recent years broadband is not associated with more bank loans in mostly white areas; instead, broadband availability reduced the average loan distance, evidence consistent with fintech lenders gaining market share in loans formerly supplied as distance loans offered by banks. These findings shed light on how access to broadband can help all entrepreneurs surmount the liquidity constraint, while being even more important in some areas with a large proportion of minorities, seen most clearly for blacks.

The exposition proceeds in the next section with discussion of the literature and formulation of hypotheses to test. Background information, past research, and hypotheses regarding new business formation, the local banking environment, broadband, and interactions among these factors concerning the startup decision are covered in general first. In section II.D, aspects of these relationships unique to minority entrepreneurs is covered. The data for the empirical analysis is described in section III and the results are presented in section III.F. A final section contains a summary of the many hypothesis tests and a discussion of policy implications.

II. Literature, Theory, and Hypotheses

A. Entrepreneurship, the liquidity constraint, and the local banking environment

The first barrier to starting a new business an entrepreneur faces is often the liquidity constraint (see Evans and Jovanovic (1989) for seminal theory and empirical investigation by Kerr & Nanda (2009) and Braggion et al. (2018)). The most common source of startup capital, by far, is personal or family savings of the owner (64%; data from the US Census Bureau).[3] However, business loans from banks are the second most common source, at 20%, and therefore the most important external source of commercial funding. Adding the categories of home-equity loans (8% of startups), government-guaranteed business loans from banks (2%) and carrying balances on business (6%) or personal (11%) credit cards adds to the importance of commercial banks as a source of funding. In contrast, only 0.6% of startups make use of venture capital.

After opening, small firms depend primarily on banks for ongoing support and financing (Dunkelberg & Scott, 2011). In 2003, commercial banks supplied 41 percent of small businesses with credit lines, loans, or capital leases, and were the most common source of these services (Mach & Wolken, 2006). Fifteen years later, after the explosion of online lending and fintech, banks are still the most common source to which small business owners apply for credit; 46% of nonemployer and 49% of employer small businesses apply to large banks and 40% of nonemployers and 44% of employers apply to small banks (FRB of NY, 2019; FRB of Atlanta et

[3] The figures here are from the US Census Bureau's Annual Survey of Entrepreneurs (ASE) for 2014. Respondents could indicate more than one source of financing; percentages reported are for the proportion of entrepreneurs using a given method to access financial capital for the new business (among respondents that responded and did not say "don't know").

al., 2019). A rational entrepreneur will look ahead to expected difficulties in accessing credit for the ongoing business when considering the initial startup decision. Thus, theory and evidence regarding banks' relationships with small business in general, not just nascent firms, will be reviewed below to inform the empirical investigations to follow.

The local banking environment affects an entrepreneur's liquidity constraint through two channels. First is the cost of accessing the banks' services, which for local banks depends partly on proximity due to the opportunity cost of time spent traveling to and from a physical bank location. Even with online banking, the physical location of a business's primary bank is important for services such as cash management and face-to-face relationship banking. Relationship lending, in which a bank accumulates "soft" (unverifiable) information about a small business, builds trust and helps overcome the moral hazard problems that afflict lending to nascent and small businesses (Ongena & Smith, 2000; Saparito et al., 2004). Proximity to banks has been shown empirically to lower loan rates to small businesses (Degryse & Ongena, 2005) and local bank density is positively associated with the volume of small business lending (Nguyen, 2019). Furthermore, the great majority of small business lending from banks occurs within the county of a branch (Mitchell et al., 2021). For all these reasons, it is unsurprising that the size and depth of local financial markets helps explain regional variation in the formation of new firms (Sutaria and Hicks, 2004; Parajuli and Kingsley, 2015).

The local banking environment also affects startups through the quality and price of service, including the availability of loans and their rates. However, lending to small businesses is characterized by high complexity, informational opacity, and low scale over which to recoup fixed costs of lending, which can make the prospect unattractive for banks (Berger & Udell, 1998; Koentizer et al, 2016). About a quarter of nonemployer small businesses found the loan application process to be difficult, high interest rates to be a challenge, and the wait for credit decisions to be long from both large and small banks (FRB of NY, 2019). Restricted access to loans from local banks can check the small business growth rate (Rupasingha & Wang, 2017). Comprehensive, county-level data on the service and interest rates charged by local banks are unavailable for this study, and instead evidence regarding their impact on the birth rate of establishments will be inferred from the observable factors reflecting or influencing bank competition in the loan market.

Banking competition affects both of the channels linking the local banking environment to the startup decision of an entrepreneur. Competition within an area can come from rivalry between local branches or from out-of-market lenders. Consider first the impact of competition on the bank location channel. In recent decades, many small businesses have been unshackled from local options for loans, instead securing funding from out-of-market banks and online lenders. The increasing distance between small business borrowers and their lenders accelerated greatly in 1995, at the start of the internet era (DeYoung et al., 2008), leading to rising out-of-county small business lending (Adams et al., 2021; Anenberg et al., 2018; Jagtiani & Lemieux, 2016). Much of this growth in distance lending was driven by automated lending processes made possible by credit scoring models (DeYoung et al., 2008) and a small number of banks specializing in high-volume, small-loan (less than $100,000) lending nationwide (Adams et al., 2021).

From the point of view of small business, lack of competition in the banking industry can also negatively affect quality of service, lending, and interest rates. This is the *market power hypothesis* linking bank competition to entrepreneurial and small business finance. Large banks may be less willing to engage in relationship banking with small businesses because of organizational diseconomies of scope with their transactional (i.e., "hard" data driven) lending to large firms (Berger & Udell, 1998). Therefore, when competition decreases through consolidation of banks, lending to small businesses from the acquired firm can drop (Keeton, 2001), interest rates offered to small businesses can rise (Avery & Samolyk, 2004; Craig & Hardee, 2007; Rauch & Hendrickson, 2004), and the quality of service can degrade (Scott & Dunkelberg, 2003). And while the view has been proposed that only noncompetitive banks have the luxury of engaging in costly relationship banking with businesses (the *information hypothesis*), the weight of the evidence is in line with the market power hypothesis: loan rates are higher and the volume of small business credit is lower in less competitive markets (Chen, et al., 2017; Lian, 2018; Love & Martínez Pería, 2015).

Together, these effects of competition on lending options result in fewer business expansions in areas where large banks have high market share (Chen et al., 2017), fewer new businesses started where banking competition is lower (Elitcha, 2021), and more new incorporations where deregulation increased competition in banking markets (Black & Strahan, 2002).

B. Broadband and New Business Formation: Direct Effects

Where there is greater access to broadband infrastructure and there are more broadband providers competing to offer service, the area is more attractive for many new business ventures. Broadband Internet access, as a general-purpose technology (Bresnahan and Trajtenberg, 1995), can reduce production cost, increase productivity, lower entry barriers, and increase information accessibility. Broadband also expands the market for a business's products or services; by 2018, 15% of nonemployer small businesses made the majority of their sales through an app or online marketplace (FRB of NY, 2019). Higher expected profitability feeds back into the initial decision to start a business. Audretsch et al. (2015) suggest that broadband infrastructure facilitates entrepreneurial activity because broadband can reduce barriers by facilitating "connectivity, interaction and the exchange of knowledge and ideas that potentially could fuel entrepreneurial ventures." However, Hasbi (2020) states that until recently there were only a few empirical studies of whether broadband availability increases the attractiveness of a location for firms. The few existing studies generally find that broadband is conducive to firm entry (Hasbi, 2020; Kim & Orazem, 2017; Mack, 2014; McCoy et al., 2018; Prieger et al., 2017). Hence:

> **Hypothesis 1**: Greater broadband availability in an area facilitates new business formation.

C. Broadband and New Business Formation: Indirect Effects through the Financing Channels

In addition to any direct effects on profitability, broadband internet access also affects entrepreneurs' decisions through its impact on banking and financing business ventures. These indirect effects have been little-explored in the literature. Broadband attenuates the importance having banks nearby, since the cost of access drops when the bank can be accessed online instead of through a physical branch. Already by 2003 almost half of small businesses using computers used them for online banking (Mach & Wolken, 2006), and online banking lessens the dependence on relationship banking with local branches (Han, 2008). Calzada et al. (2019) found that during 2008 to 2014, the percentage of the population in the county with access to broadband reduced the density of local bank branches, a result they attribute to using the internet to access the bank instead of physical visits.

Likely the largest impact of broadband on financing is through the way that it fosters competition in lending and banking services. High-speed internet access allows more efficient use of online

banking and enables borrowing from an expanded set of traditional banks, direct banks, and fintech lenders. In addition to casting farther afield for loans from traditional banks, an increasing number of business owners turn to direct banks (also known as branchless or virtual banks) to meet their credit needs. Direct banks use online banking technology to offer services without branches (apart, possibly, from ATMs). While some direct banks are fully virtual, stand-alone operations, many large commercial banks have established direct banking divisions as well.

The most innovative recent aspect of broadband-enabled competition in the credit market comes from online lending from nonbanks, commonly known as *fintech* (Barkley & Schweitzer, 2020; Bruton et al., 2015). Fintech began in 2005 and by 2010 was expanding its market share quickly.[4] Fintech takes many forms: peer-to-peer lending by crowdfunding platforms such as LendingClub and Prosper; e-commerce merchant finance offered by platforms like Amazon, eBay, PayPal, and Square to their sellers; balance sheet lending offered by, e.g., OnDeck Capital and Kabbage, which retain loans on their own books instead of selling them to other financial institutions or individuals; and others.[5] Balance sheet business lending amounted to $12.4 billion in 2018 in the U.S., whereas peer-to-peer business funding totaled $2.0 billion (CCAF, 2020) and the payment processor PayPal Working Capital alone lent more than $1 billion to small and medium sized business during 2013-2015 (Jagtiani & Lemieux, 2016). In addition to debt funding, fintech can also offer money transfers, mobile payments, and trading platforms to small businesses. Already by 2014, nearly one in five small businesses sought credit from an online lender in the first half of the year (FRB, 2015). By 2015, 28% of microbusinesses (those without employees) applied for loans from online lenders, a figure that rose to 39% in 2018 (FRB, 2016, 2019).

Making productive use of online borrowing opportunities requires adequate broadband access to the Internet, particularly if the relationship with the financial institution moves beyond borrowing and into day to day operations such as online or mobile banking to manage cashflow, forecasting, and budgeting. For this reason, how the availability of high-speed Internet access

[4] See FinTechtris' history of fintech at https://www.fintechtris.com/blog/evolution-fintech-lending.
[5] Other forms of fintech include invoice finance, which allows a small business to monetize its outstanding receivables, supply chain finance, which finances the business's buyers, and export and trade finance (Koenitzer et al., 2015).

interacts with local banking resources and competition will be explored. While the impact of broadband on startup activity through the channel of banking competition appears to have been little explored for small business lending, fintech consumer loans have been found to penetrate highly concentrated banking markets and areas with low branch density (Jagtiani & Lemieux, 2018). There is also precedent for external changes that created more competition from out-of-area banks having invigorating effects on startup activity. Deregulation of interstate branch banking in the 1990s in the U.S., for example, has been solidly linked to increased business formation (Black and Strahan, 2002; Cetorelli & Strahan, 2006; Kerr & Nanda, 2009). Thus:

> **Hypothesis 2**: Greater broadband availability in an area lessens the importance of local banking availability in facilitating new business formation.
>
> **Hypothesis 3**: Greater broadband availability in an area lessens the detrimental impact of local bank concentration on new business formation.

D. Minority Entrepreneurship

A key focus of this research is on minority areas. While studying areas with significant minority presence is not the same as studying minority entrepreneurs, the two are closely linked. Research has found that minority owned businesses are heavily concentrated in minority neighborhoods (Bates & Robb, 2015; Marion, 2009) and that nearly half of small firms located in urban minority neighborhoods are owned by minorities (Bates & Robb, 2014). Therefore, in the discussion below issues regarding minority small business owners will be discussed, even though the empirical results are necessarily for minority areas.

Minorities, banks, and competition

Minority entrepreneurs may face additional considerations and constraints as members of the local business financing ecosystem. The dependence on banks for minority startups may be lower than for other small business owners (FRB of NY, 2019): Black and Hispanic entrepreneurs are 19% and 31% less likely than white entrepreneurs to obtain business loans from banks or other financial institutions as a source of startup capital (Robb and Morelix, 2016). These differences continue with established businesses. In 2019, Black small business owners were half as likely as White small business owners to have obtained funding from banks (FRB of Atlanta et al., 2020). However, these differences do not appear to be by choice of the entrepreneurs; 45% of minority small business owners say that availability of credit is a problem

for their business, compared to only 21% of White small business owners (U.S. Chamber of Commerce, 2005).

Even if they wished to, many minorities may not be able to rely on banks for business financing in the same way that White entrepreneurs can. Counties with large proportions of minority residents have fewer bank branches, as will be documented below. One study found that the proportion of Black and Hispanic residents in Chicago neighborhoods is negatively related to the number of bank branches (Hegerty, 2020). Low-income ZIP codes had the fewest bank branches before the Great Recession, and the number has declined since then (Battisto et al., 2019). Braggion et al. (2018) find that in areas with greater financial inequality (as in many minority areas), there are fewer bank establishments and that entrepreneurs are less likely to apply for a loan, fearing that their applications will be turned down. Discouraged borrowers are more prevalent in minority areas and minority business owners were more likely to be discouraged borrowers than Whites (Bates & Robb, 2015, 2016; Blanchflower et al., 2003). In 2018, 37% of Black and 29% of Hispanic nonemployer small business owners did not apply for financing due to discouragement, whereas only 1% of white small business owners were discouraged (FRB of NY, 2019). Fears of rejected loan applications are grounded in realities facing minority entrepreneurs. Black non-employer small businesses were approved for business loans at a rate 21 percentage points lower than whites in 2018 (FRB of Atlanta et al., 2019). Differences persist in most studies after controlling for observed characteristics of would-be borrowers (Blanchflower et al., 2003; de Zeeuw & Barkley, 2019; Mitchell & Pierce, 2011).[6] For example, compared to observably similar applications from white borrowers, a loan application from an African-American small business owner has a 30 percentage point higher probability of rejection (Palia, 2016) and the odds ratio of a minority small business owner having all loan applications denied is 5.3 (Bates & Robb, 2015).[7]

Lack of access to financial capital from commercial banks places obstacles in the path of minority entrepreneurs. Informal social or co-ethnic networks and credit-card borrowing may allow minorities to raise enough cash or informal credit to finance their venture, but doing so is a sign of disadvantage and credit so raised can be costly (Bates & Robb, 2013). Whereas 41% of

[6] See also the many studies cited in Jackson et al. (2018).
[7] The latter figure is computed from Bates & Robb's (2015) coefficient of 1.666 for minority ownership in a logistic regression of having all loan applications rejected.

white nonemployer small business owners said they experienced no financial challenges in 2018, only 24% of Black and 30% of Hispanic small business owners say they did not (FRB and NY, 2019). Therefore, access to banks might be even *more* important in minority areas.

> **Hypothesis 4**: Banking availability in an area facilitates new business formation *more* in minority areas than in other areas.

Competition in the banking sector may help minority borrowers even more than others. If there is prejudicial (taste-based) or otherwise irrational discrimination in lending markets, greater competition will squeeze out such unprofitable behavior (Becker, 1971; Friedman, 1962). Discrimination against minority borrowers may also stem from financial institutions using race or ethnicity to signal that a minority entrepreneur is a higher credit risk (i.e., statistical discrimination; Phelps, 1972). Whether taste-based or statistical, discrimination in what Shelton (2010) terms the *industry social environment*, composed of resource providers and gatekeepers, can result in disparate opportunity structures for entrepreneurs, hindering minorities from accumulating the resources needed to overcome barriers to entrepreneurial success. For example, a "mystery shopper" field experiment revealed that although banks quoted minority entrepreneurs similar interest rates as white customers, the former were less frequently provided information on loan fees and terms, asked to provide more information about their businesses and personal financials, and less frequently offered a business card or help with the loan application or future banking needs (Bone et al., 2014). Competitive pressure can force changes in the social environment. Furthermore, when disparate outcomes for minority borrowers stem from the entrepreneurs' poor bargaining positions, competition can improve minority opportunities for lending by reducing search costs and high reservation prices (Bates et al., 2018).

Minorities and broadband

The impact of broadband on entrepreneurship in minority areas seems to be as yet unexplored. Broadband may be even more important for minority entrepreneurs if they can use it to reduce the greater entry barriers they face and level the playing field with their established competitors (for example, by buying and selling online without revealing their race).

> **Hypothesis 5**: Greater broadband availability in an area facilitates new business formation more in minority areas than in other areas.

On the other hand, past research has shown that compared to whites, Blacks and Hispanics are less likely to use broadband in the home (Prieger, 2015) and less likely to use various forms of ICT in their small businesses (Coleman, 2004; Middleton & Byus, 2011). If minority small business owners are more likely than others to lack the education, training, experience, or support to use broadband to its full advantage, or simply choose to open businesses for which ICT is less important (e.g., yard care services), then local broadband availability may be a less important—or even irrelevant—factor when starting a new business.

In addition to the considerations involved in the nexus of broadband and the local banking environment discussed above for all entrepreneurs, several aspects may differ for minorities. For example, minority borrowers' higher search costs for loans (Bates et al., 2018) can be lowered with broadband-mediated lending. Fintech lending, predominantly offered by nonbank entities, often replaces tedious, time-consuming loan applications with quick applications and speedy decisions (enabled by information technology such as machine learning). Furthermore, loan applications completed online may allow entrepreneurs to conceal their race and ethnicity. The Equal Credit Opportunity Act (1974) prohibits discrimination in consumer and business loans, and when applying for credit a lender may not ask the applicant to reveal race or national origin,[8] but race may be hard to conceal when applying in person at a bank branch. When race is known, minorities are less able to obtain loans and are offered higher interest rates than comparable whites; with race-blind applications there is no disadvantage (Blanchflower, 2009). Possibly for such reasons, small business owners in low-income and high-poverty areas substituted away from loans originated by banks towards Lending Club when it entered various markets (Kim & Stähler, 2020).[9]

More than half of Black microbusiness owners (52%) applied for online funding in 2018, which is 12 percentage points more the white microbusiness owners (FRB of NY, 2019). It is therefore possible that broadband helps entrepreneurs in black areas more than in white areas to overcome barriers raised by local financial constraints.

[8] As long as the loan does not have a home as collateral, in which case other laws mandate that the lender ask for information on race and ethnicity.
[9] Not all fintech is race blind. Examples include peer-to-peer lending platforms that post videos of would-be borrowers making their pitch or linking to their social media accounts.

Hypothesis 6: The moderating effects of broadband regarding local branch density, bank competition, and startups (as posited in Hypotheses 2 and 3) are larger in minority areas

On the other hand, Hispanic microbusiness owners are four percentage points less likely than whites to seek online loans (FRB of NY, 2019). Although online funding is not the only channel through which greater broadband availability may lower the importance of local banks, it may be that broadband lowers the banking-related barriers to starting new businesses less in Hispanic areas than in other areas. Thus, Hypothesis 6 may not hold in Hispanic areas.

III. Description of the data

This section describes the data used for the empirical investigation. The period of study is 2009 to 2017. The starting date is chosen to coincide with the changed lending environment after the financial crisis of 2008, when bank lending to small businesses shrank dramatically for several years (Goldston & Lee, 2020) and online lending from nonbank fintech firms accelerated in response.

A. Definition and Measures of Entrepreneurship

Over the past several decades, the literature has explored several ways to measure entrepreneurship, including self-employment, the number of establishments, and births of establishments or firms. This study uses *establishment births per member of the labor force* to measure entrepreneurial activities. Data on the birth rate of establishments are from the Business Dynamics Statistics (BDS), which the US Census Bureau constructs from longitudinal administrative data on all firms with employment.[10] An establishment is a single physical location where business or operations are conducted, and so a new establishment need not be an entirely new firm, but it almost always is: in the final year of the BDS data used in this study, 98.9% of establishment births in the nation represented new businesses. Regardless, except for any barriers that nascent entrepreneurs face only with initial entry, all the same considerations regarding the importance of banking and broadband resources discussed above also apply to expanding firms. Establishment births are business locations with employees in the current year but no employment in the previous year, where employment is measured in March each year.[11]

[10] These are the most finely geographically disaggregated data on establishment (or firm) births available to the public. See https://www.census.gov/programs-surveys/bds/about.html.

[11] The number of employees at the establishment is measured in BDS for the payroll period include March 12 each year. Employment after temporary shutdowns (e.g., a single year with no employment) are not counted as births.

The establishment data, and therefore the unit of observation for the study, are specific to a year, county, and two-digit NAICS industry sector. There are 18 two-digit private industry sectors represented in the BDS; the sectors of agriculture, forestry, fishing and hunting and the public administration sector are excluded.[12]

The Census Bureau censors the publicly-available BDS data to protect the confidentiality of individual firms. The number of establishment births is unknown when there are one or two firms in the sector and county, or if only one or two firms opened new establishments. Nearly a quarter of the observations on establishment births are censored. To reduce the risk of bias from the missing values, they were imputed. Imputation was performed by bounding the censored births above and below using all possible information in the BDS and then using censored Poisson regression to fill in the missing values (details are in the appendix). The imputed data are then used as the dependent variable in the regressions reported in this paper.

To more closely study entrepreneurship, the coefficients on the broadband and banking variables are broken out by three industry categories: innovative, service, and other industries. The innovative industries are three that other researchers have found to be highly innovative compared to other industries: manufacturing, information, and professional, scientific, and technical services.[13] Births in these industries may more closely be identified with innovative entrepreneurship than in other industries. The service industry group is the two-digit "other services" industry, and includes equipment and machinery repair shops, drycleaners and laundries, personal and pet care services, temporary parking services, and other similar service activities—in other words, many of the sorts of small businesses that are run by minorities in local communities.[14] For example, 9% of African American small business owners offer health, beauty, or fitness services (Pickard-Whitehead, 2018) and 16% of Hispanic business owners

[12] The sectors are: mining, quarrying, and oil and gas extraction; utilities; construction; manufacturing; wholesale trade; retail trade; transportation and warehousing; information; finance and insurance; real estate and rental and leasing; professional, scientific, and technical services; management of companies and enterprises; administrative, support, waste management, & remediation services; educational services; health care and social assistance; arts, entertainment, and recreation; accommodation and food services; other services (except public administration).
[13] For example, Low (Table 4.3, 2009) finds that the manufacturing industry is relatively high tech, high churn, and high patenting; the information industry is high tech and high churn; and the professional, scientific, and technical services industry is high skill, high tech, and high churn, all of which characteristics she identifies with innovative industries.
[14] The *other services* category does not include restaurants or other food services, because those are grouped with accommodation services in another sector.

requesting loans from an online platform (Biz2Credit) were in an "other services" industry (Arora, 2018).

The dataset for the regressions was constructed so that the regressors refer to conditions at or before the beginning of year *t* while establishment births refers to activity between March of year *t* and March of year *t*+1. Summary statistics for the data, including the proportion of firms in each main industry sector group, are in Table 1.

B. Minority Areas

Due to the nature of data available on establishment births and broadband, minority areas must be examined instead of minority entrepreneurs directly. While neither the race nor the ethnicity of the entrepreneurs associated with the establishment births in a county are known, other research has found that minority owned businesses are heavily concentrated in minority neighborhoods (Bates & Robb, 2015; Marion, 2009) and that nearly half of small firms located in urban minority neighborhoods are owned by minorities (Bates & Robb, 2014).

Data on the racial and ethnic composition of county population are from intercensal estimates from the US Census Bureau. The estimates for July 1 of year *t*-1 are matched to establishment birth observations of year *t* (all regressors are timed to avoid any simultaneity with entrepreneurial activity in the year the observation captures). Two minority areas are considered: counties with a proportion of Black residents greater than 30%, and the same for Hispanics.[15] These areas have roughly twice as many Black or Hispanic residents as the average county, which in the sample is 12.9% Black and 15.1% Hispanic. These counties will be referred to as having a *substantial* population of Blacks or Hispanics, and they will be compared with *mostly white* areas: counties that are majority non-Hispanic white and neither substantially Black or Hispanic themselves. About 10% of counties have a substantial proportion of blacks (nearly all in the South, with a few other urban counties; see Figure 2) and 6.9% of counties have a substantial proportion of Hispanics (mainly in California and the Southwest, with a few other agriculture-heavy counties). About 81% of counties (most of the rest) are mostly white.

[15] For all definitions, the black population is taken to be those who are black alone (i.e., not biracial or multiracial). Persons of Hispanic ethnicity may be of any race.

The time trends of average establishment births per member of the labor force across all sectors and various types of counties are in Figure 1. The heavy line is for the average birth rate across all counties and sectors. The decline in the few years preceding the start of the estimation sample and in the latest two years is striking. Areas with a high proportion of black residents have many fewer establishment births; areas with a high proportion of Hispanic residents in most years have about the same or more establishment births than the overall national average.

Figure 3 shows a similar breakdown of establishment births for innovative industries. Counties with a substantial black presence have the lowest level of innovative establishment births. Areas with a substantial Hispanic population have lower rates of new business formation than the national average in most years. Figure 4 shows establishment births for services. Substantially black counties have fewer service establishment births than mostly white counties in most years after 2009. In almost all years, counties with a substantial Hispanic presence have the lowest rates.

Supplementary regressions examine the total value of small business loans to a Census tract. The smaller geography in these regressions allows a higher threshold for designation as a minority area, and a majority threshold (50%) is used for Blacks and Hispanics. Similarly, the threshold for mostly non-Hispanic white counties is raised to be the median, which is 72%.

C. Bank Location and Competition Data

Data on the location of FDIC-insured bank branches are taken from the FDIC Summary of Deposits database.[16] These data are used to create a variable for the log number of bank branches in the county per capita. Data are as of July, and the regressor is lagged to reflect banking conditions a half-year before the start of year *t* in which establishment entry may have occurred. In addition to avoiding simultaneity, the regressor is lagged also to represent the set of banking options in place when the entrepreneur was considering opening a new business. The time series of banks per capita are shown in Figure 5 (the heavy dark lines), where it is seen clearly that there are substantially fewer banks in minority areas.

[16] See https://www7.fdic.gov/sod/dynaDownload.asp. Only full-service brick and mortar offices, full-service retail offices, and limited service loan production offices are included.

Competition in local banking markets has been measured in various ways in the literature (Leon, 2015). The main measure of competition in small business loans adopted herein is the (HHI) computed from bank shares of the total value of commercial and industrial (C&I) loans and nonfarm nonresidential secured loans. Data on loans are from the FDIC's Statistics on Depository Institutions (SDI), and cover all FDIC-insured institutions.[17] In keeping with the focus on nascent entrepreneurial endeavors, only loans with original value under $250,000 are included.[18] C&I loans are those made to business enterprises for commercial, industrial, and professional purposes, and may be secured (but not by real estate).[19] Loans guaranteed by the Small Business Administration (SBA) are included in this category. Nonfarm nonresidential secured loans are those secured by liens on business and industrial properties. While there is no guarantee that such a loan is used strictly for entrepreneurial or business purposes, when the loan amount is less than $1 million the FDIC considers these to be "small business loans". Furthermore, mortgages are the leading source of external funding for small businesses, and commercial mortgages make up a larger share of mortgage-secured small business debt than single or multifamily residential mortgages (Jagtiani & Lemieux, 2016).

The FDIC's SDI data, taken from the mid-year Quarterly Reports for year *t*-1, provide loan totals by bank but not by county. All loans are aggregated to the level of the bank holding company. To create a proxy for county-level concentration in small business loans, the bank totals were allocated to its branches in the county (using the bank location data described above) assuming that its loan dollars per capita are constant across all branches and counties. This allocation method likely overstates loan shares in a non-metropolitan county for large banks (at least if it faces some small community banks there). Thus, the HHI computed for each county is not meant to be a literal measure of concentration in the local market for small business loans, but instead is a proxy which may be skewed toward higher concentration when large national banks have

[17] Nearly every bank in the US is FDIC-insured.

[18] For comparison, the average small business loan in Q4 2017 (the end of the sample period) was $66,200. The statistic is computed from data from the Small Business Lending Survey by the Federal Reserve Bank of Kansas City on approved loans (see Table C.2 of kansascityfed.org/documents/8165/ExcelAggregateData_SmallBizLendingSurvey_June2021.xlsx). These data pertain to loans made to firms with $5 million or less in annual gross revenue.

[19] Examples in the FDIC reporting instructions to banks of loan security in this category include the pledge of a merchant's own installment paper (payments to be received for items purchased by the merchant's customers on installment plans), conditional sales contracts made to finance the purchase of commercial transportation equipment, and production payments (e.g., oil or mining production payments). Real estate is excluded as security because such loans are included in the separate categories (e.g., nonfarm nonresidential secured loans, as described next).

branches in a county. Given that concerns in the literature on banking competition center around consolidation among these large banks,[20] a measure of concentration that is positively biased when large banks are present in local markets does not seem to harm the usefulness of this regressor to proxy the local competitive environment for loans. The time series of bank concentration measured this way are shown in Figure 5 (the thinner, lighter lines); concentration in the market for small business loans from banks is much higher in minority areas than overall or in mostly white areas.[21]

D. Broadband Availability Data

Data on broadband provision come from the FCC and the National Telecommunications and Information Administration (NTIA). The broadband provider data available for observation years 2009 and 2010 (the "early years") come from the FCC's Form 477. The source data are a count of distinct broadband providers in a Census tract as of the end of year t-1.[22] The provider count is used as a variable related to the availability, price, and quality of broadband infrastructure.[23] A county-level measure is constructed as the population-weighted average of the number of providers in the tracts. This count includes all forms of fixed broadband service, including wired, satellite, and terrestrial fixed wireless.[24] The speed threshold is 200 kbps in at least one direction.

For observation years 2011 to 2017 (the "later years"), broadband speed data are extracted from the National Broadband Map (NBM) (through 2014) and the FCC's revised Form 477 (thereafter).[25] Maximum advertised download speed categories and counts of providers in different broadband types are recorded over Census blocks. The block-level provider counts are

[20] See the literature cited in section **Error! Reference source not found.**.
[21] Note that including concentration in bank loans as a regressor but no measures on fintech competition is meant to imply that the latter is unimportant. The data are merely unavailable.
[22] Providers owned by the same holding company are not treated as distinct providers.
[23] Most areas have at least one broadband provider, at least when tracts are the basic geographical unit, and so a binary availability variable would not be useful. When there are more providers in an area, there will likely be higher geographical coverage throughout the area, prices will be lower on average (Wallsten & Mallahan, 2010), and the speed of service will be higher (Molnar & Savage, 2017; Reed & Watts, 2018).
[24] Tract counts of one to three providers are censored. Before aggregation to the county level, the censored observations in the source data were replaced with their expected values (based on a censored Poisson regression controlling for year and population). The computation of the expected values are as described in the appendix for the imputation of establishment births.
[25] The data are from the NBM through observation year 2014 and from the FCC's revised Form 477 thereafter. The NBM was the creation of NTIA in collaboration with state agencies and the FCC. Beginning with the 2014 end of the year broadband data, the FCC revised its Form 477 to be able to report similar data as was in the NBM.

aggregated to county level averages using population-weighted allocation factors. Various speed thresholds are available; here 25 mbps is chosen, the FCC's speed threshold since 2015 for what it deems to be broadband. Only providers offering terrestrial fixed service (including fixed wireless) are included.

Figure 6 shows how the four broadband measures changed over time. The time series for broadband in the later years begin at lower points than in 2010 not because broadband coverage declined but because the basic geographical unit shrinks from tract to block; there will naturally be fewer distinct firms within a smaller area. The year fixed effects in the regressions will account for the discontinuities in definition. Broadband providers offered 25 mbps speed relatively rarely in 2011, but by 2017 the average local area had more than one provider. The differences in the provider counts by the minority status of the county are relatively small.

For 2016-2017, data on 4G LTE mobile broadband deployment are also available. The data are from the FCC, and as before the block-level provider counts are aggregated to county level averages using population-weighted allocation factors. With the increased speeds offered by 4G (and now 5G), mobile broadband can be an effective substitute for fixed broadband for some small businesses. This variable will be used as a robustness check only, since including it requires using a subset of only two years of the data.

E. Other Control Variables

Three other control variables commonly appearing in the literature are also included. The first is the unemployment rate in the county. When unemployment is high, the opportunity costs of starting a new venture may be lower because the expected returns to wage employment diminish. On the other hand, high regional unemployment and its resulting drag on disposable income in the area may reduce demand for local goods and services, and therefore reduce the incentive for entrepreneurs to begin local businesses (Sutaria & Hicks, 2004; Parajuli & Haynes, 2015). Another control variable is the fraction of the county population that lives in rural Census areas.[26] Urbanization has been found to be positively associated with new firm formation (Parajuli & Haynes, 2015). Because all except the initial set of regressions will include county-

[26] The data are from the 2000 and 2010 Censuses, with other years filled in with interpolation and extrapolation. Linear interpolation and extrapolation were used except when values would have been negative; in such cases exponential extrapolation was used.

year fixed effects, other county-year control variables are not necessary since they would be subsumed into those fixed effects.

The remaining control variable is sector-specific: the fraction of county employment in the industry at firms with more than 250 employees.[27] Where more employment is at large firms, their dominant power could hinder the formation of new, small ventures (Armington and Acs, 2002). Alternatively, if new small firms need to rely on the existence of established large firms (from which to raid local talent or to supply other inputs), more new businesses would be started in areas with more large firms, as found by Sutaria & Hicks (2004).

F. Lending data for supplementary regressions

Data on the average small business lending distance and total lending to an area are explored in supplementary regressions. For loan distances, data on small business lending at the bank-county level is taken from Community Reinvestment Act (CRA) data. All small (which in these data mean less than $1 million) business loans are covered in the CRA data for banks meeting an asset size threshold. Thus, the smallest lending institutions are not included, and as with the FDIC lending data described above most fintech lending is not included. In 2010 about 87% of the total amount of all small business loans were included in the CRA data (Williams, 2012). For each county and bank, the distance from the county centroid to the closest branch of the lending bank was computed, and then the distances were averaged, weighted by loan amounts, across all banks for the county and year.[28]

CRA data on total small business lending include the total loan origination amount by Census tract and year. In these data, loans can be restricted to those of less than $250,000 each, as with the FDIC data. The lending institution are not identified in these data.

[27] These data are computed from the Census Bureau's County Business Patterns (CBP) and are only approximate. CBP provides the number of establishments in various size classes by county and industry. For purposes of calculation, employment at each establishment was taken to be equal to the national-average for the establishment size category (data for which is available from the national-level CBP data). Beginning in 2017, the Census Bureau began censoring the number of establishments in cells with only a few of them. To fill in missing values for 2017, linear extrapolation was performed (with results bounded between zero and one).

[28] Details of the procedure are in the appendix.

IV. Regression Model and Empirical Results

The main estimations are fixed-effect Poisson regressions. Conditional fixed-effects Poisson regression allows a natural way to model multiplicative effects of regressors in the conditional mean of count data, is immune to the incidental parameter problem, and (unlike least squares regression with a log dependent variable) requires no special treatment of zero counts.[29] Furthermore, Poisson regression is robust to overdispersion, and the standard errors in such cases can be consistently estimated with robust formulas.[30] The coefficients from a Poisson regression can be interpreted the same way as in a log-linear regression, and when the regressor is in logs the coefficients are elasticities. The first Poisson estimations to follow are of this form:

$$\ln E(Y_{ict}/LF_{ct}|X, Z, LF, \alpha, \iota) = \beta' X_{ct} + \gamma' Z_{ict} + \alpha_{st} + \iota_i$$

where the indexes are *i* for the NAICS two-digit industry, *c* for county, *s* for state, and *t* for time. The dependent variable Y_{ict} is the count of new establishments in an industry, year, and county, expressed as a rate per labor force member LF_{ct}.[31] The broadband and banking variables and most of the control variables vary by county and year but not by industry, and so are included in *X*. The only control variable that additionally varies across industries within a county-year (*Z*) is the fraction of employment at large firms (although after orthogonalization, as described later in the paper, the broadband variables in some specifications will also be included in *Z*). The state-year fixed effects, α, control for every possible otherwise-omitted confounding factor common to counties across a state, whether they change over time or not. Examples of such factors include state government programs for assisting minority businesses, state laws concerning banking and fintech, and state regulation of broadband providers (which can affect prices and other aspects of broadband service apart from its availability as captured by the broadband regressors). Those

[29] That is, there is no problem of what to do with $Y = 0$ merely because the log of zero is undefined.

[30] Contrary to apparent belief in some of the entrepreneurship literature employing count data models, the Poisson model does *not* require equidispersion of the data for the coefficient estimates to be consistent. To be precise, estimation in the present case is Pseudo-Poisson Maximum Likelihood (PPML; see Gourieroux, Monfort & Trognon (1984)), also known as Quasi-Maximum Likelihood Estimation (QMLE; see Wooldridge (1999) and §19.2.2 of Wooldridge (2010)); no assumption that the data are generated by a Poisson process is required. QMLE produces consistent and asymptotically normal regression coefficient estimates as long as the mean is a correctly specified exponential function of the regressors, and using the sandwich estimator for the variance produces consistent estimates of the standard errors.

[31] The rate variable *LF* is the *exposure variable* in the Poisson regressions, which enters the specification as a regressor with a fixed coefficient of 1. Examining new establishments per worker is common in the labor-oriented approach in the entrepreneurship literature. The regressions were performed using Stata 15.1 with the user-contributed command `ppmlhdfe` (Correia, Guimarães, & Zylkin, 2019).

state-year fixed effects also, of course, control for every possible secularly trending and confounding factor common to the whole nation. The other fixed effect, ι, is for the industry, and accounts for the fact that the rates of new business formation can differ greatly across industries. Identification in this case is from variation across counties and industries within a state and year (net of *national* level differences among industries).

Some specifications will additionally include κ, a set of fixed effects for the county-year:

$$\ln E(Y_{ict}/LF_{ct}|X, Z, LF, \kappa, \iota) = \beta_i{}'X_{ct} + \gamma'Z_{ict} + \kappa_{ct} + \iota_i$$

In such specifications, κ subsumes α and every possible time-varying county-level confounding factor. Identification in this case is from variation across industries within a county and year. This is an especially powerful specification, given the multitude of time-varying local economic and other factors explored in the empirical literature on entrepreneurship, many of which are correlated with starting a new business; to the extent that they affect new business formation in a like manner across industries (as is tacitly assumed in any cross-industry regression without industry-specific coefficients, i.e., most of the literature) they need not be added explicitly to the regression specification because they are subsumed into κ. When coefficients are desired for the marginal effects of a member of *X*, the regressor must be interacted with industry dummy variables to yield industry-specific coefficients (β_i in the expression above). This specification is similar in form, therefore, to those of conditional or multinomial logits, in which the β coefficients are understood as relative to the unknown coefficient for the base category.

A. Estimations with State-Year Fixed Effects

The first estimation, Estimation A1 in the first column of Table 2, is for all counties and contains state-year and industry fixed effects, as do the other estimations in this table. The banking and broadband banking coefficients are allowed to vary among innovative, service, and other industries. The results indicate that the number of banks per capita is strongly and positively associated with new businesses in all three industry groups. For each industry group higher concentration in the provision of small business loans in the county is positively and significantly associated with new establishments. Broadband availability is positively associated with new business formation for all three industry groups and both periods. Thus, the evidence supports Hypothesis 1. The results show that broadband is more important for new business formation in innovative than in other industries in both periods, although the difference is not large in the

early years. The broadband coefficient for service industries is roughly similar to those for other industries in the first period, but is over twice as large as the coefficient for other industries in the later years. For the control variables, the rural population fraction is not significant, the unemployment rate is negatively associated with new business formation, and the fraction of large firms in the industry is positively associated.

How do the coefficients in the minority-heavy subsample of counties compare with those in mostly white counties (estimations A2 through A4)? The differences in the importance of local banks there are interesting. In counties with a substantial black or Hispanic population, bank presence matters for innovative industries even more than for mostly white counties. Thus local commercial financial resources appear to be more important for starting innovative firms in areas where many blacks and Hispanics live, which is evidence in favor of Hypothesis 4. The opposite holds for service and other industries, where the coefficients are lower in the minority areas. The latter finding may indicate that many small service firms run by minorities (e.g., local yard care services) do not look to banks to meet their potentially modest needs for financial capital.

Bank loan concentration also appears to hinder new business formation in minority areas, although significance is only at the 10% level in substantial-Hispanic counties for other industries. Concentration in bank loans has much larger negative effects on establishment births in substantially minority counties than in mostly white areas. Given the higher concentration in the market for small business loans from banks in minority areas (see Figure 6), these results suggest that lack of competition may be a significant barrier to minority entrepreneurship. There is no significant difference among types of counties for service firms.

Regarding the associations between broadband and new business formation, in the early years the effect sizes are larger in the minority areas than in the mostly white counties, and the same is true for substantially black counties in the later years, so Hypothesis 5 is accepted for those counties and years. However, for substantially Hispanic areas (estimation A4), in the later years there is no significant association between broadband and new business formation at all. Thus, not only is Hypothesis 5 rejected for substantially Hispanic areas, but so is Hypothesis 1. Recall that the definition of broadband is 25 mbps during those years; these results may indicate either that entrepreneurs in Hispanic areas are able to "do what they need to do" with broadband of

more moderate speeds or lack the training or experience to make full use of opportunities provided by broadband.

B. Estimations with County-Year Fixed Effects

In Table 3, the state-year fixed effects are replaced with county-year fixed effects. Since this specification controls for all factors pertaining to the county-year level, the control variables are subsumed into the fixed effects (except employment at large firms, which varies by industry within a county). Since the broadband and bank regressors would also be dropped, they are interacted with dummy variables for innovative and service industries. Thus the coefficients for a regressor interacted with (for example) the innovative industry indicator are to be read as relative to the (unknown) baseline effects for the excluded industry category, which is "other industries". Even though the baseline coefficients for other industries are unknown, if the results with only the state-year fixed effects in the previous table are not too badly biased then those coefficients can suggest at least the sign of the baseline marginal effects, if not the exact magnitudes.

The results of Estimation B1 for all counties are qualitatively and quantitatively similar to those in the previous set of estimations, keeping in mind that the coefficients in the new estimations are to be compared with the *difference* in the innovative (and service industry) coefficients with the baseline "other industry" coefficients. For example, from Estimation A1 in Table 2 the difference between the branch density coefficients for innovative and other industries is (0.254-0.341 =) -0.087, whereas in Estimation B1 in Table 3 the same difference is -0.096. That is, innovative industries display a slightly lower importance of local banks than other industries, whether the county-year fixed effects are included or not. Also as before, establishment births in innovative and service industries are negatively affected by loan concentration to a greater degree than other industries. The results also show that broadband is more important for new business formation in innovative and service industries than in other industries in both periods. Innovative industries display a lower importance of local banks than other industries, as was also the case in Estimation A1. In each case where a broadband or bank coefficient is significant, it is close numerically to the corresponding coefficient in Table 2. The same is true for the minority subsamples. This result gives some confidence that the results in Table 2 are not tainted by much bias from unobserved factors that change over time and location. The coefficients for employment at large firms, the one apples-to-apples comparison possible between Estimations

A1 and B1, are also both positive (0.56 vs. 0.37). The smaller coefficient in Estimation B1 may indicate that there are indeed unobserved county-year specific confounders that are important to control for.

C. Broadband as a Moderating Influence on the Impact of Local Banks

In the final set of estimations, the banking and broadband regressors are interacted to estimate whether broadband availability has a moderating influence on the effect of local bank branches and bank concentration on new business formation. Thus the conditional mean for the Poisson regression model is now specified as:

$$\ln E(Y_{ict}/LF_{ct}|X,Z,\delta,\iota) = \beta_{1i}{}'BranchDensity_{ct} + \beta_{2i}{}'LoanHHI_{ct} + \beta_{3i}{}'BB_{ct} + \gamma'EmpLrg_{ict} + \delta'_{1i}(BB^{o}_{ct} \times BranchDensity_{ct}) + \delta'_{2i}(BB^{o}_{ct} \times LoanHHI_{ct}) + \delta_{ct} + \iota_i$$

where it is understood that BB_{ct} is the broadband availability measure, in logs, relevant to year *t*. Since the broadband and bank branch variables are in logs, the elasticity of new establishments with respect to local banks per capita in industry *i* is $\beta_{1i} + \delta_{1i}BB^{o}$, and this is the sense in which broadband is a moderating factor. (There is a slight abuse of notation in that *i* refers to two-digit industries for the dependent variable and the industry fixed effect but to the three major industry groups (innovative industries, service industries, and other industries) for δ, to avoid a multiplicity of coefficients). Similarly, the marginal effect of small business loan concentration is a semi-elasticity equal to $\beta_{2i} + \delta_{2i}BB^{o}$.

If the sign on a coefficient on the interaction term δ_{1i} is negative, then (assuming that the baseline coefficient β_{1i} for bank branches is positive, as the evidence above indicates) broadband would appear to lessen the importance of local banks for entrepreneurship (Hypothesis 2). If the sign on a coefficient δ_{2i} is positive, then (again, assuming that the baseline coefficient β_{2i} is negative, as the evidence above indicates) broadband lessens the detrimental impact of local concentration in small business loans on the establishment birth rate (Hypothesis 3).

The broadband variables are orthogonalized with respect to all other regressors before interacting them with the bank variable (hence the *o* superscript in BB^{o}). This ensures that the estimated moderating influence of broadband on the bank impact reflects the influence of broadband alone,

untainted from the latter's correlation with the other factors (Balli & Sorensen, 2013). After orthogonalizing, the broadband×bank variables vary by industry within a county-year,[32] and so coefficients for all three industry groups for the interactions can be estimated.

The results are in Table 4; the coefficients on the interactions between the broadband and bank variables are of primary interest and only those are shown in the table (see the appendix for the full set of results). In estimation C1 for all counties, all of the coefficients for the broadband and branch density interactions are negative and significant. This is in accord with Hypothesis 2. Furthermore, all of the coefficients for the broadband and loan concentration interactions are positive and significant, in line with Hypothesis 3. These findings support the notion that broadband frees local entrepreneurs from limitations imposed by purely local sources of commercial financing, whether due to access or quality of service.

For the counties with a substantial black presence (Estimation C3), the negative coefficients on the broadband-branch density interactions are significant, in accord with Hypothesis 6, and are even larger in magnitude and of higher significance than for mostly white areas. Recall from the discussion of Estimations A2 and A3 that local formal financial resources appear to be more important for innovative entrepreneurship in areas where many blacks live. If banks were plentiful in such areas, that could be a beneficial factor for black entrepreneurship in innovative industries. However, the opposite is true: there are 31% fewer banks per capita in substantially black counties compared to mostly white counties. Thus, lack of sufficient access to local banks may hinder black entrepreneurship, and access to broadband appears to alleviate that bottleneck.

The signs of the coefficients regarding the moderating effect of broadband on loan concentration are all positive in substantially black areas, again in accord with Hypotheses 6 (and again larger than in mostly white areas), but the coefficients are individually significant only in later years (although they are jointly significant in the early years, too). The results differ greatly for Hispanic areas, where *none* of the coefficients on the interactions are individually significant. Thus, Hypothesis 6 is rejected for Hispanic areas; it appears that broadband does not help lower

[32] This is so because the broadband variables are orthogonalized with respect to the industry fixed effects and employment at large firms, which vary by sector. The full set of such variables includes all the regressors explicitly listed in Table 2, the two-digit NAICS industry fixed effects, and the state-year fixed effects.

the barrier to new business formation posed by lack of access to local banks or high concentration in the loan market in heavily Hispanic areas.

D. Supplementary regressions of loan amounts and lending distance

To supplement these results and to examine directly the relationship between broadband and the procurement of loans, the impact of broadband on total bank loan amounts and lending distance is examined here. First, the log of Census tract-level total CRA small business loan originations is regressed on the broadband variables and a host of control variables. Regressors include the log number of jobs for businesses located in the tract, the racial and ethnic composition, poverty status, median income, and educational attainment of residents, and the unemployment rate and rural status of the tract. (Sources and details on the variable are in the appendix; coefficients for these are not shown). These regressions all include tract and county-year fixed effects. The first regression (D1), shown in Table 5, reveals that broadband had a positive effect on total small business loans in the early years but not after 2011. Estimation D2 splits the broadband impacts by the minority status of the county, and shows that the early broadband positive effect applies to loans in all types of counties. However, during the later years, broadband has positive effects in Black and Hispanic tracts only, not in mainly white tracts. For the later broadband years only, additional control variables are available: the proportion of jobs by age, size, and industry sector of firm, all for businesses in the tract. Since these factors may be correlated with both broadband provision in the area and the supply and demand for loans, they may be important to avoid omitted variables bias. The estimations with these additional controls, D3 and D4, confirm that broadband had a positive effect on small business loans but only in Black and Hispanic areas.

These results showing that broadband is positive related to total loans in minority areas are in accord with the findings above showing that broadband provision is positively and strongly associated with establishment births and appears to lower barriers for starting new businesses caused by having fewer banks or a less-competitive local banking environment in minority areas. But what explains the apparent lack of broadband relevance for mainly white areas after 2011, given the results in Table 4 the broadband moderated lack of banking competition in mostly white counties? Recall that broadband can enable owners to turn to fintech for funding, and that most fintech loans are not included in the CRA data (because they are not from banks). Instead of using broadband to turn to banks outside the county, it may be instead that entrepreneurs in

such areas often turned to fintech instead. One implication, if that was the case, may be that bank loan distances to such counties dropped. As Brevoort and Hannan (2006) explain theoretically and empirically, technological changes (credit scoring in their earlier context, fintech in the present context) in lending can have the effect of "peeling off" some of the longest distance loans from smaller and local lenders. As loans move from these lenders to fintech, then, an observable and testable result is that average loan distance *from banks* may decrease.

To test this implication, the average CRA loan distance in mostly white counties is regressed on the broadband variables and the other regressors from Table 2, controls for the size, age, and sectoral distribution of firms in the county, a full set of regressors for residents' race and ethnicity, and county and year fixed effects. The results (in the appendix) show that whether the dependent variable is loan distance or the percentage of loans that originate outside the county, there is no impact of broadband during the early years but a negative impact during the later years, as suggested by the notion that fintech "peeled off" some loans that otherwise would have been from banks lending at distance. The magnitude of the effect is fairly small (the elasticity of loan distance with respect to the average number of broadband providers in the county is 0.005 (s.e. = 0.001) but highly statistically significant.

E. Robustness checks

To test the robustness of the results, alternative regressors in the main regressions were explored. There are many ways to measure competition in loans to small businesses. While the loan concentration variable used above includes nonfarm nonresidential (NFNR) loans, some studies in the literature examine only C&I loans. The estimations were therefore redone using the small business loan HHI constructed as before but excluding NFNR loans. The results were very close to the main estimations and there is no change in any conclusions regarding the hypotheses (full results for all robustness tests are in the appendix; these are in Table A - 3 to Table A - 5). For the second robustness check, the HHI includes C&I and NFNR loans, but amounts up to $1 million are included. This is the threshold used by the FDIC to delineate small and large business loans. The results are again almost entirely similar (see Table A - 6 to Table A - 8).[33]

[33] All hypotheses are accepted or rejected as with the main set of estimations except for the following: Hypothesis 7 is rejected when comparing black and mostly white areas for service industries.

As a third robustness check, a lower download speed threshold is used to define broadband in the later years. While the threshold used above, 25 mbps, fits the current definition set by the FCC, in 2011 (the start of the later years in the sample) the agency's threshold was lower and Figure 6 shows that the average census block did not have a provider offering broadband with download speed of 25 mbps in 2011.[34] Thus, the estimations were repeated with a speed threshold of 10 mbps for the later years (see Table A - 9 to Table A - 11). The conclusions regarding the hypotheses are as for the main results except as follows. More competitive banking markets no longer facilitate new business formation more in substantially Hispanic areas. Greater broadband availability in an area facilitates new business formation more in black areas than in mostly white areas, as judged by comparing the magnitude of the coefficients (Hypothesis 5), but the coefficients are not significant in the later years in black areas. On the other hand, there is evidence for Hypothesis 5 in Hispanic areas with this slower broadband, whereas there was not with the faster broadband. This may indicate that moderate-speed broadband is sufficient to meet the needs of the sorts of small businesses started by Hispanic entrepreneurs.

Since mobile broadband is not included in the main estimations, its role of mobile broadband (4G LTE) for years 2016 and 2017 is explored in Table A - 12 in the appendix. The results show that fixed broadband is more important for new establishment births than mobile broadband, and that the estimates change little after controlling for unobserved county-year factors. The moderating influence of fixed broadband on the effects of local branch density and loan competition on establishment births is even larger than before, albeit with slightly lower significance levels (in part likely due merely to the smaller sample size here).

Other robustness checks include replacing the broadband provider counts with an indicator for the presence of any broadband (Table A - 13 to Table A - 15 in the appendix), varying the threshold for minority counties (Table XXX to XXX), and …. None of these alter the main findings.

[34] From 2010 to 2015, the FCC's threshold download speed for broadband was 4 Mbps. Even if that threshold was appropriate in 2010, by 2014 it was not. For example, HD video typically requires at least 5 Mbps download speed. Hence the higher threshold chosen for the robustness test.

V. Discussion

In summary, the main and various alternative regression specifications show that there is generally support for Hypotheses 1 to 3: broadband availability facilitates startups, and broadband lowers barriers for entrepreneurs posed by lack of local banks and bank concentration. For innovative industries, local bank availability helps establishment births more in minority areas than in mostly white areas (Hypothesis 4), while the opposite holds for service and other industries. Broadband availability has a greater effect on establishment births in minority areas during 2009 to 2010 (Hypothesis 5), but only for black areas during 2011 to 2017. The ability of broadband to lower barriers for starting new businesses caused by having a sparser or less competitive local banking environment also applies to black areas, but not Hispanic areas. Given the differences in some of the results between areas with substantial numbers of black and Hispanic areas, it is clear that entrepreneurs in different minority areas face different challenges and that broadband is not a panacea for all to overcome finance-related barriers to success.

While the results by themselves do not prove that minority entrepreneurs face discrimination from commercial banks, much less whether any discrimination stems from profit or preferences, it seems that counties with large proportions of minority are more adversely affected by lack of access to and competition among banks, and that broadband can mitigate these negative effects, at least for blacks. It is important to note that except for the supplemental loan regressions using tract-level data, the counties used for the main estimations are quite large areas. There are areas of the country with predominantly minority neighborhoods that are necessarily grouped with non-minority counties in the present analysis. Thus it should be kept in mind that the present results, strictly speaking, apply only to a subset of areas in the US with many minority residents.

There are some policy implications that follow. To find that 1) broadband appears to be an important driver of entrepreneurship, 2) even more so in some minority areas, and 3) also helps lower barriers from deficient local banking options and competition leads to the issue of what can (or should) be done to promote broadband. Many current and potential policies affect broadband availability and usage. Federal and state subsidies such as those from the Connect America Fund, the Rural Digital Opportunity Fund, and the proposed new Broadband Equity, Access, and Deployment Program to be funded by the Infrastructure Investment and Jobs Act

(IIJA) incentivize broadband providers to deploy infrastructure in underserved areas.[35] Federal subsidies for broadband subscription for low-income households through the FCC's Lifeline program and the newly proposed Affordable Connectivity Benefit[36] could enable some qualifying minorities with home-based businesses to benefit from access to the wider realm of online finance. Digital inclusion initiatives to offer access, hardware, and training to low-income households can help minority and other entrepreneurs to gain the skills to gainfully use the internet (Hauge & Prieger, 2010); such efforts would receive a boost of funding under the new Digital Equity Act of 2021 in the IIJA.[37] Less direct but no less important policies such as net neutrality rules, steep municipal fees to access public rights-of-way charged to infrastructure deployers, and intrusive price or access regulation can lower the incentive for private investment in network infrastructure (Cambini & Jiang, 2009; Connolly, Lee, & Tan, 2017; FCC, 2018; Hazlett & Wright, 2017; Prieger & Lee, 2008). The connections among broadband and entrepreneurship in minority areas heighten the importance of finding effective ways to promote or remove obstacles to the deployment of broadband infrastructure.

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[35] The new infrastructure bill (passed by the Senate on August 10, 2021 and currently awaiting passage in the House and the president's signature) provides $42.45 billion for the Broadband Equity, Access, and Deployment Program (Div. F, Title I of the IIJA), a joint federal and state effort offering grants to entities to build out broadband in unserved and underserved areas (with broadband defined by a minimum download speed of 100 Mbps).

[36] The Emergency Broadband Benefit, an FCC program instituted in response to the pandemic, offered a subsidy of $50/month to low-income households and others who experienced substantial income loss due to COVID-19. The subsidy was renamed the Affordable Connectivity Benefit, reduced to $30/month, and extended indefinitely by the IIJA (Div. F, Title V).

[37] The Digital Equity Act (Div. F, Title III of the IIJA) authorizes $60 million in planning grants to states to set up State Digital Equity Plans and $1.44 billion in grants to states to fund public and private organizations to accomplish the goals in the plans.

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Tables and Figures

Table 1: Summary statistics for the data

Variable	Innovative	Other Services	Other Sectors
Proportion of firms			
In the full sample of counties	0.182	0.111	0.707
In the subsample of mostly white counties	0.175	0.114	0.710
In the subsample of substantially black counties	0.169	0.123	0.707
In the subsample of substantially Hispanic counties	0.199	0.092	0.709

Variable	Mean	S.d.	Min	Max
Dependent variable				
Establishment births/Labor force (BDS)				
In the full sample of counties	0.210	0.288	0.000	12.078
In the subsample of innovative industries	0.165	0.227	0.000	6.726
In the subsample of service industries	0.314	0.257	0.000	4.695
In the subsample of mostly white counties	0.212	0.293	0.000	12.078
In the subsample of substantially black counties	0.185	0.231	0.000	7.262
In the subsample of substantially Hispanic counties	0.214	0.287	0.000	6.631
Regressors				
Fixed BB providers (200 kbps), 2009-2010	0.820	0.738	0.000	5.240
Fixed BB providers (25 mbps), 2011-2017	0.000	0.000	0.000	0.003
4G Mobile BB providers, 2016-2017	3.346	0.964	0.000	6.506
Number of FDIC-insured banks per 1000 people	0.344	0.250	0.029	1.000
Unemployment rate	0.601	0.315	0.000	1.000
% rural population	6.023	4.188	0.015	28.861
% employment at large firms	0.064	0.164	0.000	1.000

Note: There are 507,222 county-sector-year observations in the full sample, 84,537 observations in the innovative industries sample, 28,179 observations in the other services sample, 409,482 observations in the mostly white sample, and 52,146 observations in the substantially black sample, 35,208 observations in the substantially Hispanic sample. *S.d.* is standard deviation.

Table 2: Poisson Regression Estimations with State-Year Fixed Effects

Y = establishment births per labor force member	A1 All Counties	A2 Mostly White Counties	A3 Black – Substantial Fraction	A4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	0.255 (0.076)***	0.220 (0.048)***	0.580 (0.182)***	0.607 (0.145)***
Banks per capita (log) × Service industries	0.338 (0.055)***	0.388 (0.027)***	0.250 (0.086)***	0.266 (0.109)**
Banks per capita (log) × Other industries	0.341 (0.042)***	0.399 (0.022)***	0.363 (0.080)***	0.317 (0.083)***
Loan concentration (HHI) × Innovative industries	-1.606 (0.297)***	-1.060 (0.269)***	-1.712 (0.331)***	-3.027 (0.488)***
Loan concentration (HHI) × Service industries	-0.519 (0.107)***	-0.360 (0.104)***	-0.323 (0.125)***	-0.293 (0.137)**
Loan concentration (HHI) × Other industries	-0.280 (0.072)***	-0.101 (0.070)	-0.232 (0.096)**	-0.219 (0.118)*
BB (2009-2010) × Innovative industries	0.272 (0.075)***	0.215 (0.028)***	0.284 (0.111)**	0.276 (0.107)**
BB (2009-2010) × Service industries	0.246 (0.075)***	0.179 (0.028)***	0.292 (0.106)***	0.279 (0.105)***
BB (2009-2010) × Other industries	0.254 (0.075)***	0.189 (0.028)***	0.269 (0.107)**	0.290 (0.107)***
BB (2011-2017) × Innovative industries	0.028 (0.006)***	0.024 (0.004)***	0.038 (0.013)***	0.008 (0.009)
BB (2011-2017) × Service industries	0.011 (0.003)***	0.007 (0.002)***	0.013 (0.006)**	0.007 (0.005)
BB (2011-2017) × Other industries	0.005 (0.002)**	0.004 (0.002)***	0.010 (0.004)**	-0.007 (0.005)
Rural population (fraction)	0.040 (0.046)	-0.141 (0.032)***	0.112 (0.075)	0.073 (0.062)
Unemployment rate	-0.018 (0.005)***	-0.018 (0.004)***	-0.035 (0.015)**	-0.043 (0.010)***
Employment at large firms (fraction)	0.556 (0.052)***	0.454 (0.036)***	0.616 (0.139)***	0.383 (0.076)***
SER	0.57	0.57	0.56	0.49
N	508,050	410,310	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: Figures shown are regression coefficients (and robust standard errors). *Mostly White Counties* are those with a majority white non-Hispanic population that are also neither black-substantial nor Hispanic-substantial. The *BB* regressor is log average count of broadband providers in the local area; see text for details. All estimations include state-year and industry fixed effects. Std. errors are robust to clustering on the county but are not adjusted for the imputed data.

Table 3: Poisson Regression Estimations with County-Year Fixed Effects

Y = establishment births per labor force member	B1 All Counties	B2 Mostly White Counties	B3 Black – Substantial Fraction	B4 Hispanic – Substantial Fraction
BB (2009-2010) × Innovative industries	0.019 (0.003)***	0.028 (0.004)***	0.018 (0.013)	-0.009 (0.008)
BB (2009-2010) × Service industries	-0.007 (0.003)***	-0.009 (0.004)**	0.022 (0.012)*	-0.010 (0.006)*
BB (2011-2017) × Innovative industries	0.023 (0.005)***	0.019 (0.005)***	0.026 (0.014)*	0.015 (0.009)*
BB (2011-2017) × Service industries	0.006 (0.002)***	0.002 (0.001)*	0.003 (0.008)	0.014 (0.004)***
Banks per capita (log) × Innovative industries	-0.096 (0.054)*	-0.195 (0.039)***	0.220 (0.163)	0.290 (0.143)**
Banks per capita (log) × Service industries	0.000 (0.023)	-0.010 (0.017)	-0.108 (0.075)	-0.058 (0.069)
Loan concentration (HHI) × Innovative industries	-1.203 (0.266)***	-0.901 (0.279)***	-1.338 (0.281)***	-2.443 (0.359)***
Loan concentration (HHI) × Service industries	-0.181 (0.050)***	-0.230 (0.052)***	-0.054 (0.100)	-0.035 (0.099)
Employment at large firms (fraction)	0.372 (0.034)***	0.380 (0.033)***	0.430 (0.126)***	0.200 (0.070)***
SER	0.51	0.52	0.54	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: All estimations include county-year and industry fixed effects. SE's are robust to clustering on the county. See notes to previous table regarding the *BB* regressors.

Table 4: Poisson Regression Estimations with Broadband as a Moderating Influence for Bank Presence and Competition

Y = establishment births per labor force member	C1 All Counties	C2 Mostly White Counties	C3 Black – Substantial Fraction	C4 Hispanic – Substantial Fraction
⊥ Early BB × Banks/cap. × Innovative industries	-2.557† (0.953)***	-1.536† (1.054)	-4.940† (1.820)***	-0.855 (0.674)
⊥ Early BB × Banks/cap. × Service industries	-2.466† (0.951)***	-1.427† (1.056)	-4.811† (1.821)***	-0.875 (0.672)
⊥ Early BB × Banks/cap. × Other industries	-2.483† (0.952)***	-1.442† (1.056)	-4.841† (1.824)***	-0.880 (0.669)
⊥ Later BB × Banks/cap. × Innovative industries	-0.389† (0.144)***	-0.304† (0.200)	-0.940 (0.358)***	-0.150† (0.114)
⊥ Later BB × Banks/cap. × Service industries	-0.386† (0.144)***	-0.302† (0.200)	-0.938 (0.358)***	-0.152† (0.115)
⊥ Later BB × Banks/cap. × Other industries	-0.388† (0.144)***	-0.303† (0.200)	-0.939 (0.358)***	-0.153† (0.115)
⊥ Early BB × Loan HHI × Innovative industries	7.656 (3.254)**	7.897 (4.346)*	9.182† (5.915)	5.025 (6.013)
⊥ Early BB × Loan HHI × Service industries	7.904 (3.272)**	8.606 (4.396)*	10.735† (5.861)*	2.676 (5.683)
⊥ Early BB × Loan HHI × Other industries	7.962 (3.280)**	8.676 (4.401)**	10.732† (5.853)*	2.761 (5.690)
⊥ Later BB × Loan HHI × Innovative industries	0.854† (0.361)**	1.256† (0.608)**	1.910 (0.779)**	-0.288 (0.532)
⊥ Later BB × Loan HHI × Service industries	0.836† (0.369)**	1.236† (0.620)**	1.999 (0.797)**	-0.416 (0.506)
⊥ Later BB × Loan HHI × Other industries	0.835† (0.369)**	1.231† (0.620)**	2.001 (0.796)**	-0.405 (0.514)
SER	0.51	0.52	0.53	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$; † $p<0.05$ for the joint set of coefficients pertaining to this interaction (joint across industry types).

Notes: Estimation method is linear panel data regression. Coefficients for additional regressors (the main broadband and bank variables) are included in the model but not shown here (see Table A - 1 in the appendix). The symbol ⊥ denotes an orthogonalized regressor. All estimations include county-year and industry fixed effects. Std. errors are robust to clustering on the county. In the broadband×bank variable interactions, the broadband variables are orthogonalized with respect to all other regressors listed in Table 2.

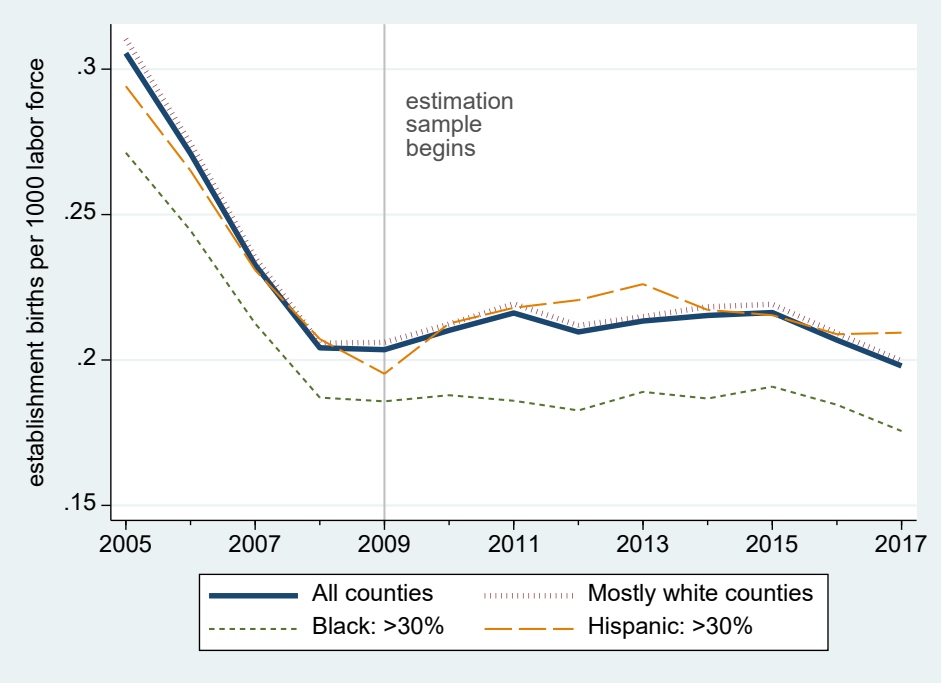
Table 5: Fixed Effect Regressions of Total Tract Small Business Loans on Broadband

Y = log total CRA small business loans	D1 2009-2017	D2 2009-2017	D3 2011-2017	D4 2011-2017
BB (2009-2010)	0.062 (0.006)***			
BB (2011-2017)	-0.001 (0.001)		0.001 (0.001)	
BB (2009-2010) × Mainly White		0.067 (0.006)***		
BB (2009-2010) × Majority Black		0.059 (0.008)***		
BB (2009-2010) × Majority Hispanic		0.036 (0.007)***		
BB (2009-2010) × Other county		0.059 (0.006)***		
BB (2011-2017) × Mainly White		-0.003 (0.001)***		-0.001 (0.001)
BB (2011-2017) × Majority Black		0.005 (0.002)**		0.005 (0.002)**
BB (2011-2017) × Majority Hispanic		0.007 (0.001)***		0.008 (0.001)***
BB (2011-2017) × Other county		-0.002 (0.001)**		-0.000 (0.001)
Basic controls included	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes
SER	0.45	0.45	0.42	0.42
N	619,475	619,475	477,556	477,556

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

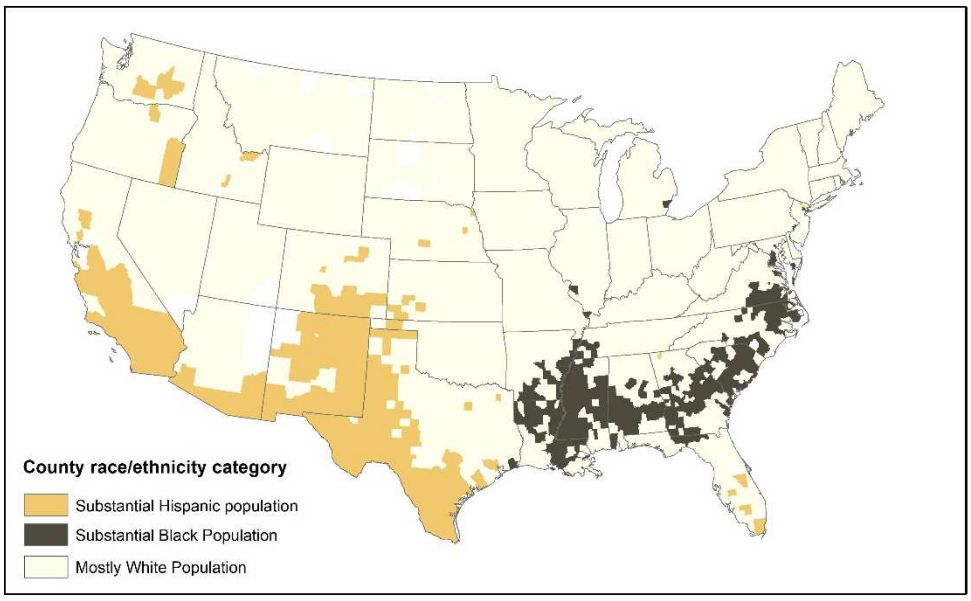
Notes: Estimates are elasticities of the broadband variable for the type of county listed in the row heading. All estimations include county-year and tract fixed effects. SE's are robust to clustering on the tract. Basic controls include the log number of jobs for businesses located in the tract, the racial and ethnic composition, poverty status, median income, and educational attainment of residents, and the unemployment rate and rural status of the tract. The additional control variables are the fraction of firms in the tract in various size and age categories, which are only available from 2011 on.

Figure 1: Establishment births per county, average across all industry sectors, by minority status



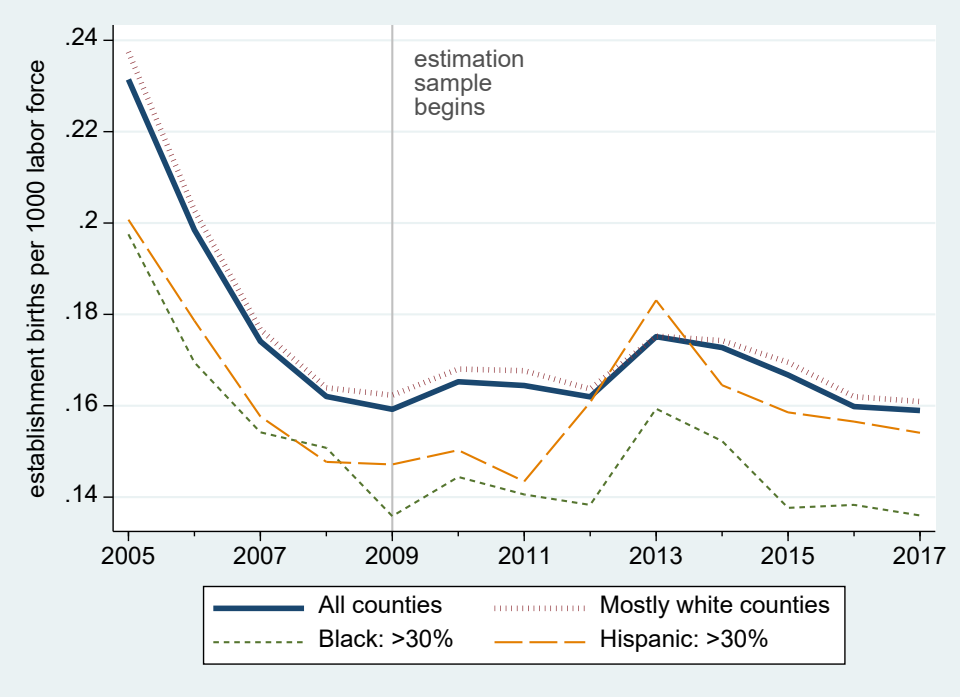
Notes: The time series are for the yearly average of the establishment birth rate per individual industry sector in a county. *Mostly white counties* have majority non-Hispanic white population and are also exclusive of the substantially Black and Hispanic counties. See text and appendix for description of data source and imputation.

Figure 2: Counties by categorization as mostly white or with a substantial proportion of Black or Hispanic residents



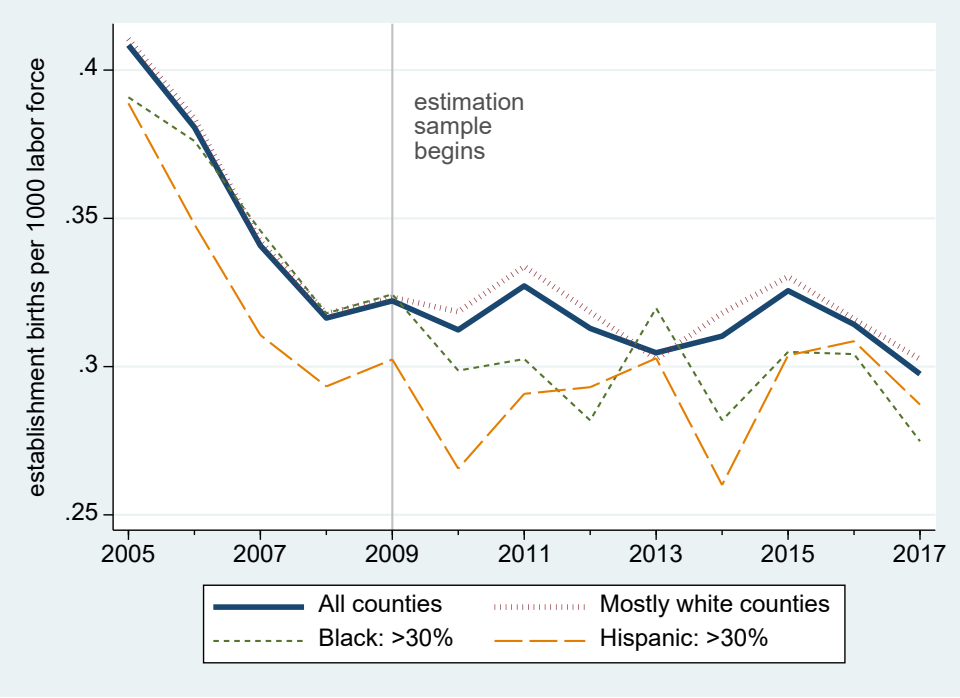
Notes: *Mostly white counties* have majority non-Hispanic white population and are also exclusive of the substantially Black and Hispanic counties. Substantial Black (Hispanic) counties have more than 30% Black (Hispanic) residents.

Figure 3: Establishment births per county, average across innovative industries, by minority status



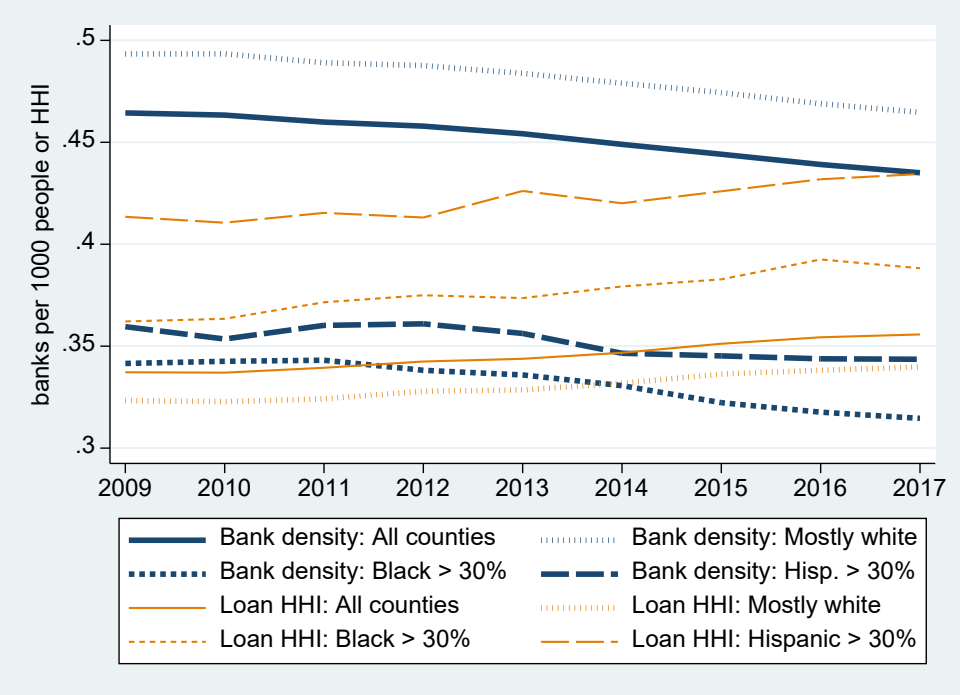
Notes: The time series are for the yearly average of the establishment birth rate per individual innovative industry sector (manufacturing, information, and professional, scientific, and technical services) in a county. See also notes to previous figure.

Figure 4: Establishment births per county, total for "other service" sector, by minority status



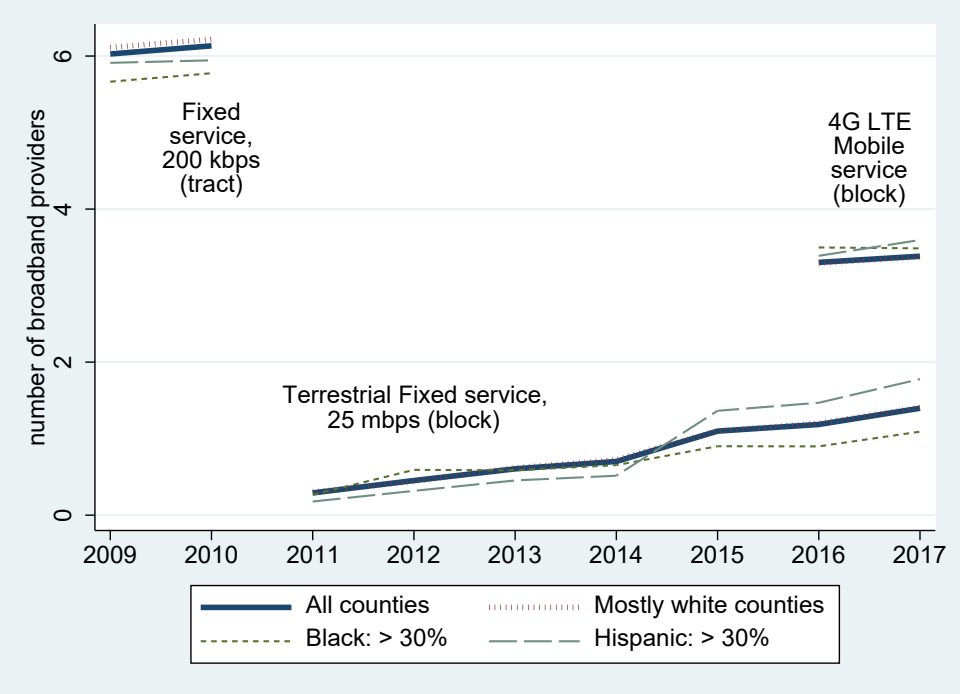
Notes: The time series are for the yearly average of the establishment birth rate in the *other services* sector in a county.

Figure 5: Average bank branch density and small business loan concentration in county, by minority status



Notes: Data are shown as matched with the observation year *t* in the regressions: for July of the previous year.

Figure 6: Average number of broadband providers in a local area, by minority status



Notes: Data are shown as matched with the observation year *t* in the regressions: for December 31 of the previous year. See text for data sources and definition of the time series. For data after 2011, the time series for *mostly white counties* is nearly identical to those for *all counties*.

Appendix

The following material is for the use of the reviewers and will be made available as an online appendix.

A. Imputation for Missing Establishment Births

The BDS data on establishment births are censored when there are one or two firms in the industry sector in a county. The birth count of establishments is also censored if only one or two firms opened new establishments. The following imputation procedure was used to replace censored values with a single figure.

Step 1: Bounding the counts of establishment births

The relationships among the number of establishments in periods *t* and *t*-1, establishment deaths, and establishment births allow (approximate) upper and lower bounds to be ascertained in many cases. The assumed relationships among the various quantities are based on accounting relationships that must hold if the universe of firms covered by the data for a county and industry sector were unchanging.

Those relationships provided bounds on about one-fifth of the censored births. In all other cases, the missing value for establishment entry was assumed to be between zero and three, since in nearly all observed cases (>99%) that is the case.

The cases and rules used to establish bounds are the following. The fundamental accounting identity (FAI for reference below) for longitudinal consistency is:

$$N_t = N_{t-1} + B_t - X_t$$

where N_t is the number of establishments in year *t* (where it is understood that all data and computations apply to a single industry sector and county), B_t is the number of establishment births since year *t*-1, and X_t is the number of exiting establishments since year *t*-1. In addition, define *Ft* to be the number of firms in year *t*, D_t as the number of exiting firms caused by firm deaths since year *t*-1, E_t as the number of entering firms since year *t*-1, and DX_t as the number of exiting establishments caused by firm deaths since year *t*-1.

Case 1. B_t is missing but N_t, N_{t-1}, and X_t are available. Rearranging the FAI yields $B_t = N_t - N_{t-1} + X_t$ (call this FAI′ for reference below), and so the upper and lower bound for B_t is set to N_t - N_{t-1} + X_t. This rule fills in 34.4% of missing observations on entry.

Case 2. B_t is missing but N_t, N_{t-1}, and DX_t are available. Since $X_t \geq DX_t$ (the latter is a subset of the former), FAI′ implies that $B_t \geq N_t - N_{t-1} + DX_t$. This rule provides a useful lower bound (a bound greater than zero) for 3.4% of observations still missing after applying the rule for case 1.

Case 3. B_t and DX_t are missing but N_t, and N_{t-1} are available. Since $X_t \geq 0$, FAI′ implies that $B_t \geq N_t - N_{t-1}$. This rule provides a weaker lower bound than the rule for case 2, but fills in a lower bound for 7.8% of observations still missing after applying the rule for case 1.

Case 4. B_t and N_{t-1} are missing but N_t and X_t are available. Since $N_{t-1} \geq 0$, FAI′ implies that $B_t \leq N_t + X_t$. This rule provides a (very weak) upper bound for 3.1% of observations still missing after applying the rule for case 1.

Case 5. B_t is missing but F_t, F_{t-1}, and D_t are available. Since $E_t = F_t - F_{t-1} + D_t$ and $E_t \leq B_t$, we have $B_t \geq F_t - F_{t-1} + D_t$. This rule provides a tighter lower bound than the rules for cases 2 and 3 for 1.4% of observations still missing after applying the rule for case 1.

Note that the cases are non-exclusive. After computing the lower bounds using the rules for cases 1, 2, 3, and 5, the largest one is chosen for the final lower bound on establishment entry. The tightest upper bound is the minimum of the bounds computed for cases 1 and 4.

After applying the rules above, 55.2% of observations with missing establishment births have no bounds available (call this Case 6). For these observations, a reasonable upper bound for establishment births could be chosen if the distribution of births in markets with only one or two firms at all or with only one or two firms causing all establishment births (the censored cases) were known. Since that distribution cannot be observed, instead the distribution of establishment births in markets with three to five firms was examined as a stand-in. In 99.94% of such markets for which the data are uncensored, there were no more than three establishment births. Since in the censored markets there are at most two firms responsible for the establishment births, and in the reference distribution there are at least three firms causing the establishment births (otherwise

they would be censored, too), it should be that the actual proportion of censored births being greater than three is even less than 0.06%. For this reason, the remaining censored observations were assumed to be bounded in the interval [0,3].

A feature of the BDS data can render any of the rules above potentially false in some cases. The accounting relationships among the stocks and flows of establishments can break down because the universe of firms covered by the data for a county and industry sector may change. Firms can move in and out of the scope of the BDS data, since not all industries are covered.[38] Second, firms can move in and out of the particular sector covered by a time series for a county. When an establishment switches between categories, it does not count as an establishment exit in the old category or an establishment birth in the new category, since it is a continuing establishment. Given these possibilities, the bounds determined can be approximate only. However, there appear to be relatively few deviations from the FAI. For cases in which the observed number of firms is three (the closest one can observe to the censored cases of one or two firms, the establishment dynamics are in accord with the FAI in 97.0% of cases.

Step 2: Regression for imputation

In the second step, Poisson maximum likelihood estimation (MLE) for censored regression was performed on the censored and fully observed entry counts (Cameron & Trivedi, 2013; Terza, 1985). The likelihood for the estimator for observations that are uncensored (or produced by the FAI from case 1 above) is the usual Poisson likelihood. For cases 2-6, the rules result in either left-censored or right-censored counts (it never happens that there is true interval censoring, in which the lower bound is greater than zero). For such observations the likelihood is the sum of likelihoods for the counts contained within the censoring range. The MLE was performed separately for each industry sector. Estimation was performed with command *cpoisson* in Stata

[38] An example provided by the Census Bureau: "an establishment may switch from an in-scope industry to an out of scope industry such as 52592 Trusts, Estates, and Agency Accounts." See https://www.census.gov/programs-surveys/bds/documentation/faq.html. The FAI may also be violated if an establishment temporarily shuts down (i.e., has a year with zero employment), in which case it is excluded from the count of exits but the establishment count drops (see https://www.census.gov/programs-surveys/bds/documentation/methodology.html).

17.0. The dependent variable was regressed on log population, log land area of the county, and year and state fixed effects.[39]

Step 3: Imputation missing observations with expected values

In the third step, missing values were replaced with the expected number of births, conditional on the regressors and the interval into which the establishment births must fall (based on the upper and lower limits established by the rules above), using the estimated regression coefficients from step two. The expected value of establishment births, $\hat{B}_{ict}$, for sector *i*, county *c*, and year *t*, is computed as follows. Let $f(y|x,\beta)$ be the PDF of a Poisson random variable y conditional on covariates x, where the Poisson rate parameter λ is specified as $\lambda = \exp(\beta' x)$. Thus

$$f(y|x,\beta) = \frac{\lambda^y e^{-y}}{y!}$$

Define the Poisson CDF to be

$$F(y|x,\beta) = \sum_{n=0}^{y} f(n|x,\beta)$$

Then:

Uncensored observations

$$\hat{B}_{ict} = E(\widehat{B_{ict}|x_{ct}}) = \sum_{y=0}^{\infty} y f(y|x_{ct},\hat{\beta}_i) = \exp(\hat{\beta}_i' x_{ct})$$

Observations with establishment births less than or equal to an upper limit of U_{ict}

This is the expectation of a Poisson distribution truncated above. Using the relationship

$$y f(y|x,\beta) = y\frac{\lambda^y e^{-y}}{y!} = \lambda\frac{\lambda^{y-1} e^{-y}}{(y-1)!} = \lambda f(y-1|x,\beta)$$

we have:

[39] To avoid numerical errors in the MLE, observations with population greater than one million were dropped. This is unlikely to cause any noticeable bias in the estimates because in the set of censored observations only 129 of them (out of over 100,000 censored observations) are in counties with such large population.

$$\hat{B}_{ict} = E(\widehat{B_{ict}}|x_{ct}) = \frac{\sum_{y=0}^{U_{ict}} yf(y|x_{ct},\hat{\beta}_i)}{F(U_{ict}|x_{ct},\hat{\beta}_i)} = \exp(\hat{\beta}_i' x_{ct}) \frac{F(U_{ict}-1|x_{ct},\hat{\beta}_i)}{F(U_{ict}|x_{ct},\hat{\beta}_i)}$$

Observations with establishment births greater than or equal to a lower limit of L_{ict}

This is the expectation of a Poisson distribution truncated below. Using the relationship that $\sum_{y=a}^{\infty} yf(y|x,\beta) = 1 - F(a-1|x,\beta)$, we have:

$$\hat{B}_{ict} = E(\widehat{B_{ict}}|x_{ct}) = \frac{\sum_{y=L_{ict}}^{\infty} yf(y|x_{ct},\hat{\beta}_i)}{1-F(L_{ict}-1|x_{ct},\hat{\beta}_i)} = \exp(\hat{\beta}_i' x_{ct}) \frac{1-F(U_{ict}-2|x_{ct},\hat{\beta}_i)}{1-F(U_{ict}-1|x_{ct},\hat{\beta}_i)}$$

Note that the imputed values from these expectations are not integers in general. This poses no problem for the Poisson regressions in the main text, since the factorials in the Poisson likelihood are evaluated with the gamma function in Stata. In any event, it is known that Poisson regression can be used for consistent estimation of regression coefficients for any real-valued non-negative dependent variables whenever the effects of the regressors are multiplicative instead of additive (see, e.g., §19.4.1 of Wooldridge (2010)).

B. Additional Regression Results

This section show results from regressions discussed in the main text but not shown there.

The full set of results for the main regression for the moderating influence of broadband

The full set of regression coefficients for the estimations reported in Table 4 are as follows:

Table A - 1: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition

	C1 All Counties	C2 Mostly White Counties	C3 Black – Substantial Fraction	C4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.111 (0.053)**	-0.197 (0.038)***	0.222 (0.171)	0.314 (0.143)**
Banks per capita (log) × Service industries	0.017 (0.022)	-0.002 (0.016)	-0.051 (0.082)	-0.043 (0.066)
Loan concentration (HHI) ×	-1.177	-0.893	-1.178	-2.577

	C1 All Counties	C2 Mostly White Counties	C3 Black – Substantial Fraction	C4 Hispanic – Substantial Fraction
Innovative industries	(0.223)***	(0.236)***	(0.215)***	(0.364)***
Loan concentration (HHI) × Service industries	-0.179 (0.039)***	-0.212 (0.042)***	-0.052 (0.104)	-0.045 (0.103)
BB (2009-2010) × Innovative industries	-0.000 (0.006)	0.003 (0.007)	-0.039 (0.025)	-0.005 (0.015)
BB (2009-2010) × Service industries	-0.005 (0.003)	-0.005 (0.004)	0.038 (0.014)***	-0.008 (0.008)
BB (2011-2017) × Innovative industries	0.020 (0.004)***	0.016 (0.003)***	0.029 (0.017)*	0.014 (0.009)
BB (2011-2017) × Service industries	0.010 (0.002)***	0.007 (0.001)***	0.004 (0.010)	0.015 (0.005)***
⊥ Early BB × Banks/cap. × Innovative industries	-2.557 (0.953)***	-1.536 (1.054)	-4.940 (1.820)***	-0.855 (0.674)
⊥ Early BB × Banks/cap. × Service industries	-2.466 (0.951)***	-1.427 (1.056)	-4.811 (1.821)***	-0.875 (0.672)
⊥ Early BB × Banks/cap. × Other industries	-2.483 (0.952)***	-1.442 (1.056)	-4.841 (1.824)***	-0.880 (0.669)
⊥ Later BB × Banks/cap. × Innovative industries	-0.389 (0.144)***	-0.304 (0.200)	-0.940 (0.358)***	-0.150 (0.114)
⊥ Later BB × Banks/cap. × Service industries	-0.386 (0.144)***	-0.302 (0.200)	-0.938 (0.358)***	-0.152 (0.115)
⊥ Later BB × Banks/cap. × Other industries	-0.388 (0.144)***	-0.303 (0.200)	-0.939 (0.358)***	-0.153 (0.115)
⊥ Early BB × Loan HHI × Innovative industries	7.656 (3.254)**	7.897 (4.346)*	9.182 (5.915)	5.025 (6.013)
⊥ Early BB × Loan HHI × Service industries	7.904 (3.272)**	8.606 (4.396)*	10.735 (5.861)*	2.676 (5.683)
⊥ Early BB × Loan HHI × Other industries	7.962 (3.280)**	8.676 (4.401)**	10.732 (5.853)*	2.761 (5.690)
⊥ Later BB × Loan HHI × Innovative industries	0.854 (0.361)**	1.256 (0.608)**	1.910 (0.779)**	-0.288 (0.532)
⊥ Later BB × Loan HHI × Service industries	0.836 (0.369)**	1.236 (0.620)**	1.999 (0.797)**	-0.416 (0.506)
⊥ Later BB × Loan HHI × Other industries	0.835 (0.369)**	1.231 (0.620)**	2.001 (0.796)**	-0.405 (0.514)
Employment at large firms (fraction)	2.153 (0.645)***	1.198 (0.501)**	7.499 (2.639)***	1.508 (1.069)
SER	0.51	0.52	0.53	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Coefficients for additional regressors (the main broadband and bank variables) are included in the model but not shown (see the additional tables in the appendix). The symbol ⊥ denotes an orthogonalized regressor. All

estimations include county-year and industry fixed effects. Std. errors are robust to clustering on the county. In the broadband×bank variable interactions, the broadband variables are orthogonalized with respect to all other regressors listed in Table 2.

The full set of results for the regressions in Error! Reference source not found. including mobile broadband

The full set of regression coefficients for the estimations reported in **Error! Reference source not found.** are as follows:

Table A - 2: Poisson Regression Estimations with Fixed and Mobile Broadband as a Moderating Influence for Banks

Y = establishment births per labor force member	D1 All Counties	E1 All Counties	F1 All Counties
Banks per capita (log) × Innovative industries	0.278 (0.072)***	-0.055 (0.052)	-0.054 (0.051)
Banks per capita (log) × Service industries	0.343 (0.047)***	0.025 (0.020)	0.025 (0.022)
Banks per capita (log) × Other industries	0.319 (0.040)***	Reference category	Reference category
Loan concentration (HHI) × Innovative industries	-1.200 (0.320)***	-0.777 (0.294)***	-0.912 (0.231)***
Loan concentration (HHI) × Service industries	-0.551 (0.091)***	-0.170 (0.056)***	-0.110 (0.080)
Loan concentration (HHI) × Other industries	-0.333 (0.066)***	Reference category	Reference category
Fixed BB × Innovative industries	0.255 (0.060)***	0.204 (0.045)***	0.205 (0.048)***
Fixed BB × Service industries	0.049 (0.026)*	0.009 (0.014)	0.030 (0.023)
Fixed BB × Other industries	0.037 (0.020)*	Reference category	Reference category
Mobile BB × Innovative industries	-0.010 (0.026)	-0.009 (0.024)	-0.051 (0.031)
Mobile BB × Service industries	0.026 (0.016)	0.028 (0.011)***	0.021 (0.022)
Mobile BB × Other industries	-0.003 (0.014)	Reference category	Reference category
⊥ Fixed BB × Banks per capita × Innovative industries			-1.446 (0.743)*
⊥ Fixed BB × Banks per capita ×			-1.442

Y = establishment births per labor force member	D1 All Counties	E1 All Counties	F1 All Counties
Service industries			(0.743)*
⊥ Fixed BB × Banks per capita × Other industries			-1.445 (0.743)*
⊥ Mobile BB × Banks per capita × Innovative industries			0.008 (0.008)
⊥ Mobile BB × Banks per capita × Service industries			-0.007 (0.004)**
⊥ Mobile BB × Banks per capita × Other industries			--
⊥ Fixed BB × Loan HHI × Innovative industries			3.085 (1.731)*
⊥ Fixed BB × Loan HHI × Service industries			3.196 (1.760)*
⊥ Fixed BB × Loan HHI × Other industries			3.203 (1.760)*
⊥ Mobile BB × Loan HHI × Innovative industries			0.583 (0.203)***
⊥ Mobile BB × Loan HHI × Service industries			-0.214 (0.064)***
⊥ Mobile BB × Loan HHI × Other industries			--
Rural population (fraction)	0.035 (0.044)		
Unemployment rate	-2.544 (0.680)***		
Employment at large firms (fraction)	0.432 (0.044)***		1.614 (0.662)**
SER	0.56		0.51
N	112,950		112,950

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See notes to **Error! Reference source not found.**.

The loan distance regressions discussed in section IV.D.

	Y = log loan distance	Y = % loans outside county
BB (2009-2010)	-0.083	-0.002

	(0.044)*	(0.015)
BB (2011-2017)	-0.005	-0.002
	(0.001)***	(0.000)***
Loan concentration (HHI)	0.160	0.084
	(0.108)	(0.035)**
Banks per capita (log)	-0.018	-0.050
	(0.046)	(0.015)***
Log labor force	-0.004	-0.083
	(0.125)	(0.044)*
Unemployment rate	-0.015	-0.002
	(0.004)***	(0.001)*
Employment at large firms (fraction)	-0.070	0.006
	(0.086)	(0.028)
L.firmPCsize2	0.322	0.098
	(0.750)	(0.236)
L.firmPCsize3	0.510	0.109
	(0.813)	(0.235)
L.firmPCage1	-0.767	0.137
	(0.716)	(0.198)
L.firmPCage2	-1.178	-0.104
	(0.679)*	(0.205)
L.firmPCage3	-0.254	0.107
	(0.741)	(0.207)
L.firmPCage4	-1.103	-0.195
	(0.709)	(0.217)
L.firmPCsector_construct	-0.001	0.039
	(0.556)	(0.147)
L.firmPCsector_manu	-1.902	-0.502
	(0.885)**	(0.277)*
L.firmPCsector_trade	0.514	0.262
	(0.607)	(0.150)*
L.firmPCsector_svcs	0.349	0.007
	(0.462)	(0.103)
blackPC	1.372	0.043
	(1.838)	(0.573)
amerindPC	-7.196	-0.217
	(6.797)	(2.670)
asianPC	10.350	1.025
	(2.283)***	(0.900)
pacisldrPC	-57.087	-4.923
	(18.624)***	(6.103)
twoOrMoreRacePC	-5.402	-2.352
	(6.813)	(2.123)
hispanicPC	-5.335	-2.271
	(1.644)***	(0.568)***
SER	0.37	0.12

N	19,883	19,883

Notes: Figures shown are regression coefficients (and robust standard errors). Only *Mostly White Counties* are included in the sample. All estimations include county and year fixed effects. Std. errors are robust to clustering on the county.

Robustness check: Drop nonfarm nonresidential loans from the loan concentration HHI regressor (include only C&I loans)

In the tables in this section, regressor *loan concentration (HHI)* is computed (as described in the text for the main version of the variable) without the nonfarm nonresidential loans (leaving only the C&I loans in the market shares).

Table A - 3: Poisson Regression Estimations with State-Year Fixed Effects (with only C&I loans included in HHI)

	A1.1 All Counties	A1.2 Mostly White Counties	A1.3 Black – Substantial Fraction	A1.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	0.240 (0.075)***	0.206 (0.046)***	0.563 (0.182)***	0.601 (0.147)***
Banks per capita (log) × Service industries	0.332 (0.054)***	0.384 (0.027)***	0.242 (0.087)***	0.260 (0.109)**
Banks per capita (log) × Other industries	0.336 (0.042)***	0.397 (0.022)***	0.355 (0.080)***	0.311 (0.084)***
Loan concentration (HHI) × Innovative industries	-1.612 (0.301)***	-1.048 (0.271)***	-1.717 (0.353)***	-3.101 (0.478)***
Loan concentration (HHI) × Service industries	-0.499 (0.108)***	-0.355 (0.107)***	-0.324 (0.125)***	-0.287 (0.131)**
Loan concentration (HHI) × Other industries	-0.275 (0.071)***	-0.102 (0.071)	-0.233 (0.102)**	-0.243 (0.113)**
BB (2009-2010) × Innovative industries	0.274 (0.076)***	0.216 (0.028)***	0.274 (0.106)***	0.266 (0.107)**
BB (2009-2010) × Service industries	0.251 (0.076)***	0.182 (0.028)***	0.288 (0.101)***	0.274 (0.105)***
BB (2009-2010) × Other industries	0.259 (0.076)***	0.192 (0.028)***	0.266 (0.103)***	0.285 (0.107)***
BB (2011-2017) × Innovative industries	0.030 (0.006)***	0.025 (0.004)***	0.038 (0.013)***	0.007 (0.009)
BB (2011-2017) × Service industries	0.011 (0.003)***	0.007 (0.002)***	0.014 (0.006)**	0.007 (0.005)
BB (2011-2017) × Other industries	0.005 (0.002)**	0.004 (0.002)***	0.010 (0.004)**	-0.008 (0.005)
Rural population (fraction)	0.040 (0.046)	-0.143 (0.033)***	0.114 (0.074)	0.076 (0.062)

	A1.1 All Counties	A1.2 Mostly White Counties	A1.3 Black – Substantial Fraction	A1.4 Hispanic – Substantial Fraction
Unemployment rate	-0.018 (0.005)***	-0.018 (0.004)***	-0.035 (0.015)**	-0.042 (0.010)***
Employment at large firms (fraction)	0.558 (0.053)***	0.454 (0.036)***	0.621 (0.138)***	0.376 (0.076)***
SER	0.57	0.57	0.56	0.49
N	507,222	409,482	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See notes to Table 2.

Table A - 4: Poisson Regression Estimations with County-Year Fixed Effects (with only C&I loans included in HHI)

	B1.1 All Counties	B1.2 Mostly White Counties	B1.3 Black – Substantial Fraction	B1.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.105 (0.053)**	-0.205 (0.038)***	0.210 (0.162)	0.289 (0.142)**
Banks per capita (log) × Service industries	-0.002 (0.023)	-0.013 (0.017)	-0.109 (0.074)	-0.058 (0.068)
Loan concentration (HHI) × Innovative industries	-1.215 (0.271)***	-0.887 (0.278)***	-1.334 (0.295)***	-2.543 (0.370)***
Loan concentration (HHI) × Service industries	-0.169 (0.053)***	-0.224 (0.054)***	-0.055 (0.104)	-0.012 (0.100)
BB (2009-2010) × Innovative industries	0.017 (0.003)***	0.026 (0.004)***	0.011 (0.013)	-0.013 (0.007)*
BB (2009-2010) × Service industries	-0.008 (0.003)***	-0.009 (0.004)**	0.022 (0.012)*	-0.010 (0.006)*
BB (2011-2017) × Innovative industries	0.024 (0.005)***	0.020 (0.004)***	0.026 (0.014)*	0.014 (0.008)*
BB (2011-2017) × Service industries	0.006 (0.002)***	0.003 (0.001)**	0.003 (0.008)	0.014 (0.004)***
Employment at large firms (fraction)	0.372 (0.034)***	0.381 (0.033)***	0.432 (0.126)***	0.194 (0.071)***
SER	0.51	0.52	0.54	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See notes to Table 3.

Table A - 5: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition (with only C&I loans included in HHI)

	C1.1 All Counties	C1.2 Mostly White Counties	C1.3 Black – Substantial Fraction	C1.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.119 (0.052)**	-0.206 (0.036)***	0.212 (0.170)	0.313 (0.142)**
Banks per capita (log) × Service industries	0.015 (0.022)	-0.005 (0.016)	-0.052 (0.082)	-0.043 (0.066)
Loan concentration (HHI) × Innovative industries	-1.192 (0.227)***	-0.881 (0.235)***	-1.162 (0.228)***	-2.670 (0.376)***
Loan concentration (HHI) ×	-0.167	-0.207	-0.051	-0.026

	C1.1 All Counties	C1.2 Mostly White Counties	C1.3 Black – Substantial Fraction	C1.4 Hispanic – Substantial Fraction
Service industries	(0.041)***	(0.044)***	(0.110)	(0.104)
BB (2009-2010) × Innovative industries	-0.003 (0.006)	0.001 (0.007)	-0.044 (0.025)*	-0.012 (0.015)
BB (2009-2010) × Service industries	-0.005 (0.003)*	-0.006 (0.004)	0.038 (0.014)***	-0.009 (0.008)
BB (2011-2017) × Innovative industries	0.021 (0.004)***	0.017 (0.003)***	0.029 (0.017)*	0.012 (0.009)
BB (2011-2017) × Service industries	0.010 (0.002)***	0.007 (0.001)***	0.004 (0.009)	0.015 (0.005)***
⊥ Early BB × Banks/cap. × Innovative industries	-2.469 (0.930)***	-1.437 (1.045)	-4.657 (1.744)***	-0.874 (0.692)
⊥ Early BB × Banks/cap. × Service industries	-2.382 (0.928)**	-1.332 (1.047)	-4.530 (1.745)***	-0.891 (0.689)
⊥ Early BB × Banks/cap. × Other industries	-2.398 (0.929)***	-1.346 (1.047)	-4.559 (1.748)***	-0.896 (0.687)
⊥ Later BB × Banks/cap. × Innovative industries	-0.371 (0.139)***	-0.276 (0.195)	-0.901 (0.349)***	-0.148 (0.112)
⊥ Later BB × Banks/cap. × Service industries	-0.369 (0.139)***	-0.274 (0.195)	-0.900 (0.349)***	-0.151 (0.112)
⊥ Later BB × Banks/cap. × Other industries	-0.370 (0.139)***	-0.276 (0.195)	-0.900 (0.349)***	-0.151 (0.112)
⊥ Early BB × Loan HHI × Innovative industries	7.982 (3.273)**	6.515 (4.439)	9.739 (5.882)*	5.993 (6.301)
⊥ Early BB × Loan HHI × Service industries	7.956 (3.317)**	6.907 (4.506)	11.162 (5.858)*	3.915 (6.018)
⊥ Early BB × Loan HHI × Other industries	8.065 (3.328)**	7.022 (4.519)	11.113 (5.833)*	4.034 (6.006)
⊥ Later BB × Loan HHI × Innovative industries	0.877 (0.375)**	1.163 (0.633)*	1.867 (0.776)**	-0.175 (0.547)
⊥ Later BB × Loan HHI × Service industries	0.858 (0.382)**	1.144 (0.642)*	1.942 (0.794)**	-0.302 (0.527)
⊥ Later BB × Loan HHI × Other industries	0.857 (0.383)**	1.139 (0.642)*	1.944 (0.793)**	-0.299 (0.534)
Employment at large firms (fraction)	2.134 (0.639)***	1.158 (0.504)**	7.423 (2.637)***	1.500 (1.056)
SER	0.51	0.52	0.53	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

See notes to Table A - 1.

Robustness check: Change the limit for loan size to $1 million in the loan concentration HHI regressor

In the tables in this section, regressor *loan concentration (HHI)* is computed (as described in the text for the main version of the variable) with both C&I and nonfarm nonresidential loans but the loan size threshold is $1 million.

Table A - 6: Poisson Regression Estimations with State-Year Fixed Effects (with loans up to $1M included in HHI)

	A2.1 All Counties	A2.2 Mostly White Counties	A2.3 Black – Substantial Fraction	A2.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	0.294 (0.076)***	0.231 (0.048)***	0.598 (0.181)***	0.667 (0.141)***
Banks per capita (log) × Service industries	0.346 (0.054)***	0.390 (0.028)***	0.242 (0.086)***	0.264 (0.108)**
Banks per capita (log) × Other industries	0.342 (0.042)***	0.398 (0.022)***	0.352 (0.078)***	0.313 (0.082)***
Loan concentration (HHI) × Innovative industries	-2.064 (0.329)***	-1.344 (0.281)***	-2.138 (0.412)***	-3.511 (0.613)***
Loan concentration (HHI) × Service industries	-0.615 (0.112)***	-0.398 (0.106)***	-0.474 (0.133)***	-0.309 (0.139)**
Loan concentration (HHI) × Other industries	-0.359 (0.078)***	-0.130 (0.072)*	-0.318 (0.109)***	-0.226 (0.124)*
BB (2009-2010) × Innovative industries	0.255 (0.073)***	0.208 (0.027)***	0.261 (0.112)**	0.262 (0.108)**
BB (2009-2010) × Service industries	0.229 (0.073)***	0.173 (0.027)***	0.267 (0.107)**	0.261 (0.106)**
BB (2009-2010) × Other industries	0.237 (0.074)***	0.182 (0.028)***	0.244 (0.109)**	0.271 (0.108)**
BB (2011-2017) × Innovative industries	0.023 (0.006)***	0.021 (0.004)***	0.034 (0.012)***	0.002 (0.009)
BB (2011-2017) × Service industries	0.010 (0.003)***	0.006 (0.002)***	0.011 (0.006)*	0.007 (0.005)
BB (2011-2017) × Other industries	0.004 (0.002)*	0.004 (0.002)***	0.009 (0.004)**	-0.006 (0.005)
Rural population (fraction)	0.045 (0.045)	-0.133 (0.031)***	0.115 (0.073)	0.073 (0.061)
Unemployment rate	-0.017 (0.005)***	-0.017 (0.004)***	-0.033 (0.014)**	-0.042 (0.009)***
Employment at large firms (fraction)	0.534 (0.051)***	0.444 (0.035)***	0.601 (0.137)***	0.361 (0.077)***
SER	0.57	0.57	0.56	0.50

	A2.1 All Counties	A2.2 Mostly White Counties	A2.3 Black – Substantial Fraction	A2.4 Hispanic – Substantial Fraction
N	507,222	409,482	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See notes to Table 2.

Table A - 7: Poisson Regression Estimations with County-Year Fixed Effects (with loans up to $1M included in HHI I)

	B2.1 All Counties	B2.2 Mostly White Counties	B2.3 Black – Substantial Fraction	B2.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.065 (0.053)	-0.185 (0.040)***	0.243 (0.160)	0.347 (0.135)**
Banks per capita (log) × Service industries	0.003 (0.023)	-0.009 (0.017)	-0.107 (0.075)	-0.057 (0.069)
Loan concentration (HHI) × Innovative industries	-1.480 (0.268)***	-1.107 (0.273)***	-1.574 (0.335)***	-2.766 (0.429)***
Loan concentration (HHI) × Service industries	-0.193 (0.053)***	-0.233 (0.055)***	-0.117 (0.112)	-0.041 (0.099)
BB (2009-2010) × Innovative industries	0.020 (0.003)***	0.028 (0.004)***	0.020 (0.013)	-0.004 (0.008)
BB (2009-2010) × Service industries	-0.007 (0.003)***	-0.009 (0.004)**	0.023 (0.012)*	-0.010 (0.006)*
BB (2011-2017) × Innovative industries	0.019 (0.005)***	0.016 (0.004)***	0.024 (0.013)*	0.009 (0.008)
BB (2011-2017) × Service industries	0.006 (0.002)***	0.002 (0.001)*	0.002 (0.007)	0.014 (0.004)***
Employment at large firms (fraction)	0.367 (0.034)***	0.376 (0.033)***	0.432 (0.125)***	0.191 (0.073)***
SER	0.51	0.52	0.54	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

See notes to Table 3.

Table A - 8: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition (with loans up to $1M included in HHI)

	C2.1 All Counties	C2.2 Mostly White Counties	C2.3 Black – Substantial Fraction	C2.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.082 (0.051)	-0.188 (0.038)***	0.242 (0.168)	0.370 (0.135)***
Banks per capita (log) × Service industries	0.021 (0.022)	0.000 (0.016)	-0.051 (0.084)	-0.041 (0.067)
Loan concentration (HHI) × Innovative industries	-1.437 (0.238)***	-1.076 (0.243)***	-1.384 (0.258)***	-2.921 (0.431)***
Loan concentration (HHI) × Service industries	-0.186 (0.044)***	-0.212 (0.046)***	-0.112 (0.110)	-0.041 (0.105)
BB (2009-2010) × Innovative industries	0.002 (0.006)	0.004 (0.007)	-0.035 (0.025)	0.003 (0.015)
BB (2009-2010) × Service industries	-0.005 (0.003)	-0.005 (0.004)	0.038 (0.014)***	-0.009 (0.008)
BB (2011-2017) × Innovative industries	0.016 (0.005)***	0.014 (0.004)***	0.028 (0.016)*	0.006 (0.009)
BB (2011-2017) × Service industries	0.010 (0.002)***	0.007 (0.001)***	0.003 (0.009)	0.015 (0.005)***
⊥ Early BB × Banks/cap. × Innovative industries	-2.692 (0.946)***	-1.589 (1.026)	-5.008 (1.882)***	-0.920 (0.710)
⊥ Early BB × Banks/cap. × Service industries	-2.603 (0.944)***	-1.480 (1.028)	-4.885 (1.883)***	-0.940 (0.709)
⊥ Early BB × Banks/cap. × Other industries	-2.622 (0.945)***	-1.496 (1.028)	-4.915 (1.886)***	-0.947 (0.707)
⊥ Later BB × Banks/cap. × Innovative industries	-0.413 (0.144)***	-0.325 (0.199)	-0.970 (0.378)**	-0.146 (0.112)
⊥ Later BB × Banks/cap. × Service industries	-0.411 (0.144)***	-0.322 (0.199)	-0.968 (0.377)**	-0.148 (0.112)
⊥ Later BB × Banks/cap. × Other industries	-0.412 (0.144)***	-0.324 (0.199)	-0.969 (0.377)**	-0.148 (0.112)
⊥ Early BB × Loan HHI × Innovative industries	9.784 (3.524)***	12.756 (4.992)**	5.387 (5.625)	6.126 (6.229)
⊥ Early BB × Loan HHI × Service industries	10.275 (3.538)***	13.905 (5.111)***	6.800 (5.529)	3.194 (5.630)
⊥ Early BB × Loan HHI × Other industries	10.236 (3.550)***	13.930 (5.107)***	6.868 (5.493)	3.207 (5.652)
⊥ Later BB × Loan HHI × Innovative industries	1.245 (0.420)***	1.895 (0.738)**	1.560 (0.756)**	-0.085 (0.523)
⊥ Later BB × Loan HHI × Service industries	1.230 (0.427)***	1.884 (0.752)**	1.664 (0.780)**	-0.271 (0.492)
⊥ Later BB × Loan HHI × Other industries	1.234 (0.429)***	1.881 (0.752)**	1.667 (0.777)**	-0.251 (0.501)

	C2.1 All Counties	C2.2 Mostly White Counties	C2.3 Black – Substantial Fraction	C2.4 Hispanic – Substantial Fraction
Employment at large firms (fraction)	2.249 (0.638)***	1.259 (0.497)**	7.515 (2.706)***	1.532 (1.079)
SER	0.51	0.52	0.53	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

See notes to Table A - 1.

Robustness check: Change the broadband speed threshold in the later years

In the tables in this section, the broadband regressor after 2011 is defined using a download speed threshold of 10 mbps instead of 25 mbps as in the main estimations.

Table A - 9: Poisson Regression Estimations with State-Year Fixed Effects (with Broadband Speed of 10 mbps+ in later years)

	A3.1 All Counties	A3.2 Mostly White Counties	A3.3 Black – Substantial Fraction	A3.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	0.284 (0.076)***	0.229 (0.046)***	0.596 (0.177)***	0.628 (0.145)***
Banks per capita (log) × Service industries	0.339 (0.055)***	0.384 (0.027)***	0.256 (0.085)***	0.276 (0.112)**
Banks per capita (log) × Other industries	0.342 (0.042)***	0.397 (0.022)***	0.361 (0.078)***	0.327 (0.088)***
Loan concentration (HHI) × Innovative industries	-1.383 (0.271)***	-0.980 (0.264)***	-1.311 (0.251)***	-2.735 (0.418)***
Loan concentration (HHI) × Service industries	-0.495 (0.100)***	-0.367 (0.103)***	-0.237 (0.130)*	-0.183 (0.120)
Loan concentration (HHI) × Other industries	-0.254 (0.066)***	-0.097 (0.070)	-0.234 (0.093)**	-0.117 (0.111)
BB (2009-2010) × Innovative industries	0.348 (0.085)***	0.254 (0.031)***	0.388 (0.132)***	0.380 (0.101)***
BB (2009-2010) × Service industries	0.256 (0.077)***	0.181 (0.028)***	0.311 (0.106)***	0.344 (0.101)***
BB (2009-2010) × Other industries	0.259 (0.077)***	0.190 (0.028)***	0.270 (0.107)**	0.331 (0.103)***
BB (2011-2017, 10 mbps) × Innovative industries	0.225 (0.047)***	0.128 (0.026)***	0.312 (0.160)*	0.184 (0.059)***

	A3.1 All Counties	A3.2 Mostly White Counties	A3.3 Black – Substantial Fraction	A3.4 Hispanic – Substantial Fraction
BB (2011-2017, 10 mbps) × Service industries	0.041 (0.014)***	0.012 (0.008)	0.086 (0.051)*	0.088 (0.027)***
BB (2011-2017, 10 mbps) × Other industries	0.027 (0.010)***	0.012 (0.005)**	0.034 (0.024)	0.030 (0.017)*
Rural population (fraction)	0.039 (0.045)	-0.140 (0.032)***	0.111 (0.072)	0.091 (0.061)
Unemployment rate	-0.016 (0.005)***	-0.017 (0.004)***	-0.036 (0.014)**	-0.040 (0.009)***
Employment at large firms (fraction)	0.543 (0.049)***	0.450 (0.035)***	0.605 (0.134)***	0.368 (0.078)***
SER	0.57	0.57	0.56	0.50
N	507,222	409,482	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: For 2011-2017, the download speed threshold for broadband is 10 mbps. See also notes to Table 2.

Table A - 10: Poisson Regression Estimations with County-Year Fixed Effects (with Broadband Speed of 10 mbps+ in later years)

	B3.1 All Counties	B3.2 Mostly White Counties	B3.3 Black – Substantial Fraction	B3.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.078 (0.053)	-0.189 (0.037)***	0.231 (0.159)	0.302 (0.141)**
Banks per capita (log) × Service industries	-0.002 (0.024)	-0.013 (0.017)	-0.103 (0.075)	-0.057 (0.070)
Loan concentration (HHI) × Innovative industries	-1.058 (0.258)***	-0.842 (0.278)***	-1.020 (0.226)***	-2.315 (0.314)***
Loan concentration (HHI) × Service industries	-0.192 (0.050)***	-0.243 (0.050)***	0.013 (0.087)	-0.042 (0.095)
BB (2009-2010) × Innovative industries	0.073 (0.013)***	0.092 (0.024)***	0.229 (0.148)	0.121 (0.037)***
BB (2009-2010) × Service industries	-0.004 (0.003)	-0.002 (0.005)	0.042 (0.053)	0.044 (0.016)***
BB (2011-2017, 10 mbps) × Innovative industries	0.150 (0.034)***	0.058 (0.010)***	0.102 (0.058)*	0.040 (0.017)**
BB (2011-2017, 10 mbps) × Service industries	0.009 (0.006)	-0.009 (0.004)**	0.037 (0.020)*	0.008 (0.007)
Employment at large firms (fraction)	0.369 (0.034)***	0.379 (0.033)***	0.428 (0.124)***	0.198 (0.070)***

	B3.1 All Counties	B3.2 Mostly White Counties	B3.3 Black – Substantial Fraction	B3.4 Hispanic – Substantial Fraction
SER	0.51	0.52	0.54	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: For 2011-2017, the download speed threshold for broadband is 10 mbps. See also notes to Table 3.

Table A - 11: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition (with Broadband Speed of 10 mbps+ in later years)

	C3.1 All Counties	C3.2 Mostly White Counties	C3.3 Black – Substantial Fraction	C3.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.080 (0.050)	-0.190 (0.036)***	0.225 (0.166)	0.303 (0.144)**
Banks per capita (log) × Service industries	0.011 (0.022)	-0.009 (0.016)	-0.038 (0.085)	-0.042 (0.066)
Loan concentration (HHI) × Innovative industries	-0.949 (0.234)***	-0.804 (0.247)***	-0.815 (0.253)***	-2.319 (0.315)***
Loan concentration (HHI) × Service industries	-0.160 (0.042)***	-0.221 (0.043)***	0.104 (0.124)	0.027 (0.103)
BB (2009-2010) × Innovative industries	0.057 (0.013)***	0.032 (0.009)***	0.053 (0.067)	0.051 (0.029)*
BB (2009-2010) × Service industries	0.005 (0.004)	-0.000 (0.004)	0.066 (0.035)*	0.020 (0.012)
BB (2011-2017) × Innovative industries	0.148 (0.030)***	0.087 (0.021)***	0.228 (0.158)	0.127 (0.043)***
BB (2011-2017) × Service industries	0.023 (0.008)***	0.007 (0.006)	0.079 (0.083)	0.066 (0.020)***
⊥ Early BB × Banks/cap. × Innovative industries	-2.611 (0.934)***	-1.532 (1.051)	-4.840 (1.796)***	-0.763 (0.672)
⊥ Early BB × Banks/cap. × Service industries	-2.523 (0.932)***	-1.424 (1.053)	-4.715 (1.798)***	-0.779 (0.667)
⊥ Early BB × Banks/cap. × Other industries	-2.541 (0.933)***	-1.440 (1.053)	-4.745 (1.802)***	-0.787 (0.665)
⊥ Later BB × Banks/cap. × Innovative industries	-2.122 (0.748)***	-3.681 (2.412)	-3.327 (1.272)***	-0.724 (0.592)
⊥ Later BB × Banks/cap. × Service industries	-2.108 (0.748)***	-3.670 (2.412)	-3.306 (1.269)***	-0.718 (0.593)

	C3.1 All Counties	C3.2 Mostly White Counties	C3.3 Black – Substantial Fraction	C3.4 Hispanic – Substantial Fraction
⊥ Later BB × Banks/cap. × Other industries	-2.110 (0.748)***	-3.673 (2.412)	-3.307 (1.271)***	-0.720 (0.593)
⊥ Early BB × Loan HHI × Innovative industries	7.513 (3.219)**	7.823 (4.319)*	9.123 (5.911)	4.648 (5.939)
⊥ Early BB × Loan HHI × Service industries	7.999 (3.250)**	8.643 (4.382)**	10.767 (5.881)*	2.616 (5.689)
⊥ Early BB × Loan HHI × Other industries	8.074 (3.258)**	8.705 (4.386)**	10.871 (5.882)*	2.737 (5.690)
⊥ Later BB × Loan HHI × Innovative industries	4.255 (1.927)**	14.881 (7.385)**	6.402 (2.708)**	-2.483 (2.733)
⊥ Later BB × Loan HHI × Service industries	4.500 (1.947)**	15.032 (7.412)**	6.948 (2.786)**	-2.495 (2.693)
⊥ Later BB × Loan HHI × Other industries	4.518 (1.952)**	15.009 (7.414)**	7.096 (2.789)**	-2.421 (2.691)
Employment at large firms (fraction)	2.194 (0.632)***	1.197 (0.500)**	7.360 (2.601)***	1.366 (1.065)
SER	0.51	0.52	0.53	0.46
N	507,060	409,320	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Notes: For 2011-2017, the download speed threshold for broadband is 10 mbps. See also notes to Table A - 1.

Robustness check: Include mobile broadband (4G LTE)

Estimations A1, B1, and C1 are repeated with the addition of the 4G LTE broadband variable; the sample is for years 2016 and 2017. The provision of fixed and mobile broadband deployment are positively correlated ($r = 0.38$). Thus, adding the mobile broadband regressor can help ensure that the apparent impacts of fixed broadband deployment found to this point are not spurious because fixed broadband is proxying for mobile broadband. Estimation A4.1 in **Error! Reference source not found.** shows that fixed broadband remains conducive for establishment births (Hypothesis 1) after controlling for mobile broadband, but only significantly so for innovative industries. For service and other industries, the fixed broadband coefficients are still in line with Hypothesis 1 but are significant only at the 10% level ($p = 0.06$ for service industries, $p = 0.07$ for other industries). The results also show that in terms of new establishment births, fixed broadband is more important than mobile broadband. Estimation A4.2

shows that the differences among industries in the broadband effects change little after controlling for unobserved county-year factors. Estimation A4.3 shows that the moderating influence of fixed broadband on the connection between local branch density and establishment births is even larger than before, albeit with lower significance levels ($p = 0.052$ for each coefficient). The same is true of fixed broadband's moderation of the effect of loan competition on startups ($p = 0.07$ for each coefficient). Given that the magnitude of the coefficients on the fixed broadband interactions with the banking variables are larger than in the main estimation (C1), the lower levels of significance may be due merely to the smaller sample size here.[40]

Table A - 12: Poisson Regression Estimations with Fixed and Mobile Broadband as a Moderating Influence for Banks

Y = establishment births per labor force member	**A4.1 All Counties**	**A4.2 All Counties**	**A4.3 All Counties**
Banks per capita (log) × Innovative industries	0.278***	-0.055	-0.054
Banks per capita (log) × Service industries	0.343***	0.025	0.025
Banks per capita (log) × Other industries	0.319***	Ref. cat.	Ref. cat.
Loan concentration (HHI) × Innovative industries	-1.200***	-0.777***	-0.912***
Loan concentration (HHI) × Service industries	-0.551***	-0.170***	-0.110
Loan concentration (HHI) × Other industries	-0.333***	Ref. cat.	Ref. cat.
Fixed BB × Innovative industries	0.255***	0.204***	0.205***
Fixed BB × Service industries	0.049*	0.009	0.030
Fixed BB × Other industries	0.037*	Ref. cat.	Ref. cat.
Mobile BB × Innovative industries	-0.010	-0.009	-0.051
Mobile BB × Service industries	0.026	0.028***	0.021
Mobile BB × Other industries	-0.003	Ref. cat.	Ref. cat.
⊥ Fixed BB × Banks per capita × Innov. inds.			-1.446*
⊥ Fixed BB × Banks per capita × Service inds.			-1.442*
⊥ Fixed BB × Banks per capita × Other inds.			-1.445*
⊥ Mobile BB × Banks per capita × Innov. inds.			0.008
⊥ Mobile BB × Banks per capita × Service inds.			-0.007**
⊥ Fixed BB × Loan HHI × Innovative industries			3.085*
⊥ Fixed BB × Loan HHI × Service industries			3.196
⊥ Fixed BB × Loan HHI × Other industries			3.203*

[40] The moderating role of mobile broadband cannot be assessed directly in estimation F1 since the interaction coefficients for mobile broadband are not absolute but relative to the other industry category, which coefficient is dropped due to multicollinearity in the data.

Y = establishment births per labor force member	A4.1 All Counties	A4.2 All Counties	A4.3 All Counties
⊥ Mobile BB × Loan HHI × Innovative inds.			0.583***
⊥ Mobile BB × Loan HHI × Service industries			-0.214***
Rural population (fraction)	0.035		
Unemployment rate	-2.544***		
Employment at large firms (fraction)	0.432***		1.614**
SER	0.56		0.51
N	112,950		112,950

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.
Ref. cat. means the reference category for sets of categorical regressors (with coefficients set to zero for identification). All estimations are for all counties and include industry fixed effects. The symbol ⊥ denotes an orthogonalized regressor. Std. errors (not shown here, but see in the appendix) are robust to clustering on the county. In the broadband×bank interactions, the broadband variables are orthogonalized with respect to all other regressors listed in Table 2. The coefficients for Mobile BB × Banks per capita × Other industries and Mobile BB × Loan HHI × Other industries were omitted due to multicollinearity.

Robustness check: Change the broadband variable in the later years to presence of any broadband

In the tables in this section, the broadband regressor after 2011 is defined based on an indicator variable at the Census block level for availability of 25 mbps downstream service (instead of the number of such providers as in the main estimations). The block-level indicator is aggregated to county level averages using population-weighted allocation factors. Note that since almost every tract had at least one broadband provider by the definition in the earlier years, this approach cannot be used before 2011.

Table A - 13: Poisson Regression Estimations with State-Year Fixed Effects (with Broadband Presence instead of Provider Count in later years)

	A5.1 All Counties	A5.2 Mostly White Counties	A5.3 Black – Substantial Fraction	A5.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	0.262 (0.076)***	0.238 (0.045)***	0.610 (0.181)***	0.599 (0.147)***
Banks per capita (log) × Service industries	0.340 (0.055)***	0.388 (0.027)***	0.266 (0.086)***	0.260 (0.109)**
Banks per capita (log) ×	0.344	0.400	0.386	0.319

	A5.1 All Counties	A5.2 Mostly White Counties	A5.3 Black – Substantial Fraction	A5.4 Hispanic – Substantial Fraction
Other industries	(0.042)***	(0.022)***	(0.079)***	(0.084)***
Loan concentration (HHI) × Innovative industries	-1.467 (0.292)***	-0.936 (0.258)***	-1.389 (0.272)***	-3.047 (0.493)***
Loan concentration (HHI) × Service industries	-0.489 (0.107)***	-0.350 (0.106)***	-0.244 (0.120)**	-0.298 (0.146)**
Loan concentration (HHI) × Other industries	-0.248 (0.071)***	-0.087 (0.071)	-0.099 (0.091)	-0.183 (0.122)
BB (2009-2010) × Innovative industries	0.380 (0.084)***	0.329 (0.037)***	0.461 (0.126)***	0.308 (0.114)***
BB (2009-2010) × Service industries	0.253 (0.076)***	0.179 (0.029)***	0.304 (0.103)***	0.314 (0.102)***
BB (2009-2010) × Other industries	0.248 (0.074)***	0.186 (0.029)***	0.303 (0.112)***	0.293 (0.106)***
BB (2011-2017, 10 mbps) × Innovative industries	0.360 (0.070)***	0.351 (0.053)***	0.560 (0.119)***	0.044 (0.105)
BB (2011-2017, 10 mbps) × Service industries	0.128 (0.029)***	0.087 (0.025)***	0.197 (0.053)***	0.052 (0.055)
BB (2011-2017, 10 mbps) × Other industries	0.097 (0.023)***	0.081 (0.020)***	0.246 (0.049)***	-0.023 (0.050)
Rural population (fraction)	0.046 (0.046)	-0.128 (0.032)***	0.122 (0.071)*	0.078 (0.061)
Unemployment rate	-0.017 (0.005)***	-0.017 (0.004)***	-0.034 (0.014)**	-0.043 (0.009)***
Employment at large firms (fraction)	0.547 (0.052)***	0.445 (0.035)***	0.603 (0.137)***	0.381 (0.077)***
SER	0.57	0.57	0.56	0.49
N	508,050	410,310	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: See notes to Table 2.

Table A - 14: Poisson Regression Estimations with County-Year Fixed Effects (with Broadband Presence instead of Provider Count in later years)

	B5.1 All Counties	B5.2 Mostly White Counties	B5.3 Black – Substantial Fraction	B5.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.093 (0.055)*	-0.179 (0.037)***	0.225 (0.163)	0.282 (0.144)*
Banks per capita (log) × Service industries	-0.002 (0.024)	-0.013 (0.017)	-0.116 (0.074)	-0.065 (0.069)

	B5.1 All Counties	B5.2 Mostly White Counties	B5.3 Black – Substantial Fraction	B5.4 Hispanic – Substantial Fraction
Loan concentration (HHI) × Innovative industries	-1.102 (0.264)***	-0.791 (0.272)***	-1.166 (0.223)***	-2.512 (0.360)***
Loan concentration (HHI) × Service industries	-0.188 (0.050)***	-0.238 (0.051)***	-0.115 (0.089)	-0.075 (0.097)
BB (2009-2010) × Innovative industries	0.134 (0.027)***	0.141 (0.025)***	0.154 (0.053)***	0.017 (0.031)
BB (2009-2010) × Service industries	0.005 (0.007)	-0.007 (0.007)	0.002 (0.027)	0.022 (0.017)
BB (2011-2017, 10 mbps) × Innovative industries	0.264 (0.060)***	0.262 (0.055)***	0.303 (0.120)**	0.059 (0.071)
BB (2011-2017, 10 mbps) × Service industries	0.029 (0.016)*	0.004 (0.015)	-0.046 (0.064)	0.074 (0.040)*
Employment at large firms (fraction)	0.371 (0.034)***	0.378 (0.033)***	0.429 (0.126)***	0.201 (0.070)***
SER	0.51	0.52	0.53	0.46
N	507,888	410,148	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Notes: See notes to Table 3.

Table A - 15: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition (with Broadband Presence instead of Provider Count in later years)

	C5.1 All Counties	C5.2 Mostly White Counties	C5.3 Black – Substantial Fraction	C5.4 Hispanic – Substantial Fraction
Banks per capita (log) × Innovative industries	-0.108 (0.054)**	-0.185 (0.036)***	0.218 (0.169)	0.306 (0.144)**
Banks per capita (log) × Service industries	0.014 (0.022)	-0.006 (0.016)	-0.059 (0.080)	-0.051 (0.067)
Loan concentration (HHI) × Innovative industries	-1.115 (0.228)***	-0.811 (0.237)***	-1.090 (0.192)***	-2.661 (0.365)***
Loan concentration (HHI) × Service industries	-0.193 (0.039)***	-0.229 (0.041)***	-0.104 (0.095)	-0.103 (0.098)
BB (2009-2010) × Innovative industries	0.095 (0.023)***	0.097 (0.021)***	0.084 (0.060)	0.015 (0.037)
BB (2009-2010) × Service industries	0.019 (0.007)***	0.008 (0.006)	0.022 (0.036)	0.027 (0.020)
BB (2011-2017) ×	0.208	0.208	0.253	0.043

	C5.1 All Counties	C5.2 Mostly White Counties	C5.3 Black – Substantial Fraction	C5.4 Hispanic – Substantial Fraction
Innovative industries	(0.053)***	(0.046)***	(0.120)**	(0.073)
BB (2011-2017) × Service industries	0.052 (0.016)***	0.027 (0.014)**	-0.034 (0.071)	0.076 (0.042)*
⊥ Early BB × Banks/cap. × Innovative industries	-2.465 (0.947)***	-1.460 (1.041)	-4.933 (1.819)***	-0.857 (0.677)
⊥ Early BB × Banks/cap. × Service industries	-2.382 (0.944)**	-1.360 (1.043)	-4.819 (1.822)***	-0.875 (0.674)
⊥ Early BB × Banks/cap. × Other industries	-2.403 (0.946)**	-1.377 (1.043)	-4.848 (1.825)***	-0.886 (0.672)
⊥ Later BB × Banks/cap. × Innovative industries	-0.376 (0.143)***	-0.292 (0.198)	-0.941 (0.358)***	-0.151 (0.115)
⊥ Later BB × Banks/cap. × Service industries	-0.373 (0.143)***	-0.290 (0.198)	-0.939 (0.358)***	-0.153 (0.115)
⊥ Later BB × Banks/cap. × Other industries	-0.375 (0.143)***	-0.291 (0.198)	-0.939 (0.358)***	-0.153 (0.115)
⊥ Early BB × Loan HHI × Innovative industries	7.199 (3.211)**	7.188 (4.262)*	9.153 (5.925)	5.051 (6.024)
⊥ Early BB × Loan HHI × Service industries	7.502 (3.233)**	7.974 (4.316)*	10.734 (5.856)*	2.623 (5.684)
⊥ Early BB × Loan HHI × Other industries	7.542 (3.243)**	8.023 (4.323)*	10.705 (5.850)*	2.670 (5.681)
⊥ Later BB × Loan HHI × Innovative industries	0.866 (0.361)**	1.250 (0.608)**	1.925 (0.785)**	-0.264 (0.531)
⊥ Later BB × Loan HHI × Service industries	0.849 (0.367)**	1.239 (0.620)**	1.999 (0.795)**	-0.403 (0.507)
⊥ Later BB × Loan HHI × Other industries	0.835 (0.368)**	1.223 (0.620)**	1.990 (0.793)**	-0.419 (0.515)
Employment at large firms (fraction)	2.096 (0.642)***	1.164 (0.497)**	7.503 (2.639)***	1.512 (1.073)
SER	0.51	0.52	0.53	0.46
N	507,888	410,148	52,146	35,208

* $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Notes: See also notes to Table A - 1.

Robustness check: Change the thresholds for minority counties

In the tables in this section, instead of a 30% threshold for minority counties, alternative figures of 25% and 35% are used. For the first table below, akin to Table 3 results, there are no changes in the results for Hispanics—nothing is significant, as in the main regressions. For the areas with

many Blacks, there are no changes for the bank density results but some significance changes for the loan concentration coefficients (the early broadband × loan HHI gains significance with the 25% threshold, and the later BB × loan HHI significance drops to the 10% level with the 35% threshold. In the former case, the early broadband × loan HHI coefficients were already jointly significant at the 5% level in the Black Substantial sample.

Table A - 16: Poisson Regression Estimations with County-Year Fixed Effects (with alternative thresholds for minority counties)

Y = establishment births per labor force member	**B6.1** **Black – 25% threshold**	**B6.2** **Black - 35% threshold**	**B6.3** **Hispanic – 25% threshold**	**B6.4** **Hispanic - 35% threshold**
Banks per capita (log) × Innovative industries	0.165 (0.124)	0.306 (0.188)	0.238 (0.113)**	0.274 (0.158)*
Banks per capita (log) × Service industries	-0.127 (0.058)**	-0.105 (0.086)	0.032 (0.070)	-0.092 (0.077)
Loan concentration (HHI) × Innovative industries	-1.444 (0.220)***	-1.445 (0.368)***	-2.272 (0.306)***	-2.323 (0.340)***
Loan concentration (HHI) × Service industries	-0.043 (0.069)	-0.111 (0.128)	-0.076 (0.110)	-0.002 (0.100)
BB (2009-2010) × Innovative industries	0.014 (0.008)	0.026 (0.015)*	-0.003 (0.005)	-0.014 (0.007)*
BB (2009-2010) × Service industries	0.016 (0.010)*	0.026 (0.013)*	-0.015 (0.005)***	-0.011 (0.007)
BB (2011-2017) × Innovative industries	0.025 (0.011)**	0.038 (0.020)*	0.015 (0.009)	0.021 (0.007)***
BB (2011-2017) × Service industries	0.002 (0.006)	0.009 (0.011)	0.018 (0.005)***	0.015 (0.005)***
Employment at large firms (fraction)	0.439 (0.092)***	0.359 (0.150)**	0.333 (0.094)***	0.194 (0.080)**
SER	0.49	0.55	0.45	0.47
N	66,006	39,996	44,748	28,548

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table A - 17: Poisson Regression Estimations with Fixed Broadband as a Moderating Influence for Bank Presence and Competition (with alternative thresholds for minority counties)

Y = establishment births per labor force member	**C6.1** **Black – 25% threshold**	**C6.2** **Black - 35% threshold**	**C6.3** **Hispanic – 25% threshold**	**C6.4** **Hispanic – 35% threshold**
⊥ Early BB × Banks/cap. ×	-4.299	-5.046	-0.959	-1.325

Y = establishment births per labor force member	C6.1 Black – 25% threshold	C6.2 Black - 35% threshold	C6.3 Hispanic – 25% threshold	C6.4 Hispanic – 35% threshold
Innovative industries	(1.784)**	(1.891)***	(0.724)	(1.163)
⊥ Early BB × Banks/cap. ×	-4.200	-4.919	-0.953	-1.347
Service industries	(1.778)**	(1.892)***	(0.729)	(1.154)
⊥ Early BB × Banks/cap. ×	-4.218	-4.944	-0.959	-1.362
Other industries	(1.780)**	(1.898)***	(0.721)	(1.155)
⊥ Later BB × Banks/cap. ×	-0.816	-0.854	-0.156	-0.190
Innovative industries	(0.339)**	(0.333)**	(0.119)	(0.148)
⊥ Later BB × Banks/cap. ×	-0.816	-0.852	-0.157	-0.192
Service industries	(0.339)**	(0.333)**	(0.119)	(0.147)
⊥ Later BB × Banks/cap. ×	-0.817	-0.853	-0.158	-0.192
Other industries	(0.339)**	(0.333)**	(0.119)	(0.147)
⊥ Early BB × Loan HHI ×	14.246	6.122	6.330	14.442
Innovative industries	(6.490)**	(6.219)	(4.935)	(11.283)
⊥ Early BB × Loan HHI ×	15.256	7.762	3.798	11.669
Service industries	(6.288)**	(6.107)	(4.353)	(10.396)
⊥ Early BB × Loan HHI ×	15.374	7.928	4.079	11.643
Other industries	(6.355)**	(6.122)	(4.452)	(10.444)
⊥ Later BB × Loan HHI ×	1.386	1.484	0.346	-0.094
Innovative industries	(0.654)**	(0.826)*	(0.456)	(0.655)
⊥ Later BB × Loan HHI ×	1.431	1.560	0.197	-0.191
Service industries	(0.668)**	(0.845)*	(0.437)	(0.613)
⊥ Later BB × Loan HHI ×	1.427	1.564	0.199	-0.181
Other industries	(0.669)**	(0.844)*	(0.442)	(0.620)
SER	0.49	0.54	0.45	0.47
N	66,006	39,996	44,748	28,548

C. Additional data used in the regressions of Community Reinvestment Act loan data

Discuss how loan distance and loan totals were constructed.

The regressors used for Table XXX for the exploration of total loan amounts by tract are:

Control variables from U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) Dataset, Workplace Area Characteristics (WAC) File (See https://lehd.ces.census.gov/data): these data are extracted from LODES v. 7.5 (for the 2010 Census tracts) and LODES v.5.0 (for the 2000 Census tracts). All variables pertain to jobs at businesses located in the tract (not necessarily held by residents living in the tract)

- Log of total jobs.
- Fraction of jobs in firm industrial sector (by NAICS groupings): agriculture and extractive industries, utilities, construction, manufacturing, wholesale and retail trade, services, and public administration.
- Fraction of jobs in firm size categories: 1-19 employees, 20-49 employees, 50-249 employees, 250-499 employees, and 500+ employees. Available only for 2011 and thereafter.
- Fraction of jobs in firm age categories: 0-1 years, 2-3 years, 4-5 years, 6-10 years, and 11+ years. Available only for 2011 and thereafter.

Control variables from ACS 5-year estimates: these data are from various tables in the U.S. Census Bureau's American Community Survey, where year *n* in the dataset is associated with the midpoint year of the 5-year estimates.

- Fraction of population that is white alone non-Hispanic, Black alone, and Hispanic.
- Fraction of population in a family below the poverty threshold.
- Median income.
- Fraction of population age 25+ with educational attainment of: high school only, bachelors degree, and higher degree.
- Unemployment rate.

Other control variables: the rural status of the tract is taken from the 2010 Census, Summary File 1.

Additional References

Cameron, A. C., & Trivedi, P. K. (2013). *Regression analysis of count data* (2nd ed). Cambridge University Press.

Terza, J. V. (1985). A tobit-type estimator for the censored Poisson regression model. *Economics Letters* 18(4): 361–365. https://doi.org/10.1016/0165-1765(85)90053-9