Bank Lending in the Knowledge Economy*

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Abstract

We study bank portfolio allocations during the transition of the real sector to a knowledge economy in which firms increasingly use intangible assets. We show that higher corporate investment in intangible assets slows down banks' commercial lending. Banks reallocate the resulting lending capacity to other assets, notably mortgages. The findings are consistent with financial intermediation frictions due to lower collateral value of corporate intangible assets. Additional tests rule out alternative explanations such as higher mortgage demand. We estimate that higher corporate intangible assets conservatively explain 25-40% of the decline in bank commercial lending since the mid-1980s.

JEL Codes: E22, E44, G21.

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1 Introduction

U.S. corporate intangible capital has increased dramatically over the last five decades. The stock of assets such as intellectual property, human capital, business strategy, and brand equity, has tripled since the 1960s, reaching \$3.6 trillion, or 50% of tangible capital by the early 2000s (Corrado et al., 2009). Intangible assets tend to be more firm-specific and more difficult to verify, price, and liquidate than tangible assets. The corporate finance literature shows that the lower collateral value of intangible assets constrains the corporate sector's debt capacity, which explains the long-run trend towards greater reliance on internal funds by firms (e.g., Bates et al. (2009), Falato et al. (2013)). Yet, the question of how corporate intangible capital affects the banking sector remains unexplored. This paper attempts to fill this gap.

In this paper, we posit that the rise of intangible assets in the U.S. real sector affects the banking sector by increasing credit intermediation frictions. If intangible assets significantly reduce firms' debt capacity, then banks' commercial and industrial (C&I) loans should decline as firms are less able to rely on debt financing, including on bank loans, to finance their investment opportunities. Reduced commercial lending opportunities, in turn, may induce banks to reallocate their lending capacity to non-C&I assets, notably real estate loans.

Aggregate trends are strikingly consistent with this story. The economy-wide rise in corporate intangible assets has coincided with a secular decline in the share of banks' commercial loans and a rise in banks' real estate loans. Figures 1 and 2 illustrate these trends. For U.S. establishments, the share of R&D capital relative to tangible assets rose from roughly 10% in the 1970s to about 18% in the 2000s (see Figure 1). Over the same period, the share of commercial loans in banks' total assets fell by a third, while the share of real estate loans more than doubled (see Figure 2). That said, the link between the trends in corporate intangible capital and bank portfolio allocations might be due to other developments in the economy, such as innovations in securitization and deeper bond markets.

The objective of this paper is to establish a link between the rise of corporate intangible capital and bank lending patterns. For this purpose, we exploit cross-sectional geographical variation in corporate intangible capital across metropolitan statistical areas (MSAs) and examine how banks' portfolios change when firms that constitute their local borrowing base invest more in intangible assets. If intangible corporate assets imply fewer commercial lending opportunities, then the decline in commercial loan growth should be more pronounced for banks operating in MSAs where the increase in intangible assets is larger. Further, these banks can reallocate their lending capacity to non-C&I assets, such as mortgage lending.

Using comprehensive data on bank balance sheets from the U.S. Call Reports over 1984-2008, we present robust empirical evidence that an increase in local corporate intangible assets is associated with a significant reduction in commercial loan growth, controlling for time-varying bank characteristics and variables that capture MSA-level demand for bank loans. Coefficient estimates in baseline specifications indicate that a one standard deviation increase in local corporate intangible asset growth is associated with a 0.9 percentage point decline in bank commercial loan growth (14% of the sample mean). Our resulting conservative estimates indicate that between 25% and 40% of the decline in the share of commercial loans in bank loan portfolios since the mid-1980s can be attributed to the increase in corporate intangible assets.

In the baseline analysis we capture a bank's exposure to corporate intangible capital based on the firms that are located in a bank's headquarters MSA. This approach may work less well after the mid-1990s, when geographical restrictions on inter- and intra-state banking activities were removed, and some banks developed sizable operations outside their headquarters MSAs. Therefore, we construct two alternative measures of a bank's exposure to changes in corporate intangible capital by weighting local changes in corporate intangible capital by the geographical distribution of the bank's mortgage-lending and deposit-taking activities. These alternative measures deliver results that are virtually identical in economic magnitude to those based on headquarters MSA.

We also examine the effect of corporate intangible capital on bank commercial lending in loan-level data from the market for syndicated loans. These data (sourced from DealScan) provide information on each bank's actual corporate borrowers and allows us to measure their level of intangible capital directly. We show that firms with more intangible assets receive smaller and more expensive bank loans. These findings confirm our main results in a different dataset and show that they hold even for large firms and large banks that typically operate in the syndicated loan market.

Next, we examine how the contraction in banks' commercial lending opportunities affects other components of their balance sheets. If banks face capital constraints, they are likely to reallocate the spare lending capacity resulting from lower commercial lending to other assets that were previously rationed out as less profitable. Then, the effect of local intangible capital will be manifest not on overall bank size, but rather on the composition of bank balance sheets. Indeed, we find that banks that are exposed to a rise in corporate intangible assets do not reduce their size, rather, they increase non-C&I assets, including real estate loans.

To support a causal interpretation of our results, we need to rule out potential identification concerns. First, we need to address the issue of reverse causality. For instance, it is possible that banks reduce their commercial lending for exogenous reasons, which in turn may induce local firms to invest in less external finance-intensive intangible assets. This concern is unlikely to apply to our results given that our measure of MSA corporate intangible asset growth is constructed as the product of *national* industry-level intangible asset growth rates and *historical* MSA-level industry composition. The baseline analysis uses 3-year lagged MSA industry shares, which reflects a trade-off between pre-determined industry shares and precisely measured industrial structure. Remarkably, our estimates have virtually identical economic magnitudes if we construct our measure of corporate intangible capital using 5 or 10-year lags, or even industry shares in 1975, which predates our sample period.

A second concern is that corporate intangible capital may affect banks not through frictions in commercial lending, but through higher local demand for bank non-C&I assets, generating a similar bank portfolio reallocation at the MSA level ("local demand channel"). For example, more R&D-intensive firms may attract a different, better paid workforce, leading to higher mortgage demand. To rule out this alternative explanation, we analyze the effects of corporate intangible assets on banks' real estate lending using mortgage-level data from HMDA. Using these data, we can identify the effect of corporate intangible capital on a bank's mortgage lending *in a given MSA and year*, while controlling for mortgage demand using borrower MSA×year fixed effects, similar to Khwaja and Mian (2008). We find that higher corporate intangible asset growth increases bank mortgage loan volumes and acceptance rates in locations other than bank headquarters MSA. This finding is inconsistent with the local demand channel. If an increase in corporate intangible assets affected banks through an expansion of local non-C&I loan demand in a particular location, say headquarters MSA, banks would reallocate their limited lending capacity towards that location and away from other MSAs. Instead, this finding is consistent with our interpretation that an increase in corporate intangible assets creates frictions in commercial lending and induces banks to reallocate to other types of lending.

Our findings offer a new perspective on the long-term decline in the share of commercial loans in bank assets by showing that a significant part of this decline was due to greater reliance on intangible capital in the corporate sector. Moreover, our evidence suggests that banks responded to this phenomenon by reallocating their portfolios toward other types of assets, notably real estate loans, rather than downsizing. Thus, our results imply that the rise in corporate intangible capital over the last few decades contributed to the expansion of real estate lending through this bank portfolio reallocation channel. Our paper is the first to empirically document the impact of the knowledge economy on mortgage markets.

The long-term shift in bank lending away from commercial and toward real estate loans has so far been explained by developments in housing markets and by the growth of securitization and bond markets. Chakraborty et al. (2018) and Loutskina and Strahan (2009) convincingly document these quantitatively important trends for bank lending patterns. Chakraborty et al. (2018) show that banks exposed to strong housing markets reduce the supply of commercial loans and increase the supply of mortgage loans, with negative effects for the real economy. Loutskina and Strahan (2009) show that deep mortgage secondary markets fostered by securitization increase banks' willingness to originate illiquid loans, raising mortgage loan supply. We add to these studies an additional explanation for changes in bank lending that is linked to a fundamental shift toward greater investment in intangible assets by the corporate sector.

The transformation of financial intermediation that we document in this paper has important macroeconomic implications. The lower efficiency of financial intermediation in an intangible capital-intensive economy may explain some of the decline in investment rates that underlies the "secular stagnation" hypothesis (Summers, 2014). The finding that the banks which are constrained in their commercial lending search for alternative investment opportunities, such as those in real estate lending, is consistent with "banking glut" observations (Shin, 2012). Finally, the fact that the relative importance of bank commercial lending for firm financing has declined may change how monetary policy affects the real economy (Kashyap and Stein, 2000; Kishan and Opiela, 2000). The effects of bank conditions on firm investment (Chodorow-Reich, 2013) may become smaller, whereas those on asset valuations, notably real estate, may become larger (Mishkin, 2007).

2 Literature Review and Hypotheses

The literature on the economics of innovation documents a dramatic increase in firms' investment in intangible assets over the last 50 years (Corrado et al., 2009; Corrado and Hulten, 2010). In a seminal paper, Corrado et al. (2009) undertake the most comprehensive approach to date to measuring aggregate intangible capital in the U.S. economy. Their measure is based on capitalized past investments in intangible assets.[1] They show that the share of aggregate intangible capital stock increased three-fold relative to tangible capital during 1973-2003, reaching an estimated $3.6 trillion, or 50% of the tangible capital stock by 2003. Of the total intangible capital stock in the 2000s, 49% is knowledge capital (accumulated R&D), 37% is organizational capital (accumulated economic competencies), and 14% is IT capital (software and computerized information). Knowledge capital can further be decomposed into scientific R&D and product innovation. During 1973-2003, the fastest growing categories of intangible assets were product innovation, computerized information, and organizational capital.[2]

A growing literature explores the implications of the rise in intangible capital on corporate finance.

[1] Investments in intangible assets are typically reported a current expense, and capital that is created by such investments is usually not captured on firms' balance sheets (except patents and post-merger goodwill). Corrado et al. (2009) identify categories of aggregate expenditures, such as R&D for example, that are likely to be investments in intangible capital. They then use a variety of data sources, such as the National Income and Product Accounts (NIPAs), the U.S. Census, and the NSF's R&D Survey, to measure such investments and capitalize them to produce their estimates of the aggregate intangible capital.

[2] Several papers, including Lev and Radhakrishnan (2005), Eisfeldt and Papanikolaou (2013), and Falato et al. (2013), use financial statements of public firms in the U.S. to build firm-level measures of corporate intangible capital. The measure in Falato et al. (2013), which reflects the three types of intangible investments identified in Corrado et al. (2009), shows an upward trend during 1970-2010 that is even steeper compared to the macro data-based measure, suggesting that intangible capital grew even more dramatically in publicly-listed firms.

Intangible assets are often more firm-specific and more difficult to value and liquidate than tangible assets.[3] As a result, intangible assets have relatively low collateral values, exacerbating frictions in debt financing. Empirical studies find strong evidence that firms finance intangible assets primarily through equity or internal cash flows (Carpenter and Petersen (2002), Brown et al. (2009), Bates et al. (2009), Falato et al. (2013), Brown et al. (2013)). While some intangible assets, notably patents, can be used as collateral, as discussed, for example, in Loumioti (2012) and Mann (2015), this practice is not prevalent, suggesting that the collateral value of intangible assets is significantly lower than that of similarly productive tangible assets.[4]

In this paper, we posit that the rise in corporate intangible capital and the resulting reduced availability of collateral in firms increases frictions in bank commercial lending. Collateral facilitates financial intermediation by limiting the agency problems associated with asymmetric information and the inalienability of human capital (Bester, 1985; Chan and Thakor, 1987; Hart and Moore, 1994) and facilitate enforcement of repayment (Rampini and Viswanathan, 2013). Consequently, credit is cheaper and more abundant when collateral is readily available. This phenomenon is evident in real estate finance markets, where households can obtain mortgage loans on terms (both volumes and interest rates) that are unattainable for other forms of borrowing. Overall, the literature suggests that collateral reduces agency costs in lending in a way that cannot be replicated by other means, such as enhanced borrower screening or monitoring (see, e.g., Berger and Udell (1990), Rajan and Winton (1995), and Rampini and Viswanathan (2013)).

At the aggregate level, a technological trend that increases the use of intangible assets in firms acts as a financial frictions shock. This shock affects both borrowers and lenders. For firms that need external funds, increased intermediation frictions are similar to a negative credit supply shock, as the firms find it more difficult and/or expensive to obtain credit.[5] For banks, an increase in

[3]For example, the value of a partially-developed technology is likely to be intrinsically linked with the human capital of the researchers who work on it. Should a bank take over this asset and try to sell it on the market, it would likely recoup only a fraction of its original value.

[4]For bank lending, frictions are amplified by limited regulatory recognition of intangible collateral, which is related to difficulties in its valuation and verification. See "Banks eye intangible assets as collateral" in Financial Times (June 11, 2012).

[5]One alternative interpretation of the decline in C&I lending associated with greater asset intangibility is that investment in intangible assets is less lumpy and hence requires less upfront funding. However, from the banking system's point of view this has the same implications as our collateral story. More critically, this view is not consistent with the fact that firms investing in intangible assets also accumulate substantial cash holdings (precautionary savings)

intermediation frictions reduces the pool of qualified borrowers and hence acts as a negative credit demand shock. Our analysis focuses on the equilibrium outcome of these two forces for banks, leading to our first empirical hypothesis:

Hypothesis 1: An increase in the share of intangible assets in firms' capital reduces the equilibrium volume of bank C&I lending.

A contraction in banks' commercial lending opportunities may in turn affect other components of bank balance sheets. Banks are usually constrained in raising capital and other funding, and hence in their lending capacity. This premise is standard in the literature, and underpins, for example, the bank lending channel of monetary policy (Kashyap and Stein, 2000; Kishan and Opiela, 2000). When banks are constrained, a reduction in their commercial lending generates spare lending capacity, which banks can reallocate to other assets. The argument that capital- and lending-constrained banks are more likely to adjust their asset allocation than their size was developed in Chakraborty et al. (2018). They document that banks exposed to better real estate lending opportunities reduce their commercial lending. Our paper highlights a mirroring channel. Banks facing fewer commercial lending opportunities increase their non-C&I assets, including real estate lending. This is our second empirical hypothesis:

Hypothesis 2: An increase in the share of intangible assets in firms' capital increases the equilibrium volume of bank non-C&I assets and reduces the profitability of these assets.

Empirically testing hypotheses 1 and 2 forms the core of our analysis. The mechanism behind these hypotheses is related to the emerging theoretical literature on the effects of intangible capital on financial intermediation (Döttling and Perotti, 2016; Caggese and Perez, 2017). While the intermediation frictions associated with intangible assets have been well documented in the corporate finance literature from the firms' side, to our knowledge, this is the first paper to empirically study the effect of such frictions on the lending dynamics of banks.

(Falato et al., 2013).

3 Data

Our hypotheses on the effect of the rise in corporate intangible capital on bank lending appear consistent with the aggregate trends depicted in Figures 1-2: the secular rise in corporate intangible capital has been accompanied by a bank balance sheet reallocation from commercial lending towards real estate lending. However, the aggregate data cannot tell us whether these long-run trends in bank lending are caused by the rise of the knowledge economy or by some other macroeconomic trends such as innovations in securitization or deeper bond markets. Our empirical strategy therefore focuses on exploiting cross-sectional geographic variation in corporate intangible capital across MSAs. We examine how bank portfolios change in response to corporate intangible capital growth in the MSAs where they operate, while controlling for aggregate trends with year fixed effects.

In this Section, we describe our main variables and present descriptive statistics. Summary statistics for selected regression variables are reported in Table 1. (Details on data sources and variable definitions are in the Appendix and Table A1.)

3.1 Corporate Intangible Capital

Our main explanatory variable—growth in MSA-level corporate intangible capital—is constructed using two data sources: industry-level intangible capital measures from the Bureau of Economic Analysis' (BEA) Fixed Assets data and MSA-level industry employment shares from the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW).

The BEA calculates industry-level intangible capital based on capitalized private expenditure on scientific R&D, software, and artistic originals. The BEA measure is narrower than the comprehensive aggregate measure in Corrado et al. (2009), as it excludes organizational capital and product innovation, two of the faster-growing types of intangible assets. Consequently, the BEA measure shows lower but still meaningful levels and growth rates of intangible capital: from about 10% of tangible assets in late 1970s to about 18% in the 2000s, as depicted in Figure 1.[6] The fact that

[6]In the breakdown provided in Table 2 of Corrado et al. (2009), our BEA-based measure is closest to "scientific innovative property," which accounts for about 25% of total intangible capital in 2003; or for about 12.5% of tangible capital given that 2003 total intangible capital in Corrado et al. (2009) is about 50% of tangible capital.

the BEA measure underestimates the level and growth of intangible capital compared to its more comprehensive measures suggests that our estimates are conservative and provide a lower bound for the impact of corporate intangible capital on bank lending.

The benefit of the BEA measure is that it is available at a sufficiently granular industry level and it captures *all* establishments in the U.S. (as opposed to firm-level measures, such as those in Falato et al. (2013), that are constructed solely from data for large publicly-listed firms). By capturing all firms, the BEA measure is well suited for geographical matching of banks and firms given that most small firms borrow predominantly from banks located within 5 miles of their headquarters (Amel and Brevoort, 2005; Agarwal and Hauswald, 2010; Brevort et al., 2010).

To measure the geographical variation in intangible capital growth—our main variable of interest—we weigh BEA industry-level intangible capital growth by MSA-level industry employment shares. Our baseline measure of MSA-level intangible capital growth is:

$$IK_{jt} = \sum_{k \in K_j} \left[s_{jkt-l} IK_{kt}^{BEA} \right] \tag{1}$$

where j indexes areas (MSAs), k indexes industries, and t indexes years. The first term in brackets is the employment share of industry k in area j in year $t-l$ that we obtain from the BLS. The second term is the industry-level growth in the ratio of intangible capital to tangible capital (equipment and structures) from the BEA. The industries are based on the 3-digit NAICS classification.[7] In our baseline analysis, we use employment shares lagged 3 years, i.e. $l = 3$. The choice of lag reflects the trade-off between pre-determined industry shares and precisely measured industrial structure. In robustness exercises we consider deeper lags. Using lagged employment shares ensures the exogeneity of MSA-level IK measures, which by construction depend only on historical MSA-level industry composition and U.S.-wide industry-level intangible capital ratios.

The typical MSA in our sample has an average sector-weighted intangible-to-tangible capital ratio of 13.8%. The average annual growth rate of the intangible capital ratio is 4.5% in the cross-section of MSAs. Figure 3 depicts the geographical distribution of intangible capital growth rates

[7] We map employment shares to intangible capital by industry using the BEA crosswalk from BEA industry definitions to 3-digit NAICS codes.

across MSAs during the sample period. Among the more populated MSAs, the top five—Memphis (TN), Tampa (FL), New Orleans (LA), Sacramento (CA), Bakersfield (CA)—had an average annual intangible capital growth rate of at least 5% during 1984-2008. In the bottom five MSAs—Carson City (NV), Ithaca (NY), Sandusky (OH), Flagstaff (AZ), and Merced (CA)—corporate intangible capital grew on average at less than 0.5%. About 10% of MSA-year observations exhibit negative growth rates. Overall, there is a large amount of cross-sectional variation in intangible capital growth over our sample period, which we will exploit in our empirical analysis.

3.2 Bank Data

We use several data sources to document the impact of corporate intangible assets on banks. (See Data Appendices A-II and A-III for detailed descriptions.)

3.2.1 U.S. Call Reports Data

We collect bank-level data on banks' commercial lending and other balance sheet components from the U.S. Call Reports. We restrict our sample to commercial banks and use data that reflect domestic operations and ignore banks' foreign activities. Commercial loans are defined as secured or unsecured loans for commercial and industrial purposes to sole proprietorships, partnerships, corporations, and other business enterprises. This category excludes loans secured by real estate (which are classified as "real estate loans"), agricultural loans, and personal consumer loans. The bank-level panel starts in 1984, the first year since major changes in the definitions of key bank variables such as C&I loans and total equity.[8] The analysis ends in 2008 to exclude shocks to bank lending associated with the financial crisis and post-crisis changes in banking regulation. In the baseline analysis, we use bank headquarters location from the Call Reports to capture a bank's area of operations.

The baseline sample covers about 7,800 commercial banks with headquarters in 271 MSAs. Table 1 reports key descriptive statistics. The average bank in the sample has about $60 million in assets and the distribution of bank size is highly skewed with a few large banks. Commercial loans stand

[8] See Data Appendix A-II for details.

at about 12% of bank assets on average and real estate loans represent over a third of total bank assets. In terms of growth rates over the sample period, commercial loans grew at an average annual rate of about 6%, similar to the overall bank balance sheet expansion rate of 5.5%, whereas real estate loans grew on average substantially faster at 10%.

3.2.2 Mortgage Lending and Deposit Location Data

In addition to our baseline definition of bank's area of operations based on headquarters MSA, we construct alternative measures that reflect the entire geographical footprint of a bank's operations. We employ two separate data sources that contain detailed data on the location of banks' deposit-taking and mortgage-lending activities. The data on deposit balances at the branch level for all banks in our sample come from the Federal Deposit Insurance Corporation's (FDIC) Summary of Deposits and are available starting in 1994. The data are provided on an annual basis and contain information on each branch's parent bank, address, and location. We aggregate the deposit volumes at the MSA level, matching branch locations at the zipcode level to MSAs using the crosswalk from the U.S. Census Bureau, thereby obtaining a measure of the bank's geographical footprint across all MSAs in which it has a deposit-taking branch.

Bank mortgage lending data are collected by the Federal Financial Institutions Examinations Council (FFIEC) under the provisions of the Home Mortgage Disclosure Act (HMDA data). Reliable HMDA data starts in 1995. These loan-level data cover the near-universe of mortgage loan applications and originations, except those from institutions with assets below $30 million. We also use HMDA mortgage lending data separately in the analysis of the reallocation of bank lending to the real estate sector in response to growth in corporate intangible capital.

For each loan, we observe the amount, loan characteristics (e.g., property location, type of originating institution, whether the loan is insured, etc.), borrower characteristics (e.g., income, race, and gender), and whether the mortgage loan was granted or denied. From the raw data we drop loans that are originated by non-bank institutions, loans that are not conventional (e.g., loans that are insured by the Federal Housing Administration, Veterans Administration, Farm Service Agency, or Rural Housing Service), and loans that have missing characteristics. We then aggregate the individual loans to bank-borrower MSA-year level, matching property counties to MSAs using the crosswalk from the U.S. Census Bureau. We drop bank-MSA-year observations with fewer than 10 mortgage loan applications as they do not reflect a bank's active presence in an MSA.

The resulting dataset covers 9,255 commercial banks operating in 420 MSAs (including several non-metropolitan areas, i.e., population centers that are removed from large cities). The median bank is present in 21 MSAs and originates around $5 million worth of mortgages per year and MSA. The median mortgage loan is just over $120,000 and the median mortgage application acceptance rate is 85%, similar to Loutskina and Strahan (2009). Summary statistics for mortgage applicant characteristics in the HMDA dataset are shown in Appendix Table A2.

3.3 Syndicated Loan Data

In an extension of our baseline analysis, we use DealScan Loan Pricing Corporation (LPC) loan-level data to directly match banks and firms based on their lending relationships. DealScan reports detailed information (including volumes and pricing) for large corporate loans mostly extended by bank syndicates (comprising at least two lenders). As documented in Ivashina and Scharfstein (2010), syndicated loans account for about one-quarter of aggregate banking system C&I loans and about one one-third of C&I loans on the balance sheets of large U.S. banks.

We use data on loans granted to non-financial firms between 1990 and 2008.[9] The data are aggregated at the bank-borrower-year level by computing total loan volumes and the average of loan spreads (weighted by loan volumes) for each bank-firm pair in a given year. Furthermore, the data are double-matched with bank balance sheet information from the U.S. Call Reports and with borrowing firms' financial information from Compustat.[10]

3.4 MSA-Level Controls

In all our regressions, we include a broad set of MSA-level control variables for local macroeconomic conditions that can affect banks' lending decisions. We control for MSA-level household income and

[9]We exclude loans signed before 1990 due to the sparseness of the data and the fact that sovereigns (rather than firms) were the main borrowers in the syndicated loan market during the 1980s.

[10]See Data Appendix A-III for details.

population using data from the U.S. Census. These data are available at the county level and are aggregated to the MSA level using a crosswalk between counties and MSAs from the U.S. Census Bureau. We control for MSA-level house prices using the all-transactions seasonally-adjusted house price index (HPI) from the Federal Housing Finance Agency (FHFA). We also control for MSA-level business conditions using average sales growth and market-to-book ratio of Compustat firms with headquarters in that MSA.

4 Corporate Intangible Capital and Bank Asset Allocations

This section presents our baseline analysis of the impact of corporate intangible capital on bank lending. Specifically, we study (i) how a bank's commercial lending changes due to growth in corporate intangible capital in the areas where it operates and (ii) how these changes affect the rest of the bank's balance sheet. We begin by describing the econometric specification. We then present the findings of our baseline analysis, which defines a bank's area of operations as the MSA of its headquarters. We further examine alternative measures of banks' exposure to corporate intangible capital that define a bank's area of operation from the spatial distribution of its activities. Finally, we explore the terms of loans extended by banks to firms with varying degrees of intangible assets using syndicated loan data. This analysis enables us to confirm the baseline results on the link between corporate intangible capital and bank commercial lending in an alternative data environment.

4.1 Empirical Strategy

We estimate the baseline specification for three dependent variables: banks' commercial loan growth, total asset growth, and non-C&I asset growth. Our hypotheses from Section 2 predict that higher growth of corporate intangible capital in the bank's area of operations leads to a decline in its commercial lending and an expansion of the non-C&I components of its balance sheet. To take the predictions to the data, we estimate the following empirical model:

$$Y_{it} = \alpha_t + \beta_1 IK_{it} + \beta_2 X_{it} + \beta_3 Z_{it} + \epsilon_{it}, \tag{2}$$

where banks are indexed by i and years by t. Y_{it} is each of the three dependent variables considered. IK_{it} is the growth rate of intangible capital to which the bank is exposed, as defined in Section 3.1. X_{it} is a matrix of macro controls for economic conditions in the bank's area of operations that may directly impact the demand for bank credit: house prices, per capita income, population, and firm sales growth, and firm market-to-book ratio. Z_{it} is a matrix of bank controls: bank size (log-total assets) and capital ratio (total equity divided by total capital), both lagged by one year. All specifications include year fixed effects α_t to control for shocks that are common to all banks in each year. All variables except bank size, bank capital, and firm market-to-book ratio are expressed as yearly growth rates. By estimating a specification in changes, we exploit within-bank variation and hence control for time-invariant bank heterogeneity. Finally, the specifications for banks' commercial loans and non-C&I assets control for total bank balance sheet growth. Therefore, the estimates can be interpreted as the growth of the shares of these bank balance sheet components in total assets.[11] Standard errors are clustered at the bank level.[12]

The coefficient of interest, β_1, captures the effect of corporate intangible capital growth on the change in the three outcomes of interest: banks' commercial lending, total size, and non-C&I assets. Our hypotheses predict that $\beta_1 < 0$ for commercial loan growth and $\beta_1 > 0$ for non-C&I asset growth. In obtaining an unbiased estimate of β_1 as the impact of intangible capital growth on bank lending, we face two identification issues: reverse causality and omitted unobserved loan demand effects. After presenting the results from specification 2 in this Section, in Section 5 we discuss these identification concerns in detail and perform additional tests to rule them out.

4.2 Baseline Results

Table 2 presents the baseline results. In columns 1-4, the dependent variable is C&I loan growth. We first show the bivariate specification that only includes local corporate intangible capital growth as an explanatory variable (column 1), then add MSA- and bank-level controls (column 2), and then add year fixed effects (column 3). Columns 4-6 present the main specifications for the three dependent variables we examine throughout the analysis: C&I loan growth, total bank asset growth,

[11]We test the robustness of our results to excluding total balance sheet growth from the specifications in Table A4.

[12]We assess the sensitivity of main estimates' statistical significance to alternative clustering choices in Table A6.

and non-C&I asset growth. These specifications include the full set of macro controls, year fixed effects, as well as bank total asset growth in columns 4 and 6.

The first set of results shows that higher local corporate intangible capital growth is associated with lower commercial loan growth, and the coefficient estimate is statistically significant at the conventional levels (columns 1-4). The magnitude of the coefficient in consistent across specifications and suggests high economic significance. Using estimated coefficients from the full specification in column 4, a one standard deviation increase in corporate intangible capital growth is associated with a decline in the growth rate of bank commercial loans of 0.9 percentage points, or close to 14% of the sample average annual growth in C&I loans. Our measure of intangible capital increased by 5% over the sample period (1984-2008), suggesting that it contributed to 25% of the decline in the share of commercial loans in total bank assets over the same period. Over the longer sample (1975-2015), shown in Figure 1, the same estimate implies that the long-run growth in corporate intangible capital contributed to about 40% of the decline in the share of bank's commercial loans. Given that our measure of corporate intangible capital does not capture product innovation and organizational capital, which, according to Corrado et al. (2009), have risen faster than other components of intangible capital, the 25-40% estimate can be interpreted as a lower bound for the true impact of the secular increase in corporate intangible assets on bank commercial lending.

Next, we examine the effects of a rise in corporate intangible capital on other bank balance sheet components. The results in columns 5 and 6 of Table 2 demonstrate that an increase in local intangible capital has no effect on bank total assets but is associated with higher growth in bank non-C&I assets. These findings are consistent with hypothesis 2 of Section 2, according to which banks that face capital and lending constraints respond to fewer commercial lending opportunities not by shrinking but by reallocating their lending capacity to other assets.

The estimated coefficients on the macroeconomic controls have expected signs. Banks' total assets grow faster in response to better local economic conditions, as measured by faster house price, per capita income, population, and firm sales growth; and firm market-to-book ratio. Controlling for bank total asset growth, C&I loans respond more to house price and income growth, whereas non-C&I assets respond more to population growth and firm market-to-book ratio. In Appendix

Table A4 we show that both C&I loan growth and non-C&I asset growth respond positively to all macroeconomic controls when not scaled by bank balance sheet growth. In addition, C&I loans grow slower in larger banks, which might be less well suited for information-sensitive lending (Berger et al., 2005), but faster in better-capitalized banks, which might have superior risk-bearing capacity.

We perform a range of robustness tests to verify that the baseline results in columns 4-6 of Table 2 are robust to alternative specifications and refinements. These results are reported in the Appendix. First, we show that our main findings are robust to the inclusion of bank fixed effects and MSA fixed effects (Table A5). This is a very demanding test as our baseline specification from Equation 2 is estimated in growth rates and thus removes time-invariant bank and MSA heterogeneity. Adding bank or MSA fixed effects removes any residual differences in growth rates between banks or MSAs. Next, in Table A6 we show that our results are robust to alternative clustering on bank and year (columns 1-3), MSA (columns 4-6), and MSA and year (columns 7-9). Under all alternative clustering approaches, the coefficient on intangible capital growth maintains levels of statistical significance that are similar to the baseline results.

4.3 Results using Banks' Geographical Footprint

In the baseline analysis, we defined a bank's area of operations as its headquarters MSA and used corporate intangible capital growth in *that* MSA as the key explanatory variable. This approach assumes that banks are significantly exposed to loan demand from firms in their headquarters MSA. However, after the removal of geographical restrictions on inter- and intra-state banking activities and consequent bank consolidation, our MSA-based baseline measure of corporate intangible capital may become less precise. To address this possibility, in this section we check the robustness of our results to measuring a bank's exposure to corporate intangible capital based on that bank's entire geographical footprint. We capture the bank's area of operations from the geographical distribution of its mortgage lending (from HMDA) or deposits (from the FDIC Summary of Deposits). The resulting alternative measures of corporate intangible capital growth are given by:

$$IK_{it} = \sum_{j \in J} [l_{ijt} IK_{jt}] \tag{3}$$

where i indexes banks, j indexes MSAs in which bank i operates, and t indexes years. The first term in brackets is MSA j's share in a bank's total mortgage lending (by the number of applications or by the volume of applications) or deposit taking (by volume) in year t. The second term is the MSA-level corporate intangible capital growth computed as in Section 3.1. The resulting measure is at the bank level, reflecting the spatial distributions of banks' activities. Thus, it can vary even across banks with headquarters in the same MSA.[13]

Table 4 reports the results. Across all alternative measures of corporate intangible capital, the results are similar to the baseline analysis (Table 2) as relates to both statistical and economic significance. These findings suggest that the headquarters-based baseline measure of a bank's area of operations captures well that bank's exposure to the rise in corporate intangible capital.

4.4 Results from Syndicated Loan Data

The purpose of this section is to confirm our insights from bank-level analysis on the link between corporate intangible capital and banks' commercial lending with loan-level data. We use DealScan data on large corporate loans, most of which are syndicated. Syndicated loans represent a sizeable segment of the C&I loan market and mainly involve large banks and firms. Given that we observe individual loans, we can identify each bank's actual borrowers and we can measure their level of intangible assets directly at the firm level. Consequently, the analysis no longer hinges on the geographical matching of banks and firms on MSA, providing a useful robustness check. One limitation of the DealScan data is that the syndicated loan market primarily involves large banks and firms and only captures the intensive margin of lending adjustment. Thus, the baseline bank-level and the loan-level analyses in this Section are complementary and together provide a comprehensive test of our hypotheses in two different data environments.

[13] Given that both HMDA and FDIC Summary of Deposits data start in the mid-1990s, we backfill the data to the beginning of our sample (1984) using the earliest available year in each dataset.

DealScan data afford us several additional advantages. First, the data allow us to control for C&I loan demand and other unobservables, at a granular level, with a wide range of fixed effects. Second, we are able to analyze loan prices in addition to loan volumes. Third, we have the opportunity to replicate our key findings in an independent loan-level dataset that is completely different from regulatory filings on banks' aggregate lending activities.

We estimate a specification that links loan terms—loan volume and pricing—to firm-specific intangible capital. We use the Falato et al. (2013) firm-level measure of intangible capital constructed from past investments in intangible assets, using firm accounting data from Compustat starting in 1970. Firm-level intangible capital is computed, for each firm-year, as the sum of capital accumulated through three types of intangible investments: knowledge capital, organizational capital, and informational capital. In the cross-section of firms, intangible capital is on average 36%, which is greater than the average of 13.8% for our BEA corporate IK measure for two main reasons: it includes estimates of organizational capital and is based on large publicly-listed firms with access to the syndicated loan market. Both the firm-level measure and the MSA-level measure of corporate intangible capital exhibit similar aggregate upward trends over the sample period.

The results are reported in Table 5 for two dependent variables: log-transformed loan volume and average loan spread (in basis points). In addition to the usual bank-level controls, we add standard firm-level determinants of firm borrowing, including firm size, growth opportunities (market-to-book ratio), profitability (ROA), cash ratio, and collateral (PP&E ratio). We also control for local economic conditions in the bank headquarters MSA with interacted bank MSA×year fixed effects. Furthermore, in the spirit of Khwaja and Mian (2008), we control for loan demand by alternately including: (i) firm industry and Standard & Poor's (S&P) credit rating category fixed effects, which capture time-invariant loan demand; and (ii) interacted firm industry×credit rating category×year fixed effects, which capture time-varying loan demand.[14,15]

[14] There are 23 S&P credit rating categories (including a category for unrated firms) and 503 4-digit SIC industry categories in the regression sample.

[15] Similar to previous studies (such as Acharya et al. (2016); De Haas and Van Horen (2012)), we control for loan demand with fixed effects for relatively homogenous clusters of firms as opposed to individual firms. In our context, this approach is necessary because our regressor of interest, firm-level intangible capital, varies at the firm-year level. Therefore, estimation of its impact would be infeasible with firm×year fixed effects as in the original Khwaja and Mian (2008) estimator.

As shown in Table 5, corporate intangible capital is negatively related to loan volumes and positively related to loan spreads. Firms with more intangible assets receive smaller and more expensive bank loans. One standard deviation increase in firm-level intangible capital (63.9%) is associated with loan volumes that are smaller by close to 10% (columns 2-3) and loan spreads that are higher by almost 5 basis points, which corresponds to 4% of sample mean loan spreads (columns 5-6). These results confirm our hypothesized relationship between corporate intangible capital and credit intermediation frictions in bank commercial lending in a dataset with a different data structure from our baseline analysis and for a segment of the credit market where borrowers tend to be large firms, with lower monitoring and screening requirements than small local firms.

5 Identification

Our results so far show that there is a statistically significant and economically meaningful negative relation between local corporate intangible capital and commercial loans. Further, banks offset lower commercial lending by expanding the rest of their balance sheet. In interpreting these findings as evidence of bank lending frictions induced by corporate intangible capital, we face two identification concerns.

The first potential concern is reverse causality. Intangible capital growth in local firms may depend on local bank balance sheet conditions and the banks' supply of commercial loans. Our baseline analysis addresses this concern by calculating local intangible capital growth using *lagged* local industry composition and *national* industry-level corporate intangible capital growth rates. This approach makes our baseline measure of MSA-level corporate intangible capital robust to potential concerns about reverse causality from local economic conditions. In Section 5.1, we show that our results are insensitive to the degree to which local industry employment shares are lagged in the construction of MSA-level corporate intangible capital, including to using employment shares from 1975.

The second concern is about omitted variables related to the demand for bank non-C&I loans. In particular, firms' investment in intangible assets may directly affect the demand for bank non-C&I loans. For example, intangible capital-intensive firms may attract better paid employees, who in turn drive up mortgage demand. We refer to these potential effects as the "local demand channel." In the baseline specifications, we control for local demand effects with macroeconomic variables such as income growth, employment growth, and house price growth within the MSA. However, these controls may not fully capture the demand for non-C&I loans, leaving open the possibility that residual loan demand is correlated with corporate intangible capital. In Section 5.2 we fully control for local loan demand conditions using more granular data and specifications with borrower MSA×year fixed effects, and verify that the effects of corporate intangible capital growth on bank lending are consistent with frictions in bank commercial lending but not with higher demand for bank non-C&I loans.

5.1 Reverse Causality

Our first identification concern stems from the possibility that local firms' investments in intangible assets depend on the availability of commercial loans from local banks. Consider banks that choose to reduce their commercial lending for some exogenous reason. This may induce firms to invest more in intangible assets because they are less external-finance dependent. Such reverse causality would imply a negative relation between bank commercial lending and corporate intangible capital, but for reasons that are different from our hypothesized mechanism. At the same time, if banks primarily reduce *unsecured* commercial lending, firms may disproportionately reduce their intangible capital investments that rely on such lending. In this case, there will be a positive association between bank commercial lending and corporate intangible capital, which would work against us finding significant results.

Our baseline measure of corporate intangible capital uses local (MSA-level) industry employment shares that are lagged 3 years to alleviate reverse causality concerns. Here we examine whether our main results hold for measures of MSA-level corporate intangible capital growth that use alternative lags of industry employment shares. Specifically, we construct the measures of intangible capital as in Equation 1, but using shorter (1 year) or deeper (5 and 10 years) lags of employment shares. We also construct a measure of intangible capital using employment shares from 1975, the first year for which employment data is available from the BLS. As the latter measure is based on employment shares fixed at their values 10 years prior to the start of our sample period, we view the results using 1975 shares as best suited to address reverse causality concerns.

Table 3 reports the results. For all lags, the effects of corporate intangible capital growth on bank lending are very close to the baseline results reported in Table 2 in terms of both statistical and economic significance. If anything, the point estimates for the shorter (1 year) lag are somewhat smaller than in the baseline specifications, suggesting that reverse causality from banks' commercial lending to intangible capital growth, which should be more pronounced for shorter lags, works against our results by attenuating the coefficient on intangible capital growth. For all the deeper lags considered, the point estimates are very close to those in the baseline. These results are not entirely surprising since given that the geography of industry composition is highly persistent (Autor and Dorn, 2013). We conclude that the baseline 3-year industry employment share lags are well suited to address reverse causality concerns.

5.2 Controlling for Loan Demand

Our results so far showed that banks in areas with high corporate intangible capital growth experience a slowdown in their C&I lending and a shift of their balance sheet capacity toward non-C&I assets. In Section 2 we argued this reallocation was due to frictions in bank lending to intangible capital-intensive firms. Previously we showed that the results were robust to potential concerns about reverse causality. The remaining identification challenge is to rule out an alternative explanation, a "local demand channel," by which increased investment in intangible capital by local firms generates stronger local economic conditions that can drive up demand for banks' non-C&I loans, causing a similar bank balance sheet reallocation. The MSA-level controls we included in the baseline analysis may not entirely capture local economic conditions, in which case we cannot rule out that unobserved macroeconomic factors confound our results.

To address this concern, we use mortgage-level data from HMDA and estimate specifications in which we can control for local economic conditions (including loan demand) directly using interacted borrower MSA$\times$year fixed effects (as in Khwaja and Mian (2008)). This section discusses our identification strategy and presents the resulting estimates.

5.2.1 Empirical Strategy

The crux of our identification strategy is as follows. In HMDA data, we observe each bank's entire portfolio of mortgage originations across all the MSAs where the bank operates. Multiple banks extend mortgages in each MSA. These banks can be exposed to heterogenous corporate intangible capital growth rates, for example because their headquarters are in different MSAs or they have a different geographical footprint of their operations. Therefore, we can examine variation in mortgage lending by different banks to the same MSA while controlling the "local demand channel" with MSA×year fixed effects, in the spirit of Khwaja and Mian (2008). Our empirical specification is:

$$Y_{ijt} = \alpha_{jt} + \beta_1 IK_{it-1} + \beta_2 X_{it-1} + \beta_3 Z_{it-1} + \beta_4 L_{ijt} + \epsilon_{ijt}, \tag{4}$$

where banks are indexed by i, MSAs where the mortgage is originated by j, and years by t. Y_{ijt} are two dependent variables: the change in the log volume of mortgage lending and the change in the mortgage acceptance rate. IK_{it-1} is the growth rate of intangible capital to which bank i is exposed (i.e., in the bank's headquarters MSA in the baseline). X_{it-1} are the controls for macroeconomic conditions in the same MSA where intangible capital is measured (house prices, per capita income, etc.). Z_{it-1} are other bank-level controls: bank size, bank equity, and total balance sheet growth. We use one-year lagged bank-level intangible capital growth and other macroeconomic variables to allow for a delay in the bank's mortgage lending response. Further, L_{ijt} are controls for changes in bank i's mortgage applicant pool in MSA j, i.e., changes in applicants' average income and loan-to-income ratios, the share of female and minority loan applicants, and the average income and the share of minority applicants in the census tract of the property. These control variables follow Loutskina and Strahan (2009), with the interpretation that some changes in a bank's mortgage lending can be attributed to changes in that bank's mortgage applicant pool.

The coefficient of interest, β_1, represents the effect of bank-level intangible capital growth on the bank's mortgage lending to a given MSA relative to other banks that lend to the same MSA (and in the same year). Banks that lend to borrowers in the same MSA are affected by heterogeneous changes in intangible capital coming from their headquarters MSAs or the geographical footprint of their operations. Our hypothesis is that higher corporate intangible capital causes frictions in banks' commercial lending, leaving banks that are exposed to corporate intangible capital growth with spare lending capacity that they reallocate to mortgage lending. Therefore, we expect $\beta_1 > 0$. If the alternative local demand channel is correct, and higher corporate intangible assets drive up local demand for banks' non-C&I loans, then banks facing a rise in corporate intangible capital should have less spare lending capacity. Therefore, the alternative demand channel predicts $\beta_1 < 0$.

A crucial ingredient to the specification are the interacted borrower MSA×year fixed effects α_{jt}. These fixed effects allow us to exploit cross-sectional variation in the corporate intangible capital growth rates facing different banks that lend *to the same MSA and in the same year*, thus controlling for any unobserved time-varying heterogeneity in loan demand within an MSA. This approach addresses the potential concern that local intangible capital affects bank loan demand though channels that are not fully captured by our baseline macroeconomic controls and which could confound our baseline findings.

5.2.2 Reallocation to Mortgage Lending

Table 6 shows the results for the effects of corporate intangible capital on banks' mortgage lending. The main explanatory variable is growth in corporate intangible capital in bank headquarters MSA, consistent with the baseline specification of Table 2. In columns 1-3 the dependent variable is the growth rate of banks' mortgage loan volume in a given MSA; in columns 4-6 it is the change in the mortgage acceptance rate. For each dependent variable, we first show the results with no controls (columns 1 and 4) and then with controls (columns 2 and 5). In columns 3 and 6 we drop loans extended by the bank to borrowers in its headquarters MSA to examine the bank's mortgage loan supply response to changes in corporate intangible capital in MSAs other than the headquarters MSA.

The results are consistent across specifications. Higher growth rates of corporate intangible capital induce banks to expand their mortgage lending, including in locations other than the banks' headquarters MSA. The coefficient estimates are also economically meaningful. The estimates in columns 3 and 6 indicate that a one standard deviation increase in corporate intangible capital growth is associated with an expansion of bank mortgage loan volume by close to 36% (almost half of the standard deviation of mortgage loan growth) and an increase in the mortgage acceptance rate by 2.7 percentage points (or about one-fifth of the standard deviation) in non-headquarters MSAs.

These results suggest that local demand for non-C&I loans does not drive the link between corporate intangible capital and banks' commercial lending. An expansion of mortgage lending following a rise in corporate intangible capital is consistent with our hypothesis that banks which are exposed to an increase in corporate intangible capital obtain spare lending capacity which they reallocate to real estate lending, and is inconsistent with the alternative "local demand channel."

Interestingly, most control variables for macroeconomic conditions in a bank's headquarters MSA have coefficients that are statistically insignificant or have inconsistent signs. This result suggests that it is corporate intangible capital rather than concurrent local macro factors that affect mortgage lending. In fact, firm sales growth and per capita income growth are negatively correlated with mortgage loan growth, which is inconsistent with corporate intangible capital affecting non-C&I loan demand through more vibrant local economic conditions.[16]

In Table 7 we report results for the same specification using geographical-footprint-based (rather than headquarters MSA-based) measures of bank exposure to corporate intangible capital. The footprint measures, based on the spatial distribution of bank mortgage-lending or deposit-taking activities, are identical to those in Table 4. These footprint-based corporate intangible capital measures may be particularly relevant in the HMDA analysis because HMDA data starts in 1995 and hence cover the post-deregulation period when U.S. banks were already geographically diversified. Across all specifications and bank-level measures of corporate intangible capital, the results are consistent with those in the baseline analysis.

Overall, the results in this section support the notion of bank balance sheet reallocation to the collateral-rich real estate sector as a result of intermediation frictions due to rising corporate

[16]Control variables for changes in the attributes of mortgage applicants have broadly anticipated signs. Greater applicant income increases loan volumes and acceptance rates. Higher loan-to-income ratios capture demand for larger loans (given that borrower income is already controlled for) and are associated with increased loan volumes. Female and minority applicants have lower mortgage loan acceptance rates. Loans in more affluent neighborhoods have higher acceptance rates and are larger. Loans in minority neighborhoods are larger as well, possibly related to incentives provided by the Community Reinvestment Act.

intangible assets.

5.3 Effects on Real Estate Loan Profitability

In the previous section, we presented results supporting the idea that rising intangible corporate assets generate spare bank balance sheet capacity, which banks use to expand their mortgage lending. Here we return to the U.S. Call Reports, our baseline dataset, to examine whether banks' reallocation to real estate in response to firms' investments in intangible assets is also borne out in the bank balance sheet data.

In Table 8, we use a specification similar to that of the baseline Table 2, focusing on the components of bank non-C&I assets as dependent variables. The estimates indicate that higher local corporate intangible capital is positively related to banks' real estate lending (column 1), especially residential real estate lending (column 2). The effect on commercial real estate lending is statistically insignificant (column 3), suggesting that firms with intangible assets face impediments to substituting commercial real estate for the lacking collateral. In Appendix Table A4 we show that the same results hold without controlling for bank total asset growth.

Finally, the estimates in column 4 show that higher growth rate in corporate intangible capital in the MSA of a bank's headquarters is associated with lower real estate loan profitability (calculated as the interest and fee income on real estate loans divided by real estate loans). This finding is consistent with hypothesis 2 of Section 2, by which banks that experience commercial lending frictions start to lend to more marginal real estate loan borrowers. This finding is again inconsistent with the "local demand channel," by which corporate intangible capital generates higher demand for real estate loans, as this mechanism would have *increased* the profitability of real estate lending.

6 Conclusions

Over the past few decades, U.S. firms have dramatically increased their investment in intangible assets (Corrado et al., 2009; Corrado and Hulten, 2010). The macroeconomics literature has documented the impact of corporate intangible capital on GDP, labor productivity, and the labor share.

The corporate finance literature has highlighted its effects on corporate savings. Yet, little is known about the effect of intangible capital on financial intermediation. In this paper, we examine the impact of the rise in corporate intangible assets on the portfolio allocations of U.S. banks.

We start from the observation that the long-run increase in intangible assets coincides with a secular decline in the share of commercial loans in bank portfolios. We argue that the two trends are closely linked through a collateral channel. Intangible assets have lower collateral value than tangible assets, increasing frictions in corporate borrowing that lead to fewer commercial lending opportunities for banks. We hypothesize that a rise in intangible assets in the real sector reduces the growth rate of commercial lending by banks and induces them to reallocate funds to other assets, such as real estate loans.

To establish a link between corporate intangible capital and bank lending, we exploit the local nature of banking and examine how bank portfolios change when firms that constitute their local borrowing base invest more in intangible assets. Using a comprehensive panel dataset for 7,800 commercial banks from the U.S. Call Reports over 1984-2008, we find strong and robust evidence that exposure to corporate intangible capital induces banks to reduce their commercial lending and reallocate toward other assets, particularly real estate loans. The results are confirmed in specifications controlling for reverse causality and local macroeconomic factors. Further, they hold in loan-level data from the syndicated loan market (DealScan) and in mortgage-level data (HMDA).

Overall, the empirical evidence provided in our paper suggests that the long-run change in the composition of the U.S. capital stock toward intangible capital has a quantitatively large effect on financial intermediary balance sheets. The results have important implications. Our evidence from mortgage-level data shows that the increase in the share of intangible capital in production generates supply-side pressures in real estate lending by constraining banks' commercial lending opportunities, consistent with Shin (2012)'s "banking glut" argument. These findings shed light on possible reasons for a supply-driven boom in real estate lending in the run-up to the 2007-2008 financial crisis. At the macroeconomic level, greater financial intermediation frictions stemming from rising intangibles might lead to an increase in banks' demand for safe assets. In this context, our findings may provide a complementary explanation to the secular decline in safe yields that is at the center of the debate on secular stagnation (Summers, 2015).

Our results also contribute to the large literature on the bank lending channel of monetary policy (Kashyap and Stein, 2000; Kishan and Opiela, 2000) as they suggest that the growing importance of intangible capital investments might make firms less bank-dependent. This implies that the economy-wide trend towards greater use of corporate intangible assets would make bank balance sheet conditions less important for the real sector. At the same time, given that banks exposed to corporate intangible assets reallocate their lending capacity from commercial loans to non-C&I assets, bank balance sheet conditions may might become increasingly important for mortgage markets. Consequently, the bank lending channel of monetary policy may become weaker for corporate investment but stronger for household credit.

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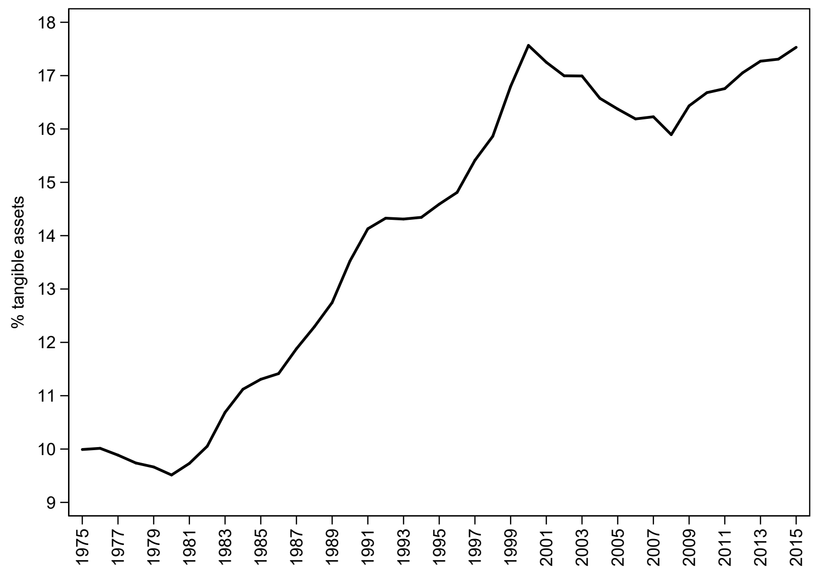
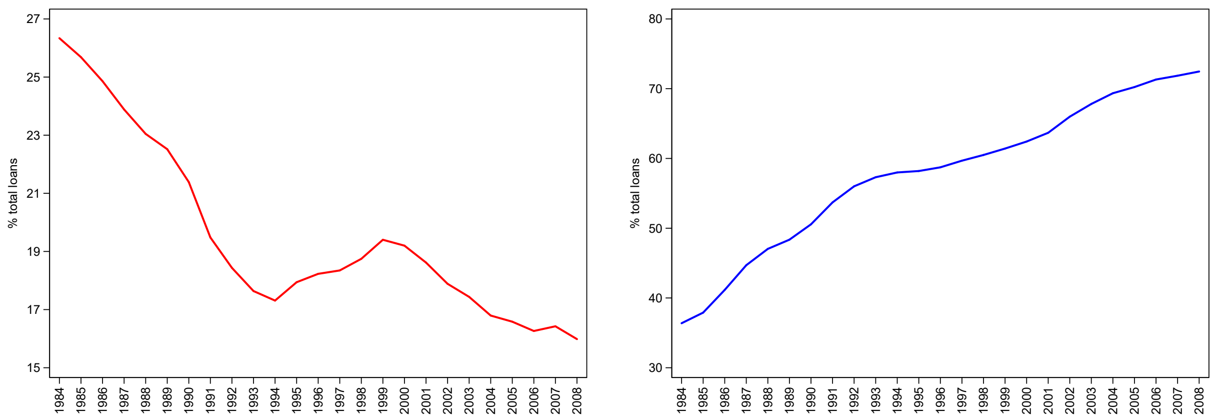
Figures and Tables

Figure 1: Corporate Intangible Capital, 1975-2015



Notes: Notes: The figure depicts the long-run trend in the aggregate corporate intangible capital ratio. The aggregate intangible capital ratio is computed as the weighted average of industry-level ratios of intangible capital to tangible capital, with weights given by each industry's share in total U.S. employment. Industries are defined at the NAICS-3 level, and the sample period is 1975-2015. Data sources: BEA, BLS.

Figure 2: Bank Lending Trends, 1984-2008

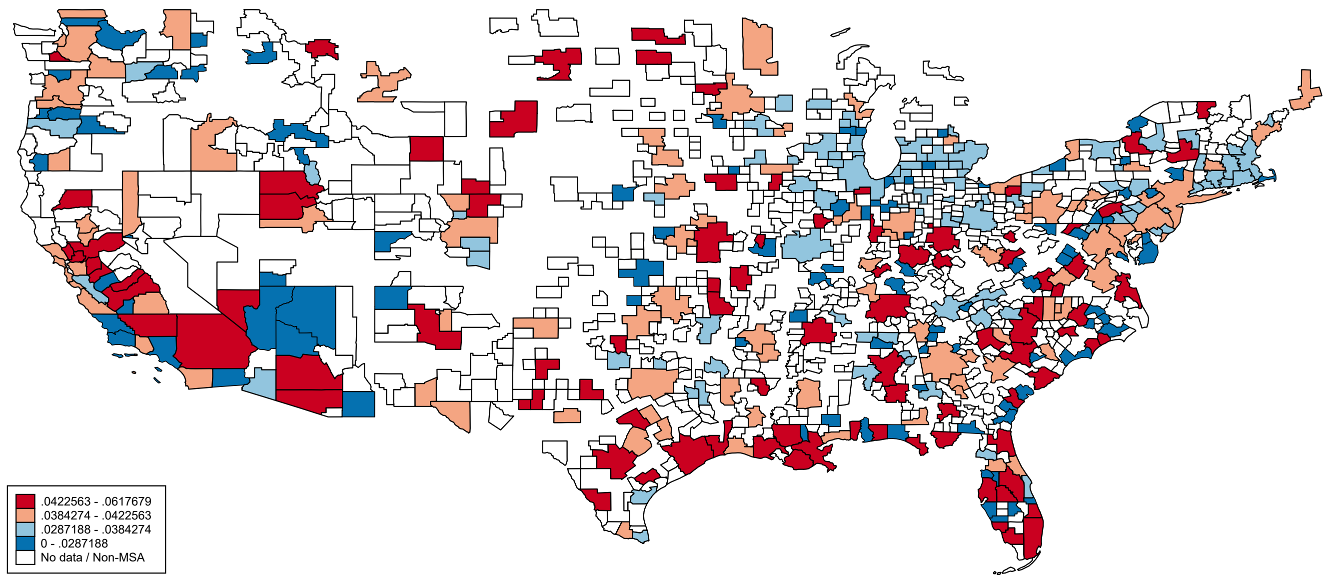


(a) Bank commercial & industrial loans

(b) Bank real estate loans

Notes: The figure depicts the average share of C&I loans in total loans (Panel A) and the average share of real estate loans in total loans (Panel B) across U.S. commercial banks in our sample over 1984-2008. *Data sources*: U.S. Call Reports.

Figure 3: Corporate Intangible Capital Growth across U.S. MSAs, 1984-2008



Notes: The map depicts average growth rates of corporate intangible capital at the MSA level over 1984-2008 . *Data sources*: BEA, BLS.

Table 1: Descriptive statistics for selected regression variables

	Obs.	Mean	St. Dev.	p25	Median	p75
A. Main variables						
IK level	78986	13.81%	5.73%	10.66%	13.10%	16.54%
IK growth	78986	4.45%	4.26%	1.55%	4.82%	7.91%
C&I loan - growth	72060	6.41%	23.94%	-9.79%	3.64%	19.19%
Non C&I asset - growth	77035	5.73%	9.45%	-1.04%	4.13%	10.94%
Bank asset - growth	78986	5.45%	9.05%	-0.94%	3.89%	10.23%
Real estate loan - growth	74063	10.03%	15.99%	-0.87%	7.49%	18.20%
Real estate loan profitability - growth	48475	-6.01%	7.01%	-10.26%	-7.63%	-2.81%
Bank size (log-assets)	78986	17.96	1.21	17.11	17.83	18.64
Bank capital	78986	13.71%	6.79%	9.35%	12.45%	16.31%
HP growth	78986	3.98%	5.16%	1.96%	3.93%	5.85%
Pc income growth	78986	4.67%	2.50%	3.26%	4.65%	6.05%
Population growth	78986	1.44%	1.31%	0.67%	1.25%	2.02%
Firms' sales growth	78986	11.87%	14.60%	4.96%	11.51%	17.61%
Firms' market-to-book	77450	1.83	0.59	1.48	1.76	2.10
B. HMDA variables						
Log(lending volume)	53723	8.58	1.63	7.47	8.53	9.65
Acceptance rate	53874	0.82	0.18	0.75	0.87	0.94
Δ log(lending volume)	53273	0.21	0.86	-0.26	0.13	0.57
Δ acceptance rate	53874	0.00	0.13	-0.05	0.00	0.04
C. DealScan variables						
Log(1+loan volume)	11241	7.61	1.16	7.13	7.67	8.19
Loan spread (bps)	10551	126.63	96.04	50.00	101.32	175.00

Notes: The table presents descriptive statistics for selected regression variables. Growth rates of bank-level variables are winsorized and trimmed at 5% of the distribution. The variable "IK level" refers to the MSA-level intangible capital ratio using employment shares lagged at $t-3$ (see Section 3 for details.) IK growth is winsorized at 1% of the MSA-level distribution. Firms' sales growth and market-to-book ratio (original variables are winsorized at the 5% of the distribution) are computed at the MSA level as unweighted averages across the firms headquartered in each MSA. The units of observation and sample period are 1) bank-year and 1984-2008 for variables in the main regression analysis (Panel A), 2) bank-borrower MSA-year and 1995-2008 for mortgage lending analysis (Panel B), and 3) bank-firm-year over 1990-2008 for syndicated lending analysis (Panel C). See Appendix Table A2 for additional descriptive statistics. *Data sources*: See Data Appendices for details and Appendix Table A1 for variable definitions and sources.

Table 2: Corporate intangible capital and bank portfolio allocations—Baseline

	C&I loans (1)	C&I loans (2)	C&I loans (3)	C&I loans (4)	Bank assets (5)	Non C&I assets (6)
IK growth	-0.3179***	-0.2533***	-0.1770**	-0.2073***	0.0437	0.0467***
	(0.022)	(0.026)	(0.072)	(0.068)	(0.030)	(0.012)
HP growth		0.2386***	0.2698***	0.1476***	0.1827***	-0.0236***
		(0.019)	(0.022)	(0.022)	(0.009)	(0.004)
Pc income growth		0.2828***	0.1931***	0.1037**	0.1298***	-0.0351***
		(0.038)	(0.046)	(0.044)	(0.016)	(0.009)
Population growth		0.7103***	0.5701***	0.0513	0.7848***	0.0288**
		(0.077)	(0.077)	(0.071)	(0.041)	(0.013)
Firm sales growth		0.0477***	0.0025	-0.0013	0.0066**	-0.0011
		(0.007)	(0.006)	(0.006)	(0.003)	(0.001)
Firm market-to-book		0.0010	0.0011	-0.0037**	0.0072***	0.0009***
		(0.002)	(0.002)	(0.002)	(0.001)	(0.000)
Bank size		-0.0037***	-0.0040***	-0.0042***	0.0003	0.0002
		(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Bank capital		0.1326***	0.0792***	0.0725***	0.0327***	-0.0320***
		(0.021)	(0.024)	(0.022)	(0.010)	(0.004)
Bank asset growth				0.6599***		0.9721***
				(0.011)		(0.002)
Observations	71,916	70,477	70,477	70,477	77,450	75,443
R-squared	0.003	0.012	0.027	0.082	0.078	0.812
Year FE	No	No	Yes	Yes	Yes	Yes

Notes: The dependent variables are bank-level C&I loan growth (columns 1-4), total asset growth (column 5), and the growth rate of assets other than C&I loans (column 6). Macro controls include house price growth, per capita income growth, population growth, firm sales growth, and firm market-to-book ratio. Bank controls include bank size, capital, and, in Columns (4) and (6), total bank asset growth. Corporate IK growth and macro controls correspond to the MSA of the banks headquarters. Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 3: Corporate intangible capital and bank portfolio allocations—Alternative lags

	C&I loans (1)	Bank assets (2)	Non C&I assets (3)
	IK: employment shares at (t-1)		
IK growth	-0.1319**	0.0053	0.0279***
	(0.063)	(0.026)	(0.010)
Observations	70,477	77,450	75,443
R-squared	0.082	0.078	0.812
	IK: employment shares at (t-5)		
IK growth	-0.2128***	0.0464	0.0394***
	(0.070)	(0.032)	(0.012)
Observations	70,477	77,450	75,443
R-squared	0.082	0.078	0.812
	IK: employment shares at (t-10)		
IK growth	-0.2578***	-0.0390	0.0494***
	(0.070)	(0.032)	(0.011)
Observations	70,477	77,450	75,443
R-squared	0.082	0.078	0.812
	IK: employment shares in 1975		
IK growth	-0.2082***	-0.0414	0.0341***
	(0.063)	(0.032)	(0.010)
Observations	70,477	77,450	75,443
R-squared	0.082	0.078	0.812
Macro controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: The table reports coefficient estimates for corporate IK growth from regressions using the baseline specification in column 4 of Table 2. The dependent variables are bank-level C&I loan growth, total asset growth, and the growth rate of assets other than C&I loans. Panel headings indicate the lag structure for employment shares used in constructing corporate IK growth. Macro controls and bank controls are defined as in Table 2 and are included in all specifications (coefficients not shown). Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 4: Corporate intangible capital and bank portfolio allocations—IK measures based on banks' geographical presence

	C&I loans (1)	Bank assets (2)	Non C&I assets (3)
	IK: weighted by volume of mortgage applications		
IK growth	-0.2897***	0.0461	0.0444***
	(0.098)	(0.044)	(0.017)
Observations	37,367	40,030	39,317
R-squared	0.084	0.069	0.845
	IK: weighted by number of mortgage applications		
IK growth	-0.2128***	0.0464	0.0394***
	(0.070)	(0.032)	(0.012)
Observations	37,367	40,030	39,317
R-squared	0.084	0.069	0.845
	IK: weighted by deposits		
IK growth	-0.2578***	-0.0390	0.0494***
	(0.070)	(0.032)	(0.011)
Observations	63,401	69,218	67,715
R-squared	0.081	0.075	0.830
Macro controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: The table reports coefficient estimates for corporate IK growth from regressions using the baseline specification in column 4 of Table 2. The dependent variables are bank-level C&I loan growth, total asset growth, and the growth rate of assets other than C&I loans. Unlike in the baseline analysis, here the corporate IK growth variable is constructed at the bank level using the bank's geographical presence across MSAs and years. We measure the bank's geographical presence using the volume and number of mortgage applications received by the bank (top and middle panels) and the bank's distribution of deposits (bottom panel). Macro controls are also constructed at the bank level using the same approach as for corporate IK growth. Macro controls and bank-level controls are included in all specifications (coefficients not shown). Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 5: Corporate intangible capital and loan terms—Evidence from bank-firm data

	Log(loan volume)			Loan spread		
	(1)	(2)	(3)	(4)	(5)	(6)
Firm-level IK	-0.1808***	-0.1496***	-0.1460***	14.1367***	7.7116***	6.5852***
	(0.026)	(0.020)	(0.033)	(2.353)	(1.945)	(1.888)
Bank size		0.0382	-0.1912		-31.2371**	12.5807
		(0.207)	(0.239)		(15.122)	(17.019)
Bank capital		-0.1911	-7.4801***		-146.0456	349.4239
		(1.282)	(2.807)		(135.743)	(220.062)
Bank asset growth		0.2462	0.6251*		38.0683	43.3664*
		(0.380)	(0.375)		(26.254)	(22.759)
Firm size (Large firm)		0.2892***	0.4034***		-45.5413***	-59.2494***
		(0.031)	(0.052)		(2.647)	(6.068)
Firm market-to-book		0.0303**	0.0639**		-5.8134***	-7.2409**
		(0.012)	(0.028)		(1.187)	(2.820)
Firm ROA		0.3773***	0.6463**		-160.4714***	-164.3408***
		(0.129)	(0.270)		(20.094)	(30.711)
Firm cash ratio		-0.2213	0.0241		-15.5463	-36.0964
		(0.144)	(0.288)		(11.455)	(25.752)
Firm PP&E ratio		-0.1211	0.1161		-21.5129**	-27.2062
		(0.077)	(0.175)		(8.428)	(22.744)
Observations	11,370	11,370	8,629	10,617	10,617	8,020
R-squared	0.335	0.343	0.661	0.513	0.564	0.824
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank MSA×Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm industry FE	Yes	Yes		Yes	Yes	
Firm rating category FE	Yes	Yes		Yes	Yes	
Industry×Rating category×Year FE			Yes			Yes

Notes: The dependent variables are log(loan amount) (columns 1-3) and loan spreads in basis points (columns 4-6). The data is at the bank-firm-year level and is constructed from loan-level information on large syndicated loans (from DealScan). For firms with multiple borrowing relationships in a given year we take the average loan amount and the average loan spread across the loans in that year, weighted by loan size. The sample period is 1990-2008. All bank-level controls are defined as in the baseline regressions (see Table 2). Macro controls (at the bank's MSA level) are absorbed by bank MSA× year FE. Firm-level corporate IK is constructed following Falato et al. (2013). Firm industry refers to SIC-4 digit industries. Firm rating category refers to 23 S&P firm rating categories (including unrated category). Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 6: Corporate intangible capital and bank portfolio allocations—Reallocation to real estate

	Δ log(lending volume)			Δ acceptance rate		
	All obs.	All obs.	Outside HQ MSA	All obs.	All obs.	Outside HQ MSA
	(1)	(2)	(3)	(4)	(5)	(6)
IK growth	7.0477**	6.8266**	8.4258**	0.4645***	0.5102***	0.6477***
	(3.5778)	(3.2104)	(3.6148)	(0.1353)	(0.1768)	(0.2202)
HP growth		0.0820*	0.0712		-0.0177	-0.0236
		(0.0496)	(0.0619)		(0.0142)	(0.0162)
Pc income growth		-0.2459	-0.3071		0.0183	0.0179
		(0.1779)	(0.2088)		(0.0294)	(0.0334)
Population growth		0.0225	0.2067		0.0168	0.0329
		(0.5581)	(0.6261)		(0.0772)	(0.0847)
Firm sales growth		-0.0062**	-0.0090***		-0.0003	-0.0004
		(0.0029)	(0.0030)		(0.0004)	(0.0004)
Firm market-to-book		-0.0272	-0.0318		-0.0011	-0.0021
		(0.0265)	(0.0337)		(0.0033)	(0.0040)
Bank size		0.0352**	0.0277		0.0006	0.0028
		(0.0140)	(0.0213)		(0.0034)	(0.0055)
Bank capital		-0.4572*	-0.8620**		-0.0287	-0.0553
		(0.2571)	(0.3537)		(0.0293)	(0.0468)
Bank asset growth		1.1746***	1.4101***		0.0753**	0.1109**
		(0.1614)	(0.2506)		(0.0307)	(0.0462)
Δ applicants' loan-to-income ratio		0.0524***	0.1336***		-0.0001	0.0016
		(0.0189)	(0.0319)		(0.0008)	(0.0023)
Δ applicants' log income		0.3808***	0.3732***		0.0586***	0.0590***
		(0.0399)	(0.0439)		(0.0057)	(0.0082)
Δ share of female applicants		-0.0710	-0.0200		-0.0346***	-0.0345***
		(0.0454)	(0.0561)		(0.0061)	(0.0070)
Δ share of minority applicants		-0.0705	-0.0115		-0.0933***	-0.0862***
		(0.0609)	(0.0733)		(0.0108)	(0.0125)
Δ share of minority residents		0.0047**	0.0061**		0.0003	0.0003
		(0.0020)	(0.0025)		(0.0003)	(0.0004)
Δ log(personal income)		0.5104***	0.5124***		0.0841***	0.1038***
		(0.1490)	(0.1743)		(0.0210)	(0.0262)
Observations	53,245	53,245	31,147	53,874	53,874	31,763
R-squared	0.1679	0.2036	0.2584	0.1175	0.1476	0.1954
Borrower MSA×Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are the growth rate in mortgage lending volume (change in log(lending volume)) (columns 1-3) and the change in the acceptance rate for mortgage applications (columns 4-6). The data is at the bank-borrower MSA-year level and is aggregated from loan-level data on individual mortgages (from HMDA). The sample period is 1995-2008. Corporate IK growth, macro controls, and bank controls are as in the baseline specification in column 4 of Table 2. Additional controls for the banks' pool of mortgage applicants in each MSA include Δ applicants' loan-to-income ratios and average income, Δ share of female, Δ share of minority loan applicants, Δ average income and Δ share of minority residents in the census tract of the property). Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 7: Corporate intangible capital and bank portfolio allocations—Reallocation to real estate

	Δ log(lending volume) (1)	Δ acceptance rate (2)
	IK: weighted by volume of mortgage applications	
IK growth	2.4746***	0.2249**
	(0.8089)	(0.0885)
Observations	68,817	69,553
R-squared	0.1799	0.1304
	IK: weighted by number of mortgage applications	
IK growth	2.3344***	0.1901**
	(0.7974)	(0.0940)
Observations	68,817	69,553
R-squared	0.1798	0.1300
	IK: weighted by deposits	
IK growth	2.3509#	0 .2338#
	(1.6728)	(0.1715)
Observations	68,109	68,823
R-squared	0.1821	0.1304
Macro controls	Yes	Yes
Bank controls	Yes	Yes
Loan pool controls	Yes	Yes
Borrower MSA×Year FE	Yes	Yes

Notes: The table reports coefficient estimates for corporate IK growth from regressions using the main specifications in columns 2 and 5 of Table 6. The dependent variables are the growth rate in mortgage lending volume (change in log(lending volume)) (column 1) and the change in the acceptance rate for mortgage applications (column 2). Unlike in the Table 6, here the corporate IK variable is constructed at the bank level using the bank's geographical presence across MSAs and years. We measure the bank's geographical presence using the volume and number of mortgage applications received by the bank (top and middle panels) and the bank's distribution of deposits (bottom panel). Macro controls (house price growth, per capital income growth, population growth, firm sales growth, and firm market-to-book ratio) are also constructed at the bank level using the same approach as for corporate IK. Macro controls, bank-level controls, and loan pool controls are included in all specifications (coefficients not shown). Standard errors are clustered on bank. # indicates statistical significance at the 20% level, *** at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table 8: Corporate intangible capital and bank portfolio allocations—Reallocation to real estate (by loan type) and real estate loan profitability

	Real estate loans	Residential RE loans	Commercial RE loans	RE loan profitability
	(1)	(2)	(3)	(4)
IK growth	0.1079**	0.1624***	0.0771	-0.0527*
	(0.044)	(0.056)	(0.070)	(0.027)
HP growth	0.3993***	0.3111***	0.4273***	0.0144*
	(0.015)	(0.019)	(0.022)	(0.008)
Pc income growth	0.1546***	0.0663*	0.2029***	0.0296**
	(0.029)	(0.038)	(0.044)	(0.014)
Population growth	0.4568***	0.5216***	0.2044***	-0.0757*
	(0.051)	(0.068)	(0.073)	(0.044)
Firm sales growth	-0.0018	-0.0118**	0.0055	-0.0059**
	(0.004)	(0.006)	(0.006)	(0.002)
Firm market-to-book	-0.0015	-0.0032**	0.0023	-0.0004
	(0.001)	(0.001)	(0.002)	(0.001)
Bank size	-0.0036***	-0.0044***	-0.0051***	0.0062***
	(0.000)	(0.001)	(0.001)	(0.000)
Bank capital	-0.0183	-0.0392**	-0.0406*	0.0210**
	(0.016)	(0.017)	(0.023)	(0.010)
Bank asset growth	0.7183***	0.5974***	0.7009***	-0.0003
	(0.008)	(0.010)	(0.011)	(0.005)
Observations	72,743	69,472	69,258	48,399
R-squared	0.202	0.107	0.101	0.244
Year FE	Yes	Yes	Yes	Yes

Notes: The dependent variables are bank balance sheet real estate loan growth (column 1), its components (residential real estate and commercial real estate loan growth) (columns 2-3), and real estate loan profitability growth (column 4). Data on real estate loan profitability are interpolated within bank when missing. All controls are as in Table 2. Corporate IK growth and macro controls correspond to the MSA of the banks headquarters. Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Appendix (not for publication) - "Bank lending in the knowledge economy"

This document contains data appendices with details on our data sources, merges, and transformations for the regression sample; and additional results.

A-I Data Appendix: Intangible Capital Data

Our main explanatory variable, growth in MSA-level corporate intangible capital, is constructed using two data sources: industry-level estimates of intangible capital from Bureau of Economic Analysis' (BEA) Fixed Assets data and MSA-level distribution of employment by industry from the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW).

Intangible assets are more difficult to measure than physical (tangible) assets such as property, plant, and equipment (PP&E). In general, the literature recognizes three types of investment as important for the accumulation of intangible capital: investment in knowledge capital, organizational capital, and informational capital (see, for example, Corrado et al. (2009)). In 2013, BEA revised the national income and product accounts (NIPAs) to explicitly recognize R&D spending as intangible capital to be included in estimates of fixed assets. Previously, R&D spending was treated as expenditures, similar to the way it is treated in companies' financial statements. The 2013 revision's measure of intangible capital, which includes software and capitalized private expenditures on R&D, entertainment, literary, and artistic originals, is estimated starting in 1947 and is available at the industry level. For R&D expenditures at the establishment level, BEA relies on NSF's R&D Survey administered by the U.S. Census. For our measure of industry-level corporate intangible capital, we take the ratio of intangible capital to tangible capital stock (equipment and structures) from BEA's revised Fixed Assets data.

For industry employment shares we use data from the BLS' QCEW over the 1984-2008 period. We use data at the 3-digit NAICS classification and MSA level. To map employment shares from QCEW to intangible capital from BEA, we use the BEA-provided crosswalk from the BEA industry definitions to 3-digit NAICS codes.

A-II Data Appendix: U.S. Call Reports

We construct our bank-year panel for the baseline analysis as follows. Bank financial information comes from the U.S. Call Reports (available for all the banks regulated by the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency) that are publicly available on the website of the Federal Reserve Bank of Chicago. The sample period in our baseline analysis (Sections 4.1-4.3) is 1984-2008. Starting our sample in 1984 ensures time-series consistency in regards to the definitions of several key variables, including total assets, C&I loans, and total equity (as discussed in Kashyap and Stein (2000) and Den Haan et al. (2002)). The data refer to non-consolidated accounts (that is, on an "individual bank basis") that reflect domestic operations and ignore banks' foreign activities.

Our sample is restricted to commercial banks (variable RSSD9331 takes value 1), that is, we drop state-chartered savings banks, federal savings banks, cooperative banks, industrial banks, and foreign banking organizations. Following Den Haan et al. (2002), we also limit the sample to insured banks (RSSD9424 takes values 1, 2 or 6) and banks that are located in the 50 states and District of Columbia. For each bank we observe the MSA of its headquarters (variable RSSD9180). The bank-level panel covers about 7,800 commercial banks that are headquartered in 271 MSAs.

Main variable definitions and transformations are listed below:

- **Commercial and industrial (C&I) loans**. Commercial and industrial loans in USD or divided by total assets (RCON2170). For years 1984-2000, we use RCON1600. For years 2001-2008, we use (RCON1755+RCON1766). If RCON1755 is missing, we only use RCON1766.
- **Non-C&I assets**. Difference between total assets (RCON2170) and C&I loans.
- **Real estate loans**. Loans secured by real estate in USD (RCON1410) or divided by total assets (RCON2170). This variable is split into its components: residential real estate loans (RCON1430+RCON1460) and commercial real estate loans (the difference between total and residential real estate loans).
- **Real estate loan profitability**. Interest and fee income on real estate loans or real estate-backed loans (RIAD4435+RIAD4436) divided by loans secured by real estate (RCON1410).
- **Bank size**: Log of total bank assets (RCON2170).
- **Bank equity**: Total bank equity (RCON3210) divided by total assets (RCON2170).

A-III Data Appendix: Dealscan and Cross-Walks with Other Data

DealScan Data. In Section 4.4 we use detailed loan-level data on originations of large corporate loans from DealScan Thomson Reuters's Loan Pricing Corporation (LPC). We start with information on 141,187 individual loan deals, structured in 197,851 facilities, and signed between January 1990 and December 2008. From these data we construct an unbalanced bank-borrowing firm-year panel. Loan volumes at the bank-firm-year level are summed up across multiple loans for any given bank-firm pair and year. For loan spreads, which are available for 82,093 loan deals, we calculate the weighted average of the "all-in-spread drawn" (which refers to the spread over the reference rate, usually the London Interbank Offered Rate (LIBOR), expressed in basis points, plus the facility fee associated with granting the loan) where the weights are given by loan size.

Loan volumes are obtained from the raw data by multiplying loan shares (contributed by individual banks to each loan deal) with the loan amount. We use the actual loan shares as reported in DealScan when available. When loan shares are not available, we estimate them following the regression-based approaches suggested by De Haas and Van Horen (2012) and Kapan and Minoiu (2018). More precisely, we predict these shares using a regression estimated on the sample of loans with reported shares. The dependent variable is the loan share and the regressors are log-transformed loan amount, syndicate size (number of banks in the syndicate), number of lead banks in the syndicate, dummies for loan currency, lead banks, bank country, loan type (term loan, letter of credit, bond, etc.), deal purpose (corporate purposes, working capital, debt repayment, LBO, etc.), firm country, firm industry (4-digit SIC code), and time (year:quarter dummies). The model has an adjusted R-squared of 75.67%. Our regression results are robust to two additional approaches to imputing the missing loan shares from previous studies.[17]

Merging DealScan with Compustat. We merge the bank-firm-year level panel from DealScan with borrowing firms' financial information from Compustat. The merge is conducted using the Dealscan-Compustat link (dated August 31, 2012) from Chava and Roberts (2008). We find a total

[17] In the first approach, advocated by Duchin and Sosyura (2014), missing shares are imputed as follows: for lead banks, we use the average share for lead banks in the sample of loans with non-missing shares, and for other syndicate participants, we split the remainder of the loan in equal shares. In the second approach, used in Hale (2012), missing loan shares are distributed equally across deal participants, regardless of their role in the syndicate.

number of 8,990 firms (with GVKEY identifier in Compustat) at the intersection of DealScan and Compustat during the 1990-2008 period; of these, we have information on borrowing activities and firm-level intangible capital on a yearly basis (from Falato et al. (2013)) for close to 6,500 firms. We drop firms with missing industry information and financial firms (with 4-digit SIC industry codes between 6000 and 6799).

Merging DealScan with U.S. Call Reports. We merge the bank-firm-year level panel from DealScan with bank balance sheet information from the U.S. Call Reports. Given that there is no common identifier across the two datasets, we perform a careful manual match based on bank name (supplemented by information on location, as needed). Out of almost 4,500 banks that appear as lenders in DealScan, we are able to unambiguously assign a Federal Reserve identification number (RSSD ID) to about 500 banks. To be conservative, we ignore all ambiguous matches.[18]

The dataset that represents the intersection of DealScan, Compustat, U.S. Call Reports, with non-missing information on the location and balance sheets of banks and firms spanning the sample period 1990-2008, comprises lender-borrower pairs involving 503 banks and 4,453 non-financial firms. We use this dataset in the DealScan regressions in Table 5.

[18]When we bring in balance sheet information from U.S. Call Reports to DealScan lenders we notice that several banks with missing equity data in the 1990s were actively lending in the syndicated loan market during that period. In addition, their missing equity data is compounded in DealScan by the large number of loans they granted. To limit the loss of sample size, we impute bank equity data when missing with the average of equity for those banks in the years when it is available; or with the average of equity for banks in the same MSA and year. We make sure our regression results are not confounded by this imputation procedure by controlling for a dummy variable that takes value 1 for observations with missing equity in the original U.S. Call Reports (in Table 5, coefficient estimate on missing equity dummy variable not shown).

Table A1: Variable definitions and sources

	Variable definition	Data source
CORPORATE INTANGIBLE CAPITAL (IK) VARIABLES		
IK	Weighted average of of industry-level estimate of intangible capital stock for all U.S. establishments. Weighted given by employment shares at the MSA and industry (NAICS-3) level. MSA-year level variable.	Bureau of Economic Analysis (BEA) for capital stock estimates; Bureau of Labor Statistics (BLS) for employment shares.
IK: Mortgages, volume	As above, but weights given by bank's volume of mortgage applications at the MSA level. Bank-year level variable.	BEA, BLS, HMDA
IK: Mortgages, number	As above, but weights given by bank's number of mortgage applications at the MSA level. Bank-year level variable.	BEA, BLS, HMDA
IK: Deposits	As above, but weights given by bank's deposits at the MSA level. Bank-year level variable.	BEA, BLS, Federal Deposit Insurance Corporation (FDIC) Summary of Deposits
Firm-level IK	Capitalized past expenditures on knowledge capital (R&D), organizational capital (SG&A), and informational capital (computerized information and software)	Falato et al. (2013) based on Compustat
BANK LEVEL VARIABLES		
C&I loans	Commercial and industrial loans. See Data Section A-II for details.	U.S. Call Reports
Non-C&I assets	Difference between total assets and C&I loans.	U.S. Call Reports
Real estate loans	Loans backed by real estate. See Data Section A-II for details.	U.S. Call Reports
Real estate loan profitability	Interest and fee income on real estate loans or real estate backed loans divided by real estate loans. See Data Section A-II for details.	
Bank size	Log(total bank assets).	U.S. Call Reports
Bank capital	Bank equity divided by bank assets.	U.S. Call Reports
MACRO VARIABLES		
House prices (HP)	All transactions seasonally-adjusted HP index at the MSA level	Federal Housing Finance Agency
Per capita (pc) income	Per capita household income at the MSA level	BEA Loan Area Personal Income accounts
Population	Total MSA-level population	BEA Loan Area Personal Income accounts
Firm sales growth	Growth rate of firm total sales, calculated as unweighted average across firms headquartered in a given MSA and year.	Compustat
Firm market-to-book	Unweighted average of market-to-books across firms headquartered in a given MSA and year.	Compustat

Table A2: Summary Statistics - Additional Variables

	Obs.	Mean	St. Dev.	p25	Median	p75
A. Additional corporate IK measures						
IK growth: Employment shares at $t-1$	78986	4.46%	4.35%	1.44%	5.05%	7.80%
IK growth: Employment shares at $t-5$	78986	4.40%	4.26%	1.55%	4.82%	7.74%
IK growth: Employment shares at $t-10$	78986	4.46%	4.27%	1.62%	4.95%	7.66%
IK growth: Employment shares in 1975	78986	4.43%	4.20%	1.65%	4.78%	7.44%
IK growth: Mortgages, volume	40030	3.10%	4.36%	-0.99%	3.01%	6.77%
IK growth: Mortgages, number	40030	3.10%	4.36%	-0.99%	3.00%	6.77%
IK growth: Deposits	69218	4.14%	4.35%	1.05%	4.56%	7.74%
B. US Call Reports variables						
C&I loans - level	78986	11.64%	8.66%	5.50%	9.68%	15.62%
Real estate loans - level	78986	35.19%	16.80%	22.79%	33.81%	46.39%
Residential real estate loan - growth	72816	8.78%	19.34%	-4.08%	5.39%	17.75%
Commercial real estate loan - growth	72628	12.50%	24.29%	-3.56%	8.70%	23.98%
Consumer loan - growth	70922	0.63%	18.19%	-11.93%	-1.43%	10.58%
C. HMDA variables						
Δ applicants' loan-to-income ratio	53874	0.05	1.51	-0.16	0.04	0.25
Δ applicants' log income	53874	0.03	0.26	-0.07	0.03	0.14
Δ share of female applicants	53874	0.01	0.15	-0.05	0.01	0.06
Δ share of minority applicants	53874	0.00	0.12	-0.02	0.00	0.04
Δ share of minority residents	53874	0.62	3.18	0.02	0.44	1.13
Δ log(personal income)	53874	0.04	0.05	0.02	0.04	0.06
D. DealScan variables						
Firm-level IK	11241	36.6%	63.9%	9.1%	22.0%	43.5%
Firm size (Large firm)	11241	0.62	0.49	0.00	1.00	1.00
Firm Tobin's q	11241	176.68%	98.69%	114.72%	146.52%	202.09%
Firm ROA	11241	0.14	0.11	0.10	0.14	0.19
Firm cash ratio	11241	7.75%	11.23%	1.30%	3.36%	9.18%
Firm PP&E ratio	11241	33.24%	23.71%	14.71%	27.52%	47.70%

Notes: The table presents descriptive statistics for additional regression variables. Panel A refers to additional measures of corporate IK growth that are constructed using the banks' headquarters MSA with different lag structure for industry-level employment shares (see Table 3); and several measures of corporate IK that are calculated using the bank's area of operations based on the geographical footprint of its mortgage lending or deposit-taking activities, rather than its headquarters MSA (see Table 4). Panel B refers to additional U.S. Call Reports variables including the dependent variables in Table 8. Panel C refers to additional control variables used in the HMDA analysis (see Tables 6-7). Firm size is a dummy variable for firms with above-median total assets in the DealScan sample. Panel D refers to additional variables used in the DealScan analysis (Table 5). *Data sources*: See Appendix.

Table A3: Industry Rankings Based On Corporate Intangible Capital Level and Growth, 1984-2008

	Top 6 industries by average IK level
1	Motion picture and sound recording industries
2	Publishing industries (including software)
3	Miscellaneous professional, scientific, and technical services
4	Performing arts, spectator sports, museums, and related activities
5	Chemical products
6	Electrical equipment, appliances, and components
	Bottom 6 industries by average IK level
1	Oil and gas extraction
2	Accommodation
3	Real estate
4	Forestry, fishing, and related activities
5	Railroad transportation
6	Farms
	Top 12 industries by average IK growth
1	Chemical products
2	Publishing industries (including software)
3	Motion picture and sound recording industries
4	Computer and electronic products
5	Miscellaneous manufacturing
6	Information and data processing services
7	Administrative and support services
8	Management of companies and enterprises
9	Insurance carriers and related activities
10	Printing and related support activities
11	Miscellaneous professional, scientific, and technical services
12	Computer systems design and related services

Notes: The table reports the top and bottom six industries by average corporate intangible level; and the top twelve industries by average corporate intangible growth during 1984-2008. The industries are at the NAICS-3 digit level. *Data sources*: See Appendix.

Table A4: Robustness - Baseline Regressions Without Bank Asset Growth as Control

	C&I loans (1)	Bank assets (2)	Non C&I assets (3)	RE loans (4)	Residential RE loans (5)	Commercial RE loans (6)	Consumer loans (7)
IK growth	-0.1770**	0.0437	0.0941***	0.1491***	0.2039***	0.1153	0.1916***
	(0.072)	(0.030)	(0.031)	(0.053)	(0.062)	(0.077)	(0.059)
HP growth	0.2698***	0.1827***	0.1528***	0.5295***	0.4196***	0.5521***	0.1669***
	(0.022)	(0.009)	(0.009)	(0.017)	(0.020)	(0.024)	(0.019)
Pc income growth	0.1931***	0.1298***	0.0960***	0.2097***	0.1141***	0.2514***	0.1152***
	(0.046)	(0.016)	(0.018)	(0.033)	(0.039)	(0.046)	(0.036)
Population growth	0.5701***	0.7848***	0.7540***	0.9406***	0.9140***	0.6806***	-0.0241
	(0.077)	(0.041)	(0.041)	(0.062)	(0.073)	(0.082)	(0.066)
Firm sales growth	0.0025	0.0066**	0.0049*	0.0003	-0.0101*	0.0078	0.0086*
	(0.006)	(0.003)	(0.003)	(0.005)	(0.006)	(0.007)	(0.005)
Firm market-to-book	0.0011	0.0072***	0.0078***	0.0044***	0.0015	0.0081***	-0.0005
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Bank size	-0.0040***	0.0003	0.0006	-0.0037***	-0.0044***	-0.0052***	-0.0024***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Bank capital	0.0792***	0.0327***	-0.0111	-0.0251	-0.0595***	-0.0523*	-0.0088
	(0.024)	(0.010)	(0.010)	(0.020)	(0.020)	(0.027)	(0.021)
Observations	70,477	77,450	75,443	71,404	68,169	67,980	64,818
R-squared	0.027	0.078	0.061	0.057	0.036	0.037	0.040
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the robustness of our main baseline results (columns 4-6 in Table 2 and columns 1-4 in Table 8) to dropping total asset growth as a control variable. The dependent variables are indicated as column headings. Corporate IK growth, house price growth, per capital income growth, population growth, firm sales growth, and firm market-to-book ratio, are at the MSA level, for the MSA where the bank is headquartered. Bank size, capital, and total asset growth are at the bank level. Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table A5: Robustness - Baseline Regressions with Additional Fixed Effects

	C&I loans	Bank assets	Non C&I assets	C&I loans	Bank assets	Non C&I assets
	(1)	(2)	(3)	(4)	(5)	(6)
	Add bank fixed effects			**Add bank MSA fixed effects**		
IK growth	-0.1488*	-0.0450	0.0440***	-0.1342*	-0.0230	0.0387***
	(0.084)	(0.028)	(0.014)	(0.078)	(0.029)	(0.013)
HP growth	0.0774***	0.1769***	-0.0085*	0.0785***	0.1569***	-0.0153***
	(0.025)	(0.009)	(0.005)	(0.023)	(0.010)	(0.005)
Pc income growth	0.1172***	0.1577***	-0.0271***	0.1320***	0.1273***	-0.0376***
	(0.045)	(0.016)	(0.009)	(0.044)	(0.016)	(0.009)
Population growth	0.7357***	0.5378***	-0.0849***	0.5808***	0.4402***	-0.0773***
	(0.136)	(0.053)	(0.026)	(0.120)	(0.051)	(0.024)
Firm sales growth	0.0069	0.0030	-0.0015	0.0101	0.0018	-0.0025**
	(0.007)	(0.002)	(0.001)	(0.007)	(0.002)	(0.001)
Firm market-to-book ratio	-0.0030	0.0013	0.0001	-0.0032	0.0017**	0.0005
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
Bank size	-0.0133***	-0.0304***	0.0017***	-0.0053***	-0.0036***	0.0001
	(0.003)	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)
Bank capital	0.1098***	0.1346***	-0.0370***	0.0559**	0.0113	-0.0303***
	(0.038)	(0.017)	(0.007)	(0.022)	(0.010)	(0.004)
Bank asset growth	0.5928***		0.9751***	0.6588***		0.9704***
	(0.013)		(0.003)	(0.011)		(0.002)
Observations	70,001	77,003	74,970	70,476	77,449	75,442
R-squared	0.185	0.362	0.835	0.088	0.116	0.814
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes			
MSA FE				Yes	Yes	Yes

Notes: This table examines the robustness of our main baseline results (columns 4-6 in Table 2) to including additional fixed effects (bank fixed effects in columns 1-3 and bank's MSA fixed effects in columns 4-6). The dependent variable is bank-level C&I loan growth (columns 1, 4), total asset growth (columns 2, 5), and the growth rate of assets other than C&I loans (columns 3, 6). Corporate IK growth, house price growth, per capital income growth, population growth, firm sales growth, and firm market-to-book ratio, are at the MSA level, for the MSA where the bank is headquartered. Bank size, capital, and total asset growth are at the bank level. Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.

Table A6: Robustness – Baseline Regressions with Alternative Clustering

	C&I loans	Bank assets	Non C&I assets	C&I loans	Bank assets	Non C&I assets	C&I loans	Bank assets	Non C&I assets
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IK growth	-0.2073**	0.0437	0.0467**	-0.2073***	0.0437	0.0467***	-0.2073**	0.0437	0.0467**
	(0.093)	(0.039)	(0.019)	(0.075)	(0.055)	(0.015)	(0.094)	(0.054)	(0.020)
HP growth	0.1476**	0.1827***	-0.0236**	0.1476***	0.1827***	-0.0236***	0.1476**	0.1827***	-0.0236**
	(0.060)	(0.037)	(0.010)	(0.037)	(0.019)	(0.007)	(0.065)	(0.038)	(0.011)
Pc income growth	0.1037	0.1298***	-0.0351*	0.1037*	0.1298***	-0.0351***	0.1037	0.1298***	-0.0351*
	(0.085)	(0.044)	(0.018)	(0.059)	(0.028)	(0.013)	(0.085)	(0.044)	(0.018)
Population growth	0.0513	0.7848***	0.0288	0.0513	0.7848***	0.0288	0.0513	0.7848***	0.0288
	(0.099)	(0.057)	(0.022)	(0.152)	(0.111)	(0.027)	(0.148)	(0.112)	(0.028)
Firm sales growth	-0.0013	0.0066**	-0.0011	-0.0013	0.0066*	-0.0011	-0.0013	0.0066*	-0.0011
	(0.011)	(0.003)	(0.002)	(0.008)	(0.004)	(0.001)	(0.011)	(0.004)	(0.002)
Firm market-to-book ratio	-0.0037**	0.0072***	0.0009***	-0.0037*	0.0072***	0.0009***	-0.0037*	0.0072***	0.0009**
	(0.002)	(0.001)	(0.000)	(0.002)	(0.002)	(0.000)	(0.002)	(0.002)	(0.000)
Bank size	-0.0042***	0.0003	0.0002	-0.0042***	0.0003	0.0002	-0.0042***	0.0003	0.0002
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Bank capital	0.0725**	0.0327	-0.0320***	0.0725***	0.0327**	-0.0320***	0.0725**	0.0327	-0.0320***
	(0.030)	(0.029)	(0.006)	(0.023)	(0.015)	(0.004)	(0.030)	(0.030)	(0.006)
Bank asset growth	0.6599***		0.9721***	0.6599***		0.9721***	0.6599***		0.9721***
	(0.013)		(0.006)	(0.013)		(0.003)	(0.014)		(0.006)
Clustering level	bank, year	bank, year	bank, year	MSA	MSA	MSA	MSA, year	MSA, year	MSA, year
Observations	70,477	77,450	75,443	70,477	77,450	75,443	70,477	77,450	75,443
R-squared	0.082	0.078	0.812	0.082	0.078	0.812	0.082	0.078	0.812
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the robustness of our main baseline results (columns 4-6 in Table 2) to alternative clustering estimators for the standard errors. The standard errors are clustered on bank and year in columns 1-3, on bank's MSA in columns 4-6, and on MSA and year in columns 7-9. The dependent variables are bank-level C&I loan growth (columns 1, 4, 7), total asset growth (columns 2, 5, 8), and the growth rate of assets other than C&I loans (columns 3, 6, 9). Corporate IK growth, house price growth, per capital income growth, population growth, firm sales growth, and firm market-to-book ratio, are at the MSA level, for the MSA where the bank is headquartered. Bank size, capital, and total asset growth are at the bank level. Standard errors are clustered on bank. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. *Data sources*: See Appendix.