Capital Market Integration and Growth Across the United States*

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Abstract

What drives the integration of national financial markets, and what are its consequences for regional growth? We digitize and collect US state-level banking data from 1953 to 1983 and document a tight link between high nominal short rates and financial integration, as measured by the narrowing of regional differences in bank loan interest rates. We explain this pattern with a model in which banks face frictions in accessing external capital markets and are restricted by regulation from using internal capital markets to move funds across regions. An increase in the nominal rate fosters integration because it prompts households to move their liquidity away from unremunerated deposits at their local banks and towards national money markets (e.g., via money-market funds). This forces banks to seek more funding from national markets and makes lending less dependent on local deposits, which ultimately erodes regional differences in bank loan interest rates. We nest our banking model in a quantitative dynamic spatial model and show that financial integration explains up to a fifth of the higher observed growth in GDP and population of the American South and West and of the relative decline of the Northern financial centers. We draw the implications of our findings for current debates on capital market integration. Low-rate environments amplify frictions introduced by restrictions on capital flows, substantially increasing the gains from deregulation.

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Introduction

A well-functioning national financial market allows areas with abundant savings to supply credit to areas with high loan demand, enabling growth where opportunities arise. American capital markets today resemble this type of geographic integration. Large banks can use their national branch networks to seamlessly move funds across regions, and firms can also tap other well-functioning and deep national capital markets. Yet financial segmentation along geographical lines has prevailed in earlier periods and remains today in economies with incomplete banking unions and shallow financial markets. What causes the geographic integration of financial markets? And how does the movement of capital enabled by these markets impact growth?

This paper studies the geographic integration of American banking markets between 1953 and 1983, three decades of US history when banks were prohibited from branching across states. In the 1950s, we document large financial segmentation. Differences across states in bank lending rates were as high as 180 basis points and banks relied mostly on local deposits to fund their loans. However, by the early 1980s, *before* deregulation allowed banks to locate freely, regional differences in loan rates had already halved and banks' liabilities had increasingly reached beyond state borders. Interbank loans on the Fed Funds market and wholesale negotiable certificates of deposits made up a third of bank liabilities, up from less than one percent in the 1950s. As financial capital increasingly flowed across states, population and GDP growth in the initially capital-scarce South and West far outpaced that in the Northern financial centers. What explains these processes?

The first part of this paper proposes and quantifies a "nominal rate channel" of financial integration. Increases in short-term national nominal interest rates (e.g., the rate on three-month Treasury Bills) are a powerful driver of financial integration because they prompt households to move their liquidity to national markets, instead of holding it in deposits at their local bank. National markets then redistribute this liquidity across regions, as banks increasingly turn to these markets to finance their loans. Hence, financial integration is not always a gradual and steady process: it can ebb and flow with market conditions. We test the unique reduced form predictions of our channel and show that rising nominal rates during the Great Inflation explain half of the integration we document between 1959 and 1983.

The second part of the paper shows that financial integration can have large real effects. We develop and estimate a quantitative dynamic spatial model of the US economy that nests our banking theory of integration. Rising financial integration explains up to one-fifth of the observed rise of the initially capital-scarce South and West and relative fall of the Northern financial centers. We then use the model to draw implications for current debates on capital market integration (Lagarde 2023; Draghi 2024b). We show that, in low-rate environments, gains from deregulation may be much higher than previously thought. The post-1982 US interstate branching deregulation would have been twice as powerful had it occurred in a low-rate environment because, by 1982, exceptionally high rates had already done much of the work of integrating financial markets.

The paper starts by providing the key empirical motivation for our new nominal rate channel, using newly digitized state-level data on banks' balance sheets and income statements. We measure financial integration as the narrowing of regional differences in bank lending rates (henceforth, "regional spreads") and show that the degree at which regional spreads narrowed was tightly linked to the level of the nominal rate. Regional spreads narrowed when nominal rates rose but then opened up again when nominal rates declined. This non-monotonicity requires moving beyond traditional "secular" theories under which financial integration is the slow-moving product of deregulation or technological progress. Furthermore, the path of regional spreads points to the unique role of the nominal rate. The narrowing of regional spreads was not tied to other features of the business cycle beyond nominal rates and also cannot be explained by changes in risk premia, whose path in our period would have pushed in the opposite direction.[1]

To explain how nominal rates can foster integration, we write a model in which, because of regulation, banks need to rely on costly external markets to raise financing from other regions—as in the US before branching deregulation. In this setting, a bank has two ways to fund its loans: either through cheap local deposits or by borrowing funds on wholesale national money markets. Our key assumption is that financing on these wholesale markets faces frictions that grow with the amount of borrowing (as in, e.g., Bernanke and Gertler 1995; Kashyap and Stein 1995; Stein 1998), for example because it is unsecured and uninsured. Consequently, lending rates are lower in states with abundant local deposits relative to loan demand because banks there do not need to raise much costly financing on wholesale markets.

This financing friction gives rise to a nominal rate channel of financial integration because the nominal rate affects the amount of inframarginal cheap deposits available to banks. When the nominal rate is high, households substitute away from deposits toward money-like national instruments because the remuneration of bank deposits and their associated liquidity services do not rise one-for-one with the nominal rate.[2] The outflow of deposits induced by rising nominal rates affects deposit-abundant regions more because these regions stand to lose a larger share of funding. Thus, banks' marginal costs in initially deposit-abundant regions increase by more when nominal rates rise, and so do their lending rates. However, these regions are also those that had lower lending rates ex ante, when they were flush with local savings. Hence, increases in the

[1] Risk premia rose together with the nominal rate during our period and would have thus pushed towards rising regional spreads if regional spreads were mainly driven by differences in risk across states.

[2] In our period, deposit remuneration mechanically did not rise one-for-one because Regulation Q prohibited it on checking accounts and limited it on other deposits. However, even absent regulation, banks optimally avoid fully passing-through aggregate rate increases to deposit rates, either because it increases profits on inframarginal depositors who do not pull their liquidity or because high rates increase banks' market power over cash (Drechsler et al. 2017).

nominal rate have a larger impact on local lending rates (i.e., a larger pass-through) in states that had initially lower rates, thereby driving a geographic convergence in lending rates.

As an example, consider the two largest banks in the US in our sample period: Chase, based in capital-abundant New York, and Bank of America (BofA), based in (relatively) capital-scarce California. In 1960, when the nominal rate was low and deposits abundant, Chase enjoyed large deposit supply relative to its loan demand, financing 75% of its assets with unremunerated demand deposits and lending at 5.0%. By contrast, BofA could finance only 47% of its assets with demand deposits and lent at 6.1%. By 1974, the nominal rate increased by five percentage points and many households moved their deposits to the national money market. This deposit outflow hurt Chase more than BofA, because Chase was more reliant on cheap deposits. By draining deposits from the system, higher nominal rates eroded part of Chase's advantage over BofA. As differences in their funding costs narrowed, so did their lending spreads, which dropped from 110 to 17 basis points.

We test the main predictions of the model and recover its main parameters using our state-level data and historical Flow of Funds releases from the Federal Reserve, which we also digitized. In the aggregate, rising nominal rates were indeed associated with inflows of households' liquidity into national money markets and with increased reliance by banks on these markets. The time-series correlation between the three-month Treasury Bill rate and households' holdings of money market securities as a fraction of income is of .96 (.77 in year-on-year changes). Similarly, for banks' share of assets funded from national markets this correlation is of .90 (.59 in changes). In the cross-section, during the pre-1959 low-rate environment, lending rates were lower in states where local demand deposits were abundant relative to loan demand. Yet this advantage faded between 1959 and 1983 as nominal rates rose and deposits moved to the money market. We implement a difference-in-difference design based on states' initial deposit abundance to show that nominal rate increases led to larger increases in bank financing costs and lending rates in initially deposit-abundant states, compared to deposit-scarce ones. That is, the pass-through of nominal rates to local financing and lending rates was higher in initially deposit-abundant and low-rate states, leading to financial convergence.

To address concerns that our results might be driven by unobservable shocks hitting capital-abundant states in high-rate years, we exploit the fact that the substitution between local and national sources of funding should apply with much greater force to large banks. Only large banks had access to national markets, while small banks' financing was always entirely local, so that there were no differences across states in how much small banks relied on local funding to begin with. We implement a triple-difference design across states and bank size using bank-level data from 1960 onward obtained via a Freedom of Information Act request.[3] The rate-driven narrowing of regional spreads is indeed driven exclusively by large banks—which experienced this switch

[3] This data was used for the first time by Drechsler et al. (2020).

from local to national funding—while small banks exhibit a smaller and monotonic convergence.

Quantitatively, the nominal rate channel alone can explain 51% of the integration observed between 1959 and 1983 and can match its time-varying path. To show this, we first use the same variation as in our reduced form results to estimate the two key parameters in our model: the latent deposit abundance of each state and the elasticity of households' deposit demand with respect to the nominal rate. We then simulate the model by allowing only our channel to be at play and compare the convergence generated by our channel to that observed in the data.

We also find a declining trend in the cost of accessing national markets that interacts with our channel in a quantitatively powerful way. This declining trend indicates that secular forces of integration were also at play, reflecting, for instance, the financial innovations that allowed banks to more effectively tap national markets, such as the invention of negotiable certificates of deposits in 1961. This secular channel can explain 69% of the overall integration we document, but cannot match its time-varying path.[4] In a counterfactual where both the secular and nominal channel are at play they explain 89% of the integration, substantially less than their sum when taken separately. The two channels substitute for each other: having efficient national markets is more powerful in eroding regional spreads when regional differences in deposit endowments are large. Nominal rates erode these differences in funding, thus acting as a substitute to other sources of integration.

We then turn to our second main question and evaluate the real effects of financial convergence. In the data, GDP growth was higher in the initially capital-scarce states that benefited from integration, and it was driven by higher net in-migration rather than by higher growth in GDP per capita or fertility. The relationship between growth and financial integration, as well as the importance of migration in driving it, survives even when we look only within broad US regions and control for a host of factors known to affect growth dynamics during the period we study, such as initial wages (Barro and Sala-i-Martin 1992), right-to-work laws (Holmes 1998), sectoral shocks (Bartik 1991), and January temperatures (Glaeser and Tobio 2008). Still, it is hard to control for all initial conditions that may be co-determined or correlated with initial rates and that may have independent effects on growth. Furthermore, because financial variables affect real ones with long and variable lags, we also cannot exploit the identification strategy at annual frequencies that we used above to identify our nominal channel of financial integration. The reduced form is also not informative about the aggregate effects of financial integration.

To make quantitative progress, we nest our banking block in a dynamic spatial general equilibrium model of the US economy. This dynamic extension introduces endogenous regional lending differentials to a state of the art dynamic spatial model with many regions populated by workers and

[4] This exercise effectively provides a lower bound on the potency of our nominal channel because we do not allow nominal rates to also have an effect on the frictions of accessing national markets. However, several accounts strongly suggest that the financial innovations in our era came partly as a reaction to the high-rate environment (Stigum 1978; Scadding 1979; Mishkin 1990). We do not model this channel since we do not have observational data on frictions.

capitalists who make forward-looking decisions about where to live and about how much physical capital to accumulate (Bilal and Rossi-Hansberg 2023). Financial integration affects firms' costs because firms need to finance a share of their inputs (labor and physical capital) with local bank loans before they can sell their products. This assumption fits with the observation that most bank loans during the period we study were used to finance working capital.[5] If borrowing from banks becomes cheaper, firms expand production, which bids up wages and the rental rate of capital, ultimately attracting new workers to the region and prompting greater investment.

We study the transition dynamics of each state's population and stock of physical capital to the rise in nominal rates and the estimated decline in frictions of accessing national markets. These aggregate sources of financial integration are independent of local economic conditions and allow us to avoid reverse causality.[6] Two main parameters discipline the effects of financial integration. One is the pass-through of local bank lending rates to firms' costs, which depends on how much firms rely on banks for financing. We calibrate it from the observed fraction of business debt that is financed using bank loans, which was half at the time. The other is the migration elasticity, which governs how much changes in local wages affect migration.

We estimate the migration elasticity using the model's full transition dynamics. We implement this routine by leveraging the recent theoretical advances in the mean-field games literature (Bilal 2023), which yield very computationally efficient solutions for the full transition dynamics. We target the observed growth of population *relative* to total GDP growth as a function of initial capital scarcity but leave the absolute level of growth untargeted. We recover a value that is within the range found in the literature (Caliendo et al. 2019; Bilal and Rossi-Hansberg 2023). This also suggests that the dynamics we observed in the data—the fact that population growth drove most of the GDP growth in initially capital-scarce states—are quantitatively plausible in our model under standard values of the migration elasticity.

Financial integration has sizable effects. Holding other fundamental drivers of growth fixed, financial integration on its own can explain 6% of the higher GDP growth and 10% of the higher population growth that we observe in the capital-poor South and West, and 14% and 21% of the relative decline in GDP and population of the Northern financial centers. This uncovers a new geographic channel of monetary policy under which increases in nominal rates have heterogeneous real effects across space if mobility of financial capital is frictional.

Finally, we conclude by discussing some implications of our findings for current debates on

[5] In 1957, 62.6% of bank business loans had a maturity of six months or less at origination (Redenius 2006). We also do not model households' borrowing because, differently from commercial lending, mortgage markets were already integrated due to the federal interventions of the 1930s, as shown by Angelova and D'Amico (2024). Financial integration would have larger effects if it affected also rates faced by households and by firms for long-term projects.

[6] If we were agnostic about financial integration and just read changes in local lending rates from the data, we would be exploiting changes that were themselves due to evolving local economic conditions.

capital market integration. We start by showing that the effects of deregulation aimed at integrating capital markets may be much larger than previously thought. We perform a counterfactual where we relax geographical restrictions on branching, which integrates banking markets by allowing banks to move deposits across regions via internal branch networks. Our perceptions on the potency of these policies mostly come from the rich literature, stemming from Jayaratne and Strahan (1996), who studied the post-1982 lifting of US interstate bank branching restrictions.[7] However, this episode occurred after an exceptionally high-rate environment, when nominal rates as high as 15% in 1982 had already moved local deposits to national markets. In this scenario, allowing banks to branch everywhere and reallocate deposits across states via internal capital markets is much less powerful because nominal rates already did much of the same work that deregulation is set to do. In the counterfactual where deregulation occurred in the more normal rate environment of the late 1950s, it would have been twice as powerful both in terms of reducing lending differentials and in accelerating growth in capital-scarce states.

Our results thus show that, both in real and in financial terms, integrating financial markets is much more powerful in low-rate environments where savings are local, and less so if high rates already mobilized them towards national markets. Our framework does not apply today to the large American banks because they now have branches throughout the US. Yet it does speak to the Eurozone because domestic regulators effectively limit banks' use of internal capital markets by imposing limits on cross-border deposit flows, even within banking groups.[8] If deregulation, such as completing the EU banking union, were to occur in the Eurozone today, it could have even larger effects than in the American case of the 1980s. America at the time emerged from a high-rate environment that moved deposits to national money markets, while the Eurozone is emerging from the prolonged low-rate environment of 2013–22 during which retail deposits surged. It also provides a silver lining to the post-2023 high-rate environment as a partial substitute for deregulation.

Related literature. We contribute to several strands of the literature. First, our paper is closely related to the large body of work that studies how monetary policy affects the real economy via the banking system, particularly to the deposit channel in Drechsler et al. (2017).[9] They show

[7] Berger et al. (1999) reviews early papers. See Morgan et al. (2004), Cetorelli and Strahan (2006), Beck et al. (2010), Amore et al. (2013), Favara and Imbs (2015), Landier et al. (2017), Hombert and Matray (2017), Bai et al. (2018), Célerier and Matray (2019), Mian et al. (2020), Levine et al. (2021), and Oberfield et al. (2024) for more recent work.

[8] Even if some EU banks are present in multiple member states (MS), national EU regulators can exercise "options and discretions" to limit within-group cross-border flows. MS can apply, for instance, country-specific macroprudential requirements and exposure limits that are evaluated at the individual entity level rather than at the group level, thereby effectively restricting the mobility of funds within banking groups (see, for instance, Recital 22 of EU Directive 2019/878 and Sapir 2016; Gardella et al. 2020; Enria 2021, 2023).

[9] In addition to the references above, see, e.g., Bernanke and Blinder (1988, 1992), Kashyap and Stein (2000), Jiménez et al. (2012, 2014, 2020), Gomez et al. (2021), Heider et al. (2021), Bianchi and Bigio (2022), Piazzesi et al. (2022), and Greenwald et al. (2024). Within this strand of the literature, our results on segmentation in low rate environments relate especially to the recent work studying monetary policy transmission under low interest rates (Wang et al. 2022;

that increases in aggregate rates cause outflows of deposits because banks optimally decide not to pass through rate increases to depositors, which then translates into cuts to lending.[10] Our work shows that, if regulation prevents banks from using internal capital markets, deposit outflows have new geographic implications because they force banks to substitute local sources of funding with national ones.[11]

Second, our work relates to the large literature on financial frictions and capital market integration.[12] This literature usually studies financial frictions in a cross-country context and the empirical work focuses on episodes of opening up to foreign investors. We study integration within a country, which adds a new margin, via labor mobility, through which financial integration can affect development. Higher GDP growth as a result of capital inflows can come from higher immigration, if expanded production attracts new workers by bidding up wages. In a related paper, Angelova and D'Amico (2024) show that the government-driven integration of American mortgage markets in the wake of the Great Depression was also associated with population growth in initially capital-scarce cities.

Third, our novel focus on the interplay between the mobility of labor and that of financial capital builds on the latest generation of dynamic spatial general equilibrium models (Caliendo et al. 2019; Bilal and Rossi-Hansberg 2023; Kleinman et al. 2023). We are the first to add endogenous lending differentials across space to a dynamic spatial general equilibrium model with forward-looking migration and physical capital accumulation. Studying financial integration in spatial general equilibrium also allows us to assess its distributional consequences across regions, highlighting that, in a setting where real factors are mobile, integration accelerates growth in some areas but can also slow it in others.[13]

Abadi et al. 2023; Onofri et al. 2023; Eggertsson et al. 2024; Eichenbaum et al. 2024).

[10] As anticipated, in our period the lack of pass-through of aggregate rates to retail deposit rates was exacerbated by Regulation Q, which prevented banks from remunerating checking deposits. However, the point holds more broadly so long as banks optimally avoid passing through rates to depositors. In addition to Drechsler et al. (2017), a rich literature has covered deposit pricing dynamics and outflows (Berger and Hannan 1989; Diebold and Sharpe 1990; Hannan and Berger 1991; Driscoll and Judson 2013; Egan et al. 2017; Drechsler et al. 2021, 2023; Begenau and Stafford 2023), with recent work focusing on how they evolved in today's digital world (Koont et al. 2023; Erel et al. 2024; Lu et al. 2024). Digitalization (Haendler 2022; Jiang et al. 2022; Koont 2023) is interesting in our context because digital platforms remove the local nature of deposits since they are not issued via physical branches.

[11] Several related papers highlighted other factors that can give rise to a geographic heterogeneity in the effects of monetary policy (Carlino and DeFina 1998; Fratantoni and Schuh 2003; Di Maggio et al. 2017; Alpanda and Zubairy 2019; Beraja et al. 2019; Bellifemine et al. 2023; Herreño and Pedemonte 2023; Rogers 2023). Our results also relate to the work studying the heterogeneous effects of inflation (see, e.g., Doepke and Schneider 2006; Leombroni et al. 2020; Afrouzi et al. 2024; Del Canto et al. 2024).

[12] See the reviews by Prasad et al. (2003) and Matsuyama et al. (2007), and, e.g., Obstfeld and Taylor (2003), Alfaro et al. (2004, 2008, 2009, 2010), Caballero and Krishnamurthy (2004, 2006, 2009), Colacito and Croce (2010), Buera et al. (2011), Gourinchas and Jeanne (2013), Kalemli-Özcan et al. (2013a,b), Moll (2014), Midrigan and Xu (2014), Gopinath et al. (2017), Maggiori (2017), Pellegrino et al. (2021), Morelli et al. (2022), Bau and Matray (2023), and Fonseca and Matray (2024) among others.

[13] A small but growing literature is also bringing finance to spatial models. We are particularly close to Ramos-

Fourth, our findings on the American financial and economic developments of the twentieth century are related to two large strands of the literature that studied this topic. On one hand, a rich financial literature studied convergence in lending rates, usually focusing before our period. These articles highlighted the role of changes in market power, converging risk levels, and technological developments in driving financial convergence.[14] We introduce a new channel of financial convergence under which the narrowing of differentials may be non-monotonic over time and comes from households reacting to market conditions, as high nominal rates prompt households away from local deposits that pay zero.

On the other hand, a parallel literature highlighted the movement of workers and firms to the South and West over the last two centuries and the higher growth rates of initially less-developed states (e.g., Steckel 1983; Greenwood and Hunt 1984; Barro and Sala-i-Martin 1992; Haines 2000; Glaeser and Tobio 2008; Molloy et al. 2011; Alder et al. 2023). We show that *financial* convergence was itself a quantitatively important cause of the sort of *economic* convergence studied by the literature. The movement of financial capital from the rich North to the developing South and West can explain a sizable fraction of the movement of labor along the same geographic lines.

Finally, the evidence on the real effects of financial integration relates to the work that studied the effects of local credit conditions on real outcomes (e.g., Guiso et al. 2004; Becker 2007; Paravisini 2008; Gilje et al. 2016; Cortés and Strahan 2017; Nguyen 2019; Wang 2021; Granja et al. 2022).[15] Local credit conditions matter for economic development also in our setting, and we offer a way of studying these effects in spatial general equilibrium, relating to recent work on aggregation by Catherine et al. (2022), Mian et al. (2022), and Herreño (2023).

1 Data

State-level financial data. We create an annual state-level panel of banking variables from 1953 to 1983 by assembling two main sources of banking data. To the best of our knowledge, this is the first panel combining income statements and balance sheets at the sub-national level for this period and contributes to the digitization effort in this literature.[16]

Menchelli and Van Doornik (2022), who embed exogenous financial wedges in a dynamic spatial model, while we endogenize them. Maingi (2023), Morelli et al. (2024), and Oberfield et al. (2024) develop static models with rich spatial banking networks.

[14] Davis (1965), Sylla (1972), Smiley (1975, 1981, 1985), James (1976b), and Sushka and Barrett (1984) focus on technological improvements and the creation of new markets; Sylla (1969, 1975) and James (1976a) study changes in market power and regulation; Rockoff (1977), Bodenhorn (1992, 1995), and Gendreau (1999) study the role of risk.

[15] It also complements the extensive literature that studies the real effects of credit shocks (e.g., Bernanke 1983; Khwaja and Mian 2008; Amiti and Weinstein 2011; Cingano et al. 2016; Huber 2018; Costello 2020; Jiménez et al. 2020; Mian et al. 2020; Alfaro et al. 2021; Xu 2022; Blattner et al. 2023), especially the work that focuses on employment dynamics (Pagano and Pica 2012; Chodorow-Reich 2014; Bentolila et al. 2018; Benmelech et al. 2019; Greenstone et al. 2020; Benmelech et al. 2021).

[16] Bodenhorn (1995) constructs series of state-level lending rates for 1880–1960, extended to 1975 by Redenius (2006). Correia et al. (2024) assembled a very rich bank-level dataset that stretches back to 1863, but without income

The first source consists of bank-level balance sheet items coming from Call Reports, which banks have to submit to their supervisory agency every quarter. Data after 1976 is publicly available and we obtained data between 1960 and 1975 under a Freedom of Information Act (FOIA) request to the Federal Reserve Board. Drechsler et al. (2020) used the 1960–75 data for the first time. Data in 1960 is missing for 40% of banks making up 14% of assets.

To go further back in time, we use the methods developed in Correia and Luck (2023) to digitize the annual reports of the Office of the Comptroller of the Currency (OCC) between 1953 and 1970, allowing for a ten-year overlap with Call Reports to confirm that the two sources are consistent with each other. The annual OCC reports contain balance sheet items aggregated at the state level for all active US banks. Throughout our analyses, we focus on "national" banks, defined as commercial banks with a federal charter, because income statements are only available for this type of banks, which received greater coverage in the OCC's reports because they were under its supervision.[17] This group accounts for half of overall banking assets and, for the period when we have complete data from the Call Reports, we confirm that results are similar to those obtained when we use all commercial banks. Figure A.1 shows an example table from the 1953 report.

For this data to be representative of banking markets in each state, we need to assume that most banking activity occurred within state lines, so that balance sheets of banks headquartered in a given state are an accurate description of the financial developments in that state. This a standard assumption in papers set in the pre-interstate-branching era, when banks could not branch across states (and, in most cases, even across cities). Because branching deregulation started picking up in 1982 and because Call Reports change substantially in 1984, we end our sample in 1983.[18]

Our main object of interest is the state-level loan interest rate. To construct it, we follow the historical literature that studied the convergence of US bank lending rates before the period we study, which also digitized reports from the OCC (starting with James 1976a, who digitized data for 1893–1911). We use income statements and balance sheets for national banks and define the loan interest rate for state j in year t as

$$r^L_{jt} = \frac{\text{Interest Earned on Loans}_{jt} + \text{Fees Charged on Loans}_{jt}}{\text{Total Loans}_{j,t-\frac{1}{2}}} \tag{1}$$

where $t - \frac{1}{2}$ indicates that total loans are taken at the end of the second quarter of the year, while the numerator is taken at the end of the last quarter.[19] This measure of local rates reflects annual

statements before 1960. Our paper focuses on 1953–83, but our panel goes back to 1942.

[17] Despite the name, national banks were always confined to branch within their state.

[18] As discussed in Kroszner and Strahan (2014), Maine started allowing entry of other states' banks in 1978, conditional on other states reciprocating the agreement. However, no state passed similar laws until 1982, when Alaska and New York also eased restrictions. Massachusetts and Connecticut followed in 1983, and most other states did so, too, in the following five years. By 1992 the de-regulation process was essentially complete, except for Hawaii.

[19] As argued by James (1978), using current loans in the denominator, instead of lagged ones, would bias rate estimates

frequency changes only if loan maturities at origination were somewhat short, or if most lending was on an adjustable-rate basis. In 1957, 62.6% of business loans, which are themselves approximately half of total bank loans, had a maturity of six months or less at origination (Redenius 2006). Appendix Section A.1 reports the other variables we have available.

There are two main challenges to ensuring that our long-ranging financial series remain consistent over time. First, the level of detail reported changes over time. For example, before 1961 savings deposits were included together with time deposits, and separately thereafter. For all our analyses, we construct variables that are as granular as possible subject to the constraint that they are consistent over our full sample period. Second, and more importantly, accounting definitions change. The most important change is that, in 1976, banks started reporting income and expenses from foreign subsidiaries on a consolidated line-by-line basis. For instance, from 1976 onward, interest income on loans included loans made by foreign branches. Before 1976, all foreign income was collapsed in a residual income category. This accounting change requires adjusting for the extent of banks' foreign operations after 1976. We detail our adjustment in Appendix Section A.2.2. The adjusted state-level series are smooth around 1976, while the raw series are not. For robustness, we also repeat our reduced form analyses excluding years after 1975 and find that, reassuringly, all results remain robust within this shorter, but consistent, time window.

Appendix Section A.2 reports other details on the data construction.

Aggregate financial data. We also digitize sector statements for households and banks from the Fed's historical Flow of Funds releases (Board's Release Z.1, 1986; 1988), which report more detailed data on households' holdings of financial assets and banks' liabilities at the US level. This has two advantages over the state-level data. First, we can directly observe household holdings. Second, this data distinguishes among small and large time and savings banks' deposits, which is important in our context since small deposits are likely retail and sourced through local branches, while large deposits are likely wholesale. The Flow of Funds data covers 1946 to 1987 and comes from a special issue where the accounting concepts relevant to us are consistent over time.

Macroeconomic data and sample. We use standard sources to collect state-level data on: population, from the Census; income and fraction of GDP from oil, from Barro and Sala-i-Martin (1992); Gross State Product, from the US Bureau of Economic Analysis (BEA); and manufacturing data, from the Census of Manufacturers as assembled in Haines and ICPSR (2010).

Following the literature, we drop Delaware and South Dakota, which experienced large shocks from the rise of credit cards in our sample period (Jayaratne and Strahan 1996; Kroszner and Strahan 1999; Mian et al. 2020). We also do not consider Alaska and Hawaii, which were not U.S. states before 1959, or the District of Columbia.

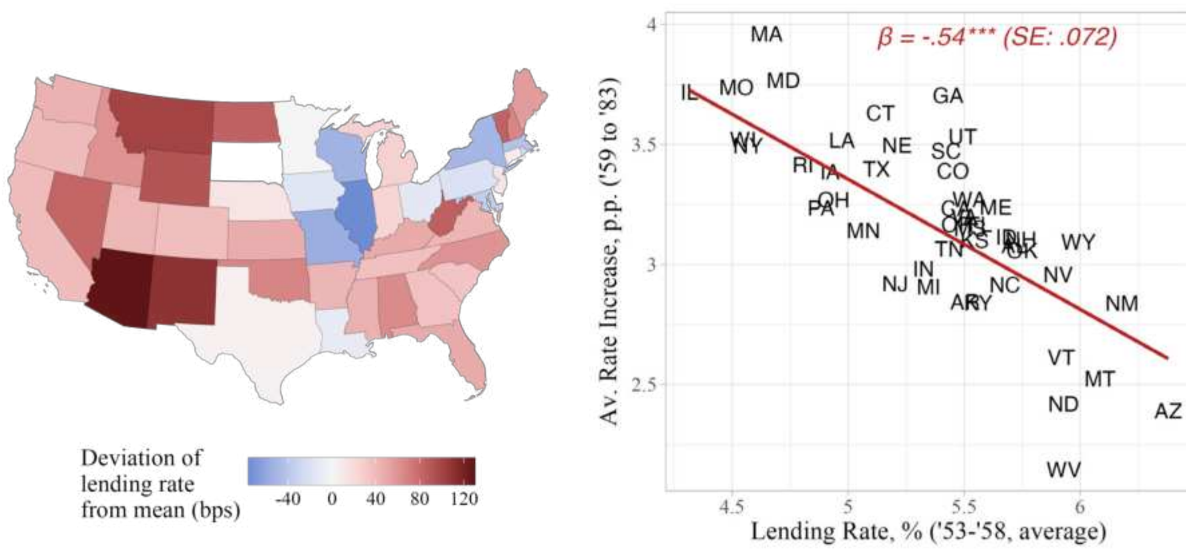
downward in areas of high loan growth. This correction largely does not matter for the reduced form results.

2 Financial Integration and the Rise of National Markets

In the US in 1950, there were 13,446 commercial banks, all prohibited from branching across state lines and, in 34 states, even outside their own city. This regulation meant that each state effectively constituted a separate banking market. Figure 1(a) shows that these markets were substantially segmented. We plot the difference in basis points between state-level lending rates and the average rate for the US. Between 1953 and 1958, interest rates ranged from 4.3% and 4.6% in Illinois and New York, to 5.5% in California, and up to 6.3% and 6.4% in Arizona and New Mexico.

FIGURE 1: SEGMENTATION AND CONVERGENCE

(A) INITIAL LENDING SPREADS IN 1953–58 (B) CONVERGENCE IN 1959–83



Notes. Panel (a) reports average basis point lending spreads in 1953–58 for each state, defined as the average lending rate in each state j between 1953 and 1958 minus the national average lending rate in the US in the same period. Panel (b) reports average changes in lending rates between 1958 and 1983 for each state, against their initial lending rates in 1953–58. Average changes in lending rates between 1958 and 1983 are defined as the average state-level lending rate in 1959–1983 minus the average state-level lending rate in 1953–58. The red line reports the best weighted linear fit and the associated coefficient, weighting states by 1950 population. Robust standard errors are in parentheses.

By 1983, however, regional spreads narrowed substantially, even though banks were still prohibited from branching across state lines, as discussed in Footnote 18. Figure 1(b) shows the average change in state-level lending rates between 1958 and 1983, defined as the average rate in 1959–83 minus the average initial rate in 1953–58, regressed against the average initial rate in 1953–58:

$$r^L_{j,\overline{59-83}} - r^L_{j,\overline{53-58}} = \alpha + \bar{\beta} \cdot r^L_{j,\overline{53-58}} + \varepsilon_j \qquad (2)$$

where j indicates a state, and $r^L_{j,\overline{t_0-t_1}}$ is the average lending rate between t_0 and t_1 in state j, $r^L_{j,\overline{t_0-t_1}} = \frac{1}{1+t_1-t_0}\sum_{t=t_0}^{t_1} r^L_{j,t}$. To be consistent with the rest of our analyses, we weight states by

FIGURE 2: YEARLY DEGREE OF FINANCIAL CONVERGENCE ACROSS STATES ($-\beta_t$)

Notes. The black line reports the negative of the coefficients (β_t) and associated 95% confidence intervals from repeated cross-sectional regressions of the change in lending rates in state j between year t and 1953–58 regressed against the initial average rate in 1953–58, weighting states by population in 1950. The repeated cross-sections always include an intercept, which partials out aggregate yearly changes. A value of $-\beta_t$ of .5 means that a state that had an interest rate that was 1 p.p. lower than the average rate in 1953–58 saw its rate increase between 1953–58 and year t by .5 p.p. more compared to the average state in that year, indicating a narrowing of regional spreads. The green line reports the level of nominal short term rates, using the three-month Treasury Bill rate.

initial population in 1950.[20] The OLS coefficient $\bar{\beta}$ is negative and economically and statistically significant. A state with one percentage point lower lending rate in the mid-50s, saw its rate increase by .54 percentage points more on average, indicating a substantial degree of convergence.

We highlight two features of this convergence that shed light on its drivers. First, financial convergence was non-monotonic and was tightly linked to the level of nominal rates. We repeat the convergence regression in (2) separately for each year between 1959 and 1983, estimating repeated cross-sectional regressions:

$$r^L_{jt} - r^L_{j,\overline{53-58}} = \alpha_t + \beta_t \cdot r^L_{j,\overline{53-58}} + \varepsilon_{jt}$$

where $r^L_{jt} - r^L_{j,\overline{53-58}}$ is the change between the interest rate in state j at time t and the average rate in 1953–58. The β_t coefficients thus decompose the average $\bar{\beta}$ over time.

Figure 2 reports the negative of the dynamic coefficients ($-\beta_t$) in black for each year, along with 95% confidence intervals. A higher value of $-\beta_t$ means a stronger degree of convergence. The green line (right axis) plots the monthly level of the three-month Treasury Bill rate. The figure shows that the degree of convergence is closely tied to the level of aggregate nominal rates.

[20] Weighting states largely does not matter for all of the qualitative results of the paper, and we replicate all reduced-form analyses without weights in Appendix G.

As nominal rates increased in 1969, regional spreads narrowed: on average, local lending rates increased by .70 p.p. more in a state with a percentage point lower initial lending rate. However as nominal rates fell in 1972, regional spreads opened up again: on average, local rates increased only by .15 p.p. more in a state with a percentage point lower initial rate. The correlation between β_t and r_t is of .89 in levels, and of .71 in year-over-year changes. Yet there is a priori no mechanical force linking β_t and r_t—the coefficients come from repeated cross-sectional regressions that partial out yearly intercepts—which motivates a theory that explains their tight co-movement.[21]

The second feature we highlight is that financial convergence over our period was accompanied by a rapid and dramatic change in the way households decided to store their liquidity and, accordingly, in the type of funding available to banks. At the time, Regulation Q prohibited banks from offering any remuneration on checking accounts, so that the opportunity cost of holding checking accounts rose one-for-one with the nominal rate. Panel (a) of Figure 3 shows that households increasingly shifted to holdings of quasi-money that, while maintaining high liquidity, offered nominal remuneration that kept up with inflation. The black line reports households' money market holdings as a fraction of income, while the dashed green line is again the three-month Treasury Bill rate. We define money market holdings as the amount invested in large time deposits, commercial paper, and money market fund shares (the latter were zero before 1974), all coming from the historical Flow of Funds releases we digitized. The left-hand side reports variables in levels, and the right-hand side in changes.

In the 1950s, the household sector held .1% of its income in the money market, only \$7.6B in 2019 dollars. By 1981, money market holdings grew more than one hundred-fold, reaching \$836B and shooting up to 14.6% of income. The correlation between money market holdings as a fraction of income and the three-month Treasury Bill rate is of .96 in levels and of .77 in changes.

Panel (b) shows that, at the same time, national money markets became a more important source of funding for banks, replacing local deposits. The solid black line reports banks' national liabilities as a fraction of total assets. We define national liabilities as large time deposits, net Fed Funds and Repos, commercial paper, and bank bonds, which also all come from the historical Flow of Funds releases we digitized.[22] These developments in the way that banks financed themselves closely mirror those for households assets. National funding went from 6% of total assets (\$104B) in 1953 to 32% (\$1,405B) at its peak in 1980, rising alongside r_t. The correlation between national

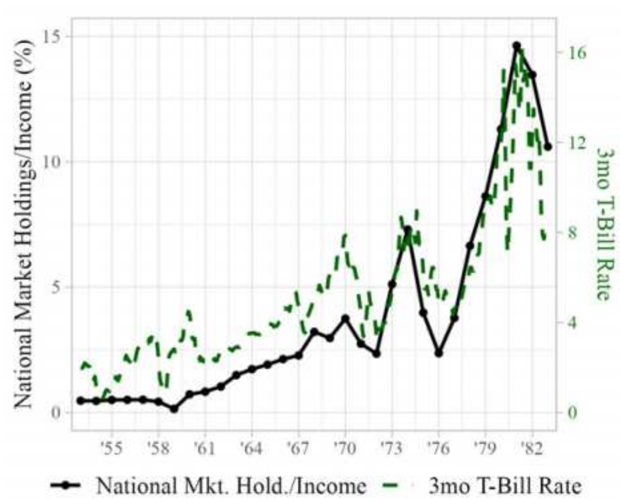
[21] Appendix Figure C.4 shows that the correlation between β_t and r_t is mostly driven by changes in nominal rates rather than real ones. Some of the changes can also be directly attributed to monetary policy interventions, for instance around the four narrative Romer and Romer (1989) shocks of our period, or when President Nixon pressured Fed Chair Arthur Burns to ease monetary policy in the run-up to the 1972 election (Abrams 2006; Drechsel 2024).

[22] A limitation of this data, however, is that we observe the net position of the banking sector in terms of Fed Funds and Repos. They do not necessarily net to zero because they can be held by other financial institutions beyond the commercial banking sector, but we are missing interbank positions. The figures anticipated in the introduction instead take interbank positions into account, as they come from separate releases (H.4.2 and H.5) covering only large banks.

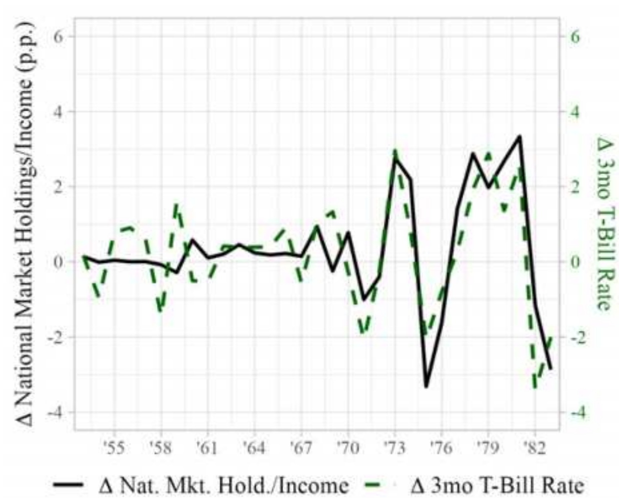
FIGURE 3: NATIONAL MARKETS AND AGGREGATE RATES

(A) HOUSEHOLD ASSETS

(A.I) LEVELS

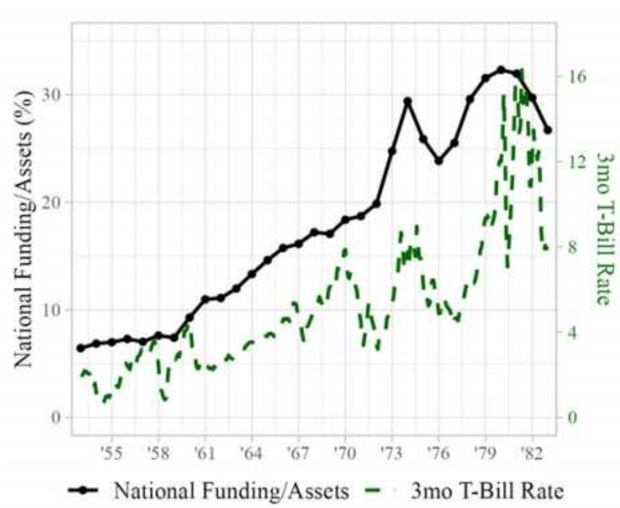


(A.II) CHANGES

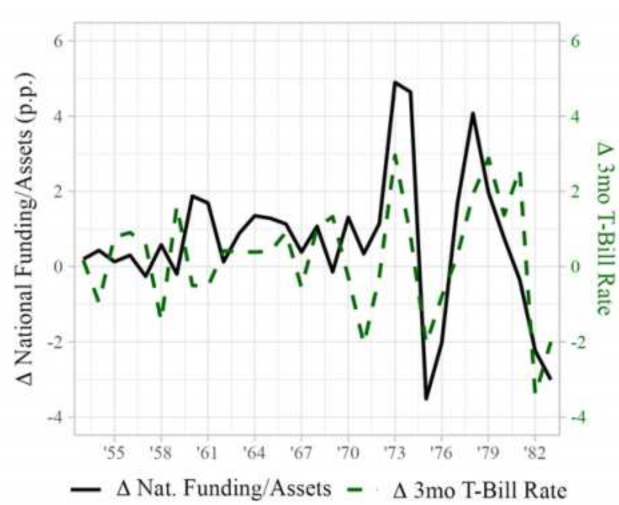


(B) BANK LIABILITIES

(B.I) LEVELS



(B.II) CHANGES



Notes. Calculations from historical Fed releases Z.1 (1986; 1988). The black lines in Panel (a) report holdings of the household sector in short-term national market securities as a fraction of households' income. Short-term national market securities are defined as money market fund shares, large time deposits, and commercial paper. The dashed green lines report the short term nominal rate, defined as the rate on three-month Treasury Bills. The black lines in Panel (b) report national market liabilities of the commercial banking sector as a fraction of total assets. National market liabilities are defined as large time deposits, bonds, Fed Funds and Repo borrowings, and commercial paper. For both panels, left-hand side figures plot series in levels while the right-hand side figures plot year-on-year changes.

liabilities as a fraction of assets and the three-month Treasury Bill rate is of .90 in levels and of .59 in changes.[23]

Several observers at the time noted that banks' increased reliance on national sources of funding was an explicit reaction to the outflow of local deposits caused by rising nominal rates. The best example of this is the invention of negotiable certificates of deposits (NCDs) by Walter Wriston, a banker at New York's Citibank who would become its CEO. Wriston introduced NCDs as a way to make up for the bank's slow growth in deposits by bidding for funds outside of the state (Stigum 1978, p. 107).[24] NCDs revolutionized bank financing and rapidly became the second-largest money market instrument, after only short-term Treasury Bills. Fed economists also noted increased use of repurchase agreements "to attract funds from a public that has become sensitive to the yields it receives on its liquid assets as market rates of interest have soared" (Scadding 1979).

The next section develops a model that clarifies why these developments can foster financial convergence. The intuition is that the nationalization of bank balance sheets caused by rising nominal rates leveled the playing field across regions in terms of banks' access to sources of financing. This led to a convergence in banks' financing costs and, in turn, in lending rates. It is likely that, in addition to leveling the playing field in terms of funding sources, these developments also made banks better at tapping wholesale markets, as suggested by the accounts of that period. That is, national financing might have become more efficient and less costly. This also might have contributed to the convergence we document, but in the more traditional (and secular) fashion that the historical financial literature has long covered (cf. fn. 14). The model takes both channels at heart.

3 A Banking Theory of Financial Integration

This section develops a static spatial model of frictional mobility of capital across banking markets within a country, which generates endogenous lending differentials that explain the trends we documented above. To clarify the forces at play, we develop the simplest version of the model. Appendix Section B.3 discusses and develops several extensions. In Section 7, we will then nest

[23] Appendix Figure C.5 plots the same time series but focuses on local household holdings as a fraction of household income and local bank liabilities as a fraction of total liabilities. They roughly mirror the patterns of Figure 3, although the data quality for households is inferior because we cannot distinguish between retail deposits and cash, and we cannot directly distinguish between small deposits held at banks and at nonbanks. These developments are the flip side of those that Supera (2021) documents right after our period, who shows that the decline in nominal short rates since the 1980s drove depositors away from time deposits and back to more liquid deposits.

[24] Geographic constraints to funding were front of mind for Wriston. In the words of Stigum (1978): "In the early 1960s the demand for funds at New York money market banks began to outstrip their traditional sources of funding. Moreover, these banks had no way to bid for funds outside their own geographic area. To solve this problem, Citibank introduced the negotiable CD". Similarly, Zweig (1996) reports several telling accounts. Lewis Preston, a JP Morgan banker who later became its CEO, remarked: "We might have been worried about interstate banking if Wriston hadn't invented the negotiable CD" (p. 142). Charles Williams, Harvard emeritus professor, described NCDs as giving banks "a degree of freedom from having to lend to their depositors and depend on their depositors. It gave them mobility. You could buy in one market and lend to another" (p. 143).

this model in a dynamic spatial general equilibrium model to study the real effects of financial integration. However, the financial predictions that we reach here will remain unchanged. All derivations are in Appendix Section B.1.

3.1 Setup

We consider a country (or currency union) consisting of J regions, each indexed by j, which are populated by a measure N_j of households who inelastically supply labor; a representative capitalist that supplies physical capital K_j; firms that employ households and rent physical capital; and banks. The model for now is static, so we omit a time index in this section. However, each static period that we consider is divided in two sub-periods. The start of the period, which we call the "morning", and the end, which we call the "evening".

Firms need to borrow to begin production in the morning, before selling their goods in the evening. We assume that a fraction of this borrowing is constrained to come from local banks (e.g., for loans that need monitoring, as in Diamond 1984), while the remainder can be financed using internal capital or the bond market at the aggregate rate. Households receive their wages in the morning but consume in the evening. Thus, they need a way to safely store their income. Banks intermediate between households and firms: they collect liquidity from households and use it to provide loans to firms. The model generates endogenous differences in lending rates across space, taking the nominal aggregate short rate r as given. We can think of r being pinned down by the central bank, changes in inflation (e.g., the OPEC shocks of our period), or international investors. In our period, the driving force of our channel is inflation rather than changes in the real rate.

The population and the physical capital stock in each region (N_j and K_j) are assumed fixed in the static version of the model. In the full dynamic model, labor and physical capital will follow the endogenous law of motions determined by migration and investment choices, but this does not change any of the conclusions from this section.

3.1.1 Loan Demand: Firms

In the morning firms set up production of a nationally traded good that we use as numeraire, with an evening price of 1. To produce, a firm uses labor N and physical capital K, according to a standard Cobb-Douglas function $F(N, K) = z_j N^{\alpha_N} K^{\alpha_K}$, where z_j is local total factor productivity (TFP) and $\alpha_N + \alpha_K = 1$. Real input costs for the firm are thus $w_j N + r_j^K K$, where w_j are local wages and r_j^K is the local rental rate of physical capital, both determined competitively.

Because production is set up in the morning, the firm has to finance these inputs before selling in the evening. Financing can occur either through local banks, using internal funds, or on the bond market. In particular, we assume that firms in region j need to finance a fraction ξ_j of upfront input payments with a loan from local banks, at a rate r_j^L to be determined in equilibrium, and the remaining fraction with internal funds or nationally-issued bonds, at a cost of r (this captures the opportunity cost of funds if these are financed internally).

ξ_j can vary across regions and is a reduced-form way to capture financial constraints for firms. For instance, it captures differences across regions in the availability of internal capital to finance inputs; or in the degree at which firms could be able to frictionlessly access a national market with a homogeneous rate; or in other determinants of financing needs, such as the length of the production process. Here we take ξ_j as a primitive for simplicity, but in Appendix Section B.3.4 we extend our results to the case where ξ_j endogenously depends on the spread between the local lending rate and the aggregate rate r.

Loan demand is then the fraction of inputs that the firm needs to finance:

$$L_j^D = \xi_j \Big(\underbrace{w_j N_j + r_j^K K_j}_{\text{Cost Net of Financing}} \Big) = \xi_j \left(\frac{y_j}{\alpha_N} \right) \tag{3}$$

where $y_j = w_j N_j$ is labor income in region j, and the last equality comes from the fact that profit maximization implies $r_j^K K_j = \frac{1-\alpha_N}{\alpha_N} y_j$. The demand curve is thus downward sloping in the local lending rate r_j^L because firms that face higher lending rates cut production, which decreases their real costs and hence the loans they take out.

3.1.2 Deposit Demand: Households

Each household i in region j earns its wage w_j, to be determined in equilibrium, in the morning. Households are hand-to-mouth, meaning that they consume all of their income in each period. However, because consumption occurs in the evening, households need to choose how to store their wage. We assume that they can either store it in bonds, which pay a rate of r, or in deposits, which are unremunerated but offer liquidity services.[25] This is the only choice that we need to consider here. We assume for simplicity that only households use their local bank to store liquidity, while owners of physical capital always use national bonds.

Liquidity services from deposits in region j yield benefits that are parametrized by a shifter χ_j, where a higher χ_j means that households value liquidity more in region j. This shifter captures regional differences in the ease of accessing banking services (due, for instance, to the distribution of branches), in costs of investing in bond markets, in the fraction of seniors (who have higher deposit demand, see, e.g., Becker 2007), in some intrinsic preferences, or in other regional characteristics.

Our key object of interest is the aggregate fraction of regional households' income held in deposits. We denote this as $\varphi\left(r - \chi_j\right)$, where $r - \chi_j$ is the net opportunity cost of holding deposits:

[25] The assumption that checkable deposits pay no rate fits exactly with our empirical setting, where Regulation Q prohibited banks from paying interest on demand deposits. While this simplifies the analysis, Section B.3.3 shows that it is not necessary for the logic of the model to work by deriving the case with remunerated savings deposits.

the return from bonds, r, minus the liquidity services in the region, χ_j. To microfound $\varphi\left(r-\chi_j\right)$, we assume that each household i makes a binary choice between holding income in bonds or in deposits and that they receive an idiosyncratic benefit of holding liquidity, ε_{ij}, on top of the regional shifter. This captures random differences across households within a region in how much they value liquidity over bonds. Household's i liquidity services are $\chi_j+\varepsilon_{ij}$, where χ_j is the regional liquidity shifter we introduced above and we assume that ε_{ij} is distributed exponential with parameter ϕ. Utility is linear in consumption C_j and in the liquidity services $\chi_j+\varepsilon_{ij}$ associated with how they store their real wage w_j if they decide to store it in deposits. Denoting m the binary choice on whether to invest in a bond or not, households solve:

$$\max_{m\in\{0,1\}} \underbrace{C_j}_{\text{Consumption}} + \underbrace{w_j(1-m)\left(\chi_j+\varepsilon_{ij}\right)}_{\text{Liquidity Services}} \qquad \text{s.t.} \quad C_j = w_j\left(1+mr\right) \tag{4}$$

Thus, household i decides to hold deposits if and only if $r\leq\chi_j+\varepsilon_{ij}$. Total deposit demand from households, D_j is hence given by the income of the fraction of households whose benefit from liquidity is higher than the return from the bond. D_j is thus decreasing in the nominal rate r and follows:

$$D_j=\varphi\left(r-\chi_j\right)w_jN_j=\exp\left(-\phi(r-\chi_j)\right)y_j \tag{5}$$

where $\varphi\left(r-\chi_j\right)=\exp\left(-\phi(r-\chi_j)\right)$, given that $\varepsilon_{ij}\sim\text{Exp}(\phi)$, with $\varphi'<0$ and $\varphi''>0$.[26]

In Appendix Section B.3.1, we show that the results do not hinge on this specific microfoundation. For the logic of the model to hold, we only need the share of regional income invested in bonds $(1-\varphi)$ to be increasing in $r-\chi_j$ and, for some results, to be also concave in $r-\chi_j$.

3.1.3 Banks

Each location is populated by a unit measure of competitive representative banks, which collect liquidity from households and lend to firms. Each bank is present only in one location, in line with the fact that banks were prohibited from branching across states. However, this can also be interpreted as banks being restricted by regulation from using internal capital markets to transfer deposits across space.

Banks can raise financing in two ways. They can raise financing locally by issuing unremunerated deposits D, whose supply they take as given in the short run since they cannot remunerate them, so that $D=D_j$.[27] They can raise financing nationally by issuing bonds M on a wholesale

[26] An isomorphic formulation is saying that households have a cost of investing in the bond market or heterogeneous returns, and that these vary across households (perhaps because they have access to different investment options). Indeed, we can restate the return from the bond as $r-\varepsilon_{ij}$ and the return from holding deposits as being fixed to χ_j.

[27] Appendix Section B.3.3 considers the case where banks can stimulate local deposit demand by issuing remunerated

market for short-term securities. Deposits and bonds together can fund loans, L, so that the budget constraint of the bank is $L = D + M$.[28]

Our key friction is that the cost of issuing wholesale financing is convex. For the first marginal unit of national financing the bank pays the national rate r, but all other units come at a convex cost scaled by a friction θ. For a bank with assets L that has issued bonds M the cost of wholesale (national) financing is quadratic in bonds and constant to scale. The increasing part of the cost of issuing bonds follows $\frac{\theta}{2}\left(\frac{M}{L}\right)^2 L$. The assumption that banks face increasing marginal costs of non-deposit financing permeates the banking literature and is necessary to give rise to the bank lending channel of monetary policy.[29] The core idea of our setup is that deposit financing is also *local* when banks cannot branch across regions (or if there are regulatory barriers to deposits crossing borders), so that this common violation of Modigliani-Miller now bites differentially across space.

Banks lend at rate r_j^L, to be determined competitively and taken as given by each bank. Profits accrue to absentee national shareholders, and the profit maximization problem reads:

$$\max_{L,M} \quad r_j^L L - rM - \frac{\theta}{2}\left(\frac{M}{L}\right)^2 L \qquad \text{s.t.} \quad L = D_j + M \tag{6}$$

The solution to this problem pins down bond issuance and an upward sloping regional loan supply function, which depends on deposits, the nominal aggregate rate, and local lending rates.

3.2 Equilibrium Lending Rates

The market clearing lending rate equates (3) and the loan supply function that solves (6). Let $\gamma_j(r)$ be the ratio of deposit demand over loan demand in equilibrium, $\gamma_j(r) = D_j/L_j$. Local lending rates follow $r_j^L = r + \frac{1}{2}\,\theta \times \left(1 - \gamma_j(r)^2\right)$, so that differences in lending rates across two regions j and h satisfy:

$$r_j^L - r_h^L = \frac{1}{2} \underbrace{\theta}_{\substack{\text{Friction of}\\ \text{accessing the}\\ \text{national market}}} \times \underbrace{\left(\gamma_h(r)^2 - \gamma_j(r)^2\right)}_{\substack{\text{Regional differences in ratio}\\ \text{of loans funded with}\\ \text{households' deposits}}} \tag{7}$$

savings deposits. The logic discussed here holds so long as there exists a local source of infra-marginal cheap financing.

[28] We consider a region of the parameter space in which deposits are always lower than loan demand so that there is no region that has an excess supply to lend on wholesale markets. This fits with the observation that all state-level banking sectors resort, at the aggregate state level, to some wholesale financing. Appendix Section B.3.2 shows that adding an interbank market where banks can lend to other banks does not alter the results. The interbank market is just a normal national market with the same frictions as other wholesale markets.

[29] The bank lending channel rests on two premises: first, that monetary policy affects the amount of deposits available to banks; second, that deposits are "special" in that they are not readily substitutable at the same cost with other sources of funding, so that a decrease in deposits raises marginal costs for banks. Our results also rest on these two premises.

Regional spreads are exclusively a function of primitives because the ratio of deposits over loans in equilibrium is itself a function of primitives, given by:

$$\gamma_j(r) = \frac{\alpha_N \varphi(r - \chi_j)}{\xi_j} = \frac{\alpha_N \exp(-\phi(r - \chi_j))}{\xi_j} \tag{8}$$

where recall that φ is the share of regional income held in deposits, α_N is the labor share of income, and the second equality comes from our assumption that the liquidity taste is exponentially distributed. Total income at the regional level cancels out because, as shown in Equations (3) and (5), loans and deposits are both shares of income: loans finance firms' costs and a fraction of those costs comes back to the bank as deposits from households. This feature allows us to solve for financial prices without specifying the law of motion of real variables, but the qualitative results are robust to a setup where income does not cancel out.

Equations (7) and (8) imply that regional spreads depend only on regional differences in the *ratio* of deposits over total loans, scaled by the friction of accessing the national market. These differences depend on how constrained firms are in borrowing from banks, which is controlled by ξ_j, vis-à-vis how likely households are to choose deposits over bonds, which depends on preferences for liquidity, χ_j, and on the aggregate nominal rate, r. The dependence of deposits on the nominal rate leads us to our main result. All proofs are in Appendix Section B.1.

Proposition 1 (Nominal and Secular Channels of Financial Convergence)**.** *An increase in the aggregate nominal rate reduces regional spreads, and so does a decrease in the friction θ.*

The decline in the friction θ describes a traditional "secular channel" of convergence. Holding constant differences in reliance on national financing, a decline in θ erodes regional spreads just because national markets become less frictional.

The fact that an increase in nominal rates also erodes regional spreads is our "nominal channel" of convergence, which rationalizes the time-varying pattern of financial convergence of Figure 2. The following lemma provides the intuition for our channel.

Lemma 1 (Heterogeneous Pass-Through)**.** *An increase in the nominal aggregate rate has a larger pass-through in a region where banks fund more of their loans with deposits. That is:*

$$\frac{\partial^2 r_j^L}{\partial r \partial \chi_j} > 0 \qquad \frac{\partial^2 r_j^L}{\partial r \partial(-\xi_j)} > 0$$

The logic of our channel can be summarized in two steps. First, as nominal rates rise, local lending rates increase by more in regions that are more reliant on deposits. These regions experience larger outflows of deposits (as a ratio of assets), compared to regions that are less reliant on deposits, and in turn see their marginal costs increase by more, which leads to the lemma above. Second, to reach Proposition 1, it is enough to note that these deposit-abundant places also had lower rates to start with, as shown in (7). Thus, as nominal rates increase, local lending rates increase more in initially deposit-abundant and low-rate states, pushing for convergence.

The larger decline in the deposit share of assets in initially deposit-abundant regions does not strictly require a particular shape of the deposit demand function. For instance, consider two regions A (abundant) and S (scarce) with the same income, where households had an identical deposit demand schedule that is declining in nominal rates with arbitrary form. Assume that firms in S are more dependent on local banks, so that $\xi_S > \xi_A$. This implies that the deposit share of assets is higher in A compared to S because banks in A face lower loan demand but the same deposit demand. Yet an increase in the nominal rate affects A more, even if outflows from households are identical in absolute terms. An identical outflow is larger in A as a *ratio* of assets because banks in A were funding fewer loans. This then implies that marginal costs rise in A more because marginal costs depend on the share of assets financed with deposits.

However, we need to impose restrictions on the shape of the deposit demand function when regional differences come only from deposit demand from households (χ_j) and the firm side is identical. Sufficient, but not necessary, conditions in this case are that the deposit share of income is constant elasticity with respect to the opportunity cost of holding them, $r - \chi_j$, or that it is convex in this opportunity cost (as in our microfoundation). This implies that deposit-rich places experience weakly larger outflows (as a share of income) because households are at a steeper part of their demand schedules.

Appendix Section B.1.1 discusses the intuition in more detail. Appendix Section B.3.1 derives the conditions on deposit demand described above for a general case and also develops the case with an arbitrary convexity on the cost of external finance. Appendix Sections B.3.2 to B.3.4 show that results are robust to having an explicit interbank market, allowing deposits to be remunerated, and for the ξ_j to be endogenously determined.

4 Testing the Nominal Rate Channel of Financial Integration

We now test the main implications of our nominal channel of integration. Section 4.1 expands on the motivating evidence of Figures 1 and 2, showing that the narrowing of regional spreads cannot be explained only by secular forces, even after we control for initial demographic and macroeconomic characteristics and look at spreads within broad regions of the US. In Section 4.2, we provide more evidence on the mechanisms through which our nominal channel operates.

4.1 Secular and Nominal Channels of Convergence

Our model's main prediction is that the pass-through of nominal rates on local lending rates is lower in states with initially high lending rates, so that an increase in nominal rates ends up narrowing regional spreads. The most direct test of this regresses local lending rates on state fixed effects, year fixed effects, and initial lending rates interacted with the level of nominal rates. This interaction captures whether the pass-through of nominal rates is different depending on the level of nominal rates. That is, we estimate:

$$r^L_{jt} = \alpha_j + \psi_{R(j),t} + \beta \cdot r_t \cdot r^L_{j,53-58} + \kappa_t \cdot \boldsymbol{X}_j + \eta \cdot \boldsymbol{C}_{jt} + \varepsilon_{jt} \tag{9}$$

where the α_js are state fixed effects; $\psi_{R(j),t}$s are region-by-year fixed effects, which capture common changes to states in six broad regions of the US, including changes due to aggregate changes in nominal rates r_t; and $r^L_{j,53-58}$ are local lending rates at the start of our period (1953–58).[30] Adding region-by-year fixed effects implies that we are only exploiting differences within region, ensuring that our results are not driven only by broad changes in the South and West compared to the Northeast. The $\boldsymbol{X}_j$ vector controls for financial and macroeconomic initial conditions that might be correlated with initial rates and might also be correlated with heterogeneity in pass-through of nominal rates. In particular, we allow for yearly coefficients κ_t that capture the time-varying effects of several initial conditions: 1953 population density and the log of population and income per capita; the 1950 fractions of rural population, of employment in manufacturing, GDP coming from oil, and of population above 65 years old of age; and initial HHI of banking assets in 1961, which controls for the fact that changes in lending rates might depend on initial market power—perhaps if banking markets were becoming more competitive over time.[31] $\boldsymbol{C}_{jt}$ is a vector of time-varying state-level controls that may be correlated with interest rates over time. These include the composition of loans to non-financial institutions, which control for evolving types of lending portfolios; and lagged population and income per capita growth, to capture the fact that interest rates might be rising in states that experience higher growth.[32] Standard errors are two-

[30] Throughout the paper we use the OCC definition of regions, which divides states into South, Pacific, West (excluding Pacific coast), Midwest, New England, and East (excluding New England). Appendix Section A.3.1 reports these groupings.

[31] We choose 1950 for variables that we need to construct from the census. 1961 is the first year in which we can construct the HHI, because we need the bank level data. Adding current as opposed to initial HHI does not alter the results, but it effectively means adding a "bad control" (Angrist and Pischke 2009), since HHI could also be an outcome of convergence. Appendix Table D.2 reports the correlation coefficients between initial lending rates and initial characteristics. Rates are lower in places with a higher share of seniors, which is coherent with findings in Becker (2007), Auclert et al. (2021), and Angelova and D'Amico (2024), and in more populous and richer states (as in Angelova and D'Amico 2024).

[32] In terms of loan portfolio composition, we control for the fraction of loans that were commercial and industrial loans, agricultural loans, consumer loans, loans secured by real estate, and other nonfinancial loans. Loan portfolio

way clustered at the state and year level and we weight each state by initial population in 1950. Unweighted results are similar and are reported in Appendix G.

The model predicts that $\beta < 0$. Yet, because nominal rates also increased secularly, a secular decline in bank financing frictions θ_t would also cause β to be negative. To isolate the cyclical component, we exploit only annual changes in nominal rates by estimating a variant of (9):

$$\Delta r^L_{jt} = \alpha^\Delta_j + \psi^\Delta_{R(j),t} + \beta^\Delta \cdot \Delta r_t \cdot r^L_{j,53-58} + \kappa^\Delta_t \cdot \boldsymbol{X}_j + \eta^\Delta \cdot \boldsymbol{C}_{jt} + \varepsilon^\Delta_{jt} \tag{9'}$$

where Δ in front of a variable indicates year-on-year changes, i.e., $\Delta x_t = x_t - x_{t-1}$. The superscript on the coefficients is just to ease notation, indicating that we estimate different coefficients in the two different specifications.

This specification clearly isolates our channel from the traditional secular channel of convergence. If changes in r_t cause convergence, we should expect both β and β^Δ to be negative.[33] If only secular forces were at play, we would also predict $\beta < 0$, just because nominal rates increased secularly over our period. Yet we would expect $\beta^\Delta = 0$ because all secular forces would be captured by the fixed effect α^Δ_j, which captures average changes in lending rates over time. That is, our nominal channel in Proposition 1 is qualitatively invariant between β and β^Δ, predicting both $\beta < 0$ and $\beta^\Delta < 0$, while the traditional channel is not.

Table 1 reports the results. The first four columns report the specification in levels (β), while the last four report the specification in changes (β^Δ). The columns progressively add controls, and the first column does not include the year fixed effects in order to report the unconditional pass-through of r_t on local lending rates, which is naturally very strong and close to 1 in levels for the average state. Yet the interaction terms show that this pass-through is highly heterogeneous across space in all specifications. In a state with a 1 percentage point higher initial local lending rate, the pass-through of r_t on local rates is between .09 and .15 percentage points lower, leading to a narrowing of regional spreads. The heterogeneity in pass-through is almost the same in changes, as the nominal rate channel—but not the secular one—predicts. In a state with a 1 percentage point higher initial local lending rate, year-over-year changes in the aggregate rate pass-through by .13 and .18 percentage points less into year-over-year changes in local lending rates. These patterns are robust across all sets of controls and, if anything, they are stronger as we add controls or as we look only at lending spreads within regions.

We can interpret Table 1 as a collapsed analog of the repeated cross-sectional regressions shown in Figure 2—which shows that local lending rates increase more in initially low-rate states in a pattern that mirrors the path of nominal rates. However, Table 1 allows us to directly isolate

composition is correlated with the lending rate, but it also might be an outcome of capital scarcity rather than just a fundamental driver of spreads, hence is also likely to be a "bad control". Results do not hinge on its inclusion.

[33] The relative levels of β and β^Δ are determined by the shape of the deposit demand function.

TABLE 1: LOWER PASS-THROUGH OF AGGREGATE RATES IN INITIALLY HIGH-RATE STATES

	Dependent variable:							
	State-level Lending Rate (pp), $r^L_{j,t}$							
	In Levels				In Changes			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US 3mo T-Bill Rate (pp), r_t	1.320							
	(.003)							
$r^L_{j,53-58} \times r_t$ (β)	−.090	−.099	−.155	−.146				
	(.011)	(.021)	(.024)	(.034)				
ΔUS 3mo T-Bill rate (pp), Δr_t					1.101			
					(.144)			
$r^L_{j,53-58} \times \Delta r_t$ (β^Δ)					−.130	−.138	−.177	−.149
					(.027)	(.045)	(.050)	(.050)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.89	.99	.99	.99	.62	.9	.92	.94
Within R^2	–	.19	.27	.48	–	.15	.15	.41
State FEs	✓	✓	✓	✓	✓	✓	✓	✓
Year FEs		✓	✓	✓		✓	✓	✓
Financial Controls		✓	✓	✓		✓	✓	✓
Region × Year FEs			✓	✓			✓	✓
Macro Controls				✓				✓

Notes. The table reports results from a WLS regression of state-level financing rates in each year between 1953 and 1983, against initial lending rates in 1953–58 interacted with the level of the three-month Treasury Bill rate and its changes. Observations are weighted by population in 1950. Controls are defined in Section 4.1.

the role of the nominal rate, providing a sharp test against the more traditional secular story of convergence, and to succinctly illustrate its robustness across controls and region fixed effects.

Alternative explanations. We address two possible alternative explanations for the heterogeneous pass-through we observe. The first is that the pattern of spreads is related to the overall strength of the US economy, not to aggregate rates, so that the relationship between spreads and aggregate rates is spurious. For instance, spreads might be converging as the US economy is growing, and they open up again as it slumps. Appendix Table D.4 repeats equations (9) and (9') but interacts initial rates with US GDP growth, rather than with the nominal rate. The coefficient in levels does indicate that convergence is somewhat faster when the economy booms, but this only comes from a secular trend and is not true in changes. Furthermore, any correlation between GDP growth and lending spreads—either in changes or in levels—completely vanishes when we also include nominal rates. Instead, the coefficients on nominal rates are almost identical to those without adding aggregate GDP growth. Similarly, Appendix Table D.5 shows that fluctuations in the short-term real rate also do not pass-through differentially across space, and that all the heterogeneous pass-through comes from fluctuations in the nominal rate.

Finally, another possible explanation of our findings is that they are driven by time-varying risk premia. If risk premia decline in years of high aggregate nominal rates, and if initial spreads depend on risk, then this would imply that spreads narrow faster in high-rate years, again pointing at a spurious correlation between convergence and r_t. However, as shown in Appendix Figure D.6, risk spreads, measured by the spread between Moody's BAA and AAA seasoned corporate bond yield, were *increasing* with the level of nominal rates (something in line with search for yield theories, e.g., Hanson and Stein 2015; Martinez-Miera and Repullo 2017). If anything, this would have pushed in the opposite direction if differences in risk were a large driver of regional spreads.

4.2 Mechanisms

We now turn to testing the mechanisms of our nominal rate channel.

4.2.1 Financial Convergence via Deposit Outflows and Banks' Financing Costs

Lemma 1 says that the pass-through of nominal rates into local lending rates is larger in deposit-abundant places, and this is what gives rise to the result in Proposition 1. The argument is that deposit-abundant states lose a larger fraction of funding when nominal rates rise and banks' funding costs and lending rates increase more as a result, ultimately leading to convergence.

Thus, the model gives us three more testable predictions. First, local lending rates and banks' funding rates should show similar patterns. That is, if we were to redo the repeated cross-sectional analyses of Figure 2 or their collapsed analog in Table 1 using banks' financing rates on the left-hand side, we should see the same pattern of coefficients. Second, the initially low-rate states should be those where deposits were initially abundant. As a result, the paths of lending and financing rates in initially low-rate states should be identical to those in initially deposit-abundant states. That is, redoing Figure 2 and Table 1 with initial deposit abundance on the right-hand side should give similar coefficients for both financing and lending rates. Finally, these patterns should be accompanied by higher deposit outflows in initially deposit-abundant and low-rate states.

The challenge to testing these links is measurement. We lack good measures of banks' marginal cost of funds as well as of the share of local (retail) deposit funding. We measure banks' financing rates using the rate paid on time and savings deposits, which we construct by dividing total interest expense on deposits divided by the total stock of time and savings deposits, which were the only types of deposits offering remuneration. This is the cleanest measure we have that is consistently available. To proxy for the share of local (retail) deposit funding, we use the fraction of liabilities funded via demand deposits. This is only a lower bound. Demand deposits are surely local because the only benefit of holding them is given by the liquidity services that customers receive at the branch, but we are missing retail time and savings deposits. In the data, these retail time and savings deposits are lumped together with all time and savings deposits, which include, for example, the large NCDs sold on national wholesale markets. Reassuringly, however, Appendix Table

D.3 shows that, as predicted by the model, the share of demand deposits is negatively correlated with initial rates.[34]

Using these proxies, we replicate Figure 2 by estimating the following generalized dynamic differences-in-differences regression:

$$y_{jt} = \alpha_j + \psi_t + \sum_{\tau \neq 1958} \beta_\tau^{y,x} x_{j,53-58} + \kappa_t \cdot \boldsymbol{X}_j + \eta \cdot \boldsymbol{C}_{jt} + \varepsilon_{jt} \tag{10}$$

where y_{jt} is either the state-level bank lending rates or the rate paid by banks on time and savings deposits. The initial condition $x_{j,53-58}$ is either the initial interest rate or the initial share of demand deposits over total bank liabilities. α_j and ψ_t are state and year fixed effects, and the controls are the same as in (2). Adding region-by-year fixed effects shows even stronger patterns, but (10) allows us to gauge at the conditional convergence across US states when $x = r^L_{j,53-58}$. The omitted year is 1958. Standard errors are two-way clustered at the state and year level, and we weight each state by initial population in 1950. Unweighted results are similar and reported in Appendix G.

Figure 4 reports the results. The black lines report coefficients $\beta_\tau^{y,x}$ when the dependent variable is the local lending rate, while the red lines report them when it is the bank financing rate. The top panel reports the coefficients when the initial condition $x_{j,53-58}$ is the 1953–58 lending rate, while the bottom panel uses the 1953–58 demand deposits share of liabilities as $x_{j,53-58}$. As in Figure 2, when we use the initial rate as initial condition, we report the negative of the coefficient, so to read it as the change in lending rates between 1958 and year t in a state with a one percentage point lower rate at baseline.

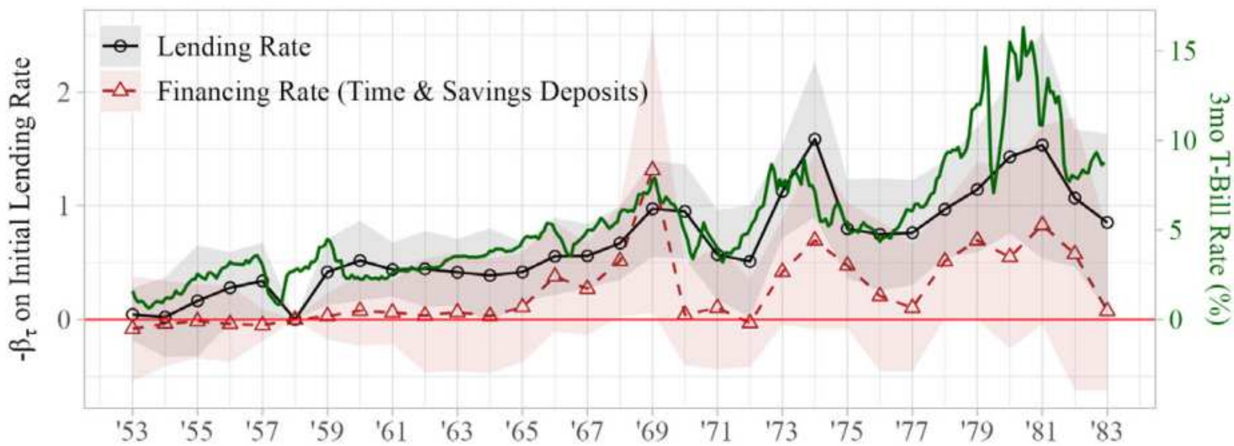
The black line in the top panel replicates our key finding from Figure 2, but with added controls. We include this as a reference for comparing the patterns across other specifications. The red line in the top panel shows that the pattern of lending rates is mirrored by that of financing rates. Furthermore, as Panel (B) shows, the results are essentially identical if we look at changes in local lending and financing rates as a function of initial deposit abundance. That is, as the model predicts, bank lending and financing rates increase more in initially low-rate states, compared to the average state, and, to an almost identical degree, also in initially deposit-abundant ones.

Appendix Tables D.6 and D.7 estimate the specifications in Equations (9) and (9'), in levels

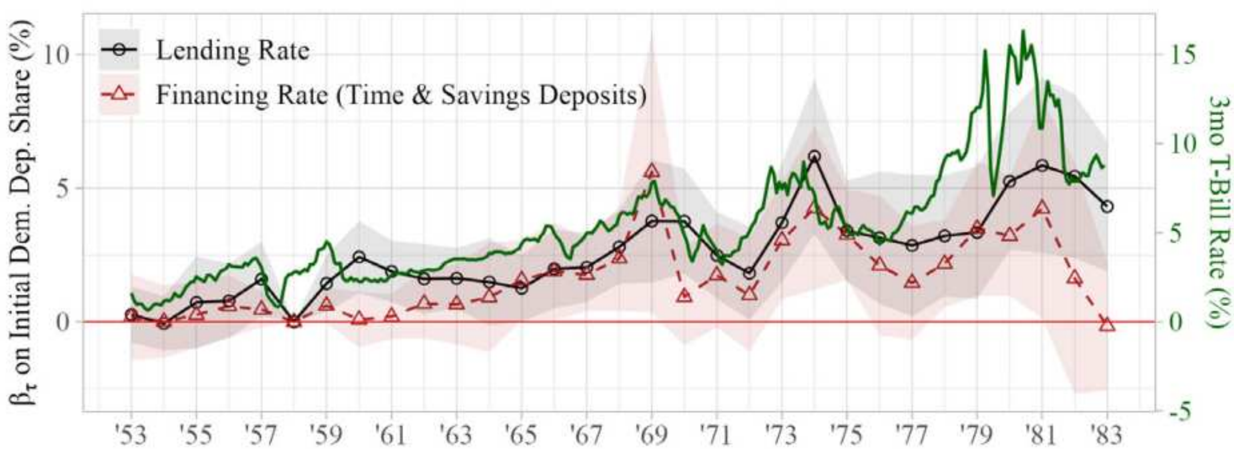
[34] The correlation is negative but noisy if we do not control for the fraction of large banks in the state, defined as the share of bank assets held by banks that were in the top 10% of assets nationally in 1961 (other thresholds give similar results). This is because measurement error in demand deposits as a measure of local deposits depends on the fraction of large banks in the state. As discussed more in detail in the next section, all small banks' liabilities were effectively local because these banks had no access to national markets, while large banks' liabilities beyond demand deposits also included national sources of funding, making demand deposits a strict lower bound. Because the fraction of large banks in a state is itself correlated with the local lending rate, this source of measurement error biases the unconditional correlation between demand deposits and local lending rates and makes it noisy, albeit still negative. This explanation is corroborated by our bank data. The demand deposit share of liabilities in 1961 is negatively correlated with the bank-level lending rate in 1961 for large banks, but not for small banks.

FIGURE 4: CHANGES IN STATE-LEVEL BANK LENDING AND FINANCING RATES, COMPARED TO US AVERAGE CHANGES

(A) IN A STATE WITH A LOWER INITIAL RATE



(B) IN A STATE WITH HIGHER INITIAL DEMAND-DEPOSITS ABUNDANCE



Notes. The black lines report the yearly coefficients (β_τ) and their associated 95% confidence intervals from dynamic diff-in-diff regressions of lending rates in state j and year t on the negative of the state-level lending rate in 1953–58 (Panel A) and on the average ratio of demand deposits on total liabilities in 1953–58 (Panel B). Lending rates are all in basis points and the average ratio of demand deposits is in percentage terms. The red lines report coefficients when the dependent variable is the state-level bank-financing rate, defined as the rate paid by banks on time and savings deposits. Regressions control for state fixed effects, year fixed effects, and the other financial and macroeconomic controls in (10). Each state is weighted by its population in 1950 and standard errors are two-way clustered at the state and year level. The omitted coefficient is 1958. The green lines report the three-month Treasury Bill rate.

and changes, using the different left- and right-hand side variables discussed above. The higher pass-through of nominal rates into local lending and bank financing rates in deposit-rich states also holds in year-over-year changes. As apparent already from Figure 4, the results are identical whether we put initial lending rates or initial deposit abundance on the right-hand side. The tables also show that, in years of high nominal rates, deposit outflows as share of assets are larger in initially lower lending rates and initially demand deposit-abundant states. This larger outflow is noisier in changes, and we show evidence using aggregate data that this noise is likely due to the measurement issues discussed above.[35]

To sum up, we find evidence for all the mechanisms of our model. Yet it might be that these low-rate and deposit-abundant states were differentially hit by unobservable demand or supply shocks that affected deposits, lending rates, and financing rates in years of high nominal rates but that had nothing to do with deposit outflows and their effects on banks' financing costs. We turn to a triple-difference to control for these state-year-level unobservable shocks.

4.2.2 Triple-Difference Between Large and Small Banks

We further probe our nominal rate channel by exploiting its heterogeneous impact across different types of banks. Our mechanism relies on a substitution between local and national sources of funding and assumes that such substitution is possible in the first place. However, such substitution was not possible for small banks, who were operating under different funding models and had no access at all to the national money market (Stigum 1978, p. 118).

Several features limited small banks' access to national markets. First, most wholesale instruments were still subject to Regulation Q caps that were just slightly above short-term safe rates. These caps did not leave enough room for small banks without the name recognition of well-known prime banks to offer attractive enough terms on their issues, also because these issues were unlikely to trade well in secondary markets (Stigum 1978, p. 118). Second, most of the popular negotiable instruments came in sizes too large for small banks to issue them. A standard NCD issue, for instance, was around \$1mm, with occasional issues of \$500,000. Yet the median bank had less than \$4mm in *total* domestic deposits. Data on large CDs (greater than \$100,000), reported by Willis (1967), clearly shows the limited participation of small banks to national markets.[36]

Because our nominal channel of convergence hinges on a substitution between local and national sources of funding, it should thus not be operating, or at least not directly, for small banks. All small banks' funding is local, so that there are no cross-sectional differences in how much these banks will substitute local sources of funding with national ones. We test how much of the time-varying pattern of financial convergence comes from small and large banks by distinguishing between banks in the top 5% in terms of 1961 assets (611 banks) and all others.[37] We estimate a

[35] Figure D.7 shows that the decline in demand deposits as a share of assets is dominated by a secular component rather than cyclical ones. Yet Appendix Figure C.5(b) shows that, when we use the aggregate data on all retail deposits as a share of assets, we see that a cyclical component clearly emerges beyond a secular decline, suggesting that demand deposits cannot capture well annual-frequency changes in retail deposits, which is what the model disciplines.

[36] In 1961 and 1966, the Fed surveyed 232 and 632 banks, respectively, to investigate banks' use of large CDs. Within this group banks that had less than \$100mm of total deposits accounted for just 3% and 1% of total outstanding large CDs in 1961 and 1966, respectively. Most of the banks in this group were still fairly large: the 95th percentile at the time in terms of assets was of \$40mm. Yet they accounted for almost nothing of the large CD market, even though, by 1966, this market had become the most important source of wholesale funding for banks.

[37] Appendix Section D.2 experiments with different thresholds and samples. We use as an upper threshold the top 10%,

bank-level version of Equation (10) separately for large and small banks, weighting observations by domestic assets.[38] In each sample of banks b of type $\varkappa(b)$ (small or large), we estimate:

$$y_{bt} = \alpha_b + \psi_{R(b),\varkappa(b),t} + \sum_{\tau \neq 1962} \beta_{\varkappa(b),\tau} \cdot r^L_{j(b),53-58} + \kappa_{\varkappa(b),t} \cdot \boldsymbol{X}_j + \eta_{\varkappa(b)} \cdot \boldsymbol{C}_{jt} + \varepsilon_{bt} \tag{11}$$

where y_{bt} is the bank-level lending or financing rate, α_b are bank fixed effects, $R(b)$ is the region of the bank, and $\psi_{R(b),\varkappa(b),t}$ are region-type-year fixed effects, which capture time-varying shocks that are common to banks of the same type in a given region. That is, we compare only variation within each type of bank and each region. $j(b)$ is the state of bank b, and $r^L_{j(b),53-58}$ is the initial interest rate that we have put in the right-hand side of the state-level analysis.[39] Controls are the same as those defined in the state-level analysis, with the only difference being that loan composition is now a bank-level control. To take into account the post-1975 accounting changes, we also control for the fraction of domestic loans at the bank level directly in the regression, allowing it to have a type-region-and-year-specific intercept, rather than using the state-level correction described in Section 1. The omitted year is 1962, since 1961 is the first year of reliable data, but rates were fairly stable in 1960–62. Standard errors are two-way clustered at the state and year level.

Figure 5 plots the dynamics of the coefficients for the two groups of banks. Almost all of the time-varying degree of convergence comes from large banks. Rates increase more in high-rate years in initially low-rate states, but only for large banks. Small banks display a small and largely monotonic degree of convergence, with the exception of a peak in 1982.[40]

These results cast doubt on other explanations for the time-varying degree of convergence. If other shocks, such as common shocks to loan demand, were affecting initially low-rate states only in high-rate years, they would likely affect both large and small banks. That is, for our argument to be violated we would need our results to be driven by unobservable shocks that affect only large banks, only in high-rate years and in initially low-rate states, which drive up both financing and lending rates but that do not have anything to do with our channel.

Finally, even if small banks were perfectly insulated from our funding channel of convergence and allowed us to capture other unobservable shocks, they would still not be a perfect control group. They compete in each market with large banks and are thus indirectly affected by shocks

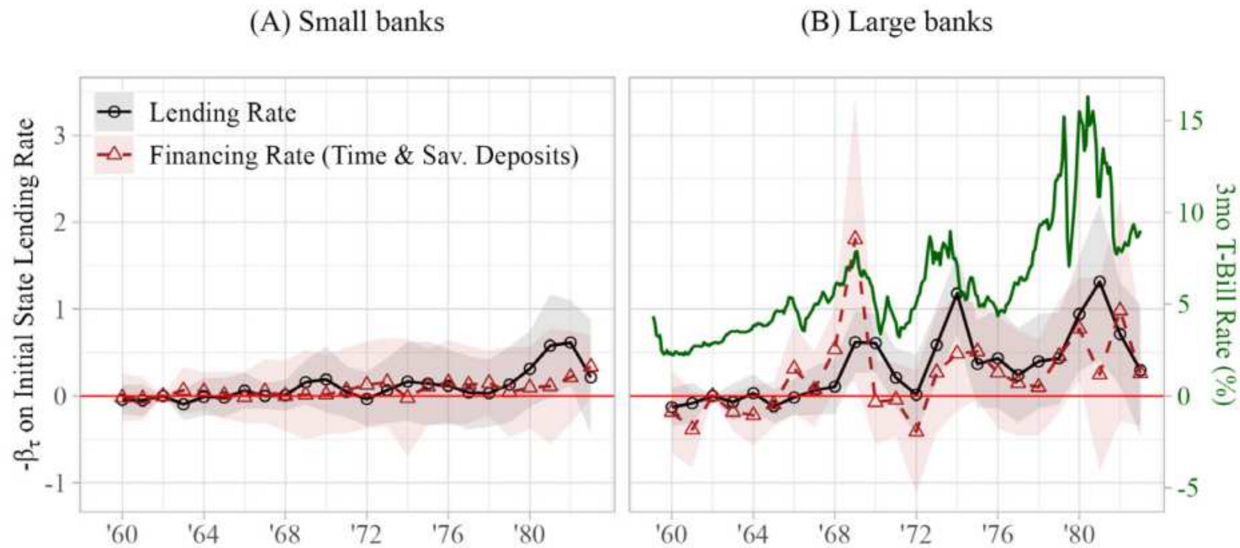
or 1% of banks, and also "doughnut" specifications where we drop medium-size banks, defined as banks between the large bank threshold and the 80th percentile. Results are consistent across all specifications.

[38] Weighting by domestic assets in 1961 yields virtually identical results.

[39] This is the variable of interest of us because we are interested in explaining the convergence we documented in the state-level analysis. Repeating the regression using the bank-level rate in 1961 yields similar results.

[40] This last uptick is interesting in itself: by 1980 Regulation Q caps were being phased out (Drechsler et al. 2020), and it might be that small banks were increasingly able to tap national markets. Of course, it might also be that the increase in small banks' lending rates in 1980–83 was a reaction to the rate increase in large banks since the two types of banks competed in the same market.

FIGURE 5: FINANCIAL CONVERGENCE IN SMALL AND LARGE BANKS



Notes. The black lines in each panel report the negative of yearly coefficients ($\beta_{\varkappa(b),\tau}$) and their associated 95% confidence intervals from dynamic diff-in-diff regressions of lending rates of bank b in year t against the average lending rate in bank b's state in 1953–58. The red lines report coefficients when the dependent variable is the bank-year financing rate, defined as the rate paid by the bank on time and savings deposits. Regressions are estimated separately in the two samples and control for bank fixed effects, region-by-year fixed effects, and the other financial and macroeconomic controls discussed in Section 4.2.2. Each observation is weighted by domestic assets and standard errors are two-way clustered at the state and year level. The omitted coefficient is 1962. The green line reports the three-month Treasury Bill rate.

to large banks. However, this violation of the stable unit treatment value assumption biases the results against us. If within-state lending markets were not at least somewhat segmented, large and small banks would show similar patterns. Yet we still see dynamics that are special to large banks in low-rate areas in high-rate years.

Appendix Table D.8 estimates a triple-difference specification that tests whether the spatial heterogeneity in pass-through is different across these groups of banks. Figure 5 already clearly suggest that this is the case, but the triple-difference formally tests whether the difference across the two samples is statistically significant and also allow us to succinctly show robustness across different sets of controls. Using the full sample of banks, we mimic (9) by estimating:

$$
\begin{aligned}
y_{bt} = & \alpha_b + \psi_{R(b),\varkappa(b),t} + \beta_0 \cdot r_t \cdot r^L_{j(b),53-58} \\
& + \beta \cdot r_t \cdot r^L_{j(b),53-58} \cdot \mathbb{1}\left(\varkappa(b) = \text{Large}\right) + \kappa_{\varkappa(b),t} \cdot \boldsymbol{X}_j + \eta_{\varkappa(b)} \cdot \boldsymbol{C}_{jt} + \varepsilon_{bt} \qquad (12)
\end{aligned}
$$

and a similar corresponding equation in differences that mirrors (9'). We allow different slopes for all controls between large and small banks, and, again, we look only at within-region variation within each type of bank. We also estimate the simple (double) diff-in-diffs separately for the two samples, which gives us the simple diff-in-diff coefficient, β_s for small banks, and the one for large banks β_ℓ.[41] The triple-difference coefficient in (12) is $\beta = \beta_\ell - \beta_s$, and (12) gives us the correct standard errors. Standard errors are always two-way clustered at the state and year level and again observations are weighted by domestic assets.

This triple-difference specification directly partials out unobservable shocks that hit low-rate states in high-rate years and that are common to large and small banks. Appendix Table D.8 progressively adds our usual set of controls and shows that large banks in low-rate states exhibit a substantially larger pass-through of aggregate rates into their lending (Columns 1 to 3) and financing rates (Columns 4 to 6), both in levels (Panel A) and in changes (Panel B). Appendix Section D.2 shows that results are robust to different size thresholds, to dropping medium-sized banks, or to only considering a balanced sample of banks that were always present throughout our period.

5 Quantifying the Financial Effects of the Nominal Rate Channel

This section quantifies how much of the financial convergence that we see in the data can be explained by our nominal channel and by the secular channel of declining frictions of accessing national markets. As shown in Equation (7) and in Proposition 1, spreads can decline for two reasons: either because an increase in aggregate rates drains local deposits from the banking system, which are the source of funding that causes regional imbalances; or because national markets become more efficient with technological progress, which lowers frictions of accessing national markets captured by θ_t in the model (adding time indexes now). We estimate the model parameters to simulate counterfactuals that isolate how much convergence can be attributed to each source.

5.1 Estimation

The key challenge to isolating the sources of convergence is that we do not observe the fraction of local funding or the level of frictions at the state level. To estimate these parameters, we derive estimating equations that use the same identifying variation as in the reduced form analysis of Section 4, and we exploit the fact that we observe the fraction of retail (local) deposits over total bank liabilities in the aggregate data. We provide the intuition for the estimation routine here and leave the implementation details, full set of moments, and proofs to Appendix E.

Recall that lending rates depend on frictions θ_t and on the share of bank assets funded with local deposits γ_{jt} in the following way:

$$r^L_{jt} = r_t + \frac{1}{2}\,\theta_t \times \left(1 - \gamma^2_{jt}\right); \qquad \text{where} \quad \gamma_{jt} = \overbrace{\frac{\alpha_N \exp(\phi \chi_j)}{\xi_j}}^{\bar{\gamma}_j} \times \exp(-\phi r_t) \tag{13}$$

[41] The estimating equation is, separately for each sample $\varkappa(b)$ = small, large: $y_{bt} = \alpha_b + \psi_{R(b),\varkappa(b),t} + \beta_{\varkappa(b)} \cdot r_t \cdot r^L_{j(b),53-58} + \kappa_{\varkappa(b),t} \cdot \boldsymbol{X}_j + \eta_{\varkappa(b)} \cdot \boldsymbol{C}_{jt} + \varepsilon_{bt}$.

The first term in the local deposit share γ_{jt} is a regional shifter $\bar{\gamma}_j$ that is proportional to the ratio between $\exp(\phi\chi_j)$ and ξ_j, where $\exp(\phi\chi_j)$ controls how much households prefer deposits in region j, and ξ_j how much firms are constrained to borrow from banks in region j. For the purpose of the counterfactuals in this section, we do not need to estimate these shifters separately, but only their ratio $\bar{\gamma}_j$. The second term captures deposit outflows as a function of r_t, with a semi-elasticity of ϕ. For J states, this means that we have $J+1$ parameters to estimate: J shifters $\bar{\gamma}_j$ and the ϕ. Finally, to estimate the secular channel of convergence, we estimate a declining trend in frictions θ_t assuming that they follow:

$$\log\theta_t = \log\theta_0 \underbrace{-b_\theta t}_{\substack{\text{Linear Trend}\\ \text{(mkt. development)}}} + \log\tilde{\theta}_t \tag{14}$$

where b_θ captures the trend in frictions and $\tilde{\theta}_t$ are unobserved shocks to funding conditions.[42] In total, we thus need $J+2$ moments to estimate all of our parameters.

Our key set of moments exploits the fact that high local deposits are associated in the model with a high pass-through of aggregate rates into local lending rates, so that the heterogeneity in pass-through should be informative of the heterogeneity in local deposit shares (the $\bar{\gamma}_j$s), up to some scale controlled by ϕ. Conditional on $\bar{\gamma}_j$, the scale of this heterogeneity should then be informative of ϕ. A second-order perturbation of the logarithm of the rate equation allows us to leverage this intuition to estimate the key moments, reaching the following proposition.

Proposition 2 (Second-Order Perturbation)**.** *A second-order perturbation around a steady state with frictions θ_0, a given aggregate rate r_0, and an average fraction of local deposits γ_0, yields:*

$$\log\left(r^L_{jt} - r_t\right) = v_0 + \underbrace{v_j}_{\textit{State FE}} + \underbrace{v_t}_{\textit{Year FE}} + \underbrace{\eta(\phi)\cdot\log\bar{\gamma}_j\cdot r_t}_{\substack{\textit{Regionally heterogeneous}\\ \textit{pass-through of } r_t}} + v_{jt} \tag{15}$$

where $\eta(\phi) = \frac{4\gamma_0^2}{(1-\gamma_0^2)^2}\phi$; $v_t = -b_\theta\cdot t + \log\tilde{\theta}_t + h(r_t;\phi,\gamma_0,r_0)$, with h being a known function of r_t parametrized by ϕ,γ_0, and r_0; and v_{jt} is a composite including controls de-meaned within state and year and a structural residual capturing shocks to banks' costs.

Equation (15) mirrors exactly the difference-in-difference Equation that we estimated in Section 4, when we regressed lending rates on the aggregate rate interacted for measures of initial capital scarcity. The only difference being that we moved to logs here because they allow us to

[42] For instance, varying risk premia, turbulences in interbank markets, or other drivers of financing costs that explain $r^L_{jt} - r_t$ over time for reasons outside of the model.

additively separate the frictions and local deposit abundance. We choose 1958 as our initial steady state, but the results are not sensitive to using any year around it.

We can bring (15) to the data by estimating $J-1$ state-specific slopes with respect to the aggregate rate. These slopes estimate the $\bar{\gamma}_j$ (up to scale and to an omitted state) under the condition that—conditional on state-fixed effects, year fixed-effects, and controls—states are not affected differentially on average by unobserved shocks (i.e., beyond changes in deposits) in years of high aggregate rates. This is similar to the identification argument we had in the reduced form analysis.

To recover the omitted state-specific $\bar{\gamma}_j$ and ϕ, we add two moments that exploit aggregate data on the US local deposit share of assets that we observe in the flow of funds (FoF), which we used to describe the broad funding trends in Figure 3. For a given ϕ and array of $\bar{\gamma}_j$, we can construct the implied US fraction of retail deposits over assets simply as the asset-weighted average across states of $\bar{\gamma}_j \exp(-\phi r_t)$. We back out the omitted state $\bar{\gamma}_j$ by forcing this model-implied average to match the data in our steady state year (1958). We identify ϕ by targeting a correlation over time of one between our model-implied retail deposit share and the time-series path of the fraction of retail deposits in the FoF. Jointly, these $J+1$ moments allow us to identify all the $\bar{\gamma}_j$s and the ϕ.

Having estimated ϕ, we show in Appendix E that we can recover b_θ by estimating a linear trend on the part of the year fixed effects v_t in (15) that is unexplained by deposit outflows, which is $v_t - h(r_t;\phi,\gamma_0,r_0) = -b_\theta t + \log \tilde{\theta}_t$. The intuition is that v_t captures the US aggregate yearly spread between local lending rates and the short-term aggregate rate (not the regional spreads). This spread depends both on the aggregate level of deposits and on frictions. Having a value for ϕ and knowing r_t allows us to partial out the part that depends on the aggregate level of deposits and to isolate the component that depends on friction.

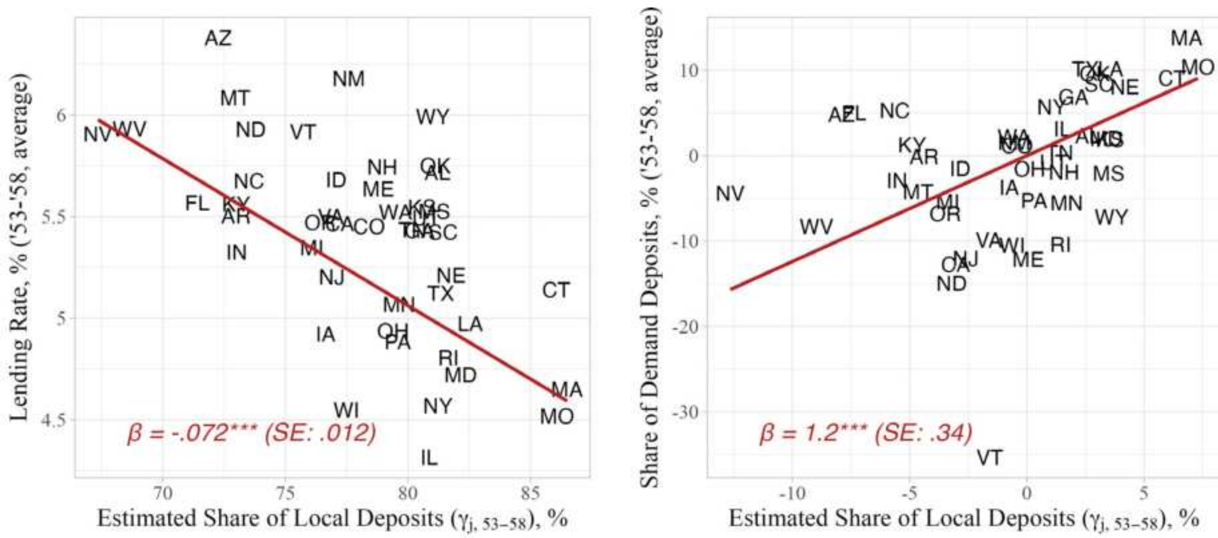
We estimate a $\phi = 4.42$—implying that a 5 percentage point increase in nominal rates reduces households' deposit holdings by 22%—and a decline in frictions of -4.31% per year.

This estimation strategy also delivers a useful over-identification test because the $\bar{\gamma}_j$s and ϕ should predict initial differences in lending rates. Higher local deposits do not only predict higher pass-through of r_t but should also predict cross-sectionally lower rates. Panel (A) of Figure 6 shows that the correlation between initial lending rates and our estimated ratio of local deposits is negative and strong, and local deposits explain on their own 34% of the cross-sectional variation in initial lending rates. This is reassuring and untargeted because we are not using average state-level differences to estimate the local deposit share. Panel (B) shows that the $\bar{\gamma}_j$s also correlate well with the initial (local) demand deposit share of bank liabilities, which is also an untargeted correlation because demand deposits are left completely outside our estimation procedure. This correlation is also important, as it shows that our estimated share of local deposits is correlated with the best proxy we have available and that we used in the reduced form analysis.[43] Finally, aggregating our

[43] We control here for the fraction of assets held by large banks in the state, to address the measure error in demand

FIGURE 6: UNTARGETED COVARIATES OF LOCAL DEPOSIT SHARES

(A) INITIAL LENDING RATES (B) INITIAL DEMAND DEPOSIT SHARE



Notes. Panel (A) reports average state-level lending rates in 1953–58 against the estimated share of local demand deposits in 1953–58, $\hat{\gamma}_{j,53-58} = \bar{\gamma}_j \mathbb{E}_{53-58}\left[\exp(-\phi r_t)\right]$. Panel (B) plots average demand deposits as a share of liabilities in 1953–58 against the local deposit share described above, controlling for the fraction of assets held by large banks in the state to account for measurement error in demand deposits discussed in Footnote 34. Each panel also reports the β from the corresponding WLS regression, weighting each state for initial population in 1950.

local deposit estimates at the US level, Appendix Figure E.8 shows that we recover a series that closely tracks the aggregate series of retail deposits as a share of total bank liabilities from the data. However, this is less surprising as we have targeted ϕ for the two series to be correlated.

5.2 Results

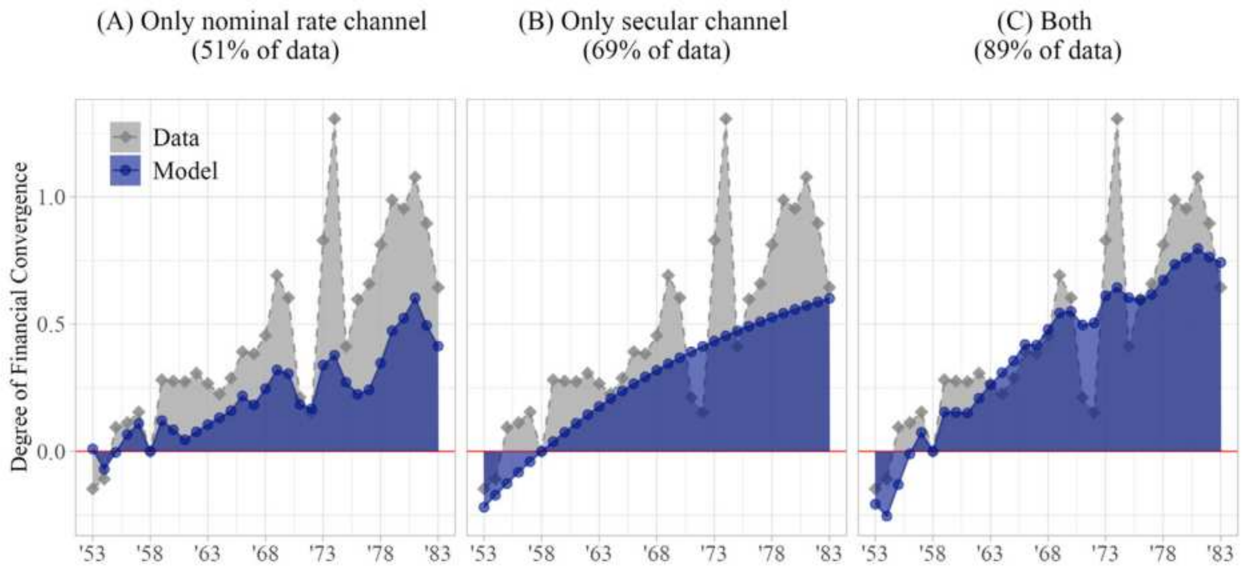
We estimate repeated cross-sectional regressions measuring the path of convergence under three counterfactual scenarios that isolate the different sources of convergence, and we benchmark them against the convergence we observed in the data in Figure 2. In particular, we estimate again:

$$r_{jt}^{L,x} - r_{j,\overline{53-58}}^{L,x} = \alpha_t + \beta_t^x \cdot r_{j,\overline{53-58}}^{L,x} + \varepsilon_{jt}$$

where now the superscript x indicates whether we are using the rates in the data or the rates generated by the model in different scenarios. Figure 7 reports the estimated coefficient across three panels. In all panels, we report the convergence coefficient in the data, $-\beta_t^{data}$, in gray diamonds in the background. These correspond precisely to the values of $-\beta_t$ in Figure 2. Blue circles

deposits discussed in Footnote 34. The correlation is still negative and significant at the 5% level without the control. The results in terms of explained financial integration that we are about to discuss are similar if we measure $\bar{\gamma}_j$ directly with demand deposits, but we would not target the initial rates as well given the measurement issues just referenced.

FIGURE 7: EXPLAINED FINANCIAL CONVERGENCE, MODEL AND DATA



Notes. In all panels, the gray diamonds report the negative of the coefficients (β_t) from repeated cross-sectional regressions of the observed change in lending rates in state j between year t and 1958 regressed against the observed initial average rate in 1958, weighting states by population in 1950. The repeated cross-sections always include an intercept, which partials out aggregate yearly changes. A value of $-\beta_t$ of .5 means that a state that had an interest rate that was 1 p.p. lower than the average rate in 1953–58 saw its rate increase between 1953–58 and year t by .5 p.p. more compared to the average state in that year. The blue lines report the same coefficients, but using the lending rates predicted by the model in the three different counterfactual scenarios discussed in Section 5. The caption in each panel reports the fraction of convergence explained by the model in different scenarios compared to the total observed convergence, which we define as the ratio between the blue and the gray area.

report the convergence coefficients generated by our model in the three counterfactual scenarios. In Panel (A), we simulate lending rates by allowing changes in nominal rates to generate deposit outflows (i.e., γ_{jt} to vary over time as a function of r_t), but we fix frictions to their initial average level in 1958. This isolates how much convergence can be generated in the model economy by our nominal channel on its own. In Panel (B), we do the opposite exercise and fix deposits at the 1958 level while allowing frictions θ_j to decay at the linear trend b_θ that we estimated. Finally, in Panel (C) we allow both frictions to decay and deposits to outflow, which is our baseline simulation.[44]

Panel A shows that our channel generates 51% of the cumulative convergence that is observed in the data, defined as the area under the curve traced by $-\beta_\tau^{data}$. Importantly, the convergence generated by our channel matches the time-varying pattern of the $-\beta_\tau^{data}$. The decrease in frictions—the more secular channel of convergence—generates 69% of the convergence in the data, but it

[44] Note that naturally in the counterfactuals we always set the residual term, $\tilde{\theta}_t$, to zero. Appendix Figure E.9 repeats this exercise using initial rates from the data rather than those generated by the model in the right-hand side of the convergence equation, so that we effectively study how much convergence can be explained by our model using the *data-implied* initial rates. This is slightly smaller than that in our preferred exercise because we are not targeting the initial steady state perfectly, so that we are bound to explain less of the observed convergence.

does not match its time-varying pattern. Together, both channels generate 89% of the convergence, substantially less than their sum.[45]

Our nominal rate channel interacts with the secular channel in quantitatively important ways because they substitute for each other. In a world where differences across states in the relative abundance of local capital are small, frictions in accessing national markets matter less for relative spreads across states. In that case, all regions borrow similar amounts nationally, so that frictions to this type of borrowing only matter for absolute spreads (vs. the safe short rate) but not for relative ones across states. Conversely, in a world where access to national markets is almost frictionless, regional differences in borrowing matter less because this sort of borrowing costs the same everywhere at the margin. Thus, as frictions decrease over time, our channel loses potency. Similarly, as differences in local capital abundance dissipate, the decline in frictions loses potency.

Implications for branching deregulation. The fact that high-rate environments on their own can generate substantial integration can affect our understanding of deregulation aimed at integrating capital markets, such as the lifting of US interstate branching prohibitions that started in 1982.[46] That episode, however, occurred after an exceptionally high-rate environment where our results suggest that the nominal rate had already done much of the work in terms of integrating financial markets. If branching deregulation had happened in the low-rate environment of 1958, for instance, it would have had much larger effects because lending differentials across space were larger. We will return to this observation in the final counterfactual of the paper, in Section 8.3, where we will assess the macroeconomic effects of branching deregulation across high- and low-rate environments.

Before turning to the macroeconomic consequences of financial integration, we note that the effects of high rates on financial integration might also explain why deregulation happened at the time it did, relating to the work of Kroszner and Strahan (1999). They argue that a possible reason for the timing of deregulation is that, by 1982, the advantages for banks of having a local deposit franchise had been eroded by the rise of money market mutual funds that attracted deposits away from banks, thus decreasing incentives for large banks to fight deregulation. Our results are consistent with this argument. The rise of money market funds is itself an outcome of the high-

[45] In estimating the potency of our channel, we are taking the path of frictions as exogenous to the model, even though the evidence from that period reviewed in Section 2 suggests that part of the innovations that allowed banks to more effectively tap national markets (such as the invention of NCDs) were a reaction to high nominal rates draining local deposits. We do not consider these effects of r_t on frictions because we lack direct data on frictions. By ignoring this feedback of r_t on θ_t, however, we are effectively providing a lower bound to the potency of nominal rates in explaining financial integration.

[46] By allowing branches everywhere, this sort of deregulation allows banks to use internal capital markets to almost frictionlessly move funds from deposit-rich places to deposit-scarce ones, effectively nullifying regional spreads. In line with this premise, related recent work by Oberfield et al. (2024) shows that, after the US interestate branching deregulation, banks branched in places with high deposit demand compared to loan demand. See Footnote 7 for further references on the literature that has studied this episode.

rate environment, which pushes savings to national markets and reduces the value of geographical restrictions to the mobility of deposits—thus reducing incumbents' incentives to lobby in favor of such restrictions. In this scenario, which is admittedly more speculative, high rates might have also affected the political feasibility of deregulation.[47]

6 Real Effects of Financial Integration: Motivating Evidence

We turn to how financial integration shaped the geography of economic activity. We start by showing that real growth and financial integration are strongly correlated in the data in ways that suggest a causal link from integration to the reallocation of economy activity across states due to migration. We then turn to a dynamic extension of our banking model in Sections 7 and 8. This allows us to quantify the effect of financial integration on regional and aggregate growth and to perform policy counterfactuals which show that deregulation has larger real effects if it occurs in low-rate environments.

US states between the sixties and eighties featured large heterogeneity in growth rates. New York and Illinois grew by 31% and 33%, California and New Mexico by 92% and 100%, up to Arizona, Texas, and Florida which almost tripled their GDP (+170%, +176%, and +184%, respectively).[48] Table 2 correlates growth with initial capital scarcity, measured using initial local lending rates, and shows a tight link between the two. Column (1) shows that, unconditionally, real GDP between 1963 and 1983 grew by 28.4 log points more (+33%) in states with a one percentage point higher lending rate in 1953–58, which were those that benefited from financial integration. Initial financial conditions have a high R^2, explaining 29% of the variation in growth rates.

This correlation survives after adding known determinants of growth during this period. Column (2) controls for right-to-work legislation, which affected firms' location choices in that period (Moore et al. 1986; Holmes 1998); January temperatures, which capture the movement to the Sunbelt associated with the rise of air conditioning (Glaeser and Tobio 2008); and controls that capture regionally heterogeneous impacts of aggregate shocks of that period—the fraction of GDP coming from oil in 1950 and Bartik controls capturing sectoral demand shocks and agricultural crop price shocks (see Appendix Section A.3.3 for details on how we construct them). Column (3) then adds region fixed effects, showing that the link between growth and initial rates survives also when we look within regions, coherently with the fact that financial convergence occurred also within

[47] This outflow of retail deposits might have also increased small banks' lobbying incentives for consolidation-friendly deregulation because such banks on their own had no way to tap national markets and counter the outflow of deposits. The rise in nominal rates did not affect them heterogeneously across space because all of their deposits were local to start with (justifying our triple-difference of Section 4.2.2), but it did affect them in absolute terms compared to large banks because they lost more funding.

[48] We start from 1963, rather than 1959, because the BEA data on state-level GDP starts in 1963. Results using state-level income, which is available well before 1959, are very similar and reported in Appendix Table H.18.

TABLE 2: REGIONAL GROWTH AND FINANCIAL CONVERGENCE

	Dependent variable: Growth Between 1963 and 1983 in								
	GDP			Population			GDP per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Lending Rate (pp), $r^L_{j,53-58}$	.284	.191	.139	.190	.149	.118	.094	.042	.021
	(.051)	(.058)	(.069)	(.041)	(.039)	(.042)	(.031)	(.033)	(.044)
Right-to-Work State		.190	.109		.012	.023		.178	.086
		(.044)	(.061)		(.033)	(.056)		(.020)	(.028)
% GDP from Oil_{50}		−.798	−1.155		−.657	−.500		−.141	−.654
		(.812)	(1.064)		(.433)	(.599)		(.451)	(.560)
January Temperature		.005	.004		.006	.005		−.001	−.001
		(.003)	(.004)		(.002)	(.003)		(.001)	(.003)
Bartik Demand Shock_{63-83}		.237	.253		.075	.112		.163	.141
		(.079)	(.105)		(.048)	(.063)		(.042)	(.057)
Bartik Agricultural Shock_{63-83}		.068	.246		−.748	.005		.815	.241
		(.571)	(.893)		(.362)	(.665)		(.301)	(.481)
Region FEs			✓			✓			✓
$\mathbb{E}(Y)$	.606	.606	.606	.243	.243	.243	.362	.362	.362
$\text{SD}(Y)$	.224	.224	.224	.18	.18	.18	.127	.127	.127
$\mathbb{E}(r^L_{j,53-58})$	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
$\text{SD}(r^L_{j,53-58})$	.475	.475	.475	.475	.475	.475	.475	.475	.475
Observations	46	46	46	46	46	46	46	46	46
R^2	.29	.771	.815	.321	.666	.724	.115	.75	.826

Notes. The table reports WLS estimates of state-level real GDP, population, and real GDP per capita growth rates between 1963 and 1983 against the average state-level lending rate in 1953–58. Controls are reported in the table and discussed in Section 6. Observations are weighted by population in 1950. Parentheses report heteroskedasticity-robust standard errors.

regions.

Columns (4) to (9) regress growth in population and GDP per capita against initial lending rates and show that growth in GDP mostly came from growth in population rather than in GDP per capita. Across specifications, 67% to 85% of the correlation between initial rates and growth in GDP is due to population growth. Appendix Table F.13 uses data available from 1960 to 1975 on net migration flows at the state level and shows that all of this population growth comes from migration rather than higher fertility.

In Appendix Table F.14, we compare our channel to that of real convergence studied by Barro and Sala-i-Martin (1992). The table shows that the link between growth and initial rates is almost unchanged when adding initial GDP per capita, suggesting that we are capturing a different determinant of growth. Furthermore, initial lending rates explain more of the overall heterogeneity in GDP growth compared to initial GDP per capita, but much less of the overall heterogeneity in GDP per capita growth, which is strongly correlated with initial GDP per capita (as in Barro and Sala-i-Martin 1992).

Finally, Appendix Figure F.10 also shows that growth was concentrated in industries that are dependent on external financing. Panel A reports the coefficient for different one-digit sectors of sector-and-state level GDP growth between 1963 and 1983 (always from the BEA data) against initial state-level lending rates. The coefficient is largest for manufacturing and small in government and services.[49] Within manufacturing, the correlation between initial interest rates and growth was concentrated in sectors with high financial dependence as measured by Rajan and Zingales (1998).

Yet it is hard to infer causality from long-run correlations, and these correlations are also uninformative about the aggregate effects of financial integration. We thus extend our theory to capture the real effects of financial integration. Our modeling choices are informed by the features of growth that we documented here and in Appendix Section F, which require moving beyond existing theories on the effects of financial frictions and growth (e.g., Buera et al. 2011; Moll 2014). These theories are usually developed in a cross-country context and highlight the effects of reducing financial frictions on wages, investment, reallocation of labor across sectors, and TFP—with no margins for labor growth at the country level. We are studying integration within a country where labor is mobile and the data shows that the driving force behind the higher GDP growth in our setting is migration, which calls for an important role of spatial dynamics.

7 Dynamics in Space

Informed by the correlations we discussed in the previous section, we extend the model of Section 3 to study the effects of financial integration on growth, quantifying its regional and aggregate implications. The model nests the financial part and is fully block-recursive, so that the financial part can still be solved separately according to the derivations in Section 3.

7.1 Setup

Time is continuous, indexed by t. As we described in Section 3, the economy is made of many states j populated at each point in time by a measure of households N_{jt}, a representative capitalist with capital K_{jt}, firms, and banks. Households choose where to live, which pins down the law of motion for state populations, and capitalists make consumption-saving decisions, which pins down the law of motion of physical capital in each state. We also add local housing markets. Each period still has two subperiods: the morning, when firms set up production and households and capitalists receive payments; and the evening, when consumption takes place. The duration of the evening is vanishingly small relative to the morning. The precise timing is reported in Appendix Figure B.3.

[49] The coefficient is also small for construction, but this is sensitive to whether we weight states by initial population. Builders usually relied on savings & loans associations, but spreads across states for these lenders were already small because of the Federal interventions in mortgage markets of the 1930s studied by Angelova and D'Amico (2024).

7.1.1 Static Choices

We start by deriving the static equilibrium, which gives us local wages and prices.

Households' extended utility. We add housing and amenities to the flow utility of households described in Equation (4) in Section 3. To live in j at time t, households need to consume one unit of housing at price h_{jt}. They enjoy amenities B_{jt}, which capture, e.g., warm weather, access to the sea, or any other non-directly priced benefits of living in j. As in Section 3, households supply labor inelastically and earn a real wage (i.e., in terms of morning prices) of w_{jt} that they use to consume a freely traded good in the evening at price $p_t(1+\pi_t)$, where p_t are prices in the morning and π_t is the inflation rate between the morning and the evening. They decide whether to store their liquidity in bonds, which pay a nominal rate of r_t, or deposits, which give liquidity services of $\chi_j + \varepsilon_{ijt}$, where ε_{ijt} is household's i taste for liquidity and χ_j is a shifter of liquidity benefits in region j.

Appendix Section B.4.1 derives the flow utility and shows that adding amenities and housing does not change the optimal liquidity choice. Thus, household i holds deposits if and only if $r_t \leq \chi_j + \varepsilon_{ijt}$, which yields the same deposit demand function as in (5). Appendix Section B.4.2 shows that for π_t small enough we can write the indirect flow utility for a household with random liquidity draw ε in real terms as:

$$u^N_{jt}(\varepsilon) = B_{jt} + w_{jt} \cdot \left(1 + \rho_s + \max\left\{0, \chi_j + \varepsilon - r_t\right\}\right) - h_{jt} \tag{16}$$

where $\rho^s = r_t - \pi_t$ is the real short-term (i.e., morning-to-evening) return on the bond and $\rho^s + \max\left\{0, \chi_j + \varepsilon - r_t\right\}$ are the financial services from deposits and bonds.

The indirect utility is thus the same as in problem (4) in Section 3, with two additions. First, we added amenities and the cost of housing. Second, we cast it in real terms, which is without loss of generality for small enough changes in the price level between the morning and the evening π_t. Appendix Section B.4.2 also shows that we can cast the model in real terms for all other agents, too, which we do in the remainder of this section. That is, the only reason why inflation matters in our model is that it affects the nominal rate, which then affects households' choices between bonds and deposits and, in turn, bank lending rates, which is the channel we want to focus on. We assume that the real short rate is constant because we are not focusing on changes in the real rate.[50]

Firms. As in Section 3, firms are constrained to borrow ξ_j of their inputs from the local bank, at cost r^L_{jt}, and the remainder is financed at a nominal rate r_t, which either captures the cost of borrowing on the national market or the opportunity cost of internal capital if this part of production

[50] The fluctuations in the real rate during our sample period do not matter for deposit outflows beyond the effects of changes in the nominal rate, and Appendix Table D.5 shows that they do not matter for financial convergence. We could easily introduce fluctuations in ρ^s, but it would be beyond the point of the model.

is financed internally. Firms' real gross costs of financing are thus, $R^F_{jt} = 1 + \rho^s + \xi_j \left(r^L_{jt} - r_t \right)$. The maximization problem reads:

$$\max_{N,K} \; z_{jt} N^{\alpha_N} K^{\alpha_K} - R^F_{jt} \left[w_{jt} N + r^K_{jt} K \right] \tag{17}$$

where we recall that z_{jt} are fundamental productivities. This pins down wages and the rental rate of capital as a function of labor and capital:

$$w_{jt} = \alpha_N \frac{z_{jt}}{R^F_{jt}} N_{jt}^{\alpha_N - 1} K_{jt}^{\alpha_K}; \qquad r^K_{jt} = \alpha_K \frac{z_{jt}}{R^F_{jt}} N_{jt}^{\alpha_N} K_{jt}^{\alpha_K - 1} \tag{18}$$

Housing supply. Housing supply is deliberately kept simple, as in Kline and Moretti (2014). We assume that housing is supplied competitively at marginal cost, which is increasing in the number of units produced, for instance because land is fixed. That is, we assume that the real price of one unit of housing, h_{jt}, follows a constant elasticity inverse supply function:

$$h_{jt} = z^h_{jt} N_{jt}^{\sigma^h_j} \tag{19}$$

where z^h_{jt} is a cost shifter and σ^h_j is the inverse price elasticity of housing supply in region j.[51]

Static equilibrium prices. Because loan demand and deposit demand have not changed, local lending rates are the same as in Section 3.2. Wages and the rental rate of capital are a function of the labor and capital stocks, following (18), and the price of housing is simply (19).

7.1.2 Dynamic Choices

Migration decisions. Across periods, households decide where to live based on their expectation of future wages, prices, and amenities in each location. They discount the future at rate ρ and receive the opportunity to migrate at rate μ. When they receive the opportunity to migrate, households receive a vector of idiosyncratic taste shocks for all regions in the economy, $\boldsymbol{\epsilon}_t \in \mathbb{R}^J$ where J is the total number of regions. These shocks are i.i.d. type-I extreme value distributed with zero mean and households have perfect foresight on future fundamentals, as in Caliendo et al. (2019). If they decide to move from j to m, they pay a bilateral moving cost of τ_{jm}.

Households' mobility choices depend on their current preference shocks for each location, the expected path of wages and taste shocks in each location, and the mobility costs. Appendix Section

[51] A low level of σ^h_j means that supply is more elastic, for instance because regulation allows new building or because land is abundant (see, e.g., Saiz 2010; Gyourko and Molloy 2015; Glaeser and Gyourko 2018), and hence prices change less as new households come in. A high level of σ^h_j means that supply is more constrained, and prices increase more as households move in. This is a standard source of "congestion" in spatial models, which helps ensuring that equilibria are unique and households do not all live in the most productive or amiable city.

B.4 shows that the expected value function in location j satisfies the Hamilton-Jacobi-Bellman equation:

$$\rho V_{jt} - \frac{dV_{jt}}{dt} = \underbrace{B_{jt} + \left(1 + \mathcal{R}_{jt}\right) w_{jt} - h_{jt}}_{\text{Expected flow utility}} + \mu \left[\underbrace{\frac{1}{\nu} \log \left(\sum_k \exp\left(\beta V_{kt} - \tau_{jk}\right)^{\nu} \right) - V_{jt}}_{\text{Continuation value from migration opportunity}} \right] \tag{20}$$

The expected flow utility is the benefit of living in location j at time t, which is given by the amenities B_{jt} and the wage w_{jt}, inclusive of expected financial services $\mathcal{R}_{jt}$, minus the price of housing h_{jt}. The expected financial services encode expected real financial returns from holding liquidity across different liquidity draws, which include the real bond remuneration and the expected liquidity services, $\mathcal{R}_{jt} = \rho^s + \frac{1}{\phi}\exp(-\phi(r_t - \chi_j))$.[52] The continuation value captures the fact that locating in j can be attractive because of the possibility of moving in the future to different locations m (including j itself).[53]

Equation (20) implies that the population distribution in each state evolves according to the Kolmogorov Forward equation (KFE):

$$\frac{dN_{jt}}{dt} = \mu \left(\sum_{i=1}^{N} m_{ij}(V_t) N_{it} - N_{jt} \right); \quad \text{where} \quad m_{ij}(V_t) = \frac{\exp \nu \left(V_{jt} - \tau_{ij}\right)}{\sum_{m=1}^{J} \exp \nu \left(V_{mt} - \tau_{im}\right)} \tag{21}$$

where $m_{ij}(V_t)$ is the migration share from i to j: the fraction of households wishing to move from i to j at time t, which is a function of the entire distribution of value functions in all regions. These law of motions characterize how the population distribution evolves over time as a function of the relative differences in the value of living in different locations in each period, which are collected in the vector of value functions V_t.

Capitalist. Each location j is populated by a representative capitalist with an initial endowment of physical capital K_{j0}, who makes standard consumption-saving decisions that solve:

$$\max_{[c^k_{jt}, X_{jt}]_0^\infty} \mathbb{E}_0 \int_0^\infty \exp(-\rho t) \log\left(c^k_{jt}\right) dt \tag{22}$$

$$\text{s.t.} \quad R^K_{jt} K_{jt} = c^K_{jt} + X_{jt}; \qquad \dot{K}_{jt} = X_{jt} - \delta K_{jt}$$

[52] In Appendix Section H.3.1, we show that our quantitative results are similar if we assume that households lack perfect information on the geographical distribution of χ_j and that they only have a prior on its expected value. In that case, liquidity services will only matter for liquidity choices conditional on living in a place, rather than for migration choices. That is, in the Appendix we set $\mathcal{R}_t = \mathbb{E}[\mathcal{R}_{jt}]$ everywhere, where the expectation is across locations.

[53] It indeed takes the intuitive form of a non-linear weighted average of value functions in all locations in the economy (the V_{kt}s) expressed as a difference from the value function at home (V_{jt}).

where c_{jt}^K is the capitalist's consumption of the traded good and X_{jt} is investment in physical capital, both occurring in the evening, δ is the depreciation rate, and R_{jt}^K is the income available to the capitalist in the evening. The capitalist does not consume housing, as in Bilal and Rossi-Hansberg (2023). The capitalist also does not use the bank to store liquidity and stores it in a bond with real short return of ρ^s, so that $R_{jt}^K = (1+\rho^s) r_{jt}^K$.[54] As in Moll (2014), the optimal policy is a linear consumption rule $c_{jt}^K = \rho K_{jt}$, which pins down the KFE for capital as:

$$\frac{dK_{jt}}{dt} = \left(R_{jt}^K - \delta - \rho\right) K_{jt} \tag{23}$$

The value function of the capitalist is $\Pi_{jt} = (A_{jt} + \log K_{jt})/\rho$, with A_{jt} satisfying the Bellman equation $\rho A_{jt} - \frac{dA_{jt}}{dt} = \rho \log \rho + R_{jt}^K - \delta - \rho$.

7.2 Steady-State and Comparative Statics

In steady state all time derivatives are zero, so there is no net migration and net accumulation of capital, i.e., (21) and (23) are both zero. The rental rate of capital is equal to $R_j^{K,SS} = \delta + \rho$ everywhere, but the local stock of capital depends on local lending rates.

We are ultimately interested in how financial integration—prompted by a change in the future path of interest rates, r_t, and a decline in frictions of accessing the national market, θ_t—affects growth dynamics in each state. To solve for these effects, we bring the model to the data and then solve for the full transition dynamics after the shocks to r_t and θ_t. However, before estimating the full transition dynamics, we provide some intuition behind the main forces that will shape them.

To do so, we derive steady-state-to-steady-state comparative statics in a simplified environment, where we assume that migration costs are identical everywhere and that, when making migration choices, households have imperfect information on the distribution across space of χ_j, the regional shifters of the benefit of holding deposits. Formally, we assume that $\tau_{ij} = \tau$ for all i, j, and that the expected financial returns on the wage perceived by households when making migration choices (i.e., in (20)) is $\tilde{\mathcal{R}}_t = \mathbb{E}[\mathcal{R}_{jt}]$ for all j. The first assumption implies that the option value of migration is identical everywhere and the second assumption simplifies the derivations because it implies that liquidity benefits only affect within-period liquidity choices but not migration choices across periods. The full transition dynamics will relax both assumptions and follow the full model described above. Migration that is driven by heterogeneous benefits of liquidity only slightly amplifies our channel, and we isolate its quantitative implications in Appendix Section H.3.1.

All proofs are in Appendix Section B.5.

[54] The real short-term rate cancels out from the net return to the capitalist because it is a return for the capitalist but also a cost for the firm, so that $R_{jt}^K \approx \frac{\partial Y}{\partial K} / (1 + \xi_j (r_{jt}^L - r_t))$. If there were no local spreads over the nominal rate, R_{jt}^K would simply be the marginal product of capital.

Proposition 3 (Effects of local lending rates on GDP)**.** *Let j be a small state in a larger economy. An increase in local lending rates in j leads to a decrease in j's population and in j's stock of physical capital, thus decreasing GDP. This increase in local lending rates also decreases GDP per capita, but less than the decrease in GDP.*

Normalizing without loss of generality the steady-state evening income, $w_j^{SS}(1+\tilde{\mathcal{R}}^{SS}) = 1$, the decrease in GDP following an increase in local lending rates is the product of two terms:

$$\frac{\partial \log Y_j^{SS}}{\partial r_j^L} = \underbrace{\frac{\xi_j}{R_j^{F,SS}}}_{\substack{\text{Increase in}\\ \text{firms' costs}}} \left(\underbrace{-\frac{\alpha_K}{1-\alpha_K}}_{\substack{\text{Direct decumulation}\\ \text{in physical capital}}} \quad \underbrace{-\frac{\alpha_N}{\eta+\sigma_h h_j^{SS}}}_{\substack{\text{Decrease in population}\\ \text{due to lower wages}}} \quad \underbrace{-\frac{\alpha_N}{\eta+\sigma_h h_j^{SS}}\frac{\alpha_K}{1-\alpha_K}}_{\substack{\text{Further decumulation}\\ \text{of physical capital}\\ \text{due to decrease in population}}} \right) \frac{1}{1-\alpha_K}$$

where $\eta = (\rho+\mu)/\nu$ is a coefficient decreasing in the migration elasticity ν, σ_h is the inverse housing price elasticity, and, given the normalization on wages, h_j^{SS} is the share of the evening income spent to pay for housing rents.

Outside the parenthesis is the direct effect on firms' costs of increased local lending rates, which is scaled by firms' dependence on local banks, ξ_j. An increase in r_j^L affects GDP because firms respond by cutting back production, which depresses wages and the rental rate of capital, leading to the general equilibrium effects inside the parenthesis. The first term, $-\frac{\alpha_K}{1-\alpha_K}$, captures the fact that the decline in the rental rate pushes capitalists to decumulate capital in order to equate again the net rental rate with their discount rate. The second term, $-\alpha_N/(\eta+\sigma_h h_j^{SS})$, captures the fact that households leave as wages decline because of lower labor demand from firms and the decumulation of capital. This term is stronger when the migration elasticity is higher (lower η) or the housing supply elasticity is higher (lower σ_h). The last term captures the interaction between the outmigration of households and decumulation of capital.

Because the migration response of labor depends on the migration elasticity and the housing supply elasticity, we reach the following corollary.

Corollary 3.1. *A change in local lending rates decreases GDP more and GDP per capita less if the migration elasticity is stronger or housing supply is more elastic.*

Finally, we can derive the heterogeneous pass-through of nominal rates to local real growth.

Proposition 4 (Geographic channel of monetary policy)**.** *Let j and h be two regions with identical wages, house prices, and population in an initial steady state. To the leading order:*

4.i. Geographic neutrality: If national financial markets are frictionless ($\theta_t = 0$) or if lending rates in j and h are ex ante identical because deposit demand and loan demand shifters are *identical ($\chi_j = \chi_h$ and $\xi_j = \xi_h$), then an increase in r_t has no differential effects across regions. That is, if $\chi_j = \chi_h$ and $\xi_j = \xi_h$, then $r^L_j = r^L_h$ and:*

$$\frac{d\log Y^{SS}_j}{dr} - \frac{d\log Y^{SS}_h}{dr} = 0 \qquad \textit{and} \qquad \frac{d\log N^{SS}_j}{dr} - \frac{d\log N^{SS}_h}{dr} = 0$$

4.ii. *Geographic non-neutrality: If national financial markets are frictional and lending rates in j and h are different, for small differences in deposit demand and/or loan demand shifters, then an increase in r_t has a more negative effect in the initially low-rate region and leads to a reallocation of population from the initially low-rate region to the initially high-rate one. That is, if $\chi_j \leq \chi_h$ and $\xi_j \geq \xi_h$ with at least one strict inequality, then $r^L_j > r^L_h$ and:*

$$\frac{d\log Y^{SS}_j}{dr} - \frac{d\log Y^{SS}_h}{dr} > 0 \qquad \textit{and} \qquad \frac{d\log N^{SS}_j}{dr} - \frac{d\log N^{SS}_h}{dr} > 0$$

Proposition 4 is the real analog to the first part of Proposition 1, which says that an increase in national rates increases local rates more in initially low-rate states. The first part provides a useful neutrality benchmark. If there were no regional spreads, either because national financial markets are frictionless or because regions are identical in their financial endowments, then an increase in the nominal rate r_t has the same real pass-through everywhere and leads to no reallocation of labor. However, if there are regional spreads, then an increase in r_t hurts the initially capital-rich states more because the financial pass-through of r_t into local lending rates is higher in those states (cf. Proposition 1). By reducing wages in h more than j, it also leads to population migration from h to j, causing a reallocation of economic activity across space.[55]

We can reach a similar result for the effect of increases in the efficiency of the national financial market on local growth, which is the real analog to the second part of Proposition 1.

Proposition 5. *To the leading order, a decrease in frictions of accessing national financial markets increases GDP more in regions that have ex ante higher lending rates because of higher loan demand shifters, lower deposit demand shifters, or both, and leads to population reallocations towards those regions. That is, if $\chi_j \leq \chi_h$ and $\xi_j \geq \xi_h$ with at least one strict inequality, then $r^L_j > r^L_h$, $\frac{d\log Y^{SS}_j}{d(-\theta)} - \frac{d\log Y^{SS}_h}{d(-\theta)} > 0$ and $\frac{d\log N^{SS}_j}{d(-\theta)} - \frac{d\log N^{SS}_h}{d(-\theta)} > 0$. If $\chi_j = \chi_h$ and $\xi_j = \xi_h$ a decline in frictions has no heterogeneous effects.*

[55] Note that there is a counteracting force in places where deposits are scarce because firms are more dependent on local banks (higher ξ_j). Those places are more sensitive to increases in r_t because bank lending is more important for real outcomes and increases in r_t increase bank lending rates more than one-for-one in absolute terms due to deposit outflows. To a first order this force is smaller than the heterogeneity across space in financial pass-through, but this is not necessarily true for higher-order changes in ξ_j, as shown in Appendix Section B.5.

7.3 Transition Dynamics

We now derive the transition dynamics of the full model. Focusing on these dynamics rather than steady-state-to-steady-state comparisons is important for two reasons. First, it allow us to more realistically model the effects of changing nominal rates, which fluctuated substantially during our period and then gradually reverted to lower levels after 1983. Second, transition dynamics in this kind of model are known to be very slow because capital adjusts slowly (as in Bilal and Rossi-Hansberg 2023; Kleinman et al. 2023). Part of this very slow adjustment in capital can also help explain why most of the reduced form correlation between initial rates and GDP growth is coming from migration rather than from wages.

The challenge with transition dynamics is that the state space in these models is large. Because choices are forward-looking, the current value functions depend on current as well as future distributions of wages and capital, generating a dynamic fixed point that is computationally intractable in our setting. We thus leverage the advances in Bilal (2023), which allows us to sidestep this issue by removing the time dependence from the value functions and making them explicit functions of the entire distributions of labor and capital, deriving what Bilal (2023) denotes "Master Equations" (MEs). In this setting, we can derive the transition dynamics of labor and capital (and, in turn, of all other endogenous variables) by simply perturbing the MEs with respect to the primitive shocks that we want to study.[56]

The key step of the ME approach is to remove some of the time dependence of the value functions by recognizing that the time differentials of the value functions can be further decomposed. For households, for instance, this follows:

$$\frac{dV_{jt}}{dt} = \underbrace{\frac{\partial V_{jt}}{\partial t}}_{\substack{\text{Effect of changes} \\ \text{in } \{r_t, \vartheta_t\}_{s=0}^{\infty}}} + \underbrace{\sum_k \frac{\partial V_{jt}}{\partial N_{kt}} \frac{dN_{kt}}{dt}}_{\substack{\text{Effect of changes in the} \\ \text{population distribution (migration)}}} + \underbrace{\sum_k \frac{\partial V_{jt}}{\partial K_{kt}} \frac{dK_{kt}}{dt}}_{\substack{\text{Effect of changes in the} \\ \text{distribution of physical capital}}}$$

where the remaining time derivative of the value function, $\partial V_{jt}/\partial t$, depends only on the effects of the known shocks that we study: the changes in aggregate nominal rates and frictions, r_t and ϑ_t. A similar differential holds also for capitalists.

Substituting these differentials in the value functions delivers the MEs. We can then derive the

[56] As summarized in Bilal and Rossi-Hansberg (2023), the approach works in two steps. The first step is to merge the local value functions for each type of agent (households and capitalists) and the KFEs for capital and labor into two equations: a ME for households and one for capitalists. The idea is that this removes (some of) the time dependence of the value function. The recursive formulation will then not depend on the labor and capital distribution today and tomorrow: it will depend on the distributions today and their (known) law of motion. The only time-dependence left is on the path of fundamentals, but this is exogenous to the model. Because the master equations are still hard to solve nonlinearly, the second step is to perturb them around a steady state, with respect to the primitive shocks we want to study, which leads us to solve for "impulse values" rather than for the full set of non-linear equations.

transition dynamics for all J regions in the economy by perturbing the MEs around a steady state and solving for the coefficients that encode the first-order changes to the MEs due to the shocks and the changes they cause in the labor and capital distributions. In particular, following Bilal (2023), we prove in Appendix Section B.6 the following Proposition 6 and Lemma 2.

Proposition 6 (Transition Dynamics)**.** *Given initial steady-state population and capital distributions, collected in the $J\times 1$ vectors n_0 and k_0, the transition dynamics in response to changes in the aggregate rate $\{r_t\}_t$ and frictions $\{\vartheta_t\}_t$ are given by the $J\times 1$ vectors $\{n_t, k_t\}$ that collect changes in labor and capital in each region $j \in J$ such that:*

$$\frac{d}{dt}n_t = \left(M^* + Gv^N\right)n_t + G\left(v^K k_t + v_t^T\right)$$
$$\frac{d}{dt}k_t = D_{KR}r_t + D_{K\theta}\vartheta_t + D_{KN}n_t + D_{KK}k_t$$

where v^N is a $J \times J$ matrix where each element j, i is the first-order change in the value function for households in j given a change in the number of households in i, $v_{ji}^N = \partial V_{jt}/\partial N_{it}$, evaluated around an initial steady state; v^K is a similar matrix encoding changes due to changes in physical capital in each location; and v_t^T is a $J\times 1$ vector that collects changes in the vector of households' value functions at time t given the path of shocks $\{r_t, \vartheta_t\}_{s=0}^{\infty}$. M^* and G are known matrices that are governed by the strength of migration responses, and D_{Kx} are known vectors of derivatives that collect the effects of first-order changes in $x = \{r_t, \vartheta_t, n_t, k_t\}$ on the law of motion of capital.

The following lemma shows that the we can use standard numerical algorithms to solve for the matrices needed to compute the transition dynamics.

Lemma 2 (First Order Approximations to the Master Equations, FAMEs)**.** *The $J \times J$ matrices v^N and v^K, which encode the first-order changes in households' value functions (v) with respect to changes in the distribution of labor N and capital K, and the corresponding matrices a^N and a^K for capitalists, follow generalized Sylvester Matrix equations that are independent of the shocks:*

$$\rho x^d = D^d + \underline{M}x^d + x^d\underline{H} + x^d P^d x^d \qquad \textit{where} \qquad x^d = \begin{pmatrix} v^N & v^K \\ a^N & a^K \end{pmatrix}$$

where $D, \underline{M}, \underline{H}$, and P are known matrices of coefficients reported in Appendix Lemma B.2. Given values for these distributional matrices, the matrices that encode changes due to the aggregate shocks, v^T and a^T, satisfy a system of Ordinary Differential Equations.

The key insight of the lemma, which allows us to solve this system easily, is that the solution is block-recursive. We can separately solve for the matrices v^N, v^K, a^N, a^K that encode the first-order deviations of the value functions given changes in the labor and capital distributions, the Distributional FAMEs. After we have solved for the Distributional FAMEs, which are just matrices of coefficients that explain how much changes in N_{jt} and K_{jt} in each location affect value functions everywhere, we can then use these coefficients to solve for the ordinary differential equations that characterize the effects of our aggregate shocks.[57]

8 Quantifying the Real Effects of Financial Integration

We use the transition dynamics to study the real effects of financial integration. We bring the model to the data assuming that the economy was in steady state in 1958 and discretizing time so that each interval is one year. We then study the transition dynamics after the increase in nominal rates between 1959 and 1983 and the parallel decline in frictions we estimated in Section 5.

8.1 Migration Elasticity and Other Parameters

We discuss here our estimation and calibration strategy for the parameters that we have not yet estimated in the financial part. All the details are reported in Appendix Section H.1.

Calibrated parameters. We set standard values for the discount rate and the depreciation rate of $\rho = \delta = .05$. We set α_N to match the average share of labor income during our period of $\alpha_N = .63$, and set μ so that the opportunity of migration $1 - e^{\mu}$ is .9, implying that 90% of households receive the opportunity to migrate each year (Bilal and Rossi-Hansberg 2023).[58] We allow the housing price elasticity σ_j^h to vary across states following the city-level estimates in Saiz (2010) and aggregating them at the state level using a population-weighted average across cities. We set the real short-term rate at its average value of .01.

Inversion of economic fundamentals. We follow the standard practice in the quantitative spatial literature of inverting fundamentals in order to match the data in our initial steady-state year (1958).

We lack data on the capital stock in 1958 because the BEA regional GDP data starts in 1963. We thus follow Bilal and Rossi-Hansberg (2023) and use manufacturing capital expenditure in 1958 from the Census of Manufacturers, which measures physical capital investment X_{jt}, and back-out the capital stock using the fact that, in steady state, $K_j^{SS} = X_j^{SS}/\delta$. To invert for fundamental productivities, we measure wages using wages in manufacturing and invert the wage equation using the imputed capital stock in manufacturing and manufacturing employment in 1958.

We invert the fixed bilateral migration costs τ_{ij} by matching the migration flows in 1955–60 and the population distribution, assuming that migration costs are symmetric, i.e., $\tau_{ij} = \tau_{ji}$ for all

[57] Note that the distributional FAMEs for the capitalist, a^N and a^K, do not show up directly in the transition dynamics because we can solve the consumption-saving problem of the capitalist explicitly.

[58] While μ affects migration responses, these responses ultimately depend on the migration elasticity, which we estimate. This parameter is necessary only in continuous time, and it is implicitly set to 1 in discrete time.

pairs of states. We then invert for place-specific amenities B_j using the implied value functions at steady state and the observed population distribution across states.

We invert the housing rent shifter z^h_{jt} using data on rents, population, and the state-level aggregates of the city-level house price elasticities estimated in Saiz (2007).

Inversion of financial fundamentals. We are left to invert for the share of firms' costs that need to be financed with bank loans (ξ_j) and the average liquidity shifter in each state (χ_j). In our financial quantification we estimated their ratio $\bar{\gamma}_j$, corresponding to the share of bank assets financed with local deposits, which was the only input needed for the financial counterfactuals. However, to quantify the real implications of financial integration we need to take a stance on the separate components of $\bar{\gamma}_j$. In the model, ξ_j is equal to the ratio of bank loans divided by state GDP. In our baseline exercise, we thus use our Call Reports data at the earliest available date (1961) and set ξ_j to be equal to the ratio of local bank loans divided by state GDP.[59] Because some of these loans are not loans to firms, and we are still missing other loans to firms, we rescale it so that the US-level average of ξ_j is equal to .51, which matches the ratio between nonfinancial corporate business loans divided by all nonfinancial corporate businesses debt from FRED in 1958. This is a closer proxy in the aggregate data for ξ_j. We are likely to be conservative with this rescaling (i.e., underestimating ξ_j) since noncorporate businesses are more dependent on bank loans, and in Appendix Table H.19 we experiment with different values. Having values for ξ_j, we then solve for χ_j from the $\bar{\gamma}_j$ that we estimated in Section 5. This implies an average real liquidity service ($\mathcal{R}_{jt}$) that is .14 (at a nominal rate of .05).[60]

Migration elasticity. Because computing transition dynamics is highly efficient, we can estimate the migration elasticity internally. We target the observed growth in population *relative* to total income growth as a function of financial integration. But, importantly, we leave the total growth generated by financial integration untargeted—so that the model can still be informative as to how much growth can be generated by financial integration.

In particular, we compute the growth path of each state in population and state-level income for any given value of the migration elasticity ν. We first invert the model as described above—separately for each draw of ν—and then simulate the transition dynamics after our shocks. We

[59] We define local loans as commercial and industrial loans, loans to farmers, and loans secured by real estate (among which we cannot unfortunately distinguish between residential and commercial). For the denominator in 1961 we interpolate GDP from 1963 as in Kleinman et al. (2023). Results are almost identical if we scale by state income.

[60] To be transparent in dealing with these parameters, Appendix Table H.19 repeats our baseline exercise under different possible choices of ξ_j and χ_j. We experiment between scenarios where: *i.* all differences in local deposit abundance come from differences in loan demand, i.e., fixing $\chi_j = \bar{\chi}$ for all states; *ii.* all differences come from differences in the liquidity shifters for households, and we fix $\xi_j = \bar{\xi}_j$. The magnitude of results is sensitive to the average value of ξ_j (intuitively, in the limit where $\xi_j = 0$, banks have no relevance for firms' costs), but only marginally to its variation across space. Results for specific states are obviously instead somewhat sensitive to the distribution of ξ_j.

iterate across values of ν until the model-implied fraction of state-level income growth in an initially high-rate state that comes from population growth—rather than income per capita growth—matches the relative fraction we observe in the data. That is, letting β^N be the coefficient of a regression of population growth between 1958 and 1983 against initial lending rates in 1953–58 and β^{Income} be the same coefficient for state-level income, we choose ν so that, when estimating the same regressions with the simulated data, $\beta^N/\beta^{\text{Income}}$ in the model equals the corresponding ratio of coefficients that we see in the data. We use income both in the data and in the model because we lack GDP data before 1963.

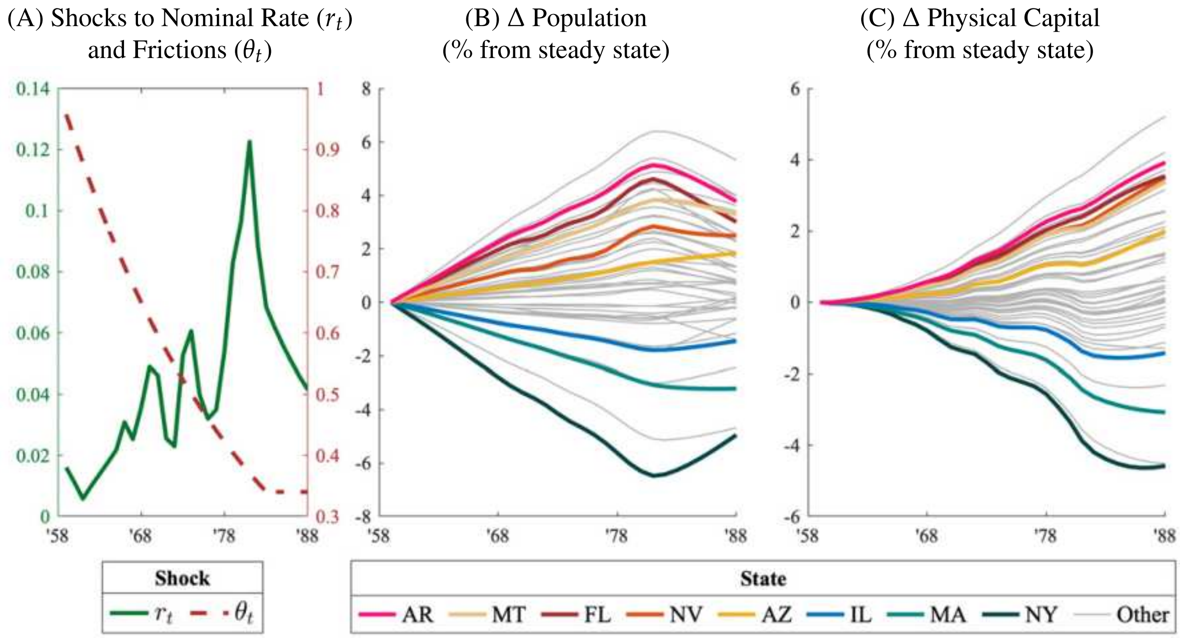
The intuition for identification follows Corollary 3.1: if the migration elasticity is high, most of the changes in state-level income following a shock, such as a decrease in local lending rates, will come from changes in population rather than changes in wages. Indeed, Appendix Figure H.14 shows that the $\beta^N/\beta^{\text{income}}$ we estimate in our counterfactuals is monotonically increasing in ν. This yields an estimate of $\nu = .23$ in our baseline, which is close to the estimate of .2 in Caliendo et al. (2019).

8.2 Results

Figure 8 reports the transition dynamics for all state populations (Panel B) and physical capital stocks (Panel C) as a result of the increase in nominal rate we observed between 1959 and 1983 and the estimated decline in frictions over the same time. These shocks are reported in Panel (A). After 1983, we assume that nominal rates revert back to their 1958 level with a persistence of .9 and that frictions remain constant at their 1983 level. The persistence in nominal rates tracks the trend of nominal rates after 1983 and the assumption that frictions remain constant follows the fact that they represent changes in technology. We keep all other real fundamentals fixed at their 1958 levels. Results are very similar if we use actual nominal rates after 1983.

The regional implications of these national financial shocks are large. This is a result left untargeted by the model because in our estimation we only targeted the response of population to financial integration relative to that total income, not the absolute response. The colored lines in Panels (B) and (C) highlight eight states, in shades of yellow and red for the states in the South and West, and shades of blue for the financial centers. All other states are reported in gray. Panel (B) shows that financial integration at its peak is responsible for a 6.5% and 3% decrease in the Northeastern financial centers of New York and Massachusetts, and a 1% decrease in Illinois. Initially capital-scarce states in the West and South instead benefited from this process and show opposite patterns. Physical capital dynamics are similar but lagged and slower, as in Bilal and Rossi-Hansberg (2023) and Kleinman et al. (2023), which helps to explain why wage responses are more muted in the data. In the short run households move to booming places, and this puts downward pressure on wages. If physical capital is slow to accumulate, it does not react fast

FIGURE 8: REAL ADJUSTMENTS AFTER FINANCIAL CONVERGENCE



Notes. Panel (A) reports the aggregate shocks we study, starting from the steady state in 1958. The green line reports the change in nominal rates, which is the observed path of the US three-month Treasury Bill rate between 1959 and 1983, assumed to revert back to its 1958 level with a persistence of .9. The red dashed line reports the the estimated change in frictions between 1959 and 1983, assumed to remain constant at their 1983 level thereafter. Panel (B) reports population transition dynamics over time, expressed as the change in population in each state at time t as a percentage of 1958 steady-state population. Panel (C) reports the same transition dynamics for physical capital. The discount and depreciation rates are .05, the estimated migration elasticity is $\nu = .23$, and the Cobb-Douglas labor share is .63. Colored lines represent the states reported in the legend, and gray lines represent all other states.

enough to offset the increase in labor supply and wages may even turn negative in the short run (but households might still move in as they expect them to turn back positive in the medium term when capital adjusts).

This exercise shows a substantial advantage of focusing on transition dynamics instead of just steady-state-to-steady-state changes. We could not have squared the evolution of wages, population, and GDP that we saw in Table 2 as easily only from steady-state-to-steady-state changes, and we would not have been able to exploit the entire non-monotonic and rapidly changing path of nominal rate shocks.

Table 3 shows that our model explains a sizable fraction of the regional growth we observe in the data. We report regional growth rates for three broad regions: the Northern financial centers, defined as New York, Massachusetts, and Illinois; the South and West; and other Northern and Midwestern regions. The first three columns focus on GDP growth between 1963 (the earliest year we can measure it) and 1983, and the last three columns on population growth over the same time span. The first column in each group reports the regional growth rate of the dependent variable,

TABLE 3: REGIONAL GROWTH RATES: DATA AND MODEL

	Regional Growth Rates, 1963–1983					
	GDP			Population		
	Data		Model	Data		Model
	Raw (1)	Conditional on Controls (2)	From Financial Convergence (3)	Raw (4)	Conditional on Controls (5)	From Financial Convergence (6)
Northern Financial Centers	−20.5%	−10.9%	−2.8%	−15.4%	−6.2%	−3.2%
Other North and Midwest	−14.7%	+1.6%	+.3%	−9.2%	+.7%	−.1%
South and West	+22.2%	+3.9%	+1.4%	+12.6%	+3.3%	+1.3%

Notes. The table reports regional real growth rates of GDP (columns 1 to 3) and population (4 to 6) between 1963 and 1983. Regional growth rates are expressed as the growth rate of the region as a whole minus the aggregate growth rate of the US economy. Columns (1) and (4) report the raw rates in the data. Columns (2) and (5) report the rates after residualizing state-level growth against the demand and supply shocks controls included in Table 2. Columns (3) and (6) report growth rates generated by the model as a result of financial convergence.

expressed for the region as a whole and as a difference with the aggregate US growth rate over the same time. Column (1), for instance, shows that GDP growth in the Northern Financial Centers was 20.5 percentage points lower than the average US growth over the same period, meaning that this region declined relative to other regions of the US. Conversely, growth was 22.2 percentage points higher in the South and West. Controlling for the other known drivers of growth in those years of Table 2, this heterogeneity narrows to −10.9 for the Northern financial centers and +3.9 for the South and West. Column (3) reports the model-implied growth rates, showing that it explains 26% of this conditional heterogeneity for the financial centers and 35% for the South and West. For population, Columns (5) and (6) show that the model explains 52% of the conditional heterogeneity for the Northern financial centers and 39% for the South and West.

The model does not match the entire convergence conditional on controls shown in Columns (2) and (5) for two reasons. First, it is likely that these few controls are not enough to capture other unobservables potentially correlated with lending rates. Second, and more importantly, some initial conditions are themselves a function of initial lending rates and are also correlated with growth dynamics for reasons unrelated to financial integration. As a result, it is impossible to isolate the effects of financial integration by residualizing against these initial conditions in a regression with a limited sample.[61] That is, the reduced form on its own cannot isolate the effects of integration on regional growth, which makes this quantification helpful.

The reduced form also cannot shed light on the aggregate consequences of our shocks, to which

[61] For instance, places with higher initial rates have lower population in the model and in the data. However, initial population by itself explains part of the growth in this period, and it is reasonable to think that this relationship comes from reasons beyond financial integration. We would like to remove this part of growth coming from initial population, but it is impossible to residualize on it in Columns (2) and (5) without also removing some of the effects of financial integration because the two are co-determined in equilibrium.

TABLE 4: AGGREGATE EFFECTS

	Horizon (t)						
	1983	1993	2003	2013	2023	2083	$t \to \infty$
Changes relative to 1958							
US GDP	$-.66\%$	$-.15\%$	.48%	.97%	1.33%	2.07%	2.23%
US Physical Capital Stock	$-.75\%$	.07%	1.24%	2.20%	2.87%	4.12%	4.33%
Path of shocks							
Nominal Rates, $r_t - r_{1958}$	6.84	2.52	.93	.34	.13	.00	.00
Frictions, θ_t / θ_{1958}	.34	.34	.34	.34	.34	.34	.34

Notes. The table reports the aggregate effects on US GDP and physical capital stock after a shock to nominal rates and to banks' frictions of accessing national wholesale markets. Total population is assumed to remain constant, so that aggregates can be interpreted in per capita terms. The change in nominal rates is the observed path of the US three-month Treasury Bill rate between 1959 and 1983, assumed to revert back to its 1958 level with a persistence of .9. The change in frictions is the estimated change in frictions between 1959 and 1983, assumed to remain constant at their 1983 level thereafter.

Table 4 turns. We report aggregate changes in US GDP and physical capital stock, estimated by aggregating the transition dynamics of Figure 8 to the US level. Total population is assumed to remain constant, so that aggregates can be interpreted in per capita terms. In the immediate aftermath of our shocks, US GDP and physical capital decline because the increase in nominal rates strains banks' balance sheets. The outflow of deposits increases banks' marginal costs and, in turn, lending rates, which ultimately leads firms to cut production. However, as rates revert to their initial level, the decline in frictions has positive effects on growth. Banks' improved ability to tap national markets lowers their marginal costs and leads to lower bank lending rates in the aggregate, which in turn increases output in the long run.

If the decline in frictions was partly a reaction to the high nominal rate environment, these results suggest that high-rate environments like the Great Inflation can have a long-run silver lining. The accounts of our period described in Section 2 (and in Stigum 1978; Scadding 1979; Mishkin 1990; Zweig 1996) strongly suggest that the financial innovations we documented were the product of the high-rate environment. Yet without better data on frictions it is challenging to quantify this potentially interesting link, but future work exploiting new data sources could explore it.

8.3 High-Rate Environments Substitute for Deregulation

Finally, we draw some implications of our findings for today. As noted in Section 5, one consequence of the nominal rate channel is that the effects of deregulation aimed at integrating capital markets depend on the rate environment in which deregulation occurs—because high nominal rates themselves can generate integration and substitute for other sources.

US interstate branching deregulation post-1982 occurred in a very high-rate environment. This is the most studied episode of deregulation aimed at integrating capital markets and it is often cited by policymakers (e.g., in Draghi 2018). Yet if policymakers were to repeat the American experiment in the Eurozone today, as is currently being debated (Draghi 2014, 2018, 2024b; Angeloni 2020, 2024; Cahen 2024), they would do so in a very different nominal rate environment. While America in 1982 was coming out from a period of exceptionally high nominal rates, the Eurozone today comes out of a protracted low-rate environment in which deposits have surged. As of 2022, households in the Eurozone held .3% of their income in money market funds, while this number was 8.4% for US households in 1982 (see D'Amico 2024 for a brief review of current trends in the Eurozone). Would deregulation have stronger effects in today's deposit-heavy Europe, compared to its effects in the US? Would US deregulation have had stronger effects if it had occurred in the deposit-heavy environment of 1958?

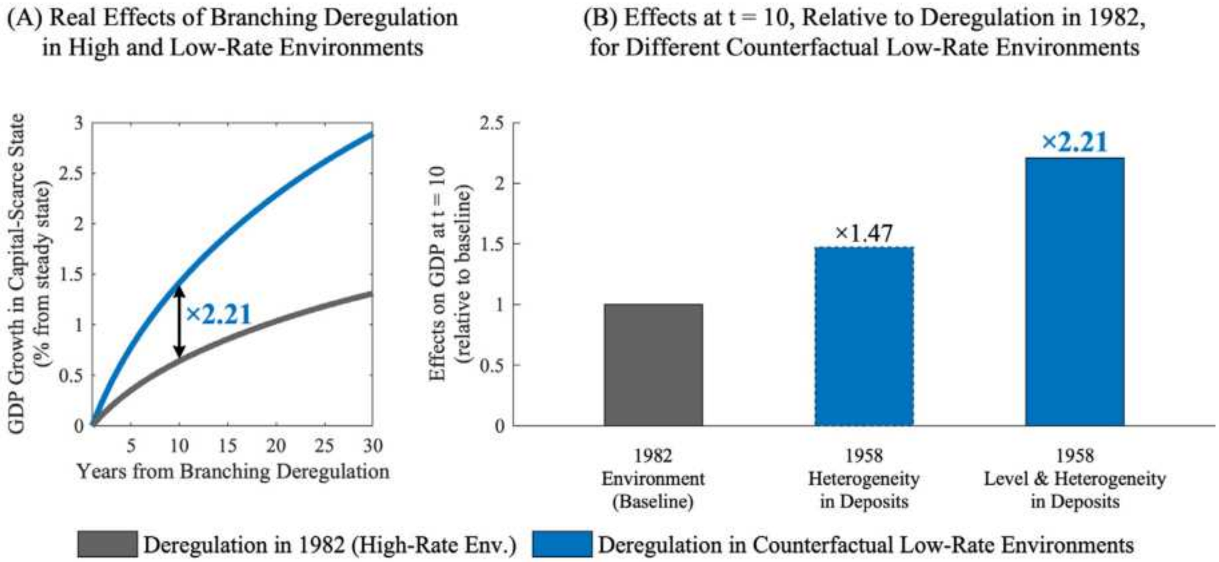
To shed light on these questions, we estimate the heterogeneous effects of branching deregulation across different rate environments. We provide the intuition here and leave the implementation details to Appendix H.4. We model branching deregulation as allowing for a representative national bank that can take deposits and extend loans in all regions of the economy, which equates lending rates everywhere. We perturb the model with respect to shocks to local lending rates implied by this equalization.

We study the effects of deregulation across three counterfactual environments. The first starts from the regional spreads implied by the model using nominal rates and frictions in 1982, which mimics in a stylized way the environment in which deregulation actually occurred in the US and constitutes our baseline scenario.[62] The initial regional spreads in the second counterfactual are instead those implied by the model if deposits across space were as heterogeneous as they were in the low-rate environment of 1958, but the aggregate level of deposits was still that of 1982. In the third, we also force the level of deposits, in addition to their heterogeneity, to match that of 1958. The difference across counterfactuals is that deposits influence the level of regional spreads that deregulation is set to erode.

Panel (A) of Figure 9 plots the effects of deregulation on growth of a capital-scarce state, defined as a state that in 1958 had a one percentage point higher lending rate than average, roughly the difference between the Northern financial centers and the South and West. The gray (bottom) line plots GDP growth over time in the baseline 1982 scenario, and the blue (top) line plots them in the third counterfactual scenario where deposits are as they were in the 1958 low-rate environment.

[62] The exercise is not apt to capture the absolute effects of the actual US branching deregulation since that episode also had important effects on bank competition and it also occurred in a staggered fashion, which would require incorporating staggered shocks and also some adjustment costs for banks in branching in different regions. The point of this exercise is to focus on the effects of deregulation on regional spreads and to benchmark the real consequences of eroding regional spreads across different aggregate rate environments.

FIGURE 9: EFFECTS OF BRANCHING DEREGULATION IN HIGH- AND LOW-RATE ENVIRONMENTS



Notes. The figure reports the simulated effect of deregulation on GDP growth in a state with a 1 percentage point higher lending rate in 1958. Deregulation is modeled as a shock driving rates everywhere to the rate charged by a national bank that can collect deposits and lend everywhere. The gray (bottom) line in Panel (A) reports the effects of deregulation over time starting from an environment with a 10.6% aggregate nominal rate, equal to the three-month Treasury Bill rate in 1982. The blue (top) line reports the effects of deregulation in an environment where the distribution of deposits matches the predicted distribution if the aggregate nominal rate was 1.8%, equal to the three-month Treasury Bill rate in 1958. Panel (B) reports effects on GDP growth at $t = 10$, relative to the 1982 baseline, in the two scenarios of Panel (A) and in an additional one where only the heterogeneity across states in deposits matched that of 1958, but the average level of deposits matched that of 1982.

Effects of deregulation are more than twice as large in the low-rate environment.

Panel (B) distinguishes how much of these higher effects are due to more heterogeneous deposit allocations compared to a higher aggregate level of deposits. We show the effect on GDP growth at $t = 10$ in two low-rate counterfactuals relative to the baseline scenario, which is reported in the first bar and normalized to one. The second bar shows that the heterogeneity in deposits matters on its own: effects of deregulation on growth would have been 47% larger if deposits in 1982 were as heterogeneously distributed across space as they were in 1958. If deposits were to match those of 1958 both in levels and dispersion, effects would have been more than twice as large, as shown by the third bar (which is also the difference between the blue and the gray lines at $t = 10$ in the left panel). In Appendix Figure H.17 we also consider the role of frictions, and find that effects of deregulation would have been three times as large if frictions were as high as in 1958 and six times as large if both frictions and deposits were as high as in 1958.

The real regional effects of branching deregulation would have been much higher if it had occurred in a low-rate environment when households kept their liquidity mostly within borders.

There are many caveats to extrapolating the estimates of the effects of US branching deregulation to the Eurozone today, or to other developing economies that lack integrated markets, because banking has undergone many transformations. Yet to the extent that the American experience can still be a useful benchmark, our results highlight that the effects of deregulation would have been much larger had it happened in the sort of low-rate environments that have traditionally been prevailing in modern times.

Conclusion

Almost sixty years ago, in his "Imperfections in the Capital Market" (1967), George Stigler invited a deeper analysis of capital market imperfections that goes beyond the simple claim that frictions—whether technological or regulatory—create differences in prices. This paper takes up his invitation by studying the micro-determinants of financial segmentation and their macroeconomic effects.

Differences in prices of loans across markets endogenously change as market conditions evolve. Following an increase in nominal rates, national assets become more appealing to households, local deposits shrinks, and banks need to compete with Treasury Bills to attract households' liquidity back. In doing so, differences in the availability of local capital become less important and national markets can also become more efficient as banks invent new ways of tapping them. As a result of these forces, regional lending spreads narrow. High nominal rate environments may thus have a silver lining: they decrease regional financial imbalances and facilitate growth in areas stunted by the scarcity of their savings.

Today, all major US banks have branches in every corner of the nation and transfer deposits frictionlessly across space. Eurozone banks, however, face frictions that resemble those faced by American banks in the mid-century (cf. Fn. 8), and are also very reliant on local deposits. Mario Draghi (2024a) recently noted:

> "The EU has very high private savings, but they are mostly funneled into bank deposits and do not end up financing growth as much as they could in a larger capital market. This is why advancing the Capital Markets Union is an indispensable part of the overall competitiveness strategy."

Did the low-rate environment that has traditionally prevailed since the creation of the euro contributed to the anemic size of EU capital markets? Has the current high-rate environment invited some integration? How much growth could be unleashed by a larger continental market? The American experience, under the lens of our theory, sheds light on these important questions. Low nominal rates keep liquidity within borders and exacerbate frictions to the mobility of capital, and this can have sizable implications for regional growth.

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Appendix

A Data Construction

A.1 Digitization and Available Data

FIGURE A.1: EXAMPLE TABLE FROM THE OCC REPORTS

TABLE NO. 39.—*Assets and liabilities of active national banks, Dec. 31, 1953*—Continued

LIABILITIES

[In thousands of dollars]

Location	Demand deposits	Time deposits	Total deposits	Bills payable, rediscounts, and other liabilities for borrowed money	Acceptances executed by or for account of reporting banks and outstanding	Other liabilities	Capital stock [1]	Surplus	Undivided profits	Reserves and retirement account for preferred stock
Maine	155, 184	88, 001	243, 185			2, 185	9, 390	10, 387	5, 502	1, 023
New Hampshire	171, 856	44, 975	216, 831	350		772	6, 094	10, 320	5, 902	1, 346
Vermont	71, 977	75, 698	147, 675			1, 722	5, 545	6, 040	3, 538	1, 197
Massachusetts	2, 735, 359	429, 109	3, 164, 468	1, 550	28, 234	43, 838	81, 464	157, 295	46, 240	18, 960
Rhode Island	120, 707	62, 315	183, 022		338	2, 210	4, 380	7, 805	2, 244	83
Connecticut	790, 544	194, 550	985, 094	150		10, 676	24, 343	28, 787	11, 900	4, 506
Total New England States	4, 045, 627	894, 648	4, 940, 275	2, 050	28, 572	61, 403	131, 216	220, 634	75, 326	27, 115
New York	11, 122, 695	2, 468, 128	13, 590, 823	3, 305	82, 048	625, 172	389, 495	624, 437	204, 669	13, 559
New Jersey	1, 751, 246	1, 188, 562	2, 939, 808	1, 450	121	22, 422	65, 779	94, 704	36, 125	8, 595
Pennsylvania	4, 937, 716	2, 133, 921	7, 071, 637	1, 630	1, 612	55, 379	207, 955	446, 410	107, 793	12, 378
Delaware	20, 912	12, 961	33, 873			33	1, 260	2, 784	846	189
Maryland	623, 251	169, 868	793, 119	580	22	3, 521	14, 960	31, 155	9, 194	5, 022
District of Columbia	656, 589	122, 767	779, 356	400		5, 118	13, 200	24, 050	7, 899	1, 455
Total Eastern States	19, 112, 409	6, 096, 207	25, 208, 616	7, 365	83, 803	711, 645	692, 649	1, 223, 540	366, 526	41, 198
Virginia	935, 153	429, 482	1, 364, 635	1, 500	553	10, 523	30, 567	52, 172	19, 898	4, 464
West Virginia	417, 514	149, 524	567, 038	150		2, 583	13, 150	24, 655	8, 713	2, 429
North Carolina	463, 189	113, 599	576, 788		4	5, 895	11, 050	24, 690	7, 094	2, 150
South Carolina	464, 820	63, 846	528, 666			4, 758	8, 962	15, 216	4, 755	1, 539
Georgia	1, 007, 750	168, 097	1, 175, 847			12, 874	23, 198	34, 276	9, 894	11, 055
Florida	1, 432, 408	269, 654	1, 702, 062	300	10	14, 840	38, 525	49, 285	13, 410	8, 074
Alabama	888, 822	222, 398	1, 111, 220		1, 017	10, 455	24, 137	36, 000	15, 792	4, 107
Mississippi	209, 859	48, 000	257, 859			1, 268	5, 353	11, 265	287	232
Louisiana	1, 291, 359	206, 528	1, 497, 887		6, 499	10, 041	22, 313	46, 190	14, 962	658
Texas	6, 387, 041	824, 121	7, 211, 162		24, 491	39, 533	179, 060	201, 931	75, 005	20, 485
Arkansas	420, 044	73, 982	494, 026			2, 993	11, 245	15, 909	8, 880	1, 604
Kentucky	604, 361	125, 533	729, 894	300		4, 794	15, 625	28, 433	8, 972	1, 937
Tennessee	1, 374, 900	371, 101	1, 746, 001		7, 815	14, 189	34, 176	59, 295	19, 150	3, 374
Total Southern States	15, 897, 220	3, 065, 865	18, 963, 085	2, 250	40, 389	134, 746	417, 361	599, 317	206, 812	62, 108

The main variables that we have for national banks include: *i)* total assets, which we can split between securities, loans, fixed assets, and other assets; *ii)* total liabilities, which we can split between demand deposits, time & savings deposits, borrowings, and capital stock; *iii)* expenses, which we can split between wages and benefits of employees, interest expenses on time and savings deposits, other interest expenses, provision for loan losses, and other expenses. We can further divide loans in: commercial and industrial loans (C&I), loans to agriculture, loans secured by real estate, loans for purchase of securities, loans to financial institutions, and other. We can also divide securities among US Government securities, securities of States and political subdivisions, and other securities.

A.2 Constructing Consistent Financial Series

A.2.1 Smoothing Across OCC and Call Reports

For the years when both OCC and Call Reports data overlap, the two sources are broadly consistent over time, states, and variables. To smooth the small differences in this overlapping time period, we paste the two sources together by taking a weighted average of the two, where the weight given to each data source in year t depends inversely on how far is year t from the end/start date of each data source. For instance, in 1961, the closest date to the end of the OCC sample, we give a weight of .9 to the OCC values and a weight of .1 to the Call Report ones. In 1965, each data source has equal weight, and so on.

A.2.2 Lending Rates Adjustments

June loans. Loans in June are reported net of reserves for expected future loan losses, but these reserves are only reported in December. To recover gross loans in June, we assume that the ratio of reserves to loans is constant in June and December of the same year. Using net loans as the denominator does not alter our results.

Loan losses. Part, but not all, of the historical literature also removes loan losses from the denominator. In our period, these are not consistently reported and are impossible to reconstruct in a consistent manner.

Accounting change. To correct for the accounting change of 1975 described in Section 1, we residualize lending rates against the state level fraction of foreign loans over domestic loans by estimating year-by-year regressions of:

$$r^L_{jt} = \alpha_t + \sum_s \beta_{t,s} \cdot \frac{\text{Domestic Loans}_{jt}}{\text{Total Loans}_{jt}} \times \mathbb{1}\left(\text{Region}(j) = s\right) + \varepsilon_{jt} \tag{24}$$

for all years between 1975 and 1983. $\mathbb{1}\left(\text{Region}(j) = s\right)$ is an indicator for the region of state j. That is, we allow different slopes for the fraction of foreign loans, to capture that banks in different US regions were exposed to different regions of the world, which might have carried different lending rates.

The corrected lending rate that we use in the counterfactuals is given by the residual of (24) plus the region-year-level means, so that we do not partial out average regional components but only use the regional indicator to account for heterogeneous slopes. The raw and corrected rate have a 96% correlation, but the correction is important for states such as New York and Massachusetts whose banks had large foreign operations. For instance, without correcting, the rate in New York is 17.1% in 1981, and the US average is 15.8%. With the correction, the rate in New York is 14.6% and the US average rate is 14.9%. Our reduced form results are all robust to discarding data after 1975.

A.2.3 Accounting Changes and Variable Definitions

See the Online Appendix, available here.

A.3 Other Variables

A.3.1 State Groups

We define regions following the geographical grouping made by the OCC. Southern States are AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA, WV. Pacific States are AZ, CA, ID, NV, OR, UT, WA3. Western States are CO, KS, MT, ND, NE, NM, OK, SD, WY. New England States are CT, MA, ME, NH, RI, VT. Middle Western States are IA, IL, IN, MI, MN, MO, OH, WI. Eastern States are MD, NJ, NY, PA.

A.3.2 Bank Location and Other Characteristics

Bank-level characteristics that include broad attributes such as bank names, addresses, charter, and bank type (whether the bank was a commercial bank, savings, or private one) are missing from the Call Reports data from 1960 to 1975. To add those, we use two sources. For banks that appear in the Call Reports in 1976, we add bank attributes from there. This allows us to recover banks' characteristics conditional on them not changing the location of their head branch and charter. Because interestate branching was forbidden, this implies that changes of head offices across states were unlikely, so we recover exactly the state of the bank. For other banks, we link them to their FFIEC record and copy relevant information from there. The FFIEC records report characteristics based on the last observed snapshot of the bank, which means either the moment of its closure or the last available year when we downloaded the data (2020). However, because the banks for which we need FFIEC data are not in the 1976+ Call Reports data, it usually means that the bank ceased operations before 1976.

Table A.1 reports the break down of the characteristics matching exercise. We focus on the asset-weighted metric because it is the one with the highest relevance for quantitative results. 93% of asset-weighted banks are rolled back directly from Call Reports. The remaining banks are covered by FFIEC. We check for sanity whether the exit date at FFIEC aligns with the last observation we see in the Call Reports data, suggesting that the characteristics at the exit date are reported correctly. 71% of banks added from FFIEC have the same exit year as the last observation in Call Reports. The remaining have an exit date mismatch (constituting 2.24% of the sample).

TABLE A.1: BANK CHARACTERISTICS: SOURCE DATA

Data source	# observations	% observations matched	% assets matched
Call reports	14668.00	87.54	92.67
FFIEC, same year exit	1491.00	8.90	4.29
FFIEC, exit mismatch	375.00	2.24	2.13
FFIEC, no exit	222.00	1.32	0.92

A.3.3 Bartik Controls

Sectoral We use sectoral GDP data from the BEA at the 2-digit level to construct a standard sectoral Bartik to control for state-level demand shocks between 1963 and year t. We project at the state level US sector-level changes in GDP between 1963 and t using the state-level share of GDP accounted for by each sector in 1963. Using employment from the CBP gives similar results.

Agricultural We construct an agricultural shift-share by projecting at the state level changes in prices between 1963 and year t in: Corn; Sorghum; Wheat; Hay and hayseeds; Fresh fruits and melons; Fresh Vegetables, Except Potatoes; Soybeans; Peanuts; Raw Cotton; Sweet potatoes; Dry beans; Livestock; Dry peas. The shares to project price changes for each agricultural product x are defined as the total amount of farmland devoted to the production of x divided by total amount of farmland. Data on farmland devoted to different uses comes from Haines (2000) and price data comes from FRED.

B Theoretical Appendix

B.1 Derivations and Proof of Proposition 1

We derive equilibrium lending rates in (7). The banks' FOC reads: The first order condition is:

$$2\left(\frac{M}{L}\right)-\left(\frac{M}{L}\right)^{2}=2\theta^{-1}\left(r_{jt}^{L}-r_{t}\right)$$
$$\left(1-\frac{D}{L}\right)\left(1+\frac{D}{L}\right)=2\theta^{-1}\left(r_{jt}^{L}-r_{t}\right)$$

Substituting households deposit demand and firms loan demand, $D_j/L_j=\gamma_j(r)=\frac{\alpha_N\varphi(r-\chi_j)}{\xi_j}$ gives:

$$r_j^L=r+\frac{1}{2}\theta\left(1-\gamma_j(r)^2\right)$$

We turn to the proof of Proposition 1.

Proof. Consider two regions j and h such that $r_j^L>r_h^L$. Let the function $\gamma(r,\chi_j,\xi_j)=\gamma_j(r)$ capture deposit demand over loan demand. The spread between these regions is:

$$r_j^L-r_h^L=\frac{1}{2}\theta\left(\gamma\left(r,\chi_h,\xi_h\right)^2-\gamma\left(r,\chi_j,\xi_j\right)^2\right)$$

Recall that $\gamma(r,\chi,\xi)=\frac{\alpha_N\varphi(r-\chi)}{\xi}=\frac{\alpha_N\exp(-\phi(r-\chi))}{\xi}$, where the last equality uses the fact that, by

(5), deposit demand as a share of regional income $\alpha_N \varphi(r-\chi) = \alpha_N \exp(-\phi(r-\chi))$. Hence:

$$\begin{aligned} r_j^L - r_h^L &= \frac{1}{2}\theta\left(\frac{\alpha_N^2 \exp(-2\phi(r-\chi_h))}{\xi_h^2} - \frac{\alpha_N^2 \exp(-2\phi(r-\chi_j))}{\xi_j^2}\right) \\ &= \frac{1}{2}\theta\left(\frac{\alpha_N^2 \exp(2\phi\chi_h)}{\xi_h^2} - \frac{\alpha_N^2 \exp(2\phi\chi_j)}{\xi_j^2}\right)\exp(-2\phi r) \end{aligned} \tag{25}$$

The derivative with respect to r is simply:

$$\begin{aligned} \frac{\partial(r_j^L - r_h^L)}{\partial r} &= -2\phi \cdot \frac{1}{2}\theta\left(\frac{\alpha_N^2 \exp(2\phi\chi_h)}{\xi_h^2} - \frac{\alpha_N^2 \exp(2\phi\chi_j)}{\xi_j^2}\right)\exp(-2\phi r) \\ &= -2\phi(r_j^L - r_h^L) < 0 \end{aligned}$$

which is negative given that $\phi > 0$ and that we are considering two regions j,h for which lending rates are such that $r_j^L - r_h^L > 0$. That is, by draining deposits from the system, the nominal rate narrows initial differences between the two regions, because these initial differences themselves depend on different initial deposit endowments as a share of loans. The functional forms here make the intuition as clear as possible in this simple case, but they are not necessary. Appendix Section B.3.1 derives the sufficient conditions under which this result follow in the more general case with arbitrary convex costs of bond financing and arbitrary deposit demand.

The result on frictions, $\frac{\partial(r_j^L - r_h^L)}{\partial(-\theta)} < 0$, similarly follows by differentiating (25). □

We now turn to the proof of Lemma 1.

Proof. Let again $\gamma(r,\chi_j,\xi_j) = \gamma_j(r) = \frac{\alpha_N \varphi(r-\chi_j)}{\xi_j}$ capture deposit demand over loan demand and recall that, by (5), $\varphi' < 0$ and $\varphi'' > 0$. Then the partial and cross-partial derivatives, indicated by subscripts, are: $\gamma_r = \alpha_N \frac{\varphi'}{\xi} < 0$, $\gamma_\chi = -\alpha_N \frac{\varphi'}{\xi} = -\gamma_r > 0$, $\gamma_\xi = \frac{-\gamma}{\xi} < 0$, $\gamma_{r\chi} = -\alpha_N \frac{\varphi''}{\xi} \leq 0$, and $\gamma_{r\xi} = \frac{-\gamma_r}{\xi} > 0$. The pass-through of aggregate rates is:

$$\frac{\partial r_j^L}{\partial r} = 1 + \underbrace{\theta\left(-\gamma_r(r,\chi_j,\xi_j)\right) \cdot \gamma\left(r,\chi_j,\xi_j\right)}_{\Delta \text{ in marginal cost} > 0}$$

Then:

$$\frac{\partial r^L}{\partial r \partial \chi} = \theta\left(\underbrace{-\gamma_{r\chi}}_{\geq 0}\gamma + \underbrace{\gamma_r^2}_{>0}\right) > 0 \qquad \frac{\partial r^L}{\partial r \partial \xi} = \theta\left(\underbrace{-\gamma_{r\xi}}_{<0}\gamma + \underbrace{(-\gamma_r)\gamma_\xi}_{<0}\right) < 0$$

□

B.1.1 Discussion

It is useful to discuss the key intuition behind Lemma 1, which carries to our main result and clarifies the conditions under which the results holds with more general deposit demand functions. Letting $\mathcal{C}$ be the part of local lending rates that, due to the increasing costs of national financing, depends on the ratio of loan demand over deposit demand, i.e. $\mathcal{C}\left(\gamma(r,\chi_j,\xi_j)\right) = \frac{\theta}{2}\left(1-\gamma(r,\chi_j,\xi_j)^2\right)$, where $\gamma(r,\chi_j,\xi_j) = \gamma_j(r) = \alpha_N \varphi(r-\chi_j)/\xi_j$ is the ratio of deposit demand over loan demand in region j, which depends on deposit demand $\varphi(r-\chi_j)$ as a share of income, itself dependent on r and the liquidity shifter χ_j, and on the loan demand shifter ξ_j. Then an increase in the aggregate has a pass-through of:

$$\frac{\partial r_j^L}{\partial r} = 1 + \underbrace{\mathcal{C}' \cdot \left(\frac{\partial \gamma(r,\chi_j,\xi_j)}{\partial r}\right)}_{\substack{\Delta \text{ in MC due to} \\ \text{deposits outflow}}>0} = 1 + (-\theta\gamma)\,\gamma_r = 1 + \theta \cdot \frac{\alpha_N^2 \varphi}{\xi_j^2}(-\varphi') > 1 \tag{26}$$

where we indicated with γ_r the partial derivative of γ with respect to r and in the last equality we expressed γ as a function of primitives. $\mathcal{C}' = -\theta\gamma_j(r) < 0$ is the decrease in local rates as the deposit share of bank assets increases, due to the fact that bond financing becomes less expensive as the bank needs less of it. $\gamma_r < 0$ is the decline in the deposit share of liabilities due to the increase in nominal rates.

The local pass-through of aggregate rates, given by (26), hence depends on two elements. The first is the one-for-one increase in the cost of the first unit of wholesale financing. The second element captures the fact that an increase in rates causes an outflow of deposits because households substitute from deposits to bonds ($\gamma_r < 0$ because $\varphi' < 0$) and this in turn increases the cost of wholesale financing because costs are convex, making $\mathcal{C}$ decreasing in γ.

To see why this pass-through can be heterogeneous across deposit-rich and deposit-scarce regions, let x indicate either the deposit or the loan demand shifter and consider for concreteness that higher values of x correspond to higher deposit abundance relative to loans, i.e. $x = \chi_j$ or $x = -\xi_j$ so that $\gamma_x = \partial\gamma/\partial x > 0$ always. Then the heterogeneity in pass-through across places is simply a function of the cross-partial derivative:

$$\frac{\partial^2 r_j^L}{\partial r \partial x} = -\theta \cdot (\gamma_x \gamma_r + \gamma\gamma_{r,x}) \tag{27}$$

for $x = \chi_j$ and/or $x = -\xi_j$. A positive value of (27) means that local rates will increase more, after an increase in r, in places where banks have a higher share of deposits because of higher x. If places differ by both χ_j and ξ_j, then the geographic heterogeneity in pass-through is going to be governed by a weighted sum of (27) across characteristics ξ_j and χ_j.[63]

The cross-partial captures the heterogeneity in deposit outflows across deposit abundant and deposit rich states. We have:

$$\frac{\partial^2 \gamma_j}{\partial r \partial(-\xi)} < 0; \qquad \frac{\partial^2 \gamma_j}{\partial r \partial \chi} \leq 0$$

The first cross-partial $\gamma_{r,-\xi}$ is always negative. Ceteris paribus, places with a lower loan demand shifter ξ_j always see larger decreases in deposits over liabilities (the outflow is more negative). This is a simple consequence of the fact that, for two ratios with an identical initial numerator (deposits), a smaller denominator (loans) amplifies, in proportional terms, a change in the numerator. Hence, if differences are driven by differences in loan demand, the pass-through will always be higher in deposit-rich places (i.e. (27) is positive), both because deposit shares of bank loans are more "exposed" to changes in deposits ($\gamma\gamma_{r,-\xi} < 0$) as well as because $\gamma_x\gamma_r < 0$. This latter term comes from the fact that, because costs are constant-to-scale convex in the fraction financed on wholesale markets, the rate equation is itself convex in γ. Thus, even identical outflows will affect initially deposit abundant places more.

The second cross-partial $\gamma_{r,\chi}$ is also strictly negative if the bond demand function $1 - \varphi(r - \chi_j)$ is strictly concave in the net benefit from holding bonds, $r - \chi_j$ (or, equivalently, deposit demand was convex in the opportunity cost $r - \chi_j$). In that case, then an equivalent change in the benefit from holding bonds (due to a change in r), will have a higher effect in places where the marginal benefits of holding bonds are relatively higher, and these are the deposit abundant places where χ_j is high. Thus, the outflow of deposits as a fraction of income will be larger in deposit-abundant areas. If it was linear, i.e. $\varphi'' = 0$, we would have $\gamma_{r\chi} = 0$, but still (27) would be positive because $\gamma_x\gamma_r < 0$.

Here is where the concavity in bond demand eases the discussion. If instead bond demand with respect to the net return from bonds is convex, then this means that places that have few deposits to start with will see larger outflows. If this convexity is large enough, this might overturn the result if differences across space depend mostly by differences in deposits endowments rather than loan demand. Ultimately, the data leans against this case: the deposit-rich states those where the deposit share of liabilities decreases the most.

[63] Without assuming a quadratic, we need to take into account also the curvature of marginal costs, which can undo some of the results, for some extremely convex "hockey-stick" like functions. We discuss and derive the results in this more general case in Appendix Section B.3.1, finding sufficient conditions in terms of the maximum convexity of the cost function. Our reduced form results will show that pass-through of rates is highest in deposit-rich places. This either implies that the convexity is not "hockey-stick" or that, even if this sufficient condition is not met, the extreme convexity does not undo the effects of the heterogeneous change in the deposit share. Results available upon request that use demand deposits as a proxy for local funding show that we cannot reject a quadratic.

B.2 Discussion of Assumptions

Convexity in National Financing The key assumption of our framework is the constant-to-scale convex cost of national financing, which is our frictional source of capital mobility. This type of wholesale financing for the bank is uninsured and unsecured, and many microfoundations deliver this common violation of Modigliani-Miller. The classic microfoundation comes from Stein (1998), which applies the Myers and Majluf (1984) logic of adverse selection to a banking model. It is an extremely common convexity, which is necessary to give rise to the large literature that discusses the bank lending channel of monetary policy: the fact that strains to bank balance sheets translate into lending cuts and end up having real effects.

The setup in international portfolio allocation of Kleinman et al. (2024) also provides another possible microfoundation that more directly captures the "geographic" origins of this convexity. This can be derived by solving the problem of a national investor that has to allocate savings across different states, subject to capital market frictions such as information acquisition costs, fees, and regulatory costs.

Household Borrowing. Our framework does not model household borrowing. That is, we consider them as net supplier of funds of the banking system, something that is true in the aggregate data. Adding them does not change the qualitative conclusions of the model. However, it would probably affect the quantitative real results in the full dynamic model if the convergence forces that we documented also affected households, primarily through mortgage rates. We decide not to include them because the convergence we document did not occur for mortgages. As shown in Angelova and D'Amico (2024), the mortgage market was essentially already integrated by the 1950s because of the federal housing policies of the post-Depression era. An example is the creation of the Federal Home Loan Bank Board, which essentially provided liquidity at the same conditions to local lenders throughout the nation. This is also coherent with the fact that in Section 6 we do not find effects on fertility, while Angelova and D'Amico (2024) find that city-level changes in mortgage rates affect fertility for young couples.

Remunerated Deposits Another assumption is the fact that banks cannot remunerate deposits and hence take them as exogenous. At the time Regulation Q prohibited any remuneration on checking accounts and even today, when banks are free to remunerate them, they optimally choose not to pass on rate increases to depositors in order to profit from inattentive/inelastic customers who do not switch when rates increase. We develop in the next Section an extension where banks can remunerate some types of local deposits.

B.3 Extension to the Financial Part

B.3.1 Arbitrary Degree of Convexity in the Cost of National Financing and General Deposit Demand Function

We relax the assumption that costs of national financing are quadratic and that deposit demand is exponential. Banks' costs of borrowing M given a total amount of lending of L is now $\frac{\theta^{1/\zeta}}{1+1/\zeta}\left(\frac{M}{L}\right)^{1+1/\zeta}L$, so that the profit maximization problem follows:

$$\begin{aligned} \max_{L,M} \quad & r_j^L L - rM - \frac{\theta^{1/\zeta}}{1+1/\zeta}\left(\frac{M}{L}\right)^{1+1/\zeta} L \\ s.t. \quad & L = D_j + M \end{aligned} \tag{28}$$

where $\zeta = 1$ is the quadratic case.

Let the fraction of income that households deposit be a general $\varphi\left(r-\chi_j\right) \in \mathcal{C}^2$ with $\varphi' < 0$.

Proposition B.1 (Nominal and Secular Channels of Financial Convergence, Arbitrary Convexity and Deposit Demand)**.** *Let banks' maximization problem follow 28 and deposit demand as a fraction of income be $\varphi\left(r-\chi_j\right) \in \mathcal{C}^2$ with $\varphi' < 0$. Consider two regions j and h where lending rates are higher in j than h, either because firms are more constrained to borrow from the bank in j, or because deposit demand is higher in h, or both. That is, let j,h be such that $r_j^L > r_h^L$ because $\xi_j \geq \xi_h$ and $\chi_j \leq \chi_h$ with at least one strict inequality. Finally, let $\gamma_i \leq 1$ be the ratio of deposits over loans in each region $i = j,h$ and $c = 1 + 1/\zeta$ indicate the convexity of banks' costs of national financing. Then:*

1. *A decrease in θ always narrows regional spreads.*

2. *If $\xi_j > \xi_h$ and $\chi_j = \chi_h$, then an increase in the nominal rate narrows regional spreads if and only if the convexity of banks' costs is not too high, $c < \bar{c}$ with $\bar{c} = \frac{2}{\bar{\gamma}} > 2$, where $\bar{\gamma} \in \left(\gamma_j, \gamma_h\right)$.*

3. *If $\xi_j = \xi_h$ and $\chi_j < \chi_h$, then an increase in the nominal rate generates convergence if the fraction of income invested in bonds is weakly concave in r (or, conversely, the deposit share of income is weakly convex, $\varphi'' \geq 0$) and the convexity of banks' costs is not too high, $c < \bar{c}$ with $\bar{c} = 1 + \frac{1}{\bar{\gamma}} + \frac{1-\bar{\gamma}}{\bar{\gamma}}\varepsilon > 2$, where $\bar{\gamma} \in \left(\gamma_j, \gamma_h\right)$ and $\varepsilon = \frac{\varphi''/\varphi'}{\varphi'/\varphi} > 0$ is the superelasticity of the deposit share of income with respect to the aggregate rate evaluated at $\bar{\gamma}$.*

4. *If $\xi_j > \xi_h$ and $\chi_j < \chi_h$, the result above follows with a threshold $\bar{c}$ for the convexity of banks' costs that is a function of the thresholds in points 2 and 3.*

Proof. We start by deriving local lending rates. The bank first order condition is:

$$(\zeta+1)\left(\frac{M}{L}\right)^{1/\zeta}-\left(\frac{M}{L}\right)^{1+1/\zeta}=(\zeta+1)\,\theta^{-1/\zeta}\left(r_{jt}^{L}-r_{t}\right)$$

which, following the same steps as in the proof to Proposition 1, leads to the local rate equation:

$$r_{j}^{L}=r+\frac{1}{\zeta+1}\theta^{1/\zeta}\left(1-\gamma_{j}\left(r\right)\right)^{1/\zeta}\left(\zeta+\gamma_{j}\left(r\right)\right)$$

The first part of the proof can be seen trivially by simply taking the derivative with respect to $-\theta$ of $r_{j}^{L}-r_{h}^{L}$. For the second to last part, we start deriving the pass-through of aggregate rates:

$$\frac{\partial r_{j}^{L}}{\partial r}=1+\underbrace{\frac{1}{\zeta}\theta^{1/\zeta}\left(-\frac{\partial\gamma_{j}}{\partial r}\right)\frac{\gamma_{j}\left(r\right)}{\left(1-\gamma_{j}\left(r\right)\right)^{1-1/\zeta}}}_{\Delta\text{in marginal cost}>0}$$

We want to derive the conditions under which $\frac{\partial r_{j}^{L}}{\partial r}<\frac{\partial r_{h}^{L}}{\partial r}$. Notice that we can remove the subscript j from the deposits over loan ratio $\gamma_{j}(r)$ by writing it as a function $\gamma(r,\chi_{j},\xi_{j})=\frac{\alpha_{N}\varphi\left(r-\chi_{j}\right)}{\xi_{j}}$. We can similarly write the passthrough $\frac{\partial r_{j}^{L}}{\partial r}$ also as a function of χ_{j} and ξ_{j} given any r. We let the function $g(\chi,\xi;r)$ define this passthrough:

$$g\left(\chi,\xi;r\right):=\frac{\partial r^{L}\left(\chi,\xi;r\right)}{\partial r}=\left(\frac{1}{\zeta}\theta^{1/\zeta}\left(-\gamma_{r}\left(r,\chi,\xi\right)\right)\left(\gamma\left(r,\chi,\xi\right)\right)\left(1-\gamma\left(r,\chi,\xi\right)\right)^{1/\zeta-1}\right)$$

Note that g is continuous and differentiable since r^{L} is continuous and double differentiable. By the mean value theorem:

$$g\left(\chi_{j},\xi_{j};r\right)-g\left(\chi_{h},\xi_{h};r\right)=\frac{\partial g\left(\bar{\chi},\bar{\xi};r\right)}{\partial\chi}\left(\chi_{j}-\chi_{h}\right)+\frac{\partial g\left(\bar{\chi},\bar{\xi};r\right)}{\partial\xi}\left(\xi_{j}-\xi_{h}\right)$$

where $\bar{\chi}\in\left(\chi_{j},\chi_{h}\right),\bar{\xi}\in\left(\xi_{h},\xi_{j}\right)$. To show that $\frac{\partial r_{j}^{L}}{\partial r}<\frac{\partial r_{h}^{L}}{\partial r}$ is true it is enough to show that $g\left(\chi_{j},\xi_{j};r\right)-g\left(\chi_{h},\xi_{h};r\right)<0$. We consider the different cases.

<u>Differences in loan demand</u>. Let $\xi_{j}>\xi_{h},\chi_{j}=\chi_{h}$. Then $g\left(\chi_{j},\xi_{j};r\right)-g\left(\chi_{h},\xi_{h};r\right)=\frac{\partial g\left(\bar{\chi},\bar{\xi};r\right)}{\partial\xi}\left(\xi_{j}-\xi_{h}\right)$ and we only need to show $\frac{\partial g\left(\bar{\chi},\bar{\xi};r\right)}{\partial\xi}<0$ which amounts to showing $\frac{\partial^{2}r^{L}}{\partial r\partial\xi}<0$.

$$\frac{\partial^{2}r^{L}}{\partial r\partial\xi}=\frac{\partial}{\partial\xi}\left(\frac{1}{\zeta}\theta^{1/\zeta}\left(-\gamma_{r}\left(r,\chi,\xi\right)\right)\left(\gamma\left(r,\chi,\xi\right)\right)\left(1-\gamma\left(r,\chi,\xi\right)\right)^{1/\zeta-1}\right)$$

$$= -\frac{1}{\zeta}\theta^{1/\zeta}\left(1-\bar{\gamma}\right)^{1/\zeta-1}\left(\gamma_{r\xi}\bar{\gamma}+\gamma_r\gamma_\xi\cdot\left(\frac{\zeta-\bar{\gamma}}{\zeta\left(1-\bar{\gamma}\right)}\right)\right)$$

We need to show that:

$$\gamma_{r\xi}\bar{\gamma}+\gamma_r\gamma_\xi\cdot\left(\frac{\zeta-\bar{\gamma}}{\zeta\left(1-\bar{\gamma}\right)}\right)>0$$

Substituting $\gamma_\xi = -\frac{\bar{\gamma}}{\xi}$ and $\gamma_{r\xi} = -\frac{\gamma_r}{\xi}$, the inequality above is true if and only if:

$$\zeta > \frac{\bar{\gamma}}{2-\bar{\gamma}}$$

Implying that the convexity must be:

$$1+\frac{1}{\zeta} < 1+\frac{2-\bar{\gamma}}{\bar{\gamma}} = \frac{2}{\bar{\gamma}}$$

A sufficient condition is that $1+\frac{1}{\zeta}\leq 2$, because $\bar{\gamma}=\gamma(r,\bar{\chi},\bar{\xi})=\frac{\alpha\varphi(r-\bar{\chi})}{\bar{\xi}}<1$ since $\xi_h<\bar{\xi}<\xi_j$ and $\gamma_h\leq 1$.

Differences in deposit demand. Let $\xi_j=\xi_h, \chi_j<\chi_h$, following similar steps, $g\left(\chi_j,\xi_j;r\right)-g\left(\chi_h,\xi_h;r\right)=\frac{\partial g\left(\bar{\chi},\bar{\xi};r\right)}{\partial\chi}\left(\chi_j-\chi_h\right)$ and we only need to show that $\frac{\partial^2 r^L}{\partial r\partial\chi}>0$. We have:

$$\frac{\partial^2 r^L}{\partial r\partial\chi} = \frac{\partial}{\partial\chi}\left(\frac{1}{\zeta}\theta^{1/\zeta}\left(-\gamma_r\left(r,\chi,\xi\right)\right)\gamma\left(r,\chi,\xi\right)\left(1-\gamma\left(r,\chi,\xi\right)\right)^{1/\zeta-1}\right)$$
$$= -\frac{1}{\zeta}\theta^{1/\zeta}\left(1-\gamma\right)^{1/\zeta-1}\left(\gamma_{r\chi}\bar{\gamma}+\gamma_r\gamma_\chi\cdot\left(\frac{\zeta-\bar{\gamma}}{\zeta\left(1-\bar{\gamma}\right)}\right)\right)$$

And now need to show that:

$$\gamma_{r\chi}\bar{\gamma}+\gamma_r\gamma_\chi\cdot\left(\frac{\zeta-\bar{\gamma}}{\zeta\left(1-\bar{\gamma}\right)}\right)<0$$

We use $\gamma_\chi=\frac{\partial}{\partial\chi}\left(\frac{\alpha_N\varphi(r-\chi)}{\xi}\right)=-\frac{\alpha_N\varphi'}{\xi}=-\gamma_r$ and $\gamma_{r\chi}=-\frac{\alpha_N\varphi''}{\xi}$ and show that the inequality above is true if and only if:

$$\zeta\left(\varphi\varphi''\left(1-\bar{\gamma}\right)+\left(\varphi'\right)^2\right)>\left(\varphi'\right)^2\bar{\gamma}$$

A sufficient condition is that $\varphi''\geq 0$ and:

$$1+\frac{1}{\zeta}<1+\frac{1+\varepsilon^{\varphi}\left(1-\bar{\gamma}\right)}{\bar{\gamma}}$$

where $\varepsilon^{\varphi} = \frac{\varphi \varphi''}{(\varphi')^2}$, and note that the convexity being quadratic is sufficient because $1 + \frac{1+\varepsilon^{\varphi}(1-\bar{\gamma})}{\bar{\gamma}} > 2$ given that $\bar{\gamma} < 1$ and $\varepsilon^{\varphi} \geq 0$.

Differences in both deposit and loan demand. We finally consider $\xi_j > \xi_h, \chi_j < \chi_h$. We need to show:

$$g(\chi_j, \xi_j; r) - g(\chi_h, \xi_h; r) = \frac{\partial g(\bar{\chi}, \bar{\xi}; r)}{\partial \chi} \Delta\chi + \frac{\partial g(\bar{\chi}, \bar{\xi}; r)}{\partial \xi} \Delta\xi < 0$$

From the derivations above, we have:

$$\begin{aligned} g(\chi_j, \xi_j; r) - g(\chi_h, \xi_h; r) = &- \frac{1}{\zeta} \theta^{1/\zeta} (1-\gamma)^{1/\zeta - 1} \left(\gamma_{r\chi} \bar{\gamma} + \gamma_r \gamma_\chi \cdot \left(\frac{\zeta - \bar{\gamma}}{\zeta (1-\bar{\gamma})} \right) \right) \Delta\chi \\ &- \frac{1}{\zeta} \theta^{1/\zeta} (1-\bar{\gamma})^{1/\zeta - 1} \left(\gamma_{r\xi} \bar{\gamma} + \gamma_r \gamma_\xi \cdot \left(\frac{\zeta - \gamma}{\zeta (1-\gamma)} \right) \right) \Delta\xi \end{aligned}$$

We thus need to sign:

$$\left(\gamma_{r\chi} \bar{\gamma} + \gamma_r \gamma_\chi \cdot \left(\frac{\zeta - \bar{\gamma}}{\zeta (1-\bar{\gamma})} \right) \right) \Delta\chi + \left(\gamma_{r\xi} \bar{\gamma} + \gamma_r \gamma_\xi \cdot \left(\frac{\zeta - \gamma}{\zeta (1-\gamma)} \right) \right) \Delta\xi > 0$$

Multiplying both sides by $\zeta(1-\bar{\gamma})$ gives:

$$(\gamma_{r\chi} \bar{\gamma} \zeta (1-\bar{\gamma}) + \gamma_r \gamma_\chi \cdot (\zeta - \bar{\gamma})) \Delta\chi + (\gamma_{r\xi} \bar{\gamma} \zeta (1-\gamma) + \gamma_r \gamma_\xi \cdot (\zeta - \gamma)) \Delta\xi > 0$$

Following the derivations above, we can reach:

$$\zeta > \bar{\gamma} \frac{-\Delta\chi + \frac{\bar{\gamma}}{-\alpha_N \varphi'} \Delta\xi}{-\Delta\chi (1 + (1-\bar{\gamma}) \varepsilon^{\varphi}) + (2-\bar{\gamma}) \frac{\bar{\gamma} \Delta\xi}{-\alpha_N \varphi'}}$$

Expressed in terms of convexity as:

$$1 + \frac{1}{\zeta} < 1 + \frac{1}{\bar{\gamma}} \frac{-\Delta\chi (1 + (1-\bar{\gamma}) \varepsilon^{\varphi}) + (2-\bar{\gamma}) \frac{\bar{\gamma} \Delta\xi}{-\alpha_N \varphi'}}{-\Delta\chi + \frac{\bar{\gamma}}{-\alpha_N \varphi'} \Delta\xi}$$

where $1 + (1-\bar{\gamma}) \varepsilon^{\varphi}$ in the numerator in the threshold for the case in which all differences come from deposit demand, while $2 - \bar{\gamma}$ is the numerator in the threshold for the case in which all differences come from loan demand. □

B.3.2 Interbank Market

We consider here parts of the parameter space where banks' deposits in some regions can be in excess of loan demand, allowing banks to invest excess liquidity in an interbank market. Banks can lend L at rate r_j^L and buy assets A in an interbank market (or a general bond market) that pay r. The key assumption that does not overturn our results is that banks lending in the interbank market do not cash-in the part of convex costs that banks borrowing from the interbank market have to pay. That is, the increasing cost of external financing represents an actual friction, coherently with the literature that also incorporates this friction (Bernanke and Gertler 1995; Kashyap and Stein 1995; Stein 1998; Bernanke et al. 1999; Kashyap and Stein 2000; Drechsler et al. 2017; Wang et al. 2022) and its microfoundations (Froot et al. 1993; Stein 1998; Hanson et al. 2015). As in the main text, they collect deposits D_j from households and issue national wholesale financing of M at convex costs that are constant-to-scale. Deposit demand and loan demand are unaffected and still follow (5) and (3).

Banks' maximization problem is now:

$$\begin{aligned} \max_{L,A,M} \quad & r_j^L L + rA - rM - \frac{\theta}{2}\left(\frac{M}{L+A}\right)^2 (L+A) \\ s.t. \quad & L + A = D_j + M \\ & L, A, M \geq 0 \end{aligned} \tag{29}$$

The Lagrangian is:

$$\begin{aligned} \mathcal{L} = & \, r_j^L L + rA - rM - \frac{\theta}{2}\left(\frac{M}{L+A}\right)^2 (L+A) \\ & + \lambda\left(L + A - D_j - M\right) + \mu^L(-L) + \mu^A(-A) + \mu^M(-M) \end{aligned}$$

Using the budget constraint, the KKT conditions give:

$$r_j^L - r = \mu^L - \mu^A \tag{30}$$

$$-\mu^M - \mu^A = \frac{\theta}{2}\left(1 - \left(\frac{D_j}{L+A}\right)^2\right) \tag{31}$$

along with $\mu^A, \mu^L, \mu^M \leq 0$ and the complementary slackness conditions. From (30), the non-negativity conditions and the slackness conditions we have that $r^L = r \implies L > 0, A > 0$.

Loan market equilibrium requires that $L_j = L$, where L_j is loan demand by firms as in (3). Letting $\aleph = (\alpha_N, \xi_j, \chi_j, r)$ collect the parameters, consider two cases. First, assume that $\aleph$ is such that deposits are less than loan demand:

$$\frac{\xi_j}{\alpha_N} > \exp(-\phi(r - \chi_j)) \implies L_j > D_j$$

this is the part of the parameter space we considered in the main text. In this case, the right-hand side of (31) is strictly positive and $\mu^L = 0$, which implies $\mu^A < 0$ and $A = 0$. The budget constraint implies $M = L_j - D_j > 0$, which implies $\mu^M = 0$. Substituting μ^A in (30) with μ^A from (31), lending rates are:

$$r_j^L = r + \frac{\theta}{2}\left(1 - \left(\frac{D_j}{L_j}\right)^2\right)$$

which is the same as in Section 3.

Assume now that $\aleph$ is such that deposits are in excess of loan demand:

$$\frac{\xi_j}{\alpha_N} < \exp(-\phi(r - \chi_j)) \implies L_j < D_j$$

Then again $\mu^L = 0$. If $A = 0$, then by the budget constraint $L_j - D_j = M < 0$, a contradiction given (29). Thus, $A > 0$, which implies $\mu^A = 0$. By (30), this is possible only if $r_j^L = r$.

Finally, if $\aleph$ is such that $L_j = D_j$, then by the budget constraint $A = M \geq 0$. Assume $A = M > 0$, this again implies $\mu^A = 0$. The right-hand side of (31) is strictly positive, which implies that $\mu^M < 0$, which implies $M = 0$, a contradiction. Thus, $A = M = 0$, which implies $r_j^L = r$.

Hence, lending rates are:

$$r_j^L = r + \max\left\{\frac{\theta}{2}\left(1 - \left(\frac{D_j}{L_j}\right)^2\right), 0\right\}$$

and all the results of Section 3 apply in regions where banks issue wholesale financing (i.e. $D_j/L_j < 1$), which correspond to all states in our data.

B.3.3 Remunerated Deposits

Deposit supply. Assume now that banks can issue remunerated deposits to local households, S, in addition to unremunerated checking accounts D and bonds M. That is, the bank solves:

$$\max_{L,M,S} \quad r_j^L L - r_j^S S - rM - \frac{\theta}{2}\left(\frac{M}{L}\right)^2 L \tag{32}$$
$$s.t. \quad L = D_j + M + S$$

Removing subscripts, the first order conditions give:

$$r^L = r + \theta\frac{M}{L} - \frac{\theta}{2}\left(\frac{M}{L}\right)^2$$

$$r^S = r + \theta \frac{M}{L}$$

That is, the bank equates the cost of issuing a local saving deposit to the marginal cost of issuing a bond.[64]

Deposit demand. Households now can choose between checking deposits, which yield a liquidity benefit of $\chi + \varepsilon_D$; savings deposits, which yield a benefit of $r^S + \varepsilon_S$; and bonds, which yield a benefit of $r + \varepsilon_M$. The ε_i capture idiosyncratic valuations that households have for each product, and to remain close to the main text, we assume that ε_i is type-I extreme value distributed with scale ϕ. The share of households holding checking deposits, d, and savings deposits, s, follow:

$$d = \frac{\exp(\phi\chi)}{\exp(\phi\chi) + (\phi r) + \exp(\phi r^S)}$$
$$s = \frac{\exp(\phi r^S)}{\exp(\phi\chi) + (\phi r) + \exp(\phi r^S)}$$

Loan demand. The firm side is the same as in the main text, so that loan demand is always $\xi w N / \alpha_N$.

Equilibrium. Checking and savings deposit demand over loan demand in equilibrium is:

$$\frac{D+S}{L} = \eta(d+s); \qquad \text{where} \quad \eta = \frac{\alpha_N}{\xi}$$

Let m be the the fraction of bond financing, using the budget constraint we have $m = M/L = 1 - (D+S)/L$. We can write:

$$\begin{aligned} 1 - m &= \eta \left(\frac{\exp(\phi r^S) + \exp(\phi\chi)}{\exp(\phi\chi) + (\phi r) + \exp(\phi r^S)} \right) \\ &= \eta \left(1 - \frac{\exp(\phi r)}{\exp(\phi\chi) + (\phi r) + \exp(\phi r^S)} \right) \\ &= \eta \left(1 - \frac{1}{1 + \exp(\phi(\chi - r)) + \exp(\phi(r^S - r))} \right) \end{aligned}$$

And we note that:

$$m + \eta - 1 > 0$$

for any value of r^S because $m + \eta - 1 = \eta / \left(1 + \exp(\phi(\chi - r)) + \exp\left(\phi\left(r^S - r\right)\right)\right)$.

[64] We can also interpret r^S as being a composite cost between returns paid and advertising or costly liquidity services.

We operate the change of variable $x = r^L - r$ and substitute $r^S - r = \theta m$ using banks' FOC. We reach the simple system:

$$x = \theta m - \frac{\theta}{2}(m)^2 \tag{33}$$

$$1 - m = \eta \left(1 - \frac{1}{1 + \exp\left(\phi\left(\chi - r\right)\right) + \exp\left(\phi\theta m\right)}\right) \tag{34}$$

We show that Lemma 1 holds also in this setting, which amounts to showing that:

$$\frac{\partial^2 x}{\partial(-\xi)\partial r} > 0; \quad \frac{\partial^2 x}{\partial\chi\partial r} > 0$$

Using (33):

$$\frac{\partial x}{\partial r} = \theta m_r (1 - m)$$
$$\frac{\partial^2 x}{\partial r \partial \chi} = \theta m_{r\chi} (1 - m) - \theta m_r m_\chi$$
$$\frac{\partial^2 x}{\partial r \partial \xi} = \theta m_{r\xi} (1 - m) - \theta m_r m_\xi$$

These comparative statics are identical to those in the main text. Also in this case, all that matters is how the fraction of bond financing responds to nominal rates, as well as any geographic heterogeneity in this response. Adding savings deposits does not alter this result because the bank will simply equate them to the marginal cost of bond financing.

We solve for the changes in the fraction of bond financing using the implicit function theorem on (34). In particular, rearranging, we have:

$$(1 - m) A = \eta (A - 1)$$

where we are denoting $A = 1 + f(\chi - r) + f(\theta m)$, $f(z) = \exp(\phi z)$. Noting that $A_r = -f_z(\chi - r) + f_z(\theta m)\theta m_r$ and using the implicit function theorem by differentiating with respect to r, we reach:

$$-m_r A + (1 - m) A_r = \eta A_r$$
$$-m_r A + (1 - m)\left(-f_z(\chi - r) + f_z(\theta m)\theta m_r\right) = \eta\left(-f_z(\chi - r) + f_z(\theta m)\theta m_r\right)$$

where we let $f_z(\cdot)$ indicate $\frac{\partial f(z)}{\partial z} = \phi \exp(\phi z)$. Letting $B = m + \eta - 1 > 0$, we reach:

$$-m_r\left(A + B f_z(\theta m)\right) = -B f_z(\chi - r)$$

$$m_r = \frac{Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta} > 0$$

That is, an increase in nominal rates increases the amount of bond financing, as in the main text.

We then show that, cross sectionally, a higher deposit demand shifter (loan demand shifter) corresponds to lower (higher) lending rates. In particular, following the same steps as above, differentiating with respect to χ yields:

$$-m_\chi A + (1-m)A_\chi = \eta A_\chi$$
$$-m_\chi A + (1-m)(f_z(\chi - r) + f_z(\theta m)\theta m_\chi) = \eta(f_\chi(\chi - r) + f_\chi(\theta m)\theta m_r)$$

which implies:

$$m_\chi = \frac{-Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta} < 0 \tag{35}$$

Similarly we reach for ξ:

$$-m_\xi A + (1-m)A_\xi = \eta A_\xi + \eta_\xi(A-1)$$
$$-m_\xi A + (1-m)\left(f_z(\theta m)\theta m_\xi\right) = \eta\left(f_z(\theta m)\theta m_\xi\right) + \eta_\xi(A-1)$$
$$m_\xi = \frac{-\eta_\xi(A-1)}{A + Bf_z(\theta m)\theta} > 0 \tag{36}$$

which is positive because $\eta_\xi = -\frac{\eta}{\xi} < 0$. Thus, the bond share of liabilities is increasing in the loan demand shifter ξ and decreasing in the deposit demand shifter χ. Consequently, local lending rates are increasing in ξ and decreasing in χ, as in the main text

To sign $\frac{\partial^2 x}{\partial r \partial \chi}, \frac{\partial^2 x}{\partial r \partial \xi}$, we turn to the cross-partials, applying again the implicit function theorem on the first partial m_r we just derived.

$$m_{r\xi} = \frac{B_\xi f_z(\chi - r)(A + Bf_z(\theta m)\theta) - \left(A_\xi + B_\xi f_z(\theta m)\theta + Bf_{zz}(\theta m)\theta^2 m_\xi\right)Bf_z(\chi - r)}{(A + Bf_z(\theta m)\theta)^2}$$

The sign of the numerator is:

$$\begin{aligned} &AB_\xi f_z(\chi - r) + BB_\xi f_z(\chi - r)f_z(\theta m)\theta - A_\xi Bf_z(\chi - r) \\ &-BB_\xi f_z(\chi - r)f_z(\theta m)\theta - B^2 f_z(\chi - r)f_{zz}(\theta m)\theta^2 m_\xi = \\ &\underbrace{f_z(\chi - r)\left(AB_\xi - A_\xi B\right)}_{<0}\underbrace{-B^2\phi f_z(\chi - r)f_z(\theta m)\theta^2 m_\xi}_{<0} < 0 \end{aligned}$$

Where we used $f_{zz} = \phi f_z$ and signed the first term by noting that $A_\xi = f_z(\theta m)\theta m_\xi > 0$ and $B_\xi = m_\xi + \eta_\xi = \frac{-\eta_\xi(A-1)}{A+Bf_z(\theta m)\theta} + \eta_\xi = \eta_\xi\left(1 - \frac{A-1}{A+Bf_z(\theta m)\theta}\right) < 0$, where we substituted m_ξ using (36) and noted that $\frac{A-1}{A+Bf_z(\theta m)\theta} < 1$ and $\eta_\xi < 0$. Thus, we have $m_{r\xi} < 0$. We can hence show:

$$\frac{\partial^2 x}{\partial r \partial \xi} = \theta m_{r\xi}(1-m) - \theta m_r m_\xi < 0$$

since $m_r > 0, m_\xi > 0$, and $m_{r\xi} < 0$.

We follow similar steps to turn to the cross-partial with respect to χ. Differentiating m_r with respect to χ gives:

$$m_{r\chi} = \frac{\left(B_\chi f_z(\chi - r) + Bf_{zz}(\chi - r)\right)\left(A + Bf_z(\theta m)\theta\right) - \left(A_\chi + B_\chi f_z(\theta m)\theta + Bf_{zz}(\theta m)\theta^2 m_\chi\right)Bf_z(\chi - r)}{\left(A + Bf_z(\theta m)\theta\right)^2}$$

Again developing the numerator we reach

$$\begin{aligned} AB_\chi f_z(\chi - r) + ABf_{zz}(\chi - r) + BB_\chi f_z(\chi - r) f_z(\theta m)\theta + B^2 f_{zz}(\chi - r) f_z(\theta m)\theta \\ - A_\chi Bf_z(\chi - r) - B_\chi Bf_z(\chi - r) f_z(\theta m)\theta - B^2 f_z(\chi - r) f_{zz}(\theta m)\theta^2 m_\chi = \\ f_z(\chi - r)\left(AB_\chi - A_\chi B + AB\phi\right) + B^2 f_{zz}(\chi - r) f_z(\theta m)\theta - B^2 f_z(\chi - r) f_{zz}(\theta m)\theta^2 m_\chi \end{aligned}$$

The sign of the last two terms is surely positive, but the sign of $D = AB_\chi - A_\chi B + AB\phi$ is in general ambiguous. It follows:

$$D = Am_\chi - f_z(\chi - r)B - f_z(\theta m)m_\chi \theta B + AB\phi$$

Substituting m_χ using (35), we have:

$$\begin{aligned} D &= A\frac{-Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta} - f_z(\chi - r)B - f_z(\theta m)\frac{-Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta}\theta B + AB\phi \\ &= -Bf_z(\chi - r)\left(A\frac{1}{A + Bf_z(\theta m)\theta} + 1 - \frac{Bf_z(\theta m)\theta}{A + Bf_z(\theta m)\theta}\right) + AB\phi \\ &= -\frac{Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta}\left(A + A + Bf_z(\theta m)\theta - Bf_z(\theta m)\theta\right) + AB\phi \\ &= -\frac{Bf_z(\chi - r)}{A + Bf_z(\theta m)\theta}(2A) + AB\phi \\ &= AB\phi\left(1 - \frac{2f_z(\chi - r)/\phi}{A + Bf_z(\theta m)\theta}\right) \\ &= \frac{A^2 B\phi}{A + Bf_z(\theta m)\theta}\left(1 + \frac{B\phi f(\theta m)\theta}{A} - 2\frac{f(\chi - r)}{A}\right) \end{aligned}$$

where we used $f_z = \phi f$. Noting that $\frac{f(\chi - r)}{A}$ is the share of household income in checking deposits, a sufficient condition for the term above to be positive is that the share of income in deposits is less than half, which is true in the data. In terms of primitives, we can simply assume that liquidity services $\chi < r$ are below the nominal rate for the above to be surely positive, which a fortiori implies that $m_{r\chi} > 0$ as desired. Note also that this is only one term of $m_{r\chi}$, while the others are positive and that the cross-partial we are ultimately interested in is:

$$\frac{\partial^2 x}{\partial r \partial \chi} = \theta m_{r\chi} (1 - m) - \theta m_r m_\chi$$

The second part is always negative because $m_r m_\chi < 0$. The first part is also surely negative under the sufficient condition described above. For sanity, Figure B.2 simulates regional spreads between two regions j and h as a function of the nominal rate, and show that they decline, as in Proposition 1. The left hand-side panel considers the case where regional spreads are due to differences in liquidity shifters, $\chi_j < \chi_h$. The right hand-side panel considers the case where regional spreads are due to difference in loan demand shifters, $\xi_j > \xi_h$.

B.3.4 Endogenous Dependence on Local Banking

We relax the assumption that the regional share of inputs financed by bank loans is exogenous and set to ξ_j. We endogenize loan demand following a simplified version of the derivations in Altavilla et al. (2022), Herreño (2023), and Paravisini et al. (2023).

We assume that firm production combines different tasks ω produced with labor and physical capital and financed either with bank loans at rate r_j^L or by borrowing from non-banks at rate $r + \tilde{\xi}_j + \varepsilon(\omega)$, where $\varepsilon(\omega)$ is a random realization of the cost of non-bank borrowing for task ω. We can interpret $\varepsilon(\omega)$ as a spread between bank loans and non-bank financing. Assuming that banks have a comparative advantage in monitoring, for instance, this captures differences in the monitoring required by the lender for a task of type ω. $\tilde{\xi}_j > 0$ is a region-level shifter in the cost of non-bank borrowing, capturing the same type of heterogeneity discussed in the main text and that was captured by ξ_j.

For simplicity, assume that the firm needs to set up its production plans before submitting them for financing. That is, we assume that when choosing the mix of tasks, it does not know the random component of the spread $\varepsilon(\omega)$. In particular, the firm produces according to:

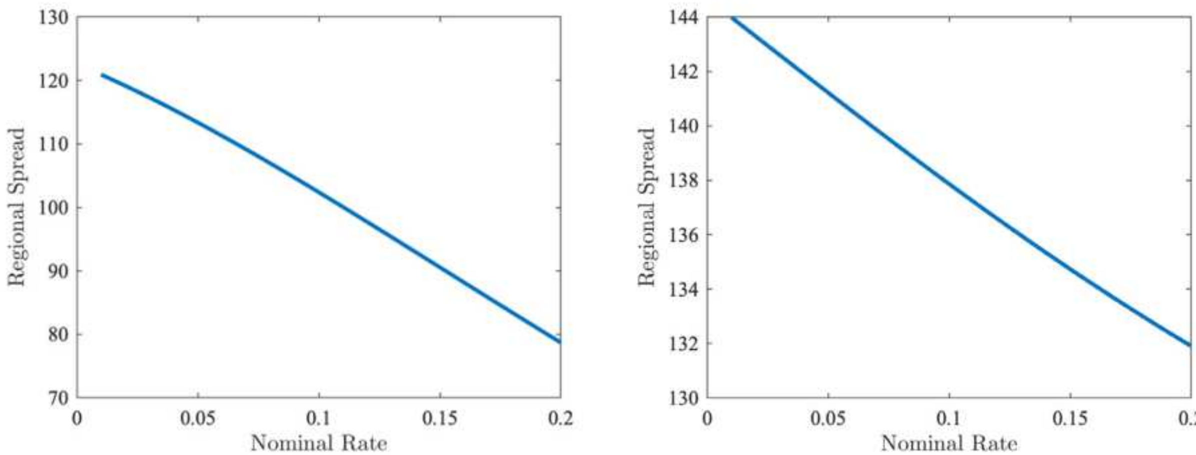
$$Y_j = z_j \left(\int_0^1 \left((n_j(\omega))^{\alpha_N} (k_j(\omega))^{\alpha_K} \right)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}$$

where $n_j(\omega)$ and $k_j(\omega)$ are capital and labor allocated to task ω, and σ is the elasticity of substitution between tasks. To simplify as much as possible, we assume that productivity of the firm in

FIGURE B.2: NOMINAL RATES AND REGIONAL SPREADS WITH REMUNERATED SAVINGS DEPOSITS

(A) DIFFERENCES IN DEMAND FOR CHECKING ACCOUNTS (χ)

(B) DIFFERENCES IN LOAN DEMAND (ξ)



Notes. The figure reports simulated differences in lending rates, $r_j^L - r_h^L$, for two regions j and h that differ in shifters χ and ξ. Panel A consider regions with different preferences for checking accounts (χ), where $\chi_j = \bar{\chi} - .05$, $\chi_j = \bar{\chi} + .05$, and $\bar{\chi} = .05$; and where $\xi_j = \xi_h = \bar{\xi}$, with $\bar{\xi} = .51$ set to the calibrated share of working capital financed with bank loans (cf. Section 8). Panel B consider regions with different dependence on bank lending (ξ), where $\xi_j = \bar{\xi} + .05$ and $\xi_h = \bar{\xi} - .05$; and $\chi_j = \chi_h = \bar{\chi}$.

each task is identical and equal to z_j. The firm solves:

$$\max_{n_j(\omega),k_j(\omega)} z_j \left(\int_0^1 \left((n_j(\omega))^{\alpha_N} (k_j(\omega))^{\alpha_K} \right)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} - \mathbb{E}\left[R_j^F(\omega) \right] \left(\int_0^1 w_j n_j(\omega) + r_j^K k_j(\omega) d\omega \right)$$

where $\mathbb{E}\left[R_j^F(\omega) \right]$ is the expected financing cost across all tasks and the factor market clearing conditions imply $\int_0^1 n_j(\omega) = N_j$ and $\int_0^1 k_j(\omega) = K_j$. The first order conditions show that the capital labor ratios in each task are identical and labor is constant across tasks. This implies that loan demand is:

$$\begin{aligned} L_j^D &= \int_0^1 \left(w_j n_j(\omega) + r_j^K k_j(\omega) \right) \mathbf{1}\left(r_j^L < r + \tilde{\xi}_j + \varepsilon(\omega) \right) d\omega \\ &= \frac{N_j w_j}{\alpha_N} \int_0^1 \mathbf{1}\left(r_j^L < r + \tilde{\xi}_j + \varepsilon(\omega) \right) d\omega = \frac{N_j w_j}{\alpha_N} \left(1 - F\left(r_j^L - r - \tilde{\xi}_j \right) \right) \end{aligned}$$

For symmetry with deposit demand in (5), we assume that $\varepsilon \sim \text{Exp}(\nu)$, so that loan demand is:

$$L_j^D = \frac{N_j w_j}{\alpha_N} \exp\left(-\nu \left(r_j^L - r - \tilde{\xi}_j \right) \right)$$

Deposits are as in the (5) and the bank problem is also identical to (6). Thus, loan market clearing implies:

$$r_j^L = r + \frac{\theta}{2}\left(1 - \left(\frac{D_j}{L_j^D}\right)^2\right) = r + \frac{\theta}{2}\left(1 - \left(\frac{N_j w_j \exp\left(-\phi\left(r-\chi_j\right)\right)}{\frac{N_j w_j}{\alpha_N}\exp\left(-\nu\left(r_j^L - r - \tilde{\xi}_j\right)\right)}\right)^2\right)$$
$$= r + \frac{\theta}{2}\left(1 - \left(\frac{\alpha_N \exp\left(-\phi\left(r-\chi_j\right)\right)}{\exp\left(-\nu\left(r_j^L - r - \tilde{\xi}_j\right)\right)}\right)^2\right)$$

That is, the condition is identical up to two differences. Our loan demand shifter across space is now $\xi_j = \exp(\nu\tilde{\xi}_j)$, and the denominator in the deposit/loan ratio depends on the spread between local lending rates and national rates.

We show that the cross-partials have the same sign as those of Lemma (1). In particular, dropping the j subscript and expressing $r^L\left(\chi, \xi, r\right)$, we use the implicit function theorem to derive:

$$\frac{\partial r^L}{\partial r} = \frac{\partial}{\partial r}\left(r + \frac{\theta}{2}\left(1 - \frac{\alpha_N^2 \exp\left(-2\phi\left(r-\chi\right) + 2\nu\left(r^L - r\right)\right)}{\xi^2}\right)\right)$$
$$= 1 + \theta\left(-\gamma^2\left(-\phi + \nu\frac{\partial s^L}{\partial r} - \nu\right)\right)$$

which implies:

$$\frac{\partial r^L}{\partial r} = \frac{1 + \theta\gamma^2\left(\phi + \nu\right)}{1 + \theta\gamma^2\nu} = 1 + \frac{\theta\gamma^2\phi}{1 + \theta\gamma^2\nu}$$

The cross-partials are:

$$\frac{\partial^2 r^L}{\partial r \partial \chi} = \frac{2\theta\gamma\gamma_\chi\phi \cdot \left(1 + \theta\gamma^2\nu\right) - 2\theta\gamma\gamma_\chi\nu \cdot \theta\gamma^2\phi}{\left(1 + \theta\gamma^2\nu\right)^2} = \frac{2\theta\gamma\gamma_\chi\phi}{\left(1 + \theta\gamma^2\nu\right)^2}$$

And similarly:

$$\frac{\partial^2 r^L}{\partial r \partial \xi} = \frac{2\theta\gamma\gamma_\xi\phi}{\left(1 + \theta\gamma^2\nu\right)^2}$$

With the signs depending on γ_χ and γ_ξ, which have the same sign as in the main text. In particular:

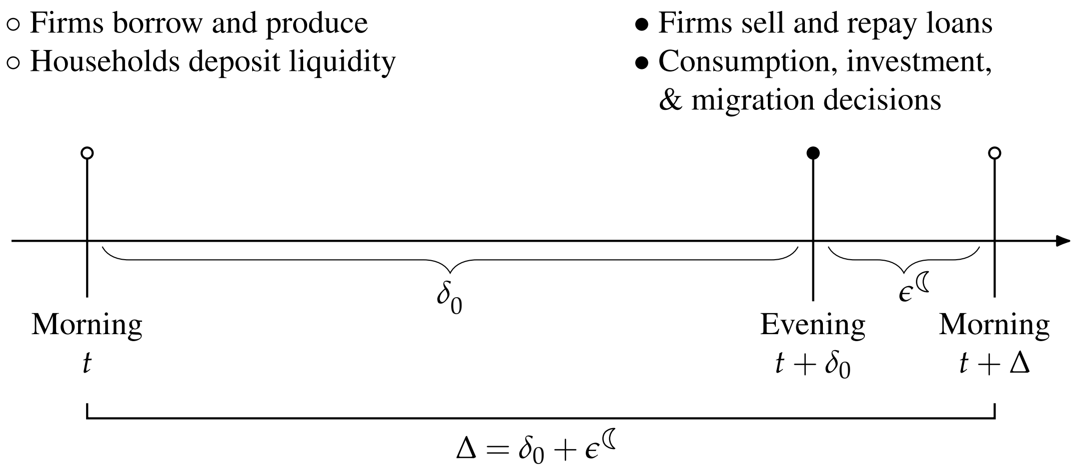
$$\frac{\partial \gamma}{\partial \xi} = \frac{\partial}{\partial \xi}\left(\frac{\alpha_N \exp\left(-\phi\left(r-\chi\right) + \nu\left(r^L - r\right)\right)}{\xi}\right) = \gamma\phi > 0$$

$$\frac{\partial \gamma}{\partial \xi} = \frac{\partial}{\partial \xi}\left(\frac{\alpha_N \exp\left(-\phi\left(r-\chi^2\right)+\nu\left(r^L-r\right)\right)}{\xi}\right) = -\frac{\gamma}{\xi} < 0$$

That is, endogenous loan demand dampens the heterogeneity in the passthrough of nominal rates, but the qualitative predictions are unchanged.

B.4 Derivations for Section 7.1

FIGURE B.3: TIMING OF CHOICES



B.4.1 Households' Flow Utility and Liquidity Choices in the Dynamic Model

Let choices follow the timing in Figure B.3, B_{jt} be amenities, C_{jt} be consumption of the numeraire with an evening price of $p_{t+\delta_0(\Delta)}$, and $p_{t+\delta_0(\Delta)}h_{jt}$ be the evening price of one unit of housing, and $\tilde{w}_{jt}$ be nominal wages received in the morning. Let $e_{ijt} = \chi_j + \varepsilon_{ijt}$, individual i decides to hold bonds in the morning ($m = 1$) by solving:

$$\begin{aligned} \max_{m\in\{0,1\}} \quad & \overbrace{\Delta\left(C_{jt}+B_{jt}\right)}^{\text{Flow consumption}} + \overbrace{\delta_0(\Delta)\frac{\tilde{w}_{jt}}{p_{t+\delta_0(\Delta)}}(1-m)e_{ijt}}^{\text{Liquidity benefits from depositing in the morning}} \\ \text{s.t.} \quad & \underbrace{\Delta p_{t+\delta_0(\Delta)}\left(C_{jt}+h_{jt}\right)}_{\text{Flow expenditure}} = \underbrace{\delta_0(\Delta)\left(\tilde{w}_{jt}\left(1+mr_t\right)\right)}_{\text{Flow income from working in the morning \& using bonds}} \end{aligned} \tag{37}$$

Substituting in the budget constraint yields:

$$\max_{m\in\{0,1\}} \quad \frac{\delta_0(\Delta)\tilde{w}_{jt}\left(1+mr_t\right)}{p_{t+\delta_0(\Delta)}} - \Delta h_{jt} + \Delta B_{jt} + \frac{\delta_0(\Delta)\tilde{w}_{jt}}{p_{t+\delta_0(\Delta)}}(1-m)e_{ijt}$$

Which gives:

$$\Delta u_{jt}(m,e_{ijt}) = \begin{cases} \frac{\delta_0(\Delta)\tilde{w}_{jt}(1+r_t)}{p_{t+\delta_0(\Delta)}} - \Delta h_{jt} + \Delta B_{jt} & \text{if } m = 1 \\ \frac{\delta_0(\Delta)\tilde{w}_{jt}\left(1+e_{ijt}\right)}{p_{t+\delta_0(\Delta)}} - \Delta h_{jt} + \Delta B_{jt} & \text{if } m = 0 \end{cases}$$

So that the optimal choice is $m = 1 \iff r_t > e_{ijt}$, as in Section 3, and the indirect utility is:

$$u_{ijt} = \frac{1}{\Delta}\left[\tilde{w}_{jt}\frac{\delta_0(\Delta) + \delta_0(\Delta)r_t + \delta_0(\Delta)\max\left\{0,e_{ijt} - r_t\right\}}{p_{t+\delta_0(\Delta)}}\right] - h_{jt} + B_{jt} \tag{38}$$

B.4.2 Equivalency Between Real and Nominal Model

Proposition B.2 (Nominal to Real Equivalence)**.** *Under the timing of Figure B.3, in any period t, for an arbitrary small interval* Δ *and a vanishing evening subinterval* $\epsilon^{☾} \to 0$*, the instantaneous profits of the firm, the instantaneous utility of households, and the budget constraint of capitalists are:*

$$\textit{Firm profits}: \quad F(N,K) - \left(1 + \rho^s + \xi_j s_{jt}\right)\left(w_{jt}N + r^K_{jt}K\right) \tag{39}$$

$$\textit{Household utility}: \quad w_{jt}\left(1 + \rho^s + \max\left\{0,e_{ijt} - r_t\right\}\right) - h_{jt} + B_{jt} \tag{40}$$

$$\textit{Capitalist budget}: \quad (1 + \rho^s)\, r^K_{jt}K_{jt} = c^k_{jt} + X_{jt} \tag{41}$$

where ρ^s *is an exogenous short-term (i.e. morning-to-evening) discount rate,* r_t *is the nominal short-term rate,* h_{jt} *are real house prices in the evening,* w_{jt} *and* r^K_{jt} *are factor prices in terms of morning prices.*

Proof. We derive the equivalence between the nominal and real model for an arbitrary small time interval between two mornings. This time interval is $\Delta = \delta_0 + \epsilon^{☾}$, where we consider a vanishing $\epsilon^{☾}$. We define the instantaneous inflation rate as:

$$\pi_t = \lim_{x\to 0}\frac{p_{t+x} - p_t}{x}\frac{1}{p_t} \tag{42}$$

so that $p_{t+\delta_0} = (1 + \delta_0\pi_t)\, p_t$ for small enough δ_0. Let ρ^s be an exogenous short-term discount rate. The short-term nominal return (i.e. between the morning and the evening) is:

$$\delta_0 r_t = \delta_0\rho^s + \delta_0\pi_t \tag{43}$$

We start by proving firms' profits.

Firms Firms sell in the evening facing a price of $p_{t+\delta_0(\Delta)}$ and hire in the morning. In each interval Δ, with an associated morning length of $\delta_0(\Delta)$, they maximize flow profits:

$$\max_{N,K} \underbrace{\Delta p_{t+\delta_0(\Delta)} F(N,K)}_{\text{Sales in the period}} - \underbrace{\delta_0(\Delta)\left(1+r_t+\xi_j s_{jt}\right)\left(\tilde{w}_{jt}N+\tilde{r}^K_{jt}K\right)}_{\text{Costs incurred in the morning}}$$

where $\tilde{w}_{jt}$ and $\tilde{r}^K_{jt}$ are nominal wages and the nominal rental rate of capital, $p_{t+\delta_0(\Delta)}$ is the sale price in the evening. $\delta_0(\Delta)$ is a function of Δ and we are considering the case where $\delta_0(\Delta) \to \Delta$. ξ_j is the dependence on bank borrowing (as opposed to borrowing from national markets) and $s_{jt} = r^L_{jt} - r_t$ is the instantaneous spread charged by the bank. The problem can be restated as solving:

$$\max_{N,K} F(N,K) - \frac{1}{\Delta}\left[\frac{\delta_0(\Delta)+\delta_0(\Delta)\rho^s+\delta_0(\Delta)\pi_t+\delta_0(\Delta)\xi_j s_{jt}}{1+\delta_0(\Delta)\pi_t}\left(\frac{\tilde{w}_{jt}}{p_t}N+\frac{\tilde{r}^K_{jt}}{p_t}K\right)\right]$$

where we divided by $\Delta p_{t+\delta_0(\Delta)}$, used (42) and (43), and moved p_t inside the last parenthesis. For small enough π_t, costs are approximately equal to:

$$\frac{\delta_0(\Delta)}{\Delta}\left(1+\rho^s+\xi_j s_{jt}\right)\left(w_{jt}N+r^K_{jt}K\right)$$

where $w_{jt} = \frac{\tilde{w}_{jt}}{p_t}$ and $r^K_{jt} = \frac{\tilde{r}^K_{jt}}{p_t}$ are the "real" wages and rental rates of capital, meaning that they are expressed in terms of morning prices. For vanishing evening time ($\epsilon^{☾} \to 0$), $\delta_0 \to \Delta$ and the problem becomes:

$$\max_{N,K} F(N,K) - \left(1+\rho^s+\xi_j s_{jt}\right)\left(w_{jt}N+r^K_{jt}K\right)$$

This delivers:

$$w_{jt} = \frac{F_N}{1+\rho^s+\xi_{jt}s_{jt}(r_t)}; \qquad r^K_{jt} = \frac{F_K}{1+\rho^s+\xi_{jt}s_{jt}(r_t)}$$

where we highlight that factor prices depend on the nominal rates only through bank spreads. We turn to households' utility.

Households Following the derivations in Section B.4.1, the indirect utility of household i is:

$$u_{ijt} = \frac{1}{\Delta}\left[\tilde{w}_{jt}\frac{\delta_0(\Delta)+\delta_0(\Delta)r_t+\delta_0(\Delta)\max\left\{0,e_{ijt}-r_t\right\}}{p_{t+\delta_0(\Delta)}}\right] - h_{jt} + B_{jt}$$

Following the same steps as for firms, we substitute $\delta_0(\Delta)r_t$ and $p_{t+\delta_0(\Delta)}$ using (42) and (43). The financial services on the wage are:

$$\frac{\tilde{w}_{jt}}{\Delta}\frac{\delta_0(\Delta)+\delta_0(\Delta)\rho^s+\delta_0(\Delta)\pi_t+\delta_0(\Delta)\max\{0,e_{ijt}-r_t\}}{(1+\delta_0(\Delta)\pi_t)\,p_t}\approx\frac{\delta_0(\Delta)}{\Delta}\frac{\tilde{w}_{jt}}{p_t}\left(1+\rho^s+\max\{0,e_{ijt}-r_t\}\right)$$

Taking the limit for $\epsilon^{☾} \to 0$ delivers:

$$u_{ijt}=w_{jt}\left(1+\rho^s+\max\{0,e_{ijt}-r_t\}\right)-h_{jt}+B_{jt}$$

where we subsituted $\tilde{w}_{jt}/p_t=w_{jt}$. We finally turn to the capitalists' budget constraint.

Capitalist The capitalist receives rents in the morning, invests it all in within-period bonds, and buys goods in the evening. The flow income by the evening is $\delta_0(\Delta)(1+r_t)\tilde{r}^K_{jt}$ and the flow cost of the consumption and investment good in the evening is $\Delta p_{t+\delta_0(\Delta)}\left(c^K_{jt}+X_{jt}\right)$. The capitalist solves:

$$\begin{aligned}
&\max_{[c^k_{jt},X_{jt}]_0^\infty}\mathbb{E}_0\int_0^\infty \exp(-\rho t)\log\left(c^k_{jt}\right)dt\\
&\text{s.t.}\quad \delta_0(\Delta)(1+r_t)\tilde{r}^K_{jt}K_{jt}=\Delta p_{t+\delta_0(\Delta)}\left(c^K_{jt}+X_{jt}\right)\\
&\qquad\ \ \dot{K}_{jt}=X_{jt}-\Delta K_{jt}
\end{aligned}$$

Again substituting $\delta_0(\Delta)r_t$ and $p_{t+\delta_0(\Delta)}$ using (42) and (43), the budget constraint can be rewritten as:

$$\begin{aligned}
\frac{1}{\Delta}\left(\frac{\delta_0(\Delta)+\delta_0(\Delta)\rho^s+\delta_0(\Delta)\pi_t}{(1+\delta_0(\Delta)\pi_t)\,p_t}\right)\tilde{r}^K_{jt}K_{jt}&=c^k_{jt}+X_{jt}\\
\frac{\delta_0}{\Delta}\left(1+\rho^s\right)r^K_{jt}K_{jt}&=c^k_{jt}+X_{jt}
\end{aligned}$$

where the second equality uses the fact that $\delta_0(\Delta)\pi_t$ is small enough and substitutes $\tilde{r}^K_{jt}/p_t=r^K_{jt}$. For $\epsilon^{☾} \to 0$, the budget constraint is thus:

$$\left(1+\rho^s\right)r^K_{jt}K_{jt}=c^k_{jt}+X_{jt}$$

□

B.5 Proofs for Section 7.2

B.5.1 Proof of Proposition 3

Proof. Setting the KFEs to zero at steady-state gives:

$$N_{jt} = \frac{\exp\nu\left(V_{jt}-\tau\right)}{\exp\nu\left(V_{jt}-\tau\right)+\exp\nu\left(V_{ot}-\tau\right)}$$
$$r_j^{K,SS} = \left(1+\rho^s\right)\left(\delta+\rho\right)$$

From the firms' first order conditions, we solve for capital as a function of labor:

$$K_j^{SS}\left(N_j^{SS}\right) = \left(\frac{1}{\left(1+\rho^s\right)\left(\delta+\rho\right)}\frac{\alpha_K z_{jt}}{R_{jt}^F}\left(N_j^{SS}\right)^{\alpha_N}\right)^{\frac{1}{1-\alpha_K}}$$

The value function for workers is:

$$\left(\rho+\mu\right)V_j^{SS} = \underbrace{B_j+(1+\mathcal{R})w_j^{SS}-h_j^{SS}}_{U_j^{SS}} + \underbrace{\frac{\mu}{\nu}\log\left(\sum_m \exp\nu\left(V_{mt}-\tau\right)\right)}_{\mathcal{M}[V]}$$

where note that $\mathcal{M}[V]$ is identical everywhere if migration costs are symmetric. We can rewrite labor as:

$$\begin{aligned}\log N_j^{SS} =& \log\left(\frac{\exp\nu\left(\frac{1}{\rho+\mu}U_j^{SS}+\frac{1}{\rho+\mu}\mathcal{M}[V]-\tau\right)}{\exp\nu\left(\frac{1}{\rho+\mu}U_j^{SS}+\frac{1}{\rho+\mu}\mathcal{M}[V]-\tau\right)+\exp\nu\left(\frac{1}{\rho+\mu}U_o^{SS}+\frac{1}{\rho+\mu}\mathcal{M}[V]-\tau\right)}\right)\\ =& \upsilon U_j^{SS} - \log\left(\exp\upsilon U_j^{SS}+\exp\upsilon U_o^{SS}\right)\end{aligned}$$

where $\upsilon = \frac{\nu}{\rho+\mu}$. Wages and housing prices are also a function of labor:

$$h_j^{SS} = z_j^h\left(N_j^{SS}\right)^{\sigma_h}; \qquad w_j^{SS} = \alpha_N\frac{z_j}{R_j^{F,SS}}\left(N_j^{SS}\right)^{\alpha_N-1}\left(K_j^{SS}\left(N_j^{SS}\right)\right)^{\alpha_K}$$

Around the steady-state, an increase in lending rate:

$$\frac{d\log Y_j^{SS}}{dr_j^L} = \alpha_N\frac{d\log N_j^{SS}}{dr_j^L}+\alpha_K\frac{d\log K_j^{SS}}{dr_j^L}$$

We can use the implicit function theorem to derive the differentials:

$$
\begin{aligned}
\frac{d\log N_j^{SS}}{dr_j^L} &= \frac{d}{dr_j^L}\left[vU_j^{SS} - \log\left(\sum_m \exp vU_m^{SS}\right)\right] \\
&= \left[v\frac{dU_j^{SS}}{dr_j^L} - \frac{v}{\sum_m \exp vU_m^{SS}}\left(\exp vU_j^{SS}\frac{dU_j^{SS}}{dr_j^L} + \exp vU_o^{SS}\frac{dU_o^{SS}}{dr_j^L}\right)\right] \\
&= v\left[\left(1 - N_j^{SS}\right)\frac{dU_j^{SS}}{dr_j^L} + \frac{dU_o^{SS}}{dr_j^L}N_o^{SS}\right]
\end{aligned}
$$

Note now, for the outside region:

$$
\frac{d\log N_o^{SS}}{dr_j^L} = v\left[\left(1 - N_o^{SS}\right)\frac{dU_o^{SS}}{dr_j^L} + \frac{dU_j^{SS}}{dr_j^L}N_j^{SS}\right]
$$

with:

$$
\frac{dU_o^{SS}}{dr_j^L} = -\frac{dh_o^{SS}}{dr_j^L} + \frac{dw_o^{SS}}{dr_j^L}\left(1 + \mathcal{R}\right)
$$

where:

$$
\frac{dh_o^{SS}}{dr_j^L} = \frac{d}{dr_j^L}\left(z_o^h\left(N_o^{SS}\right)^{\sigma_h}\right) = \sigma_h h_o^{SS}\frac{d\log N_o^{SS}}{dr_j^L}; \quad \frac{dw_o^{SS}}{dr_j^L} = w_o^{SS}\left(\left(\alpha_N - 1\right)\frac{d\log N_o^{SS}}{dr_j^L} + \alpha_K\frac{d\log K_o^{SS}}{dr_j^L}\right)
$$

So that:

$$
\frac{dU_o^{SS}}{dr_j^L} = -\sigma_h h_o^{SS}\frac{d\log N_o^{SS}}{dr_j^L} + w_o^{SS}\left(\left(\alpha_N - 1\right)\frac{d\log N_o^{SS}}{dr_j^L} + \alpha_K\frac{d\log K_o^{SS}}{dr_j^L}\right)\left(1 + \mathcal{R}_t\right)
$$

Where capital evolves:

$$
\left(1 - \alpha_K\right)\frac{d\log K_o^{SS}}{dr_j^L} = \alpha_N\frac{d\log N_o^{SS}}{dr_j^L}
$$

Substituting the change in utility in the labor equation and taking the limit for the atomistic case $\frac{dU_j^{SS}}{dr_j^L}N_j^{SS} \to 0$, one has:

$$
\frac{d\log N_o^{SS}}{dr_j^L} = v\left(1 - N_o^{SS}\right)\left[-\sigma_h h_o^{SS}\frac{d\log N_o^{SS}}{dr_j^L} + w_o^{SS}\left(\alpha_N - 1 + \frac{\alpha_K\alpha_N}{1 - \alpha_K}\right)\frac{d\log N_o^{SS}}{dr_j^L}\left(1 + \mathcal{R}_t\right)\right]
$$

$$0=\left[v\left(1-N_o^{SS}\right)\left(-\sigma_h h_o^{SS}+w_o^{SS}\left(\alpha_N-1+\frac{\alpha_K\alpha_N}{1-\alpha_K}\right)(1+\mathcal{R})\right)-1\right]\frac{d\log N_o^{SS}}{dr_j^L}$$

which implies $\frac{d\log N_o^{SS}}{dr_j^L}=0$ and $\frac{dU_o^{SS}}{dr_j^L}=0$. Back to region j, we reach:

$$\frac{d\log N_j^{SS}}{dr_j^L}=v\frac{dU_j^{SS}}{dr_j^L}=v\left(-\frac{dh_j^{SS}}{dr_j^L}+\frac{dw_j^{SS}}{dr_j^L}(1+\mathcal{R})\right)$$

where:

$$\begin{aligned}\frac{dh_j^{SS}}{dr_j^L}&=\frac{d}{dr_j^L}\left(z_j^h\left(N_j^{SS}\right)^{\sigma_h}\right)=\sigma_h h_j^{SS}\frac{d\log N_j^{SS}}{dr_j^L}\\ \frac{dw_j^{SS}}{dr_j^L}&=w_j^{SS}\left((\alpha_N-1)\frac{d\log N_j^{SS}}{dr_j^L}+\alpha_K\frac{d\log K_j^{SS}}{dr_j^L}-\frac{1}{R_j^{F,SS}}\frac{\partial R_j^{F,SS}}{\partial r_j^L}\right)\end{aligned}$$

So that:

$$\frac{dU_j^{SS}}{dr_j^L}=-\sigma_h h_j^{SS}\frac{d\log N_j^{SS}}{dr_j^L}+w_j\left((\alpha_N-1)\frac{d\log N_j^{SS}}{dr_j^L}+\alpha_K\frac{d\log K_j^{SS}}{dr_j^L}-\frac{\xi_j}{R_j^{F,SS}}\right)(1+\mathcal{R})$$

From the capital-labor ratio, one has:

$$\begin{aligned}(1-\alpha_K)\frac{d\log K_j^{SS}}{dr_j^L}&=-\frac{\xi_j}{R_j^{F,SS}}+\alpha_N\frac{d\log N_j^{SS}}{dr_j^L}\\ \frac{d\log K_j^{SS}}{dr_j^L}&=\frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^{F,SS}}+\alpha_N\frac{d\log N_j^{SS}}{dr_j^L}\right)\end{aligned}$$

Substituting into the change in flow utility:

$$\frac{dU_j^{SS}}{dr_j^L}=-\left(\sigma_h h_j^{SS}+w_j^{SS}\tilde{\alpha}(1+\mathcal{R})\right)\frac{d\log N_j^{SS}}{dr_j^L}-\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^{F,SS}}(1+\mathcal{R})$$

where $\tilde{\alpha}=\frac{1-\alpha_N-\alpha_K}{1-\alpha_K}\geq 0$ and in our case $\tilde{\alpha}=0$ since production is constant returns to scale. Plugging the above in the spatial equilibrium equation, and considering the capital-labor ratio equation, one has:

$$\frac{d\log N_j^{SS}}{dr_j^L} = -\frac{1}{\frac{1}{\upsilon}+\sigma_h h_j^{SS}} \frac{w_j^{SS}\left(1+\mathcal{R}\right)}{1-\alpha_K} \frac{\xi_j}{R_j^{F,SS}} = -\frac{m_j}{1-\alpha_K} \frac{\xi_j}{R_j^{F,SS}}$$
$$\frac{d\log K_j^{SS}}{dr_j^L} = -\frac{1}{1-\alpha_K}\left(1+\frac{\alpha_N}{\frac{1}{\upsilon}+\sigma_h h_j^{SS}}\frac{w_j^{SS}\left(1+\mathcal{R}\right)}{1-\alpha_K}\right)\frac{\xi_j}{R_j^{F,SS}}$$
$$= -\frac{1}{1-\alpha_K}\left(1+\alpha_N\frac{m_j}{1-\alpha_K}\right)\frac{\xi_j}{R_j^{F,SS}}$$

where we denoted:

$$m_j = \frac{w_j^{SS}\left(1+\mathcal{R}\right)}{\frac{1}{\upsilon}+\sigma_h h_j^{SS}}$$

One finally has:

$$\frac{d\log Y_j^{SS}}{dr_j^L} = \left(-\alpha_N m_j - \frac{\alpha_K}{1-\alpha_K} - \alpha_N m_j \frac{\alpha_K}{1-\alpha_K}\right)\frac{\xi_j}{R_j^{F,SS}}\frac{1}{1-\alpha_K}$$

The effect on GDP per capita is:

$$\frac{d\log Y_j^{SS}}{dr_j^L} - \frac{d\log N_j^{SS}}{dr_j^L} = -\frac{\xi_j}{R_j^{F,SS}}\left(\frac{\alpha_K}{1-\alpha_K}\right)\frac{1}{1-\alpha_K}$$

which is less negative than the change in total GDP for $m_j > 0$. The difference between the two is just the change in population, which is obviously increasing in ν, since $\upsilon = \frac{\nu}{\rho+\mu}$, and decreasing in σ_h, thus delivering Corollary 3.1. □

B.5.2 Proof of Proposition 4

Proof. Following the same steps as in the previous proof:

$$\log N_j^{SS} = \upsilon U_j^{SS} - \log\left(\exp \upsilon U_j^{SS} + \exp \upsilon U_h^{SS}\right)$$
$$\log K_j^{SS} = \frac{1}{1-\alpha_K}\left(\log\left(\frac{\alpha_K z_j}{\left(1+\rho^s\right)\left(\delta+\rho\right)}\right) - \log\left(R_{jt}^F\right) + \alpha_N \log\left(N_j^{SS}\right)\right)$$
$$r_j^{K,SS} = \left(1+\rho^s\right)\left(\delta+\rho\right)$$

where $\upsilon = \frac{\nu}{\rho+\mu}$. Wages and housing prices are also a function of labor:

$$h_j^{SS} = z_j^h \left(N_j^{SS}\right)^{\sigma_h}; \qquad w_j^{SS} = \alpha_N \frac{z_j}{R_j^{F,SS}} \left(N_j^{SS}\right)^{\alpha_N - 1} \left(K_j^{SS}\left(N_j^{SS}\right)\right)^{\alpha_K}$$

Around the steady-state, an increase in aggregate rates:

$$\frac{d \log Y_j^{SS}}{dr_t} = \alpha_N \frac{d \log N_j^{SS}}{dr_t} + \alpha_K \frac{d \log K_j^{SS}}{dr_t}$$

For ease of notation, we drop the SS superscripts and let:

$$\begin{aligned} n_j &= \log N_j & k_j &= \log K_j & e_j &= \exp\left(\upsilon U_j\right) & & \\ \tilde{n}_j &= \frac{\partial n_j}{\partial r} & \tilde{k}_j &= \frac{\partial k_j}{\partial r} & \tilde{e}_j &= \frac{\partial e_j}{\partial r} = e_j \upsilon \tilde{U}_j & \tilde{U}_j &= \frac{\partial U_j}{\partial r} \end{aligned}$$

Then one has that:

$$\begin{aligned} n_j &= \upsilon\left(U_j\right) - \log\left(e_j + e_h\right) \\ \tilde{n}_j &= \upsilon \tilde{U}_j - \frac{1}{e_j + e_h}\left(e_j \upsilon \tilde{U}_j + e_h \upsilon \tilde{U}_h\right) \\ &= \upsilon\left(1 - N_j\right)\tilde{U}_j - \upsilon N_h \tilde{U}_h \end{aligned}$$

If the states have the same initial population, this is:

$$\begin{aligned} \tilde{n}_j &= \frac{\upsilon}{2}\left(\tilde{U}_j - \tilde{U}_h\right) \\ \tilde{n}_h &= \frac{\upsilon}{2}\left(\tilde{U}_h - \tilde{U}_j\right) \end{aligned}$$

Note now that:

$$\begin{aligned} \tilde{U}_j = \frac{\partial U_j}{\partial r} &= \mathcal{R}' w_j + (1 + \mathcal{R}) \frac{dw_j}{dr} - \frac{dh_j}{dr} \\ \frac{dh_j}{dr} &= w_j \left(\left(\alpha_N - 1\right) \tilde{n}_j + \alpha_K \tilde{k}_j - \frac{\xi_j}{R_j^F} \frac{\partial s_j}{\partial r} \right) \\ \frac{dw_j}{dr} &= \sigma_h h_j \tilde{n}_j \end{aligned}$$

where we recall that:

$$R_j^F = 1 + \rho^s + \xi_j s_j$$

$$\frac{\partial R_j^F}{\partial r} = \xi \frac{\partial s_j}{\partial r}$$

From the capital-labor condition again:

$$\tilde{k}_j = \frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} + \alpha_N \tilde{n}_j\right)$$

Substituting in we have:

$$\begin{aligned}
\tilde{U}_j =& \mathcal{R}' w_j + (1+\mathcal{R}) w_j \left((\alpha_N - 1)\, \tilde{n}_j + \alpha_K \tilde{k}_j - \frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} \right) - \sigma_h h_j \tilde{n}_j \\
=& \mathcal{R}' w_j + (1+\mathcal{R}) w_j \left((\alpha_N - 1)\, \tilde{n}_j + \frac{\alpha_K}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} + \alpha_N \tilde{n}_j \right) - \frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} \right) - \sigma_h h_j \tilde{n}_j \\
=& \mathcal{R}' w_j + (1+\mathcal{R}) w_j \left(\frac{\alpha_N - \alpha_N\alpha_K - 1 + \alpha_K + \alpha_K\alpha_N}{1-\alpha_K}\tilde{n}_j - \frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} \right) - \sigma_h h_j \tilde{n}_j \\
=& \mathcal{R}' w_j - (1+\mathcal{R}) w_j \left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} \right) - \sigma_h h_j \tilde{n}_j
\end{aligned}$$

And similarly for region h. Let $\bar{\kappa}_j = \mathcal{R}' w_j - (1+\mathcal{R}) w_j \left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} \right)$ the non-distributional part of the change in U, we solve for the difference in the change in flow utilities as:

$$d\tilde{U} = \tilde{U}_j - \tilde{U}_h = \bar{\kappa}_j - \bar{\kappa}_h - \sigma_h h_j \left(\tilde{n}_j - \tilde{n}_h \right)$$

Noting $\tilde{n}_j - \tilde{n}_h = \frac{v}{2}\left(\tilde{U}_j - \tilde{U}_h\right) - \frac{v}{2}\left(\tilde{U}_h - \tilde{U}_j\right) = v d\tilde{U}$. Considering a steady state where $h_j = h_h = h$, we have:

$$\begin{aligned}
d\tilde{U} &= \bar{\kappa}_j - \bar{\kappa}_h - \sigma_h h v d\tilde{U} \\
d\tilde{U} &= \frac{\bar{\kappa}_j - \bar{\kappa}_h}{1 + \sigma_h h v}
\end{aligned}$$

Which implies that changes in labor are:

$$\tilde{n}_j - \tilde{n}_h = \frac{\nu}{1+\sigma_h h v}\left(\bar{\kappa}_j - \bar{\kappa}_h\right)$$

Consider now a steady state where $w_j = w_h = w$, one has:

$$\begin{aligned}\bar{\kappa}_j - \bar{\kappa}_h &= \mathcal{R}'w - (1+\mathcal{R})w\left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r}\right) - \mathcal{R}'w + (1+\mathcal{R})w\left(\frac{1}{1-\alpha_K}\frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial r}\right)\\ &= -\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} - \frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial r}\right)\end{aligned}$$

We can express a function $\delta(\xi, \chi, r) = \frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r}$ since spreads are themselves only functions of ξ, χ, r. This implies:

$$\bar{\kappa}_j - \bar{\kappa}_h = -\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\delta(\xi_j, \chi_j, r) - \delta(\xi_h, \chi_h, r)\right)$$

We reach the first result on neutrality. If $\xi_j = \xi_h$ and $\chi_j = \chi_h$, then increases in the nominal rate have no effects on the distribution of labor. Note also that growth rates of GDP are also identical, because:

$$\begin{aligned}\tilde{k}_j - \tilde{k}_h &= \frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r} + \alpha_N \tilde{n}_j\right) - \frac{1}{1-\alpha_K}\left(-\frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial r} + \alpha_N \tilde{n}_h\right)\\ &= \frac{1}{1-\alpha_K}\left(-\delta(\xi_j, \chi_j, r) + \delta(\xi_h, \chi_h, r) + \alpha_N(\tilde{n}_j - \tilde{n}_h)\right)\\ &= \frac{1}{1-\alpha_K}\Bigg(-\delta(\xi_j, \chi_j, r) + \delta(\xi_h, \chi_h, r)\\ &\qquad + \frac{\nu\alpha_N}{1+\sigma_h h_j \nu}\left(-\frac{(1+\mathcal{R})w}{1-\alpha_K}\right)\left(\delta(\xi_j, \chi_j, r) - \delta(\xi_h, \chi_h, r)\right)\Bigg)\\ &= -\frac{1}{1-\alpha_K}\left(\delta(\xi_j, \chi_j, r) - \delta(\xi_h, \chi_h, r)\right)\left(1 + \frac{\nu\alpha_N}{1+\sigma_h h_j \nu}\left(\frac{(1+\mathcal{R})w}{1-\alpha_K}\right)\right)\end{aligned}$$

Hence if $\xi_j = \xi_h$ and $\chi_j = \chi_h$, then $\tilde{n}_j - \tilde{n}_h = 0$, $\tilde{k}_j - \tilde{k}_h = 0$ and, in turn, $\tilde{y}_j - \tilde{y}_h = 0$. Likewise, if $\theta_t = 0$, $\delta(\xi, \chi, r) = 0$, which implies $\tilde{n}_j - \tilde{n}_h = 0$, $\tilde{k}_j - \tilde{k}_h = 0$ and, in turn, $\tilde{y}_j - \tilde{y}_h = 0$.

We now consider the case where the regions are different in their deposit/loan ratios. We approximate around a region and steady state where spreads are null, i.e. deposits are enough to fund all loans in the reference region h. Then to a first order:

$$\delta(\xi_j, \chi_j, r) \approx \delta(\xi_h, \chi_h, r) + (\xi_j - \xi_h)\delta_\xi + (\chi_j - \chi_h)\delta_\chi$$

Now note:

$$\delta\left(\xi,\chi,r\right)=\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial r}$$

$$\begin{aligned}
\delta_\xi=\frac{\partial\delta}{\partial\xi}&=\frac{1}{R^F}\frac{\partial s}{\partial r}+\frac{\xi}{R^F}\frac{\partial^2 s}{\partial r\partial\xi}-\frac{\xi}{(R^F)^2}\frac{\partial s}{\partial r}\frac{\partial R^F}{\partial\xi}\\
&=\underbrace{\frac{1}{R^F}\frac{\partial s}{\partial r}}_{>0}+\underbrace{\frac{\xi}{R^F}\frac{\partial^2 s}{\partial r\partial\xi}}_{<0}\underbrace{-\frac{\xi}{(R^F)^2}\underbrace{\frac{\partial s}{\partial r}\left(s+\xi\frac{\partial s}{\partial\xi}\right)}_{>0}}_{<0}<0\\
\delta_\chi=\frac{\partial\delta}{\partial\chi}&=\underbrace{\frac{\xi}{R^F}\frac{\partial^2 s}{\partial r\partial\chi}}_{>0}\underbrace{-\frac{\xi}{(R^F)^2}\underbrace{\frac{\partial s}{\partial r}}_{>0}\underbrace{\left(\xi\frac{\partial s}{\partial\chi}\right)}_{<0}}_{>0}>0
\end{aligned}$$

Where note that we reach the inequality on δ_ξ because the sum of the first two terms is negative:

$$\begin{aligned}
\frac{1}{R^F}\frac{\partial s}{\partial r}+\frac{\xi}{R^F}\frac{\partial^2 s}{\partial r\partial\xi}&=\frac{1}{R^F}\left(\frac{\partial s}{\partial r}+\xi\frac{\partial^2 s}{\partial r\partial\xi}\right)\\
&=\frac{1}{R^F}\left(\phi\theta\left(\frac{\alpha_N^2\exp\left(-2\phi\left(r-\chi\right)\right)}{\xi^2}\right)-2\xi\frac{\phi\theta}{\xi}\left(\frac{\alpha_N^2\exp\left(-2\phi\left(r-\chi\right)\right)}{\xi^2}\right)\right)\\
&=-\frac{\phi\theta}{R^F}\left(\frac{\alpha_N^2\exp\left(-2\phi\left(r-\chi\right)\right)}{\xi^2}\right)<0
\end{aligned}$$

However, this is not necessarily true at the second order. At a first-order, one has:

$$\begin{aligned}
\bar{\kappa}_j-\bar{\kappa}_h&\approx-\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\delta_\xi+\left(\chi_j-\chi_h\right)\delta_\chi\right)\\
&\approx\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_\xi\right)+\left(\chi_h-\chi_j\right)\delta_\chi\right)
\end{aligned}$$

Thus:

$$\begin{aligned}
\tilde{n}_j-\tilde{n}_h&\approx\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_\xi\right)+\left(\chi_h-\chi_j\right)\delta_\chi\right)\\
\tilde{k}_j-\tilde{k}_h&\approx\frac{1}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_\xi\right)+\left(\chi_h-\chi_j\right)\delta_\chi\right)\left(1+\frac{\nu\alpha_N}{1+\sigma_h h_j\nu}\left(\frac{(1+\mathcal{R})w}{1-\alpha_K}\right)\right)
\end{aligned}$$

Which allows us to state that a change in the aggregate rate has causes a more negative change in

h compared to j if and only if:

$$\tilde{n}_j > \tilde{n}_h \text{ and } \tilde{k}_j > \tilde{k}_h \iff \quad \left(\xi_j - \xi_h\right)\left(-\delta_\xi\right) + \left(\chi_h - \chi_j\right)\delta_\chi > 0$$

Which is true if $\chi_j < \chi_h$ and $\xi_j \geq \xi_h$ or if $\chi_j \leq \chi_h$ and $\xi_j > \xi_h$. □

B.5.3 Proof of Proposition 5

Proof. Following the same steps as in the previous proof:

$$\begin{aligned}
\log N_j^{SS} &= vU_j^{SS} - \log\left(\exp vU_j^{SS} + \exp vU_h^{SS}\right)\\
\log K_j^{SS} &= \frac{1}{1-\alpha_K}\left(\log\left(\frac{\alpha_K z_j}{(1+\rho^s)(\delta+\rho)}\right) - \log\left(R_{jt}^F\right) + \alpha_N \log\left(N_j^{SS}\right)\right)\\
r_j^{K,SS} &= (1+\rho^s)(\delta+\rho)
\end{aligned}$$

where $v = \frac{\nu}{\rho+\mu}$. Wages and housing prices are also a function of labor:

$$h_j^{SS} = z_j^h\left(N_j^{SS}\right)^{\sigma_h}; \qquad w_j^{SS} = \alpha_N \frac{z_j}{R_j^{F,SS}}\left(N_j^{SS}\right)^{\alpha_N - 1}\left(K_j^{SS}\left(N_j^{SS}\right)\right)^{\alpha_K}$$

We prove results for an increase in frictions. Results for a decline simply have the opposite sign. Around the steady-state, an increase in frictions:

$$\frac{d\log Y_j^{SS}}{d\theta_t} = \alpha_N \frac{d\log N_j^{SS}}{d\theta_t} + \alpha_K \frac{d\log K_j^{SS}}{d\theta_t}$$

For ease of notation, we drop the time subscripts and SS superscripts and let:

$$\begin{aligned}
&n_j = \log N_j && k_j = \log K_j && e_j = \exp\left(vU_j\right) \\
&\tilde{n}_j = \frac{\partial n_j}{\partial\theta} && \tilde{k}_j = \frac{\partial k_j}{\partial\theta} && \tilde{e}_j = \frac{\partial e_j}{\partial\theta} = e_j v\tilde{U}_j && \tilde{U}_j = \frac{\partial U_j}{\partial\theta}
\end{aligned}$$

Following the same steps above, if the states are ex ante identical:

$$\begin{aligned}
\tilde{n}_j &= \frac{v}{2}\left(\tilde{U}_j - \tilde{U}_h\right)\\
\tilde{n}_h &= \frac{v}{2}\left(\tilde{U}_h - \tilde{U}_j\right)
\end{aligned}$$

Note now that:

$$\tilde{U}_j = \frac{\partial U_j}{\partial \theta} = (1+\mathcal{R})\frac{dw_j}{d\theta} - \frac{dh_j}{d\theta}$$
$$\frac{dw_j}{d\theta} = w_j\left(\left(\alpha_N - 1\right)\tilde{n}_j + \alpha_K \tilde{k}_j - \frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta}\right); \qquad \frac{dh_j}{d\theta} = \sigma_h h_j \tilde{n}_j$$

where we recall that:

$$R_j^F = 1 + \rho^s + \xi_j s_j \qquad\qquad \frac{\partial R_j^F}{\partial \theta} = \xi \frac{\partial s_j}{\partial \theta}$$

From the capital-labor condition again:

$$\tilde{k}_j = \frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta} + \alpha_N \tilde{n}_j\right)$$

Substituting in we have:

$$\begin{aligned}\tilde{U}_j =& (1+\mathcal{R})w_j\left(\left(\alpha_N - 1\right)\tilde{n}_j + \alpha_K \tilde{k}_j - \frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta}\right) - \sigma_h h_j \tilde{n}_j \\ =& -(1+\mathcal{R})w_j\left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta}\right) - \sigma_h h_j \tilde{n}_j\end{aligned}$$

And similarly for region h. Let $\bar{\kappa}_j = -(1+\mathcal{R})w_j\left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta}\right)$ the non-distributional part of the change in U, we solve for the difference in the change in flow utilities as:

$$d\tilde{U} = \tilde{U}_j - \tilde{U}_h = \bar{\kappa}_j - \bar{\kappa}_h - \sigma_h h_j\left(\tilde{n}_j - \tilde{n}_h\right)$$

Noting $\tilde{n}_j - \tilde{n}_h = \frac{v}{2}\left(\tilde{U}_j - \tilde{U}_h\right) - \frac{v}{2}\left(\tilde{U}_h - \tilde{U}_j\right) = v d\tilde{U}$. Considering a steady state where $h_j = h_h = h$, we have:

$$\begin{aligned}d\tilde{U} &= \bar{\kappa}_j - \bar{\kappa}_h - \sigma_h h v d\tilde{U} \\ d\tilde{U} &= \frac{\bar{\kappa}_j - \bar{\kappa}_h}{1+\sigma_h h v}\end{aligned}$$

Which implies that changes in labor are:

$$\tilde{n}_j - \tilde{n}_h = \frac{\nu}{1+\sigma_h h v}\left(\bar{\kappa}_j - \bar{\kappa}_h\right)$$

Consider now a steady state where $w_j = w_h = w$, one has:

$$\begin{aligned}
\bar{\kappa}_j - \bar{\kappa}_h &= -(1+\mathcal{R})w\left(\frac{1}{1-\alpha_K}\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta}\right) + (1+\mathcal{R})w\left(\frac{1}{1-\alpha_K}\frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial \theta}\right) \\
&= -\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta} - \frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial \theta}\right)
\end{aligned}$$

Now note $\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta} = \frac{\xi_j}{R_j^F}\frac{\partial}{\partial \theta}\left(\frac{1}{2}\theta\left(1 - \frac{\alpha_N^2 \exp(-2\phi(r-\chi))}{\xi^2}\right)\right) = \frac{\xi_j}{R_j^F}\frac{1}{2}\left(1 - \frac{\alpha_N^2 \exp(-2\phi(r-\chi))}{\xi^2}\right) = \frac{\xi_j}{R_j^F}\frac{s_j}{\theta}$ since spreads are themselves only functions of ξ, χ, θ. This implies:

$$\bar{\kappa}_j - \bar{\kappa}_h = -\frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\frac{\xi_j}{R_j^F}\frac{s_j}{\theta} - \frac{\xi_h}{R_h^F}\frac{s_h}{\theta}\right)$$

For capital, following similar steps:

$$\begin{aligned}
\tilde{k}_j - \tilde{k}_h &= \frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta} + \alpha_N \tilde{n}_j\right) - \frac{1}{1-\alpha_K}\left(-\frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial \theta} + \alpha_N \tilde{n}_h\right) \\
&= \frac{1}{1-\alpha_K}\left(-\frac{\xi_j}{R_j^F}\frac{\partial s_j}{\partial \theta} + \frac{\xi_h}{R_h^F}\frac{\partial s_h}{\partial \theta} + \alpha_N\left(\tilde{n}_j - \tilde{n}_h\right)\right) \\
&= -\frac{1}{1-\alpha_K}\left(\frac{\xi_j}{R_j^F}\frac{s_j}{\theta} - \frac{\xi_h}{R_h^F}\frac{s_h}{\theta}\right)\left(1 + \frac{\upsilon \alpha_N}{1+\sigma_h h_j \upsilon}\left(\frac{(1+\mathcal{R})w}{1-\alpha_K}\right)\right)
\end{aligned}$$

Now again denote $\delta\left(\xi_j, \chi_j\right) = \frac{\xi_j}{R_j^F}\frac{s_j}{\theta}$ and consider small differences in ξ_j and χ_j, so that:

$$\delta\left(\xi_j, \chi_j\right) \approx \delta\left(\xi_h, \chi_h\right) + \left(\xi_j - \xi_h\right)\delta_\xi + \left(\chi_j - \chi_h\right)\delta_\chi$$

One has:

$$\begin{aligned}
\delta_\xi &= \frac{\partial \delta}{\partial \xi} = \frac{1}{R^F}\frac{s}{\theta} + \frac{\xi}{R^F \theta}\frac{\partial s}{\partial \xi} - \frac{\xi}{\left(R^F\right)^2 \theta}\frac{\partial R^F}{\partial \xi} > 0 \\
\delta_\chi &= \frac{\partial \delta}{\partial \chi} = \frac{\xi}{R^F \theta}\underbrace{\frac{\partial s}{\partial \chi}}_{<0} < 0
\end{aligned}$$

Where, to sign δ_ξ, we note that:

$$\delta_\xi = \frac{1}{\theta R^F}\left(s + \xi\frac{\partial s}{\partial \xi} - \frac{\xi}{R^F}\frac{\partial R^F}{\partial \xi}\right) \propto \left(s + \xi\frac{\partial s}{\partial \xi} - \frac{\xi}{R^F}\left(s + \xi\frac{\partial s}{\partial \xi}\right)\right)$$

$$\propto s\left(1-\frac{\xi}{R^F}\right)+\xi\frac{\partial s}{\partial \xi}\left(1-\frac{\xi}{R^F}\right)=\left(s+\xi\frac{\partial s}{\partial \xi}\right)\left(1-\frac{\xi}{R^F}\right)>0$$

because $\xi<1$ and $R^F>1$ so that $1-\frac{\xi}{R^F}>0$ and $\frac{\partial s}{\partial \xi}>0$.

$$\begin{aligned}
\bar{\kappa}_j-\bar{\kappa}_h &\approx \frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_{\xi}\right)+\left(\chi_h-\chi_j\right)\delta_{\chi}\right)\\
\tilde{n}_j-\tilde{n}_h &\approx \frac{(1+\mathcal{R})w}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_{\xi}\right)+\left(\chi_h-\chi_j\right)\delta_{\chi}\right)\\
\tilde{k}_j-\tilde{k}_h &\approx \frac{1}{1-\alpha_K}\left(\left(\xi_j-\xi_h\right)\left(-\delta_{\xi}\right)+\left(\chi_h-\chi_j\right)\delta_{\chi}\right)\left(1+\frac{\nu\alpha_N}{1+\sigma_h h_j\nu}\left(\frac{(1+\mathcal{R})w}{1-\alpha_K}\right)\right)
\end{aligned}$$

Thus, if $\xi_j>\xi_h$ and $\chi_j\leq\chi_h$ or $\xi_j\geq\xi_h$ and $\chi_j<\chi_h$, then $\delta\left(\xi_j,\chi_j\right)>\delta\left(\xi_h,\chi_h\right)$ and:

$$\bar{\kappa}_j-\bar{\kappa}_h<0,\quad \tilde{n}_j-\tilde{n}_h<0\quad \tilde{k}_j-\tilde{k}_h<0$$

That is, an increase in friction causes higher declines in population, capital, and GDP in the initially high rate state. □

B.6 Proof of Proposition 6

We start by defining the Master Equations, following the derivations in Section 7.3

Lemma B.1 (Master Equations)**.** *The Master Equations for households follow:*

$$\begin{aligned}
\rho V_{jt}\left(N_t,K_t,\log\theta_t,r_t\right)=&\overbrace{U_{jt}\left(N_t,K_t,\log\theta_t,r_t\right)}^{\text{Flow utility}}+\overbrace{\mathcal{M}_{jt}\left[V\right]}^{\substack{\text{Continuation Value}\\ \text{from Migration Opportunity}}}+\overbrace{\frac{\partial V_{jt}}{\partial t}}^{\substack{\text{Effect of changes}\\ \text{in }\{r_t,\vartheta_t\}_{s=0}^{\infty}}}\\
&+\underbrace{\sum_k\frac{\partial V_{jt}}{\partial N_{kt}}\left[M^*(V_t)N_t\right]_k}_{\substack{\text{Effect of changes in the}\\ \text{population distribution}}}+\underbrace{\sum_k\frac{\partial V_{jt}}{\partial K_{kt}}\left(R^K_{kt}-\delta-\rho\right)K_{kt}}_{\substack{\text{Effect of changes in the}\\ \text{distribution of physical capital}}}
\end{aligned}\tag{44}$$

For capitalists, the Master Equations similarly follow:

$$\begin{aligned}
\rho A_{jt}\left(N_t,K_t,\log\theta_t,r_t\right)=&\rho\log\rho+r^K_{jt}\left(N_t,K_t,\log\theta_t,r_t\right)-\delta-\rho\\
&+\frac{\partial A_{jt}}{\partial t}+\sum_k\frac{\partial A_{jt}}{\partial N_{kt}}\left[M^*(V_t)N_t\right]_k+\sum_k\frac{\partial A_{jt}}{\partial K_{kt}}\left(R^K_{kt}-\delta-\rho\right)K_{kt}
\end{aligned}\tag{45}$$

Proof. For households, it is enough to develop the partial differential dV_{jt}/dt as:

$$\frac{dV_{jt}}{dt} = \underbrace{\frac{\partial V_{jt}}{\partial t}}_{\substack{\text{Effect of changes} \\ \text{in } \{r_t, \vartheta_t\}_{s=0}^{\infty}}} + \underbrace{\sum_k \frac{\partial V_{jt}}{\partial N_{kt}} \frac{dN_{kt}}{dt}}_{\substack{\text{Effect of changes in the} \\ \text{population distribution (migration)}}} + \underbrace{\sum_k \frac{\partial V_{jt}}{\partial K_{kt}} \frac{dK_{kt}}{dt}}_{\substack{\text{Effect of changes in the} \\ \text{distribution of physical capital}}} \tag{46}$$

and then use the KFEs (21) and (23) to $\frac{dN_{kt}}{dt}$ and $\frac{dK_{kt}}{dt}$ in (46), and substitute (46) in (20). The same applies for the capitalist. We develop dA_{jt}/dt :

$$\frac{dA_{jt}}{dt} = \frac{\partial A_{jt}}{\partial t} + \sum_k \frac{\partial A_{jt}}{\partial N_{kt}} \frac{dN_{kt}}{dt} + \sum_k \frac{\partial A_{jt}}{\partial K_{kt}} \frac{dK_{kt}}{dt} \tag{47}$$

then substitute the KFEs, and substitute inside the value function from (22), $\rho A_{jt} - \frac{dA_{jt}}{dt} = \rho \log \rho + R^K_{jt} - \delta - \rho$. □

We then prove the following lemma.

Lemma B.2 (Distributional First-Order Approximations to the Master Equations (FAMEs))**.** *The matrices v^N, and v^K, which encode the first-order changes around a steady state in households' Master Equations* (44)*, with respect to changes in the distribution of labor N and capital K, satisfy:*

$$\begin{aligned} \rho v^N &= -D_{UN} + M v^N + v^N M^* + v^N G v^N + v^K \cdot D_{KN} \\ \rho v^K &= \quad D_{UK} + M v^K + v^K G v^K + v^K \cdot D_{KK} \end{aligned}$$

Similarly, the corresponding matrices for the capitalist that encode first order changes in (45) *around a steady state, due to changes in the labor and capital distribution, a^N and a^K, satisfy:*

$$\begin{aligned} \rho a^N &= \quad D_{RN} + a^N M^* + a^N G v^N + a^K \cdot D_{KN} \\ \rho a^K &= -D_{RK} + a^N G v^K + a^K \cdot D_{KK} \end{aligned}$$

with the known matrices:

$$G = \mu \nu \left(\mathbf{diag}\left(m^* N^{SS} \right) - m^* \mathbf{diag}\left(N^{SS} \right) m \right)$$

$$D_{UN} = \mathbf{diag}\left(\frac{\partial u_{jt}}{\partial N_{jt}} \right); \qquad D_{UK} = \mathbf{diag}\left(\frac{\partial u_{jt}}{\partial K_{jt}} \right)$$

$$D_{RN} = \mathbf{diag}\left(\frac{\partial R^K_{jt}}{\partial N_{jt}} \right); \qquad D_{RK} = \mathbf{diag}\left(\frac{\partial R^K_{jt}}{\partial K_{jt}} \right)$$

$$D_{KN} = \mathbf{diag}\left(K_j^{SS}\right) D_{RN} = \mathbf{diag}\left(\alpha_N r_{jt}^K \frac{K_{jt}}{N_{jt}}\right) \qquad D_{KK} = \mathbf{diag}\left(\alpha_K R_{jt}^K - \delta - \rho\right)$$

evaluated at steady state.

Proof. We search for vectors of coefficients v^N, v^K, v^T and a^N, a^K, a^T that can characterize first-order deviations of the value function with respect to small shocks to the aggregate labor and capital distribution, and the aggregate state ($\vartheta_t = \log \theta_t$ and r_t). That is, we are searching for a solution:

$$V_j\left(N_{1t},...,N_{Jt},K_{j1},...,K_{jt},\log\theta_t,r_t;\epsilon\right) \approx V_j^{SS} + \epsilon\left\{\sum_k v_{jk}^N n_k + \sum_k v_{jk}^K k_k + v_{jt}^T\right\}$$
$$A_j\left(N_{1t},...,N_{Jt},K_{j1},...,K_{jt},\log\theta_t,r_t;\epsilon\right) \approx A_j^{SS} + \epsilon\left\{\sum_k a_{jk}^N n_k + \sum_k a_{jk}^K k_k + a_{jt}^T\right\}$$

where $N_{jt} = N_j^{SS} + \epsilon n_j$ and $K_{jt} = K_j^{SS} + \epsilon k_j$; $v_{jk}^X = \frac{\partial V_{jt}}{\partial X_{kt}}$ and $a_{jk}^X = \frac{\partial A_{jt}}{\partial X_{kt}}$ for $X = N, K$; and $v_{jt}^T = \frac{\partial V_{jt}}{\partial t}$, $a_{jt}^T = \frac{\partial A_{jt}}{\partial t}$. Denoting the vectors $v = \epsilon^{-1}(V_j - V_j^{SS})$ and $a = \epsilon^{-1}(A_j - A_j^{SS})$, in vector form we are searching for matrices v^N, v^K, a^N, a^K and vectors v^T, a^T such that:

$$v = v^N n + v^K k + v^T; \qquad a = a^N n + a^K k + a^T$$

where the elements of these matrices v^N, v^K are v_{jk}^N, v_{jk}^K defined above, and similarly for a^N, a^K and for the vectors v^T, a^T. To derive these matrices, we expand the right-hand side of the MEs (44) and (45), term by term.

Flow utility. The flow utility is:

$$U_{jt}\left(N_{jt},K_{jt},\vartheta_{jt},r_t\right) = B_{jt} + w_{jt}\left(N_{jt},K_{jt},\vartheta_{jt},r_t\right) \times \left(1 + \mathcal{R}_{jt}(r_t)\right) - h_{jt}\left(N_{jt}\right)$$

where $\mathcal{R}_{jt} = \rho^s + \frac{1}{\phi}\exp(-\phi(r_t - \chi_j))$ are the expected financial services. To a first order:

$$\begin{aligned} U_{jt} - U_j^{SS} = &\left(\frac{dw_j}{dr_t}\left(1 + \mathcal{R}_{jt}\right) + w_{jt}\frac{\partial \mathcal{R}_{jt}}{\partial r_t}\right) dr_t \\ &+ \left(\left(1 + \mathcal{R}_{jt}\right)\frac{\partial w_j}{\partial r_{jt}^L}\frac{\partial r_{jt}^L}{\partial \vartheta_t}\right) d\vartheta_t \\ &+ \left(-\frac{\partial h_{jt}}{\partial N_{jt}} + \frac{\partial w_j}{\partial N_{jt}}\left(1 + \mathcal{R}_{jt}\right)\right) dN_{jt} \end{aligned}$$

$$+\left(\frac{\partial w_j}{\partial K_{jt}}\left(1+\mathcal{R}_{jt}\right)\right)dK_{jt}$$

In vector notation:

$$\epsilon^{-1}\left(U_t - U^{SS}\right) = D_{UR}\tilde{r}_t + D_{U\theta}\vartheta_t^D - D_{UN}\cdot n + D_{UK}\cdot k$$

where $\tilde{r}_t = dr_t$, $\vartheta_t^D = d\log\theta_t$, $D_{UR} = \mathbf{diag}\left(\frac{dw_j}{dr_t}\left(1+\mathcal{R}_{jt}\right) + w_{jt}\frac{\partial\mathcal{R}_t}{\partial r_t}\right)$, $D_{U\theta} = \mathbf{diag}\left(\left(1+\mathcal{R}_{jt}\right)\frac{\partial w_j}{\partial r_{jt}^L}\frac{\partial r_{jt}^L}{\partial\log\theta_t}\right)$, $D_{UN} = \mathbf{diag}\left(-\left(-\frac{\partial h_{jt}}{\partial N_{jt}} + \frac{\partial w_j}{\partial N_{jt}^L}\left(1+\mathcal{R}_{jt}\right)\right)\right)$ and $D_{UK} = \mathbf{diag}\left(\frac{\partial w_j}{\partial K_{jt}}\left(1+\mathcal{R}_{jt}\right)\right)$. Developing the derivatives, we have:

$$\frac{dw_j}{dr_t} = \frac{d}{dr_t}\left(\frac{\alpha_N z_{jt}}{1+\rho^s+\xi_{jt}\left(s_{jt}^L\left(r_t\right)\right)}N_{jt}^{\alpha_N-1}K_{jt}^{\alpha_K}\right) = -\xi_{jt}\frac{\partial s_{jt}^L}{\partial r_t}\frac{w_{jt}}{R_{jt}^F}$$

where $s_{jt}^L\left(r_t\right) = r_{jt}^L - r_t$ are local spreads. From (13), the pass-through is:

$$s_{jt}' = \frac{\partial s_{jt}^L}{\partial r_t} = \phi\theta_t\bar{\gamma}_j^2\exp(-2\phi r_t)$$

Furthermore:

$$\mathcal{R}_{jt}' = \frac{\partial\mathcal{R}_{jt}}{\partial r_t} = 1-\exp\left(-\phi(r_r-\chi_{jt})\right); \qquad \frac{\partial r_{jt}^L}{\partial\log\theta_t} = s_{jt}^L; \qquad \frac{\partial w_j}{\partial r_{jt}^L} = -\xi_{jt}\frac{w_{jt}}{R_{jt}^F}$$

Finally, with respect to population and capital:

$$\frac{\partial h_{jt}}{\partial N_{jt}} = \sigma_j^h\frac{h_{jt}}{N_{jt}}; \qquad \frac{\partial w_{jt}}{\partial N_{jt}} = \left(\alpha_N-1\right)\frac{w_{jt}}{N_{jt}}; \qquad \frac{\partial w_{jt}}{\partial N_{jt}} = \alpha_K\frac{w_{jt}}{K_{jt}}$$

Putting everything together:

$$D_{UR} = \mathbf{diag}\left(-\xi_{jt}s_{jt}'\frac{w_{jt}}{R_{jt}^F}\left(1+\mathcal{R}_{jt}\right) + w_{jt}\mathcal{R}_{jt}'\right); \qquad D_{U\theta} = \mathbf{diag}\left(-\left(1+\mathcal{R}_{jt}\right)w_{jt}\frac{\xi_{jt}s_{jt}^L}{R_{jt}^F}\right)$$

$$D_{UN} = \mathbf{diag}\left(\sigma_h\frac{h_{jt}}{N_{jt}} + \left(1-\alpha_N\right)\frac{w_{jt}}{N_{jt}}\left(1+\mathcal{R}_{jt}\right)\right); \qquad D_{UK} = \mathbf{diag}\left(\alpha_K\frac{w_{jt}}{K_{jt}}\left(1+\mathcal{R}_{jt}\right)\right)$$

Rental rate. We linearize $R^K_{jt}(N_t, K_t, \log\theta_t, r_t)$:

$$R^K_{jt} - R^{K,SS}_{jt} = \frac{\partial R^K_{jt}}{\partial N_{jt}} dN_{jt} + \frac{\partial R^K_{jt}}{\partial K_{jt}} dK_{jt} + \frac{\partial R^K_{jt}}{\partial r^L_{jt}} \frac{\partial r^L_{jt}}{\partial \vartheta_t} d\vartheta_t + \frac{dR^K_{jt}}{dr_t} dr_t$$

Using (18), the derivatives are:

$$\frac{\partial R^K_{jt}}{\partial N_{jt}} = \frac{\alpha_N}{N_{jt}} R^K_{jt}; \qquad \frac{\partial R^K_{jt}}{\partial K_{jt}} = \frac{\alpha_K - 1}{K_{jt}} R^K_{jt}$$

$$\frac{\partial R^K_{jt}}{\partial r^L_{jt}} = -\xi_{jt} \frac{R^K_{jt}}{R^F_{jt}}; \qquad \frac{dR^K_{jt}}{dr_t} = -\xi_{jt} \frac{\partial s^L_{jt}}{\partial r_t} \frac{R^K_{jt}}{R^F_{jt}}$$

So we have:

$$\epsilon^{-1}\left(R^K_t - R^{K,SS}\right) = D_{RR}\tilde{r}_t + D_{R\theta}\vartheta^D_t + D_{RN} \cdot n - D_{RK} \cdot k$$

Where:

$$D_{RN} = \mathbf{diag}\left(\alpha_N \frac{R^K_{jt}}{N_{jt}}\right) \qquad D_{RK} = \mathbf{diag}\left((1-\alpha_K)\frac{R^K_{jt}}{K_{jt}}\right)$$

$$D_{RR} = \mathbf{vec}\left(-\xi_{jt} s'_{jt} \frac{R^K_{jt}}{R^F_{jt}}\right) \qquad D_{R\theta} = \mathbf{vec}\left(-\xi_{jt} s^L_{jt} \frac{R^K_{jt}}{R^F_{jt}}\right)$$

Continuation value from migration. Recall that: $\mathcal{M}_{jt}[V] = \mu\left\{\frac{1}{\nu}\log\left(\sum_k \exp\nu\left(V_{kt+1} - \tau_{jk}\right)\right) - V_{jt}\right\}$
To a first order:

$$\begin{aligned}
\mathcal{M}_j[V] - \mathcal{M}_j\left[V^{SS}\right] &= \mu\left\{\frac{1}{\nu}\sum_h \frac{\partial}{\partial V_h}\left(\log\left(\sum_k \exp\nu\left(V^{SS}_k - \tau_{jk}\right)\right)\right) dV_h - dV_j\right\} \\
&= \mu\left\{\sum_h \frac{\exp\nu\left(V^{SS}_h - \tau_{jh}\right)}{\left(\sum_k \exp\nu\left(V^{SS}_k - \tau_{jk}\right)\right)} dV_h - dV_j\right\} = \mu\left\{\sum_h m_{jh}\left(V^{SS}\right) dV_h - dV_j\right\} \\
&= \left(M\left(V^{SS}\right) dV\right)_j = \left(M\left(V^{SS}\right) \cdot \epsilon\left\{v^N n + v^K k + v^T\right\}\right)_j
\end{aligned}$$

where we used $dV = \epsilon^{-1} v = \epsilon^{-1}(v^N n + v^K k + v^T)$ and where $M = M\left(V^{SS}\right) = \mu\left(m(V^{SS}) - Id\right)$.
In matrix form:

$$\epsilon^{-1}\left(\mathcal{M}[V] - \mathcal{M}\left[V^{SS}\right]\right) = M \cdot v^N \cdot n + M \cdot v^K \cdot k + M \cdot v^T$$

Continuation value from changes in the population distribution. We linearize:

$$\mu \sum_k \frac{\partial V_{jt}}{\partial N_{kt}} \left(\sum_{i=1}^{J} m_{ikt}(V_t) N_{it} - N_{kt} \right) = \mu \sum_k v_{jk}^N \left(\sum_{i=1}^{J} m_{ikt}(V_t) N_{it} - N_{kt} \right)$$

The migration term is:

$$\begin{aligned} \sum_{i=1}^{J} m_{ikt}(V_t) N_{it} - N_{kt} \approx \left(\sum_{i=1}^{J} m_{ik}(V^{SS}) N_i^{SS} - N_k^{SS} \right) + \sum_{i=1}^{J} m_{ik}(V^{SS}) \left(N_{it} - N_i^{SS} \right) - \left(N_{kt} - N_k^{SS} \right) \\ + \sum_{i=1}^{J} \left(\sum_h \frac{\partial m_{ik}}{\partial V_h} dV_h N_i^{SS} \right) \end{aligned}$$

In steady state, the term in the first parenthesis is zero. The second component on the first line is simply:

$$\sum_{i=1}^{J} m_{ik}(V^{SS}) \left(N_{it} - N_i^{SS} \right) - \left(N_{kt} - N_k^{SS} \right) = \epsilon \left(M^* \cdot n \right)_k \tag{48}$$

For the term in the second line, note:

$$\frac{\partial m_{ik}}{\partial V_h} = \begin{cases} -\nu \frac{\exp \nu \left(V_k^{SS} - \tau_{ik} \right) \exp \nu \left(V_h^{SS} - \tau_{ih} \right)}{\left(\sum_p \exp \nu \left(V_p^{SS} - \tau_{jp} \right) \right)^2} = -\nu m_{ik} m_{ih} & \text{if } h \neq k \\ \nu \frac{\exp \nu \left(V_h^{SS} - \tau_{ih} \right) \left(\sum_p \exp \nu \left(V_p^{SS} - \tau_{jp} \right) \right) - \exp \nu \left(V_h^{SS} - \tau_{ih} \right) \exp \nu \left(V_h^{SS} - \tau_{ih} \right)}{\left(\sum_p \exp \nu \left(V_p^{SS} - \tau_{jp} \right) \right)^2} = \nu m_{ih} (1 - m_{ih}) & \text{if } h = k \end{cases}$$

Hence one has that:

$$\begin{aligned} N_i^{SS} \sum_h \frac{\partial m_{ik}}{\partial V_h} dV_h &= N_i^{SS} \nu \left(m_{ih}(1 - m_{ih}) - \sum_{h \neq k} m_{ik} m_{ih} dV_h \right) \\ &= N_i^{SS} \nu \left(m_{ik} dV_k - \sum_h m_{ik} m_{ih} dV_h \right) \end{aligned}$$

Summing across i:

$$\begin{aligned} \sum_{i=1}^{J} \left(\sum_h \frac{\partial m_{ik}}{\partial V_h} dV_h N_i^{SS} \right) &= \nu \sum_{i=1}^{J} \left(m_{ik} \left(dV_k - [m \cdot dV]_i \right) \right) N_i^{SS} = \nu \sum_{i=1}^{J} m_{ik} N_i^{SS} dV_k - \sum_{i=1}^{J} [m \cdot dV]_i N_i^{SS} \\ &= \nu \left[\left(\mathbf{diag} \left(m^* N^{SS} \right) - m^* \mathbf{diag} \left(N^{SS} \right) m \right) \cdot dV \right]_k \end{aligned} \tag{49}$$

To derive the second line, note that:

$$\text{diag}(m^* N^{SS}) = \text{diag}\left(\begin{bmatrix} m_{11} & m_{21} & ... & m_{N1} \\ m_{12} & m_{22} & ... & m_{N2} \\ ... & & & \\ m_{1N} & m_{2N} & ... & m_{NN} \end{bmatrix} \cdot \begin{bmatrix} N_1^{SS} \\ N_2^{SS} \\ ... \\ N_N^{SS} \end{bmatrix}\right) = \text{diag}\left(\begin{bmatrix} \sum_i m_{i1} N_i^{SS} \\ \sum_i m_{i2} N_i^{SS} \\ ... \\ \sum_i m_{iN} N_i^{SS} \end{bmatrix}\right)$$

So that $\left[\text{diag}(m^* N^{SS}) \cdot dV\right]_k = \sum_i m_{ik} N_i^{SS} dV_k$, which is the first part. For the second part, note:

$$m^* \text{diag}(N^{SS}) = \begin{bmatrix} m_{11} & m_{21} & ... & m_{N1} \\ m_{12} & m_{22} & ... & m_{N2} \\ ... & & & \\ m_{1N} & m_{2N} & ... & m_{NN} \end{bmatrix} \cdot \begin{bmatrix} N_1^{SS} & 0 & ... & 0 \\ 0 & N_2^{SS} & ... & 0 \\ ... & & & \\ 0 & 0 & ... & N_N^{SS} \end{bmatrix} = \begin{bmatrix} m_{11} N_1^{SS} & m_{21} N_2^{SS} & ... & m_{N1} N_N^{SS} \\ m_{12} N_1^{SS} & m_{22} N_2^{SS} & ... & m_{N2} N_N^{SS} \\ ... & & & \\ m_{1N} N_1^{SS} & m_{2N} N_2^{SS} & ... & m_{NN} N_N^{SS} \end{bmatrix}$$

Multiplying this by m gives:

$$m^* \text{diag}(N^{SS}) m = \begin{bmatrix} \sum_i m_{i1}^2 N_i^{SS} & \sum_i m_{i1} m_{i2} N_i^{SS} & ... & \sum_i m_{i1} m_{iN} N_i^{SS} \\ \sum_i m_{i2} m_{i1} N_i^{SS} & \sum_i m_{i2}^2 N_i^{SS} & ... & \sum_i m_{i2} m_{iN} N_i^{SS} \\ ... & & & \\ \sum_i m_{iN} m_{i1} N_i^{SS} & \sum_i m_{iN} m_{i2} N_i^{SS} & ... & \sum_i m_{iN}^2 N_i^{SS} \end{bmatrix}$$

and multiplying by dV gives: $\left[m^* \text{diag}(N^{SS}) m \cdot dV\right]_k = \sum_h \sum_i m_{ik} m_{ih} N_i^{SS} dV_h = \sum_i m_{ik} N_i^{SS} \left[m \cdot dV\right]_i$ Bringing (48) and (49) together, we reach:

$$\mu \sum_k v_{jk}^N \left(\sum_{i=1}^J m_{ikt}(V_t) N_{it} - N_{kt}\right) = \epsilon \left(v^N \cdot M^* \cdot n\right)_j + \left(v^N \cdot G \cdot dV\right)_j$$

where $G = \mu\nu \left(\mathbf{diag}\left(m^* N^{SS}\right) - m^* \mathbf{diag}\left(N^{SS}\right) m\right)$. Stacking everything, we reach:

$$\begin{aligned} \epsilon^{-1} \left(\mu \sum_k v_{jk}^N \left(\sum_{i=1}^J m_{ikt}(V_t) N_{it} - N_{kt}\right)\right)_{j=1}^J &= v^N \cdot M^* \cdot n + v^N \cdot G \cdot \epsilon^{-1} dV \\ &= v^N \cdot M^* \cdot n + v^N \cdot G \cdot \left(v^N n + v^K k + v^T\right) \end{aligned}$$

where in the second line we recalled $dV = \epsilon \left(v^N n + v^K k + v^T\right)$. Similarly, for the capitalist:

$$\epsilon^{-1} \left(\sum_k \frac{\partial A_{jt}}{\partial N_{kt}} \left(\sum_{i=1}^J m_{ikt}(V_t) N_{it} - N_{kt}\right)\right)_{j=1}^J = a^N \cdot M^* \cdot n + a^N \cdot G \cdot \left(v^N n + v^K k + v^T\right)$$

Continuation value from changes in the capital distribution We linearize:

$$\sum_k \frac{\partial V_{jt}}{\partial K_{kt}} \left(R_{kt}^K - \delta - \rho\right) K_{kt} = \sum_k v_{jk}^K \left(\left(\frac{\partial R_{kt}^K}{\partial K_{kt}} dK_{kt} + \frac{\partial R_{kt}^K}{\partial N_{kt}} dN_{kt} + \frac{\partial R_{kt}^K}{\partial \vartheta_t} d\vartheta_t + \frac{\partial R_{kt}^K}{\partial r_t} dr_t \right) K_{kt} + \left(R_{kt}^K - \delta - \rho\right) dK_{kt} \right)$$

where we denoted $dK_{kt} = k_{kt}$. In vector notation:

$$\epsilon^{-1} \left(\sum_k v_{jk}^K \left(R_{kt}^K - \delta - \rho\right) K_{kt} \right)_{j=1}^J = v^K \left(D_{KR}\tilde{r}_t + D_{K\theta}\vartheta_t^D + D_{KN} n + D_{KK} k \right)$$

where note $(1+\rho^s)\frac{\partial r_{kt}^K}{\partial K_{kt}} K_{kt} k_{kt} + R_{kt}^K k_{kt} = \alpha_K R_{kt}^K k_{kt}$, so that:

$$D_{KK} = \mathbf{diag}\left(\alpha_K R_{jt}^K - \delta - \rho\right); \qquad D_{KN} = \mathbf{diag}\left(\alpha_N R_{jt}^K \frac{K_{jt}}{N_{jt}}\right) = \mathbf{diag}\left(K_{jt}\right) \odot D_{RN}$$

$$D_{KR} = \mathbf{vec}\left(-K_{jt}\xi_{jt}s_{jt}' \frac{R_{jt}^K}{R_{jt}^F}\right) = \mathbf{vec}\left(K_{jt}\right) \odot D_{RR}; \quad D_{K\theta} = \mathbf{vec}\left(-K_{jt}\xi_{jt}s_{jt}^L \frac{R_{jt}^K}{R_{jt}^F}\right) = \mathbf{vec}\left(K_{jt}\right) \odot D_{R\theta}$$

And similarly for the capitalist:

$$\epsilon^{-1} \left(\sum_k a_{jk}^K \left(R_{kt}^K - \delta - \rho\right) K_{kt} \right)_{j=1}^J = a^K \left(D_{KR}\tilde{r}_t + D_{K\theta}\vartheta_t^D + D_{KN} n + D_{KK} k \right)$$

FAMEs. We can now perturb the master equations (44) and (45):

$$\rho V_{jt}\left(N_t, K_t, \log\theta_t, r_t\right) - \frac{\partial V_{jt}}{\partial t} = U_{jt}\left(N_t, K_t, \log\theta_t, r_t\right) + \mathcal{M}_{jt}[V] + \sum_k \frac{\partial V_{jt}}{\partial N_{kt}} \left[M^*(V_t) N_t\right]_k + \sum_k \frac{\partial V_{jt}}{\partial K_{kt}} \left(R_{kt}^K - \delta - \rho\right) K_{kt}$$

in first differences:

$$\rho\left(v^N n + v^K k + v^T\right) - \frac{\partial v^T}{\partial t} = D_{UR}\tilde{r}_t + D_{U\theta}\vartheta_t^D - D_{UN} n + D_{UK} k + M \cdot \left(v^N \cdot n + v^K \cdot k + v^T\right) + v^N \cdot M^* \cdot n + v^N \cdot G \cdot \left(v^N \cdot n + v^K \cdot k + v^T\right) + v^K \left(D_{KR}\tilde{r}_t + D_{K\theta}\vartheta_t^D + D_{KN} n + D_{KK} k\right)$$

and:

$$
\begin{aligned}
\rho A_{jt}\left(N_t, K_t, \log\theta_t, r_t\right) - \frac{\partial A_{jt}}{\partial t} =& \rho\log\rho + R^K_{jt}\left(N_t, K_t, \log\theta_t, r_t\right) - \delta - \rho \\
&+ \sum_k \frac{\partial A_{jt}}{\partial N_{kt}}\left[M^*(V_t)N_t\right]_k + \sum_k \frac{\partial A_{jt}}{\partial K_{kt}}\left(R^K_{kt} - \delta - \rho\right)K_{kt}
\end{aligned}
$$

in first differences:

$$
\begin{aligned}
\rho\left(a^N n + a^K k + a^T\right) - \frac{\partial a^T}{\partial t} =& D_{RR}\tilde{r}_t + D_{R\theta}\vartheta^D_t + D_{RN}\cdot n - D_{RK}\cdot k \\
&+ a^N \cdot M^* \cdot n + a^N \cdot G \cdot \left(v^N \cdot n + v^K \cdot k + v^T\right) \\
&+ a^K\left(D_{KR}\tilde{r}_t + D_{K\theta}\vartheta^D_t + D_{KN} n + D_{KK} k\right)
\end{aligned}
$$

We can collect the coefficients, where the unknown are in bold, exploiting the block-recursive structure:

$$
\begin{aligned}
\rho\mathbf{v}^{\mathbf{N}} &= -D_{UN} + M\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{v}^{\mathbf{N}}\cdot M^* + \mathbf{v}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{v}^{\mathbf{K}}\cdot D_{KN} \\
\rho\mathbf{v}^{\mathbf{K}} &= D_{UK} + M\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{v}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{v}^{\mathbf{K}}\cdot D_{KK} \\
\rho\mathbf{v}^T_t - \frac{\partial\mathbf{v}^T}{\partial t} &= \begin{bmatrix} D_{UR} + \mathbf{v}^{\mathbf{K}} D_{KR} & D_{U\theta} + \mathbf{v}^{\mathbf{K}} D_{K\theta} \end{bmatrix}\begin{bmatrix} \tilde{r}_t \\ \vartheta^D_t \end{bmatrix} + \left(M + \mathbf{v}^{\mathbf{N}}\cdot G\right)\cdot\mathbf{v}^T_t
\end{aligned}
$$

Similarly:

$$
\begin{aligned}
\rho\mathbf{a}^{\mathbf{N}} &= D_{RN} + \mathbf{a}^{\mathbf{N}}\cdot M^* + \mathbf{a}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{a}^{\mathbf{K}} D_{KN} \\
\rho\mathbf{a}^{\mathbf{K}} &= -D_{RK} + \mathbf{a}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{a}^{\mathbf{K}} D_{KK} \\
\rho\mathbf{a}^{\mathbf{T}}_{\mathbf{t}} - \frac{\partial\mathbf{a}^{\mathbf{T}}}{\partial t} &= \begin{bmatrix} D_{RR} + \mathbf{a}^{\mathbf{K}} D_{KR} & D_{R\theta} + \mathbf{a}^{\mathbf{K}} D_{K\theta} \end{bmatrix}\begin{bmatrix} \tilde{r}_t \\ \vartheta^D_t \end{bmatrix} + \mathbf{a}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^T_t
\end{aligned}
$$

Collecting the deterministic FAMEs:

$$
\begin{aligned}
\rho\mathbf{v}^{\mathbf{N}} &= -D_{UN} + M\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{v}^{\mathbf{N}}\cdot M^* + \mathbf{v}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{v}^{\mathbf{K}}\cdot D_{KN} \\
\rho\mathbf{v}^{\mathbf{K}} &= D_{UK} + M\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{v}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{v}^{\mathbf{K}}\cdot D_{KK} \\
\rho\mathbf{a}^{\mathbf{N}} &= D_{RN} + \mathbf{a}^{\mathbf{N}}\cdot M^* + \mathbf{a}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{N}} + \mathbf{a}^{\mathbf{K}} D_{KN} \\
\rho\mathbf{a}^{\mathbf{K}} &= -D_{RK} + \mathbf{a}^{\mathbf{N}}\cdot G\cdot\mathbf{v}^{\mathbf{K}} + \mathbf{a}^{\mathbf{K}} D_{KK}
\end{aligned}
$$

which proves the lemma. This system constitutes a generalized Sylvester matrix equation:

$$\rho \mathbf{x}^d = D^d + \underline{\mathrm{M}}\mathbf{x}^d + \mathbf{x}^d\underline{\mathrm{H}} + \mathbf{x}^d P^d \mathbf{x}^d \qquad \mathbf{x}^d = \begin{bmatrix} \mathbf{v}^N & \mathbf{v}^K \\ \mathbf{a}^N & \mathbf{a}^K \end{bmatrix}$$

where:

$$D^d = \begin{bmatrix} -D_{UN} & D_{UK} \\ D_{RN} & -D_{RK} \end{bmatrix} \qquad P^d = \begin{bmatrix} G & 0 \\ 0 & 0 \end{bmatrix}$$
$$\underline{\mathrm{M}} = \begin{bmatrix} M & 0 \\ 0 & 0 \end{bmatrix} \qquad \underline{\mathrm{H}} = \begin{bmatrix} M^* & 0 \\ D_{KN} & D_{KK} \end{bmatrix}$$

□

We can immediately prove the following lemma.

Lemma B.3 (Trend FAMEs)**.** *For a given path of shocks to the aggregate rate* $\{r_t\}_t$ *and frictions* $\{\vartheta_t\}_t$*, the matrices* v_t^T *and* a_t^T*, which encode the first-order changes with respect to time of the workers' and capitalists value functions around a steady-state, satisfy the system of Ordinary Differential Equations:*

$$\rho v_t^T - \frac{\partial v^T}{\partial t} = \left(D_{UR} + v^K D_{KR}\right) r_t + \left(D_{U\theta} + v^K D_{K\theta}\right)\vartheta_t + \left(M + v^N \cdot G\right) \cdot v_t^T$$
$$\rho a_t^T - \frac{\partial a^T}{\partial t} = \left(D_{RR} + a^K D_{KR}\right) r_t + \left(D_{R\theta} + a^K D_{K\theta}\right)\vartheta_t + a^N \cdot G \cdot v_t^T$$

that can be collapsed in:

$$\rho \mathbf{x}_t^T = \frac{\partial \mathbf{x}_t^T}{\partial t} + D_t^T + \underline{M}\mathbf{x}_t^T + \mathbf{x}_t^d P^d \mathbf{x}_t^T \qquad \mathbf{x}_t^T = \begin{bmatrix} v_t^T \\ a_t^T \end{bmatrix}$$

where:

$$\underbrace{D_t^T}_{2N\times 1} = \begin{bmatrix} \left(D_{UR} + v^K D_{KR}\right)\tilde{r}_t + \left(D_{U\theta} + v^K D_{K\theta}\right)\vartheta_t^D \\ \left(D_{RR} + a^K D_{KR}\right)\tilde{r}_t + \left(D_{R\theta} + a^K D_{K\theta}\right)\vartheta_t^D \end{bmatrix}$$

Proof. We simply collect the trend FAMEs from the FAMEs derived in the previous proof, again putting in bold the unknowns:

$$\rho \mathbf{v}_t^T - \frac{\partial \mathbf{v}^T}{\partial t} = \begin{bmatrix} D_{UR} + \mathbf{v}^{\mathbf{K}} D_{KR} & D_{U\theta} + \mathbf{v}^{\mathbf{K}} D_{K\theta} \end{bmatrix} \begin{bmatrix} \tilde{r}_t \\ \vartheta_t^D \end{bmatrix} + \left(M + \mathbf{v}^{\mathbf{N}} \cdot G\right) \cdot \mathbf{v}_t^T$$

$$\rho \mathbf{a_t^T} - \frac{\partial \mathbf{a^T}}{\partial t} = \left[\begin{array}{cc} D_{RR} + \mathbf{a^K} D_{KR} & D_{R\theta} + \mathbf{a^K} D_{K\theta} \end{array}\right] \left[\begin{array}{c} \tilde{r}_t \\ \vartheta_t^D \end{array}\right] + \mathbf{a^N} \cdot G \cdot \mathbf{v}_t^T$$

□

The proofs for Lemmas B.2 and B.3 also prove Lemma 2. We can then turn to the proof of Proposition 6.

Proof of Proposition 6. We can derive the linearized law of motion for labor around a steady state as:

$$\begin{aligned} \frac{dN_{jt}}{dt} &\approx 0 + \mu \left(\sum_{i=1}^{J} m_{ij}(V^{SS}) \left(N_{it} - N_i^{SS}\right) - \left(N_{jt} - N_j^{SS}\right) \right) + \mu \left(\sum_{i=1}^{N} m_{ijt}(V + dV) N_{it} - N_{jt} \right) \\ &\approx \epsilon \left(M^* \cdot n\right)_j + \epsilon \left(G \cdot \left(v^N n + v^K k + v^T \right) \right)_j \end{aligned}$$

where the second line follows the derivation in the Proof of B.2 and the coefficients G and M^* follow Lemma B.2.

The linearized law of motion of capital around a steady state similarly follows:

$$\begin{aligned} \frac{dK_{jt}}{dt} &\approx 0 + \left(\frac{\partial R_{jt}^K}{\partial K_{jt}} dK_{jt} + \frac{\partial R_{jt}^K}{\partial N_{jt}} dN_{jt} + \frac{\partial R_{jt}^K}{\partial \vartheta_t} d\vartheta_t + \frac{\partial R_{jt}^K}{\partial r_t} dr_t \right) K_{jt} + \left(R_{jt}^K - \delta - \rho \right) dK_{jt} \\ &\approx \left(D_{KR} \tilde{r}_t + D_{K\theta} \vartheta_t^D + D_{KN} \cdot n + D_{KK} \cdot k \right)_j \end{aligned}$$

Collecting the linearized law of motions, we reach:

$$\begin{aligned} \frac{d}{dt} n_t &= \left(M^* + G v^N \right) n_t + G \cdot \left(v^K k_t + v_t^T \right) \\ \frac{d}{dt} k_t &= D_{KR} \tilde{r}_t + D_{K\theta} \vartheta_t^D + D_{KN} n + D_{KK} k \end{aligned}$$

□

C Appendix to Section 2

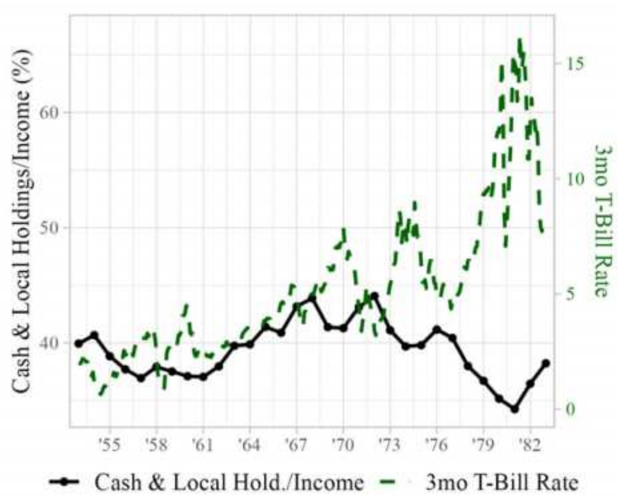
FIGURE C.4: NOMINAL AND REAL INTEREST RATES, 1953–1983

Notes. Calculations from FRED. The solid green line reports the three-month Treasury Bill secondary market rate. The dashed blue line reports the three-month Treasury Bill secondary market rate minus the 12-month change in the consumer price index for all urban consumers.

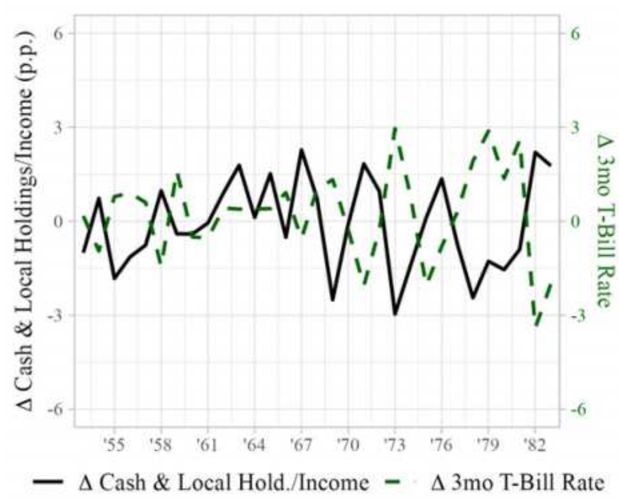
FIGURE C.5: LOCAL DEPOSITS AND AGGREGATE RATES

(A) HOUSEHOLDS ASSETS

(A.I) LEVELS

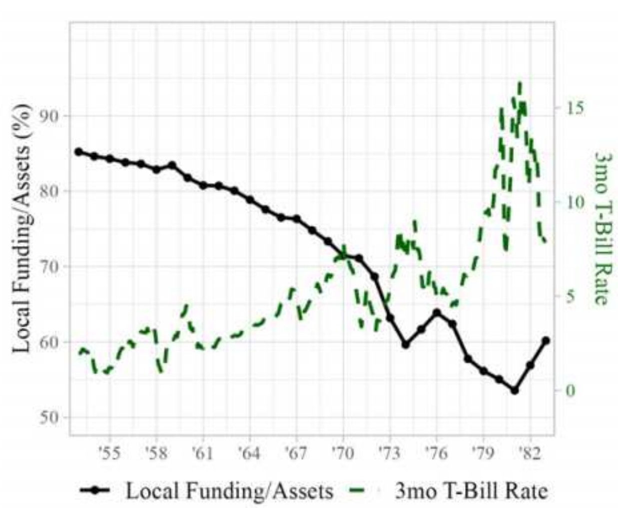


(A.II) CHANGES

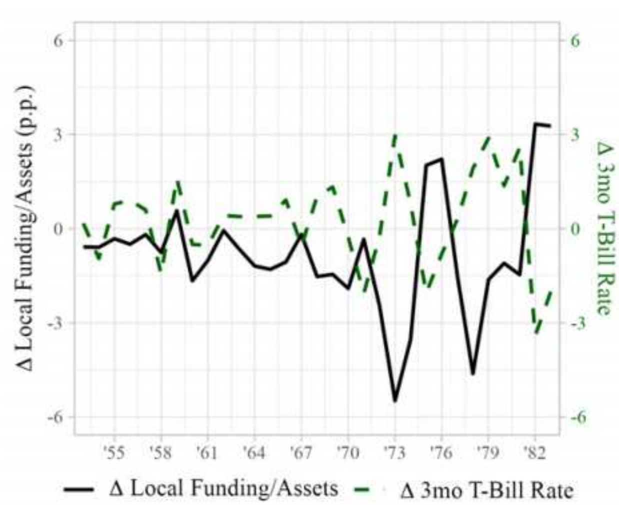


(B) BANKS LIABILITIES

(B.I) LEVELS



(B.II) CHANGES



Notes. Calculations from historical Fed releases Z.1 (1986; 1988). The black lines in Panel (a) report local holdings of the household sector as a fraction of total income. Local household holdings are defined as cash and checking accounts (reported together in the Z.1 accounts), and small time and savings deposits, excluding deposits in nonbanks, which we impute by digitizing the corresponding series of small deposits of nonbanks. The dashed green lines report the short term nominal rate, defined as the rate on three-month Treasury Bills. The black lines in Panel (b) report local liabilities of the commercial banking sector as a fraction of assets. Local liabilities are defined as checking accounts and small time and savings deposits. For both panels, left-hand side figures plot series in levels while the right-hand side figures plot year-on-year changes.

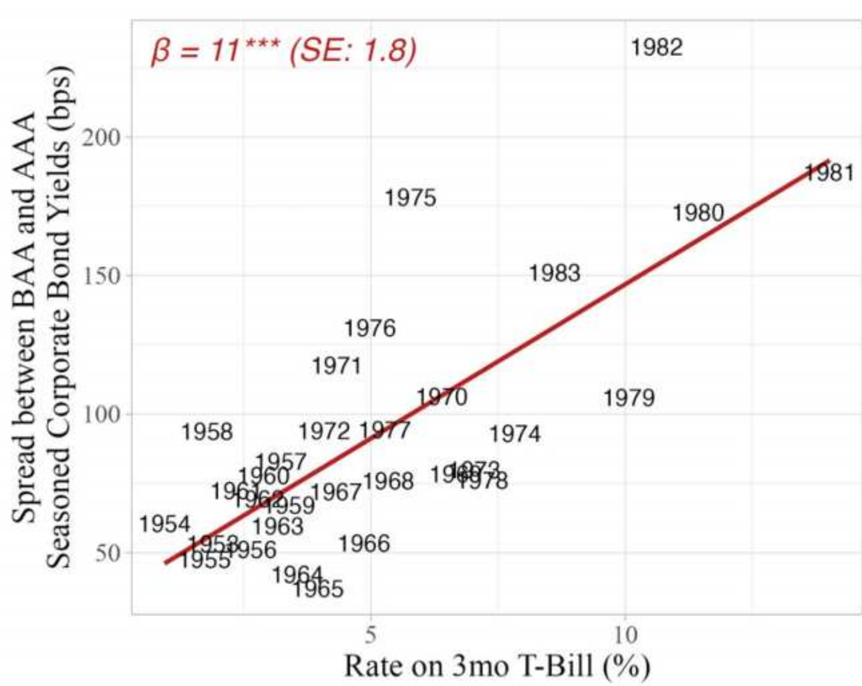
D Appendix to Section 4

TABLE D.2: CORRELATES OF AVERAGE STATE-LEVEL LENDING RATES IN 1953–58 AND CONTROLS IN DYNAMIC DIFFERENCE-IN-DIFFERENCE REGRESSIONS

	Correlation Coefficient with $r^L_{j,53-58}$	
	Unconditional	Multivariate
Bank Assets HHI$_{61}$	0.16 (0.16)	0.03 (0.13)
Share of farm pop.$_{50}$	0.31 (0.11)	-0.2 (0.2)
Share employed in mfg.$_{50}$	-0.53 (0.12)	-0.02 (0.15)
Share pop. aged 65+$_{50}$	-0.37 (0.15)	-0.19 (0.11)
Share of GDP from Oil$_{50}$	0.4 (0.14)	0.14 (0.06)
Population density$_{53}$	-0.5 (0.12)	-0.28 (0.17)
log(population)$_{53}$	-0.64 (0.11)	-0.5 (0.12)
log(income p.c.)$_{53}$	-0.37 (0.13)	-0.25 (0.19)

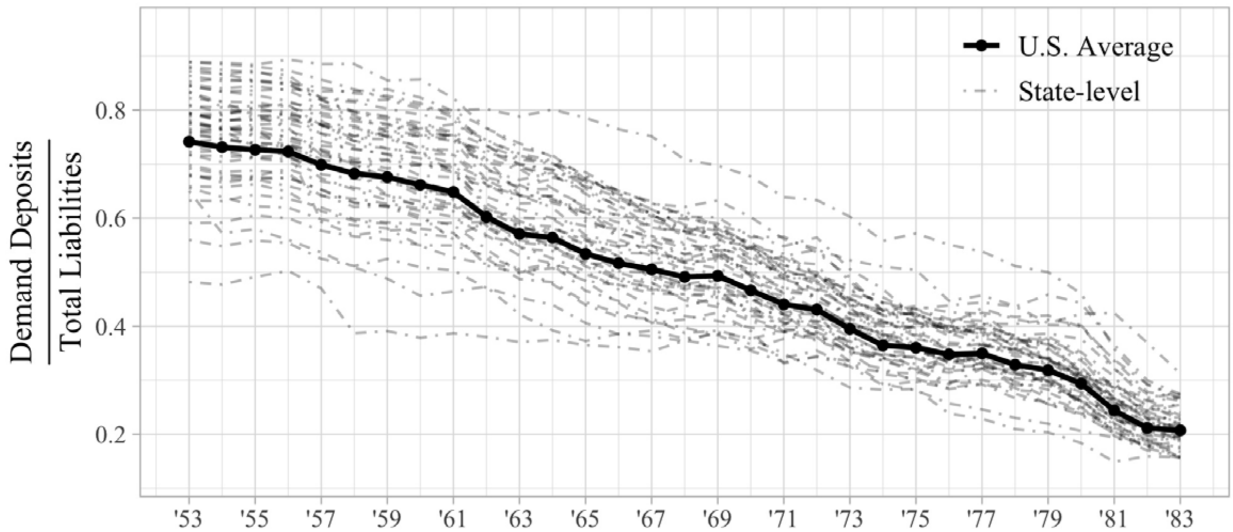
Notes. The table reports correlation coefficients between average state-level lending rates in 1953–58 and different financial and macroeconomic state-level variables. The first column reports unconditional correlation coefficients from univariate regressions of $r^L_{j,53--58}$ on each variable, with normalized scales. The second reports coefficients from a multivariate regression where all variables are included. Robust standard errors are in parentheses.

FIGURE D.6: RISK SPREADS AND NOMINAL RATES



Notes. Calculations from FRED. Each observation is a year. The vertical axis reports the difference in basis points between Moody's Seasoned BAA Corporate Bond Yield and Moody's Seasoned AAA Corporate Bond Yield. The horizontal axis reports the rate on the three-month Treasury Bill. The red line reports the best linear fit. The figure also reports the OLS coefficient. Robust standard errors are in parentheses.

FIGURE D.7: THE DECLINE OF DEMAND DEPOSITS



Notes. The solid black line reports the time series of demand deposits over total liabilities at the aggregate US level, computed from our data on national banks' balance sheets. The gray dashed line report the corresponding series for each state.

D.1 Extra Regression Tables

TABLE D.3: DEMAND-DEPOSIT ABUNDANCE, INITIAL RATES, AND DEPOSIT OUTFLOWS

	Dependent Variable: State-Level					
	Initial Lending Rate (bp)			Change between '59 and '83 in Dem. Dep./Tot. Liab. (pp)		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial Demand Deposit/Tot. Liab. (%)	−.453	−1.690	−2.331	−.823	−.799	−.829
	(.673)	(.882)	(.690)	(.057)	(.069)	(.090)
Fract. of Large Banks in State (%)		−1.206	−.713		.023	.010
		(.431)	(.357)		(.020)	(.035)
Region FEs			✓			✓
E(Y)	538	538	538	-48	-48	-48
SD(Y)	47.5	47.5	47.5	8.88	8.88	8.88
Observations	46	46	46	46	46	46
R^2	.008	.2	.71	.86	.86	.87

Notes. The table reports WLS estimates of average state-level lending rates in 1953–58 (Columns 1 to 3) and state-level changes in the fraction of liabilities funded with demand deposits between 1983 and 1959 (Columns 4 to 6) against the average demand deposit share in 1953–58. The fraction of large banks is taken as of 1961, since that is the first year the bank-level data is available for all banks. Observations are weighted by population in 1950. Parentheses report heteroskedasticity-robust standard errors.

TABLE D.4: REGIONAL SPREADS AND AGGREGATE GDP GROWTH (PLACEBO)

	Dependent variable:							
	State-level Bank Lending Rate (pp)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: dependent variable in levels								
US GDP Growth Rate (pp), g_t	.402				.046			
	(.010)				(.003)			
$r^L_{j,53-58} \times g_t$	−.027	−.025	−.037	−.047	−.003	−.004	.005	−.014
	(.041)	(.019)	(.032)	(.036)	(.014)	(.011)	(.012)	(.018)
US 3mo T-Bill Rate (pp), r_t					1.308			
					(.005)			
$r^L_{j,53-58} \times r_t$					−.089	−.099	−.156	−.142
					(.014)	(.021)	(.024)	(.034)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.089	.99	.99	.99	.89	.99	.99	.99
Within R^2	.077	.041	.047	.39	–	.19	.27	.49
Panel B: dependent variable in changes								
ΔUS GDP Growth Rate (pp), Δg_t	−.217				−.142			
	(.007)				(.031)			
$r^L_{j,53-58} \times \Delta g_t$	.024	.028	.041	.020	.015	.019	.029	.011
	(.018)	(.021)	(.032)	(.030)	(.005)	(.011)	(.011)	(.018)
ΔUS 3mo T-Bill Rate (pp), Δr_t					1.056			
					(.149)			
$r^L_{j,53-58} \times \Delta r_t$					−.125	−.132	−.169	−.146
					(.032)	(.042)	(.047)	(.053)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.13	.89	.91	.94	.68	.9	.92	.94
Within R^2	–	.066	.078	.38	–	.15	.16	.41
State FEs	✓	✓	✓	✓	✓	✓	✓	✓
Year FEs & Financial Conts.		✓	✓	✓		✓	✓	✓
Region × Year FEs			✓	✓			✓	✓
Macro Controls				✓				✓

Notes. The table reports results from a WLS regression of state-level lending rates against the initial state-level lending rate in 1953–58 interacted with the rate of US GDP growth, with the level of the three-month Treasury Bill rate, and their changes. The real short term US rate is constructed as the difference between the three-month Treasury Bill rate quoted on a discount basis and the yearly change in the US CPI. Observations are weighted by population in 1950. Parentheses report two-way clustered standard errors at the state and year level.

TABLE D.5: HETEROGENEOUS PASS-THROUGH OF AGGREGATE RATES, REAL AND NOMINAL DRIVERS

	Dependent variable:							
	State-level Bank Lending Rate (pp)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: dependent variable in levels								
US Short Real Rate (pp), ρ_t^s	−.010				−.125			
	(.018)				(.029)			
$r^L_{j,53-58} \times \rho_t^s$	.036	.042	.028	.035	.044	.054	.039	.043
	(.067)	(.038)	(.062)	(.063)	(.014)	(.013)	(.026)	(.027)
US 3mo T-Bill Rate (pp), r_t					1.327			
					(.051)			
$r^L_{j,53-58} \times r_t$					−.092	−.104	−.156	−.147
					(.010)	(.020)	(.025)	(.034)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.038	.99	.99	.99	.9	.99	.99	.99
Within R^2	.026	.052	.04	.38	–	.22	.28	.49
Panel B: dependent variable in changes								
ΔUS Short Real Rate (pp), $\Delta\rho_t^s$	−.250				−.179			
	(.086)				(.076)			
$r^L_{j,53-58} \times \Delta\rho_t^s$	.061	.073	.058	.024	.053	.065	.047	.015
	(.052)	(.083)	(.068)	(.059)	(.014)	(.044)	(.035)	(.037)
ΔUS 3mo T-Bill Rate (pp), Δr_t					1.084			
					(.157)			
$r^L_{j,53-58} \times \Delta r_t$					−.125	−.132	−.173	−.148
					(.027)	(.036)	(.050)	(.050)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.023	.89	.91	.94	.66	.9	.92	.94
Within R^2	.022	.085	.07	.38	–	.18	.16	.41
State FEs	✓	✓	✓	✓	✓	✓	✓	✓
Year FEs & Financial Conts.		✓	✓	✓		✓	✓	✓
Region × Year FEs			✓	✓			✓	✓
Macro Controls				✓				✓

Notes. The table reports results from a WLS regression of state-level lending rates against the initial state-level lending rate in 1953–58 interacted with the real short term US rate, with the level of the three-month Treasury Bill rate, and their changes. The real short term US rate is constructed as the difference between the three-month Treasury Bill rate quoted on a discount basis and the yearly change in the US CPI. Observations are weighted by population in 1950. Parentheses report two-way clustered standard errors at the state and year level.

TABLE D.6: HETEROGENEOUS PASS-THROUGH OF AGGREGATE RATES, BY INITIAL LENDING RATES

	Dependent variable:								
	Lending Rate (pp)			Bank Financing Rate (pp)			Demand Dep. Share (%)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: dependent variable in levels									
Initial Lending Rate (pp), $r^L_{j,53-58}$	.999			.067			−1.142		
	(.063)			(.088)			(2.643)		
US 3mo T-Bill Rate (pp), r_t	1.320			.999			−5.194		
	(.013)			(.037)			(.463)		
$r^L_{j,53-58} \times r_t$	−.090	−.155	−.146	−.056	−.125	−.087	.235	.691	.934
	(.011)	(.024)	(.034)	(.009)	(.021)	(.032)	(.117)	(.235)	(.337)
Panel B: dependent variable in changes									
Initial Lending Rate (pp), $r^L_{j,53-58}$	.010			.039			.076		
	(.018)			(.029)			(.092)		
ΔUS 3mo T-Bill Rate (pp), Δr_t	1.101			1.195			−.745		
	(.152)			(.332)			(.178)		
$r^L_{j,53-58} \times \Delta r_t$	−.130	−.177	−.149	−.153	−.217	−.069	.118	.076	−.052
	(.027)	(.050)	(.050)	(.057)	(.061)	(.068)	(.052)	(.128)	(.184)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.62	.92	.94	.54	.86	.91	.017	.64	.75
Within R^2	–	.15	.41	–	.17	.5	–	.043	.33
State & Region × Year FEs		✓	✓		✓	✓		✓	✓
Financial Controls		✓	✓		✓	✓		✓	✓
Macro Controls			✓			✓			✓

Notes. The table reports results from a WLS regression of state-level lending rates, bank-financing rates, and demand deposit shares of liabilities in each year between 1959 and 1983, against the initial state-level lending rate in 1953–58 interacted with the level of the three-month Treasury Bill rate and its changes. Observations are weighted by population in 1950. Parentheses report two-way clustered standard errors at the state and year level.

TABLE D.7: HETEROGENEOUS PASS-THROUGH OF AGGREGATE RATES, BY INITIAL DEMAND DEPOSIT ABUNDANCE

	Dependent variable:								
	Lending Rate (bp)			Bank Financing Rate (bp)			Demand Dep. Share (%)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: dependent variable in levels									
Initial Dem. Dep. Share (%)$_{53-58}$	−.817			−.490			1.029		
	(.448)			(.372)			(.054)		
US 3mo T-Bill Rate (pp), r_t	68.067			64.030			.928		
	(9.738)			(7.772)			(.691)		
Initial Dem. Dep. Share $\times r_t$	.245	.605	.452	.099	.415	.251	−.067	−.065	−.063
	(.171)	(.128)	(.175)	(.097)	(.135)	(.110)	(.011)	(.011)	(.016)
Panel B: dependent variable in changes									
Initial Dem. Dep. Share (%)$_{53-58}$	.073			−.018			−.035		
	(.148)			(.138)			(.003)		
ΔUS 3mo T-Bill Rate (pp), Δr_t	33.364			37.277			−.413		
	(.008)			(8.657)			(.00004)		
Initial Dem. Dep. Share $\times \Delta r_t$	.136	.709	.557	.055	.713	.455	.004	−.004	−.003
	(.129)	(.167)	(.297)	(.052)	(.307)	(.290)	(.003)	(.007)	(.010)
Observations	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
R^2	.61	.92	.94	.52	.85	.91	.042	.64	.75
Within R^2	–	.12	.41	–	.13	.5	–	.043	.33
State & Region × Year FEs		✓	✓		✓	✓		✓	✓
Financial Controls		✓	✓		✓	✓		✓	✓
Macro Controls			✓			✓			✓

Notes. The table reports results from a WLS regression of state-level lending rates, bank-financing rates, and demand deposit shares of liabilities in each year between 1959 and 1983, against the initial demand deposit share of liabilities in 1953–58 interacted with the level of the three-month Treasury Bill rate and its changes. Observations are weighted by population in 1950. Parentheses report two-way clustered standard errors at the state and year level.

TABLE D.8: HETEROGENEOUS PASS-THROUGH, SMALL AND LARGE BANKS

	Dependent variable:					
	Bank-level Lending Rate			Bank-level Financing Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: dependent variable in levels						
β on initial state lending rate $\times$ r_t:						
– Small banks, β_s	$-.100$	$-.103$	$-.056$	$-.027$	$-.026$	$-.008$
	(.047)	(.059)	(.028)	(.026)	(.030)	(.035)
– Large banks, β_ℓ	$-.197$	$-.202$	$-.110$	$-.147$	$-.147$	$-.069$
	(.079)	(.097)	(.038)	(.073)	(.093)	(.065)
– Triple-diff, $\beta_\ell - \beta_s$	$-.097$	$-.098$	$-.054$	$-.120$	$-.121$	$-.062$
	(.063)	(.058)	(.042)	(.069)	(.076)	(.084)
Observations, small banks	249,668	249,668	249,668	247,749	247,749	247,749
Observations, large banks	13,450	13,450	13,450	13,450	13,450	13,450
Within R^2, small banks	.026	.035	.081	.0091	.015	.046
Within R^2, large banks	.46	.47	.51	.13	.15	.22
Panel B: dependent variable in changes						
β on initial state lending rate $\times$ Δr_t:						
– Small banks, β_s	$-.134$	$-.134$	$-.041$	$-.037$	$-.031$	.027
	(.069)	(.060)	(.049)	(.035)	(.031)	(.037)
– Large banks, β_ℓ	$-.368$	$-.368$	$-.174$	$-.218$	$-.211$	$-.044$
	(.077)	(.076)	(.061)	(.100)	(.096)	(.152)
– Triple-diff, $\beta_\ell - \beta_s$	$-.235$	$-.234$	$-.133$	$-.181$	$-.180$	$-.071$
	(.070)	(.069)	(.082)	(.129)	(.110)	(.167)
Observations, small banks	238,395	238,395	238,395	236,484	236,484	236,484
Observations, large banks	12,851	12,851	12,851	12,851	12,851	12,851
Within R^2, small banks	.019	.022	.055	.011	.015	.032
Within R^2, large banks	.41	.41	.46	.12	.13	.19
Bank & Region $\times$ Year FEs	✓	✓	✓	✓	✓	✓
Ratio Domestic Loans Cont.	✓	✓	✓	✓	✓	✓
Loan Comp. Controls		✓	✓		✓	✓
Macro Controls			✓			✓

Notes. The table reports WLS estimates of coefficients coming from diff-in-diff regressions of lending (Columns 1 to 3) and financing rates (columns 4 to 6) of bank b in year t against the average lending rate in bank b's state in 1953–58 interacted with the level of the three-month Treasury Bill rate. In each panel, each row represents a different sample. β_s is the difference-in-difference coefficient estimated in the sample of banks in the bottom 90 percent of the asset distribution in 1961. β_ℓ is the difference-in-difference coefficient estimated in the sample of banks in the top 10 percent of assets in 1961. The last row reports the triple-difference coefficient across large and small banks, estimated on the entire sample. The dependent variable and the three-month Treasury Bill rate in the interaction are expressed in levels in Panel A and in year-on-year changes in Panel B. Observations are weighted by domestic assets, and the controls vary across columns according to the discussion in Section 4.2.2. Parentheses report standard errors clustered two-way at the state and year level.

D.2 Sensitivity of Triple-differences to Different Sample Selections

We show that the results from the triple-difference analysis are qualitatively similar across different choices of sample. Appendix Table D.9 drops from the sample medium-sized banks, defined as those between the 80th percentile and the 95th percentile of the asset distribution in 1961. Appendix Table D.10 further drops banks that are not present in all years in the data. Appendix Tables D.11 and D.12 define large banks as those in the top 10% and top 1% of the distribution of assets in 1961, respectively. Other permutations of the sample selection criterias yield similar results and are available upon request. The triple-difference coefficient for year-on-year changes in lending rates, which is our cleanest prediction, is always very significant across all sample selections. The triple-difference coefficient in levels is almost always significant at conventional levels, but it is more sensitive as it is affected by the secular pattern of convergence occurring for small banks. Coefficients for financing rates mirror these patterns but are noisier in some specifications.

TABLE D.9: TRIPLE-DIFFERENCE: EXCLUDING MEDIUM-SIZED BANKS ("DOUGHNUT")

	Dependent variable:					
	Bank-level Lending Rate			Bank-level Financing Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
***Panel A*: dependent variable in levels**						
β on initial state lending rate $\times$ r_t:						
– Small banks, β_s	−.083	−.088	−.034	−.032	−.031	−.008
	(.053)	(.049)	(.028)	(.024)	(.024)	(.037)
– Large banks, β_ℓ	−.197	−.202	−.110	−.147	−.147	−.069
	(.080)	(.097)	(.039)	(.077)	(.093)	(.065)
– Triple-diff, $\beta_\ell - \beta_s$	−.114	−.113	−.076	−.115	−.115	−.061
	(.084)	(.064)	(.044)	(.128)	(.098)	(.078)
Observations, small banks	211,009	211,009	211,009	209,108	209,108	209,108
Observations, large banks	13,450	13,450	13,450	13,450	13,450	13,450
Within R^2, small banks	.012	.028	.082	.0031	.0092	.034
Within R^2, large banks	.46	.47	.51	.13	.15	.22
***Panel B*: dependent variable in changes**						
β on initial state lending rate $\times$ Δr_t:						
– Small banks, β_s	−.103	−.102	.001	−.038	−.032	.036
	(.064)	(.062)	(.060)	(.034)	(.034)	(.044)
– Large banks, β_ℓ	−.368	−.368	−.174	−.218	−.211	−.044
	(.077)	(.076)	(.060)	(.103)	(.100)	(.152)
– Triple-diff, $\beta_\ell - \beta_s$	−.265	−.265	−.175	−.180	−.179	−.080
	(.084)	(.080)	(.084)	(.113)	(.104)	(.177)
Observations, small banks	201,520	201,520	201,520	199,627	199,627	199,627
Observations, large banks	12,851	12,851	12,851	12,851	12,851	12,851
Within R^2, small banks	.0088	.013	.049	.0047	.0088	.025
Within R^2, large banks	.41	.41	.46	.12	.13	.19
Bank & Region $\times$ Year FEs	✓	✓	✓	✓	✓	✓
Ratio Domestic Loans Cont.	✓	✓	✓	✓	✓	✓
Loan Comp. Controls		✓	✓		✓	✓
Macro Controls			✓			✓

Notes. See notes to Table D.8. Large banks are defined as those in the top 5% of the asset distribution in 1962, and small banks are those in the bottom 80%. Other banks are excluded.

TABLE D.10: TRIPLE-DIFFERENCE: BALANCED PANEL EXCLUDING MEDIUM-SIZED BANKS

	Dependent variable:					
	Bank-level Lending Rate			Bank-level Financing Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: dependent variable in levels						
β on initial state lending rate $\times r_t$:						
– Small banks, β_s	−.079	−.085	−.038	−.027	−.027	−.014
	(.070)	(.051)	(.028)	(.024)	(.023)	(.038)
– Large banks, β_ℓ	−.187	−.191	−.103	−.145	−.146	−.071
	(.073)	(.072)	(.045)	(.124)	(.060)	(.078)
– Triple-diff, $\beta_\ell - \beta_s$	−.108	−.106	−.065	−.119	−.119	−.057
	(.077)	(.069)	(.049)	(.129)	(.078)	(.080)
Observations, small banks	165,840	165,840	165,840	164,666	164,666	164,666
Observations, large banks	10,344	10,344	10,344	10,344	10,344	10,344
Within R^2, small banks	.012	.026	.085	.0022	.005	.026
Within R^2, large banks	.48	.49	.54	.12	.15	.22
Panel B: dependent variable in changes						
β on initial state lending rate $\times \Delta r_t$:						
– Small banks, β_s	−.097	−.098	−.027	−.021	−.020	.020
	(.057)	(.065)	(.052)	(.070)	(.029)	(.035)
– Large banks, β_ℓ	−.349	−.348	−.167	−.203	−.196	−.039
	(.452)	(.083)	(.082)	(.124)	(.126)	(.152)
– Triple-diff, $\beta_\ell - \beta_s$	−.253	−.250	−.140	−.182	−.177	−.059
	(.069)	(.093)	(.081)	(.167)	(.170)	(.164)
Observations, small banks	158,930	158,930	158,930	157,762	157,762	157,762
Observations, large banks	9,913	9,913	9,913	9,913	9,913	9,913
Within R^2, small banks	.0074	.011	.05	.00055	.002	.014
Within R^2, large banks	.42	.43	.48	.095	.11	.18
Bank & Region × Year FEs	✓	✓	✓	✓	✓	✓
Ratio Domestic Loans Cont.	✓	✓	✓	✓	✓	✓
Loan Comp. Controls		✓	✓		✓	✓
Macro Controls			✓			✓

Notes. See notes to Table D.8. Large banks are defined as those in the top 5% of the asset distribution in 1962, and small banks are those in the bottom 80%. Other banks are excluded. The sample is restricted to banks present in all years.

TABLE D.11: TRIPLE-DIFFERENCE: LARGE BANKS AS BANKS IN THE TOP 10% OF ASSETS

	Dependent variable:					
	Bank-level Lending Rate			Bank-level Financing Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: dependent variable in levels						
β on initial state lending rate $\times r_t$:						
– Small banks, β_s	−.093	−.096	−.043	−.030	−.029	−.010
	(.049)	(.050)	(.027)	(.026)	(.035)	(.034)
– Large banks, β_ℓ	−.178	−.182	−.103	−.122	−.119	−.054
	(.078)	(.062)	(.040)	(.085)	(.058)	(.056)
– Triple-diff, $\beta_\ell - \beta_s$	−.086	−.086	−.060	−.092	−.090	−.045
	(.054)	(.054)	(.038)	(.063)	(.059)	(.072)
Observations, small banks	236,644	236,644	236,644	234,739	234,739	234,739
Observations, large banks	26,474	26,474	26,474	26,460	26,460	26,460
Within R^2, small banks	.023	.035	.085	.01	.015	.043
Within R^2, large banks	.4	.41	.45	.13	.15	.22
Panel B: dependent variable in changes						
β on initial state lending rate $\times \Delta r_t$:						
– Small banks, β_s	−.121	−.121	−.023	−.038	−.033	.026
	(.067)	(.067)	(.052)	(.038)	(.030)	(.036)
– Large banks, β_ℓ	−.333	−.332	−.155	−.184	−.176	−.028
	(.075)	(.075)	(.056)	(.126)	(.099)	(.149)
– Triple-diff, $\beta_\ell - \beta_s$	−.212	−.211	−.132	−.146	−.143	−.054
	(.066)	(.064)	(.077)	(.089)	(.088)	(.146)
Observations, small banks	225,963	225,963	225,963	224,066	224,066	224,066
Observations, large banks	25,283	25,283	25,283	25,269	25,269	25,269
Within R^2, small banks	.017	.02	.056	.012	.015	.032
Within R^2, large banks	.36	.37	.41	.12	.14	.19
Bank & Region × Year FEs	✓	✓	✓	✓	✓	✓
Ratio Domestic Loans Cont.	✓	✓	✓	✓	✓	✓
Loan Comp. Controls		✓	✓		✓	✓
Macro Controls			✓			✓

Notes. See notes to Table D.8. Large banks are defined as those in the top 10% of the asset distribution in 1962, and small banks are all other banks.

TABLE D.12: TRIPLE-DIFFERENCE: LARGE BANKS AS BANKS IN THE TOP 1% OF ASSETS

	Dependent variable:					
	Bank-level Lending Rate			Bank-level Financing Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: dependent variable in levels						
β on initial state lending rate $\times r_t$:						
– Small banks, β_s	−.116	−.120	−.069	−.051	−.048	−.024
	(.048)	(.049)	(.039)	(.038)	(.059)	(.042)
– Large banks, β_ℓ	−.237	−.242	−.118	−.171	−.183	−.127
	(.067)	(.070)	(.055)	(.137)	(.118)	(.161)
– Triple-diff, $\beta_\ell - \beta_s$	−.121	−.122	−.049	−.119	−.134	−.103
	(.070)	(.080)	(.090)	(.121)	(.147)	(.169)
Observations, small banks	260,363	260,363	260,363	258,444	258,444	258,444
Observations, large banks	2,755	2,755	2,755	2,755	2,755	2,755
Within R^2, small banks	.033	.04	.08	.038	.05	.086
Within R^2, large banks	.61	.63	.68	.1	.12	.21
Panel B: dependent variable in changes						
β on initial state lending rate $\times \Delta r_t$:						
– Small banks, β_s	−.156	−.155	−.055	−.060	−.056	−.006
	(.063)	(.064)	(.057)	(.038)	(.040)	(.039)
– Large banks, β_ℓ	−.452	−.450	−.243	−.250	−.244	−.090
	(.099)	(.094)	(.111)	(.135)	(.127)	(.212)
– Triple-diff, $\beta_\ell - \beta_s$	−.296	−.295	−.188	−.189	−.188	−.083
	(.116)	(.105)	(.129)	(.142)	(.143)	(.232)
Observations, small banks	248,611	248,611	248,611	246,700	246,700	246,700
Observations, large banks	2,635	2,635	2,635	2,635	2,635	2,635
Within R^2, small banks	.029	.032	.067	.046	.05	.07
Within R^2, large banks	.55	.56	.61	.089	.1	.18
Bank & Region × Year FEs	✓	✓	✓	✓	✓	✓
Ratio Domestic Loans Cont.	✓	✓	✓	✓	✓	✓
Loan Comp. Controls		✓	✓		✓	✓
Macro Controls			✓			✓

Notes. See notes to Table D.8. Large banks are defined as those in the top 1% of the asset distribution in 1962, and small banks are all other banks.

E Appendix To Section 5

We start from the rate equation:

$$r_{jt}^L - r_t = (1+\epsilon_{jt})\frac{\theta_t}{2}\left(1 - \bar{\gamma}_j^2 \exp(-\phi r_t)\right)$$

where we are allowing for state-and-time-specific residuals ϵ_{jt} that captures shocks to banks' marginal costs, which for instance could come either from demand shocks, supply shocks, or other sources. That is, we assume that the spread (compared to r_t) on their bonds that banks in state j need to pay given that they are funding a fraction γ_{jt} of liabilities with local deposits is $\left(1+\epsilon_{jt}\right)\cdot\theta_t\cdot\left(1-\gamma_{jt}^2\right)$. If $\epsilon_{jt}=0$, the state pays the average spread charged by banks at time t. Recall that the fraction of local funding is $\gamma_{jt} = \bar{\gamma}_j \exp\left(-\phi r_t\right)$.

A second-order log-linear perturbation around $\epsilon_{jt}=0$ and a steady-state value for frictions, the aggregate rate, and the average fraction of local deposits, gives us (15), which we can bring to the data. We can rewrite it as:

$$\log\left(r_{jt}^L - r_t\right) = v_0 + \underbrace{v_j}_{\text{State FE}} + \underbrace{v_t - b_\theta t}_{\text{Year FE}} + \underbrace{\eta(\phi)\cdot\log\bar{\gamma}_j\cdot r_t}_{\substack{\text{Regionally heterogeneous} \\ \text{pass-through of } r_t}} + v_{jt}$$

where we expressed the year fixed effects as a year component and a linear trend, substituting θ_t using (14), with the random disturbances to national funding markets $\tilde{\theta}_t$ and the possible monotonic improvements in these markets given by b_θ being captured by year fixed effects. $\eta(\phi)$ is a structural coefficient that depends on ϕ, which controls the semi-elasticity of retail deposits with respect to the aggregate rate. We identify $\eta(\phi)\log\bar{\gamma}_j$ for all states up to an omitted one under the moment conditions:

$$\mathbb{E}_t[v_{jt} r_t | j, t, X_{jt}] = 0 \qquad \forall j$$

where $\mathbb{E}_t$ is the time-series average. That is, the moment conditions say that, conditional on state-fixed effects, year fixed-effects, and controls X_{jt}, states are not hit differentially by unobserved shocks (i.e. beyond changes in deposits) in years of high aggregate rates. As in the previous Sections, we weight each state by initial population, but results are similar if we do not weight, and we use controls for baseline economic and financial conditions described in Section 4.2.1.

To separately recover $\eta(\phi)$ and $\log\bar{\gamma}_j$ up to a reference omitted state, we impose the condition that the time-series variation in the model-implied fraction of retail deposits at the aggregate level $\hat{\gamma}_t = \mathbb{E}_L\left[\bar{\gamma}_{jt}\exp(-\phi r_t)\right]$, where $\mathbb{E}_L$ is a liability-weighted average across states, matches the time-series variation in the fraction of retail deposits for the overall US that we observe in the Flow of Funds accounts, γ_t.[65] To back-out the $\log \bar{\gamma}_j$ for the omitted state, we set $\hat{\gamma}_{t_0}$ for our steady state date t_0 to match γ_{t0} in the data precisely, setting $t_0 = 1958$. We use 1958 also to compute the steady state values in the log-linearization.[66] Results are not sensitive to choosing a different initial year before nominal rates start increasing. Finally, we estimate b_θ by fitting a linear trend on the unexplained component of the year fixed effects we estimated.[67]

The set of our moment conditions is satisfied for a given ϕ, b_θ and vector of $\bar{\gamma}_j$. To operationalize, we note that for every draw of ϕ we can estimate b_θ and $\bar{\gamma}_j$ linearly. Thus, we divide the algorithm in a linear step within each ϕ and a nonlinear search for ϕ.

Inner Step Within each draw of ϕ we estimate b_θ and vector of $\bar{\gamma}_j$ using our log-linear perturbation. For notational convenience we collapse ϵ_{jt} and θ_t in $\theta_{jt} = \theta_t \cdot \left(1 + \epsilon_{jt}\right)$, we indicate with $\vartheta_{jt} = \log \theta_{jt}$, and we denote with $\bar{g}_j = \log \bar{\gamma}_j$. Spreads in logs follow:

$$\log s_{jt}\left(\vartheta_{jt}, r_t, \bar{g}_j\right) = \log \frac{1}{2} + \vartheta_{jt} + \log\left(1 - \exp\left(2g_j - 2\phi r_t\right)\right)$$

Letting now:

$$\mathbf{x} - \mathbf{c} = \begin{bmatrix} \log \theta_{jt} - \log \bar{\bar{\theta}} \\ \log \bar{\gamma}_j - \log \bar{\bar{\gamma}} \\ r_t - r_0 \end{bmatrix}; \qquad D = \begin{bmatrix} D_\vartheta & D_g & D_r \end{bmatrix}; \qquad H = \begin{bmatrix} H_{\theta\theta} & H_{\theta g} & H_{\theta r} \\ H_{g\theta} & H_{gg} & H_{gr} \\ H_{r\theta} & H_{rg} & H_{rr} \end{bmatrix}$$

where

$$D_x = \frac{\partial \log s_{jt}}{\partial x}; \quad x = \vartheta_{jt}, r_t, \bar{g}_j$$
$$H_{xy} = \frac{\partial^2 \log s_{jt}}{\partial x \partial y}; \quad x, y = \vartheta_{jt}, r_t, \bar{g}_j$$

The second-order log-linear approximation follows:

$$\log s_{jt} - \log s_0 \approx D(\mathbf{x} - \mathbf{c}) + \frac{1}{2}(\mathbf{x} - \mathbf{c})^T H (\mathbf{x} - \mathbf{c})$$

[65] That is, we have the moment condition: $\mathbb{E}_t[\log \hat{\gamma}_t \varepsilon_t^\gamma] = 0$, where $\log \gamma_t = \log \hat{\gamma}_t + \varepsilon_t^\gamma$. To construct retail deposits in the Flow of Funds data, we sum the total private checking accounts (excluding deposits from the US government) and small time and savings divided by total bank liabilities (including equity, consistently with the rest of the paper).

[66] In particular, the aggregate rate around which we linearize is $r_0 = 1.73\%$, the frictions around which we linearize are computed as $\theta_0 = 2 \cdot s_{1958}/(1 - \gamma_{1958}^2)$, where γ_{1958} is the retail deposit share in 1958 in the Flow of Funds data and s_{1958} is the average state-level spread compared to the Treasury Bill rate in 1958.

[67] Note that the empirical year fixed effect is a known function of ϕ, r_t, steady-state frictions and local deposits, and a residual composed of the linear trend and the unexplained component $\log \tilde{\theta}_t$. We thus can estimate b_θ by estimating a linear trend in this residual.

At a steady state $\bar{\gamma}_{jt} = \bar{\bar{\gamma}}, \theta_t = \bar{\bar{\theta}}, r_t = r_0, \varepsilon_{jt} = 0$, the structural coefficients are:

$$D_\theta = 1; \qquad D_g = -\frac{2\gamma_0^2}{1-\gamma_0^2}; \qquad D_r = \frac{2\gamma_0^2\phi}{1-\gamma_0^2}$$

where $\gamma_0 = \bar{\bar{\gamma}} \exp\left(-\phi r_0\right)$. For the Hessian:

$$\begin{aligned}
&H_{\theta\theta} = 0 \\
&H_{\theta g} = 0 \qquad H_{gg} = -\frac{4\gamma_0^2}{(-1+\gamma_0^2)^2} \\
&H_{\theta r} = 0 \qquad H_{gr} = \frac{4\phi\gamma_0^2}{(-1+\gamma_0^2)^2} \qquad H_{rr} = -\frac{4\phi^2\gamma_0^2}{(-1+\gamma_0^2)^2}
\end{aligned}$$

The Taylor expansion is:

$$\begin{aligned}
\log s_{jt} \approxeq & \left(\check{\vartheta}_t + \bar{\vartheta}_j + \tilde{\vartheta}_{jt} - \vartheta_0\right) + D_g\left(\bar{g}_j - \bar{g}_0\right) + D_r\left(r_t - r_0\right) + \frac{1}{2}H_{gg}\left(\bar{g}_j - 2g_0\right)\bar{g}_j \\
& + \frac{1}{2}H_{rr}\left(r_t - 2r_0\right)r_t + H_{gr}\left(\bar{g}_j r_t - \bar{g}_j r_0 - \bar{g}_0 r_t\right) + \frac{1}{2}H_{gg}\bar{g}_0^2 + \frac{1}{2}H_{rr}r_0^2 + H_{gr}\bar{g}_0 r_0 \\
\approxeq & \, v_0 + v_j + v_t + H_{gr}\bar{g}_j r_t + v_{jt}
\end{aligned}$$

where we can collect all constant in $v_0 = -\vartheta_0 - D_g\bar{g}_0 - D_r r_0 + \frac{1}{2}H_{gg}\bar{g}_0^2 + \frac{1}{2}H_{rr}r_0^2 + H_{gr}\bar{g}_0 r_0$ and can express fixed effects and a structural residual as:

$$\begin{aligned}
v_j &= \left(D_g + \frac{1}{2}H_{gg}\left(\bar{g}_j - 2g_0\right) - H_{gr}r_0\right)\bar{g}_j \\
v_t &= -b_\theta \cdot t + \log\tilde{\theta}_t + \left(D_r + \frac{1}{2}H_{rr}\left(r_t - 2r_0\right) - H_{gr}\bar{g}_0\right)r_t \\
v_{jt} &= \log\left(1 + \epsilon_{jt}\right)
\end{aligned}$$

where $\left(D_r + \frac{1}{2}H_{rr}\left(r_t - 2r_0\right) - H_{gr}\bar{g}_0\right)$ corresponds to $h(r_t;\phi,\gamma_0,r_0)$ in the main text. We estimate these parameters by estimating a simple log-linear regression:

$$\log s_{jt} = v_0 + v_j + v_t + b_j \cdot r_t + \tau X_{jt} + e_{jt}$$

where X_{jt} is a vector of controls that accounts for the possible endogeneity between $\bar{g}_j r_t$ and ϵ_{jt} (in line with the reduced form exercise of Section 4.2.1), v_j and v_t are state and year fixed effects, and b_j is an heterogeneous slope on the aggregate rate. We weight again states by population in 1950 and winsorize the data from below at the 2nd percentile, which avoids four cases where local lending rates are below the three-month Treasury Bill rate (West Virginia in 1979, 1980, and 1981, and North Carolina in 1981) and very negative values of $\log(r_{jt}^L - r_t)$ when r_{jt}^L is very close to r_t. Results are not sensitive to these choices. Given that we omit an arbitrary state i, the state-specific slope for r_t identifies:

$$b_j - b_i = H_{gr}\left(\bar{g}_j - \bar{g}_i\right)$$

with $b_i = 0$. Then we can invert it to get:

$$\bar{g}_j = \frac{b_j}{H_{gr}} + \bar{g}_i$$

We use now the fact that we set the implied aggregate fraction of retail deposits in steady state to match exactly the Flow of Funds data in 1958, γ_0. That is, we use $\mathbb{E}_L\left[\bar{\gamma}_j \exp(-\phi r_0)\right] = \gamma_0$ and solve for:

$$\bar{g}_i = \log\gamma_0 - \log\mathbb{E}_L\left[\exp\left(\frac{\hat{b}_j}{H_{gr}} - \phi r_0\right)\right]$$

and we can construct: $\bar{g}_j = \hat{b}_j + \bar{g}_i$ for all j. We finally get $\bar{\gamma}_j = \exp(\bar{g}_j)$.

To estimate b_θ, we note that v_t is identified by the empirical year fixed effects v_t and yearly averages across states of the controls $\bar{x}_t = \mathbb{E}_j[\tau X_{jt}]$. We can then residualize for the part of v_t explained by aggregate deposit outflows, the $h(r_t;\phi,\gamma_0,r_0) = \left(D_r + \frac{1}{2}H_{rr}\left(r_t - 2r_0\right) - H_{gr}\bar{g}_0\right)$, by constructing $\tilde{v}_t = b_\theta \cdot t + \log\tilde{\theta}_t$ as:

$$\tilde{v}_t = v_t + \bar{x}_t - \left(D_r + \frac{1}{2}H_{rr}\left(r_t - 2r_0\right) - H_{gr}\bar{g}_0\right) r_t$$

and we can finally recover b_θ simply by estimating the linear trend in $\tilde{v}_t$.

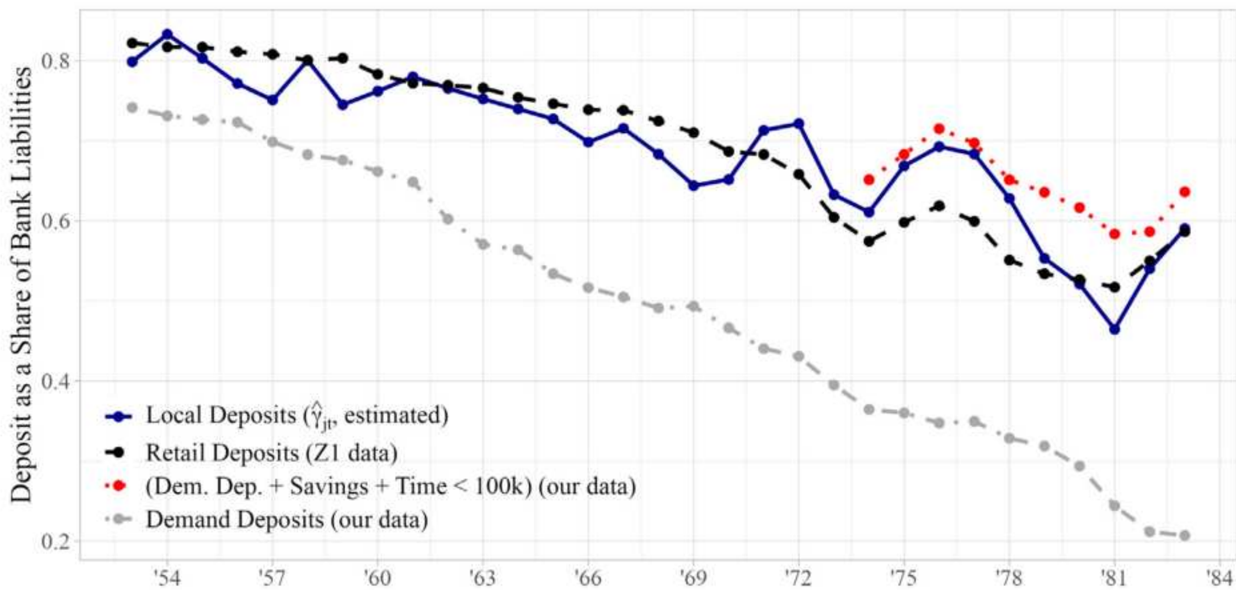
Outer Step. Having estimated $\bar{\gamma}_j$ for a given ϕ, we can construct the implied fraction of retail (local) deposits at the aggregate US level by taking the weighted average of $\hat{\gamma}_t(\phi) = \mathbb{E}_L\left[\bar{\gamma}_j \exp(-\phi r_t)\right]$. We estimate ϕ by imposing that our implied $\hat{\gamma}_t$ has a time-series correlation of one with the corresponding γ_t that we observe in the flow of funds data, minimizing:

$$\min_{\phi}\left(1 - \frac{\mathrm{Cov}\left(\log\gamma_t, \log\hat{\gamma}_t(\phi)\right)}{\mathrm{Var}\left(\log\gamma_t\right)}\right)^2$$

which is equivalent to targeting a coefficient of one in a regression of $\log\hat{\gamma}_t$ on $\log\gamma_t$, hence our moment condition.

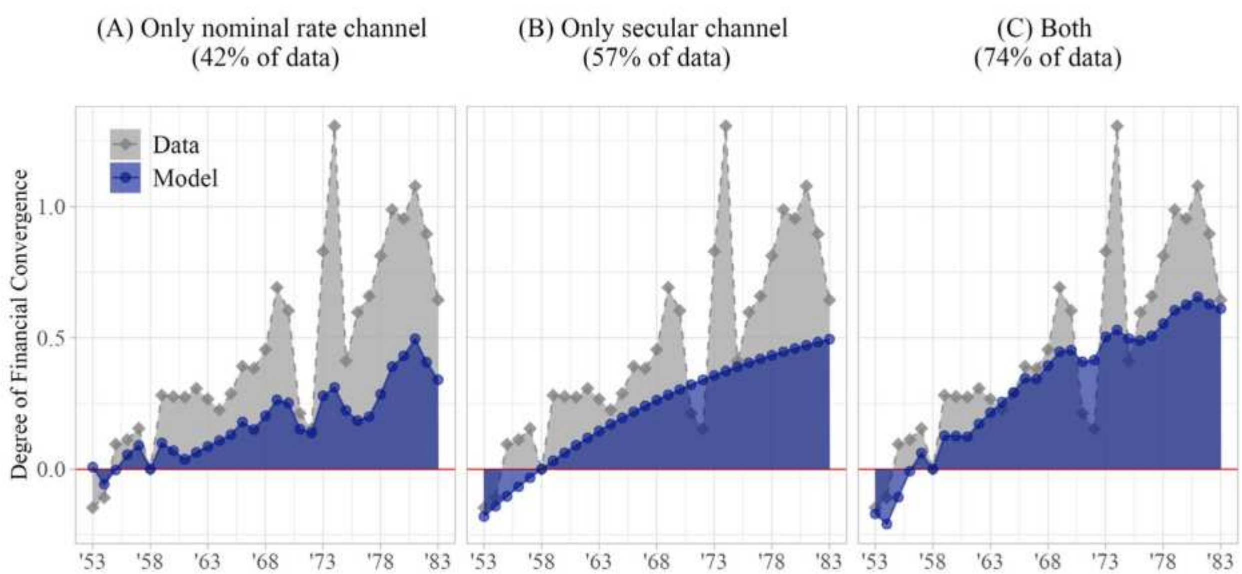
E.1 Extra Figures

FIGURE E.8: US RETAIL DEPOSITS, MODEL AND DATA



Notes. The lines report the deposit shares of bank liabilities for the US, for different types of deposits. The solid blue line reports our estimated series of retail (local) deposits as a share of bank liabilities, estimated using the procedure described in Section 5. The dashed black line reports retail deposits as a share of liabilities from the historical Flow of Funds releases (1986; 1988). The dotted red line reports demand deposits and small savings and time deposits (below \$100,000) as a share of liabilities of national commercial banks, available from 1974 onward in the Call Reports data. The dashed gray line reports demand deposits as a share of liabilities for national commercial banks.

FIGURE E.9: FINANCIAL CONVERGENCE GENERATED UNDER DIFFERENT COUNTERFACTUALS, AS A FRACTION OF CONVERGENCE IN THE DATA



Notes. See notes to Figure 7. In all panels and for all lines, the initial state-level lending rates against which we measure convergence are the ones observed in the data in 1953–58.

F Appendix to Section 6

F.1 Migration and Fertility

TABLE F.13: POPULATION GROWTH AND INITIAL LENDING RATES: MIGRATION AND FERTILITY

	Dependent variable: Population Growth Between 1960 and 1975								
	Total			Only from Migration			Only from Fertility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Lending Rate (pp), $r^L_{j,53-58}$	.132	.100	.114	.076	.075	.110	.056	.026	.004
	(.041)	(.045)	(.063)	(.034)	(.034)	(.064)	(.016)	(.021)	(.022)
Right-to-Work State		−.034	.007		−.063	−.018		.028	.025
		(.029)	(.068)		(.024)	(.049)		(.015)	(.027)
% GDP from Oil_{50}		−1.370	−1.334		−1.511	−1.412		.141	.078
		(.510)	(.748)		(.394)	(.681)		(.285)	(.309)
January Temperature		.007	.007		.005	.006		.002	.001
		(.002)	(.003)		(.002)	(.003)		(.001)	(.001)
Bartik Demand Shock_{63-83}		.198	.336		.263	.380		−.066	−.044
		(.194)	(.224)		(.159)	(.236)		(.076)	(.081)
Bartik Agricultural Shock_{63-83}		.103	−.283		.033	−.243		.071	−.040
		(.274)	(.322)		(.208)	(.234)		(.126)	(.129)
Region FEs			✓			✓			✓
$\mathbb{E}(Y)$	.226	.226	.226	.046	.046	.046	.18	.18	.18
$\text{SD}(Y)$	.203	.203	.203	.169	.169	.169	.0585	.0585	.0585
$\mathbb{E}(r^L_{j,53-58})$	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
$\text{SD}(r^L_{j,53-58})$	.475	.475	.475	.475	.475	.475	.475	.475	.475
Observations	46	46	46	46	46	46	46	46	46
R^2	.199	.554	.613	.0973	.477	.526	.279	.502	.629

Notes. The table reports WLS estimates of state-level population growth, distinguishing between migration and fertility, against the average state-level lending rate in 1953–58. Controls are reported and discussed in Section 6. Observations are weighted by population in 1950. Parentheses report heteroskedasticity-robust standard errors.

F.2 Initial Wages and Initial Lending Rates

TABLE F.14: GROWTH, INITIAL WAGES AND INITIAL RATES

(A) USING INITIAL RATES IN 1963

	Dependent variable: Growth Between 1963 and 1983 in								
	GDP			Population			GDP per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Rate, $r^L_{j,1963}$	.412		.306	.266		.195	.146		.111
	(.048)		(.078)	(.040)		(.053)	(.038)		(.037)
log(Initial GDP p.c.)$_{j,1963}$		−.650	−.321		−.216	.015		−.434	−.336
		(.177)	(.150)		(.154)	(.110)		(.069)	(.065)
Controls			✓			✓			✓
Region FEs			✓			✓			✓
Observations	46	46	46	46	46	46	46	46	46
R^2	.419	.257	.87	.432	.0703	.742	.189	.413	.922

(B) USING INITIAL RATES IN 1953–58

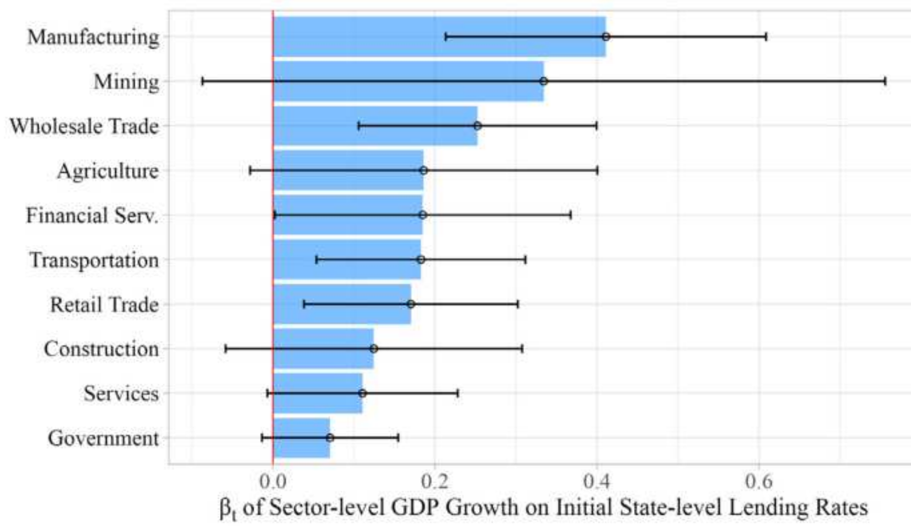
	Dependent variable: Growth Between 1963 and 1983 in								
	GDP			Population			GDP per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Rate, $r^L_{j,53-58}$	.284		.134	.190		.117	.094		.016
	(.051)		(.054)	(.041)		(.041)	(.031)		(.028)
log(Initial GDP p.c.)$_{j,1963}$		−.650	−.387		−.216	−.025		−.434	−.362
		(.177)	(.178)		(.154)	(.125)		(.069)	(.075)
Controls			✓			✓			✓
Region FEs			✓			✓			✓
Observations	46	46	46	46	46	46	46	46	46
R^2	.29	.257	.838	.321	.0703	.724	.115	.413	.9

Notes. The tables report WLS estimates of state-level real GDP, population, and real GDP per capita growth rates between 1963 and 1983 against the average state-level lending rate in 1963 (Panel A) and in 1953–58 (Panel B). Controls are discussed in Section 6. Observations are weighted by population in 1950. Parentheses report heteroskedasticity-robust standard errors.

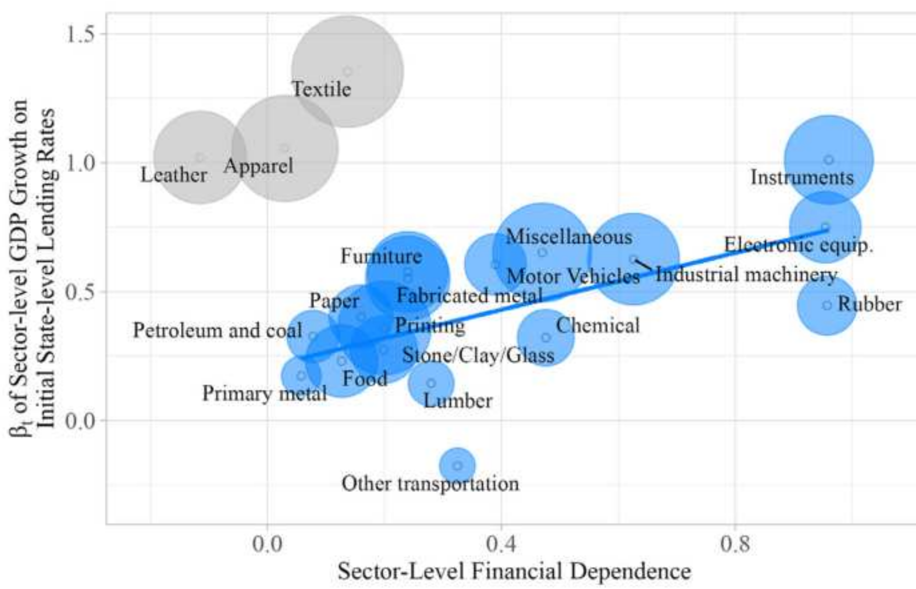
F.3 Growth Across Sectors

FIGURE F.10: SECTORAL HETEROGENEITY IN THE RELATIONSHIP BETWEEN GROWTH AND INITIAL INTEREST RATES

(A) ACROSS 1-DIGIT SECTORS



(B) ACROSS 2-DIGIT MANUFACTURING SECTORS



Notes. Each panel reports the coefficient of sector-state-level GDP growth between 1963 and 1983 on initial state-level lending rates in 1953–58, estimated separately by sector and controlling for the variables reported in Column (6) of Table 2. Panel (A) reports coefficients for 1-digit sectors, together with 95% confidence intervals. Panel (B) reports coefficients for 2-digit manufacturing subsectors against the Rajan and Zingales (1998) index of financial dependence, using the SIC87 version provided by von Furstenberg and von Kalckreuth (2006). The size of each circle in Panel (B) is proportional to the t-statistic of the coefficient. Observations are weighted by state-population in 1950. Standard errors are robust to heteroskedasticity.

G Unweighted Results

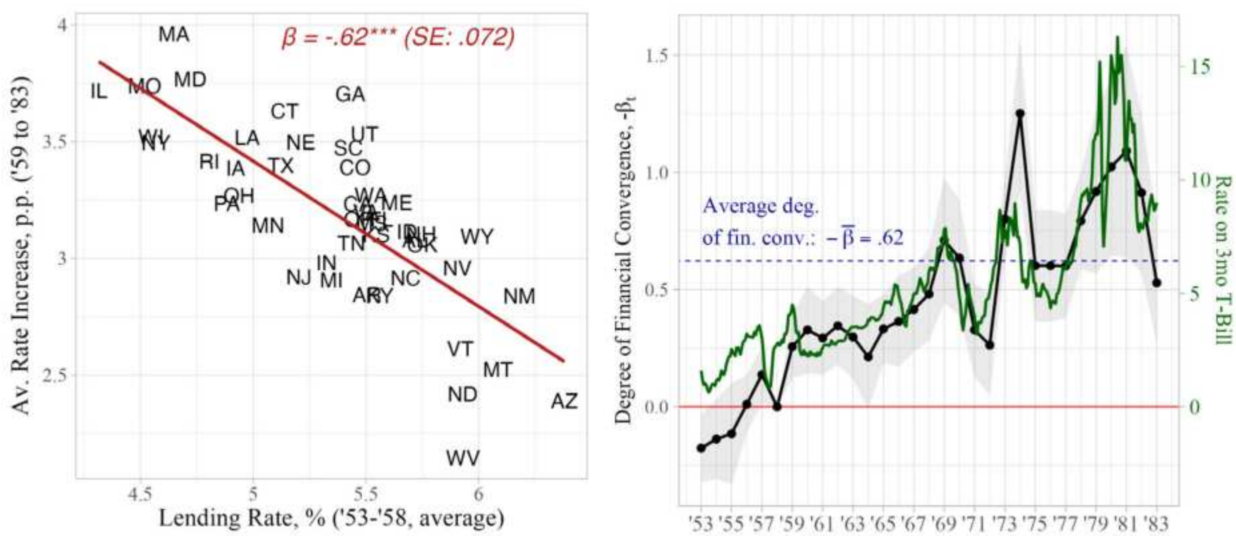
TABLE G.15: DEMAND-DEPOSIT ABUNDANCE, INITIAL RATES, AND DEPOSIT OUTFLOWS (UNWEIGTHED)

	Dependent Variable: State-Level					
	Initial Lending Rate (bp)			Change between '59 and '83 in Dem. Dep./Tot. Liab. (pp)		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial Demand Deposit/Tot. Liab. (%)	−.487	−1.126	−1.492	−.889	−.849	−.816
	(.650)	(.579)	(.627)	(.050)	(.064)	(.067)
Fract. of Large Banks in State (%)		−.781	−.823		.048	.031
		(.346)	(.298)		(.025)	(.031)
Region FEs			✓			✓
E(Y)	538	538	538	-48	-48	-48
SD(Y)	47.5	47.5	47.5	8.88	8.88	8.88
Observations	46	46	46	46	46	46
R^2	.0089	.12	.65	.85	.86	.87

Notes. The table reports OLS estimates of average lending rates in 1953–58 (Columns 1 to 3) and the change in the fraction of liabilities funded with demand deposits between 1983 and 1959 (Columns 4 to 6) against the average demand deposit share in 1953–58. The fraction of large banks is taken as of 1961, since that is the first year the bank-level data is available for all banks.

FIGURE G.11: CONVERGENCE IN 1959–83 (UNWEIGTHED)

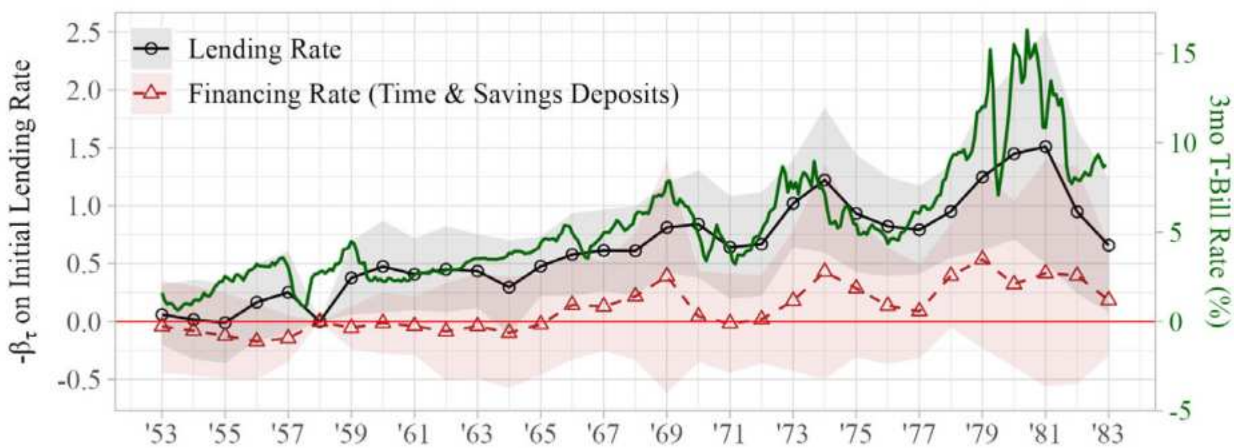
(A) AVERAGE (B) YEARLY



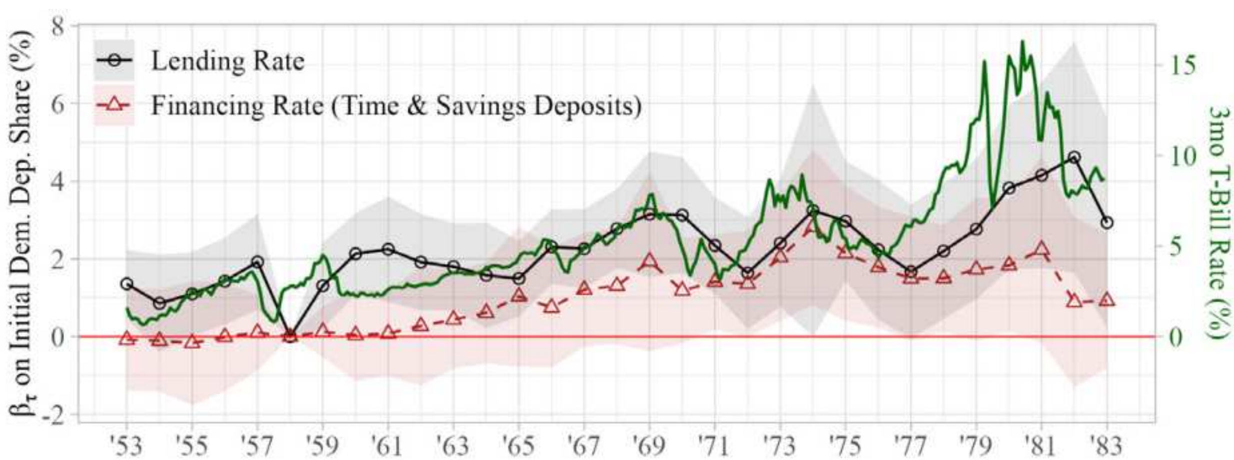
Notes. Panel (A) reports average changes in lending rates between 1958 and 1983 for each state, against their initial lending rates in 1953–58. Average changes in lending rates between 1958 and 1983 are defined as the average between 1959 and 1983 of yearly lending rates minus the initial rate in 1953–58. The red line reports the best linear fit and the associated coefficient. The parenthesis reports robust standard errors. The black line in Panel (B) reports the negative of the coefficients (β_t) and associated 95% confidence intervals from repeated cross-sectional regressions of the change in lending rates in state j between year t and 1953–58 regressed against the initial average rate in 1953–58. The repeated cross-sections always include an intercept, which partials out aggregate yearly changes. A value of $-\beta_t$ of 0.5 means that a state that had an interest rate that was 1 p.p. lower than the average rate in 1953–58 saw its rate increase between 1953–58 and year t by 0.5 p.p. more compared to the average state in that year. The green line reports the level of nominal short-term rates, using the three-month Treasury Bill rate.

FIGURE G.12: CHANGES IN STATE-LEVEL BANK LENDING AND FINANCING RATES, COMPARED TO US AVERAGE CHANGES (UNWEIGTHED)

(A) IN A STATE WITH A LOWER INITIAL RATE

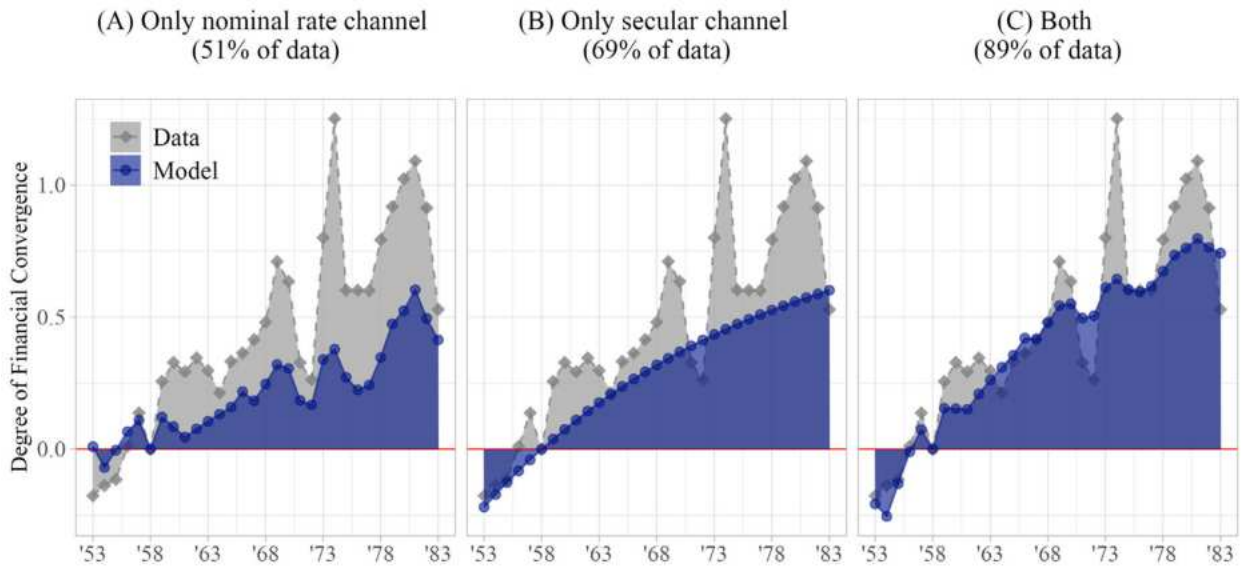


(B) IN A STATE WITH HIGHER INITIAL DEMAND-DEPOSITS ABUNDANCE



Notes. See notes to Figure 4. Observations are unweigthed.

FIGURE G.13: FINANCIAL CONVERGENCE GENERATED DIFFERENT COUNTERFACTUALS (UNWEIGTHED)



Notes. See notes to Figure 7. Observations are unweigthed.

TABLE G.16: GDP GROWTH AND INITIAL LENDING RATES (UNWEIGTHED)

	Dependent variable: Growth Between 1963 and 1983 in								
	GDP			Population			GDP per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Lending Rate (pp), $r^L_{j,53-58}$	.243	.216	.205	.188	.195	.180	.055	.021	.025
	(.053)	(.048)	(.065)	(.049)	(.047)	(.047)	(.035)	(.033)	(.042)
Right-to-Work State		.111	.075		−.012	.045		.123	.030
		(.041)	(.057)		(.047)	(.056)		(.034)	(.039)
% GDP from Oil_{50}		−1.715	−2.130		−1.136	−.750		−.579	−1.380
		(.486)	(.651)		(.426)	(.517)		(.305)	(.344)
January Temperature		.005	.002		.006	.005		−.001	−.003
		(.002)	(.003)		(.002)	(.003)		(.001)	(.002)
Bartik Demand Shock_{63-83}		.271	.320		.123	.171		.147	.150
		(.051)	(.078)		(.050)	(.069)		(.040)	(.047)
Bartik Agricultural Shock_{63-83}		.495	.546		−.561	.343		1.055	.203
		(.515)	(.759)		(.396)	(.606)		(.345)	(.429)
Region FEs			✓			✓			✓
$\mathbb{E}(Y)$	.606	.606	.606	.243	.243	.243	.362	.362	.362
$\text{SD}(Y)$	.224	.224	.224	.18	.18	.18	.127	.127	.127
$\mathbb{E}(r^L_{j,53-58})$	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
$\text{SD}(r^L_{j,53-58})$	.475	.475	.475	.475	.475	.475	.475	.475	.475
Observations	46	46	46	46	46	46	46	46	46
R^2	.265	.714	.734	.246	.525	.694	.0423	.455	.719

Notes. The table reports OLS estimates of state-level real GDP, population, and real GDP per capita growth rates between 1963 and 1983 against the average state-level lending rate in 1953–58. Controls are reported in the table and discussed in Section 6. Parentheses report heteroskedasticity-robust standard errors.

TABLE G.17: POPULATION GROWTH AND INITIAL LENDING RATES: MIGRATION AND FERTILITY (UNWEIGTHED)

	Dependent variable: Population Growth Between 1960 and 1975								
	Total			Only from Migration			Only from Fertility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Lending Rate (pp), $r^L_{j,53-58}$	.139	.110	.161	.084	.087	.137	.055	.023	.025
	(.069)	(.057)	(.054)	(.057)	(.053)	(.060)	(.016)	(.022)	(.024)
Right-to-Work State		$-.008$	.106		$-.043$	.060		.035	.046
		(.058)	(.095)		(.049)	(.080)		(.020)	(.026)
% GDP from Oil_{50}		-1.436	-1.073		-1.607	-1.224		.171	.150
		(.560)	(.813)		(.490)	(.781)		(.305)	(.339)
January Temperature		.006	.008		.005	.007		.001	.001
		(.003)	(.003)		(.003)	(.003)		(.001)	(.001)
Bartik Demand Shock_{63-83}		.102	.385		.208	.422		$-.105$	$-.036$
		(.260)	(.295)		(.251)	(.301)		(.101)	(.104)
Bartik Agricultural Shock_{63-83}		$-.441$	$-.738$		$-.261$	$-.527$		$-.180$	$-.211$
		(.442)	(.519)		(.336)	(.410)		(.181)	(.186)
Region FEs			✓			✓			✓
$\mathbb{E}(Y)$	.226	.226	.226	.046	.046	.046	.18	.18	.18
$\text{SD}(Y)$	.203	.203	.203	.169	.169	.169	.0585	.0585	.0585
$\mathbb{E}(r^L_{j,53-58})$	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
$\text{SD}(r^L_{j,53-58})$	.475	.475	.475	.475	.475	.475	.475	.475	.475
Observations	46	46	46	46	46	46	46	46	46
R^2	.106	.334	.566	.0555	.287	.503	.2	.393	.537

Notes. The table reports OLS estimates of state-level population growth, distinguishing between migration and fertility, against the average state-level lending rate in 1953–58. Controls are reported and discussed in Section 6. Parentheses report heteroskedasticity-robust standard errors.

H Appendix to Section 8

H.1 Implementation of Real Counterfactuals, Inversion, and Estimation

H.1.1 Steady State

We compute the steady-state following Bilal and Rossi-Hansberg (2023). We first express equilibrium physical capital as a function of labor by setting (23) to zero and using the firm's FOC (18).

$$K_j^{SS}\left(N_j^{SS}\right) = \left(\frac{\alpha_K(1+\rho^S)}{\rho+\delta}\frac{z_j}{R_j^{F,SS}}\left(N_j^{SS}\right)^{\alpha_N}\right)^{\frac{1}{1-\alpha_K}} \tag{50}$$

We use (50) to cast the value function of workers as a function of the labor distribution:

$$\rho V_j = \mathcal{U}_j\left(N_j^{SS}, K_j^{SS}\left(N_j^{SS}\right)\right) + \mathcal{M}_j\left[V^{SS}\right] \tag{51}$$

where:

$$\mathcal{U}_j\left(N_j^{SS}, K_j^{SS}\left(N_j^{SS}\right)\right) = B_j + \left(1+\mathcal{R}_j^{SS}\right) w_j\left(N_j^{SS}, K_j^{SS}\left(N_j^{SS}\right)\right) - h_j\left(N_j^{SS}\right)$$
$$\mathcal{M}_j\left[V^{SS}\right] = \mu\left[\frac{1}{\nu}\log\left(\sum_k \exp\left(\beta V_k^{SS} - \tau_{jk}\right)^{\nu}\right) - V_j^{SS}\right]$$

where w_j and h_j are functions of labor and capital according to (18) and (19).

We then set the labor KFE (21) to zero to express population as a function of the distribution of value functions:

$$M^*(V^{SS})N^{SS} = 0 \tag{52}$$

where is a $J \times J$ matrix $M^*(V^{SS}) = \mu(m^*(V^{SS}) - \mathrm{Id}) \in \mathbb{R}^{J\times J}$ and $m^*(V^{SS})$ is the transpose of the matrix collecting the migration shares i, j.

We then iterate alternatively on (51) and (52) to jointly solve for the population distribution and the distribution of value functions. In particular:

1. Start from a guess $N^{(0)}$ for the steady state labor distribution (for instance, a uniform distribution $N_j^{(0)} = 1/J$ for all j).
2. Solve (51) for $V^{(0)}$.
3. Update $N^{(1)}$ by solving (52) given $V^{(0)}$.
4. Iterate on 2-3 until both $N^{(i)} = N^{(i+1)} = N^{SS}$ and $V^{(i)} = V^{(i+1)} = V^{SS}$ have converged.

H.1.2 Inversion of Real Fundamentals

The routine to invert real amenities follows Bilal and Rossi-Hansberg (2023), henceforth BRH. The model is set to match exactly the population distribution in 1958. Total population is normalized to one, so that local population can be read as a share of US population. Because some of the fundamentals depend on the migration elasticity ν, when we estimate it we repeat the entire inversion routine for each draw of ν.

Productivities. We invert productivity using data on wages, employment, and the capital stock in manufacturing in 1958.

Because we have linear utility, we first normalize wages to be of order one in steady state, which ensures that the scaling of the economy does not matter for the results. We accordingly normalize house rents to have a ratio of house rents to wages that matches the ratio we observe in the data (.16).

To set $\mathbb{E}[w_j^{SS}] = 1$, we rescale the units of capital as $K_j = \tau X_j^{SS}/\delta$ where X_j^{SS} is capital expenditures from the census of manufacturers in 1958 and τ is an appropriately chosen constant such that $\mathbb{E}\left[\alpha_N \frac{z_j}{R_j^{F,SS}} \left(N_j^{SS}\right)^{\alpha_N - 1} \left(K_j^{SS}\right)^{\alpha_K}\right] = 1$. Let the subscript 0 indicate data in 1958, with $K_{j0} = X_j^{SS}/\delta$ being the non-rescaled capital in manufacturing, N_{j0} be employees in manufacturing, and w_{j0} be wages in manufacturing, we set τ such that:

$$\tau = \left(\mathbb{E}\left[\left(\frac{1+\rho_s}{\delta+\rho}\frac{\alpha_K}{\alpha_N}\right)^{\frac{\alpha_K}{1-\alpha_K}} \left(\frac{R_{j0}^F}{R_j^{F,SS}} w_{j0} \left(\frac{N_{j0}}{K_{j0}}\right)^{\alpha_K}\right)^{\frac{1}{1-\alpha_K}}\right]\right)^{\frac{1-\alpha_K}{\alpha_K}}$$

where $\mathbb{E}$ is the average across states. We finally invert for productivies as:

$$z_j = \frac{1}{\alpha_N} w_{j0} R_{j0}^F \left(\tau K_{j0}\right)^{-\alpha_K} N_{j0}^{1-\alpha_N}$$

Housing supply shifters. We accordingly rescale house rents, which we take by interpolating for 1958 the median monthly rent reported in the 1950 and 1960 censuses (as assembled by Haines and Inter-university Consortium for Political and Social Research 2010). We rescale rents at an annual cost and divide them by w_{j0} so to express them in terms of rescaled wages (which are of order 1). We invert for housing supply shifters using:

$$z_j^h = h_j N_j^{-\sigma_j^h}$$

where h_j are the rescaled housing rents.

Migration costs. We construct migration shares using data on migration flows in 1955-60 and the population distribution in 1958, assuming that migration costs are symmetric. Letting f_{ij} be migration flows from i to j in the data, we construct the migration shares that correspond to the shares in (21) as $m_{ij} = f_{ij} / (\sum_m f_{im})$. We follow the notation in BRH and construct $X_{ij} = \log m_{ij} - \log m_{ii}$. Using (21), note that $X_{ij} = \nu \left(V_j - V_i\right) - \nu\tau_{ij}$. This implies that $X_{ij} + X_{ji} = \nu \left(V_j - V_i\right) - \nu\tau_{ij} + \nu \left(V_i - V_j\right) - \nu\tau_{ji} = -\nu(\tau_{ij} + \tau_{ji})$. Imposing symmetry, $\tau_{ij} = \tau_{ji}$, we recover:

$$\tau_{ij} = -\frac{X_{ij} + X_{ji}}{2\nu}$$

Note that these costs depend on ν, and when we estimate ν we repeat the entire inversion routine for each draw of ν.

Amenities. We invert amenities from the population distribution and wage distribution implied at steady state given the fundamentals above that we just inverted. We follow the notation in BRH and construct $X_i = \exp(\nu V_i)$ and $\theta_{ki} = \exp(-\nu\tau_{ki})$. Using (52) and normalizing values X_i, we can derive the following system of equations:

$$X_i = N_i / \left(\sum_k \frac{N_k \theta_{ki}}{\sum_j \theta_{kj} X_j} \right); \qquad \sum_i X_i = 1$$

which we can solve for X_i and hence recover $V_i = (1/\nu) \log X_i$. We can then invert (51) for $B_j = \rho V_j - \left((1 + \mathcal{R}_j^{SS}) w_j^{SS} - h_j^{SS} + \mathcal{M}_j[V] \right)$.

H.1.3 Inversion of Financial Fundamentals

We invert for ξ_j and χ_j using the estimated $\bar{\gamma}_j$ in Section 5 and data on the share of local loans to GDP, which in the model corresponds to ξ_j.

Baseline. In our baseline parametrization, we define local loans L_j as the sum of loans to C&I, farmers, and loans secured by real estate (among which we cannot unfortunately distinguish between residential and commercial). We use data from Call Reports at the earliest available data (1961) instead of using data from the OCC, which is available earlier, because the OCC data we digitized is either only for national banks or for all banks (including mutual savings and private banks). However, our baseline results are consistent across different data choices. For the denominator, we interpolate GDP in 1961 following Kleinman et al. (2023). We set $\xi_j = \tau^{\xi} L_{j0} / Y_{j0}$ and rescale it by a constant τ^{ξ} such that $\mathbb{E}[\xi_j]$ across states is equal to the ratio between nonfinancial corporate business loans divided by all nonfinancial corporate business debt from FRED in 1958, which is a closer proxy—albeit available only in the aggregate—for ξ_j.

We then invert χ_j using the definition of $\bar{\gamma}_j$ in (13), in particular:

$$\chi_j = \frac{1}{\phi}\left(\log \bar{\gamma}_j + \log \xi_j - \log \alpha_N\right) \tag{53}$$

Robustness. The last rows of Table H.19 replicates our main results across different inversion choices. In one version, we fix $\xi_j = .51$ for all j and then use (53) to invert for χ_j. In the second version we fix $\chi_j = \bar{\chi}$ and then solve for $\xi_j = \alpha_N \exp(\phi\bar{\chi})/\bar{\gamma}_j$. In this case, we set $\bar{\chi}$ so that $\mathbb{E}[\xi_j] = \bar{\xi} = .51$. In particular, we let:

$$\bar{\chi} = \frac{1}{\phi}\left(\log \bar{\xi} - \log \alpha_N - \log(1/\mathbb{E}[\bar{\gamma}_j])\right)$$

Table H.19 also shows results for our baseline version but fixing $\bar{\xi} = .25$ and $\bar{\xi} = .75$.

H.1.4 Estimation of Migration Elasticity

We estimate the migration elasticity by matching the relative growth patterns of income and population that we observe in the data. We use data on income growth since we lack GDP data at the state level before 1963. Table H.18 reports the same regressions reported in Table 2, but using state-level income instead of GDP and using 1958 as the initial year. Columns (1) to (3) report the coefficient $\beta^{\text{Income}}_{\text{data}}$ of state-level growth in income between 1958 and 1983 against lending rates in 1953–58. Columns (3) to (6) use as a dependent variable is population growth and report β^{N}_{data}. We choose ν so to replicate in the model the average between $\beta^{N}_{\text{data}}/\beta^{\text{Income}}_{\text{data}}$ in the specifications with controls and $\beta^{N}_{\text{data}}/\beta^{\text{Income}}_{\text{data}}$ in the specifications with controls and regional FEs. That is, we choose ν such that the model-implied growth path of population and income after our financial shocks replicates the ratio in the data of $\beta^{N}_{\text{data}}/\beta^{\text{Income}}_{\text{data}} = .91$.

To construct $\beta^{N}(\nu)/\beta^{\text{Income}}(\nu)$ for each ν in the model, we first invert the full model following the steps described in Section 8.1 and detailed in Appendix Sections H.1.2 and H.1.3, always inverting from the 1958 steady state. We then derive the transition dynamics after the shocks to nominal rates and frictions θ_t reported in Panel A of Figure 8. Finally, we regress the growth in income in each state between 1958 and 1983 and the growth in population in each state between 1958 and 1983 against the model-implied initial lending rates in each state. We define income at the state level as $\text{Income}_{jt} = w_{jt}N_{jt} + r^K_{jt}K_{jt}$, so that its change, at a first order, is:

$$d\log(\text{Income}_j)(\nu) = \frac{w_j^{SS}N_j^{SS}\left(d\log w_j(\nu) + d\log N_j(\nu)\right) + r_j^{K,SS}K_j^{SS}\left(d\log r_j^K(\nu) + d\log K_j(\nu)\right)}{w_j^{SS}N_j^{SS} + r_j^{K,SS}K_j^{SS}}$$

where $d\log w_j, d\log N_j, d\log r_j^K$, and $d\log K_j$ are the first order changes in local factor prices and quantities between steady state and 1983, and we are highlighting that these changes are a function of the migration elasticity. For each ν we recover the coefficients of these changes on initial rates by estimating a regression of:

$$d\log x_j(\nu) = \alpha + \beta^x(\nu) r_j^{L,SS} + \varepsilon_j$$

where $r_j^{L,SS}$ is the steady-state lending rate in state j and $x \in \{\text{Income}, N\}$.

Figure H.14 shows the identification intuition, which leverages the results from Corollary 3.1. The Figure plots $\beta^N(\nu)/\beta^{\text{Income}}(\nu)$ for different values of ν and shows that it is monotonically increasing in ν. The ratio observed in the data is reported by the red dashed horizontal line. Our estimate ν^* is such that $\beta^N_{\text{data}}/\beta^{\text{Income}}_{\text{data}} = \beta^N(\nu^*)/\beta^{\text{Income}}(\nu^*)$, and is indicated by the dotted blue vertical line.

H.1.5 Solving for the Trend FAMEs

We solve for the Trend FAMEs derived in (B.3). For a time-step dt:

$$\begin{aligned}
\rho \mathbf{x}_t^T &= D_t^T + \frac{\partial \mathbf{x}^T}{\partial t} + \underline{\mathbf{M}} \mathbf{x}_t^T + \mathbf{x}_t^d P^d \mathbf{x}_t^T \\
\rho \mathbf{x}_t^T &= D_t^T + \frac{\mathbf{x}_{t+dt}^T - \mathbf{x}_t^T}{dt} + \underline{\mathbf{M}} \mathbf{x}_t^T + \mathbf{x}_t^d P^d \mathbf{x}_t^T \\
dt\left(\rho \text{Id} - \left(\underline{\mathbf{M}} + \mathbf{x}_t^d P^d\right)\right) \mathbf{x}_t^T + \mathbf{x}_t^T &= dt D_t^T + \mathbf{x}_{t+dt}^T
\end{aligned}$$

For a large enough $\bar{t}$, we have $\mathbf{x}_{\bar{t}+dt}^T = \mathbf{x}_{\bar{t}}^T$, thus:

$$\mathbf{x}_{\bar{t}}^T = \left(\rho \text{Id} - \left(\underline{\mathbf{M}} + \mathbf{x}_t^d P^d\right)\right)^{-1} D_{\bar{t}}^T$$

Iterating backwards, given $\mathbf{x}_{t+dt}^T$, we can construct:

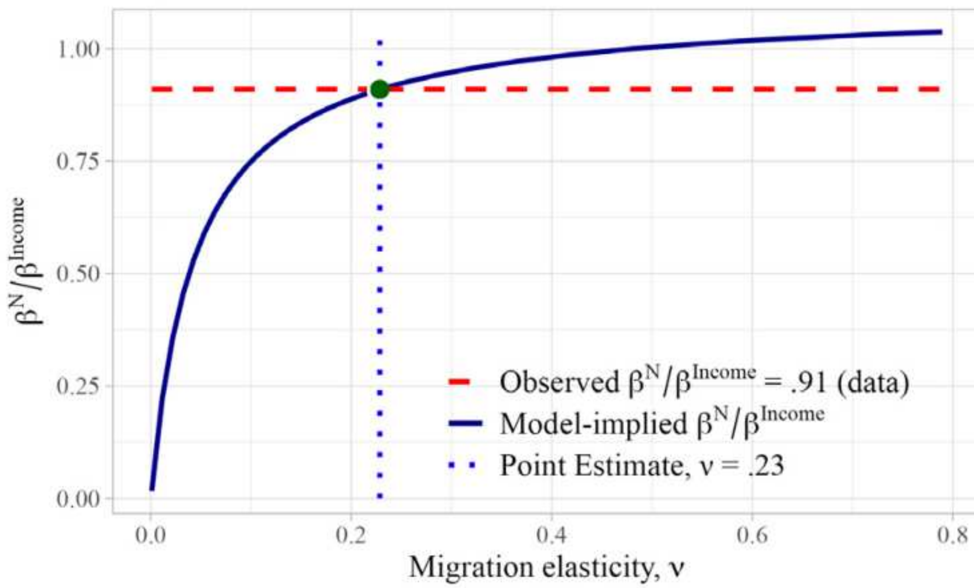
$$\mathbf{x}_t^T = \left(\text{Id} + dt\left(\rho \text{Id} - \left(\underline{\mathbf{M}} + \mathbf{x}_t^d P^d\right)\right)\right)^{-1} \left(dt D_t^T + \mathbf{x}_{t+dt}^T\right)$$

TABLE H.18: INCOME GROWTH AND INITIAL LENDING RATES

	Dependent variable: Growth Between 1958 and 1983 in								
	Income			Population			Income per capita		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial Lending Rate (pp), $r^L_{j,53-58}$	.322	.191	.188	.226	.192	.153	.096	$-.001$	.035
	(.057)	(.061)	(.078)	(.054)	(.047)	(.056)	(.026)	(.027)	(.035)
Right-to-Work State		.106	.034		$-.012$	.021		.118	.014
		(.047)	(.079)		(.035)	(.074)		(.024)	(.021)
% GDP from Oil_{50}		-1.101	-1.601		-1.362	-1.020		.261	$-.581$
		(.639)	(.879)		(.454)	(.692)		(.265)	(.296)
January Temperature		.010	.008		.009	.008		.001	.001
		(.003)	(.005)		(.002)	(.004)		(.001)	(.002)
Bartik Demand Shock_{63-83}		.087	.141		.106	.139		$-.019$	.002
		(.073)	(.102)		(.058)	(.078)		(.028)	(.037)
Bartik Agricultural Shock_{63-83}		.086	.284		$-.924$	$-.073$		1.010	.356
		(.543)	(.968)		(.446)	(.846)		(.200)	(.396)
Region FEs			✓			✓			✓
$\mathbb{E}(Y)$	.849	.849	.849	.326	.326	.326	.522	.522	.522
$\text{SD}(Y)$	.255	.255	.255	.237	.237	.237	.0946	.0946	.0946
$\mathbb{E}(r^L_{j,53-58})$	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38	5.38
$\text{SD}(r^L_{j,53-58})$	.475	.475	.475	.475	.475	.475	.475	.475	.475
Observations	46	46	46	46	46	46	46	46	46
R^2	.367	.744	.773	.292	.685	.73	.221	.698	.823

Notes. The table reports WLS estimates of state-level real income, population, and real income per capita growth rates between 1958 and 1983 against the average state-level lending rate in 1953–58. Controls are reported in the table and discussed in Section 6. Observations are weighted by population in 1950. Parentheses report heteroskedasticity-robust standard errors.

FIGURE H.14: RELATIVE CONTRIBUTION OF POPULATION GROWTH TO INCOME GROWTH ACROSS VALUES OF THE MIGRATION ELASTICITY



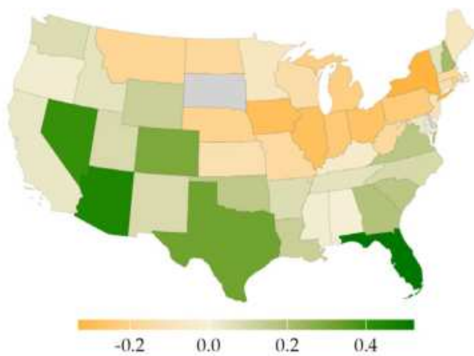
Notes. The blue line reports the ratio of β^N and β^{Income} estimated in the model for different values of ν. For each value of ν, β^N is estimated by regressing simulated population growth between 1958 and 1983 against steady state lending rates. β^{Income} is estimated via the same regression but with state-level income growth as the dependent variable. The horizontal dashed red line indicates the ratio of $\beta^N/\beta^{\text{Income}}$ when running these regressions in the data. The vertical dashed blue line indicates the estimated value of ν, corresponding to ν such that the blue line crosses the horizontal red one.

H.2 Extra Figures and Tables

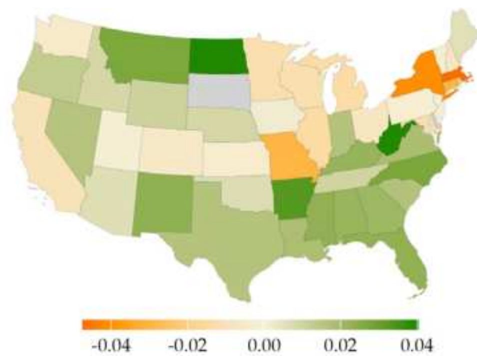
FIGURE H.15: OBSERVED AND MODEL-IMPLIED GROWTH BETWEEN 1958 AND 1983

(A) INCOME (Y_{jt})

(A.I) DATA, DEMEANED

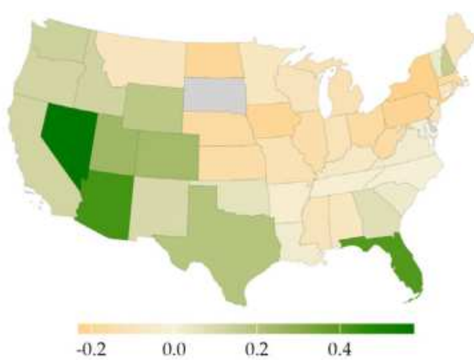


(A.II) FROM FINANCIAL INTEGRATION

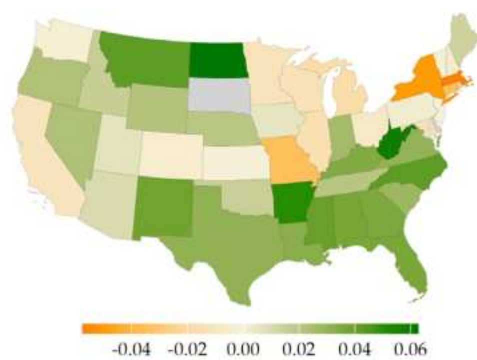


(B) POPULATION (N_{jt})

(B.I) DATA, DEMEANED

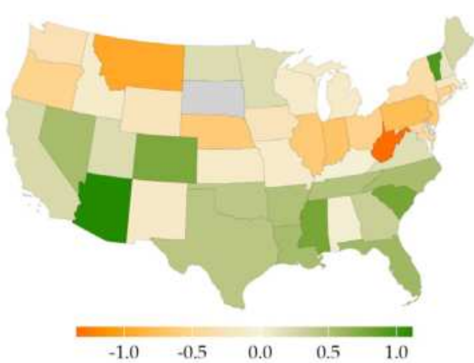


(B.II) FROM FINANCIAL INTEGRATION

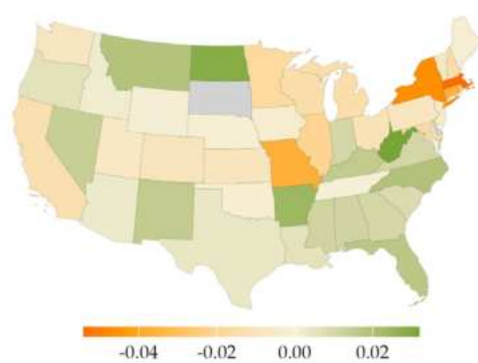


(C) PHYSICAL CAPITAL STOCK (K_{jt})

(C.I) DATA, DEMEANED



(C.II) FROM FINANCIAL INTEGRATION



Notes. The figures report state-level growth rates between 1958 and 1983 in income (Panel A), population (Panel B), and the stock of physical capital (Panel C), relative to the corresponding US growth rate in each variable. Left-hand side maps report growth rates observed in the data, while the right-hand side reports growth rates estimated in the model as a result of the financial shocks reported in Panel (A) of Figure 8.

H.3 Robustness Across Different Parametrizations

TABLE H.19: GROWTH FROM FINANCIAL INTEGRATION, DIFFERENT PARAMETER CHOICES

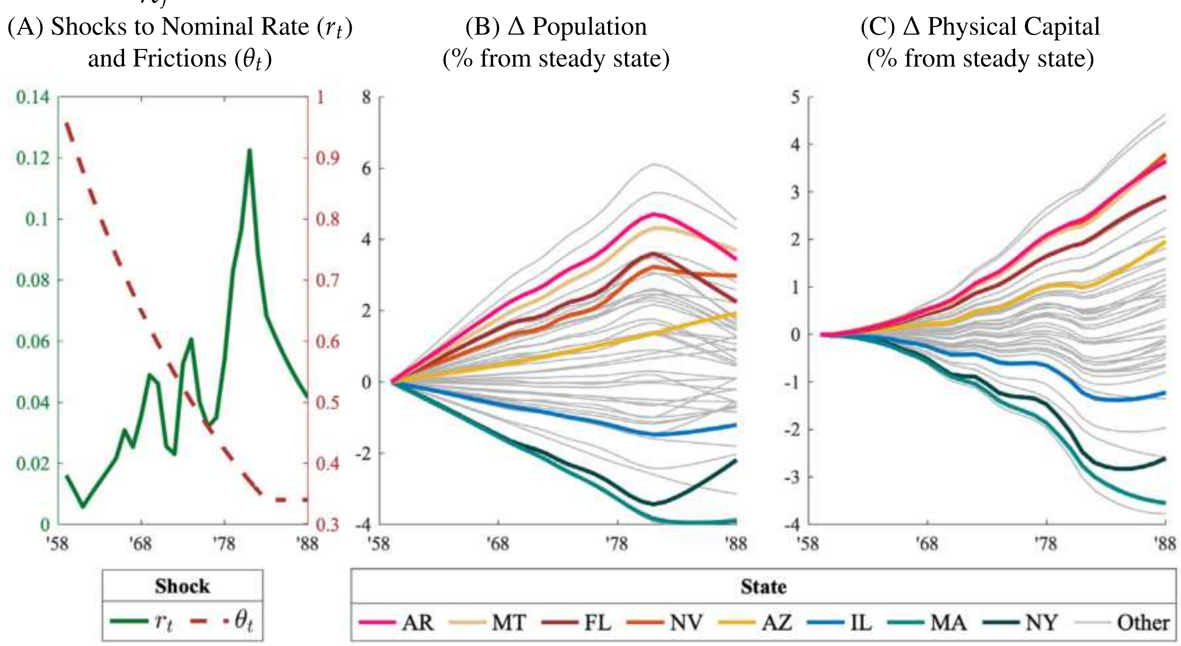
	Regional Growth Rates from Financial Integration, 1963–1983							
	GDP				**Population**			
	State	Region			State	Region		
	Capital Scarce (1)	N. Fin. Centers (2)	Other N. & Midw. (3)	S. & W. (4)	Capital Scarce (5)	N. Fin. Centers (6)	Other N. & Midw. (7)	S. & W. (8)
Baseline	+1.86%	−2.78%	+.28%	+1.37%	+1.82%	−3.23%	−.10%	+1.30%
Imperfect information on χ_j	+1.86%	−1.73%	−.17%	+1.20%	+1.83%	−2.03%	−.50%	+1.15%
Different average values of ξ_j								
∘ Low ξ_j ($\bar{\xi}_j = .25$)	+.93%	−1.61%	+.20%	+.76%	+.91%	−1.87%	+.00%	+.72%
∘ High ξ_j ($\bar{\xi}_j = .75$)	+2.71%	−2.77%	−.06%	+1.71%	+2.66%	−3.36%	−.52%	+1.66%
Different choices on distribution of ξ_j, χ_j								
∘ $\xi_j = .51$, χ_j inverted	+1.88%	−1.53%	−.14%	+1.05%	+1.83%	−1.88%	−.41%	+1.02%
∘ $\chi_j = -.09$, ξ_j inverted	+2.03%	−1.65%	−.23%	+1.22%	+2.04%	−2.10%	−.57%	+1.22%

Notes. The table reports real growth rates of GDP (columns 1 to 4) and population (5 to 8), between 1963 and 1983, for different inversion choices of financial fundamentals. Total population in the economy is left constant. Columns (1) and (5) report growth rates for a state with a one percentage point higher interest rate at baseline. The remainder columns report regional growth rates for the Northern financial centers (NY, IL, MA), other states in the North and in the Midwest, and the South and West. Regional growth rates are expressed as the growth rate of the region as a whole minus the aggregate growth rate of the US economy. The baseline model follows the choices in Section 8.1 and corresponds to the results reported in Table 3. The baseline ratio of working capital serviced by bank loans is set to an average across space of $\bar{\xi}_j = .51$, which implies an average liquidity shifter $\bar{\chi}_j = -.09$ and associated average services from liquidity of $1/\phi + \mathbb{E}[\exp(\bar{\chi}_j - r)] = .14$ at a .05 nominal rate. Imperfect information on χ_j assumes that households do not know the distribution of the local liquidity shifters χ_j and make migration choices assuming that local returns from liquidity $\mathcal{R}_{jt}$ correspond everywhere to the empirical average across states of $\mathcal{R}_{jt}$, as detailed in Section H.3.1. Different average values of ξ_j fix the average $\bar{\xi}_j$ at .25 and .75. The last two rows fix either shifter across space to its average value and invert for the other from the estimated shifter of local deposits over liabilities, $\bar{\gamma}_j$, as described in Section H.1.3.

H.3.1 Results with Uncertainty on χ_j

We replicate the main results under the assumption that households make migration choices with imperfect information on the distribution of χ_j, so that χ_j only matters for within-period liquidity choices. They migrate assuming that local returns from liquidity $\mathcal{R}_{jt}$ correspond everywhere to the empirical average across states of $\mathcal{R}_{jt}$. Regional results are very similar, aggregate results are virtually identical, and the estimated migration elasticity is slightly larger, $\nu = .29$. Figure H.16 replicates Figure 8, Table H.20 replicates Table 3, and Table H.21 replicates Table 4.

FIGURE H.16: REAL ADJUSTMENTS AFTER FINANCIAL CONVERGENCE, IMPERFECT INFORMATION ON χ_j



Notes. See notes to Figure 8. Here households are assumed to have imperfect information about the distribution of χ_j as detailed in Section H.3.1.

TABLE H.20: REGIONAL GROWTH RATES: DATA AND MODEL, IMPERFECT INFORMATION ON χ_j

	Regional Growth Rates, 1963–1983					
	GDP			**Population**		
	Data		Model	Data		Model
	Raw (1)	Conditional on Controls (2)	From Financial Convergence (3)	Raw (4)	Conditional on Controls (5)	From Financial Convergence (6)
Northern Financial Centers	−20.5%	−10.9%	−1.7%	−15.4%	−6.2%	−2.0%
Other North and Midwest	−14.7%	+1.6%	−.2%	−9.2%	+.7%	−.5%
South and West	+22.2%	+3.9%	+1.2%	+12.6%	+3.3%	+1.1%

Notes. See notes to Table 3. Here households are assumed to have imperfect information about the distribution of χ_j as detailed in Section H.3.1.

TABLE H.21: AGGREGATE EFFECTS

	Horizon (t)						
	1983	1993	2003	2013	2023	2083	$t \to \infty$
Changes relative to 1958							
US GDP	−.57%	−.06%	.56%	1.06%	1.41%	2.17%	2.36%
US Physical Capital Stock	−.69%	.15%	1.33%	2.28%	2.95%	4.21%	4.46%
Path of shocks							
Nominal Rates, $r_t - r_{1958}$	6.84	2.52	.93	.34	.13	.00	.00
Frictions, θ_t / θ_{1958}	.34	.34	.34	.34	.34	.34	.34

Notes. See notes to Table 4. Here households are assumed to have imperfect information about the distribution of χ_j as detailed in Section H.3.1.

H.4 Branching Deregulation Counterfactuals

All of our counterfactuals start from the 1982 steady state. To compute it, we follow Section H.1.1 again and invert the economic primitives to match the 1982 data, as in Section 8.1. Starting from the 1958-implied primitives and steady state, but forcing frictions and deposits to match those implied by the model in 1982, makes no quantitative difference.

We study the transition dynamics from this initial steady state feeding a one-time permanent "branching deregulation" shock. We model branching deregulation as giving rise to national banks that can now take deposits and lends in all regions. This implies that interest rates in all regions will converge to the same rate set by a representative national bank that has a fraction of deposits funding over liabilities equal to:

$$\frac{D_t}{L_t} = \frac{\sum_j D_{jt}}{\sum_j L_{jt}} = \frac{\sum_j \alpha_N \exp\left(-\phi\left(r_t - \chi_j\right)\right) y_{jt}}{\sum_j \xi_j y_{jt}} = \alpha_N \exp\left(-\phi r_t\right) \frac{\sum_j \alpha_N \exp\left(\phi \chi_j\right) y_{jt}}{\sum_j \xi_j y_{jt}}$$
$$= \alpha_N \exp\left(-\phi r_t\right) \frac{\sum_j \bar{\gamma}_j \xi_j y_{jt}}{\sum_j \xi_j y_{jt}} = \alpha_N \exp\left(-\phi r_t\right) \bar{\gamma}_{US}$$

where $\bar{\gamma}_{US} = \frac{\sum_j \bar{\gamma}_j \xi_j y_{jt}}{\sum_j \xi_j y_{jt}}$. The change in interest rate in each region is:

$$\tilde{r}^L_{jt} = r^L_{*,t} - r^L_{jt} = \frac{\theta_t \alpha_N^2 \exp\left(-\phi^2 r_t\right)}{2} \left(\bar{\gamma}_j^2 - \bar{\gamma}_{US}^2\right)$$

We thus derive transition dynamics feeding shocks directly to local lending rates. The distributional FAMEs remain obviously identical. The trend FAMEs are now different. In particular, we have the following.

Flow Utility

$$U_{jt} - U_j^{SS} = \left(\frac{dw_j}{dr^L_{jt}} \left(1 + \mathcal{R}_{jt}\right) \right) dr^L_{jt} + \mathcal{D}_U$$

where the $\mathcal{D}_U$ indicate the distributional parts that remain the same as they were in Section B.6. In vector notation:

$$\epsilon^{-1} \left(U_t - U^{SS} \right) = D_{Ur} \tilde{r}^L_{jt} - \mathcal{D}_U$$

where $D_{UR} = \mathbf{diag}\left(\frac{dw_j}{dr_t} \left(1 + \mathcal{R}_{jt}\right) \right)$ and $\frac{dw_j}{dr^L_{jt}} = -\xi_{jt} \frac{w_{jt}}{R^F_{jt}}$.

Rental rate

$$r^K_{jt} - r^{K,SS}_{jt} = \frac{\partial r^K_{jt}}{\partial r^L_{jt}} dr^L_{jt} + \mathcal{D}_{r^K}$$

Recall $r^K_{jt} = \left(\alpha_K \frac{z_{jt}}{R^F_{jt}} N^{\alpha_N}_{jt} K^{\alpha_k - 1}_{jt} \right)$, so that $\frac{\partial r^K_{jt}}{\partial r^L_{jt}} = -\xi_{jt} \frac{r^K_{jt}}{R^F_{jt}}$, leading to:

$$\epsilon^{-1} \left(r^K_t - r^{K,SS} \right) = D_{Rr} \tilde{r}^L_{jt} + \mathcal{D}_{r^K}; \qquad D_{Rr} = \mathbf{diag}\left(-\xi_{jt} \frac{r^K_{jt}}{R^F_{jt}} \right)$$

Continuation values from migration and from changes in the population distribution The continuation values from migration and changes in the population distribution are identical to those of Section B.6.

Continuation value from changes in the capital distribution In vector notation:

$$\epsilon^{-1} \left(\sum_k v^K_{jk} \left(r^K_{kt} - \delta - \rho \right) K_{kt} \right)^J_{j=1} = v^K \left(D_{Kr} \tilde{r}_t + + \mathcal{D}_K \right)$$

where:

$$D_{Kr} = \mathbf{diag}\left(K_{jt} \right) \cdot D_{Rr} = \mathbf{diag}\left(-K_{jt} \xi_{jt} \frac{r^K_{jt}}{R^F_{jt}} \right)$$

Trend FAME

$$\rho \mathbf{x}^T_t = D^T_t + \underline{\mathbf{M}} \mathbf{x}^T_t + \frac{\partial \mathbf{x}^T_t}{\partial t} + \mathbf{x}^d_t P^d \mathbf{x}^T_t \qquad \mathbf{x}^T_t = \begin{bmatrix} \mathbf{v}^T_t \\ \mathbf{q}^T_t \end{bmatrix}$$

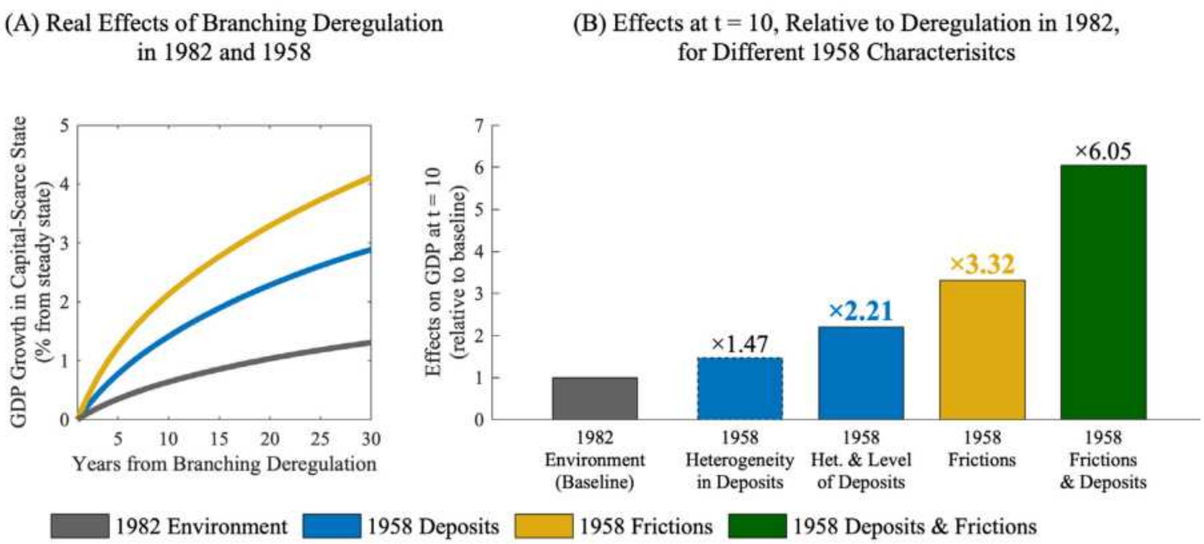
Where now one has:

$$\underbrace{D_t^T}_{2N\times 1} = \begin{bmatrix} \left(D_{Ur} + \mathbf{v^K} D_{Kr}\right) \mathbf{vec}\left(\tilde{r}_{jt}^L\right) \\ \left(D_{Rr} + \mathbf{q^K} D_{Kr}\right) \mathbf{vec}\left(\tilde{r}_{jt}^L\right) \end{bmatrix}$$

where $\mathbf{vec}\left(\tilde{r}_{jt}^L\right)$ is the $N \times 1$ vector of changes to local lending rates caused by deregulation.

H.4.1 Extra Figures

FIGURE H.17: EFFECTS OF BRANCHING DEREGULATION IN 1958 AND 1982, BY LEVEL OF FRICTIONS AND DEPOSITS



Notes. The figure reports the simulated effect of deregulation on GDP growth in a state with a 1 percentage point higher lending rate in 1958. Deregulation is modeled as a shock driving rates everywhere to the rate charged by a national bank that can collect deposits and lend everywhere. Panel (A) reports the effects over time for three different scenarios. The gray (bottom) line represents a baseline scenario where the aggregate nominal rate is 10.6% (the three-month Treasury Bill rate in 1982) and frictions of accessing national markets are at their estimated value in 1982, which corresponds to 34% of their 1958 value. The blue (middle) line estimates the impact of deregulation under the baseline level of frictions but under a nominal rate of 1.8%, equal to the three-month Treasury Bill rate in 1958. The yellow (top) line estimates the impact of deregulation with baseline nominal rates but with frictions at their estimated value in 1958. Panel (B) reports effects on GDP growth at $t = 10$, relative to the 1982 baseline, in the three scenarios of Panel (A). The bar colors in Panel (B) align with the line colors in Panel (A). Two additional scenarios are also shown: the second bar from the left (blue with dashed border) reflects a scenario where deposit heterogeneity matches 1958 levels while maintaining the 1982 average deposit level and frictions; the last bar (green) represents a scenario where both deposit levels and frictions match those of 1958.