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Hayk Sargsyan
Aleksandr Grigoryan
Olivier Bruno

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Deposits market exclusion and the emergence of premium banks

Hayk Sargsyan*, Aleksandr Grigoryan†, Olivier Bruno‡

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Abstract

In this paper we develop a model which explains exclusion from deposits market and the emergence of premium banks. Households' demand for deposits is modelled accounting for diversification motive and love for services. Market exclusion and the emergence of premium banks occur, if the diversification motive dominates. Too unequal distribution of income directed to deposits leads to the exclusion of poor from rich-serving banks' deposit product markets, resulting in higher markups and a lower level of total deposits. In the empirical part, we use a bank-branch level data and county level income inequality as a proxy for deposits inequality for the U.S. economy. We find supporting evidence for the main assumptions of the theoretical model, which are (i) price elasticities differ for rich and poor, (ii) premium banks set higher deposit prices, (iii) the likelihood of the emergence of premium banks increases in income inequality, and (iv) the total volume of deposits decreases in income inequality.

Keywords: Market exclusion, premium banks, deposit price, deposit-holdings inequality, non-homothetic preferences.

JEL code: D31, D43, E52, G21.

*Universitat Pompeu Fabra, *hayk.sargsyan@upf.edu*

†SKEMA Business School - Univeristé Côte d'Azur; corresponding author, *aleksandr.grigoryan@skema.edu*

‡Univeristé Côte d'Azur - GREDEG - CNRS - SKEMA Business School, *olivier.bruno@univ-cotedazur.fr*

1 Introduction

In banking, rich people are more demanding and cost more to serve than poor (The Economist, 2012). Wealthy clients tend to choose private banking institutions with better accessibility, most innovative products and a large variety of investment opportunities.[1] Private banks spend enormous resources to establish relationship with rich families. To attract term deposits from wealthy clients, banks need to balance costs and revenues through differentiated services to such clients. They tailor their services to meet special prerequisites to be exclusively consumed by wealthy clients. The cost, may it be for issuing a certificate of deposit or providing asset management service, can easily increase in the product size through the quality improvement and sophistication of services.

On the other hand, the literature documents that increasing income inequality is projected to extend disparity in different forms of savings (Carroll, 2000; Dynan et al., 2004a). Along the income inequality increase, demand for private banking is expanding. New financial institutions emerge as private banks to serve the rich and separate themselves from common banks serving the mass. Yet, about 27 percent of funds deposited in the global private banking sector is allocated among 10 private banks (Euromoney, 2021), signalling about the high concentration of funds and market power possessed by private bankers. These banks offer high-net-worth clients personalized care and management of their finances.[2] These are *exclusive* services designed for particularly rich clients.

A well-established observation is that individuals with lower incomes often face higher fees for essential financial services, commonly referred to as the "poverty premium" in the literature (Corfe and Keohane, 2018). Access to the most affordable commercial loans typically hinges on successfully passing stringent credit assessment. Consequently, some clients face ex-

[1]Some of the top private banks favourite among millionaires are J.P. Morgan Private Bank, UBS, Hana Bank, Fieldpoint Private, and DBS Private Bank, acclaimed as the best banks for sustainable investment, innovations and technological solutions, (Global Finance, 2021).

[2]Private banking clients with large accounts receive concierge-like services such as instant access to a bank employee or a lead advisor to complete complex transactions with their accounts. They do not wait in a queue or use services by a bank teller.

clusion from this market due to being perceived as too risky. The substantial financial exclusion experienced by a considerable portion of the population has profoundly adverse effects. What about the realm of deposit markets? Could there also be exclusion of poor clients in this market? What would be the consequences of the exclusion of economically disadvantaged clients from deposit markets? These pivotal questions, often overlooked in the existing literature, lie at the heart of this paper's research objectives.

This paper provides a market-based mechanism which explains the separation of private banks from other commercial banks, serving non-wealthy households. Our focus is the bank deposit market, which we label as "money in the bank." Specifically, we are considering the primary deposit categories in the U.S. market, outlined by Drechsler et al. (2017), which include certificates of deposit (as term deposits) and money market deposits (as savings accounts). These deposit types involve increased repayment and liquidity costs when contrasted with conventional bank savings accounts.

We develop a theoretical model, in which households demand for deposits is modelled taking into account two motives. First we consider the *diversification motive.* Modelling desirability for variety of goods goes back to Hoteling (1929), and much later to Lancaster (1975) and Dixit and Stiglitz (1977). On the other hand, Markowitz (1952) model on optimal investment choices is based on the diversification motive. This said, diversification of choices lies at the heart of both economic and financial decision-makings, and we adopt a novel approach for modelling deposit as a differentiated product. The second motive builds on depositors' desirability to consume more sophisticated and personalized services. Financial services are costly, and banks are incentivized to provide a richer menu of services for those clients who hold larger deposits in the bank. We label the motive for accessing a larger set of and more sophisticated services as *love for services.* While *diversification* motivates a depositor to allocate funds to many banks, *love for services* narrows the investment choice to a single bank to utilize the feasible highest level of services.

We show, that when the diversification motive dominates the love for services motive, along the increase in savings inequality in deposits market, banks specialize in serving either rich or poor. Exclusion of the poor from rich-serving banks' product markets results in an inefficient market outcome - a lower level of collected deposits and higher markups for banks. Higher inequality in savings invested in deposits holding leads to more exclusion and less total deposits, as banks exercise their monopoly power with high intensity. On the other hand, heightened markups empower banks, servicing exclusively rich clients, collect deposits at reduced interest rates. The mechanism can explain the joint occurrence of elevated debt levels and diminished rates of return.

In the empirical part of the paper, we provide supporting evidence for the main hypotheses derived from the model, using micro-data from the U.S. economy at a bank-branch level. We use a county-level income inequality measure to proxy deposits inequality. We provide evidence on different deposit price elasticities for rich and poor, lower deposit rates and higher markups for premium banks, higher likelihood of emergence of premium banks in counties with higher inequality, and decrease in the total volume of deposits in the U.S. counties with higher income inequality.

Relevance of income inequality for macroeconomic outcomes stems from the observation that agents heterogeneous in income have different demand elasticities. Non-homothetic consumption-saving behaviour amplifies savings differences between rich and poor. Such preferences are found in, e.g., (Carroll, 1998; De Nardi, 2004; Mian et al., 2021a; Straub, 2019). Empirical evidence supports the relevance of increasing differences in consumption and savings along the income growth (Dynan et al., 2004b; Fagereng et al., 2019). In our setting, modelling investors' decisions on deposits allocation results in non-homothetic return function similar to Foellmi and Zweimüller (2011). The authors solve a model to study the interaction between market power and income inequality. Our model shares common features with the solution mechanism found in Foellmi and Zweimüller (2011), particularly in terms of the emergence of market exclusion. In our context, varying deposit demand elasticities may lead to the outcome that poor households will find some deposits not enough attractive (the repayment rate will be too low) and in equilibrium they will be excluded from such deposit markets.

To our knowledge, this research is the first attempt to provide micro-foundations of the premium banks' emergence. We suggest a model framework, in which diversification motive is contrasted to the motive for services consumption. Somewhat surprisingly, the model shows love for services motive shuts down the exclusion channel and hence the emergence of premium banks. If love for services dominates diversification motive, both rich and poor depositors invest only in a single bank, and wealth differences do not play role in the resource allocation rule and the implied equilibrium. If diversification motive dominates services motive, premium banks emerge under large deposits inequalities. In a simplified two-agent model framework, rich and poor depositors are served by different banks.

Secondly, our study suggests a new channel which explains recent evidence on high debt levels and low rates of return. A large body of recent research associates the considerable decline in interest rates over the past few decades with the increase of income inequality. Both theoretical and empirical literature have well documented that high income households have a higher propensity to save, (Furman and Summers, 2020; Rachel and Summers, 2019; Summers, 2014). So, rising income inequality increases savings of rich and hence total saving rates, and engenders a downward pressure on aggregate demand, thus decreasing interest rates, (Auclert and Rognlie, 2018; Mian et al., 2021a,b). Reduced interest rates are necessary to balance the greater desire to save and increasing debt service payments. Mian et al. (2021b) highlight that decreased interest rates may lead the economy to debt-driven liquidity trap, which limits the effectiveness of monetary policy. In this regard, our paper suggests a novel approach explaining the emergence of low rates in times of high inequality. Our model shows that higher inequality enables banks to increase markups and collect deposits with lower interest rates. Decreased cost of funding for banks can explain evidence of simultaneously observing high debt levels and low interest rates.

The remaining of the paper is organized as follows. Section 2 describes the model and the two types of equilibria (symmetric and asymmetric). We provide empirical evidence in

Section 3. Section 4 concludes. Some of the derivations and proofs, as well as the method and data descriptions are relegated to Appendix.

2 The model

2.1 Depositors

We model optimal allocation of deposits. We have a continuum of depositors (agents) normalized to 1. A continuous range of deposits are provided by banks as differentiated products. That is, the j^{th} bank sells a deposit of type $j \in [0, N]$. Agents sign a deposit contract to receive net return R on investing one dollar in deposits, D_j. They also derive utility, in perceived monetary terms, from services increasing quadratically in a deposit size, $\frac{1}{2}sD_j$. Quadratic utility from services reflects the central role of services for attracting premium clients. The emergence of premium banks in the model is endogenous, and for clients in premium banks holding a higher level of deposits will consume more services and derive more utility. The parameter s measures the degree of love for services. Finally, agents reveal love for diversity (diversification motive) and bear cost from investing extra dollar in the same bank by the amount $\frac{1}{2}\gamma D_j$. The parameter γ governs the degree of deposits variety, identical for agents and across banks.

The components in the objective function are interpreted in monetary terms. Deposit interest payment is transferred from banks to the agent. The other two components are in *perceived* monetary terms. Service related utility derived from extra unit of deposit and from the premium client status are perceived monetary gains. Investing extra unit of deposit, on the other hand, generates perceived monetary cost for the agent.

The θ-type representative agent maximizes the expected return

$$\max_{\{D_j(\theta)\}} \int_0^N \left(R + \frac{s-\gamma}{2} D_j(\theta)\right) D_j(\theta) dj \quad \text{subject to} \quad \int_0^N P_j D_j(\theta) dj \leq W(\theta),$$

where P_j is the price for a deposit product, set by bank j and paid by the agent; $W(\theta)$ is the part of income (savings) of the agent θ directed to deposits.[3]

The price embraces the cost of deposit production, revealed in forms of commission and client service fees. \$100 savings generate less than \$100 deposits, as there are commission fees charged from a depositor per unit of deposit. From a depositor's perspective, this is the fee paid for converting her savings into deposits, ultimately subtracted from the repayment rate. The fee is proportional to the deposit size, as services are getting more sophisticated and exclusive for larger volumes of deposits.

If the cost from investing an extra dollar in the same bank is higher than the utility derived from services, $\gamma > s$, then diversification motive (or love for variety) dominates love for services. In the opposite case, $\gamma < s$, love for services is stronger than diversification motive. The two cases result in different equilibria and potentially different implication for the interplay between deposits inequality and the exclusion mechanism. Further discussion on these two possible cases, $\gamma > s$ (Case 1), and $\gamma < s$ (Case 2) is provided below.

Case 1: $\gamma > s$. We denote $Q\left(D_j\right) \equiv \left(R + \frac{s-\gamma}{2} D_j(\theta)\right) D_j(\theta)$ and restrict the parameter γ so that $Q'\left(D_j\right) = R + (s-\gamma)D_j(\theta) > 0$ for $D_j(\theta) > 0$. Marginal return of consuming an additional unit of deposit at zero is finite, $\lim_{D_j(\theta)\to 0} Q'\left(D_j\right) = R$. This property implies that there can be deposits with too high prices not affordable by depositors. Also, $Q''\left(D_j\right) = s - \gamma$, and there is a saturation level of deposits, $Q'\left(D_j\right) = 0 \Leftrightarrow D(\theta) = R/(\gamma - s)$. The higher is $\gamma - s$, the lower is the marginal return and the smaller is the saturation level.

Following Foellmi and Zweimüller (2011), we write the Lagrangian directly as a function of the type of an agent. The value of the Lagrangian function does not depend on income only, prices matter as well. However, since each bank is of measure zero with respect to the whole economy, changing one individual price does not change the value of the Lagrangian multiplier.

Then, the θ-type agent decides on the optimal quantity of deposits issued by the j^{th}

[3]We refer to $W(\theta)$ as income directed to deposits to accentuate the linkage between income inequality and deposits market outcomes.

bank, according to the first order condition:

$$R + (s - \gamma)D_j(\theta) - \lambda(\theta)P_j + \lambda_j(\theta) = 0; \quad \lambda(\theta) > 0; \quad \lambda_j(\theta) \geq 0.$$

We can put the conditions in the following form:

$$D_j(\theta) = \begin{cases} \frac{R - \lambda(\theta)P_j}{\gamma - s}, & \text{if } R > \lambda(\theta)P_j, \\ 0, & \text{if } R \leq \lambda(\theta)P_j, \end{cases} \tag{1}$$

that is, if the subjective price of the deposit j is higher than the limiting highest marginal return, $\lambda(\theta)P_j > R$, then the agent θ will not buy the deposit issued by bank j.

Lastly, we establish the deposit price elasticity of the individual demand curve contingent on income, that will play a crucial importance in the subsequent discussions:

$$\epsilon_D(\theta, j) = \frac{\partial D_j(\theta)}{\partial P_j}\frac{P_j}{D_j(\theta)} = \frac{Q'(D_j)}{D_j(\theta)Q''(D_j)} = -\frac{R - (\gamma - s)D_j(\theta)}{(\gamma - s)D_j(\theta)}.$$

Case 2: $\gamma < s$. If a depositor values services from a bank more than diversification of the deposit portfolio, it is easy to note that all the resources available to her is allocated to a single bank. Since the parameters γ and s are not depositor specific, in this case, the allocation of resources for a single depositor collapses to investing all resources to a single bank. This can be easily seen from the observation that the form of the objective function results in a corner solution as the optimal one for the deposit.

2.2 Banks

Banks have two sources of fund raising – private savings and the funds offered by the central bank. If attracted deposits fall short from allocated loans, the gap is filled by the borrowing from the central bank. Otherwise, the bank lends to the public institution. Banks have monopoly power both in deposit and loan markets, which ensures non-zero markups in these markets and leads to the condition $R^d(P_j) < R^r < R^\ell$, where R^r is the central bank's repo rate, $R^d(P_j) = 1 + R - P_j$ determines the (gross) deposit rate, and R^ℓ is the loan rate.

We model the optimal decision of a bank in deposit markets isolated from decisions on other liability and assets parts.[4] Consequently, the bank's problem for deposits can be written as follows:

$$\max_{P_j} D(P_j)\left(P_j - \tilde{R}\right), \quad \text{with} \quad \tilde{R} \equiv 1 + R - R^r + c, \tag{2}$$

where $c > 0$ is the service cost per unit of deposit. The payment for unit deposit, R, is contracted by the factor of repo rate, R^r, which, together with service cost constitutes the net cost of fund raising through deposits.

The optimality condition for an interior solution to the bank's problem in the deposit market, necessary and sufficient, can be written in the Lerner index form:

$$\frac{P_j - \tilde{R}}{P_j} = -\frac{1}{\epsilon_D(P_j)},$$

that is, the profit markup is inversely related to the demand elasticity. The standard result, which is the equilibrium price (the price of unit deposit) and the markup are higher when demand elasticity is lower, holds.

2.3 Two types of agents: rich and poor

We assume two types of agents, high-income (rich) and low-income (poor). This restriction on the income distribution simplifies the analysis greatly, but not at the expense of generality. Poor households are indexed by P and their share is α in population of continuum 1. Respectively, rich households are indexed by R and have the share $1-\alpha$. We normalize total

[4]We start from the general problem of banks, then we model the optimal decisions of a bank in deposit and loan markets separately. See more details in Appendix A.

income directed to deposits to unity,

$$\alpha W_P + (1-\alpha) W_R = 1. \tag{3}$$

Our inequality measure is then the income ratio $\upsilon = \frac{W_R}{W_P}$, which can be parametrized by the income of the poor, W_P. Equation (3) can be rewritten as follows:

$$\upsilon = \frac{1}{1-\alpha}\left(\frac{1}{W_P} - \alpha\right).$$

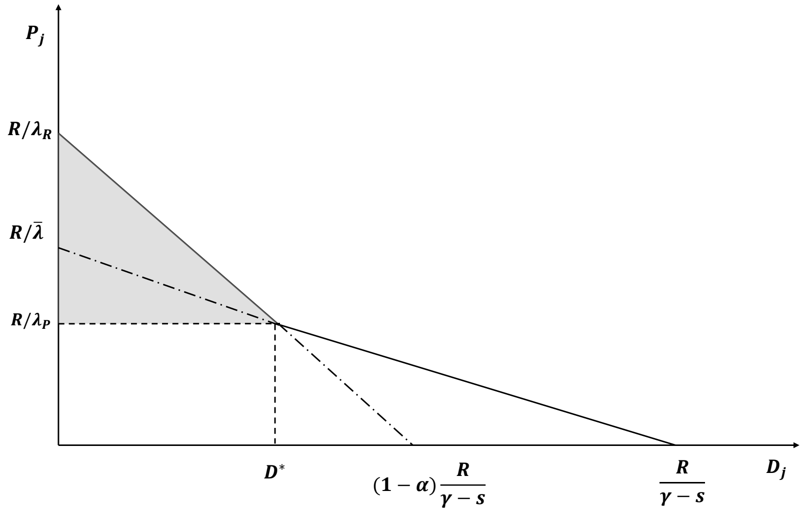
Inequality decreases in the income of the poor. Changes in income of the same proportion for rich and poor do not perturb inequality. In the model, income shares for rich and poor remain constant.

In the case of $\gamma > s$ (Case 1), after horizontal aggregation of individual demand functions in (1), we obtain the market (deposit) demand curve for deposit j:

$$D_j = \begin{cases} 0, & \text{if } P_j \in [R/\lambda_R, \infty) \\ (1-\alpha)\frac{R-\lambda_R P_j}{\gamma - s}, & \text{if } P_j \in [R/\lambda_P, R/\lambda_R) \\ \frac{R-((1-\alpha)\lambda_R + \alpha\lambda_P)P_j}{\gamma - s}, & \text{if } P_j \in [0, R/\lambda_P). \end{cases} \tag{4}$$

The market demand curve for deposit j is piece-wise linear (Figure 1). The j-th bank optimally decides to whom offer deposits, either to both rich and poor as "mass deposits," or exclusively to rich as "exclusive deposits." For prices higher than $P^* = R/\lambda_P$, with corresponding deposit volumes less than $D^* = (1-\alpha)\frac{\lambda_P - \lambda_R}{\lambda_P}\frac{R}{\gamma - s}$, the bank shifts to exclusive deposits. The shift occurs, because banks prefer to sell deposits to less price-elastic depositors with a higher demand to ensure a higher markup. Also, at any price banks prefer to sell products both rich and poor rather than only to the poor, as the latter is more elastic and reveals a lower demand. Ultimately, banks offer deposits either to the mass or only to the rich.

Figure 1: Aggregate demand for deposits issued by the j-th bank.



Note: $\bar{\lambda} = (1-\alpha)\lambda_R + \alpha\lambda_P$, $P^* = R/\lambda_P$, *and* $D^* = (1-\alpha)\frac{\lambda_P - \lambda_R}{\lambda_P}\frac{R}{\gamma - s}$.

In equilibrium, if there will be banks selling deposits only to rich, we will have *exclusion*. Then, there will be two types of deposits in terms of pricing, one that is sold to the mass, both rich and poor (P^M), and other sold exclusively to the rich (P^E). Each bank has either of this option, but not both. There will be an endogenous cut-off number $n \in [0, N]$, such that the first n banks will issue deposits for the mass, and the remaining $(N - n)$ banks sell deposits only to rich. As a result, poor households will be *excluded* from consuming $(N - n)$ types of deposits, as their willingness to buy these deposits will fall short from their market price.

Under the exclusion regime, the rich has the option to purchase deposits from either a premium bank or a mass-serving bank. Commercial banks exercise their monopoly power more intensively under the exclusion regime, as prices for $(N - n)$ deposits will be excessively high for poor. The question then arises as to why a rich would favour exclusive deposits over mass deposits. This preference for being the client of a premium bank occurs only if the deposit amounts per bank for rich clients in banks serving the general public are strictly lower compared to those in premium banks.[5] The trade-off for the rich is then either to choose mass deposits at a lower price but with lower per-bank values, or she opts to become a client of a premium bank, paying higher prices but enjoying greater values of deposits, hence, service utility. Notice that we could easily achieve diversity in the preference of the rich for being a client of a premium bank or a mass-serving bank by introducing heterogeneity in individuals' love for variety or love for service utilities.

For our research purposes, the subsequent discussion focuses on the scenario where all rich individuals choose to be clients of a premium bank and benefit from enhanced service utilities. In this case, with two types of agent assumption, the profit maximization for a bank in (2) implies the optimal prices – one for only rich and the other for mass (poor):

$$P_j = \begin{cases} \frac{1}{2}\left(\frac{R}{\lambda_R} + \tilde{R}\right), & \text{premium banks;} \\ \frac{1}{2}\left(\frac{R}{\lambda_P} + \tilde{R}\right), & \text{mass-serving banks.} \end{cases} \tag{5}$$

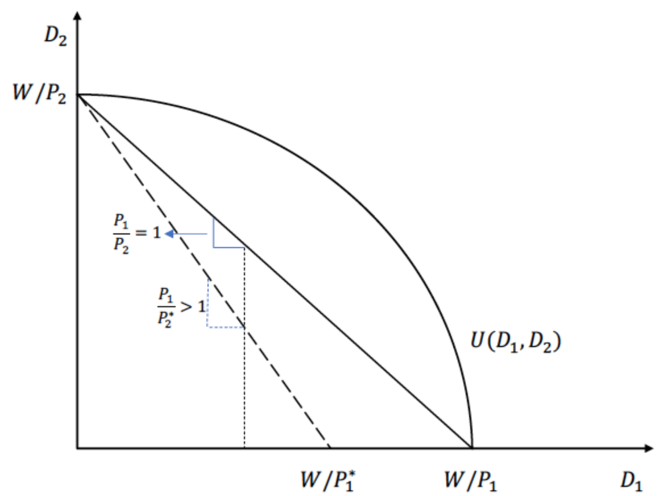
If $\gamma < s$ (Case 2), the corner solution is achieved in any of the circumstances. In Figure 2, we show that under the exclusion regime, which results in higher prices for exclusive deposits, $P^M < P^E$, the optimal solution for both types of depositors is $(0, W/P^M)$. In other words, if bank 1 begins serving rich clients only and raises its prices, $P_1 = P^E$, the depositor's only choice is bank 2, which continues to serve to both types of clients with the price $P_2 = P^M$. It is important to note that neither from depositor's side, nor from the bank's side there is any factor that could make switching form one bank to another costly. We find this argument sufficient to consider the case of $\gamma < s$ clarified from the possible exclusion perspective. The symmetric equilibrium is sustainable, and there are no factors which could incentivize banks to deviate from that equilibrium. Therefore, we conclude that, *when love for services dominates*

[5] For rich clients per-bank deposit amounts in banks serving the mass are strictly lower compared to those in premium banks when the number of premium banks is sufficiently low:

$$\frac{1}{N-n}\frac{R-\lambda_R P^E}{\gamma - s} > \frac{1}{n}\frac{R-\lambda_R P^M}{\gamma - s}, \quad \Leftrightarrow \quad n > n^* \equiv \frac{N}{2}\frac{R-\lambda_R P^M}{R-\lambda_R \bar{P}}, \quad \text{where} \quad \bar{P} \equiv \frac{P^E + P^M}{2}.$$

diversification motive, there are no market mechanisms which could lead to exclusion and hence the emergence of premium banks. In the remaining part of the paper, we study symmetric and asymmetric equilibria for $\gamma > s$ (Case 1).

Figure 2: Depositor's optimal choice with two banks ($\gamma < s$).



2.4 Symmetric equilibrium

Before turning to the asymmetric equilibrium, in which exclusion occurs, we study the symmetric one. Symmetric outcome assumes symmetric deposit quantities and prices in the equilibrium. This outcome is feasible, since deposits enter the households' return function symmetrically, and households, despite their heterogeneity in terms of income, hold identical portfolios. In fact, a symmetric equilibrium will hold, if heterogeneity among deposit consumers will not be very high. The symmetric outcome will be an equilibrium, if, given that all other banks sell deposits to the mass, no bank will have an incentive to sell only to rich, offering a different repayment. This will be the case, if for each bank we have:

$$\Pi^E < \Pi^M \Longleftrightarrow D^E\left(P^E\right)\left(P^E - \tilde{R}\right) < D^M\left(P^M\right)\left(P^M - \tilde{R}\right), \tag{6}$$

where the superscripts E and M correspond to exclusive and mass deposits, respectively.

Under the symmetric equilibrium, the price and the quantity are not a function of inequality parameters, α and υ. Thus, we have the result by (Foellmi and Zweimüller, 2011), that is, in the symmetric equilibrium case, if $\frac{Q'(D)}{Q''}$ is affine linear, income distribution does not affect on the price and hence the markup. The market demand of deposits is unaffected by the savings distribution and the interaction between inequality and aggregate outcomes is one-directional, only from outcomes to distribution, but not the opposite.

We can express maximized profits in (6) as functions of λ_R and λ_P, using (5) for all consumers. Then the no-deviation condition can be reduced to

$$\frac{1-\alpha}{\alpha} < \frac{\lambda_R}{\lambda_P}\left(\frac{R-\lambda_P\tilde{R}}{R-\lambda_R\tilde{R}}\right)^2. \tag{7}$$

The right hand side (RHS) of (7) is decreasing in the inequality parameter, υ. At some value of $\bar{\upsilon}$, the inequality in (7) will not hold for all $\upsilon > \bar{\upsilon}$. In other words, if the resource allocation is too polarized, a given bank will find profitable to deviate from the general strategy (to sell deposits to all customers) and offer deposits exclusively to rich, as she is less elastic and has more resources to attract. Consequently, the bank can charge a higher monopoly price. These findings are summarized in the following proposition.

PROPOSITION 1. *For a given composition of population α, there is an upper bound of inequality measure $\bar{\upsilon}$, such that for all $\upsilon < \bar{\upsilon}$ savings inequality has no influence on the equilibrium deposit rate and the quantity.*

Proof. See Appendix A. □

2.5 Asymmetric equilibrium

It follows that for sufficiently high savings inequality there will be banks that will sell only to rich. Then, there will be two types of deposits in terms of pricing, one that is sold to the mass (poor), and other sold only to the rich. Each bank has either of this option, but not both. In the equilibrium the number of banks serving only to the rich will be determined endogenously.

We start from the no-arbitrage condition, which must hold under the exclusion regime, $\Pi^E = \Pi^M$. The optimal deposit quantities can be expressed as functions of optimal prices, using optimal demands in (4) and eliminating λ_R and λ_P through (5). The market equilibrium quantities are then:

$$D^E = (1-\alpha)\frac{R}{\gamma - s}\left(\frac{P^E - \tilde{R}}{2P^E - \tilde{R}}\right), \quad D^M = \alpha\frac{R}{\gamma - s}\left(\frac{P^M - \tilde{R}}{2P^M - \tilde{R}}\right). \tag{8}$$

Under the no-arbitrage condition, which implies the existence of the exclusion regime, we then obtain a formula for P^E, as a function of P^M:

$$P^E - \tilde{R} = \frac{\alpha}{1-\alpha}\frac{\left(P^M - \tilde{R}\right)^2 + \left(P^M - \tilde{R}\right)\left[\left(P^M - \tilde{R}\right)^2 + 2\frac{1-\alpha}{\alpha}P^M\tilde{R}\right]^{\frac{1}{2}}}{2P^M} \equiv g\left(P^M\right).$$

and it can be checked that $g'\left(\tilde{P}^M\right) > 0$.

In the following proposition, central to the model, we establish the uniqueness of the asymmetric equilibrium and show that the equilibrium price responses to the increasing inequality.

PROPOSITION 2. *(i) The asymmetric equilibrium is unique, (ii) higher inequality (higher υ), leads to higher prices, both for mass and exclusive deposits.*

Proof. The markup condition for the exclusive deposits segment is:

$$1 - \frac{\tilde{R}}{P^E} = -\frac{1}{\epsilon_D\left(P^E;\upsilon\right)} = \frac{(\gamma - s)D^E}{R - (\gamma - s)D^E} = \frac{R - \lambda_R(\upsilon)P^E}{\lambda_R(\upsilon)P^E}. \tag{9}$$

(i) The LHS of (9) is strictly increasing, while the RHS is strictly decreasing in P^E. The price for mass deposits, P^M, is also strictly decreasing in P^E and hence equilibrium prices P^E

and P^M are unique. As equilibrium deposits D^E and D^M in (8) are monotone in P^E and P^M, respectively, equilibrium quantities are also unique.

(ii) Now, let us perturb the income of the poor (W^P) downwards and hence the parameter υ upwards. As the income of the rich will increase, the λ_R will decrease and the RHS of (9) will shift upward. The resulting equilibrium price P^E, and hence P^M, will be higher. □

Monopoly power that banks exercise towards customers is different in the mass and exclusive markets. To have the complete picture, we need to identify responses of total deposits and markups to inequality changes.

PROPOSITION 3. *Higher inequality (higher υ), leads to: (i) more exclusion, (ii) a decrease in total deposits, and (iii) higher markups.*

Proof. See Appendix A. □

Higher exclusion means that poor consumers will be excluded from more deposit markets, as the new price will be too high (too low return) for them. Lower elasticity for a price will empower banks to ensure a higher markup, thus, generating higher social welfare losses. Each bank is now better off in terms of profits, but total deposits will now be lower, since there are banks, which will shift the customer base from the mass to only rich.

That banks will increase the price for rich is quite intuitive. Higher inequality means that the rich is now even richer, and she is less elastic to a price change, as the slope of her demand becomes steeper. Less elastic demand enables banks to increase the price and hence the markup. The no-arbitrage condition implies that some banks will switch from selling to the mass to only the rich. Profits of banks that previously served only to the rich will increase, relative to those working for the mass.

The fact that $-Q'(D_j(\theta, P_j))/(Q''(D_j(\theta, P_j))D_j(\theta, P_j)$ is decreasing in $D_j(\theta, P_j)$, is crucial. For a given price, a lower income will decrease demand and hence the elasticity. This enables banks to increase the equilibrium price for the mass sector as well. As some banks move to excluded deposits sector, this enables the remaining banks to increase equilibrium quantity of deposits with lower price.

3 Empirical analysis

This section provides supporting empirical evidence for the primary theoretical findings. The model predictions are tested using micro-data at the US bank-branch level, leveraging the variation in the income inequality to proxy savings inequality and demonstrate our findings from the income distribution perspective.[6] In certain cases, branch-level data is collapsed to the county-level to test specific hypotheses. We narrow our focus to the data sample spanning from 2010 to 2019.

3.1 Data sources and description

Deposit rates. Weekly branch-level data on deposit rates is retrieved from Rate-Watch.[7] Weekly interest rates are collapsed to monthly averages by bank-branches. Along with the information on deposit rates, the data-set also contains information on institutional details, such as institution name, unique FDIC identifier, location, or head office indicator. The analyses are limited to bank and credit union data. The data covers deposit rates on new accounts by different products – certificate of deposit (CD), interest checking (INST) and savings (SAV). We disregard interest checking accounts which are bank accounts that pay interest on a client's balance. Instead, we concentrate on the two most popular deposit products in the US – money market deposit accounts with an account size of $25,000 and 12-month certificates of deposit with an account size of $10,000. The two products are similar in that they are insured "money in the bank", with the main difference that CD has a fixed term with a fixed interest rate (in most cases), and the bank intends that customers hold CD until maturity. Finally, we consider

[6] As already discussed, existing income inequality is projected to savings differences, (Carroll, 2000; Dynan et al., 2004a), among others.

[7] Data downloaded from: www.rate-watch.com.

only the sample of head offices to deal with the banks that take decisions in setting deposit rates.

Deposit volumes. The annual information on deposit quantities is taken from the Federal Deposit Insurance Corporation (FDIC) data-set.[8] The data covers the set of US bank branches and reports total branch office deposits as of June 30, as well as it contains detailed information on the institution. Branch-level FDIC and Rate-Watch data-sets are matched using the unique FDIC bank identifier.

Central to our study, FDIC data-set classifies bank-branches according to the institution's primary asset specialization in the following categories: (1) commercial lending, (2) agricultural lending, (3) consumer lending, (4) mortgage lending, (5) all other less than $1 billion, and (6) all other greater than $1 billion. We refer the institutions with the primary asset specialization being all other greater than $1 billion as *premium banks*, predominantly serving rich clients. Banks with other categories of the primary asset specialization are referred as *mass banks*, in our context, serving both rich and poor. In fact, the majority of the exclusive institutions provide premier wealth management services for high-income (net-worth) clients.[9] By categorizing banks in this manner, we can examine the empirical soundness of our key theoretical assumptions, which are essential for substantiating the main findings outlined in the theoretical part.

Bank-level data. The bank specific data is taken from US Call Reports provided by the Federal Reserve Bank of Chicago.[10] However, rather than using the original source of the data, we directly use already processed bank-level database available at Drechsler et al. (2017).[11] The data-set contains bank balance sheet details on quarterly level covering all the US banks. Bank-level Call Reports data-set is matched with branch-level Rate-Watch and FDIC data-sets using the unique FDIC bank identifier.

[8]Data downloaded from: www.fdic.gov.

[9]For example, *First PREMIER Bank* offers concierge-style, custom banking with unique banking privileges for high-income individuals, couples and families who will maintain long period relationships.

[10]Data downloaded from: www.chicagofed.org.

[11]Data downloaded from: www.pages.stern.nyu.edu.

Income inequality measure. A county-level Gini index[12] of income inequality is retrieved from the American Community Survey (ACS) data of the US Census Bureau.[13]

Other county-level characteristics. We also consider different county-level characteristics, such as population, unemployment rate, share of population enrolled in college or graduate school, the share of 25 to 64 years age group population, and the percentage of male population in the county. The data source of county-level characteristics is the US Census Bureau.

3.2 Descriptive statistics

The empirical analyses employ micro-data from bank branches in the United States, exploiting the difference in savings discrepancies, captured at the county level using a summary indicator of income inequality. Each bank branch in our sample is then assigned with the Gini index of the county in which it is located. The variation in savings distribution is substantial (between 0.35 and 0.60), as evidenced by Figure B1 of Appendix B presenting the map of Gini index across the US. A lower number (a lighter colour in the map) indicates more fair income distribution in the given county. In addition, the sample is representative of all counties in the United States, as depicted in Figure B2 in Appendix B, which displays a map illustrating the distribution of bank branches across U.S. counties in 2010-2019.

Given our classification of bank-branches, we display branch- and bank-level summary statistics in Panel A and B of Table 1. Despite the number of premium banks in the sample is about 1.6% of the total number of banks, the premium banks hold more than 33% of the total deposit portfolio. An average mass-serving branch holds about $278 million worth of deposits, while a representative premium bank-branch holds about $8.8 billion worth of deposits. Meanwhile, premium banks on average manage to attract deposits with significantly lower level of interest rate – average interest rate for mass banks is about 0.27%, for premium banks is

[12]The Gini index measures the dispersion of income across population. It ranges from zero (perfect equality) to 1 (perfect inequality) and captures the difference between the observed cumulative income distribution (the Lorenz curve) and the perfectly equal income distribution.

[13]Data downloaded from www.data.census.gov.

about 0.17%. These findings are also presented in Figure 3 that showcases a breakdown based on the primary asset specialization groups of the institutions. The data demonstrates that, in line with Proposition 3, premium banks tend to have lower deposit rates (higher markups).

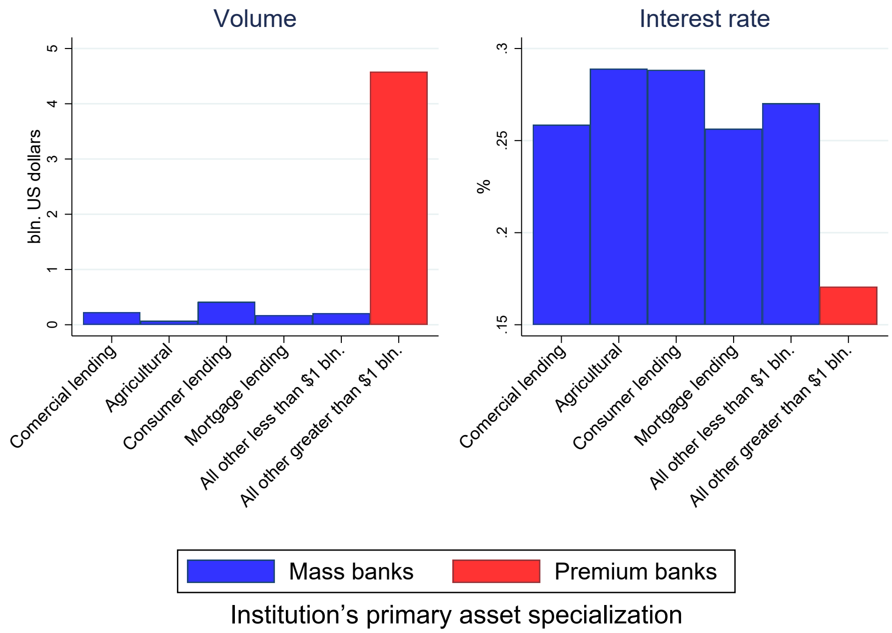
Table 1: Descriptive statistics, 2010 - 2019[1]

A. Branch-level			
	Mass banks	*Premium banks*	*Total*
Number of institutions (% in total)	98.4%	1.6%	100%[1]
Mean (SD) interest rate[2]	0.27%	0.17%	0.27%
	(0.13%)	(0.12%)	(0.13%)
Mean (SD) dep. vol., bln.	$0.278	$8.775	$0.41
	($2.42)	($25.83)	($4.14)
Share in total deposits	66.9%	33.1%	
B. Bank-level			
	Mass banks	*Premium banks*	*Total*
Mean (SD) total assets, bln.	$1.07	$79.05	$1.81
	($8.49)	($275.71)	($29.11)
Mean (SD) deposits/liabilities	94.23%	85.26%	94.15%
	(8.28%)	(20.2%)	(8.5%)
C. County-level			
	Full sample	*Core urban area pop* $< 10K$	*Core urban area pop* $< 50K$
Mean (SD) per capita deposits	$24.81	$22.43	$26.2
	($140.36)	($151.97)	($227.49)
Mean (SD) Gini index	0.44	0.44	0.45
	(0.03)	(0.03)	(0.03)
Mean (SD) unemployment rate	7.24%	7.63%	7.64%
	(3.32%)	(3.05%)	(2.62%)
Mean (SD) college/graduate enroll.	45.99%	45.61%	42.68%
	(28.63)	(26.63)	(19.66)
Mean (SD) male pop. share	49.84%	49.67%	49.29%
	(2.03%)	(1.74%)	(1.18%)
Mean (SD) 26-64 age pop. share	49.14%	49.03%	48.48%
	(3.97%)	(3.99%)	(4.38%)

Note: [1] *The total number of institutions in the examined sample is 13,928.* [2] *Sample for 2013.*

Panels B of Table 1 further demonstrate that premium bank branches represent the institutions with significantly higher levels of total assets. The average level of total assets in mass banks is about $1.07 billion, while the comparable number of the premium banks is more than $79 billion. Furthermore, the deposit to liabilities ratio demonstrates that premium banks are better equipped in terms of liquidity to meet unexpected fund demands.

Figure 3: Markups are higher for exclusive banks.



Note: The sample includes 4,481 institutions observed in 2013.

Panel C in Table 1 presents summarized data at the county level. The statistics are presented for different subsets of the data: the full sample (column 1), the core urban area with a population of at least 10,000 residents, including micropolitan statistical areas (column 2), and branches from core urban areas with a population of at least 50,000 residents in metropolitan statistical areas (column 3). For the full sample, the average Gini index is approximately 0.44, the average per capita deposit rate at the county level is around 24.81, and the average unemployment rate is about 7.24%. In terms of demographic distribution across the counties, approximately half of the sample consists of male population, roughly half falls within the age group of 26-64, and the enrolment rate in college or graduate school is approximately 46%. These proportions remain statistically unchanged when considering the core urban areas.

3.3 Empirical evidence

Our theoretical model suggests that the core of the deposit channel is centered around the depositors' heterogeneity in response to deposit price changes. A lower deposit price elasticity for richer clients leads to exclusion, causing additional welfare losses and triggering deposit runs from the system. To check the relevance of the elasticity channel, first we consider the price elasticity for the two groups of depositors – clients in mass and premium banks. The price elasticity of deposit demand is estimated within a two-stage instrumental variable (IV) regression model, using generalized method of moments (GMM) estimation. We regress logged deposits ($\log D_{i,c,s}$) on the logged value of deposit interest rate ($\log R^d_{i,c,s}$) and its interaction with premium banks dummy variable ($S_{i,c,s}$). We treat these variables as endogenous, instrumenting by supply side cost factors such as service charges, interest expenses and net income on deposits, available at a bank-level Call Reports data-set. We also control for bank-level characteristics, $\boldsymbol{X}_{i,c,s}$, (the log of total assets, deposits to liabilities ratio), county-level characteristics, $\boldsymbol{Z}_{c,s}$, (unemployment rate, enrolment rate in college or graduate school, the share of 25 to 64 years age group in population, and the share of male population), and state fixed effects, $\boldsymbol{\Theta}_s$. The model equation is

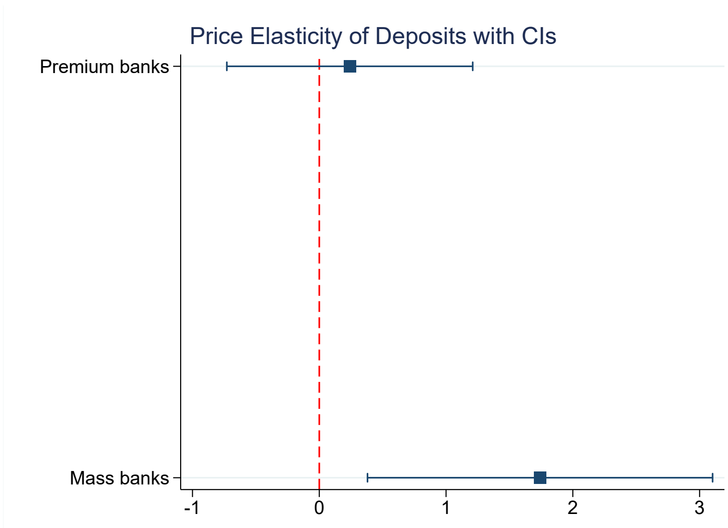
$$\begin{aligned}\log D_{i,c,s} =& \beta_0 + \beta_1 \log R^d_{i,c,s} + \beta_2 S_{i,c,s} + \beta_3 \log R^d_{i,c,s} \times S_{i,c,s} \\ &+ \boldsymbol{\gamma} \boldsymbol{X}_{i,c,s} + \boldsymbol{\omega}' \boldsymbol{Z}_{c,s} + \boldsymbol{\theta}' \boldsymbol{\Theta}_s + \varepsilon_{i,c,s}.\end{aligned} \tag{10}$$

Regression results are reported in Table B1.[14] Following Baum et al. (2007), we conduct diagnostic tests for model identification. The validity of the estimation results of IV-GMM, in particular, depends on the Hansen J test of over-identifying restrictions and the endogene-

[14]Due to the availability of deposit rate data, we examine a snapshot of the sample specifically for the year 2013 in this exercise. The Rate Watch provides free access to deposit rate information only for the year 2013.

ity test.[15] Reported Hansen J test shows that instruments satisfy the exclusion restrictions (p-value = 0.2950). The endogeneity test rejects the null at any conventional level that instrumented variables should be treated as exogenous (p-value = 0.0000). Also, the first-stage F-statistic confirms high correlation between the selected instruments and the endogenous variables.

Figure 4: Price elasticity of deposits for the two groups.



Note: The sample is 4,481 institutions observed in 2013. The elasticities are obtained from IV estimation of equation (10)*. Hansen J statistic p-value* = 0.2950*, first stage F-test for* $\log r$ *p-value* = 0.0003*, first stage F-test for* $S \times \log r$ *p-value* = 0.0000*, tests of endogeneity p-value* = 0.0000*. Standard errors are clustered at bank-branch level.*

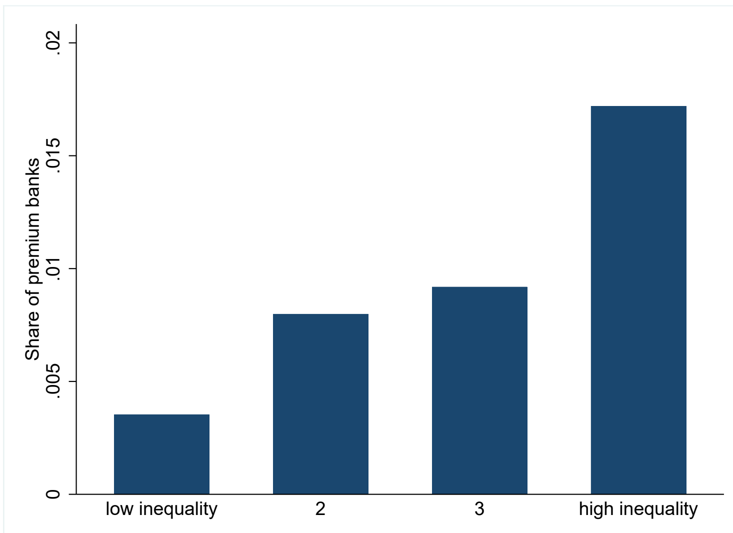
In Figure 4, we plot estimated deposit price elasticities with 95 percent confidence intervals for mass and premium banks. The elasticity is statistically significant for mass banks and insignificant for premium banks (at any conventional level), leading to the conclusion that *depositors served by a premium bank benefit from various privileged services and status-related gains, thus, might opt not to pursue higher interest rates – less responsive to deposit price changes.*

According to the theoretical model, along the sufficient increase in inequality, some banks

[15] Hansen J test checks the validity of the instruments with the null hypothesis that selected instruments are uncorrelated with the error term of the structural model. The endogeneity test is equivalent to estimating the model treating endogenous regressors as exogenous and testing the corresponding orthogonality condition. The null hypothesis is that the specified endogenous regressor can be treated as exogenous. The rejection of the null, therefore, confirms endogeneity.

switch serving only to rich in an effort to maximize profits. The positive association between inequality and the probability of market segmentation is verified by examining the distribution of premium banks among various counties, classified into four equal quartiles based on their Gini coefficients. Figure 5 demonstrates that counties characterized by high income inequality exhibit a notable emergence of exclusion.

Figure 5: Gini index and the share of premium banks.



Note: The sample includes 13,928 institutions observed from 2010 to 2019. Bins are quartiles of Gini coefficient.

We further verify the positive correlation between the probability of exclusion and savings inequality by regressing the binary indicator for premium banks on the Gini index of a county, where the bank-branch is located.[16] We control for bank- and county-level characteristics, year and state fixed effects. Standard errors are clustered at bank-branch level. The empirical model is:

$$S_{i,c,s,t} = \beta_0 + \beta_1 Gini_{c,s,t} + \boldsymbol{\gamma}' \boldsymbol{X}_{i,c,s,t} + \boldsymbol{\omega}' \boldsymbol{Z}_{c,s,t} + \boldsymbol{\lambda}' \boldsymbol{\Lambda}_t + \boldsymbol{\theta}' \boldsymbol{\Theta}_s + \varepsilon_{i,c,s,t} \tag{11}$$

where $S_{i,c,s,t}$ is the exclusive bank dummy; $Gini_{c,s,t}$ is the Gini index; $\boldsymbol{X}_{i,c,s,t}$ is the bank specific

[16]The presence of rare events (in terms of the emergence of a premium bank) is dealt with the inclusion of sampling weights based on bank size to weight the sample back to the population from which the sample was drawn, to avoid selection bias. The presence of rare events in binary response models is a common practice, and the modification of the maximum likelihood estimation through weights used by, e.g., (Field and Smith, 1994; Manski and Lerman, 1977; Wedderburn, 1974).

characteristic; $\boldsymbol{Z}_{c,s,t}$ includes county specific characteristics; $\boldsymbol{\Lambda}_t$ is the year fixed effects; and $\boldsymbol{\Theta}$ is the state fixed effects. We estimate the model by OLS, Logit and Probit and report marginal effects in Table B2. The key observation is that higher income inequality in a county increases the probability that banks in that county will switch to a premium segment.

Though under the exclusion each bank separately is better off, the total deposits decrease, since many customers are excluded from rich-serving banks' product markets. One can observe this correlation empirically by regressing per capita total deposits ($pcD_{c,t}$) on Gini index ($Gini_{c,t}$). As in previous regression models, we control for county specific characteristics embedded in $\boldsymbol{Z}_{c,t}$, as well we include year ($\boldsymbol{\Lambda}_t$) and state ($\boldsymbol{\Theta}_s$) fixed effects:

$$pcD_{c,s,t} = \beta_0 + \beta_1 Gini_{c,s,t} + \boldsymbol{\gamma}\boldsymbol{Z}_{c,s,t} + \boldsymbol{\lambda}'\boldsymbol{\Lambda}_t + \boldsymbol{\theta}'\boldsymbol{\Theta}_s + \varepsilon_{c,s,t}. \tag{12}$$

Estimation results in Table B3 show that a higher income inequality is associated with a lower volume of total deposits, with significant coefficients for both full and the two sub-samples. The scale for the impact of income inequality on per capita deposit level is considerably higher for the sample of core urban area counties with at least 50,000 population. Specifically, a one percentage point increase in the Gini index is associated with 290.3 USD decrease in per capita deposits in core urban areas with at least 50,000 population.

4 Conclusion

In this paper, we model the emergence of separation in banking - along the increase in deposits inequality rich and poor clients are served by different banks. High savings inequality distorts the growth of total deposits, as fewer banks produce deposits for mass. The emergence of premium banks comes at the cost of lowered total deposits and higher prices. In the empirical part, using micro-level data from U.S. bank-branches, we provide supporting evidence for the main findings of the theoretical model. We show that deposits price elasticities are different for rich and poor, deposit rates are lower for exclusive banks, the emergence of exclusive banks are more likely and deposit volumes are smaller in counties with higher income inequality.

Our study is an essential step towards understanding the mechanism behind the emergence of bank separation and deposits market exclusion. The major limitation in the model is that the allocation of deposits and the implied equilibrium take the resource for deposits (W) as given. While the mechanism behind market exclusion and the emergence of premium banks can be explained for any level of income directed to the deposits market, the implications of policy changes (monetary or macroprudential) should be studied by allowing for an alternative investment technology such as government bonds and entrepreneurial (risky) assets. Choices in deposits markets characterized in our model potentially opens a new deposits channel for the monetary policy transmission mechanism. Another extension can be relaxing the assumption of an interior solution for the bank's problem and analyse the implications from the market exclusion perspectives.

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Appendix

A. Omitted Derivations and Proofs

Optimal deposit demand function

A depositor's problem is

$$\max_{\{D_j(\theta)\}} \int_0^N \left(R + \frac{s-\gamma}{2} D_j(\theta) \right) D_j(\theta) dj \quad \text{subject to} \quad \int_0^N P_j D_j(\theta) dj \leq W(\theta), \quad D_j(\theta) \geq 0,$$

hence, the Lagrangian function will be

$$\mathcal{L} = \int_0^N \left(R + \frac{s-\gamma}{2} D_j(\theta) \right) D_j(\theta) dj - \lambda(\theta) \left(\int_0^N P_j D_j(\theta) dj - W(\theta) \right) + \int_0^N \lambda_j D_j(\theta) dj$$

The first order condition (FOC) of the Lagrangian function is

$$R + (s-\gamma) D_j(\theta) - \lambda(\theta) P_j + \lambda_j = 0,$$

with $\lambda(\theta) \geq 0$.

In Case 1, $\gamma > s$, an interior optimal solution can be achieved from the FOC, when $\lambda_j = 0$ and $\lambda(\theta) > 0$. In this case we have

$$D_j(\theta) = \frac{R - \lambda(\theta) P_j}{\gamma - s}.$$

If, however, the subjective price is larger than the marginal return at $D_j = 0$,

$$R \leq \lambda(\theta) P_j,$$

the depositor θ does not invest in the bank j. In the compact form, the optimal solution can be characterized as follows:

In both cases, $\gamma > s$ and $\gamma < s$, the deposit demand will be given by

$$D_j(\theta) = \begin{cases} \frac{R-\lambda(\theta)P_j}{\gamma - s}, & \text{if } R > \lambda(\theta)P_j. \\ 0, & \text{if } R \leq \lambda(\theta)P_j. \end{cases}$$

In Case 2, there is no interior solution. If $\gamma < s$, the depositor either invests the entire wealth in a single bank, $D_j = D$, or no investment is made in that bank. If a bank will set a deposit price higher than the market price, $P_j > P$, clients will withdraw their deposit to shift to another bank.

A bank's problem

Banks attract financial resources and provide loans. Both products, deposits and loans, are differentiated, and the degree of differentiation determines the monopoly power of banks. The profit maximization of a bank has the following form:

$$\max_{\{R_j^\ell, P_j, B^{CB}\}} \Pi = L\left(R_j^\ell\right) R_j^\ell - D\left(P_j\right)\left(R^d\left(P_j\right) + c\right) - B^{CB} R^r - \bar{K} R^k$$

subject to

$$L\left(R_j^\ell\right) \leq D\left(P_j\right) + B^{CB} + \bar{K},$$
$$\frac{L\left(R_j^\ell\right)}{\bar{K}} \leq \kappa, \quad \text{and} \quad B^{CB} \leq \bar{B}^{CB};$$

where R_j^ℓ is the loan rate; $R^d\left(P_j\right) = 1 + R - P_j$ determines the (gross) deposit rate; R^r is the central bank's refinancing (repo) rate; c is the service cost per unit of deposit, $L(\cdot)$ and $D(\cdot)$ are loan and deposit demand functions, respectively; $\bar{K}$ is the bank owners' capital which is fixed; R^k is the cost of capital; B^{CB} is the amount borrowed from the central bank; $\bar{B}^{CB}$ is the cap on borrowing from the central bank: the parameter $\kappa \in (0, 1)$ is another restriction set by the central bank, which governs the loans-to-equity ratio.

Given the fixed level of capital, banks have two sources of long term fund raising – private savings and the funds offered by the central bank. If attracted deposits fall short from allocated loans, $L\left(R_j^\ell\right) - D\left(P_j\right) > 0$, the gap is filled by the borrowing from the central bank, otherwise the bank lends to the public institution. We restrict our analysis to the interior solution, such that $L^* \in \left(0, \kappa \bar{K}\right)$ and $B^{CB^*} < \bar{B}^{CB}$. This enables to effectively plug the resource constraint with equality into the objective function and eliminate B^{CB}. Then, it is useful to write the profit function as follows:

$$\begin{aligned}\Pi\left(R_j^\ell, P_j\right) &= L\left(R_j^\ell\right) R_j^\ell - D\left(P_j\right)\left(R^d\left(P_j\right) + c\right) - R^r\left(L\left(R_j^\ell\right) - D\left(P_j\right) - \bar{K}\right) - \bar{K}R^k \\ &= \underbrace{L\left(R_j^\ell\right)\left((1-p)R_j^\ell - R^r\right)} + \underbrace{D\left(P_j\right)\left(R^r - R^d\left(P_j\right) - c\right)} + \underbrace{\bar{K}(R^r - R^k)}.\end{aligned}$$

Banks have monopoly power both in deposit and loan markets, which ensures non-zero markups in these markets and leads to the condition $R^d + c < R^r < R^\ell$. Also, the terms in the sum are only linked through the repo rate so that we can think of two separate activities. Firstly, the bank collects $D\left(P_j\right)$ amount of deposits with the rate $R^d\left(P_j\right)$ and lends to the central bank with R^r. Secondly, it borrows $L\left(R_j^\ell\right)$ amount from the central bank with the rate R^r and lends these resources to the private sector with R_j^ℓ, which ensures that $R^r < R^\ell$. As a result, the optimization problem can be separated into two parts:

– $\max_{R_j^\ell} \Pi\left(R_j^\ell, \bar{P}\right)$ reduced to:

$$\max_{R_j^\ell} L\left(R_j^\ell\right)\left(R_j^\ell - R^r\right),$$

– $\max_{P_j} \Pi\left(\bar{R}^\ell, P_j\right)$ reduced to:

$$\max_{P_j} D\left(P_j\right)\left(P_j - (1 + R - R^r + c)\right) \equiv D\left(P_j\right)\left(P_j - \tilde{R}\right).$$

where $\tilde{R} \equiv 1 + R - R^r + c$.

In the credit market, given the deposit prices, first-order conditions imply:

$$dL\left(R_j^\ell\right)\left(R_j^\ell - R^r\right) + L\left(R_j^\ell\right) dR_j^\ell = 0$$
$$\Rightarrow \frac{R_j^\ell - R^r}{R_j^\ell} = -\frac{L\left(R_j^\ell\right) dR_j^\ell}{dL\left(R_j^\ell\right) R_j^\ell} = -\frac{1}{\frac{dL\left(R_j^\ell\right)/L\left(R_j^\ell\right)}{dR_j^\ell/R_j^\ell}} = -\frac{1}{\epsilon_L\left(R_j^\ell\right)}.$$

In the deposit market, given the lending rates, first-order conditions imply:

$$dD\left(P_j\right)\left(P_j - \tilde{R}\right) + D\left(P_j\right) dP_j = 0$$
$$\Rightarrow \frac{P_j - \tilde{R}}{P_j} = -\frac{D\left(P_j\right) dP_j}{dP\left(P_j\right) P_j} = -\frac{1}{\frac{dD(P_j)/D(P_j)}{dP_j/P_j}} = -\frac{1}{\epsilon_D\left(P_j\right)}.$$

Derivation of optimal prices with two types of agents

As argued, the profit maximization for a bank can be reduced to:

$$\max_{P_j} D\left(P_j\right)\left(P_j - \tilde{R}\right), \quad \text{subject to } D_j = \begin{cases} 0, & \text{if } P_j \in [R/\lambda_R, \infty) \\ (1-\alpha)\frac{R-\lambda_R P_j}{\gamma - s}, & \text{if } P_j \in [R/\lambda_P, R/\lambda_R) \\ \alpha \frac{R-\lambda_P P_j}{\gamma - s}, & \text{if } P_j \in [0, R/\lambda_P). \end{cases}$$

For banks, selling deposits to mass (poor), we have:

$$\max_{P^M} \alpha \frac{R - \lambda_P P^M}{\gamma - s}\left(P^M - \tilde{R}\right)$$

FOC implies

$$\frac{\alpha}{\gamma - s}\left[-\lambda_P\left(P^M - \tilde{R}\right) + R - \lambda_P P^M\right] = 0 \quad \Rightarrow \quad P^M = \frac{1}{2}\left(\frac{R}{\lambda_P} + \tilde{R}\right).$$

For banks, selling deposits to only rich, we have:

$$\max_{P^E}(1-\alpha)\frac{R-\lambda_R P^E}{\gamma-s}\left(P^E-\tilde{R}\right)$$

FOC implies

$$\frac{1-\alpha}{\gamma-s}\left[-\lambda_R\left(P^E-\tilde{R}\right)+R-\lambda_R P^E\right]=0 \quad \Rightarrow \quad P^E=\frac{1}{2}\left(\frac{R}{\lambda_R}+\tilde{R}\right).$$

Proof of Proposition 1

Proof. No-deviation condition will be:

$$\begin{aligned}
D^E\left(P^E\right)\left(P^E-\tilde{R}\right) &< D^M\left(P^M\right)\left(P^M-\tilde{R}\right) \quad \Rightarrow \\
(1-\alpha)\frac{R-\lambda_R P^E}{\gamma-s}\left(P^E-\tilde{R}\right) &< \alpha\frac{R-\lambda_P P^M}{\gamma-s}\left(P^M-\tilde{R}\right) \quad \Rightarrow \\
(1-\alpha)\frac{R-\lambda_R\frac{1}{2}\left(\frac{R}{\lambda_R}+\tilde{R}\right)}{\gamma-s}\left(\frac{1}{2}\left(\frac{R}{\lambda_R}+\tilde{R}\right)-\tilde{R}\right) &< \alpha\frac{R-\lambda_P\frac{1}{2}\left(\frac{R}{\lambda_P}+\tilde{R}\right)}{\gamma-s}\left(\frac{1}{2}\left(\frac{R}{\lambda_P}+\tilde{R}\right)-\tilde{R}\right) \quad \Rightarrow \\
(1-\alpha)\left(R-\lambda_R\tilde{R}\right)\left(\frac{R-\lambda_R\tilde{R}}{\lambda_R}\right) &< \alpha\left(R-\lambda_P\tilde{R}\right)\left(\frac{R-\lambda_P\tilde{R}}{\lambda_P}\right) \quad \Rightarrow \\
\frac{1-\alpha}{\alpha} &< \frac{\lambda_R}{\lambda_P}\left(\frac{R-\lambda_P\tilde{R}}{R-\lambda_R\tilde{R}}\right)^2,
\end{aligned}$$

where the right hand side is decreasing in the inequality parameter, υ. To see this, recall that

$$\upsilon=\frac{1}{1-\alpha}\left(\frac{1}{W_P}-\alpha\right), \quad \text{or} \quad W_P=\frac{1}{(1-\alpha)\upsilon+\alpha},$$

which implies that

$$\frac{\partial\lambda_P}{\partial\upsilon}=\frac{\partial\lambda_P}{\partial W_P}\frac{\partial W_P}{\partial\upsilon}=-\frac{\partial\lambda_P}{\partial W_P}\frac{1-\alpha}{\left[(1-\alpha)\upsilon+\alpha\right]^2}>0.$$

Thus, the first derivative of the RHS with respect to inequality parameter υ is

$$-\frac{\lambda_R}{\lambda_P^2}\frac{\partial\lambda_P}{\partial\upsilon}\left(\frac{R-\lambda_P\tilde{R}}{R-\lambda_R\tilde{R}}\right)^2-2\frac{\lambda_R}{\lambda_P}\left(\frac{R-\lambda_P\tilde{R}}{R-\lambda_R\tilde{R}}\right)\frac{\tilde{R}}{R-\lambda_R\tilde{R}}\frac{\partial\lambda_P}{\partial\upsilon}<0.$$

Therefore, at some value of $\bar{\upsilon}$, the inequality will not hold for all $\upsilon>\bar{\upsilon}$. □

Derivations for the proof of Proposition 2

Using optimal demands in (4) and eliminating λ_R and λ_P through (5), results the market equilibrium quantities:

$$D^E=(1-\alpha)\frac{R-\lambda_R P^E}{\gamma-s}=\frac{R-\frac{R}{2P^E-\tilde{R}}P^E}{\gamma-s}=(1-\alpha)\frac{R}{\gamma-s}\left(\frac{P^E-\tilde{R}}{2P^E-\tilde{R}}\right),$$
$$D^M=\alpha\frac{R-\lambda_P P^M}{\gamma-s}=\alpha\frac{R-\frac{R}{2P^M-\tilde{R}}P^M}{\gamma-s}=\alpha\frac{R}{\gamma-s}\left(\frac{P^M-\tilde{R}}{2P^M-\tilde{R}}\right).$$

No-arbitrage condition implies:

$$D^E\left(P^E\right)\left(P^E-\tilde{R}\right)=D^M\left(P^M\right)\left(P^M-\tilde{R}\right)\quad\Rightarrow$$
$$(1-\alpha)\frac{R}{\gamma-s}\frac{\left(P^E-\tilde{R}\right)^2}{2P^E-\tilde{R}}=\alpha\frac{R}{\gamma-s}\frac{\left(P^M-\tilde{R}\right)^2}{2P^M-\tilde{R}}\quad\Rightarrow$$
$$\left(P^E-\tilde{R}\right)^2=\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)}\left(2\left(P^E-\tilde{R}\right)+\tilde{R}\right)\quad\Rightarrow$$
$$\left(P^E-\tilde{R}\right)^2-2\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)}\left(P^E-\tilde{R}\right)-\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)}\tilde{R}=0.$$

Therefore:

$$
\begin{aligned}
P^E - \tilde{R} =& \frac{2\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)} \pm \left[\left(2\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)}\right)^2 + 4\frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2}{\left(2P^M-\tilde{R}\right)}\tilde{R}\right]^{\frac{1}{2}}}{2} \\
=& \frac{\alpha}{1-\alpha}\frac{\left(P^M-\tilde{R}\right)^2 \pm \left(P^M-\tilde{R}\right)\left[\left(P^M-\tilde{R}\right)^2 + \frac{1-\alpha}{\alpha}\left(2P^M-\tilde{R}\right)\tilde{R}\right]^{\frac{1}{2}}}{\left(2P^M-\tilde{R}\right)}.
\end{aligned}
$$

We only consider the positive solution. Define $P^M - \tilde{R} \equiv \tilde{P}^M$ and $P^E - \tilde{R} \equiv g\left(\tilde{P}^M\right)$. Thus,

$$
g\left(\tilde{P}^M\right) = \frac{\alpha}{1-\alpha}\frac{\left(\tilde{P}^M\right)^2 + \tilde{P}^M\left[\left(\tilde{P}^M\right)^2 + 2\frac{1-\alpha}{\alpha}\left(\tilde{P}^M+\tilde{R}\right)\tilde{R}\right]^{\frac{1}{2}}}{2\left(\tilde{P}^M+\tilde{R}\right)}.
$$

Note that P^E is increasing with P^M, or in other words $g'\left(P^M-\tilde{R}\right) > 0$.

Proof.

$$
\begin{aligned}
g'\left(\tilde{P}^M\right) =& \frac{\alpha}{1-\alpha}\frac{\left[2\tilde{P}^M + [\cdot]^{\frac{1}{2}} + \tilde{P}^M[\cdot]^{-\frac{1}{2}}\left[2\tilde{P}^M + 2\frac{1-\alpha}{\alpha}\tilde{R}\right]\right]\left(\tilde{P}^M+\tilde{R}\right) - \left[\left(\tilde{P}^M\right)^2 + \tilde{P}^M[\cdot]^{\frac{1}{2}}\right]}{\left(\tilde{P}^M+\tilde{R}\right)^2} \\
=& \frac{\alpha}{1-\alpha}\frac{\mathcal{A}_1+\mathcal{A}_2+\mathcal{A}_3-\mathcal{B}_1-\mathcal{B}_2}{\mathcal{C}}.
\end{aligned}
$$

where

$$\mathcal{A}_1 \equiv 2\tilde{P}^M\left(\tilde{P}^M + \tilde{R}\right),$$
$$\mathcal{A}_2 \equiv [\cdot]^{\frac{1}{2}}\left(\tilde{P}^M + \tilde{R}\right),$$
$$\mathcal{A}_3 \equiv 2\tilde{P}^M[\cdot]^{-\frac{1}{2}}\left[\tilde{P}^M + \frac{1-\alpha}{\alpha}\tilde{R}\right]\left(\tilde{P}^M + \tilde{R}\right),$$
$$\mathcal{B}_1 \equiv \left(\tilde{P}^M\right)^2,$$
$$\mathcal{B}_2 \equiv \tilde{P}^M[\cdot]^{\frac{1}{2}},$$
$$\mathcal{C} \equiv \left(\tilde{P}^M + \tilde{R}\right)^2.$$

As $\mathcal{A}_1 - \mathcal{B}_1 = \left(\tilde{P}^M\right)^2 > 0$, $\mathcal{A}_2 - \mathcal{B}_2 = [\cdot]^{\frac{1}{2}}\tilde{R} > 0$, $\mathcal{A}_3 > 0$ and $\mathcal{C} > 0$, $g'\left(\tilde{P}^M\right) > 0$. □

The proof of Proposition 3

Proof. **(i)** Aggregating individual budget constraints with respect to corresponding shares given by α, we obtain:

$$(N-n)P^E D^E + nP^M D^M = 1, \quad \Rightarrow \quad n = \frac{1 - NP^E D^E}{P^M D^M - P^E D^E}$$

When taking the total differentiation of the aggregated constraint with respect to P^M, and solving it for $n'(P^M)$, we have:

$$\frac{\partial n}{\partial P^M} = -\frac{n\partial\left(P^M D^M\right)/\partial P^M + (N-n)\,\partial\left(P^E D^E\right)/\partial P^M}{P^M D^M - P^E D^E} < 0,$$

To observe that n decreases in P^M (indicating that the exclusion probability rises with greater savings inequality), consider the no-arbitrage condition which implies that:

$$\frac{D^M}{D^E} = \frac{P^E - \tilde{R}}{P^M - \tilde{R}} > 1 \Rightarrow D^M > D^E, \text{ and } \left(P^M D^M - P^E D^E\right) = \tilde{R}\left(D^M - D^E\right) > 0,$$

and it is easy to check that $\frac{\partial\left(P^M D^M\right)}{\partial P^M} > 0$ and $\frac{\partial\left(P^E D^E\right)}{\partial P^M} > 0$, using the fact that $\partial P^E/\partial P^M > 0$:

$$\frac{\partial\left(P^M D^M\right)}{\partial P^M} D^M + P^M \alpha \frac{R}{\gamma - s}\left(\frac{\left(2P^M - \tilde{R}\right) - 2\left(P^M - \tilde{R}\right)}{\left(2P^M - \tilde{R}\right)^2}\right) = D^M + \alpha \frac{R\tilde{R}P^M}{(\gamma - s)\left(2P^M - \tilde{R}\right)^2} > 0,$$

$$\begin{aligned}\frac{\partial\left(P^E D^E\right)}{\partial P^M} &= \frac{\partial P^E}{\partial P^M} D^E + P^E(1-\alpha)\frac{R}{\gamma - s}\left(\frac{\left(2P^E - \tilde{R}\right)\frac{\partial P^E}{\partial P^M} - 2\left(P^E - \tilde{R}\right)\frac{\partial P^E}{\partial P^M}}{\left(2P^E - \tilde{R}\right)^2}\right) \\ &= \frac{\partial P^E}{\partial P^M} D^E + (1-\alpha)\frac{R\tilde{R}\frac{\partial P^E}{\partial P^M}P^E}{(\gamma - s)\left(2P^E - \tilde{R}\right)^2} > 0.\end{aligned}$$

(ii) We start from total deposits, $D = (N-n)\,D^E + nD^M$, and evaluate its derivative with respect to P^M:

$$\frac{\partial D}{\partial P^M} = (N-n)\frac{\partial D^E}{\partial P^E}\frac{\partial P^E}{\partial P^M} - \frac{\partial n}{\partial P^M} D^E + \frac{\partial n}{\partial P^M} D^M + n\frac{\partial D^M}{\partial P^M}.$$

Then, the condition $\frac{\partial D}{\partial P^M} < 0$ is equivalent to:

$$-\frac{\partial n}{\partial P^M} D^M > (N-n)\frac{\partial D^E}{\partial P^E}\frac{\partial P^E}{\partial P^M} - \frac{\partial n}{\partial P^M} D^E + n\frac{\partial D^M}{\partial P^M} \equiv H,$$

where both sides are positive.

To see that the condition is satisfied, take the differential of aggregate budget constraint with respect to P^M:

$$\begin{aligned}-\frac{\partial n}{\partial P^M} P^E D^E + (N-n)\frac{\partial P^E}{\partial P^M} D^E + (N-n)\,P^E\frac{\partial D^E}{\partial P^E}\frac{\partial P^E}{\partial P^M} + \frac{\partial n}{\partial P^M} P^M D^M + nD^M \\ + nP^M\frac{\partial D^M}{\partial P^M} = 0.\end{aligned}$$

Then,

$$-\frac{\partial n}{\partial P^M} D^M = (N-n)\frac{\partial D^E}{\partial P^E}\frac{\partial P^E}{\partial P^M}\frac{P^E}{P^M} - \frac{\partial n}{\partial P^M} D^E\frac{P^E}{P^M} + n\frac{\partial D^M}{\partial P^M} + \frac{(N-n)\frac{\partial P^E}{\partial P^M}D^E + nD^M}{P^M}$$

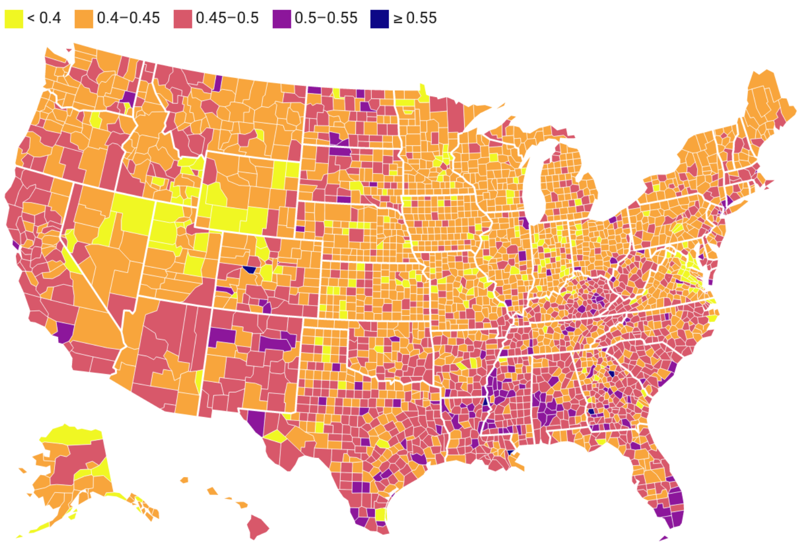
As $\frac{(N-n)\frac{\partial P^E}{\partial P^M}D^E+nD^M}{P^M} > 0$ and $\frac{P^E}{P^M} > 1$, we can write

$$-\frac{\partial n}{\partial P^M}D^M > (N-n)\frac{\partial D^E}{\partial P^E}\frac{\partial P^E}{\partial P^M}\frac{P^E}{P^M} - \frac{\partial n}{\partial P^M}D^E\frac{P^E}{P^M} + n\frac{\partial D^M}{\partial P^M} > H.$$

(iii) Higher inequality leads to higher equilibrium prices and deposits, and linear demands become steeper in both segments. As a result, for each price level the elasticity will be smaller, implying that the LHS of equation $\frac{P_j-\tilde{R}}{P_j} = -\frac{1}{\epsilon_D(P_j)}$ will be upward shifted (it is decreasing in P_j). Considering that the Lerner index (RHS of the equation) is increasing in P_j, the new equilibrium markup will now be higher. □

B. Data Appendix

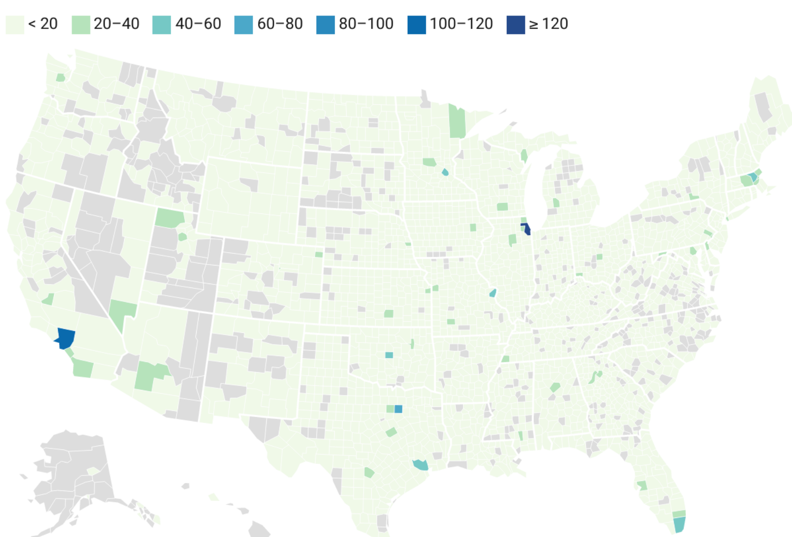
Figure B1: income inequality in the U.S.



2a.png

Note: *Average values of the county-level Gini index for 2010-2019 are constructed.*

Figure B2: Number of bank branches in the U.S.



2b.png

Note: *Average values for 2010-2019 are constructed.*

Table B1: In exclusive banks clients do not respond significantly to deposit rate changes.

	First stage		Second stage
	$log\left(R^d_{i,c,s}\right)$	$log\left(R^d_{i,c,s}\right) \times S_{i,c,s}$	$log\left(D_{i,c,s}\right)$
$log\left(R^d_{i,c,s}\right)$			1.741***
			(0.694)
$log\left(R^d_{i,c,s}\right) \times S_{i,c,s}$			-1.501**
			(0.594)
$ServiceCharge_{i,c,s}$	-3.7827^{**}	-2.9228^{***}	
	(1.855)	(1.188)	
$IntCost_{i,c,s}$	7.3014^{**}	1.6922	
	(3.149)	(2.633)	
$IntIncome_{i,c,s}$	-0.0981	-0.0340	
	(0.365)	(0.288)	
$DtL_{i,c,s}$	0.2681^{*}	-0.0099	-0.257
	(0.141)	(0.057)	(0.497)
$LTA_{i,c,s}$	-0.1166^{***}	-0.0281^{***}	0.765^{***}
	(0.007)	(0.006)	(0.070)
$Unemp_{c,s}$	-0.7217^{**}	-0.1682^{*}	0.974
	(0.313)	(0.092)	(0.798)
$Enrollment_{c,s}$	0.0654	-0.0235^{**}	-0.380^{***}
	(0.045)	(0.011)	(0.111)
$Male_{c,s}$	-0.1572	-0.0889	-0.684
	(0.403)	(0.121)	(0.865)
$Age_{c,s}$	-0.1979	0.0350	0.0512
	(0.197)	(0.050)	(0.434)
Constant	0.4092	0.6527^{***}	0.551
	(0.437)	(0.168)	(1.254)
State FE	✓	✓	✓
Observations			4,445
R-squared			0.021
F-test of excluded instruments (F-Prob)			0.000
Endogeneity test (χ^2-Prob)			0.000
Sargan-Hansen J test (χ^2-Prob)			0.295

Note: The period coverage is 2013. $R^d_{i,c,s}$ is deposit rate; $D_{i,c,s}$ is deposit volume; $S_{i,c,s}$ is premium bank dummy; $DtL_{i,c,s,t}$ is deposits to liabilities ratio; $ServiceCharge_{i,c,s,t}$ is service charges on domestic deposits, mln USD; $IntCost_{i,c,s,t}$ is interest expense, mln. USD; $IntIncome_{i,c,s,t}$ is net interest income, mln. USD; $Unemp_{c,s,t}$ is unemployment rate; $Enrollment_{c,s,t}$ is enrolment rate in college or graduate school; $Male_{c,s,t}$ is the share of 25 to 64 years age group in population; $Age_{c,s,t}$ is the share of male population. Clustered (at bank-branch level) robust standard errors are given in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

Table B2: Exclusion emerges with the increase in income inequality.

Variables	(1) OLS	(2) Logit	(3) Probit
$Gini_{c,s,t}$	0.131^{***}	0.0489^{***}	0.0606^{***}
	(0.0415)	(0.0130)	(0.0154)
$DtL_{i,c,s,t}$	-0.0762^{***}	-0.0118^{***}	-0.0179^{***}
	(0.0260)	(0.0031)	(0.0041)
$ServiceCharge_{i,c,s,t}$	0.531^{**}	0.0702^{**}	0.0961^{***}
	(0.254)	(0.0274)	(0.0355)
$IntCost_{i,c,s,t}$	0.363^{**}	0.0235^{**}	0.0353^{**}
	(0.177)	(0.0100)	(0.0140)
$IntIncome_{i,c,s,t}$	−0.0063	−0.00044	−0.0002
	(0.0308)	(0.0022)	(0.0030)
$Unemp_{c,s,t}$	−0.0087	−0.0028	−0.0015
	(0.0333)	(0.0205)	(0.0226)
$Enrollment_{c,s,t}$	−0.0014	−0.0014	−0.0020
	(0.0032)	(0.0018)	(0.0021)
$Male_{c,s,t}$	−0.0018	−0.0083	−0.0094
	(0.0327)	(0.0243)	(0.0268)
$Age_{c,s,t}$	−0.0152	-0.0156^{*}	−0.0175
	(0.0207)	(0.0095)	(0.0113)
State FE	✓	✓	✓
Year FE	✓	✓	✓
$Constant$	0.0314		
	(0.0311)		
Obs.	63,545	54,604	54,604
R-squared	0.097		
Pseudo R-squared		0.210	0.215

Note: Marginal effects are reported. The sample is weighted with log of deposits. The period coverage is 2010-2019. $Gini_{c,s,t}$ is the gini measure of income inequality; $DtL_{i,c,s,t}$ is deposits to liabilities ratio; $ServiceCharge_{i,c,s,t}$ is service charges on domestic deposits, mln USD; $IntCost_{i,c,s,t}$ is interest expense, mln. USD; $IntIncome_{i,c,s,t}$ is net interest income, mln. USD; $Unemp_{c,s,t}$ is unemployment rate; $Enrollment_{c,s,t}$ is enrolment rate in college or graduate school; $Male_{c,s,t}$ is the share of 25 to 64 years age group in population; $Age_{c,s,t}$ is the share of male population. Clustered (at bank-branch level) robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

Table B3: Total deposits decrease in income inequality.

Variables	(1) Full sample	(2) Core urban area ($Pop. > 10K$)	(3) Core urban area ($Pop. > 50K$)
$Gini_c$	-23.03^{*}	-36.83^{*}	-290.3^{**}
	(13.05)	(20.73)	(136.8)
$Unemp_{c,s,t}$	27.68^{**}	35.86^{**}	125.6^{*}
	(13.54)	(16.62)	(67.99)
$Enrollment_{c,s,t}$	8.064^{***}	11.11^{***}	14.70^{***}
	(2.017)	(2.464)	(5.498)
$Male_{c,s,t}$	28.45	138.7^{**}	$1,449^{**}$
	(37.42)	(64.10)	(598.0)
$Age_{c,s,t}$	30.05	44.78^{**}	63.68^{*}
	(18.68)	(22.67)	(34.12)
State FE	✓	✓	✓
Year FE	✓	✓	✓
Constant	3.849	−55.61	-595.7^{**}
	(22.31)	(34.56)	(255.8)
Observations	22,761	18,883	8,256
R-squared	0.962	0.963	0.964

Note: The period coverage is 2010-2019. $Gini_{c,s,t}$ is the gini measure of income inequality; $Unemp_{c,s,t}$ is unemployment rate; $Enrollment_{c,s,t}$ is enrolment rate in college or graduate school; $Male_{c,s,t}$ is the share of 25 to 64 years age group in population; $Age_{c,s,t}$ is the share of male population. Clustered (at state level) robust standard errors are given in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

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