How Do Commercial Banks Leverage Market Power?

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Abstract

Cluster products are complementary goods that have reduced transaction costs when purchased from a single company. These products are economically important and abundant in markets. A notable example is the commercial banking products. In this particular market, consumers arguably select banks rather than specific banking products, allowing banks to leverage their power in one product market, such as loans, to set rates in another product market, such as deposits. Although the concept of cluster products has roots in seminal Supreme Court decisions from the 1960s, modern regulatory analysis of proposed bank mergers often overlooks this phenomenon. In this paper, we present a structural demand and supply model for loans and deposits that accounts for the complementarity between these commercial banking products. In our model, banks compete in these two product markets by taking into consideration the interplay between the demands for both products. We use our model to predict the impact of actual mergers on deposit and loan rates charged by and market shares of each market participant. Subsequently, we compare these predictions to the rates and shares that were realized after the studied mergers.

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1 Introduction

A basic feature of consumption is the presence of complementary products. Consumers might be using two products in conjunction, and the value they derive from the former can depend on their ability to acquire the latter. Firms offering these products often have fundamentally different incentives when it comes to setting prices, promotions and product selection. Complementarity across products can be observed more broadly, but it is especially salient in loans that commercial banks issue and deposits they collect. In the commercial bank setting, consumers are arguably choosing banks, as they are inclined to go to the same bank for different commercial banking products. Furthermore, some banks also impose the requirement that a borrower has a deposit account with them as a precondition for taking out a loan. It is theoretically ambiguous how banks use their market power over one product to set prices for the other product. In other words, it is an open question how banks take into consideration consumers' preferences for their loan products when setting deposit rates, and vice versa. In this paper, we answer how commercial banks compete in rates when consumers view loans and deposits as complements and shop for banks, rather than for banking products.

The Supreme Court and subsequent banking regulations, in principle, embraced the unified approach that we are adopting in this paper. The Court emphasized that it is the cluster of products and services, rather than individual products and services, that is relevant in the analysis of mergers between banks:"[I]t is the *cluster* of products and services that full-service banks offer that as a matter of trade reality makes commercial banking a distinct line of commerce[...] The clustering of financial products and services in banks facilitates convenient access to them for all banking customers."[1] However, in

[1]United States v. Phillipsburg Nat'l Bank Trust Co., 399 U.S. 350, 360 (1970).

practice, agencies are examining markets for loans and deposits separately. For instance, the Federal Reserve relies solely on deposits as a metric to gauge a bank's market share and determine market concentration when assessing a proposed bank merger, following the 1995 Bank Merger guidelines.[2] In contrast, the Antitrust Division of the Department of Justice considers the market for small business lending as an additional but separate factor. Examining concentration levels for individual banking products in isolation can potentially be misleading.

Figures 1 and 2 illustrate this potential outcome. In Figure 1, we report concentration levels calculated using banks' deposit market shares, while in Figure 2 we present concentration levels calculated using banks' mortgage market shares. Color differences depict differences in Herfindahl-Hirschman Index (HHI). In both figures, blue represents states with HHI less than 1000, the threshold below which the agencies regard the banking market to be unconcentrated. Gray represents HHIs ranging from 1000 to 1800, denoting markets with low to higher concentration. According to the Bank Merger Guidelines, mergers in these markets might be challenged if they increase the HHI by more than 100. Red represents states with HHIs above 1800, indicating highly concentrated markets where the agencies scrutinize mergers that lead to an increase in concentration by more than 100-200. A state, such Montana, may fall below the threshold when concentration is assessed using deposit shares, but exceed the acceptable threshold when concentration is measured based on mortgage shares.

In this paper, we model supply and demand of commercial banking products taking into account the demand complementarities between these two products, estimate our structural model in markets that are affected by bank mergers,

[2]U.S. Dep't of Justice Fed. Trade Comm'n, Bank Merger Guidelines (1995), https://www.justice.gov/atr/bank-merger-competitive-review-introduction-and-overview-1995.

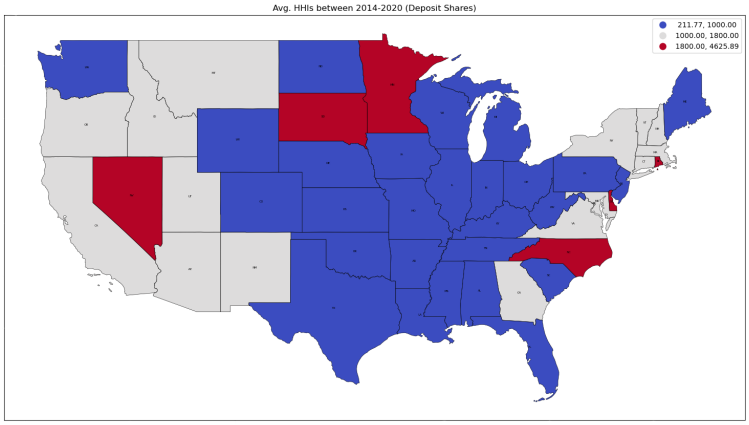

Figure 1: Market concentration measured by deposits

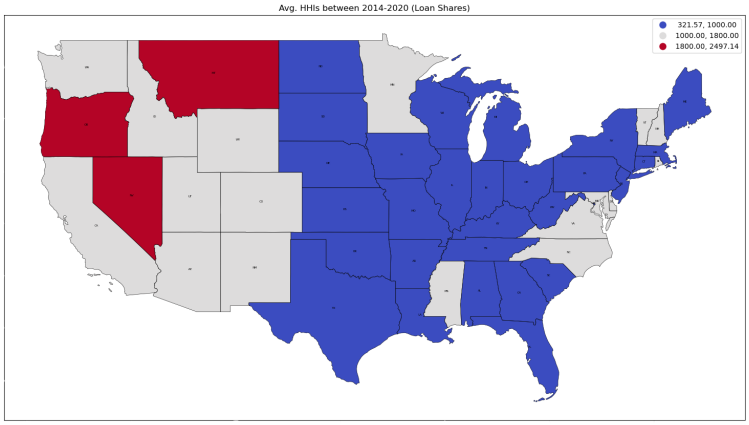

Figure 2: Market concentration measured by mortgages

and use our estimates to predict post-merger rates and shares. We assess the predictive accuracy of our model by regressing realized rates and shares on those that are predicted by our model. When consumers perceive loans and deposits as complementary goods, banks have the opportunity to leverage their market power in one product to impact the rates they set for another product. Consequently, neglecting the complementarities can lead to an inaccurate representation of the competitive effects resulting from a merger. For this reason, our structural model provides antitrust regulators with a valuable tool in their assessment of proposed bank mergers.

The model of the commercial banking industry features consumers of loans and deposits with heterogenous preferences over rates on the demand side. The utility a consumer derives from a loan incorporates both the loan and the deposit rate offered by the bank. Similarly, the deposit utility includes both rates set by the bank. In our setting, observable taste heterogeneity over prices comes from individuals' income, and following Berry, Levinsohn, Pakes (1995), the utility has random coefficients discrete choice specification.[3] Discrete choice random coefficient model with logit shocks allows for flexible substitution patterns between differentiated products.

On the supply side, commercial banks are producers of differentiated loan and deposit products, and they are oligopolies. A bank's profit function comprises three components: the profit obtained from loans, the cost associated with issuing deposits, and the bank's lending or borrowing activities in the intra-bank market. If the bank lends to consumers more than it receives in deposits, it borrows in the intra-bank market to balance its finances. Banks borrow in the intra-bank market at a cost equal to the sum of the fed funds rate and the bank's specific marginal cost of borrowing. Conversely, if the bank

[3]Steven Berry et al., *Automobile Prices in Market Equilibrium*, 63 Econometrica 841 (1995).

has more deposits than its loans, it lends the surplus in the intra-bank market, and receives additional income. A bank lends at the intra-bank market at the fed-funds rate, but pays an idiosyncratic cost for operating in this market. The BLP (1995) specification allows us to recover product-bank-state marginal cost estimates.[4] Using these marginal cost and share price elasticity estimates from our structural model, we then simulate the effects of a merger, and obtain predictions for post-merger prices and shares (Nevo 2001).[5]

Our analysis reveals a positive relationship between our predicted post-merger rates and shares, and the actual values observed after the mergers. The relationship between realized and predicted post-merger rates is statistically significant. Furthermore, we also find that our model's marginal cost estimates for issuing banking products covary with the federal funds rate in a manner that is consistent with common practices in the banking industry. Specifically, our marginal cost estimates for issuing loans increase with the federal funds rate, holding fixed the interest rates banks charge on their loans. This finding is consistent with the actual practices of banks, as they typically borrow funds from the intra-bank market at the federal funds rate in order to finance loans that exceed their deposits. On the other hand, our marginal cost estimates for issuing deposits decrease with the federal funds rate, holding fixed the interest rates banks offer for deposits. This finding is also in line with banks' practices, as they commonly lend their excess deposits in the intra-bank market at the federal funds rate.

This paper contributes to the growing structural industrial organization literature on the banking system. Dick (2008), Ho and Ishii (2011), Egan, Hortaçsu and Matvos (2017), Drechsler, Savov and Schnabl (2017) and Xiao

[4] Berry et al., *supra* note 3.

[5] Aviv Nevo, *Measuring Market Power in Ready-to-Eat Cereal Industry*, 69 Econometrica 307 (2001).

(2020) estimate demand models for deposits.[6] In contrast Crawford, Pavanini, and Schivardi (2018), Corbae and DíErasmo (2019), and Wang, Whited, Wu and Xiao (2022) study loan markets.[7] Aguirregabiria, Clark and Wang (2019) examine both deposit and loan markets, but their focus is on the geographical imbalance of deposits and loans, as well as the flow of credit across locations.[8]

Second, our paper is related to the legal literature on cluster markets. Notably, this paper is the first to present an empirical approach to incorporating cluster markets into merger analysis. Ayres (1985) studies the antitrust market definition based on clusters.[9] He introduces the term "transactional complements," which refer to goods that have lower transaction costs when bought from a single firm. Hovenkamp (2022) proposes the minimum requirements for recognizing cluster markets, and examines the relevance of network effects in identifying cluster products.[10] McCarthy (1996) studies different approaches adopted by the agencies in their examination of bank mergers. He proposes disaggregating the cluster market and analyzing specific product markets at the final, case-specific stage of the merger analysis.[11]

This paper is organized as follows. Section 2 provides a concise overview of the regulatory and legal framework governing the analysis of proposed bank

[6] Astrid A. Dick, *Demand Estimation and Consumer Welfare in the Banking Industry*, 32 J. Banking & Fin. 1661 (2008); Kate Ho & Joy Ishii, *Location and Competition in Retail Banking* 29 Int'l J. Indus. Org. 537 (2011); Mark Egan et al., *Deposit Competition and Financial Fragility: Evidence from the US Banking Sector* 107 Am. Econ. Rev. 169 (2017); Itamar Drechsler, *The Deposits Channel of Monetary Policy* , 132 Q.J. Econ. 1819 (2017) Kairong Xiao, *Monetary Transmission through Shadow Banks* 33 Rev. Fin. Stud. 2379 (2020).

[7] Gregory S. Crawford et al., *Demand Estimation and Consumer Welfare in the Banking Industry*, 108 Am. Econ. Rev. 1659 (2018); Dean Corbae & Pablo D'Erasmo, *Capital Requirements in a Quantitative Model of Banking Industry Dynamics* (Nat'l Bureau of Econ. Rsch., Working Paper No. 25424, 2019); Yifei Wang et al., *Bank Market Power and Monetary Policy Transmission: Evidence from a Structural Estimation* 77 J. Fin. 2093 (2020).

[8] Victor Aguirregabiria et al., *The Geographic Flow of Bank Funding and Access to Credit: Branch Networks, Local Synergies, and Competition* (2019).

[9] Ian Ayres, *Rationalizing Antitrust Cluster Markets*, 95 Yale L.J. 109 (1985).

[10] Herbert Hovenkamp, *Digital Cluster Markets*, Columbia Bus. L. Rev. (forthcoming 2022).

[11] Tim McCarthy, Note, *Refining Product Market Definition in the Antitrust Analysis of Bank Mergers*,46 Duke L. J. 865 (1996).

mergers. Section 3 describes the dataset employed in the paper. Section 4 provides the structural supply and demand models incorporating cluster products approach in the banking sector. Section 5 details the estimation of the structural model. Section 6 elaborates on the identification of demand parameters, and provides the instruments used for identification. Section 7 reports the cost estimates and post-merger rate and share predictions obtained from the structural model. Section 8 concludes.

2 Institutional Background

A number of federal agencies have oversight over bank mergers, and they are all entrusted with the responsibility to block any merger that would create a monopoly, substantially lessen competition, or in any other manner restrain trade. The definition of the product market plays a critical role in their assessment of proposed bank mergers. As this section outlines, agencies adopt different, and sometimes conflicting, approaches to identifying the product market in which banks operate. The primary reason for this disparity stems from the fact that commercial banks offer cluster products. While the legal theory concerning the provision of cluster products draws heavily from Supreme Court precedent on bank mergers, the practical implementation of this concept has not been adequately explored in the economics or legal literature. Instead, regulatory agencies and courts have developed proxy measures to assess the market shares of merging entities and to evaluate the competitive consequences of a proposed merger.

2.1 Merger Review in the Banking Industry

Bank mergers are subject to the Bank Merger Act, the Bank Holding Company Act, and Section 7 of the Clayton Act.[12] Additionally, bank mergers are also governed by Sections 1 and 2 of the Sherman Act.[13] According to the Bank Merger Act, the banking agency tasked with overseeing either the acquiring or the acquired institution needs to grant approval for the merger to proceed. Table 1 provides the agency supervision and examination authority over different kinds of commercial banks.[14] While the Antitrust Division of the Department of Justice is not involved in the supervision or examination of banks, and therefore is not listed in Table 1, it does possess authority over mergers involving any commercial entity. As a result, it has the power to block a bank merger, even a merger that has been approved by the relevant banking agencies.

Federal Agency	**Institution Type**
Comptroller of Currency (Treasury)	National Charters, Federal Savings Associations, Savings&Loans, Savings Banks
Federal Reserve Board	State Charters Federal Reserve Members
Federal Deposit Insurance Corporation	National Banks, State Charters Federal Reserve Members, State Charters Non-Members, Savings&Loans, Savings Banks

Table 1: Agency supervision and examination authority over banks

In addition to the statutes, bank mergers are governed by federal agency policy statements and guidelines, among which are the Bank Merger Guidelines.

[12] Bank Merger Act, 12 U.S.C. §1828(c) (2018); Bank Holding Company Act, 12 U.S.C. §1842 (2018); Clayton Act, 15 U.S.C. §18 (2018).

[13] Sherman Act, 15 U.S.C. §§ 1, 2.

[14] Michael P. Malloy & William A. Lovett, Banking and Financial Institutions Law in a Nutshell 144 (2019)

The most recent Bank Merger Guidelines date back to 1995 and are jointly issued by the Department of Justice and the bank regulatory agencies. These guidelines allow banking agencies and the Department of Justice to identify transactions that require further competitive review. These guidelines have two screens, namely Screen A and B, both of which use solely deposits to evaluate pre- and post-merger concentration. Hence, the initial screening process almost exclusively focuses on banks' deposit market presence, neglecting both the loan products and the complementarities across different banking products.[15]

After the preliminary screening process, conducting a more thorough analysis of the proposed bank merger involves identifying the pertinent product and geographic markets.[16] It entails calculating market shares of the transacting entities, assessing the entry conditions for nascent competitors, and determining efficiencies that may arise from the merger. Despite adhering to the same legal precedent, which emphasizes the value of clustering different banking products, the Department of Justice and the federal banking agencies diverge in their approach to measuring market shares.

In principle, the Federal Reserve adopts the "cluster products" approach, defining the product market as encompassing a collection of products and services offered by commercial banks. This cluster theoretically includes both deposits and various loan types. However, in practice, the Federal Reserve employs Screen A of the Bank Merger Guidelines, where regulators calculate HHI scores based on banks' deposit market shares. As a result, deposits serve as a proxy for the range of products provided by a typical commercial bank, while

[15]The Department of Justice can employ a modified 2% test when it determines Screen A does not sufficiently capture the competitive effects of the proposed transaction. Under this test, Screen A is modified to exclude deposits of branches that have less than 2% of their assets in commercial and industrial loans. However, even under this modified Screen A, the screening process solely focuses on deposit market shares.

[16]Despite removing market definition as the initial step of a merger analysis, the 2010 Horizontal Merger Guidelines still use market definition in various steps of competitive analysis, including the determination of market participants, market shares and substitutes. *See* Westlaw Bank Mergers and Acquisitions, Practical Law Practice Note 5-505-0193.

concentration in the loan markets is not taken into consideration during this assessment.

In contrast, the Department of Justice examines the market for deposits and the market for small and medium business loans separately. This approach closely aligns with a "submarket analysis" where each bank product market is assessed independently.[17]

This discrepancy in regulatory approaches can lead to divergent conclusions about the same merger. For instance, the Department of Justice concluded that the merger between First Hawaiian and First Interstate of Hawaii would have substantial adverse effects on competition.[18] In contrast, the Federal Reserve approved the same merger. In the issued order, the Fed referred to the Supreme Court's "cluster of products and services" approach, and emphasized that the convenience of access to this cluster created economic value beyond those of the constituent products and services.[19] In its assessment of the merger, the Board exclusively relied on banks' deposit shares as a proxy for market shares. The Fed further disagreed with the DOJ's analysis of loans to small and medium-sized businesses as a separate product market, noting that such an analysis "differs from the traditional definition of the product market established by the Supreme Court, and is not supported by recent studies of the market behavior of bank customers.'[20]

[17] For the origination of "submarket analysis" in the law, *see* Brown Shoe Co. v. United States, 370 U.S. 294 (1962).

[18] *First Hawaiian Inc., Honolulu, Hawaii*, 77 Fed. Res. Bull. 52 (Nov., 1991).

[19]

> The Board traditionally has recognized that the appropriate product market for evaluating bank mergers and acquisitions is the cluster of products (various kinds of credit) and services (such as checking accounts and trust administration) offered by banking institutions. The Supreme Court has emphasized that it is this cluster of products and services that as a matter of trade reality makes banking a distinct line of commerce. According to the Court, this clustering facilitates the convenient access to these products and services, and vests the cluster with economic significant beyond the individual products and services that constitute the cluster.

Id.

[20] *Id.*

2.2 History of Bank M&A Law

The foundation of the current merger regulations for the banking sector can be traced back to the earliest cases in which the Supreme Court was asked to interpret various antitrust and banking statues as they relate to bank mergers. In 1963, the Supreme Court encountered its first case involving a dispute over a bank merger when the Department of Justice filed a lawsuit against the merger between Philadelphia National Bank and Girard Trust Corn Exchange Bank. In *Philadelphia National Bank*, the Court defined the relevant market as "the cluster of products (various kinds of credit) and services (such as checking accounts and trust administration) denoted by the term 'commercial banking'."[21] The Court acknowledged that commercial banks provide many services in conjunction, and examined different commercial banking products to deem the merger under scrutiny illegal.[22]

The notion of "cluster products" and the market definition established by the Court have endured. The main distinction between agencies' approach and Supreme Court precedent lies in the calculation of banks' market shares. Although the Court did not propose a proxy for market share measures in *Philadelphia National Bank*, the Department of Justice mentioned only deposits in its 1968 Merger Guidelines.[23]

In 1970, the Court was presented with another bank merger in *United States v. Phillipsburg National Bank and Trust Co.*, when the Department of Jus-

[21] United States v. Philadelphia Nat'l Bank, 374 U.S. 321, 342 (1963).

[22] *Id.* at 326-327 ("Banking operations are varied and complex; 'commercial banking' describes a congeries of services and credit devices. But among them the creation of additional money and credit, the management of checking-account system, and the furnishing of short-term business loans would appear to be the most important."). *See also id.* at 331 ("Were the proposed merger to be consummated, the resulting bank would be the largest in the four-county area, with (approximately) 36% of the area banks' total assets, 36% of deposits, and 34% of net loans.")

[23] U.S. Dep't of Justice Fed. Trade Comm'n, Merger Guidelines (1968), https://www.justice.gov/archives/atr/1968-merger-guidelines ("In some markets, such as commercial banking, it is more appropriate to measure the market by other indicia, such as total deposits.").

tice challenged the merger between Phillipsburg National Bank and the Second National Bank of Phillipsburg. The Court reaffirmed its previous analysis and emphasized the importance of assessing the competitive effects of a bank merger by looking at cluster of products and services, rather than individual products and services:

> Commercial banks are the only financial institutions in which a wide variety of financial products and services – some unique to commercial banking and others not – are gathered together in one place. The clustering of financial products and services in banks facilitates convenient access to them for all banking customers[...] In short, the cluster of products and services termed commercial banking has economic significance well beyond the various products and services involved.[24]

Notably, the Court expressed a preference for the cluster products approach over the analysis of submarkets, which involves evaluating each commercial banking product separately.

> Submarkets [...] would be clearly relevant, for example, in analyzing the effect on competition of a merger between a commercial bank and another type of financial institution. But submarkets are not a basis for the disregard of a broader line of commerce that has economic significance.[25]

In assessing the competitive impacts of the merger, the Court employed measures such as total assets, deposits, loans, and the number of banking offices.[26]

By 1974, when the Supreme Court was presented with two bank merger disputes, the widely accepted definition of the relevant product market was "the business of commercial banking and the cluster of products and services associated with it."[27] Nonetheless, there was still ambiguity about the proxy to be

[24] United States v. Phillipsburg Nat'l Bank Trust Co., 399 U.S. 350, 360 (1970).
[25] *Id.*
[26] *See id.* at 357 ("The merged bank would have five of the seven banking offices in Phillipsburg and its environs and would be three times as large as the other Phillipsburg bank: it would have 75.8% of the city's banking assets, 76.1% of its deposits, and 84.1% of its loans.")
[27] United States v. Marine Bancorporation, Inc., 418 U.S. 602, 617 (1974).

used to measure market shares. In certain sections of the *Marine Bancorporation* opinion, the Court primarily concentrated on deposits when quantifying market shares, while in other instances, it referred to total assets, deposits, and loans collectively.[28]

Among the last two commercial bank merger cases to go to the Supreme Court was *United States v. Connecticut National Bank* in 1974. The case emerged from the Department of Justice's challenge to the proposed merger between Connecticut National Bank and First New Haven National Bank.[29] In its ruling, the Court explicitly dismissed the District Court's decision to include savings banks in the relevant market alongside commercial banks, despite a recent state statute granting savings banks the authority to provide personal checking accounts, which were considered to be "traditional indicia of commercial banks."[30] To justify the exclusion of savings banks from the relevant product market, the Court relied on the notion of "cluster of products and services" that it first introduced in *Philadelphia National Bank*, saying that "it is the unique cluster of services provided by commercial banks that sets them apart for the purposes of §7."[31] The Court recognized that savings banks were on the verge of gaining legal authorization to provide demand deposits, mirroring the privileges of commercial banks. Nonetheless, it determined that savings banks should not be considered part of the relevant product market due to their inability to offer the distinctive cluster of products and services that differentiates commercial banks. Essentially, the Court reiterated that the distinguishing characteristic of commercial banks lies in their capacity to provide a comprehensive range of banking products and services as a cohesive unit, rather than in their ability to

[28] For equal emphasis on total assets, deposits and loans, *see id.* at 606. For the Court's focus on deposits, *see id.* at 609.

[29] United States v. Connecticut Nat'l Bank, 418 U.S. 656 (1974). On the same day the Court decided *Connecticut National Bank*, it also issued *Marine Bancorporation*. *See* United States v. Marine Bancorporation, Inc., 418 U.S. 602 (1974).

[30] United States v. Connecticut Nat'l Bank, 418 U.S. 656, 660 (1974)

[31] *Id.* at 664.

offer individual banking products in isolation.[32]

These Supreme Court decisions, along with statutes and the agency interpretations created the contemporary regulatory framework for commercial bank mergers and acquisitions.

3 Data

3.1 Sources

Data come from various public and proprietary sources. Summary of Deposits (SOD) by the Federal Deposit Insurance Corporation provides annual data on deposits at the branch level. Each branch is identified by its location, a unique identification number for the branch office (UNINUMBER), the RSSD ID of the bank, and the RSSD ID of the bank holding company (if applicable). RSSD ID is a unique identifier assigned to financial institutions by the Federal Reserve.

Home Mortgage Disclosure Act (HMDA) provides mortgage loan data at the branch level for financial institutions. We use newly issued mortgages as a proxy for a bank's loans. To link mortgage values with the SOD dataset, we merge the two datasets using the name and RSSD ID of the bank, as well as the state and year of the branch level observation.

RateWatch is the primary source for deposit and loan rate data at branch level. We use state and year specific 12-month COD rate as the deposit rate offered by a bank. If the 12-month COD rate is missing for an institution in a particular year and state, we impute it using a no-arbitrage argument from 6-month, 18-month, 24-month, 36-month or 48-month CD rates for the same institution in that year. The loan rates belong to 30-year fixed mortgage

[32] *Id.*

products. If the 30-year fixed mortgage rate is missing for an institution in a particular year and state, we impute it using a no-arbitrage argument from 10-year, 15-year or 20-year fixed mortgage rate for the same institution in that year. RateWatch dataset is merged with other datasets using the name and RSSD ID of the bank, as well as the state and year of the branch level observation.

Bank characteristics that are used as controls and demand instruments, such as leverage ratio, bank age, total interest paid on federal funds borrowed, credit risk cost variable and expenses on premises, are calculated using data from FDIC's Quarterly Financials database.[33]

We obtain a list of bank mergers from Refinitiv. Macroeconomic data, such as the 30-year bond rate, are provided by FRED. Census data, which are used in the estimation, come from US Census Bureau's annual surveys.

3.2 Summary Statistics

Table II provides a summary of data at the institution-year-state level, with the term "institution" referring to the highest-level entity, such as a bank holding company if applicable, or a bank. These observations belong to the five states, namely Georgia, Illinois, Indiana, Pennsylvania and Wisconsin, that were affected by a horizontal merger and for which we have complete loan and deposit share and rate data. A horizontal merger is characterized as the consolidation of two existing entities having branches in the same state before the transaction is finalized. The dataset we build covers 2014 to 2021.

There are 1,362 observations spread over 310 institutions, 5 states and 8 years. The average deposit rate is 0.39%, and the average loan (mortgage) rate

[33]Leverage ratio is calculated as the ratio of Tier 1 capital to assets. Total interest paid on federal funds borrowed is calculated as the difference between federal funds purchased and federal funds sold in a year, multiplied by the average federal funds rate in that year. Credit risk cost variable is the allowance for losses on loans and leases divided by assets. Expenses on premises are calculated by normalizing the value of bank premises and equipment with bank assets.

is 3.88%. The deposit share of an institution is calculated as the deposits that the institution's branches report in a specific state and year divided by the total deposits reported in that state and year. A bank's loan share is calculated analogously. Both the mean deposit share and the mean loan share are 0.01%. The table also reports the summary statistics for bank characteristics, as bank characteristics constitute some of the instruments and controls we employ in the estimation.

	Count	*Mean*	*St. Dev.*	*Min.*	*Max.*
Deposit Rate	1,362	0.39	0.31	0.01	2.13
Deposit Share	1,362	0.01	0.03	0.0001	0.25
Loan Rate	1,362	3.88	0.67	0	8.42
Loan Share	1,362	0.01	0.02	0.00002	0.22
Credit Risk	1,362	0.009	0.004	0.001	0.043
Institutional Net Borrowing (mil)	1,362	-0.405	5.047	-95.500	6.508
Expenses (Premises&Equipment)	1,362	0.016	0.008	.0009	0.056
No. of Employees	1,362	26.5	193.4	3.8	4034.3

Table 2: Summary Statistics

Table III reports the mergers studied in this paper, and includes the names of the target and the acquirer, as well as the year in which the merger was completed. The target column provides name of the highest-level entity that was acquired. Overall, we study the effects of nine bank mergers between the year 2015 and 2020.

4 Model

We model loans and deposits as products offered by commercial banks that consumers consider to be complementary. Loans and deposits are deemed complementary by consumers for a variety of economically significant reasons. To begin with, individuals typically opt for banks or specific bank branches instead

Acquirer	*Target*	*Merger Year*
Juniata Valley Financial Corp.	FNBPA Bancorp	2015
First Midwest Bancorp Inc.	NI Bancshares Corp. (IL)	2016
Nicolet Bankshares Inc.	Baylake Corp.	2016
First Midwest Bancorp Inc.	Standard Bancshares Inc. (IL)	2017
First Merchants Corp.	Independent Alliance Banks Inc.	2017
BB&T Corp.	SunTrust Banks Inc.	2019
S&T Bancorp Inc. (PA)	DNB Financial Corp.	2019
Nicolet Bankshares Inc.	Choice Bancorp Inc.	2019
Fidelity Deposit & Discount	MNB Corp.	2020

Table 3: Bank mergers studied in this paper

of selecting specific banking products, and they exhibit a tendency to conduct various commercial banking transactions with the same bank for the sake of convenience. Additionally, certain loan product applications necessitate borrowers to have a deposit account with the same bank, indicating the joint consumption of these two products.

Banks typically offer various products, and therefore, it is reasonable to expect that rational banks take into account the interplay of demand complementarities between these offerings when setting interest rates. Banks have the ability to leverage their power in one product market to establish rates of another product, especially when consumers perceive the bank's product offerings as a cluster. We refer to the impact of a bank's cross-market presence on its rate setting behavior as a "market power spillover."

In our model, we incorporate the complementarity between loans and deposits by including the rates of both products in the utility that consumers derive from each product. In other words, a consumer's utility from a bank's deposit product includes both the deposit and the loan rate offered by that bank. The utility obtained from a loan product is defined analogously.

In our model, banks generate profits from the entire range of their product offerings. The complementarity between loans and deposits is incorporated in

their profit function via their market shares in each product. Specifically, banks assess the impact of market power spillovers through the loan price elasticity of their deposit market shares and deposit price elasticity of their loan market shares. The loan price elasticity of a bank's deposit market share refers to the percentage change in a bank's deposit market share when the bank increases the loan rate it charges by one percent. Similarly, the deposit price elasticity of a bank's loan market share measures the percentage change in a bank's loan market share when the bank increases the deposit rate it offers by one percent. Banks set rates for these two products simultaneously, taking into account how their presence in the deposit market will influence consumers demand for their loan product, and vice versa.

4.1 Demand

Utilities that consumers derive from loans and deposits are specified separately. Following Berry, Levinsohn, Pakes (1995), loan and deposit utilities have discrete choice random coefficient specification.[34] We index consumers by i, banks by f, products within a market by j, and markets by t. The two different bank product types, namely loans and deposits, are denoted in superscripts by l and d, respectively. The utility that a consumer derives from a loan product is given by

$$u^l_{ijt}(x^l_{jt}, p^l_{jt}, p^d_{jt}, \xi^l_{jt}, \epsilon^l_{ijt}; \theta^l) = \beta^l_t x^l_{jt} - \alpha^l p^l_{jt} + \kappa^d p^d_{jt} + \xi^l_{jt} + \Sigma_k x^{lk}_{jt} \sigma^{lk} \zeta^{lk}_{it} + \epsilon^l_{ijt} \quad (1)$$

The utility that a consumer derives from a particular loan product is affected not only by the bank's loan interest rate, denoted by p^l, but also by the bank's deposit interest rate, denoted by p^d. As consumers pay interest rate to the bank when borrowing, the loan rate has a negative coefficient, denoted by $-\alpha^l$.

[34] Berry et al., *supra* note 3.

Because consumers receive an interest on their deposits, the coefficient on deposit rate, denoted by κ^d, is positive. x represents bank and macroeconomic characteristics that could influence a consumer's utility from a loan. It includes the bank's leverage ratio, which proxies for the bank's financial strength, the number of branches the bank has in the state, which measures how conveniently consumers in the state can access the bank, bank's age, and bank fixed effects. The coefficients on x, jointly denoted by β, measure the effects of these bank and macroeconomic characteristics on consumption utility.

Banks produce differentiated products and cater to consumers with heterogeneous preferences. In our setting, observed taste heterogeneity among consumers arises out of individuals income. This variable is drawn from the actual distribution of demographics in the market t and is denoted by ζ_{it}^{lk}. ζ_{it}^{lk} multiplied by σ^{dk} represents the idiosyncratic and observable utility value that consumer i in market t gives to a unit increase in the loan product characteristic x^{lk}. Unobserved taste heterogeneity among consumers is represented by ϵ_{ijt}^{l}, and has a Type-1 extreme value distribution. Bank-product specific shocks at the market level are denoted by ξ_{jt}^{l},

Utility can be decomposed into two components: the mean utility, which is common across all consumers of the same product, and random utility, which is unique to each consumer. The mean utility of good j in market t is denoted by δ_{jt}^{w}, and individual i's idiosyncratic component of utility from good j in market t is given by ν_{ijt}:

$$\delta_{jt}^{l} = \beta_{it}^{l} x_{jt}^{l} + \alpha^{l} p_{jt}^{l} + \kappa^{d} p_{jt}^{d} + \xi_{jt}^{l} \tag{2}$$

$$\nu_{ijt}^{l} = \Sigma_k x_{jt}^{lk} \sigma^{lk} \zeta_{it}^{lk} + \epsilon_{ijt}^{l} \tag{3}$$

Consumption utility obtained from a deposit product is specified analogously

and is given by:

$$u^d_{ijt}(x^d_{jt}, p^d_{jt}, p^l_{jt}, \xi^d_{jt}, \epsilon^d_{ijt}; \theta^d) = \beta^d_t x^d_{jt} + \alpha^d p^d_{jt} - \kappa^l p^l_{jt} + \xi^d_{jt} + \Sigma_k x^{dk}_{jt} \sigma^{dk} \zeta^{dk}_{it} + \epsilon^d_{ijt} \quad (4)$$

Market shares, or choice probabilities, for each bank in the loan and deposit markets are obtained by integrating consumer choice over the distribution of individual heterogeneity:

$$s^w_{jt}(\delta^w_t, x^w_t, \sigma^w) = Pr(y^w_{it} = j) = \int_{A_j(\delta^w_t)} dF_\nu(\nu^w_{i0t}, \nu^w_{i1t}, ..., \nu^w_{iJt} | x^w_t, \sigma^w) \quad (5)$$

In this equation, w denotes the two commercial products, namely loans and deposits. $A_j(\delta^w_t)$ represents the space in which product j in market t is chosen over every other product in the market because it yields a higher utility:

$$A_j(\delta^w_t) = \{(\nu^w_{i0t}, \nu^w_{i1t}, ..., \nu^w_{iJt}) \in \mathbb{R}^{J+1} | \delta^w_{jt} + \nu^w_{ijt} \geq \delta^w_{j't} + \nu^w_{ij't} \forall j' \neq j\}$$

4.2 Pricing

In our model, banks offer a single loan product and a single deposit product in each geographic market. The bank's profit function comprises three components. First, it includes the profit generated from its loans. Profit from loans is equal to the difference between the loan rate the bank charges to consumers and its marginal cost of issuing loans, multiplied by the quantity of loans the bank "sells" to its customers. In the expression for this first component, p^l_{ft} denotes the loan rate bank f offers in market t, and mc^l_{ft} is bank f's marginal cost of issuing loans in the same market. M^l_t is the size of the loan market, and s^l_{ft} represents bank f's loan market share.

$$(p^l_{ft} - mc^l_{ft})M^l_t s^l_{ft}$$

Second, a bank's profit function includes the outflow of funds that the bank disburses to its customers as interest on their deposits. The unit cost of issuing deposits is the sum of the deposit rate provided to consumers and a bank specific marginal cost of issuing deposits. The deposit rate a bank offers to its customers is represented by p^d_{ft}, and a bank's unique cost of issuing deposits is denoted by mc^d_{ft}. M^d_t is the size of the deposit market, and s^d_{ft} represents bank f's deposit market share. Putting these components together, we use the following expression for a bank's cost of issuing deposits:

$$-(p^d_{ft} + mc^d_{ft})M^d_t s^d_{ft}$$

The third component of a bank's profit function accounts for the borrowing or lending in which the bank engages in the intra-bank market to balance its finances. When a bank lends to its customers more than it receives in deposits, it borrows in the intra-bank market to equalize the two sides of its balance sheet. A bank can borrow in the intra-bank market at a cost equivalent to the sum of the fed funds rate and a bank's idiosyncratic marginal cost of borrowing. Conversely, if the bank receives more deposits than its loans, it lends this surplus in the intra-bank market. The bank receives the fed funds rate as a return for its excess deposits in the intra-bank market, while it incurs a bank-specific marginal cost of lending. The idiosyncratic cost of transacting in the intra-bank market is denoted by mc_{0ft}, and federal funds rate is represented by r_{0t}. The following expression provides the third component of a bank's profit function.

$$-(M^l_t s^l_{ft} - M^d_t s^d_{ft})(r_{0t} + mc_{0ft})$$

Adding these three components yields the bank's profit function:

$$\begin{aligned}\Pi_{ft} \quad = \quad & (p^l_{ft} - mc^l_{ft}) M^l_t s^l_{ft}(p^l_t, p^d_t, \xi^l_t; \theta^l) \\ & - (p^d_{ft} + mc^d_{ft}) M^d_t s^d_{ft}(p^d_t, p^l_t, \xi^d_t; \theta^d) \\ & - (M^l_t s^l_{ft} - M^d_t s^d_{ft})(r_{0t} + mc_{0ft})\end{aligned} \tag{6}$$

In our estimation, we will not parametrize marginal costs. Consequently, we define overall marginal costs of issuing loans and deposits by collecting terms that are multiplied by the bank's loan and deposit quantities, respectively. A bank's overall marginal cost of issuing loans is denoted by $\tilde{mc}^l_t$, and that for deposits is represented by $\tilde{mc}^l_t$. Our estimation procedure yields values for these bank-market-product specific marginal costs.

$$\tilde{mc}^l_{ft} = mc^l_{ft} + r_{0t} + mc_{0ft} \tag{7}$$

$$\tilde{mc}^d_{ft} = mc^d_{ft} - r_{0t} - mc_{0ft} \tag{8}$$

Incorporating these overall marginal costs of issuing loans and deposits results in the following equation for a bank's profits:

$$\Pi_{ft} = (p^l_{ft} - \tilde{mc}^l_t) M^l_t s^l_{ft}(p^l_t, p^d_t, \xi^l_t; \theta^l) - (p^d_{ft} + \tilde{mc}^d_{ft}) M^d_t s^d_{ft}(p^d_t, p^l_t, \xi^d_t; \theta^d) \tag{9}$$

In each market, a Nash equilibrium of the price-setting game yields the deposit and loan rates that banks offer. Banks maximize their profits Π_{ft} by setting the first-order conditions of the profit function with respect to loan and deposit rates to zero. The first order condition of the profit function with respect to the loan rate is given by:

$$p^l_{ft} - \tilde{mc}^l_{ft} = [(\Delta^{dd}_t)^{-1}\Delta^{ld}_t - (\Delta^{dl}_t)^{-1}\Delta^{ll}_t]^{-1}[(\Delta^{dl}_t)^{-1} s^l_{ft} + \frac{M^d_t}{M^l_t}(\Delta^{dd}_t)^{-1} s^d_{ft}] \tag{10}$$

where

$$\Delta_{jr}^{wq} = \begin{cases} -\frac{\delta s_r^w}{\delta p_j^q}, & \text{if j=r} \\ 0, & \text{otherwise} \end{cases}$$

and $w, q \in \{\text{loans, deposits}\}$. Δ_t^{wq} is the diagonal matrix of derivatives of product type w shares with respect to product type q prices. For instance, the matrix Δ_{jr}^t contains derivatives of loan shares with respect to deposit prices. M_t^d is the deposit market size and the M_t^l is the loan market size. s_{ft}^d and s_{ft}^l are bank f's market shares in the deposit and loan markets, respectively.

Overall, price cost markup for loans depends not only the derivative of loan share with respect to loan rate, but also on the derivative of loan share with respect to the deposit rate, and the derivative of deposit share with respect to the two types of rates. Furthermore, the magnitude of a bank's deposit market share affects its loan markup. The importance of a bank's deposit market share for its loan markup is determined by the size of the deposit market relative to the size of the loan market. The incidence of deposit related terms in the loan markup equation reveals the effect of market power spillovers across complementary products. Deposit related terms in the loan markup equation captures the effect of a bank's deposit market presence in its price setting behavior within the loan market. Specifically, a bank takes into account how consumer preference for its deposit products alters when the bank changes its loan rate, and vice versa.

Deposit markup is obtained analogously and shows similar characteristics:

$$p_{ft}^d + \tilde{mc}_{ft}^d = [(\Delta_t^{ll})^{-1}\Delta_t^{dl} - (\Delta_t^{ld})^{-1}\Delta_t^{dd}]^{-1}[(\Delta_t^{ld})^{-1}s_t^d + \frac{M_t^l}{M_t^d}(\Delta_t^{ll})^{-1}s_t^l] \quad (11)$$

5 Estimation

5.1 Demand

We estimate demand parameters in the loan and deposit utility functions separately, following BLP (1994).[35] The loan utility specification is given by Equation (13), and the deposit utility specification is provided by Equation (14):

$$u^l_{ijt}(x^l_{jt}, p^l_{jt}, p^d_{jt}, \xi^l_{jt}, \epsilon^l_{ijt}; \theta^l) = \beta^l_t x^l_{jt} - \alpha^l p^l_{jt} + \kappa^d p^d_{jt} + \xi^l_{jt} + \Sigma_k x^{lk}_{jt} \sigma^{lk} \zeta^{lk}_{it} + \epsilon^l_{ijt} \quad (12)$$

$$u^d_{ijt}(x^d_{jt}, p^d_{jt}, p^l_{jt}, \xi^d_{jt}, \epsilon^d_{ijt}; \theta^d) = \beta^d_t x^d_{jt} + \alpha^d p^d_{jt} - \kappa^l p^l_{jt} + \xi^d_{jt} + \Sigma_k x^{dk}_{jt} \sigma^{dk} \zeta^{dk}_{it} + \epsilon^d_{ijt} \quad (13)$$

In our setting, a bank's deposit and mortgage rates enter into utility functions both linearly, as denoted by p^d_{jt} and p^l_{jt}, and with random coefficients, through x^{dk}_{jt}. In the loan utility specification, α^l and κ^d represent the utility contributions of loan and deposit rates that are common across consumers. In contrast, $\sigma^{lk}\zeta^{lk}_{it}$ denotes the individual specific effects of loan and deposit rates on the utility a consumer derives from a certain loan product. Analogous terms are included in the deposit utility specification. Importantly, the individual specific coefficients for loan and deposit rates depend on the individual's income. As a result, our estimation is able to capture how the importance of the loan or the deposit rate offered by a bank changes according to the consumer's income level. In other words, our model allows for high- and low- income consumers to respond differently to changes in rates offered by banks.

Certain bank characteristics also contribute to the utility an individual derives from a banking product. In our specification, these characteristics are the

[35] Berry et al., *supra* note 2.

bank's leverage ratio, number of branches the bank has in the state, bank's age, and bank fixed effects. These characteristics enter into utility functions linearly.

The coefficients associated with linear characteristics in the loan utility function, namely $\beta^l, \alpha^l, \kappa^d$, are represented collectively as θ_1^l. Linear coefficients in the deposit utility specification, $\beta^l, \alpha^l, \kappa^d$, are collectively denoted by θ_1^d. Each utility specification further includes nonlinear coefficients for deposit and loan rates. The nonlinear coefficients in the loan utility function are denoted by θ_2^l, while those in the deposit utility function are represented by θ_2^d. From this stage of the estimation, we obtain θ_1^l, θ_1^d, θ_2^l and θ_2^d.

5.2 Marginal costs

Once demand parameters are estimated, product and market specific marginal costs of each bank can be recovered using the bank's first order conditions. Equation (14) contains the bank specific marginal cost of issuing loans, and Equation (15) has bank specific marginal cost of issuing deposits.

$$\hat{mc}^l = p^l - [(\Delta^{dd})^{-1}\Delta^{ld} - (\Delta^{dl})^{-1}\Delta^{ll}]^{-1}[(\Delta^{dl})^{-1}s^l + \frac{M^d}{M^l}(\Delta^{dd})^{-1}s^d] \quad (14)$$

$$\hat{mc}^d = -p^d + [(\Delta^{ll})^{-1}\Delta^{dl} - (\Delta^{ld})^{-1}\Delta^{dd}]^{-1}[(\Delta^{ld})^{-1}s^d + \frac{M^l}{M^d}(\Delta^{ll})^{-1}s^l] \quad (15)$$

In Equations (14) and (15), prices, shares, and market sizes, denoted by s, p, and M, respectively, are obtained from data. To calculate share price derivatives, denoted by $\Delta^{wq}(p^w, p^q)$, we use the Morrow and Skerlos (2011) decomposition of choice probability derivatives:[36]

[36] W. Ross Morrow & Steven J. Skerlos, *Fixed-Point Approaches to Computing Bertrand-Nash Equilibrium Prices Under Mixed-Logit Demand*, 59 Operations Rsch. 328 (2011).*See also* Chris Conlon & Jeff Gortmaker, *Best Practices for Demand Estimation with pyBLP*, 51 RAND J. Econ. 1108 (2020).

$$\Delta^{wq}(p^w, p^q) = \Lambda^{wq}(p^w, p^q) - \tilde{\Gamma}^{wq}(p^w, p^q) \tag{16}$$

$\Lambda^{wq}(p^w, p^q)$ is a diagonal matrix with $\lambda_f^{wq}(p^w, p^q)$ on the diagonal, where,

$$\lambda_f^{wq}(p^w, p^q) = (D_{qf} u_f^w)(p_f^w, p_f^q) s_f^w(p^w, p^q) \tag{17}$$

$\tilde{\Gamma}^{wq}(p^w, p^q)$ has non-zero elements $(\tilde{\Gamma}^{wq}(p))_{f,f'} = \gamma_{f,f'}(p^w, p^q)$ only if banks f and f' are the same entity, where

$$\gamma_{f,f'}^{wq}(p^w, p^q) = (D_{qf} u_f^w)(p_f^w, p_f^q) s_f^w(p^w, p^q) s_{f'}^q(p^w, p^q) \tag{18}$$

Recall that in our setting, w and q denote commercial banking product types, namely loans and deposits. Given that each bank offers only one loan and one deposit product, we index utilities and shares using banks, denoted by f, rather than products denoted by j. To illustrate, when w represents deposits and q represents loans, u_f^w refers to the consumer utility derived from bank f's deposit product. Similarly, $D_{qf} u_f^w$ denotes the derivative of utility from bank f's deposit product with respect to bank f's loan rate. The market structure is incorporated through the ownership matrix $\tilde{\Gamma}^{wq}(p^w, p^q)$.

5.3 Post-Merger Prices and Shares

In order to obtain our model's predictions for post-merger rates and market shares, we follow the approach proposed in Nevo (2001) and modify the ownership matrix $\tilde{\Gamma}^{wq}(p^w, p^q)$ according to the merger.[37] We then solve for the new price equilibrium in both loan and deposit markets. We denote loan and deposit

[37] Nevo, *supra* note 3.

markups with $\zeta^l(p^l, p^d)$ and $\zeta^d(p^l, p^d)$, respectively, where,

$$\zeta^l(p^l, p^d) = [(\Delta^{dd})^{-1}\Delta^{ld} - (\Delta^{dl})^{-1}\Delta^{ll}]^{-1}[(\Delta^{dl})^{-1}s^l + \frac{M^d}{M^l}(\Delta^{dd})^{-1}s^d] \quad (19)$$

$$\zeta^d(p^l, p^d) = [(\Delta^{ll})^{-1}\Delta^{dl} - (\Delta^{ld})^{-1}\Delta^{dd}]^{-1}[(\Delta^{ld})^{-1}s^d + \frac{M^l}{M^d}(\Delta^{ll})^{-1}s^l] \quad (20)$$

Loan and deposit rates can be rewritten as:

$$p^l = \tilde{mc}^l + \zeta^l(p^l, p^d) \quad (21)$$

$$p^d = -\tilde{mc}^d + \zeta^d(p^l, p^d) \quad (22)$$

In Equations (21) and (22), marginal costs $\tilde{mc}^l$ and $\tilde{mc}^d$ are known from the previous estimation stage, and loan and deposit markups have known functional forms, given in Equations (19) and (20). To calculate the deposit and loan rates after a merger, we run two fixed-point iterations simultaneously and interactively. This estimation strategy aims to replicate a bank's concurrent loan and deposit rate setting behavior, where the loan rate set by the bank is affected by both competition in the loan market and the bank's presence in the deposit market, and vice versa. In each fixed-point iteration for the loan rate, the loan markup is updated using the loan and deposit rates from the most recent iteration. Each fixed-point iteration for the deposit rate is completed similarly. Both iterations terminate when the norms of both first order conditions are less than epsilon. At the end of this procedure, the algorithm yields predictions for post-merger rates, using which we can also calculate post-merger shares.

6 Identification

The equilibrium quantity of each commercial banking product depends on endogenous prices as well as unobserved characteristics of all products. Consequently, the identification of price coefficients in the utilities requires instruments. We jointly identify the coefficients on loan and deposit rates by using five instruments, consisting of both unique instruments specific to our setting and instruments previously used in other papers.

Our set of instruments includes the federal funds rate interacted with the bank's net borrowing, a credit risk cost variable specific to the bank, the bank's expenses on premises and equipment, the number of employees of competing banks within the state, and the return on 30-year bond. In our framework, the federal funds rate interacted with net borrowing serves as an excluded cost shifter, as it appears in the bank's cost of issuing loans and deposits.[38] Consequently, it functions as a classical demand instrument. Additionally, we employ other cost shifters such as the credit risk cost variable and the bank's premises expenses, following the approach of Ho and Ishii (2011).[39] We also use the number of employees of competing banks within the state as a BLP (1994) instrument.[40] Table 4 provides the result of regressing loan and deposit rates on these instruments, showing the strength of our instruments. As the table reports, the probability that all instruments have zero coefficients is close to zero in these regressions.

[38] *See* Equations 6,7 and 8.
[39] Ho and Ishii, *supra* note 4.
[40] Berry et al., *supra* note 2.

	Loan Rate	*Deposit Rate*
Credit Risk Cost	-10.104***	3.399
	(3.995)	(2.195)
Expenses on Premises	7.734***	2.975***
	(1.865)	(1.024)
No. of Competitors	-0.001***	0.0002*
	(0.0001)	(0.00008)
No. of Competitor Employees	-6.30e-08	-3.24e-07***
	(9.03e-08)	(4.96e-08)
30yr Bond	0.719***	0.034*
	(0.034)	(0.019)
Borrow x Fed Funds Rate	-1.11e-09	-1.51e-09
	(5.76e-09)	(3.17e-09)
F-Test	105.78	10.22
Prob > F	0.0000	0.0000
No. of Obs.	1,362	1,362

Table 4: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. The unit of observation is a bank-state-year. Loan rates and deposit rates are regressed on instruments. Credit risk cost is the quotient of bank's loan loss allowance and assets. Expenses on premises is the value of bank premises and fixed assets divided by bank assets. Number of competitors refers to number of bank holding institutions in the same state and year. Number of competitor employees is total number of full-time employees a competitor has divided by its number of offices. 30-year bond refers to the yield of a U.S. 30-year treasury bond. "Borrow x Fed Funds rate" is the product of federal funds rate and the bank's net purchase of federal funds. F-test sums the predictive power of all instruments, and determines the probability that all instruments have zero coefficients.

7 Results

7.1 Marginal Costs

To balance its finances, a bank participates in the intra-bank market. When a bank accumulates more deposits than loans extended to customers, it lends the surplus funds in the intra-bank market, earning the federal funds rate as a return. Conversely, if the bank has more loans than deposits, it needs to borrow from the intra-bank market and incurs the federal funds rate as interest. Consequently, holding the deposit rate the bank provides to its customers fixed, the

marginal cost of issuing deposits decreases with the federal funds rate. Similarly, holding the interest rate the bank charges its customers fixed, the marginal cost of issuing loans increases with the federal funds rate. Equations (5) and (6), which are provided again below for convenience, show how the federal funds rate, denoted by r_{0t}, increases a bank's marginal cost of issuing loans and decreases its marginal cost of issuing deposits.

$$\tilde{mc}_t^l = mc_t^l + r_{0t} + mc_{0t}$$
$$\tilde{mc}_t^d = mc_t^d - r_{0t} - mc_{0t}$$

In our estimation of the structural model, we do not parametrize marginal costs. In other words, the marginal cost of each banking product, represented by $\tilde{mc}^l t$ and $\tilde{mc}^d t$, is estimated without empirically specifying its components. Therefore, the validity of our model can be empirically verified by examining whether the realized correlation between the federal funds rate and the estimated marginal costs conforms to the relationship proposed in our model.

We regress estimated marginal costs of issuing loans and deposits on the average federal funds rate in the same year, and report the results in Table 5. Column 1 presents the regression of estimated costs of issuing loans on federal funds rate, and Column 2 provides the regression of estimated costs of issuing deposits on federal funds rate. A unit of observation is a bank-state-year. As expected, we find that the cost of issuing loans increases and the cost of issuing deposits decreases with federal funds rate. Standard errors are clustered at the bank level, and both coefficients are significant. These empirical findings align with economics theory.

7.2 Post Merger Rate and Share Predictions

The estimation of our structural model allows us to obtain predictions for post-merger rates and shares. We use demand parameter estimates and data

	Loan Cost	*Deposit Cost*
Fed Funds Rate	0.0721*	-0.1908**
	(0.0380)	(0.0793)
R^2	0.003	0.0265
No of obs.	1286	1286

Table 5: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. The unit of observation is a bank-state-year. Loan cost and deposit cost refer to banks' cost of issuing loans and deposits predicted by a model, respectively. Errors are clustered at the bank level.

from a year before the merger to predict the post-merger loan and deposit rates and shares for all market participants. To evaluate the predictive ability of our model, we regress realized rates and shares on those that are predicted by our model, while controlling for any macroeconomic changes after the merger through state and year fixed effects. Table 6 reports the results of these regressions. Specifically, the coefficient of predicted loan rates when realized loan rates are regressed on them is 0.5534, and it is statistically significant at 1%. When we regress realized deposit rates on deposit rates predicted by our model, we get a coefficient of 0.1976, which is also significant at 1%. The coefficient of predicted loan shares is 0.0114, and that of predicted deposit shares is 0.0777.

	Price/Rate		*Market Share*	
	Loans	*Deposits*	*Loans*	*Deposits*
Coef.	0.5534***	0.1976***	0.0114	0.0777
	(0.0743)	(0.0559)	(0.0168)	(0.0562)
FE	✓	✓	✓	✓
R^2	0.7416	0.4127	0.1804	0.1109
No of obs.	351	351	351	351

Table 6: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. The unit of observation is a bank-state-year. Post-merger realized prices and shares are regressed on rates and shares predicted by the model proposed by this paper, with year and state fixed effects. Errors are clustered at the bank level.

8 Conclusion

Although the Supreme Court introduced "cluster product" markets in merger analysis in the 1960s, the challenge of devising effective tools to implement this market definition has hindered its adoption by courts and agencies. Nevertheless, cluster and complementary products continue to hold substantial importance in the economy. In this paper, we present a structural model for demand and supply in the commercial banking sector, factoring in the complementarities across different banking products. In our demand specification, consumers consider the attributes of the product cluster provided by a bank when deciding which bank to borrow from or where to open a deposit account. In our supply specification, banks determine rates for a particular banking product by taking into account its impact on the demand for their other products. The structural model we develop can serve as a valuable tool for agencies when evaluating proposed bank mergers.

To obtain rate and share predictions following a change in market structure, we conduct simulations using real bank mergers in our structural model. Subsequently, we perform regressions to compare the realized post-merger loan and deposit rates with the predictions made by our model. The regression coefficients are found to be 0.55 for loan rates and 0.20 for deposit rates. Similarly, when regressing the realized post-merger loan and deposit shares on the model-predicted values, the coefficients are determined to be 0.01 for loan shares and 0.08 for deposit shares. Additionally, we observe a positive covariance between bank- and market-specific estimates of marginal costs for issuing loans and the federal funds rate, while estimates of marginal costs for issuing deposits display a negative covariance with the federal funds rate. These findings are in accordance with the practical operations of a bank, where the bank borrows or lends

in the intra-bank market at the federal funds rate to equalize the two sides of its balance sheet.