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FINANCIAL SOPHISTICATION AND BANK MARKET POWER

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ABSTRACT

We study the relation between bank funding costs and the financial sophistication of bank customers. In doing this, we make use of a natural experiment that allows us to identify banks that—either intentionally or unintentionally—price time deposits in a way that can result in financially-unsophisticated customers essentially being shortchanged. We find that these banks have significantly lower deposit funding costs. These results provide evidence that having financially-unsophisticated customers may provide banks with substantial market power and be an important component of the value of a bank's deposit franchise.

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A data appendix is available at http://www.nber.org/data-appendix/w33049

1. INTRODUCTION

Understanding how banks price deposits has become a major focus in current banking research. This issue is particularly important since deposits represent a significant investment asset class in the U.S.[1] A central theme in this rapidly-growing literature is that banks may have a form of market power over their customers that allows them to pay lower rates on deposits. The resulting reduction in bank funding costs for these sticky deposits enhances bank profitability and can be a source of deposit franchise value (Flannery (1981, 1983), Hutchison and Pennacchi (1996), Drechsler, Savov, and Schnabl (2017, 2021)).

Recent papers suggest that a key source of this market power could be a lack of financial sophistication among bank customers (Gorton and Pennacchi (1990), Drechsler, Savov, and Schnabl (2017, 2021), Hanson, Ivashina, Nicolae, Stein, Sunderam, and Tarullo (2024)). For example, financially-unsophisticated customers may accept lower rates on deposit accounts simply because they are unaware of the alternative investment opportunities available to them.

The objective of this paper is to provide new perspectives on the role that customer financial sophistication may play in banking markets. In doing this, we make use of a natural experiment that allows us to identify banks that—either intentionally or unintentionally—price deposits in a way that can result in financially-unsophisticated customers essentially being shortchanged. In particular, we show that these banks often offer term structures of CD rates that are so internally inconsistent that the rates for some tenors are actually dominated by those for other tenors and, therefore, should never be accepted by a financially-sophisticated value-maximizing depositor. These dominated CDs, however, represent a hazard to naive financially-unsophisticated customers who may unwittingly invest in (or automatically roll over into) them without realizing the opportunity cost.

To illustrate how term structures of CD rates can be internally inconsistent, imagine that a household has a one-year horizon and wants to invest in a bank CD. Assume that a bank offers a one-percent rate for a one-year CD, and a five-percent rate for a five-year CD. If the household invests in a one-year CD, it receives a cash flow of 1.010 in one year. If the household invests in the five-year CD, however, it can liquidate the CD in one year by paying an early withdrawal

[1]Total deposits at commercial banks in the U.S. totaled $17.26 trillion as of the end of the sample period in June 2023.

penalty of six months of interest, resulting in a net cash flow of 1.050 − 0.025 = 1.025. Thus, investing in the one-year CD is suboptimal since it is dominated by the five-year CD. Note that banks have no fiduciary responsibility to alert customers to internal inconsistencies in their deposit pricing. We find that more than 52 percent of all CD term structures offered by banks during the 2001–2023 study period include dominated rates.

If having a less-sophisticated customer base provides banks with market power, then banks that price deposits in ways that could adversely impact these customers may be more profitable. Testing whether these banks have lower funding costs provides us with a novel direct way to explore the relation between bank market power and the financial sophistication of bank customers. In doing this, we use a measure of how frequently the bank engages in inconsistent pricing as an instrument for the scope of its activities that could extract value from unsophisticated customers. We note, of course, that offering inconsistent CD term structures is just one of the many ways in which banks could earn rents from these customers, and may not necessarily be the most-significant one in terms of its financial impact. The intuition behind the use of this instrument, however, is that banks that offer inconsistent term structures are presumably more likely to follow other similar strategies that could potentially have large effects on unsophisticated customers and bank profitability. Thus, this instrument should be viewed as a broad reflection of a bank's overall activity relative to its unsophisticated customers.

We explore the relation between bank funding costs and financial sophistication by regressing the interest expense paid by banks for various types of deposits on the frequency of inconsistent pricing and on a range of fixed effects and control variables. The results make a strong case that banks that follow deposit pricing strategies that may adversely impact financially-unsophisticated customers have significantly lower deposit costs. This effect is also significant in economic terms. In particular, the results indicate that the most-frequently-inconsistent banks have deposit interest costs that are more than 15 basis points lower than the least-frequently-inconsistent banks. This difference represents a substantial fraction of the average deposit interest expense or funding costs experienced by banks during the study period. These results have direct implications for current banking theory and research. In particular, these results provide support for Drechsler, Savov, and Schnabl (2017) and others who argue that financially-unsophisticated customers can be an important source of market power allowing banks to pay lower rates on deposits. In turn, this implies that financial sophistication may play a central role in determining the value of a bank's deposit franchise.

The evidence of a strong link between bank funding costs and the fre-

quency of inconsistent pricing is an objective empirical finding that holds irrespective of whether the inconsistent pricing is intentional or not. To put these results into better perspective, however, it is worthwhile to explore whether banks might offer internally-inconsistent term structures of CD rates intentionally, or whether banks simply disregard the early withdrawal option and ignore the internal-consistency issue. We find empirical patterns suggesting that many banks are aware of the potential pitfalls that dominated CDs create for unwary customers, and appear to go to great lengths to either avoid them or embrace them. In particular, we find that there are many active banks that never offered a single internally-inconsistent term structure throughout the entire study period. In stark contrast, many other banks offered nothing other than internally-inconsistent term structures during the same period. Both of these outcomes are highly unlikely to have occurred by chance.

Why do some banks offer internally-inconsistent term structures while others do not? One possibility is that banks may acquire private information about the financial sophistication of their depositors through their banking relationships. This process would parallel how banks learn about the creditworthiness of borrowers through their monitoring activities (Diamond (1984), Fama (1985), Gale and Hellwig (1985)). Banks with a less-sophisticated customer base might choose to target these customers in a variety of ways. The results provide support for this interpretation. In particular, we find that inconsistent pricing is more frequent in states with older less-educated populations. Furthermore, banks that rely more heavily on larger uninsured deposits from wealthier customers as a source of financing are much less likely to offer internally-inconsistent term structures. Surprisingly, however, larger banks are more likely to offer inconsistent term structures. These results reveal a rich amount of cross-sectional variation in how banks interact with customers who may lack financial sophistication. These results are also consistent with a broader view of banking in which monitoring activities not only provide banks with private information about borrower creditworthiness, but also about the financial sophistication of their depositors.

Related Literature

This paper is related to the extensive literature on bank deposit pricing. One of the key findings in this literature is that banks are often slow in adjusting deposit rates when market interest rates change. This implies that deposit spreads tend to widen when interest rates increase. Examples include Diebold and Sharpe (1990), Hannan and Berger (1991), Neumark and Sharpe (1992), Driscoll and Judson (2013), Drechsler, Savov, and Schnabl (2017, 2021), Yankow (2023), and Erel, Liebersohn, Yannelis, and Earnest (2023). We extend this literature by examining the internal consistency of the deposit rates offered by banks.

An important branch of the deposit pricing literature focuses on the role of

deposit betas and banking market power in setting deposit rates and creating deposit franchises. Key examples include Flannery (1981, 1983), Hutchison (1995), Hutchison and Pennacchi (1996), Drechsler, Savov, and Schnabl (2017, 2021), Begenau and Stafford (2022a, 2022b), Whited, Wu, and Xiao (2021), Wang, Whited, Wu, and Xiao (2022), Choi and Rocheteau (2023), and DeMarzo, Krishnamurthy, and Nagel (2024). We contribute to this literature by testing directly whether financially unsophisticated customers may be a source of banking market power and deposit franchise value.

Another important strand in the deposit pricing literature is that different types of banks such as large/small banks and online/brick-and-mortar banks may follow different deposit pricing strategies. Examples include Heitfield and Prager (2004), Park and Pennacchi (2008), Egan, Hortaçsu, and Matvos (2017), Kundu, Park, and Vats (2021), Haendler (2022), Benmelech, Yang, and Zator (2023), Koont (2023), Koont, Santos, and Zingales (2024), and Kundu, Muir, and Zhang (2024). We add to this literature by showing that banks also differ in the strategies they use to price CDs of different tenors.

Finally, this paper is also related to the literature on financial sophistication in banking markets. Drechsler, Savov, and Schnabl (2017) present a model in which the limited financial sophistication of households allows banks to adjust their rates slowly during periods when market interest rates are increasing. Bolton, Li, Wang, and Yang (2023) describe how depositor inertia results in banks earning higher deposit spreads. Chavaz and Slutzky (2023) show that surges in public attention can lower depositor inertia, leading banks to earn lower deposit spreads. d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023) find that customers of larger banks tend to receive lower interest rates even though they are generally located in areas with demographics that suggest greater financial sophistication. Hanson, Ivashina, Nicolae, Stein, Sunderam, and Tarullo (2024) discuss the role of sleepy/inattentive depositors in allowing banks to offer low deposit rates. Lu, Song, and Zeng (2024) show that access to digital banking technologies can make depositors more alert by allowing them to shift their deposits across bank accounts more quickly and efficiently.[2] This paper confirms previous results and extends this literature by showing that banks that price deposits in a way that may entice unsophisticated depositors into accepting lower rates tend to have lower funding costs. These results suggest that household financial sophistication could play a major role in banking markets.

[2]Bhutta, Fuster, and Hizmo (2024) find that limited borrower sophistication may provide lenders with market power in the U.S. mortgage market.

2. BANK CDs

Bank certificates of deposit (CDs) are savings certificates where the principal amount deposited is held in a bank account for a fixed period of time. The term of these time deposits typically ranges from one month to five years or more. The holder of a CD accrues interest at a specified fixed rate (the CD rate) and receives a single cash flow in the amount of the principal plus accrued interest at maturity. Bank CDs effectively have the same credit risk as Treasury bonds since they are guaranteed by the Federal Deposit Insurance Corporation (FDIC) (up to a specified limit).

A unique feature of bank CDs that distinguishes them from conventional fixed income instruments such as Treasury bonds is that the depositor has the right to redeem a CD at any time prior to its stated maturity at its accrued value minus a withdrawal penalty. We refer to this feature as the early withdrawal option and observe that it is similar in nature to a put option on a bond.[3] The early withdrawal penalty is typically expressed in terms of a certain number of days of foregone interest.[4] To illustrate, suppose that a depositor owns a \$10,000 CD with a one-year term and a CD rate of four percent. Assume that the early withdrawal penalty is 90 days of interest. This means that if the depositor redeems the \$10,000 anytime before the one-year term is over, the penalty would be $90/365 \times 0.0400 \times \$10,000 = \$98.63$. Furthermore, if the depositor were to redeem the CD early at any time during the first 90 days of the one-year term, the depositor would actually incur a loss of principal.

When a CD reaches its maturity date, many banks automatically renew or roll over the CD into a new one with similar terms, unless the depositor actively communicates to the bank the decision to opt-out of this automatic renewal feature. In many cases, this actually entails the depositor having to call the bank and give clear instructions to either withdraw the funds or transfer them to a different account. Most banks offer a grace period, typically lasting about seven to ten days after the maturity date, during which depositors can still withdraw or transfer funds without penalty. Failure to act during this time period may result in the funds being locked into a new CD term, potentially at less favorable interest rates, or early withdrawal penalties, if the depositor decides to terminate

[3]See Fleckenstein and Longstaff (2024) for a detailed description of the early withdrawal option.

[4]Investors can redeem a CD at any time without prior notice. Federal regulations require a minimum withdrawal penalty of seven days of simple interest on early withdrawals during the first six days after investing in a CD. There is no rule limiting the maximum withdrawal penalties.

the CD after the grace period has expired.

Our focus in this paper is exclusively on the plain-vanilla type of FDIC-insured bank CDs described above. We observe, however, that there are other types of investments in the markets that are often referred to as CDs. These include brokered CDs and negotiable CDs. These types of investments are fundamentally different in nature from bank CDs. For example, these CDs have no early redemption feature since holders can sell them in the secondary market at any time. Furthermore, these investments may be callable, or may not be covered by FDIC insurance. Accordingly, we exclude these types of CDs from the analysis.

3. IDENTIFYING INCONSISTENT PRICING

To illustrate how an internally-inconsistent term structure of CD rates can be identified, consider the following simple example. Let r_N denote the rate for an N-year CD, and let r_M denote the rate for an M-year CD, where $M > N$. At maturity, a depositor who invests in the N-year CD receives a cash flow of

$$(1 + r_N)^N. \tag{1}$$

Alternatively, a depositor who invests in the M-year CD, but then makes an early withdrawal after N years, receives a net cash flow of

$$(1 + r_M)^N - \gamma\, r_M, \tag{2}$$

in N years, where $\gamma\, r_M$ denotes the early withdrawal penalty (the fraction γ of a year's interest that the depositor foregoes by making an early withdrawal times the annual interest rate r_M). If the cash flow in Equation (1) is less than the cash flow in Equation (2), we say that the N-year CD is inconsistent with the M-year CD. Intuitively, describing the N-year CD as inconsistent makes sense since no value-maximizing depositor with an N-year horizon would choose to invest in the N-year CD since it is dominated by the M-year CD. The size of the inconsistency can be expressed in terms of the difference between the yield on the N-year CD and the yield implied by the net cash flow from investing in the M-year CD and making an early withdrawal. The difference in yields is given by

$$\frac{((1 + r_M)^N - \gamma r_M)^{1/N}}{(1 + r_N)} - 1. \tag{3}$$

We identify a term structure of CD rates as internally inconsistent if any tenor is inconsistent with any other tenor. The size of the inconsistency for the term structure is the maximum inconsistency taken over all pairwise comparisons of tenors across the term structure.

4. THE DATA

This section provides a brief description of the primary data sets used throughout the paper. The Internet Appendix provides complete details about the data and methodology used in the analysis.

4.1 Bank CD Rates

S&P RateWatch collects weekly branch-level data on interest rates from over 96,000 branch locations in the U.S. for a wide variety of products such checking, savings, and money market accounts, and CDs. We obtain weekly data on CD rates from S&P RateWatch for the period from January 5, 2001 to June 30, 2023 for six-month, one-year, two-year, three-year, four-year, and five-year tenors. To ensure that the rates are for CDs that are fully insured by the FDIC, we restrict the sample to CDs for account sizes less than or equal to $100,000. The data set includes CD rates from 16,891 rate-setting branches and banks. For expositional simplicity, we refer to these rate-setting branches and banks generically as banks.

Since our primary focus is on the relative pricing of bank CDs with different tenors, the basic units of observation are the weekly term structures of CD rates provided by banks. To be included as a term structure observation, the term structure must include rates for two or more tenors. Table 1 presents summary statistics for the data by tenor. As shown, the sample consists of 7,216,482 weekly term structures. Since there are 1,171 weeks during the sample period, this represents an average of about 6,163 term structure observations per week.

4.2 Early Withdrawal Penalties

We obtain data on early withdrawal penalties for CDs from two sources. First, we collect quarterly interest rate risk exposure reports from the Office of Thrift Supervision (now merged with the Comptroller of the Currency) for the period from Q1 2001 to Q4 2011 and compute annual averages of the reported withdrawal penalties for CDs with original maturity T for the categories $T \leq 12$ months, $12 < T \leq 36$ months, and $T > 36$ months.[5] Second, we collect early

[5]See https://www.occ.gov/news-events/newsroom/news-issuances-by-year/ots-

withdrawal penalties from the RateWatch database for the period from January 2, 2012 to June 30, 2023 and compute annual averages across all observations for individual CD tenors of up to five years. By combining the OTS and RateWatch series, we obtain an annual time series of early withdrawal penalties measured in terms of days of foregone interest for the period from 2001 to 2023. Table 1 also provides summary statistics for the withdrawal penalties by tenor.

4.3 Bank-Specific Data

In the analysis, we include a number of bank-specific variables that are widely used in the banking literature as controls. Following Drechsler, Savov, and Schnabl (2017, 2021), English, Van den Heuvel, and Zacrajšek (2018), d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023), and many others, we include data on the size of banks, ratios reflecting the dependence of banks on various types of insured and uninsured deposits as a source of funding, the percentage interest rate expenses for various categories of deposits, and other bank-specific variables. We obtain the data for these variables are from the quarterly Federal Financial Institutions Examination Council (FFIEC) Consolidated Reports of Condition and Income, typically known as Call Reports. Table 2 provides summary statistics for these measures.

4.4 Demographic Data

Finally, we also include several demographic measures that are commonly used in the literature as proxies for financial sophistication. Again, motivated by Drechsler, Savov, and Schnabl (2017, 2021), d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023), and others, we collect data on the median age, median income, and percentage of the population with a college degree or higher for each state for each year during the sample period. The source of this data is the American Community Survey (ACS) by the U.S. Census Bureau. The ACS is an annual survey conducted by the U.S. Census Bureau on a wide range of demographic, social, economic, and housing characteristics of the U.S. population covering topics such as age, race, income, education, employment, and housing conditions. Table 2 also provides summary statistics for these demographic variables.

5. PRICING INCONSISTENCIES

The individual observations in the data set consist of a term structure of CD

issuances/ots-aggregate-irr-exposure-and-cmr-reports.html.

rates provided by a specific bank. An important advantage of having a term structure of CD rates is that it allows us to test directly whether there are pricing inconsistencies among the CD rates. Using the approach described above, we examine each of the CD term structures in the sample to determine whether it is internally inconsistent.

The results provide striking evidence that the term structures of CD rates offered by banks are frequently internally inconsistent. To illustrate this, Table 3 presents summary statistics for the frequency and size of inconsistent pricing during the sample period. Specifically, we report the percentage of term structures that are internally inconsistent, where the percentage is computed over either the entire sample period or an individual year.

As shown, 52.36 percent of all CD term structures provided by banks during the 2001–2023 sample period are internally inconsistent. Thus, internal inconsistency is the rule rather than the exception. The results for the individual years, however, indicate that there is considerable variation over time in these frequencies. To illustrate this, Figure 1 plots the time series of the frequency of inconsistent pricing. As shown, the frequencies range from nearly zero in 2001 to 80 percent or more during the 2011–2017 period.

The results also show that the size of the pricing inconsistencies is typically large and economically significant. The average size of the pricing inconsistencies taken across all inconsistent term structures during the sample period is 23.22 basis points. Recall from Table 1 that the average CD rates are on the order of 150 to 200 basis points during the sample period. Thus, the size of the pricing inconsistencies is clearly significant relative to the average values of CD rates. Note that the average size of the pricing inconsistencies is fairly stable over time. To illustrate this, Figure 2 plots the time series of the average size for the inconsistent term structures. As shown, the average size ranges from about 20 to 30 basis points during most of the sample period.

6. FINANCIAL SOPHISTICATION AND FUNDING COSTS

We have shown that many banks offer term structures of CD rates in which the rates for some tenors are actually dominated. In theory, these rates should never be accepted by any value-maximizing depositor. In reality, financially-unsophisticated customers might invest in (or automatically roll over into) tenors with dominated rates without being aware that there are better alternatives.

Whether inconsistent pricing is intentional or not, having financially-unsophisticated customers who may naively accept these lower rates represents a poten-

tial funding-cost windfall for banks. Furthermore, it is important to recognize that if a bank has customers who lack the financial sophistication to avoid accepting dominated CD rates, these same customers may very well also accept unfavorable rates in much-broader contexts such as in the pricing of demand and savings accounts. Thus, having financially-unsophisticated customers could be an important contributing factor to bank profitability.

The cross-sectional variation across banks in the frequency of inconsistent pricing provides us with a natural experiment for examining the relation between deposit pricing and customer financial sophistication. In particular, if bank customers are financially unsophisticated, banks that offer internally-inconsistent rates more frequently are more likely to benefit by having lower funding costs. In contrast, if customers are financially sophisticated, then banks that offer dominated rates more frequently should have little advantage over other banks since the lower rates they offer would not be accepted.

In this section, we examine the relation between bank funding costs and the frequency of inconsistent pricing. In doing this, we focus on three different measures of bank funding costs. The first is the ratio of the interest expense on total deposits to total deposits. The second is the ratio of the interest expense on demand and savings deposits to the sum of demand and savings deposits. The third is the ratio of the interest expense on time deposits to total time deposits. Each of these three ratios can be interpreted as the effective yield the bank pays for the respective deposits. We compute the frequency measure for each bank as the ratio of the number of internally-inconsistent term structures provided by the bank divided by the total number of term structures offered by the bank. We compute the frequency measure for each bank for each year.[6]

As a preliminary to the analysis, we first note that there is a strong univariate correlation between the average interest costs paid by banks on their deposits and the frequency of inconsistent pricing. This is readily seen in Figure 3 which plots scatterdiagrams of the average funding costs for a bank throughout the sample period against the frequency of its inconsistent pricing over the same period. As shown, the correlations between funding costs and frequencies are significantly negative for each of the three funding measures, with values of -44.02, -36.83, and -39.33 percent, respectively.

To examine the relation between bank funding costs and customer financial sophistication more formally, we regress the three measures of funding costs on bank-specific controls, demographic controls, and the frequency of inconsistent pricing. This panel regression approach provides us with a direct way of test-

[6]We require that a bank provide at least ten term structures during a year in order to compute a frequency for that bank for that year.

ing whether deposit pricing strategies that allow banks to benefit from having financially-unsophisticated customers are actually effective. If so, this would provide evidence that the lack of financial sophistication among customers may be an important source of bank market power.

As discussed earlier, we include a number of standard measures used in the banking literature as controls for bank-specific factors and demographic effects. As bank-specific controls, we include the log size of the bank, the duration of bank liabilities, the ratio of bank loans to total assets, the ratio of security holdings to total assets, the ratio of total bank equity to total assets, and the return on bank assets. To control for demographic effects, we also include the median income, median age, and education variables in the regression. Finally, we also include year and state fixed effects.

Table 4 reports the regression results. As shown, banks that offer internally-inconsistent term structures more frequently have significantly lower funding costs. This result holds for all three measures of funding costs. Thus, the relation between the frequency of inconsistent pricing and funding costs is not limited to just time deposits. This suggest that the frequency of inconsistent pricing is more than just a narrow measure of the use of a specific deposit pricing strategy. Rather, the results suggest that the frequency should be viewed more broadly as an instrument capturing the overall stance of a bank relative to its less-sophisticated customers. As discussed earlier, banks that offer customers dominated CD rates may also follow other strategies that could disproportionally affect less-sophisticated customers.

The magnitude of the relation between funding costs and the frequency of inconsistent pricing is also significant from an economic perspective. The parameter estimates reported in Table 4 indicate that banks that always offer inconsistent term structures have interest expenses on all deposits that are about 15.3 basis points lower than those of banks that never offer inconsistent term structures. Recall from Table 2 that the average interest expense on all deposits during the study period is about 135 basis points. Thus, a difference of 15.3 basis points in the funding costs represents a substantial fraction of the average.

As an alternative way of exploring the relation between funding costs and the frequency of inconsistent pricing, we reestimate the panel regression using only banks for which the frequency is greater than zero. Intuitively, the reason for doing this is that the large subset of banks that never offer internally-inconsistent term structures may have private information that their customers are financially sophisticated and unlikely to accept below-market rates on deposits. Thus, these banks may be interacting with a very different population of depositors than other banks. Table 5 reports the regression results.

As shown, the results in Table 5 are very similar to those reported in Table 4 that are based on all banks. In particular, there is a significant negative relation between the funding costs and the frequency of inconsistent pricing. As before, this holds for all three measures of the funding costs. The economic magnitude of the results is also similar to that shown in Table 4. Specifically, the parameter estimates from the panel regression imply that banks that always offer internally-inconsistent term structures have interest expenses on all deposits that are roughly 14.9 basis points lower than those of banks that never offer inconsistent term structures.

In summary, these results provide direct evidence that banks that price deposits in a way that may adversely impact their financially-unsophisticated customers tend to benefit from this activity. An important implication of this is that banks appear to have financially-unsophisticated depositors from whom they may be able to extract economic rents. For example, if a bank has financially-unsophisticated depositors who are unaware of alternative investment opportunities, their accounts can become a sticky source of low-cost funding for the bank. In turn, this implies that having financially-unsophisticated depositors could be an important determinant of a bank's deposit franchise value.

7. IS INCONSISTENT PRICING INTENTIONAL?

We have shown that the term structures of CD rates offered by banks are frequently internally inconsistent. A natural question to ask, however, is whether this inconsistent pricing is intentional or unintentional. In this section, we provide evidence that many banks offer internally-inconsistent term structures so persistently that it is very unlikely that this activity can be entirely accidental.

As one way of doing this, we study the cross-sectional distribution of the frequency of inconsistent pricing across banks. Table 6 provides summary statistics for the distribution of these frequencies for the individual banks. The results for the individual years are based on the distribution of the frequencies for all banks that provided ten or more term structures during that year. The results for the entire sample period are based on the distribution of frequencies for all banks taken over all years in which they provided ten or more term structures.

Focusing first on the results for the entire sample period, Table 6 provides evidence suggesting that many banks are aware of the consistency issue. First, Table 6 shows that there is a large subset of banks that not even once offered an internally-inconsistent CD term structure during the entire sample period. In particular, 11.81 percent of all the banks in the sample have a frequency of inconsistent pricing of exactly zero. This can be seen in the histogram in Figure

4 which shows that the distribution has a significant mass point at zero. These results are remarkable since the typical bank in this subset provides hundreds of term structures during the sample period, and many offer more than a thousand. Thus, the probability of these results occurring simply by chance is very remote. Rather, these results make a strong case that many banks focus on the issue and actively avoid offering internally-inconsistent term structures. As we show later, avoiding internally-inconsistent term structures is actually a challenging exercise and can require particular care.

Second, Table 6 also shows that there is a substantial subset of banks that offer term structures of CD rates that are always internally inconsistent. In particular, 8.36 percent of the banks offer only term structures that were internally inconsistent. Furthermore, 11.72 percent of the banks have a frequency of inconsistent pricing in excess of 90 percent. Again, the probability of these results occurring by chance appears very unlikely and suggests that the internal inconsistencies in their term structures may be deliberate.

Finally, Table 6 shows that there is a large subset of banks with frequencies of inconsistent pricing in the range of about 50 to 80 percent. In particular, 35.04 percent of the rate-setting entities in the sample have frequencies between 50 and 80 percent.

Taken together, these results suggest that we can view most banks as falling into one of three general categories: banks that are never inconsistent, banks that are always inconsistent, and banks that are often inconsistent. This pattern is readily seen in the histogram in Figure 4 which illustrates the trimodal nature of the distribution of frequencies over the sample period. These results create a strong presumption that many banks are aware of the implications of internal inconsistency and take steps to either avoid or facilitate it.

Turning next to the results for the individual years, Table 6 shows that the multimodal pattern of the distribution of frequencies is robust over time and is not simply a compositional effect. In particular, the proportion of banks that never offer an internally-inconsistent term structure during a year is always greater than 10 percent. At the other end of the spectrum, the proportion of banks that offer only internally-inconsistent term structures ranges from nearly zero to about 80 percent. Note that there are many years during which there is simultaneously a large fraction of banks that are never inconsistent and a large fraction that are always inconsistent. Again, this provides evidence that the multimodal nature of the distribution of frequencies is not just a coincidence or compositional effect, but is likely the outcome of deliberate actions by banks.

8. WHAT DRIVES INCONSISTENT PRICING?

In this section, we examine the cross-sectional patterns of CD term structures offered by banks to shed light on the potential determinants of inconsistent pricing. Recall from the earlier discussion that the banking literature identifies several possible factors that may influence deposit pricing. Rather than taking a stand on any particular theory or mechanism, our approach will simply be to explore the relation between inconsistent pricing and some of the factors suggested by the recent literature. In doing this, we use a standard panel probit regression approach to estimate the probability that a term structure of CD rates is internally inconsistent conditional on the explanatory variables.

As the first set of explanatory variables, we include several bank-specific measures to help identify which banks are more likely to offer internally-inconsistent term structures of CD rates. Following the previous literature, we include the log size of the bank as an explanatory variable. d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023) argue that the financial sophistication of customers may vary across banks of different sizes. Furthermore, the FDIC views the size of a bank as the key factor distinguishing community banks from non-community (or wholesale) banks.[7]

We also include several ratios that may serve as proxies for the type of banking that the individual banks engage in. The intuition for this is that banks with different business models may attract different types of customers with different levels of financial sophistication. The first is the ratio of demand and savings deposits to total assets.[8] Banks with a larger proportion of their liabilities in the form of these types of short-term accounts are more likely to be engaged in traditional household retail banking and may have a less-sophisticated customer base. The second is the ratio of uninsured time deposits to total assets. Banks that rely more heavily on larger uninsured deposits as a source of funding could potentially have a more financially-sophisticated customer base consisting of business and commercial accounts. The third is the ratio of wholesale funding (fed funds and repo financing) to total assets. Banks with a larger ratio of wholesale funding in their capital structure may be less focused on deposits and have a very different type of customer base. Including these ratios in the probit specification allows us to examine how potential differences in the level of financial sophistication affects how banks relate to these customers.

[7]See FDIC Community Banking Study, December 2020, Appendix A.

[8]We define total demand and savings deposits as total deposits minus total time deposits.

As the second set of explanatory variables, we include several demographic measures that have been used in the previous literature as proxies for the financial sophistication of banking customers. Specifically, we include median age, median income, and educational level in the probit specification. Including these variables into the regression allows us to test directly the relation between proxies for the financial sophistication of bank customers and the frequency with which these customers are presented with internally-inconsistent term structures of CD rates.

The final category is motivated by Drechsler, Savov, and Schnabl (2017) and others who argue that market power allows banks to build deposit franchises by slowly adjusting their rates towards riskless market rates via a deposit beta mechanism. In particular, we explore whether some of the internally-inconsistent term structures may be due to some banks simply setting CD rates using mechanical algorithms that track Treasury rates over time, albeit slowly.

This latter possibility is relevant since constructing a term structure of CD rates that avoids any internal inconsistency is far from a trivial exercise. In particular, banks that price deposits by tracking market interest rates could easily end up with an internally-inconsistent term structure of CD rates. To illustrate this, imagine that a bank simply sets its CD rates equal to the corresponding Treasury spot rates (based on either the current or a lagged term structure of Treasury rates). Since Treasury markets are very active and liquid, we would not expect the term structure of Treasury rates to be mispriced. Thus, setting CD rates equal to Treasury rates would seem to be a straightforward way of avoiding an internally-inconsistent CD term structure.

Surprisingly, however, this approach results in CD term structures that are frequently internally inconsistent, and often by significant amounts. Table 7 reports the frequency of inconsistent term structures resulting from setting the term structure of CD rates equal to the term structure of Treasury rates. Note that this results in just one term structure observation per week. As shown, 55.85 percent (or 654) of the 1,171 weekly CD term structures are internally inconsistent. Furthermore, the average size of the pricing inconsistency is 36.64 basis points (conditional on the term structure being internally inconsistent).[9]

If the Treasury term structure is not mispriced, then how could setting CD rates equal to Treasury rates result in internally-inconsistent CD term structures? The short answer is that the early withdrawal option included in bank CDs com-

[9]As a robustness exercise, the Internet Appendix presents additional results showing that the results are very similar when the term structure of CD rates is set equal to the term structure of Treasury rates minus the average spread between Treasury and CD rates.

pletely changes their economics relative to Treasuries. For example, a depositor who invests in a five-year CD can liquidate the position after one year at a fixed price (the accrued value of the CD minus the withdrawal penalty). In contrast, an investor who purchases a five-year Treasury can liquidate the position after one year, but only by selling it in the secondary market at an unknown price. The fact that CDs can be put back to the bank at a fixed price at any point in time means that the term structure of CD rates has to satisfy more restrictions to avoid internal inconsistencies than does the term structure of Treasury rates. Thus, a term structure of rates that may be perfectly legitimate from the perspective of the Treasury market may result in significant pricing inconsistencies when applied to bank CD rates. The key takeaway from these results is that avoiding internal inconsistencies can actually be a challenging task that requires careful attention by banks.

To capture the possibility that some internally-inconsistent term structures may occur by banks simply following mechanical algorithms that track Treasury rates, we include an indicator variable that takes the value one if setting the CD term structure equal to the Treasury term structure results in an internally-inconsistent CD term structure, and zero otherwise. Finally, we include weekly fixed effects in the probit regression to control for time-varying omitted variables that affect all banks in the same way. Table 8 reports the results.

Table 8 shows several intriguing patterns in the probabilities of inconsistent pricing. First, the results show that there is a strong positive relation between bank size and the probability that a CD term structure is internally inconsistent. This result may help explain the intriguing finding in d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023) that customers of banks in higher-income areas tend to earn lower rates on deposits. The positive relation with size also argues against the notion that internal inconsistencies are simply due to inadvertent pricing errors made by smaller less-experienced banks that may lack the analytic skills or expertise to recognize the issue.

Second, the results show that the probability of inconsistent pricing is also related to several of the bank funding measures. In particular, we find that banks with a higher proportion of demand and savings deposits in their capital structure are somewhat more likely (at the ten-percent level) to offer internally-inconsistent term structures. This suggests that banks that focus on more-traditional retail or community banking may view their customers as being less financially sophisticated. The results also show that banks that depend more on large uninsured deposits as a source of financing are significantly less likely to offer internally-inconsistent term structures. Since larger uninsured deposits are associated with wealthier, and presumably more-sophisticated customers, the results are consistent with there being a link between deposit pricing and the level of financial

sophistication of bank customers. Finally, there is a significant positive relation between the wholesale funding ratio and the probability of inconsistent pricing. This suggests that banks that tend to look beyond traditional deposits as a source of funding may be more likely to try to extract rents from their deposit customers.

Third, the results indicate that the probability of inconsistent pricing is significantly related to the demographic measures proxying for financial sophistication. In particular, there is a very strong positive relation between the probability and the median age in the state. Similarly, there is a significant negative relation between the probability and the fraction of households with a college degree or higher in the state. Together, the results are consistent with the interpretation that inconsistent pricing is more likely to occur in markets with older and less-educated households. This provides additional support for a connection between deposit pricing and customer financial sophistication. We acknowledge, however, that the evidence for this link is somewhat mixed since the results also show that there is a positive relation between the probability and the median income in the state.

Finally, Table 8 shows that there is a strong positive relation between the probability of inconsistent pricing and the indicator for whether setting CD rates equal to Treasury rates results in inconsistent pricing. This provides evidence that some (but not all) of the observed inconsistencies may simply be the result of banks following mechanical deposit pricing algorithms that track Treasury rates without considering whether they produce internally-inconsistent term structures.

9. CONCLUSION

This paper studies the relation between household financial sophistication and banking market power. In particular, we use a natural experiment that allows us to identify banks that price deposits in ways that may lure unwary depositors into accepting lower rates. While many banks avoid this type of deposit pricing, many others appear to embrace it. Using the frequency of this type of pricing as an instrument for how aggressively banks target their financially-unsophisticated customers, we test whether banks are able to extract value from having these unsophisticated customers.

We find that more-aggressive banks tend to have significantly lower deposit funding costs. These results provide support for Drechsler, Savov, and Schnabl (2017) and others who argue that having financially-unsophisticated customers provides banks with an important source of market power. By exercising this

market power, banks can create valuable deposit franchises.

The results also indicate that there are significant differences across banks in how they interact with their customers. In particular, our results are consistent with a framework in which banks obtain private information about the financial sophistication of their customers through their deposit pricing activities. This parallels the way in which banks may learn about the creditworthiness of borrowers through their monitoring role. Banks with financially-unsophisticated customers may choose to pursue more-aggressive deposit pricing strategies. Banks with financially-sophisticated customers may avoid aggressive deposit pricing strategies since they would likely be ineffective.

Finally, our results suggest that household financial sophistication may play a much-larger role in banking markets than has been previously recognized in the literature. These results also make clear the need for additional research leading to a deeper understanding of how banks price deposits and other strategies that they may use to generate income.

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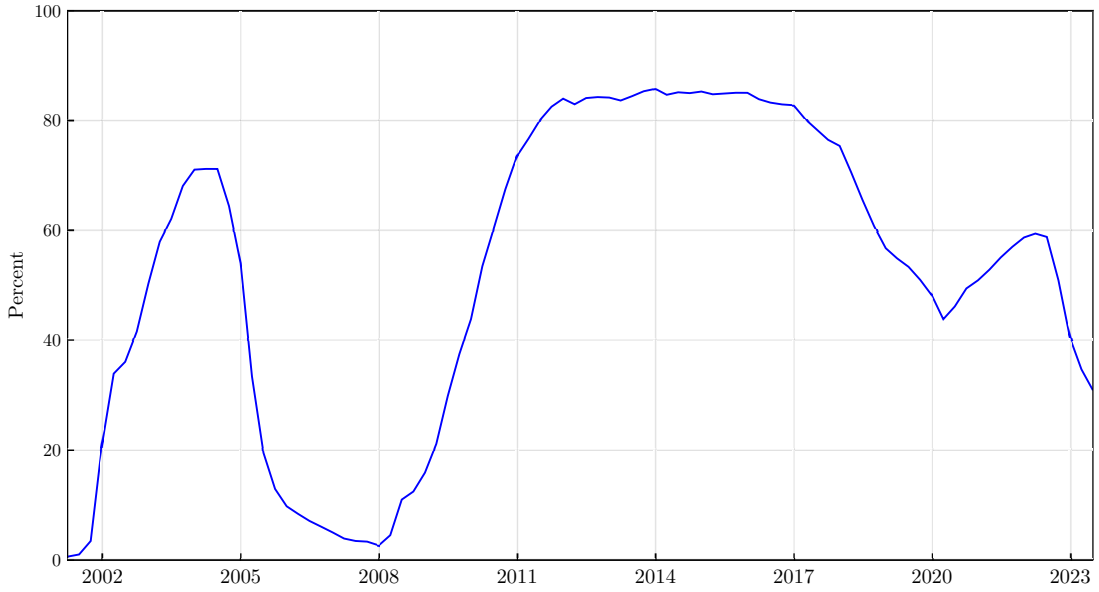

Figure 1. This graph plots the time series of the percentage of internally-inconsistent CD term structures offered by banks. The percentages are computed quarterly using all term structures reported in the S&P RateWatch data set.

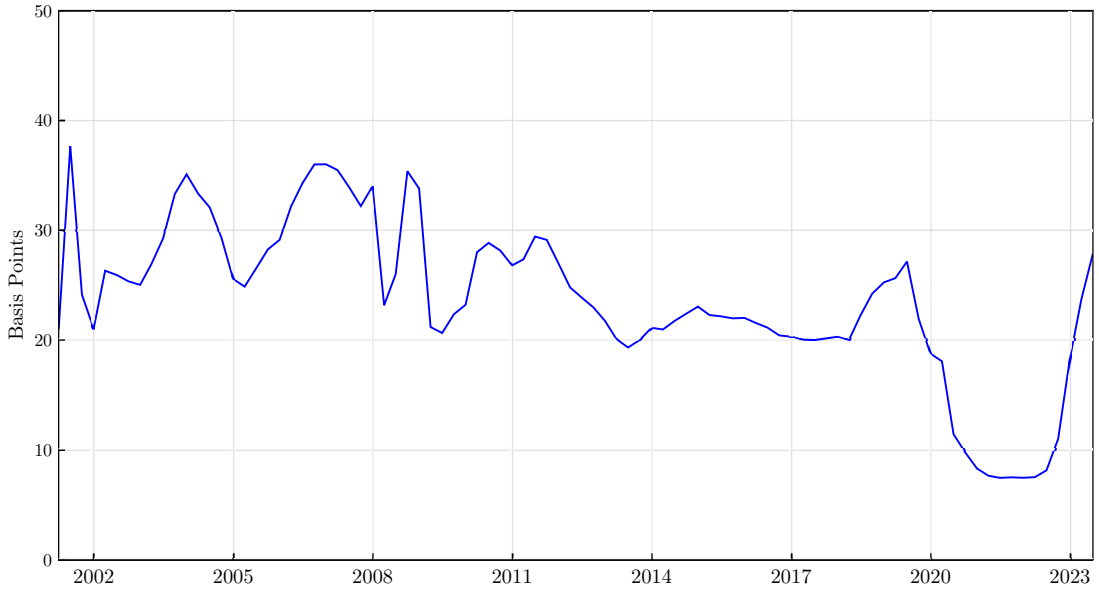

Figure 2. This graph plots the time series of the average size of the pricing inconsistencies taken over all internally-inconsistent CD term structures. The size of the pricing inconsistency for any internally-inconsistent term structure is the maximum pricing inconsistency taken over all pairwise comparisons of CD tenors in the same term structure and is expressed in basis points. The averages are computed quarterly using all term structures reported in the S&P RateWatch data set.

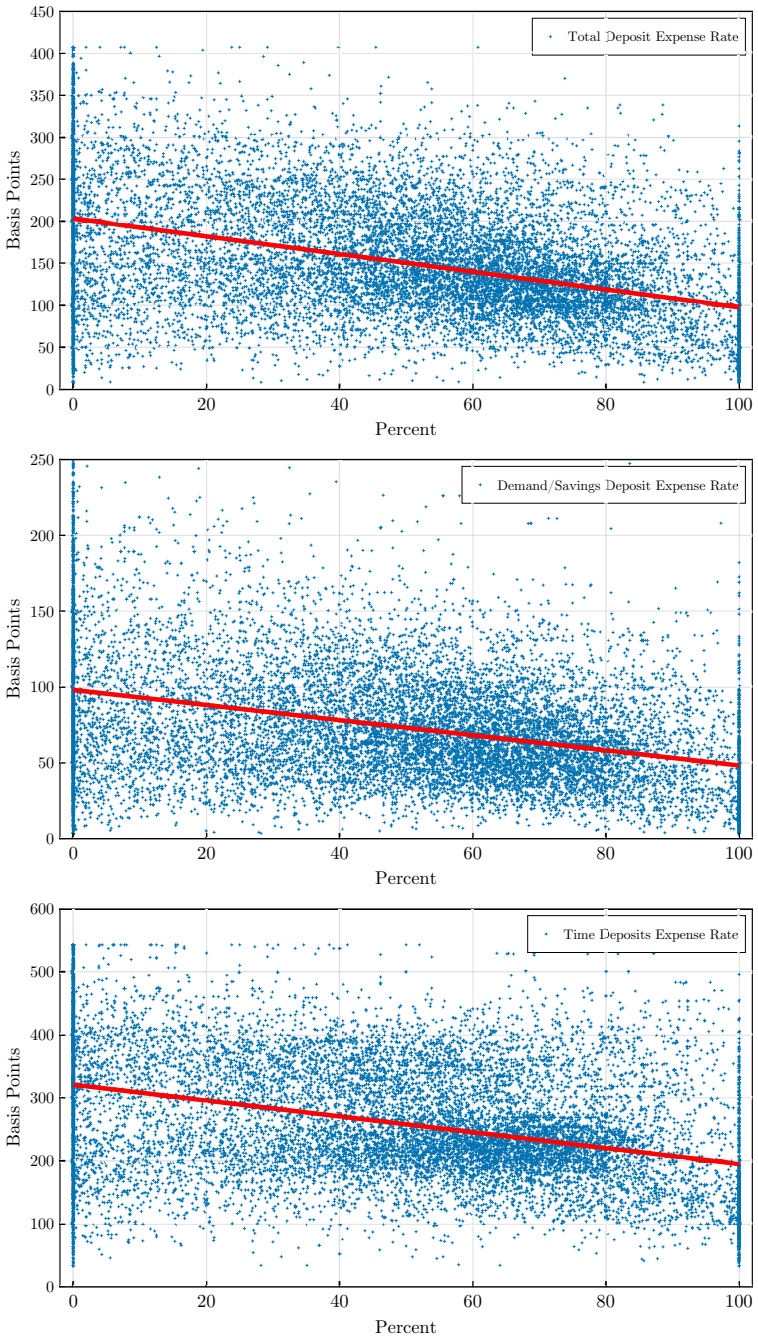

Figure 3. These graphs present scatterdiagrams of the deposit expense rates for individual banks and the frequency of inconsistent pricing in the CD term structures offered by these banks. The observations consist of annual values of the deposit expense rate and frequency of inconsistent pricing for each bank in the S&P RateWatch data set. The top, middle, and lower panels are based on the expense rates for total deposits, demand and savings deposits, and time deposits, respectively. The deposit expense rates are expressed in basis points. Frequencies are expressed as percentages.

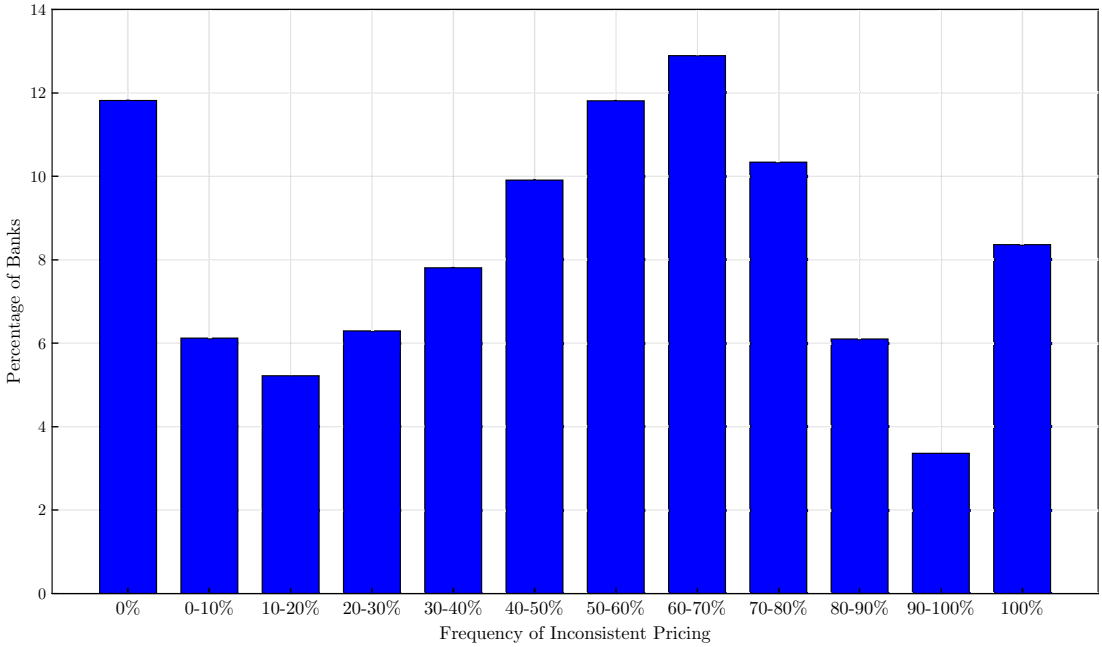

Figure 4. This graph plots the histogram of the frequency of inconsistent pricing in the term structures of CD rates offered by the individual banks in the S&P RateWatch data set. The frequency for each bank is based on all years in which the bank provided ten or more term structures.

Table 1

Summary Statistics for CD Rates and Early Withdrawal Penalties. This table presents summary statistics for CD rates and early withdrawal penalties for CDs with the indicated tenors. The top panel presents summary statistics for CD rates. The data on CD rates are furnished by S&P RateWatch and consist of weekly CD rates quoted by individual banks for principal amounts less than or equal to $100,000. CD rates are expressed as percentages. The bottom panel presents summary statistics for early withdrawal penalties. Withdrawal penalties are expressed in terms of days of foregone interest. The data on early withdrawal penalties are furnished by the Office of Thrift Supervision for the period from 2001 to 2012 and by S&P RateWatch for the period from 2013 to 2023. Mean, Std Dev, 5%, 50%, and 95% present the mean, standard deviation, the 5th percentile, the median, and the 95th percentile of the weekly observations for the indicated tenors across all banks. *N* presents the total number of weekly term structures. To be included as a term structure observation in the sample, the term structure must include for two or more tenors. The sample period is weekly from January 5, 2001 to June 30, 2023.

	Tenor	Mean	Std Dev	5%	50%	95%	*N*
CD Rate							
	Six-Month	1.249	1.239	0.085	0.768	3.900	7,216,482
	One-Year	1.499	1.323	0.140	1.083	4.230	7,216,482
	Two-Year	1.754	1.332	0.224	1.425	4.300	7,216,482
	Three-Year	1.972	1.357	0.300	1.696	4.410	7,216,482
	Four-Year	2.129	1.372	0.350	1.833	4.500	7,216,482
	Five-Year	2.340	1.400	0.450	2.029	4.670	7,216,482
Penalty							
	Six-Month	87.38	8.72	74.24	88.64	99.46	7,216,482
	One-Year	101.73	10.04	86.29	99.76	116.14	7,216,482
	Two-Year	179.69	7.37	169.12	180.91	191.93	7,216,482
	Three-Year	194.78	24.24	169.12	182.97	232.79	7,216,482
	Four-Year	243.15	7.89	231.54	241.00	256.04	7,216,482
	Five-Year	254.32	19.54	231.54	247.68	283.71	7,216,482

Table 2

Summary Statistics for Bank Characteristics and Demographic Variables. The summary statistics are based on annual observations of the indicated variables for each individual bank in the sample. Bank characteristics are from FFIEC Call Reports as of the end of the fourth quarter of each calendar year. Demographic variables are from the ACS by the U.S. Census Bureau. Assets denotes total bank assets in dollars. Demand/Savings Deposit Ratio, Uninsured Deposit Ratio, and Wholesale Ratio are the ratios of demand and savings deposits, uninsured deposits, and fed funds and repo financing to total assets, respectively. Total Deposit Expense Rate, Demand/Savings Expense Rate, and Time Deposit Expense Rate are the ratios of interest expense on total deposits to total deposits, interest expense on demand and savings deposits to total demand and savings deposits, and interest expense on time deposits to time deposits, respectively. Expense rates are annualized and expressed in basis points. Liability Duration is the Drechsler, Savov, and Schnabl (2021) measure of repricing maturity of bank liabilities and is expressed in years. Loan Ratio, Securities Ratio, and Equity Ratio are the ratios of total loans and leases, securities, and book equity to total assets, respectively. All ratios are expressed as percentages. Return on assets is the ratio of net income to quarterly average assets and is expressed as an annualized rate in basis points. Age, Income, and Percent College present the median age, median income, and percentage of the population with a college degree or higher in the states where banks quote term structures of CD rates, respectively. Median income is expressed in thousands of dollars. Mean, Std Dev, 5%, 50%, and 95% present the mean, standard deviation, the 5th percentile, the median, and the 95th percentile of of the respective variables. Num denotes the total number of annual bank-level observations of the indicated variables. The sample period is annual from 2001 to 2023.

		Mean	Std Dev	5%	50%	95%	Num
Bank Variables							
	Assets	6.205	2.235	3.704	5.561	11.536	149,553
	Demand/Savings Deposit Ratio	52.100	14.978	28.645	51.393	76.715	149,553
	Uninsured Deposit Ratio	8.492	7.367	0.791	6.436	22.957	149,553
	Wholesale Ratio	1.668	3.130	0.000	0.013	7.811	149,553
	Total Deposit Expense Rate	134.590	104.900	17.388	105.910	335.749	149,553
	Demand/Savings Expense Rate	65.165	194.686	7.040	45.827	185.825	149,553
	Time Deposit Expense Rate	232.877	143.365	57.773	202.911	490.371	149,553
	Liability Duration	0.403	0.242	0.102	0.365	0.842	149,553
	Loan Ratio	64.221	13.523	38.929	65.909	83.303	149,553
	Securities Ratio	21.385	13.176	3.337	19.327	46.494	149,553
	Equity Ratio	10.608	3.413	7.075	9.979	16.112	149,553
	Return on Assets	77.899	170.447	−99.614	97.312	209.404	149,553
Demographic Variables							
	Age	37.161	2.000	33.600	37.200	40.300	149,553
	Income	50.349	10.476	36.318	48.576	70.545	149,553
	Percent College	27.677	5.154	20.005	27.134	36.966	149,553

Table 3

Summary Statistics for the Frequency and Size of Inconsistent Pricing. This table presents summary statistics for the frequency and average size of inconsistent pricing for the indicated years. Frequency is expressed as a percentage. Size presents the average size of the pricing inconsistency for the inconsistent term structures. The size of the pricing inconsistency for any inconsistent term structure is the maximum pricing inconsistency taken over all pairwise comparisons of CD tenors in the same term structure and is expressed in basis points. N denotes the number of weekly term structures for the indicated years. The row labeled All presents summary statistics for the frequency and average size of inconsistent pricing for all years. The sample period is weekly from January 5, 2001 to June 30, 2023.

Year	Frequency	Size	N
2001	11.34	21.52	225,457
2002	40.27	25.59	391,703
2003	64.71	31.37	389,873
2004	64.87	30.27	391,356
2005	18.57	26.48	381,731
2006	6.60	34.31	373,822
2007	3.29	33.96	360,556
2008	10.90	31.19	359,892
2009	33.14	22.07	359,957
2010	63.81	27.87	371,899
2011	80.88	28.26	360,793
2012	83.83	23.35	350,812
2013	84.75	20.12	337,466
2014	84.99	22.03	316,047
2015	84.91	22.10	307,952
2016	83.18	20.85	295,996
2017	77.62	20.12	285,028
2018	63.45	22.74	283,842
2019	51.86	23.55	269,204
2020	47.45	11.76	234,799
2021	55.86	7.51	248,932
2022	52.66	10.44	211,022
2023	32.75	25.66	108,343
All	52.36	23.22	7,216,482

Table 4

Results from Regressions of Deposit Expense Rates on the Frequency of Inconsistent Pricing. This table presents the results from the panel regression of deposit expense rates on the frequency of inconsistent pricing. Bank characteristics are from FFIEC Call Reports. Demographic variables are from the ACS by the U.S. Census Bureau. Bank characteristics and demographic variables are as of the end of the previous calendar year. Total Deposit Expense Rate, Demand/Savings Expense Rate, and Time Deposit Expense Rate are the ratios of interest expense on total deposits to total deposits, interest expense on demand and savings deposits to total demand and savings deposits, and interest expense on time deposits to time deposits, respectively. Expense rates are expressed as annualized rates in basis points and winsorized at the one-percent level. Percent Inconsistent denotes the annual frequency of inconsistent pricing for each bank providing ten or more term structure during the year and is expressed as a percentage. Assets denotes total bank assets in dollars. Liability Duration is the Drechsler, Savov, and Schnabl (2021) measure of repricing maturity of bank liabilities and is expressed in months. Loan Ratio, Securities Ratio, and Equity Ratio are the ratios of total loans and leases, securities, and book equity to total assets, respectively. All ratios are expressed as percentages. Return on Assets is the ratio of net income to quarterly average assets and is expressed as an annualized rate in basis points. Age, Income, and Percent College present the median age, median income, and percentage of the population with a college degree or higher in the states where banks quote term structures of CD rates, respectively. Income is expressed in thousands of dollars and Age is expressed in months. FE_{Year} and FE_{State} denote year and state fixed effects, respectively. Robust standard errors are clustered at the bank level. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is annual from 2001 to 2023. The regression specification is

$$\begin{aligned}\text{Expense Rate}_{it} = {} & c_1 \times \text{Percent Inconsistent}_{it} + c_2 \times \text{Log Assets}_{it} + c_3 \times \text{Liability Duration}_{it} \\ & + c_4 \times \text{Loan Ratio}_{it} + c_5 \times \text{Securities Ratio}_{it} + c_6 \times \text{Equity Ratio}_{it} \\ & + c_7 \times \text{Return on Assets}_{it} + c_8 \times \text{Age}_{it} + c_9 \times \text{Income}_{it} + c_{10} \times \text{Percent College}_{it} \\ & + \text{FE}_{\text{Year}} + \text{FE}_{\text{State}} + \epsilon_{it}.\end{aligned}$$

	Total Deposit Expense Rate		Demand/Savings Deposit Expense Rate		Time Deposit Expense Rate	
	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat
Percent Inconsistent	−0.153	−20.84**	−0.114	−17.62**	−0.033	−4.19**
Log Assets	−1.543	−2.39**	1.553	4.03**	1.922	5.86**
Liability Duration	8.045	42.44**	1.128	9.45**	7.555	45.65**
Loan Ratio	0.998	11.92**	0.606	10.22**	0.631	13.56**
Securities Ratio	0.445	6.13**	0.182	3.35**	0.226	4.86**
Equity Ratio	0.633	5.44**	0.665	7.66**	−0.223	−2.48**
Return on Assets	−0.016	−5.37**	−0.009	−3.69**	−0.009	−6.72**
Age	0.167	3.51**	−0.169	−4.61**	−0.064	−1.61
Income	2.239	12.71**	0.990	6.69**	1.116	6.49**
Percent College	−4.199	−8.62**	−2.373	−6.46**	−2.634	−6.23**
Year Fixed Effects		Yes		Yes		Yes
State Fixed Effects		Yes		Yes		Yes
Adj. R^2		0.884		0.645		0.931
N		149,553		149,553		149,553

Table 5

Results from Regressions of Deposit Expense Rates on the Frequency of Inconsistent Pricing for Banks with Frequencies Greater Than Zero. This table presents the results from the panel regression of deposit expense rates on the frequency of inconsistent pricing for the subset of banks for which the frequency is greater than zero. Bank characteristics are from FFIEC Call Reports. Demographic variables are from the ACS by the U.S. Census Bureau. Bank characteristics and demographic variables are as of the end of the previous annual period. Total Deposit Expense Rate, Demand/Savings Expense Rate, and Time Deposit Expense Rate are the ratios of interest expense on total deposits to total deposits, interest expense on demand and savings deposits to total demand and savings deposits, and interest expense on time deposits to time deposits, respectively. Expense rates are expressed as annualized rates in basis points and winsorized at the one-percent level. Percent Inconsistent denotes the annual frequency of inconsistent pricing for each bank providing ten or more term structure during the year and is expressed as a percentage. Assets denotes total bank assets in dollars. Liability Duration is the Drechsler, Savov, and Schnabl (2021) measure of repricing maturity of bank liabilities and is expressed in months. Loan Ratio, Securities Ratio, and Equity Ratio are the ratios of total loans and leases, securities, and book equity to total assets, respectively. All ratios are expressed as percentages. Return on Assets is the ratio of net income to quarterly average assets and is expressed as an annualized rate in basis points. Age, Income, and Percent College present the median age, median income, and percentage of the population with a college degree or higher in the states where banks quote term structures of CD rates, respectively. Income is expressed in thousands of dollars and Age is expressed in months. FE_{Year} and FE_{State} denote year and state fixed effects, respectively. Robust standard errors are clustered at the bank level. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is annual from 2001 to 2023. The regression specification is

$$\begin{aligned}\text{Expense Rate}_{it} = {} & c_1 \times \text{Percent Inconsistent}_{it} + c_2 \times \text{Log Assets}_{it} + c_3 \times \text{Liability Duration}_{it} \\ & + c_4 \times \text{Loan Ratio}_{it} + c_5 \times \text{Securities Ratio}_{it} + c_6 \times \text{Equity Ratio}_{it} \\ & + c_7 \times \text{Return on Assets}_{it} + c_8 \times \text{Age}_{it} + c_9 \times \text{Income}_{it} + c_{10} \times \text{Percent College}_{it} \\ & + \text{FE}_{\text{Year}} + \text{FE}_{\text{State}} + \epsilon_{it}.\end{aligned}$$

	Total Deposit Expense Rate		Demand/Savings Deposit Expense Rate		Time Deposit Expense Rate	
	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat
Percent Inconsistent	−0.149	−14.37**	−0.101	−13.53**	−0.056	−5.41**
Log Assets	−1.957	−3.16**	0.568	1.49	2.102	5.66**
Liability Duration	7.403	37.96**	0.912	7.68**	8.090	42.72**
Loan Ratio	0.778	9.04**	0.417	6.48**	0.512	8.37**
Securities Ratio	0.397	5.23**	0.144	2.63**	0.188	3.14**
Equity Ratio	0.354	2.42**	0.268	2.55**	−0.293	−2.39**
Return on Assets	−0.011	−3.48**	−0.004	−1.74*	−0.007	−3.74**
Age	0.222	4.12**	−0.116	−3.11**	0.005	0.11
Income	1.818	9.40**	0.746	4.91**	0.923	4.21**
Percent College	−3.773	−6.54**	−2.259	−5.29**	−2.033	−3.67**
Year Fixed Effects		Yes		Yes		Yes
State Fixed Effects		Yes		Yes		Yes
Adj. R^2		0.865		0.614		0.907
N		97,446		97,446		97,446

Table 6

Distribution of the Frequency of Inconsistent Pricing. This table reports the percentage of banks with frequencies of inconsistent pricing in the indicated ranges. The results for the indicated years are based on the frequencies of inconsistent pricing for all banks that provided ten or more term structures during that year. The results for the category All are based on the frequencies of inconsistent pricing over the entire sample period for all banks, where the frequency for each bank is computed using only the years in which that bank provided ten or more term structures during that year. The sample period is annual from 2001 to 2023.

	Percentage of Banks with Frequency of Inconsistent Pricing in the Indicated Range											
	0%	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%
2001	59.93	7.57	8.51	7.53	7.01	3.20	3.14	1.08	0.70	0.41	0.33	0.59
2002	31.81	4.73	7.84	5.34	4.93	4.53	4.86	5.48	5.61	6.01	6.69	12.17
2003	21.53	2.21	1.88	2.00	2.07	3.60	5.07	3.74	3.85	4.03	6.85	43.17
2004	18.74	2.56	1.79	1.99	2.60	4.22	6.71	4.67	5.41	6.10	8.89	36.32
2005	50.86	11.58	7.96	7.17	4.84	2.74	2.82	2.00	1.74	1.42	1.14	5.73
2006	85.84	2.95	1.83	1.40	1.09	0.76	0.89	0.73	0.66	0.38	0.41	3.06
2007	93.92	1.18	0.83	0.56	0.19	0.20	0.21	0.19	0.59	0.33	0.26	1.54
2008	67.39	8.64	6.40	3.66	2.61	1.93	2.27	1.72	2.52	1.58	0.71	0.57
2009	42.59	6.16	5.27	4.45	3.21	3.64	5.03	4.89	4.45	4.45	4.52	11.34
2010	18.46	2.67	3.06	3.33	4.25	3.75	3.14	3.95	4.35	4.36	4.43	44.25
2011	11.00	1.18	1.41	1.51	2.06	1.55	1.83	1.72	2.11	2.87	2.79	69.97
2012	10.03	1.20	0.79	1.02	0.89	1.26	1.72	1.57	1.75	1.64	2.56	75.57
2013	11.42	0.89	0.66	0.65	0.71	0.69	0.86	0.80	1.00	1.19	1.40	79.73
2014	12.84	0.46	0.34	0.46	0.30	0.45	0.89	0.46	0.37	0.45	1.23	81.75
2015	13.29	0.44	0.33	0.34	0.51	0.38	0.39	0.36	0.48	0.38	0.69	82.41
2016	14.07	0.81	0.55	0.57	0.29	0.64	0.57	0.60	0.40	0.47	1.15	79.88
2017	17.23	0.81	0.72	1.41	1.04	1.38	1.96	1.06	1.29	1.38	1.61	70.11
2018	21.69	2.64	2.93	3.51	3.10	3.30	3.35	2.57	3.42	2.73	2.28	48.48
2019	38.29	3.32	2.03	1.75	1.28	1.58	1.39	1.94	2.31	1.91	1.88	42.32
2020	26.37	4.32	4.81	7.53	4.52	4.42	4.81	4.91	8.29	4.05	2.79	23.18
2021	32.25	2.09	2.12	2.62	2.35	2.60	2.35	2.99	2.41	3.36	4.11	40.75
2022	26.12	3.32	4.16	3.49	3.90	3.74	5.48	5.48	7.18	6.27	4.23	26.63
2023	56.42	2.93	3.15	1.86	2.11	1.22	2.29	1.38	1.07	1.62	0.76	25.19
All	11.81	6.12	5.22	6.29	7.80	9.91	11.81	12.89	10.34	6.09	3.36	8.36

Table 7

Summary Statistics for the Frequency and Size of Inconsistent Pricing When CD Rates are Set Equal to Treasury Rates. This table presents summary statistics for the frequency and average size of inconsistent pricing for the indicated years, resulting from setting the term structure of CD rates equal to the term structure of Treasury rates. Frequency is expressed as a percentage. Size presents the average size of the pricing inconsistency for the inconsistent term structures. The size of the pricing inconsistency for any inconsistent term structure is the maximum pricing inconsistency taken over all pairwise comparisons of CD tenors in the same term structure, and is expressed in basis points. N denotes the number of weekly term structures for the indicated years. The row labeled All presents summary statistics for the frequency and average size of inconsistent pricing for all years. The sample period is weekly from January 5, 2001 to June 30, 2023.

Year	Frequency	Size	N
2001	25.00	9.70	52
2002	73.08	15.53	52
2003	100.00	44.38	52
2004	43.40	31.81	53
2005	0.00	–	52
2006	0.00	–	52
2007	0.00	–	52
2008	48.08	21.85	52
2009	100.00	54.15	52
2010	100.00	65.76	53
2011	100.00	59.96	52
2012	100.00	23.14	52
2013	100.00	47.67	52
2014	100.00	61.82	52
2015	100.00	29.99	52
2016	77.36	4.03	53
2017	9.62	1.66	52
2018	0.00	–	52
2019	0.00	–	52
2020	77.55	4.99	49
2021	100.00	26.65	53
2022	1.92	6.66	52
2023	0.00	–	26
All	55.85	36.64	1,171

Table 8

Results from the Probit Regression of Pricing Inconsistency Indicators on Bank Characteristics and Demographic Variables. This table presents the results from the probit regression of indicator variables that take the value one for internally-inconsistent term structures, and zero otherwise, on bank characteristics and geographic variables. Bank Characteristics are from FFIEC Call Reports. Demographic variables are from the ACS by the U.S. Census Bureau. Bank characteristics and demographic variables are as of the end of the previous calendar year. Assets denotes total bank assets in dollars. Demand/Savings Deposit Ratio, Uninsured Deposit Ratio, and Wholesale Ratio are the ratios of demand and savings deposits, uninsured deposits, and fed funds and repo financing to total assets, respectively. Treasury is an indicator variable that takes the value one for term structures that are internally-inconsistent when the term structure of CD rates is set equal to the term structure of Treasury rates, and zero otherwise. Age, Income, and Percent College present the median age, median income, and percentage of the population with a college degree or higher in the states where banks quote term structures of CD rates, respectively. FE_{Week} denote weekly fixed effects. Robust standard errors are clustered at the bank level. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is weekly from January 5, 2001 to June 30, 2023. Denoting the conditional probability that a term structure is internally-inconsistent as $\text{P}\left(\text{Inconsistent} = 1\right)$ and the cumulative normal distribution function as Φ, the probit model is

$$\begin{aligned}\text{P}(\text{Inconsistent} = 1)_{it} = \Phi\big(&c_1 \times \text{Log Assets}_{it} + c_2 \times \text{Demand/Savings Deposit Ratio}_{it} + \\ &c_3 \times \text{Uninsured Deposit Ratio}_{it} + c_4 \times \text{Wholesale Ratio}_{it} + \\ &c_5 \times \text{Treasury}_{t} + c_6 \times \text{Log Age}_{it} + c_7 \times \text{Log Income}_{it} + \\ &c_8 \times \text{Percent College}_{it} + \text{FE}_{\text{Week}}\big)\,.\end{aligned}$$

	Coeff	t-Stat
Log Assets	0.0776	6.32^{**}
Demand/Savings Deposit Ratio	0.2833	1.79^{*}
Uninsured Deposit Ratio	−1.6328	-7.13^{**}
Wholesale Ratio	1.6226	3.21^{**}
Treasury	1.6269	56.71^{**}
Log Age	3.6109	16.30^{**}
Log Income	0.9392	6.06^{**}
Percent College	−1.6375	-3.67^{**}
Weekly Fixed Effects		Yes
Adj. R^2		0.336
N		7,216,482