INTERNET APPENDIX

IS MATURITY-TRANSFORMATION RISK PRICED INTO BANK DEPOSIT RATES?

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INTERNET APPENDIX

A.1 Data Sources

Table A1 provides a description of all the data and variables used in the study along with their definitions and corresponding sources.

A.1.1 CD Rates

We gather data for interest rates on certificates of deposit (CDs) from S&P RateWatch for the period from January 5, 2001 to June 30, 2023. 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 as checking, savings, and money market accounts, and CDs for different account sizes and tenors.[1] The data cover branch level rates from over 75% of banks and credit unions in the U.S. and represent more than 90% of deposits in commercial banking (Yankow (2023)).

Our analysis focuses on CDs with six-month, one-year, two-year, three-year, four-year, and five-year tenors and principal amounts of less than or equal to $100,000. Specifically, for each week in the sample period, we collect all CD rates and the corresponding annual percentage yields (APYs) from banks in the RateWatch dataset for principal amounts of up to and including $100,000, and calculate their arithmetic averages by tenor.[2] To ensure that the CDs are insured by the Federal Deposit Insurance Corporation (FDIC), we require that CD rates are from banks with a valid FDIC certificate number. Furthermore, we use the following algorithm to ensure the integrity of the data. First, we exclude CD rates designated as promotional rates, as well as negative rates and negative APYs. We then make use of the fact that CD rates and APYs should differ only by a small amount, with the APY being weakly larger due to the effect of compounding. In the second step, we thus exclude observations where the difference between the CD rate and the APY is greater than five basis points. Third, for the remaining observations, we test whether the absolute difference between the APY and the CD rate exceeds 10 basis points. From this subset, we exclude observations where the absolute difference between the CD rate and the

[1]See https://www.spglobal.com/marketintelligence/en/campaigns/ratewatch.

[2]In robustness tests, we also calculate weekly averages of CD rates by tenor for CDs with principal amounts of $10,000 which is the most-frequently quoted principal amount in the RateWatch dataset during the period from January 5, 2001 to June 30, 2023.

APY is greater than the square of the CD rate.[3] The resulting dataset has weekly observations from 18,812 rate-setting branches and banks. Since the analysis is at the aggregate market level, we take weekly averages of CD rates by tenor across all observations.

A.1.2 Early Withdrawal Penalties

We collect 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.[4] These reports provide early withdrawal penalties measured in terms of months of foregone interest for CDs with original maturity T for the categories $T \leq 12$ months, $12 < T \leq 36$ months, and $T > 36$ months. Since the OTS presents early withdrawal penalties in terms of months of foregone interest, we translate them into days of foregone interest by multiplying the numbers by $365.25/12 = 30.4375$. Next, we calculate annual averages of the quarterly early withdrawal penalties for each tenor to obtain an annual time series for the period from 2001 to 2011.[5]

Second, we collect early withdrawal penalties from the RateWatch database for the period from January 2, 2012 to June 30, 2023. In the RateWatch data, early withdrawal penalties are available for CDs with tenors of three months, and one, two, three, four, and five years. These penalties are measured in terms of days of foregone interest.[6] Since there are few observations in the RateWatch data for some tenors in 2012, 2013, and 2014, we start using the RateWatch data in 2015. For the period from 2015 to 2023, we calculate annual averages across all withdrawal penalty observations for the aforementioned tenors. To obtain

[3]The idea behind this criterion is straightforward. To illustrate, let r denote the CD rate. Since the APY is bounded from above by the continuously compounded CD rate $\exp(r)$, we can approximate the difference between the CD rate and the corresponding APY using a simple Taylor expansion giving the expression $\exp(r) - (1 + r) \approx (1 + r + \frac{r^2}{2}) - (1 + r) < r^2$.

[4]See https://www.occ.gov/news-events/newsroom/news-issuances-by-year/ots-issuances/ots-aggregate-irr-exposure-and-cmr-reports.html.

[5]To map the tenors available in the OTS reports to the six CD tenors, we use the $T \leq 12$-months category for six-month and one-year CDs, the $12 < T \leq 36$-months category for two-year and three-year CDs, and the $T > 36$-months category for four-year and five-year CDs.

[6]To obtain early withdrawal penalties for six-month CDs, we use the simple average of the penalties for three-month and one-year CDs.

withdrawal penalties for 2012, 2013, and 2014, we linearly interpolate between the annual averages for 2011 and 2015.

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 for CDs with six-month, one-year, two-year, three-year, four-year, and five-year tenors. Table A2 presents the resulting time series.

A.1.3 Checking, Savings and Money Market Account Rates

We collect data for interest rates on checking, savings, and money market accounts from S&P RateWatch for the period from January 5, 2001 to June 30, 2023. We use the same approach as for CD rates to construct weekly averages of checking, savings, and money market account rates. Specifically, for each week in the sample period, we collect all rates and the corresponding annual percentage yields (APYs) from banks in the RateWatch dataset for principal amounts of up to and including $100,000, and calculate the arithmetic average for checking, savings, and money market account rates. In doing this, we apply the same data consistency checks that we apply to CD rates (see Section A.1.1).

A.1.4 Repo Overnight Index Swap Rates

We collect daily data on repo overnight index swap (OIS) rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, and 30 years for the period from January 1, 2017 to June 30, 2023 from the Bloomberg system.[7] Since repo OIS data are not continuously available throughout the January 2001 to June 2023 sample period, we use the approach in Fleckenstein and Longstaff (2024) and extend the repo OIS data by making minor adjustments to effective overnight fed funds (EFFR) OIS rates. Accordingly, we also collect data on EFFR OIS rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, 30 years for the period from February 13, 2002 to December 31, 2016 from the same source.[8] In the early part of the sample period, some EFFR OIS tenors are

[7]The current repo OIS market is based primarily on a specific overnight repo rate known as the Secured Overnight Financing Rate (SOFR). SOFR measures the cost of borrowing cash in the repo market via overnight loans collateralized by U.S. Treasury securities. Repo OIS exchange fixed for floating SOFR cash flows based on the daily compounded SOFR rate annually for maturities over one year and have a single cash flow at maturity for tenors up to one year. Data from the Bloomberg system.

[8]EFFR OIS exchange fixed for floating cash flows based on the daily compounded

only quoted in terms of a basis swap spread. Accordingly, we also collect data on EFFR/Libor basis swaps and standard fixed-for-floating three-month Libor swaps for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, 30 years from the Bloomberg system for the period from January 23, 1997 to July 31, 2008.[9] We use this data to construct the risk-free discounting curve using the methodology in Fleckenstein and Longstaff (2024). We provide an overview of this approach in Section A.2 below.

A.1.5 Treasury and Fed Funds Rates

We collect daily Treasury constant maturity (CMT) rates for tenors of one, three, and six months, and one, two, three, five, seven, and ten years from the Federal Reserve Bank of St. Louis for the period from January 5, 2001 to June 30, 2023.[10] Since the one-month CMT rate is unavailable for the period from January 5, 2001 to July 30, 2001, we use secondary market yields for one-month Treasury bills from the Bloomberg system for this period.[11] We also collect daily data for the effective overnight fed funds rate and the fed funds target rate from the Federal Reserve Bank of St. Louis.

A.1.6 Interest Rate Caps and Interest Rate Swaps Data

The interest-rate cap data consist of daily at-the-money implied volatilities for one-year, two-year, three-year, and five-year caps for the period from January 5, 2001 to June 30, 2023. We collect this data from the Bloomberg system.[12] By market convention, the strike price of a T-year at-the-money cap is simply the T-year swap rate for fixed-for-floating interest rate swaps, where the floating leg of the swap is tied to the three-month London Interbank Offered Rate (Libor).

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effective overnight fed funds rate (EFFR) annually for maturities over one year, and have a single cash flow at maturity for tenors up to one year.

[9]Fed funds/Libor swaps exchange quarterly floating cash flows for the tenor of the basis swap based on the daily compounded effective overnight fed funds rate over the quarter plus a spread for floating cash flows.

[10]The data are furnished by the Federal Reserve Bank of St. Louis and available via the Federal Reserve Economic Data (FRED) database at https://fred.stlouisfed.org/categories/115.

[11]This data is available via the ticker GB1M Index in the Bloomberg system.

[12]In the Bloomberg system, at-the-money interest rate caps are available via the ticker USCVX CURNCY, where X denotes the tenor of the interest rate cap (e.g., $X = 5$ for 5-year caps).

Accordingly, we also collect data for three-month Libor interest rate swaps for tenors of six months, and one, two, three, four, and five years, as well as one-, three-, and six-month Libor interest rates for the same period.

To give some assurance that the interest rate cap market is sufficiently liquid for the data to be reliable, we collected data on market transactions in USD interest rate caps/floors from the Depository Trust & Clearing Corporation (DTCC). The DTCC captures 98% of global derivatives transactions and provides publicly-available data through its Data Repository (DDR) each quarter for the period from Q1 2012 to Q4 2022.[13] Table A4 presents the total number of trades in USD interest rate caps/floors each quarter for the period from Q1 2012 to Q4 2022. On average, there are 2,214 transactions in interest rate caps/floors each quarter over the 2013–2022 period, which gives assurance that the market for interest rate cap/floors is actively traded.[14]

A.1.7 Early Withdrawal Activity

We collect information on early withdrawals for the period from Q1 2001 to Q4 2011 from the Office of Thrift Supervision's risk exposure reports, which are available at the quarterly frequency.[15] These reports include data on the amount of early withdrawals for CDs with remaining maturities t for the categories $0 < t \leq 3$ months, $3 < t \leq 12$ months, $12 < t \leq 36$ months, and $t > 36$ months.

These reports also provide information on CD balances by original maturity T for the categories $T \leq 12$ months, $12 < T \leq 36$ months, and $T > 36$ months, and by remaining time to maturity t for the categories $0 < t \leq 3$ months, $3 < t \leq 12$ months, $12 < t \leq 36$ months, and $t > 36$ months. In addition, the OTS reports show total balances subject to early withdrawal penalties for CDs with original maturities T for the categories $T \leq 12$ months, $12 < T \leq 36$ months, and $T > 36$ months. We use this latter information to scale the total balances in the categories $0 < t \leq 3$ months, $3 < t \leq 12$ months, $12 < t \leq 36$ months, and $t > 36$ months, and then calculate the ratio of the amounts withdrawn to

[13]Under the Dodd Frank Act (DFA) and the Commodity Futures Trading Commission's (CFTC) real-time and regulatory reporting rules, swap dealers initially began reporting transactions in interest rate derivatives on December 31, 2012.

[14]We also note that Libor rates are no longer published after June 30, 2023. Our sample period ends prior to the official cessation of Libor, and we confirmed that the Libor rates and interest rate swap data we use remain actively quoted through June 30, 2023.

[15]See https://www.occ.gov/news-events/newsroom/news-issuances-by-year/ots-issuances/ots-aggregate-irr-exposure-and-cmr-reports.html.

the balance subject to early withdrawal penalties for each of the four maturity ranges. Lastly, we multiply these numbers by four to obtain annualized rates. This results in a quarterly time series of early withdrawal rates for CDs with remaining maturities t in the categories $0 < t \leq 3$ months, $3 < t \leq 12$ months, $12 < t \leq 36$ months, and $t > 36$ months for the period from Q3 2001 to Q4 2011. We calculate early withdrawal rates of CDs with remaining maturity t in the categories $t > 12$ months by aggregating early withdrawal rates for CDs with remaining maturities t in the categories $12 < t \leq 36$ months and $t > 36$ months. Table A3 presents the quarterly time series of early withdrawal rates for CDs with remaining maturities t in the categories $0 < t \leq 3$ months, $3 < t \leq 12$ months, and $t > 36$ months.[16]

A.1.8 Maturity Mismatch

To measure maturity-transformation risk, we begin by collecting data on bank balance sheets from the quarterly Reports of Condition and Income (Call Reports), which we obtain from Wharton Research Data Services (WRDS). Call Reports are filed at the quarterly frequency and offer information on balance sheet and income statement items for the majority of FDIC-insured institutions.[17] We first estimate the asset duration of individual banks. To do this, we follow the approach in English, Van den Heuvel, and Zakrajšek (2018) and Drechsler, Savov, and Schnabl (2021) and calculate the "repricing maturity" of assets at the individual bank level.[18]

Specifically, during the 2001 to 2023 sample period, banks report their holdings of five asset categories (residential mortgage loans, all other loans, Treasuries and agency debt, mortgage-backed securities (MBS) secured by residential mortgages, and other MBS) separated into six categories by repricing maturity t: $0 \leq t < 0.25$, $0.25 < t \leq 1$, $1 < t \leq 3$, $3 < t \leq 5$, $5 < t \leq 15$, and $t > 15$ years. To calculate the overall repricing maturity of a given asset category, we assign the interval midpoint to each bin (and 20 years to the last bin) and take a weighted average using the amounts in each bin as weights. For the "other MBS" category, banks report only two bins: $0 \leq t < 3$ and $t > 3$ years. We assign repricing maturities of 1.5 years and 5 years to these bins, respectively.

[16]Early withdrawals are missing for the $t > 36$-months category for Q1, Q2, and Q4 2001. Thus, there are a total of 39 quarterly observations for the period from 2001 through 2011.

[17]The data in the Call Reports is subject to regulatory oversight by the Federal Reserve System, FDIC, and the Comptroller of the Currency.

[18]The description of this approach mirrors Drechsler, Savov, and Schnabl (2021), Internet Appendix, Section III.

We compute the repricing maturity of a bank's assets as the weighted average of the repricing maturities of all of its asset categories, using their dollar amounts as weights. Cash and fed funds sold are assigned a repricing maturity of zero.

Lastly, we take a simple cross-sectional average of the bank-level asset durations each quarter, and then take the difference between these quarterly averages and the individual CD tenors to estimate the maturity mismatch of a given tenor.

A.2 The Repo OIS Discounting Function

We use the methodology in Fleckenstein and Longstaff (2024) to identify the risk-free discounting curve from the term structure of fixed-for-floating interest rate swap rates in which the floating rate is the overnight repo rate. Using repo OIS has several advantages. First, the resulting discounting curve is independent of credit risk since the overnight repo rate can be viewed as a risk-free rate. Second, repo swaps and repo loans are purely financial contracts rather than securities and, therefore, the repo OIS discounting curve is less likely to be affected by the various supply, liquidity, or intermediary balance sheet cost factors that may drive the specialness of cash market instruments such as Treasuries. We just give a brief overview of the methodology here. Full details are provided in the Internet Appendix of Fleckenstein and Longstaff (2024).

To begin, repo OIS are just a specific type of OIS that is widely used in the financial markets.[19] In a fixed-for-floating repo OIS, the counterparties agree to exchange floating rate cash flows based on the geometrically compounded overnight repo rate for fixed cash flows at regular intervals over the life of the swap. For repo OIS with maturities of one year or less, cash flows are only exchanged once at the maturity of the swap. By contrast, cash flows are exchanged at the end of every twelve-month period in OIS with maturities of more than one year. To illustrate, consider a one-year repo OIS with a notional amount of \$100 and a quoted swap rate of $F_1 = 1.200$ percent. In one year (365 days), the fixed rate payer pays $1.200 \times 365/360 = 1.21667$ and receives the geometrically compounded overnight index rate for 365 days.[20]

[19]In the U.S., OIS referencing the effective overnight federal funds rate have become the reference rate for marking-to-market cleared swap trades (see Hull and White (2013) and LCH Group (2010)).

[20]The current repo OIS market is based primarily on a particular construction of the overnight repo rate known as the Secured Overnight Financing Rate (SOFR). SOFR has been designated by the Alternative Reference Rates Committee (ARRC) to become the new benchmark risk-free interest rate in the U.S. after June 30, 2023.

To illustrate how we solve for the risk-free discounting curve using the term structure of repo OIS, we begin with the case of a one-year repo OIS. Let r_t denote the overnight repo rate. Assuming continuous cash flows, the floating leg of the swap pays a single cash flow of

$$\exp\left(\int_0^1 r_t\, dt\right) \tag{A1}$$

in one year. The value of this cash flow is

$$E\left[\exp\left(-\int_0^1 r_t\, dt\right)\exp\left(\int_0^1 r_t\, dt\right)\right] = 1. \tag{A2}$$

The fixed leg of the swap pays a single cash flow of $1 + F_1$ in one year, where F_1 is the current market rate on one-year repo OIS. Since F_1 is fixed at time zero, the present value of the fixed leg is just $(1+F_1)D(1)$. Because the initial value of the swap is zero, the present value of the fixed leg of the swap equals the present value of the floating leg, which gives

$$D(1) = \frac{1}{1+F_1}. \tag{A3}$$

This approach is easily extended to longer maturities. Since repo OIS with maturities with one year or less have a single cash flow at maturity of the swap, the risk-free discounting factor for given maturity $T \in (0.0833, 0.25, 0.50, 1.00)$ is given by

$$D(T) = \frac{1}{1+\Delta_T F_T}, \tag{A4}$$

where F_T is the repo OIS rate for tenor T, and Δ_T denotes the number of days between the inception and the maturity of the swap, expressed as a fraction of one year.[21]

Next, consider the case of a T-year repo OIS where $T > 1$. Letting $t = 1, \ldots, T$ denote the annual cash flows of a T-year repo OIS and setting the present value of the fixed leg of a T-year repo OIS equal to the present value of the floating leg gives the relation

[21] We convert all swap rates used in bootstrapping the risk-free discounting curve to the 30/360 daycount convention.

$$F_T \sum_{t=1}^{T} D(t) + D(T) = 1. \qquad (A5)$$

Since repo OIS rate data F_T are available for tenors of 1, 2, 3, 5, 7, 10, 15, 20, and 30 years, we first interpolate the term structure of repo OIS rates at annual intervals using a standard cubic spline. Then, we use Equation (A5) to recursively solve for the risk-free discounting function $D(T)$, for $T = 1, 2, 3, \ldots, 30$ at annual intervals. In the last step, we calculate discounting factors $D(t)$ for any given maturity t by interpolating the continuously compounded yields from the discounting function linearly at monthly intervals.

A.3 The Treasury Discounting Function

We also use a simple bootstrapping algorithm to calculate discounting factors based on Treasury CMT rates. To begin, let CMT(T) denote the T-year CMT rate, and let $D(T)$ denote the T-year discounting factor (the present value of one dollar to be received in T years). We note that Treasury CMT rates are quoted as bond-equivalent yields.[22] Accordingly, we follow standard market conventions and calculate the one-month and three-month discounting factors as follows:

$$D(T) = \frac{1}{1 + T \times \text{CMT}(T)} \ , \qquad (A6)$$

where $T \in \left(\frac{1}{12}, \frac{3}{12}\right)$. The six-month discounting factor is given by

$$D(0.5) = \frac{1}{1 + \frac{\text{CMT}(T)}{2}} \ . \qquad (A7)$$

We then use a standard cubic spline algorithm to interpolate the CMT par rates for $T \in (0.5, 1, 2, 3, 5)$ at semiannual intervals. These par rates are then bootstrapped to provide a discounting curve at semiannual intervals out to $T = 5$ years. To see how this is done, recall that since CMT rates represent par rates, they are easily expressed in terms of discounting factors. Specifically,

[22] See https://home.treasury.gov/policy-issues/financing-the-government/interest-rate-statistics/interest-rates-frequently-asked-questions.

$$\text{CMT}(T) = 2\left[\frac{1-D(T)}{\sum_{i=1}^{2T} D\left(\frac{i}{2}\right)}\right] . \qquad (A8)$$

Next, we simply solve for $D(T)$ in terms of the CMT rate $\text{CMT}(T)$, giving

$$D(T) = \frac{1 - \frac{CMT(T)}{2}\sum_{i=2}^{2T} D\left(\frac{i}{2} - 0.5\right)}{1 + \frac{CMT(T)}{2}} , \qquad (A9)$$

which we solve iteratively for $D(1)$, $D(1.5)$, . . ., $D(5)$.

Using the bootstrapped discounting curve at semi-annual intervals obtained in the previous step and the one-month, three-month, and six-month discounting factors from Equations (A6) and (A7), respectively, we next calculate continuously compounded Treasury spot rates

$$r(T) = -\tfrac{1}{T}\ln\left(D(T)\right) , \qquad (A10)$$

where $T \in \left(\frac{1}{12}, \frac{3}{12}, ..., 4.5, 5\right)$. In the last step, we linearly interpolate $y(T)$ at monthly intervals and then calculate the discounting curve at monthly intervals using

$$D(T) = \exp\left(-r(T) \times T\right) , \qquad (A11)$$

where $T \in \left(\frac{1}{12}, \frac{2}{12}, ..., 5\right)$.[23]

A.4 The Libor Swap Discounting Function

We also use a simple bootstrapping algorithm to calculate discounting factors based on three-month Libor rates. This algorithm is analogous to the one presented in Section A.3 above. To see how this is done, let one-month, three-month, and six-month Libor rates be denoted by $\text{Libor}(T)$ where $T \in \left(\frac{1}{12}, \frac{3}{12}, \frac{6}{12}\right)$, and recall that the T-year Libor rate is given simply in terms of the T-year Libor discounting factor $D(T)$ via the expression,

[23]We also calculate one-month forward rates using the discounting factors in Equation (A11). For the few cases where the one-month forward rate starting in two months is negative, we use the three-month CMT rate for $t \in \left(\frac{1}{12}, \frac{3}{12}\right)$.

$$\text{Libor}(T) = \frac{360}{a}\left[\frac{1}{D(T)} - 1\right] , \qquad (A12)$$

where $T \in \left(\frac{1}{12}, \frac{3}{12}, \frac{6}{12}\right)$, and where a is the actual number of days from today to time T.

Next, let $F(T)$ denote the fixed rate on a T-year Libor interest rate swap.[24] Recall that the swap rate on a T-year Libor interest rate swap can be expressed in terms of T-year Libor discounting factors via the expression

$$F(T) = 2\left[\frac{1 - D(T)}{\sum_{i=1}^{2T} D\left(\frac{i}{2}\right)}\right] . \qquad (A13)$$

Using Equations (A12) and (A13), we can apply the bootstrapping algorithm presented in Section A.3. Specifically, we first calculate one-month, three-month, and six-month Libor discounting factors using the expression

$$D(T) = \frac{1}{1 + T \times \text{Libor}(T)} , \qquad (A14)$$

where $T \in \left(\frac{1}{12}, \frac{3}{12}, \frac{6}{12}\right)$.

We then use a standard cubic spline algorithm to interpolate the three-month Libor interest rate swap rates for $T \in (0.5, 1, 2, 3, 4, 5)$ at semiannual intervals. These par rates are then bootstrapped to provide the Libor discounting curve at semiannual intervals out to $T = 5$ years. Specifically, we simply solve Equation (A13) for $D(T)$ in terms of $F(T)$, giving

$$D(T) = \frac{1 - \frac{F(T)}{2}\sum_{i=2}^{2T} D\left(\frac{i}{2} - 0.5\right)}{1 + \frac{F(T)}{2}} , \qquad (A15)$$

which we solve iteratively for $D(1)$, $D(1.5)$, …, $D(5)$.

Using the bootstrapped discounting curve at semi-annual intervals obtained in the previous step and the one-month, three-month, and six-month Libor

[24] Libor interest rate swaps exchange semi-annual cash flows on the fixed leg of the swap against quarterly cash flows based on the three-month Libor rate set at the beginning of the quarter.

discounting factors from Equation (A15), we next calculate continuously compounded Libor spot rates $r(T)$ via the expression

$$r(T) = -\frac{1}{T} \ln (D(T)) \ , \qquad (A16)$$

where $T \in \left(\frac{1}{12}, \frac{3}{12}, ..., 4.5, 5\right)$. In the last step, we linearly interpolate $r(T)$ at monthly intervals and then calculate the discounting curve at monthly intervals using

$$D(T) = \exp(-r(T) \times T) \ , \qquad (A17)$$

where $T \in \left(\frac{1}{12}, \frac{2}{12}, ..., 5\right)$.

A.5 The Black-Derman-Toy Model for Interest Rates

To model the dynamics of interest rates, we use a simple binomial-type setup that allows us to match exactly the term structure of riskless discount bond prices and the term structure of short-rate volatilities. Due to its simplicity, we use the Black, Derman, and Toy (1990) (BDT) model, which is a popular one-factor interest rate model that is widely used by practitioners. The calibration of a BDT interest rate tree requires two inputs. The first is the term structure of discount bond prices. The second is the term structure of short-rate volatilities. We begin by describing how we calibrate a BDT tree given the term structure of discount bond prices and short-rate volatilities. We then describe the basics of the interest rate caps and then discuss our approach to estimate short-rate volatilities using market prices of interest rate caps.

A.5.1 Calibrating the BDT Tree

We begin by introducing some notation and then discuss how we calibrate a BDT tree to the term structure of discount bond prices $D(T)$ and the term structure of short-term interest rate volatilities which we denote by $s(T)$.[25]

Let N denote the number of periods in the tree, where each period has length $\Delta t = \frac{1}{12}$ years. Thus, the tree spans a total of $T = N\Delta t$ years. Since the BDT tree is recombining, there are $t+1$ states at time period t ($t = 0, 1, \ldots, N$). We denote these states as $i = 1, ..., t+1$. Next, let $r_{i,t}$ denote the (annualized) one-period interest rate in state i and period t. In the next period, the short

[25] We discuss our approach to estimate $s(T)$ in Section A.5.3 below.

rate either increases to $r_{i,t+1}$ or it decreases to $r_{i+1,t+1}$ with equal (risk-neutral) probability, which we designate as the "up" and "down" states, respectively. The states are assumed to be ordered from the highest to the lowest value, with $r_{1,t}$ denoting the highest rate and $r_{t+1,t}$ the lowest rate in period t. Let $s(t)$ denote the volatility of the one-period rate for the t-th period. To give an example, suppose the one-month short-term interest rate at time zero is three percent. Given $r_{0,1} = 0.03$, the short-term interest rate can take on two possible values in one month ($t = 1$) with equal probability. Suppose these two values are 0.031 and 0.029, respectively. Using the notation introduced above, this means that $r_{1,1} = 0.031$ and $r_{2,1} = 0.029$.

Due to the recombining nature of the binomial BDT tree, the price in period t and state i of a discount bond with maturity in period $\tilde{t} > t$ is given by

$$D(i,t) = \frac{1}{1 + r_{i,t}\Delta t}\left(\tfrac{1}{2}D(i,t+1) + \tfrac{1}{2}D(i+1,t+1)\right) . \qquad (A18)$$

Moreover, in the BDT model short rates are related to the short-rate volatility $s(t)$ via the expression

$$r_{i,t} = r_{i+1,t}\exp\left(2s(t)\sqrt{\Delta t}\right) , \qquad (A19)$$

where $i = 1, 2, ..., t+1$.

To calibrate the N-period BDT tree, we proceed iteratively and calculate $r_{i,t}$ for $t = 0, 1, ..., N$ and $i = 1, ..., t+1$ such that we match the discount bond prices $D\left(t \times \Delta t\right)$ and the term structure of short-rate volatilities $s\left(t \times \Delta t\right)$ exactly. This is carried out one step at a time. Specifically, the time-zero short-rate is given simply by the one-month discounting factor using the expression

$$r_{0,1} = 12\left(\frac{1}{D\left(\frac{1}{12}\right)} - 1\right) , \qquad (A20)$$

where we use monthly compounding to match the step size Δt of the BDT tree. In the $(t+1)$-th period calibration, we calculate $r_{i,t}, i = 1, \ldots, t+1$, such that we match $D\left((t+1)\Delta t\right)$ and $s\left((t+1)\Delta t\right)$, given that all the earlier short rates $r_{i,t-1}, r_{i,t-2}, \ldots, r_{1,0}$ are already calculated to fit the term structure of discount bond prices and short-term riskless interest rate volatilities. To do this, we simply step back through the tree from period $t+1$ to time zero using Equations (A18), (A19), and (A20).

A.5.2 Interest Rate Caps

In this section, we give a brief overview of the interest rate caps market. In the next section, we discuss how we use interest rate caps to estimate the term structure of short-rate volatilities needed in the calibration of the BDT tree discussed in Section A.5.1 above.

First, it is instructive to review some standard conventions used in the interest rate caps market.[26] As discussed in Section A.1.6, we collect data on implied volatilities for at-the-money one-year, two-year, three-year, and five-year interest rate caps from the Bloomberg system. Recall that an interest rate cap is essentially a series of European call options (referred to as caplets) on the three-month Libor rate, where all caplets have identical strike prices but different expiration dates (at the end of each quarter until the cap expires).[27] For instance, a two-year cap with strike rate of three percent is simply a portfolio of seven caplets with quarterly maturities ranging from one-half to two years where each caplet has the same strike rate of three percent.[28]

To present the cash flows associated with individual caplets more formally, we begin by dropping the tenor of the Libor rate and simply use Libor to denote the three-month Libor rate. In discussing the cash flows of individual caplets, we need to distinguish between the time of the actual cash flow and the time at which the Libor rate that is used to calculate the cash flow is set. Thus, we use $\text{Libor}(T-0.25, T)$ to denote the value of the three-month Libor rate at time $T-0.25$ for the period from time $T-0.25$ to T.[29] The strike rate of a caplet is denoted by K. With this notation, the cash flow of a caplet with expiration at time T is given by

[26] For a detailed discussion of interest rate caps, see Longstaff, Santa-Clara, and Schwartz (2001).

[27] Typically, the expiration dates for the caplets are on the same cycle as the frequency of the underlying Libor rate. In the case of three-month Libor the caplets have quarterly expiration dates.

[28] It is standard market convention to omit the first caplet since the cash flow from this caplet is deterministic because the Libor rate used to calculate this cash flow is known today.

[29] In the case of a three-month Libor caplet with expiration at time T, the Libor rate used to calculate the caplet's payoff is set three months prior to the payoff date at time $T-0.25$. This means that the cash flow from the caplet becomes deterministic at time $T-0.25$, even though it is paid at time T.

$$\frac{a}{360} \max \left[0, \text{Libor}(T-0.25, T) - K\right] \ , \tag{A21}$$

where a is the actual number of days during the period from time $T-0.25$ to T.

The market convention is to quote cap prices in terms of implied volatilities from the Black (1976) model. To illustrate this, let $f(T-0.25, T)$ denote the value of the three-month Libor forward rate for the period from time $T-0.25$ to T. Recall that three-month Libor forward rates can be represented in terms of discounting factors $D(T)$ using the expression

$$f(T-0.25, T) = \frac{a}{360} \left(\frac{D(T-0.25)}{D(T)} - 1 \right) \ . \tag{A22}$$

The Black model provides a closed-form expression for the time-zero value of a caplet with expiration time T in terms of three-month Libor forward rates.[30]

$$D(T) \frac{a}{360} \left[f(T-0.25, T) N(d_1) - K N(d_2) \right] \ , \tag{A23}$$

where

$$d_1 = \frac{1}{\sigma\sqrt{T-0.25}} \ln\left(f(T-0.25, T)/K\right) + \frac{1}{2}\sigma\sqrt{T-0.25} \ , \tag{A24}$$

and

$$d_2 = d_1 - \sigma\sqrt{T-0.25} \ . \tag{A25}$$

Using Equation (A23), the value of a cap is given by simply summing the values of its individual caplets. In the market, cap prices are quoted in terms of the implied value of σ, which sets the Black model price equal to the market price.[31] As discussed in Section A.1.6, we collect time series of σ for at-the-money

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[30]Note that since $\text{Libor}(T-0.25, T) = f(T-0.25, T)$, a caplet is equivalent to an option on an individual three-month Libor forward rate.

[31]Note that this is just a convention used to quote market prices and does not mean that the Black model is the correct model to describe cap prices.

implied volatilities for one-year, two-year, three-year, and five-year interest rate caps from the Bloomberg system. At-the-money simply means that the strike price of a T-year cap is equal to the T-year interest rate swap rate which is easily expressed in terms of the Libor discounting function as shown in Equation (A13).

A.5.3 Estimating Short-Rate Volatilities

To estimate the term structure of short-rate volatilities, we begin by solving Equation (A23) for the market prices of one-year, two-year, three-year, and five-year interest rate caps given the time series of implied volatilities discussed in Section A.1.6 and the Libor discounting function from Section A.4.

Next, we assume a simple piecewise flat term structure of short-rate volatilities. Specifically, let s_1 denote the (piecewise constant) short-rate volatility for time T between zero and one year. Similarly, let s_2, s_3, and s_5 denote the (piecewise constant) short-rate volatilities for time T between one and two years, two and three years, and between three and five years, respectively. We also assume that the price of a one-year cap on the three-month Libor rate with a strike equal to the one-year Libor swap rate is the same as the price of a one-year cap on the three-month Treasury rate with the at-the-money strike equal to the one-year Treasury par rate.

We then use the following algorithm to estimate s_i, $i \in (1, 2, 3, 5)$ given Treasury discount bond prices $D(T)$ (see Section A.3). First, we pick a set of starting values for s_i. Given this set of parameter values, we then solve for the implied BDT tree that exactly matches the term structure of Treasury discount bond prices $D(T)$ and the short rate volatilities given by s_i, $i \in (1, 2, 3, 5)$ using the algorithm from Section A.5.1 above. Given the BDT tree, we then price at-the-money one-year, two-year, three-year, and five-year interest rate caps and calculate the root-mean-squared error (RMSE) between the cap prices implied by the calibrated tree and market cap prices. We then pick a new set of values for s_i, recalibrate the BDT tree, and recompute the RMSE between cap prices implied by the tree and market cap prices. We iterate over trial values of the parameters s_i until we have the best fit between cap prices calculated from the BDT tree and market cap prices and exactly fit the input term structure of Treasury discount bond prices.

A.6 Bank CDs

In this section we provide an overview of certificates of deposit (CDs). We begin by describing standard terminology of CDs and their properties and conclude with a discussion of FDIC insurance.

A.6.1 Certificates of Deposit

Bank CDs are part of the M2 monetary aggregate measure which includes currency, checkable deposits, savings deposits (including money market deposit accounts), and shares in retail money market mutual funds.[32] CDs are an important asset class for households in the United States. At year-end 2022, households held more than $9.9 trillion in time and savings deposits, representing more than nine percent of total financial assets owned by households.[33] The average household held roughly $100,000 in CDs in 2022, representing 6.5% of the value of financial assets held by the average U.S. household.[34] The total amount of CDs (with notional amounts of $100,000 or less) was more than $900 billion as of the end of July 2023.

CDs are savings certificates where the principal amount invested is held in a bank account for a set period of time (referred to as term or tenor), which typically ranges between one month and five years. CDs carry no risk of default by the issuing bank since they are backed by the full faith and credit of the United States government.[35]

The holder of a CD accrues interest and receives a single cash flow in the amount of the principal plus accrued interest at maturity. The Truth in Savings Act (12 CFR Part 1030) requires interest rates on CDs to be quoted in terms of annual percentage yields (APY). To illustrate, suppose an investor invests in a $10,000 CD with a one-year term and an APY of 4%. After one year, this investor receives one (final) cash flow of $10,000 + $400 = $10,400.[36]

While a CD is intended to be held until maturity, investors have the option to withdraw a partial amount or the full principal prior to the maturity date.[37] We

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[32]See https://www.federalreserve.gov/releases/h6/current/default.htm.

[33]See the Financial Accounts of the United States, Balance Sheet of Households Table B.101.H.

[34]See the 2022 Survey of Consumer Finances, available at https://www.federalreserve.gov/econres/scfindex.htm.

[35]See https://www.fdic.gov/resources/deposit-insurance/brochures/insured-deposits/. We discuss FDIC insurance in Section A.6.2 below.

[36]CDs can accrue interest at different periodicities such as daily, weekly, monthly, quarterly, etc. However, interest is paid out in a single cash flow at the maturity date of the CD.

[37]Investors can redeem a CD any day 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. However, there is

refer to this feature as the early withdrawal option because it is similar in nature to a put option on a bond investment (Gilkeson, Porter, and Smith (2000)). To see this, note that the investor in a putable bond has the option to sell back the bond to the issuer during some pre-specified period of time. Likewise, the holder of CD has the option to "put back" the CD to the bank at any point in time prior to the CD's maturity date.

While the holder of a putable bond typically has the option to sell the bond back to the issuer at par value, the holder of a CD incurs a penalty for doing so. Typically, this penalty is assessed in terms of a certain number of days of interest. To illustrate, suppose an investor owns a \$10,000 CD with a one-year term and an APY of 4% (annually compounded). Assume that the early withdrawal penalty on this CD is three months of interest. This means that if the investor redeems the \$10,000 anytime before the one-year term is over, the penalty amounts to $(\frac{3}{12} \times 4\%) \times \$10,000 = \$100$. If the investor were to redeem the CD early anytime during the first three months of the one-year term, the investor would actually incur a loss of principal.

Lastly, it is important to note that while we focus on this type of plain-vanilla CD described above, there are other investments oftentimes referred to as "CDs" but with fundamentally different properties. The first example is a negotiable CD (NCD). First, NCDs may be traded in secondary markets.[38] Second, NCDs have no early redemption feature (holders can sell in the secondary market). Third, some NCDs may be callable by the issuing bank. Fourth, some NCDs pay interest cash flows at regular intervals prior to the maturity date. The second example is a brokered CD (BCD) which is a type of CD that investors purchase through a brokerage firm or broker. Like NCDs, BCDs trade in the secondary market. BCDs may also be callable and pay regular interest cash flows until maturity. Unlike NCDs, however, BCDs may not be covered by FDIC insurance.

A.6.2 FDIC Insurance

In the United States, bank CDs are insured by the Federal Deposit Insurance

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no rule limiting the maximum withdrawal penalties banks can charge on early withdrawals (see 12 CFR 1030 "Truth in Savings Act (Regulation DD)"). At maturity of the CD, investors have a grace period, typically between one to two weeks, during which they may redeem the CD without penalty before the CD renews for a time period equal to the original term at the interest rate offered on the maturity date.

[38]By contrast, there is no secondary market for plain-vanilla CDs. Accordingly, they are also referred to as "non-negotiable CDs."

Corporation (FDIC) up to a certain dollar amount, called the deposit insurance limit.[39] This limit was raised several times since the FDIC was first established in 1933.[40] Specifically, at the beginning of our sample period in January 2001, the FDIC insurance limit was $100,000 (see FDIC (1998)). It was raised to $250,000 on October 3, 2008, and has remained at that level since then.[41]

Investors in CDs do not need to purchase FDIC insurance. This protection is automatic as long as the issuing bank is a member of the FDIC.[42] Moreover, any person or entity (including non-U.S. citizens or residents) are subject to FDIC insurance.[43] FDIC insurance extends to CDs, but also to other financial products including checking accounts, Negotiable Order of Withdrawal (NOW) accounts, savings accounts, money market deposit accounts (MMDAs), cashier's checks, money orders, and other official items issued by a bank.[44]

It is important to note that FDIC insurance applies to an amount of $250,000 per depositor, per insured bank, for each account ownership category.[45] This means that the FDIC insures CDs that an investor owns in one insured bank separately from any other CD that the investor owns in another separately chartered insured bank.[46] Moreover, the FDIC provides separate insurance coverage

[39] See, https://www.fdic.gov/resources/deposit-insurance/brochures/insured-deposits/.

[40] Some states in the U.S. had adopted some form deposit insurance as early as 1829. For instance, New York was the first state that adopted plans, over a period from 1829 to 1917, to guarantee bank deposits or other obligations that served as currency (FDIC (1984)).

[41] The increase on October 3, 2008 initially was a temporary measure enacted with the Emergency Economic Stabilization Act (EESA). However, on July 21, 2010 this increase was made permanent by the Dodd-Frank Wall Street Reform and Consumer Protection Act. See https://americandeposits.com/history-and-timeline-of-changes-to-fdic-coverage-limits/.

[42] The FDIC maintains a database of FDIC-insured banks and branches at https://banks.data.fdic.gov/bankfind-suite/bankfind.

[43] See https://www.fdic.gov/resources/deposit-insurance/brochures/insured-deposits.

[44] However, the FDIC does not cover stock/bond investments, mutual funds, money market funds that are held in accounts at FDIC member banks. See https://www.fdic.gov/resources/deposit-insurance/brochures/insured-deposits/.

[45] To streamline the discussion, we focus on the $250,000 insurance limit, which has been in place since October 2008.

[46] For example, if an investor owns a $250,000 CD at Bank A and another $250,000

for CDs held in different categories of legal ownership (ownership categories). To give one example, suppose investors A and B equally share an investment in a $500,000 CD in a joint account. In that case, A and B are each insured up to $250,000 resulting in the full $500,000 CD receiving FDIC insurance.[47] Lastly, FDIC insurance includes principal plus any interest accrued or due to the CD holder. For example, if an investor owns a CD with a principal balance of $247,000 and $3,000 in accrued interest, the full $250,000 is insured by the FDIC.

A.7 Robustness

First, we test the robustness of the main results with respect to an alternative choice of the discounting function used to compute option-adjusted deposit spreads. Specifically, Tables A5 through A8 present the results corresponding to those in Tables 5 through 8 in the paper when we use the discounting function based on Treasury rates (rather than the riskless discounting function based on the term structure of repo OIS). As shown, the results are very similar to those based on the repo OIS discounting function.

Second, we test the robustness of the results with respect to alternative choices of the parameters of the early withdrawal model. Specifically, Tables A9 through A12 present the results corresponding to those in Tables 5 through 8 when we set γ and λ to twice their baseline values. As shown, the results are very similar to those from the baseline parameterization.

Third, we examine how the results are impacted if we assume that households do not exercise their early withdrawal option strategically. Specifically, Tables A13 through A16 present the results corresponding to those in Tables 5 through 8 when we set γ equal to zero in the early withdrawal model. We note that in Table A15 the coefficient on the maturity mismatch variable is insignificant, and in Table A16, only the interaction of the maturity mismatch variable with the Net Stable Funding Ratio indicator is significant. These results show that the early withdrawal option is important for understanding the economics of deposit spreads.

CD at Bank B, the CDs are insured separately for the full $250,000. However, CDs held in separate branches of the same insured bank are not separately insured.

[47]This assumes that investors A and B do not also individually hold CDs. For other examples, see https://www.fdic.gov/resources/deposit-insurance/brochures/insured-deposits/.

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Table A1

Data Definitions and Sources. This table summarizes the datasets used in this study. Frequency shows at what intervals the data are available. Description and Source show the data source and its definition. All data are for the period from January 2001 to June 2023 unless indicated otherwise.

	Data	Frequency	Description and Source
1	CD Rates	Weekly	Interest rates on certificates of deposit (CDs) quoted by banks for principal amounts of less than or equal to $100,000 and with initial maturities of six months, and one, two, three, four, and five years. Data furnished by S&P RateWatch for the period from January 5, 2001 to June 30, 2023.
2	Early Withdrawal Penalties	Weekly	Data on early withdrawal penalties measured in terms of days of foregone interest for CDs with initial maturities of three months, and one, two, three, four, and five years. Data furnished by S&P RateWatch for the period from November 26, 2004 to June 30, 2023.
3	Early Withdrawal Penalties	Quarterly	Data on early withdrawal penalties measured in terms of months of foregone interest for CDs with initial maturities of 12 months or less, 13 to 36 months, and 37 or more months. Data published by the Office of Thrift Supervision (OTS) for the period from Q1 2001 to Q4 2011 and available at https://www.occ.gov/news-events/newsroom/news-issuances-by-year/ots-issuances/ots-aggregate-irr-exposure-and-cmr-reports.html.
4	Checking, Savings, and Money Market Rates	Weekly	Interest rates on certificates of checking, savings, and money market accounts quoted by banks for principal amounts of less than or equal to $100,000. Data furnished by S&P RateWatch for the period from January 5, 2001 to June 30, 2023.
5	SOFR Overnight Index Swaps	Daily	SOFR overnight index swap (OIS) rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, and 30 years for the period from January 1, 2017 to June 30, 2023. SOFR OIS exchange fixed for floating SOFR cash flows based on the daily compounded SOFR rate annually for maturities over one year and have a single cash flow at maturity for tenors up to one year. Data from the Bloomberg system.
6	EFFR Overnight Index Swaps	Daily	Effective federal funds rate (EFFR) OIS rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, 30 years for the period from February 13, 2002 to December 31, 2016. EFFR OIS exchange fixed for floating cash flows based on the daily compounded effective overnight fed funds rate (EFFR) annually for maturities over one year, and have a single cash flow at maturity for tenors up to one year. Data from the Bloomberg system.
7	EFFR/Libor Basis Swaps	Daily	End-of-day EFFR/Libor basis swap rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, 30 years from the Bloomberg system for the period from January 23, 1997 to July 31, 2008. Fed funds/Libor swaps exchange quarterly floating cash flows for the tenor of the basis swap based on the daily compounded effective overnight fed funds rate over the quarter plus a spread for floating cash flows based on the three month Libor rate set at the beginning of the quarter.

Table A1 — Continued

	Data	Frequency	Description and Source
8	Libor Interest Rate Swaps	Daily	End-of-day Libor interest rate swap rates for tenors of one, three, and six months, and 1, 2, 3, 5, 7, 10, 15, 20, 30 years from the Bloomberg system for the period from January 23, 1997 to July 31, 2008. Libor interest rate swaps exchange quarterly floating cash flows for the tenor of the interest rate swap based on the three month Libor rate set at the beginning of the quarter for fixed semi-annual cash flows.
9	Libor Rates	Daily	End-of-day London Interbank Offered Rates (Libor) rates for tenors of one, three, and six months, and one year. Data retrieved from the Bloomberg system.
10	Treasury CMT Rates	Daily	Treasury constant maturity (CMT) rates from the Federal Reserve H.15 Selected Interest Rates Release. Data retrieved from the Bloomberg system.
11	Interest Rate Cap Volatilities	Daily	Implied volatilities for at-the-money interest rate caps with tenors of one, two, three, and five years from the Bloomberg system.
12	Fed Funds Rate	Daily	Data on the effective overnight federal funds rate and the fed funds target rate for the period from January 5, 2001 to June 30, 2023. Data retrieved from the Federal Reserve Bank of St. Louis FRED database.
13	Early Withdrawal Activity	Quarterly	Data on amounts withdrawn prior to maturity and principal balances subject to early withdrawal penalties for CDs with remaining maturities of zero to 3 months, 3 to 12 months, 12 to 36 months, and 36 to 60 months. Data published by the Office of Thrift Supervision (OTS) for the period from Q1 2001 to Q4 2011 and available at https://www.occ.gov/news-events/newsroom/news-issuances-by-year/ots-issuances/ots-aggregate-irr-exposure-and-cmr-reports.html.
14	Bank Call Reports	Quarterly	Bank balance sheets and income statements from the Reports of Condition and Income (Call Reports) for the period from Q1 2001 to Q2 2023. Data obtained from Wharton Research Data Services (WRDS).
15	Treasury Richness	Monthly	The Treasury Richness measure from Fleckenstein and Longstaff (2024) for Treasury notes with maturities between 2 and 3 years.
16	AAA Spread	Monthly	The spread between yields on AAA corporate bonds and the ten-year Treasury rate. Data from the Bloomberg system.
17	Refcorp Treasury Spread	Monthly	The spread between yields on three-year Refcorp Strips and three-year Treasury spot rates. Treasury spot rates bootstrapped from the Treasury constant maturity curve. Data on Refcorp Strips from the Bloomberg system.

Table A2

Summary Statistics for CD Early Withdrawal Penalties. This table presents early withdrawal penalties for CDs with the indicated initial tenors. Early withdrawal penalties are expressed in terms of days of foregone interest for the indicated tenors. 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. Tenors are expressed in months. The numbers presented are the average withdrawal penalty for the indicated tenors and years, where the average is taken across all observations for a given tenor and year. Withdrawal penalties for 2012, 2013, and 2014 are linearly interpolated between the annual averages for 2011 and 2015.

	CD Tenor					
Year	Six-Month	One-Year	Two-Year	Three-Year	Four-Year	Five-Year
2001	94.20	94.20	162.31	162.31	225.09	225.09
2002	95.02	95.02	170.66	170.66	231.54	231.54
2003	94.13	94.13	172.58	172.58	234.37	234.37
2004	88.64	88.64	173.16	173.16	240.41	240.41
2005	86.29	86.29	171.13	171.13	244.03	244.03
2006	87.20	87.20	169.12	169.12	237.87	237.87
2007	93.75	93.75	176.92	176.92	247.38	247.38
2008	92.98	92.98	182.97	182.97	243.52	243.52
2009	97.62	97.62	179.16	179.16	247.68	247.68
2010	99.45	99.45	180.34	180.34	234.06	234.06
2011	99.76	99.76	182.17	182.17	239.77	239.77
2012	94.24	103.41	181.75	191.27	240.08	247.70
2013	88.71	107.07	181.33	200.37	240.39	255.62
2014	83.19	110.72	180.91	209.47	240.70	263.55
2015	77.66	114.37	180.49	218.58	241.00	271.48
2016	74.97	112.67	181.72	220.65	246.42	274.17
2017	73.30	112.53	185.59	226.14	251.60	279.58
2018	76.76	114.20	189.99	232.79	257.96	290.10
2019	74.24	113.08	188.23	229.53	254.72	283.37
2020	74.54	113.75	189.81	227.23	252.24	282.21
2021	77.14	116.14	191.93	230.17	254.99	283.71
2022	78.54	116.20	192.81	235.49	256.04	283.53
2023	77.98	113.63	191.54	234.69	252.56	281.72

Table A3

Summary Statistics for CD Early Withdrawal Rates. This table presents early withdrawal rates for CDs with the indicated maturities. Early withdrawal rates are calculated by dividing the total amount withdrawn prior to maturity of the CD by the total balance subject to early withdrawal penalties for the indicated maturity categories. Rates are expressed as percentages. The data on early withdrawal rates are furnished by the Office of Thrift Supervision. Data for Q4 2001 is unavailable. The sample period is quarterly from September 2001 to December 2011.

		Time to Maturity		
Year	Quarter	$t \leq 3$ Months	$3 < t \leq 12$ Months	$t > 12$ Months
2001	3	9.463	9.908	9.457
2001	4	–	–	–
2002	1	2.631	4.432	5.986
2002	2	3.671	5.209	4.838
2002	3	3.257	4.240	2.964
2002	4	4.268	5.424	3.929
2003	1	3.921	4.469	4.187
2003	2	4.097	4.461	2.948
2003	3	3.563	3.968	2.660
2003	4	3.841	4.629	3.411
2004	1	4.039	4.305	3.266
2004	3	3.225	4.660	3.344
2004	4	3.461	4.161	2.913
2005	1	3.926	4.818	3.249
2005	2	3.709	3.842	3.335
2005	3	4.078	3.460	3.194
2005	4	3.309	3.565	5.433
2006	1	2.845	3.577	3.995
2006	2	3.901	3.901	4.782
2006	4	2.874	3.508	4.671
2007	1	2.849	3.443	3.677
2007	2	3.241	3.648	3.066
2007	3	3.633	5.891	5.938
2007	4	4.378	5.704	10.927
2008	1	3.577	8.037	3.255
2008	2	4.744	8.390	3.863
2008	3	8.381	9.633	4.496
2008	4	9.232	7.139	4.132
2009	1	9.457	7.657	4.149
2009	2	4.124	6.603	3.556
2009	3	4.997	6.460	4.162
2009	4	9.793	4.886	4.291
2010	1	7.013	4.964	4.473
2010	2	5.728	4.813	4.820
2010	3	4.858	4.714	5.354
2010	4	5.702	3.642	5.223
2011	1	5.285	3.891	5.291
2011	2	5.356	4.209	5.463
2011	3	6.123	3.706	3.040
2011	4	10.279	3.923	3.769

Table A4

Summary Statistics for Interest Rate Caps/Floors Trading Activity. This table presents the total number of trades in USD interest rate caps/floors in the Depository Trust & Clearing Corporation's (DTCC) Data Repository (DDR) each quarter for the period from Q1 2012 to Q4 2022. The row labeled All presents the average number of trades across all quarters. Under the Dodd Frank Act (DFA) and the Commodity Futures Trading Commission's (CFTC) real-time and regulatory reporting rules, swap dealers initially began reporting transactions in interest rate derivatives on December 31, 2012.

Year	Quarter	Number of Trades
2013	1	161
2013	2	991
2013	3	1,286
2013	4	1,288
2014	1	1,151
2014	2	1,512
2014	3	1,507
2014	4	1,717
2015	1	1,580
2015	2	1,679
2015	3	1,675
2015	4	2,174
2016	1	1,556
2016	2	1,757
2016	3	1,922
2016	4	2,061
2017	1	1,929
2017	2	2,137
2017	3	2,039
2017	4	2,096
2018	1	2,162
2018	2	2,806
2018	3	2,273
2018	4	2,850
2019	1	2,478
2019	2	2,571
2019	3	2,795
2019	4	2,716
2020	1	2,576
2020	2	2,784
2020	3	2,091
2020	4	2,603
2021	1	2,447
2021	2	3,007
2021	3	3,068
2021	4	3,775
2022	1	3,196
2022	2	3,509
2022	3	3,890
2022	4	2,728
All		2,214

Table A5

Alternative Table 5 – Robustness Test using the Treasury Discounting Function, Summary Statistics for Option-Adjusted Deposit Spreads. This table presents summary statistics for the option-adjusted deposit spreads for CDs with the indicated tenors and summary statistics for the deposit spreads for checking, savings, and money market account rates. Deposit spreads for checking, savings, and money market accounts are calculated as the difference between checking, savings, and money market account rates and the one-month constant maturity Treasury (CMT) rate. Spreads are based on the discounting function obtained from Treasury constant maturity rates and are expressed in basis points. Mean, Min, Med, and Max present the average, minimum, median, and maximum of the spreads. The column t-Stat shows the Newey and West (1987) t-Statistic associated with the average premium reported in the column Mean. N presents the number of weekly observations. The sample period is weekly from January 5, 2001 to June 30, 2023.

	Mean	t-Stat	Min	Med	Max	N
Six-Month CD	35.08	4.32	−192.44	−10.73	416.12	1,171
One-Year CD	21.02	2.74	−196.42	−14.50	389.40	1,171
Two-Year CD	16.43	2.26	−195.52	−3.43	368.52	1,171
Three-Year CD	11.27	1.62	−196.47	1.97	358.55	1,171
Four-Year CD	12.78	1.98	−197.68	7.16	344.80	1,171
Five-Year CD	5.73	0.95	−205.66	0.61	323.14	1,171
Checking	107.50	9.85	−33.63	53.85	584.81	1,171
Savings	93.67	8.89	−53.38	34.81	573.74	1,171
Money Market	72.08	7.71	−98.37	17.51	540.54	1,171

Table A6

Alternative Table 6 – Robustness Test using the Treasury Discounting Function, Results from Regressions of Option-Adjusted Deposit Spreads on Maturity Mismatch. Panel A reports the results from the regression of option-adjusted deposit spreads for the indicated tenors on the corresponding maturity mismatch. Panel B presents the results from the regression of changes in the option-adjusted deposit spreads for the indicated tenors on changes in the corresponding maturity mismatch, where the changes are calculated over two quarters. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. Spreads are based on the discounting function obtained from Treasury constant maturity rates and are expressed in basis points. Maturity mismatch is expressed in years. Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. Standard errors are based on Newey and West (1987). The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is quarterly from Q1 2001 to Q2 2023. The regressions are

$$\text{Spread}_t = c_0 + c_1\,\text{Mismatch}_t + \epsilon_t \text{ (Panel A)} \quad \text{and} \quad \Delta\text{Spread}_t = c_0 + c_1\,\Delta\text{Mismatch}_t + \epsilon_t \text{ (Panel B).}$$

	Six-Month CD		One-Year CD		Two-Year CD		Three-Year CD		Four-Year CD		Five-Year CD	
	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat
Panel A - Levels												
Intercept	−8.160	−3.48**	−7.068	−3.65**	−4.885	−3.56**	−3.056	−3.52**	−1.277	−3.05**	0.122	0.98
Mismatch	1.906	3.52**	1.837	3.66**	1.707	3.60**	1.618	3.56**	1.470	3.32**	1.361	3.16**
Adj. R^2		0.479		0.497		0.473		0.455		0.426		0.403
N		90		90		90		90		90		90
Panel B - Differences												
Intercept	0.031	0.57	0.026	0.54	0.014	0.31	0.006	0.14	−0.000	−0.01	−0.005	−0.12
ΔMismatch	0.447	1.54	0.485	1.80*	0.582	2.15**	0.676	2.37**	0.736	2.60**	0.766	2.68**
Adj. R^2		0.036		0.043		0.048		0.059		0.072		0.079
N		88		88		88		88		88		88

Table A7

Alternative Table 7 – Robustness Test using the Treasury Discounting Function, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on quarterly fixed effects. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. Spreads are based on the discounting function obtained from Treasury constant maturity rates and are expressed in basis points. Maturity mismatch is expressed in years. *FE* denotes quarterly fixed effects. Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1\,\text{Mismatch}_{i,t} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0500	3.79**
Quarterly Fixed Effects		Yes
Adj. R^2		0.931
N		540

Table A8

Alternative Table 8 – Robustness Test using the Treasury Discounting Function, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch and Interaction with the NSFR Indicator Variable. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on the maturity mismatch interacted with the Net Stable Funding Ratio (NSFR) indicator variable I_{NSFR}. The NSFR indicator variable takes the value one for quarterly dates after July 1, 2021, when the NSFR capital requirement became effective. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. *FE* denotes quarterly fixed effects. Spreads are based on the discounting function obtained from Treasury constant maturity rates and are expressed in basis points. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1 \,\text{Mismatch}_{i,t} + c_2 \,\text{Mismatch}_{i,t} \times I_{\text{NSFR}} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0469	3.32**
Mismatch × I_{NSFR}	0.0355	3.05**
Quarterly Fixed Effects		Yes
Adj. R^2		0.931
N		540

Table A9

Alternative Table 5 – Robustness Test for Withdrawal Model Parameters at Twice their Baseline Values, Summary Statistics for Option-Adjusted Deposit Spreads. This table presents summary statistics for the option-adjusted deposit spreads for CDs with the indicated tenors and summary statistics for the deposit spreads for checking, savings, and money market account rates. Deposit spreads for checking, savings, and money market accounts are calculated as the difference between checking, savings, and money market account rates and the one-month riskless rate. All spreads are expressed in basis points. Results are based on λ and γ taking on twice their baseline values (resulting in values for λ and γ of 2.718 and 3.650 percent, respectively). Mean, Min, Med, and Max present the average, minimum, median, and maximum of the spreads. The column t-Stat shows the Newey and West (1987) t-Statistic associated with the average premium reported in the column Mean. N presents the number of weekly observations. The sample period is weekly from January 5, 2001 to June 30, 2023.

	Mean	t-Stat	Min	Med	Max	N
Six-Month CD	39.94	4.75	−186.05	−9.37	427.47	1,171
One-Year CD	24.34	3.00	−203.39	−12.15	403.81	1,171
Two-Year CD	18.61	2.46	−198.75	−1.56	380.95	1,171
Three-Year CD	10.33	1.48	−194.87	−2.78	344.82	1,171
Four-Year CD	8.56	1.33	−195.91	−1.53	324.72	1,171
Five-Year CD	−5.20	−0.85	−206.11	−11.43	303.09	1,171
Checking	122.92	10.41	−21.26	62.75	515.09	1,171
Savings	109.08	9.56	−40.88	42.77	504.02	1,171
Money Market	87.50	8.66	−80.70	26.05	470.82	1,171

Table A10

Alternative Table 6 – Robustness Test for Withdrawal Model Parameters at Twice their Baseline Values, Results from Regressions of Option-Adjusted Deposit Spreads on Maturity Mismatch. Panel A reports the results from the regression of option-adjusted deposit spreads for the indicated tenors on the corresponding maturity mismatch. Panel B presents the results from the regression of changes in the option-adjusted deposit spreads for the indicated tenors on changes in the corresponding maturity mismatch, where the changes are calculated over two quarters. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. Spreads are expressed in basis points and maturity mismatch is expressed in years. Results are based on λ and γ taking on twice their baseline values (resulting in values for λ and γ of 2.718 and 3.650 percent, respectively). Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. Standard errors are based on Newey and West (1987). The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is quarterly from Q1 2001 to Q2 2023. The regressions are

$$\text{Spread}_t = c_0 + c_1\,\text{Mismatch}_t + \epsilon_t \text{ (Panel A)} \quad \text{and} \quad \Delta\text{Spread}_t = c_0 + c_1\,\Delta\text{Mismatch}_t + \epsilon_t \text{ (Panel B)}.$$

	Six-Month CD		One-Year CD		Two-Year CD		Three-Year CD		Four-Year CD		Five-Year CD	
	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat
Panel A - Levels												
Intercept	−8.231	−3.37**	−7.242	−3.45**	−4.826	−3.15**	−2.889	−3.01**	−1.205	−2.54**	0.009	0.07
Mismatch	1.934	3.43**	1.889	3.49**	1.694	3.23**	1.528	3.11**	1.351	2.81**	1.292	2.74**
Adj. R^2		0.459		0.471		0.427		0.399		0.358		0.354
N		90		90		90		90		90		90
Panel B - Differences												
Intercept	0.028	0.50	0.021	0.41	0.007	0.14	−0.002	−0.04	−0.009	−0.20	−0.012	−0.28
ΔMismatch	0.489	1.58	0.540	1.78*	0.664	2.11**	0.724	2.21**	0.770	2.32**	0.784	2.36**
Adj. R^2		0.045		0.049		0.058		0.065		0.073		0.077
N		88		88		88		88		88		88

Table A11

Alternative Table 7 – Robustness Test for Withdrawal Model Parameters at Twice their Baseline Values, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on quarterly fixed effects. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. *FE* denotes quarterly fixed effects. Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1\,\text{Mismatch}_{i,t} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0836	6.41^{**}
Quarterly Fixed Effects		Yes
Adj. R^2		0.936
N		540

Table A12

Alternative Table 8 – Robustness Test for Withdrawal Model Parameters at Twice their Baseline Values, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch and Interaction with the NSFR Indicator Variable. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on the maturity mismatch interacted with the Net Stable Funding Ratio (NSFR) indicator variable I_{NSFR}. The NSFR indicator variable takes the value one for quarterly dates after July 1, 2021, when the NSFR capital requirement became effective. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. *FE* denotes quarterly fixed effects. Results are based on λ and γ taking on twice their baseline values (resulting in values for λ and γ of 2.718 and 3.650 percent, respectively). Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1 \, \text{Mismatch}_{i,t} + c_2 \, \text{Mismatch}_{i,t} \times I_{\text{NSFR}} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0769	5.22^{**}
Mismatch × I_{NSFR}	0.0757	3.97^{**}
Quarterly Fixed Effects		Yes
Adj. R^2		0.937
N		540

Table A13

Alternative Table 5 – Robustness Test with Liquidity Shock Only, Summary Statistics for Option-Adjusted Deposit Spreads. This table presents summary statistics for the option-adjusted deposit spreads for CDs with the indicated tenors and summary statistics for the deposit spreads for checking, savings, and money market account rates. Deposit spreads for checking, savings, and money market accounts are calculated as the difference between checking, savings, and money market account rates and the one-month riskless rate. All spreads are expressed in basis points. Results are based on the early withdrawal model with liquidity shocks and no strategic exercise of the early withdrawal option by depositors (resulting in values for λ and γ of 1.359 and zero percent, respectively). Mean, Min, Med, and Max present the average, minimum, median, and maximum of the spreads. The column t-Stat shows the Newey and West (1987) t-Statistic associated with the average premium reported in the column Mean. N presents the number of weekly observations. The sample period is weekly from January 5, 2001 to June 30, 2023.

	Mean	t-Stat	Min	Med	Max	N
Six-Month CD	39.57	4.72	−186.09	−9.38	426.25	1,171
One-Year CD	24.44	3.04	−202.00	−12.17	402.04	1,171
Two-Year CD	22.29	3.05	−187.27	4.50	377.75	1,171
Three-Year CD	23.16	3.55	−170.67	13.17	344.96	1,171
Four-Year CD	28.19	4.80	−159.30	21.44	323.55	1,171
Five-Year CD	25.53	4.73	−155.18	23.82	303.95	1,171
Checking	122.92	10.41	−21.26	62.75	515.09	1,171
Savings	109.08	9.56	−40.88	42.77	504.02	1,171
Money Market	87.50	8.66	−80.70	26.05	470.82	1,171

Table A14

Alternative Table 6 – Robustness Test with Liquidity Shock Only, Results from Regressions of Option-Adjusted Deposit Spreads on Maturity Mismatch. Panel A reports the results from the regression of option-adjusted deposit spreads for the indicated tenors on the corresponding maturity mismatch. Panel B presents the results from the regression of changes in the option-adjusted deposit spreads for the indicated tenors on changes in the corresponding maturity mismatch, where the changes are calculated over two quarters. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. Spreads are expressed in basis points and maturity mismatch is expressed in years. Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. Results are based on the early withdrawal model with liquidity shocks and no strategic exercise of the early withdrawal option by depositors (resulting in values for λ and γ of 1.359 and zero percent, respectively). Standard errors are based on Newey and West (1987). The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. The sample period is quarterly from Q1 2001 to Q2 2023. The regressions are

$$\text{Spread}_t = c_0 + c_1\,\text{Mismatch}_t + \epsilon_t \text{ (Panel A)} \quad \text{and} \quad \Delta\text{Spread}_t = c_0 + c_1\,\Delta\text{Mismatch}_t + \epsilon_t \text{ (Panel B)}.$$

	Six-Month CD		One-Year CD		Two-Year CD		Three-Year CD		Four-Year CD		Five-Year CD	
	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat	Coeff	t-Stat
Panel A - Levels												
Intercept	−8.222	−3.38**	−7.195	−3.46**	−4.579	−3.04**	−2.442	−2.57**	−0.801	−1.76*	0.305	2.48**
Mismatch	1.931	3.44**	1.878	3.50**	1.623	3.14**	1.368	2.80**	1.138	2.43**	0.976	2.17**
Adj. R^2		0.461		0.473		0.416		0.359		0.296		0.252
N		90		90		90		90		90		90
Panel B - Differences												
Intercept	0.028	0.50	0.021	0.41	0.005	0.11	−0.005	−0.11	−0.012	−0.27	−0.016	−0.37
ΔMismatch	0.487	1.58	0.539	1.79*	0.685	2.23**	0.767	2.43**	0.800	2.54**	0.803	2.56**
Adj. R^2		0.045		0.049		0.064		0.075		0.080		0.081
N		88		88		88		88		88		88

Table A15

Alternative Table 7 – Robustness Test with Liquidity Shock Only, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on quarterly fixed effects. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. *FE* denotes quarterly fixed effects. Results are based on the early withdrawal model with liquidity shocks and no strategic exercise of the early withdrawal option by depositors (resulting in values for λ and γ of 1.359 and zero percent, respectively). Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1 \,\text{Mismatch}_{i,t} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0142	0.83
Quarterly Fixed Effects		Yes
Adj. R^2		0.896
N		540

Table A16

Alternative Table 8 – Robustness Test with Liquidity Shock Only, Results from Panel Regression of Option-Adjusted Deposit Spreads on Maturity Mismatch and Interaction with the NSFR Indicator Variable. This table presents the results from the panel regression of option-adjusted deposit spreads on the corresponding maturity mismatch and on the maturity mismatch interacted with the Net Stable Funding Ratio (NSFR) indicator variable I_{NSFR}. The NSFR indicator variable takes the value one for quarterly dates after July 1, 2021, when the NSFR capital requirement became effective. Maturity mismatch is defined as the difference between the Drechsler, Savov, and Schnabl (2021) measure of asset repricing maturity of the banking sector and the tenor of the CD. *FE* denotes quarterly fixed effects. Results are based on the early withdrawal model with liquidity shocks and no strategic exercise of the early withdrawal option by depositors (resulting in values for λ and γ of 1.359 and zero percent, respectively). Adj. R^2 and N denote the adjusted regression R-squared and the number of observations, respectively. The superscripts * and ** denote significance at the ten-percent and five-percent levels, respectively. Robust standard errors are clustered by CD tenor. The data are quarterly from Q1 2001 to Q2 2023. The regression is

$$\text{Spread}_{i,t} = c_1\,\text{Mismatch}_{i,t} + c_2\,\text{Mismatch}_{i,t} \times I_{\text{NSFR}} + FE_t + \epsilon_{i,t}.$$

	Coeff	t-Stat
Mismatch	0.0043	0.22
Mismatch $\times$ I_{NSFR}	0.1121	5.29**
Quarterly Fixed Effects		Yes
Adj. R^2		0.899
N		540