Large Retail Time Deposits and U.S. Treasury Securities (1986 –95): Evidence of a Segmenting Market

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Abstract

Although investors face an ever-growing menu of securities with divergent cash flows and risk patterns, some continue to place funds in fixed-rate, fixed-maturity, default-risk-free instruments, primarily U.S. Treasury securities and FDIC-insured time deposits. Given free, easy access to noncompetitive bids in the primary Treasury market by means of the Treasury Direct program, investors could plausibly view Treasury securities and large retail time deposits (up to $100,000) as very close substitutes, and demand equal pricing. We test this hypothesis using weekly series of Treasury and large retail time deposit yields for three maturities over a 10-year period (1986-95). The data reveal a pattern of equilibrium pricing between 1986 and 1990. However, the data also show that large retail time deposits were routinely underpriced relative to Treasuries from mid-1990 onward. We conclude that the change in the pricing of large retail time deposits reflects increasing market segmentation. That is, the flight from insured balances into money market funds and other uninsured investments has left banks with a group of investors who are uncommonly insensitive to interest rates or, equivalently, have the highest switching costs. In addition, we find that increases in and persistence of the negative spread beginning in 1990 had no measurable effect on changes in aggregate time deposit balances and that average large time deposit yields exhibit stickiness relative to those of U.S. Treasuries. This suggests that banks are able to extract available surplus from the depositor segment of the risk-free debt investors. This surplus helps to make up for the loss of the banks' more rate-sensitive investors.

1. Introduction

Despite an ever-growing menu of options offering diverse risk and return possibilities, investors continue to place a large volume of funds in fixed-rate, fixed-maturity, default risk free instruments. These take two forms: purchases of U.S. Treasury securities and placement of funds in FDIC-insured large retail certificates of deposit (hereinafter Treasuries and large time deposits, or large CDs.) At the end of the first quarter of 1996, $3,375 billion in marketable Treasuries were outstanding, with 10.3 percent of these held by individuals.[1] At that time, investors also held $578 billion in large and small retail time deposits at commercial banks and $355 billion at thrift institutions (balances of $100,000 or less.)[2]

Because large CDs and Treasuries offer similar cash flow patterns and risks, they should be closely priced in an efficient market (i.e., their yields should be closely related to one another.) Any differences in their yields should be small relative to differences in yield with other securities (such as corporate bonds or equities) and should be explained by contractual features and market structures. To our knowledge, however, these two securities have not been compared from an investor's point of view.

Our study fills this gap in the literature by comparing published yields on large retail CDs with balances between $90,000 and 100,000 and maturity-matched Treasury yields. This pairing enables us to avoid three fundamental problems encountered in deposit pricing studies. First, obtaining information on deposit pricing is difficult. The primary source of information about banks' balance sheets – the call report – does not include information on deposit pricing. The *Federal Reserve Bulletin's* monthly survey of deposit yields lumps deposits into maturity buckets and the mix of products on which it reports has changed substantially over the years.

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[1]Source: *Federal Reserve Bulletin*, August 1996. Slightly more than half of these individually held Treasuries were savings bonds.

[2]Source: *Federal Reserve Bulletin*, August 1996. Small CD balances exclude all IRA and Keogh accounts, which totaled $150 billion for banks and $21 billion for thrifts in March 1996. It should be noted that large CDs have explicit FDIC insurance only on the first $100,000, though the tendency of bank supervisors to merge failed institutions rather than close them has typically provided full coverage for larger depositors.

Second, retail bank deposits provide investors with a number of nonmonetary returns for which yield equivalences are difficult to determine. These include low minimum balance requirements, reduced fees on transactions services, and low-cost, easy acquisition through systems of local branch offices. No close investment substitutes exist for these products, making yield comparisons impossible. Third, wholesale or jumbo bank deposits (minimum > $100,000), for which nonmonetary returns are insignificant, are at risk of default. Default expectations will be reflected in their yields, making direct comparisons to risk free securities, such as Treasuries, inappropriate. The $90,000 minimum we study weakens the impact of bank deposits' non-monetary returns on stated yields, while the maximum of $100,000 negates the default issue by ensuring a federal "full faith and credit" guarantee, like that for Treasury securities.

Our purpose is to test the hypothesis that the yields in the large time deposit market and the Treasury market are equivalent and that price differences between CDs and Treasuries can be explained by differences in contractual and market features. During the early part of the period studied, our results are in line with this hypothesis. That is, large CD yields fluctuated around Treasury yields and the average spreads could be explained by differences in required minimum investments. However, beginning in mid-1990, large deposit yields uniformly dropped and stayed below Treasury yields. This change does not appear to have affected aggregate investment in large deposits.

Our study also extends the work of Mahoney, White, O'Brien, and McLaughlin (1987), who document changing deposit yields for the two years following deposit deregulation. We find that deposit yields can be well represented as smoothed Treasury yields. In addition, we find support for the hypothesis that average large time CDs exhibited upward stickiness with respect to Treasury yields.

The remainder of this paper proceeds as follows: Section 2 discusses deposit pricing and its historical relation to Treasury yields. Section 3 describes the similarities and principal differences between investment in Treasuries and insured large deposits. Section 4 describes the data we studied. Section 5 describes the results of our analysis, and Section 6 summarizes these results and presents our conclusions.

2. Deposit Pricing

This paper is most closely related to the work of Mahoney et al. (1987), who studied retail deposit pricing during the two years immediately following its deregulation, November 1983 through December 1985. Our study begins in June 1986. Thus our findings can be viewed as an extension of theirs, albeit with some important differences. Although Mahoney et al. focused on comparing commercial bank and thrift institution deposit pricing (and pointing to historical differences in regulations), they also report a negative average deposit-Treasury spread over the period they studied. It is unsurprising that negative spreads are found for small minimum balance accounts, because an investor with $1,000 in a CD had little incentive to chase 50 basis points in additional return, particularly when her bank offered free checking and other benefits. Also, time deposit yields were legally constrained below Treasury yields until October 1983. Mahoney et al.'s data show that banks closed these wide negative yield spreads within the first year of deregulation and that yields on deposits moved with or above Treasury yields throughout 1985.[3]

Possible disparities between retail deposits and Treasuries are examined in studies about deposit pricing from the issuer's (bank's) point of view. Flannery (1982) developed and found some evidence supporting the hypothesis that banks can reasonably pay a premium for consumer (retail) deposits in order to maintain a core liability, relying on less expensive wholesale funds at the margin. However, he also noted that rates are not the only means by which banks offer value to depositors; they can also offer such benefits as favorable branch locations and ease of reinvestment.[4] Thus the monetary and time costs of moving deposits,

[3]See Mahoney, et al (1987), charts 1-4.

[4]During the Regulation Q era, banks also provided explicit goods (such as the infamous toaster or electric blanket) as a reward for deposits, a practice that has essentially disappeared post-deregulation. See Davis, R. G. and

called switching costs, may cause investors to accept lower yields than those earned from comparable securities. Heffernan [1992] subsequently developed specific interest-rate equivalences for non-rate components based on a small sample of British banks. These papers suggest that investors will accept yields lower than those on Treasuries to the extent that they receive nonmonetary value from time deposits, but will require higher yields when Treasuries offer net advantages.

A commonly held paradigm says that time deposit yields follow current and past Treasury yields, but they respond slowly and asymmetrically to movements in the Treasury market. The notion that large CD yields respond to changes in Treasury yields slowly is referred to as deposit yield smoothing. The idea that they fall at a different speed when Treasury yields fall than they rise when Treasury yields rise is referred to as deposit yield (price) stickiness. Hannan and Berger (1991) and Neumark and Sharpe (1992) studied these phenomena in markets of varying concentration and found that deposit yields were quicker to fall and slower to rise in markets with fewer issuers (banks). In related work, Cooperman, Lee and Lesage (1991) studied the extent to which a national market was developing for deposits and found that co-integration was increasing over time, at least among banks in the largest U.S. cities.

While our study is related to these papers, it differs in that we have a demand perspective (i.e., that of individual investors). Specifically, where Flannery compared two substitutes for bank funding, retail and wholesale deposits, we compare two close substitutes for consumer investment, insured large CDs and U.S. Treasuries.

In an unique paper, Jackson and Aber (1992) found that investor perceptions can affect deposit levels more than relative pricing. They measured the impact on deposit balances of the frequency with which banks changed their deposit yields and the closeness of those changes to changes in market interest yields. They found that banks that changed their yields frequently

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L. Korobow, "The Pricing of Consumer Deposit Products – The Non-rate Dimensions," FRBNY *Quarterly Review*, Winter 1987, pp. 14-18.

and randomly attracted more deposits than those that followed changes in market yields slowly and closely.

3. Large Retail Time Deposits and Treasury Securities as Close Substitutes.

Hannan and Hanweck (1988) and Ellis and Flannery (1992) explore the existence of bank-specific default premiums in wholesale time deposit yields. Their work implicitly claims that bank time deposit yields are most appropriately compared with those of matched-maturity U.S. Treasuries.[5] Similarly, our analysis is based on the premise that large, FDIC-insured time deposits and U.S. Treasury securities are very close substitutes from an investor's point of view. If this is true, it follows that they should be similarly priced (provide the same yield) in an efficient market. Thus, it is useful to review the primary differences between bank time deposits and U.S. Treasury securities and to acknowledge the yield disparities that these differences could potentially imply. Table 1 provides a summary of the discussion that follows. We assume throughout this discussion that Treasury securities are purchased using noncompetitive bids through the Treasury Direct program.[6]

1: Comparing Time Deposit and Treasury Security Characteristics

Characteristic	Large Retail CDs	U.S. Treasuries	Expected Effect on Relative Yields
Default Protection:	federally insured	federal guarantee	none
Minimum Investment:	$90,000	$10 / 5 / 1,000 for varying maturities	CDs > Treasuries

[5]Duffee (1996) describes changes in the relationships between Treasury security prices (yields) and other money market instruments over the period 1959 through 1994.

[6]All information regarding the Treasury Direct program is taken from *Buying Treasury Securities at Federal Reserve Banks*, Federal Reserve Bank of Richmond, 16th edition, 1993. The noncompetitive bid price (yield) for a particular auction is the value-weighted average of the winning competitive bids.

Tax Status:	fully taxed	local tax exemption	CDs > Treasuries
Secondary Market:	withdrawal penalty	deep, low cost secondary market	CDs > Treasuries
Reinvestment:	varying policies	costless rollover	CDs ≥ Treasuries
Acquisition Costs:	time	lost interest or commission	Treasuries ≥ CDs
Acquisition Ease:	any day/amount	fixed auction schedule / $1,000 increments.	Treasuries > CDs

The discussion summarized in the table above compares bank-originated, FDIC-insured time deposits requiring balances between $90,000 and 100,000 with U.S. Treasury Securities acquired using noncompetitive bids through the Treasury Direct program.

Both securities offer the default protection of a federal "full faith and credit" guarantee; thus, the default risk premium for both should be identical and close to zero. Retail time deposits with maturities of one year or less are zero-coupon securities, as are Treasury bills. Five-year Treasury notes pay interest semiannually, while the coupon frequency of time deposits of this maturity varies across issuers, with quarterly payments more typical. This variety of payment frequencies might provide a small advantage to time deposits, allowing slightly lower yields.

The minimum order for T-bills is $10,000. It is $5,000 for two- and three-year T-notes, and $1,000 for longer maturities, with increments of $1,000 available over the minimums for all maturities. As noted previously, the yields that we examine are for CDs requiring a minimum investment of $90,000. This suggests two reasons why Treasury yields should be lower than yields on those CDs. First, investors who have less than $90,000 cannot substitute these CDs for Treasuries. (As we will show, investments in smaller CDs provide significantly lower yields.) Second, investors with more than the minimum can acquire additional liquidity by splitting their investment into multiple Treasuries, each earning the quoted yield.

Income from U.S. Treasury securities is exempt from state and local taxes, while interest from time deposits is not. Therefore Treasuries could offer lower nominal yields than time deposits while providing the same after-tax income. For example, in order for a time deposit to be price competitive with a Treasury yielding 5.00 percent and owned by an investor with a 6 percent marginal local income tax rate, it would have to offer 5.32 percent or a positive spread over Treasury of 32 basis points, a significant difference.

Automatic rollover (reinvestment) of Treasuries purchased through the regional FRBs is costless, which is typical but not always the case for time deposits. In some cases, banks roll maturing time deposits into money market or savings accounts. From this perspective, time deposit yields should be equal to or perhaps slightly greater than those of Treasuries.

Three- and six-month T-bills are auctioned weekly, though one-year T-bills and two- and five-year T-notes are auctioned only monthly. The continual availability of time deposits suggests that Treasury holders should be rewarded for the sometimes inconvenient scheduling of auctions. However, in the event of unforeseen liquidity needs, Treasuries have a deep secondary market with low transactions costs, while retail time deposits face a steep early withdrawal penalty regardless of whether current market rates imply one. This suggests that large CDs should offer a yield premium over Treasuries.[7] Note, however, that time deposits and Treasuries are among the most universally accepted forms of collateral. It is quite easy, though costly, for an investor faced with an unexpected liquidity need to obtain a loan on very favorable terms, pledging either an insured time deposit or a Treasury security as collateral.

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[7] It is also possible that investors would choose between Treasury securities and insured time deposits based on their expectations of future interest rates. If investors expect rates to rise significantly in the future, they might invest in CDs, which limit the loss due to rising rates to the withdrawal penalty, rather than Treasuries, which could suffer unlimited losses if rates continue to rise. We are currently exploring this idea by studying the pattern the CD-Treasury yield spread over the rate cycle.

Finally, time deposits can be created during any business day with no explicit monetary fee. Treasuries can be purchased without fee using noncompetitive bids through the Treasury Department or any of the regional Federal Reserve Banks (FRBs) using the Treasury Direct program. However, noncompetitive bids must be received prior to the auction and be accompanied by full payment for the *face value* of the securities desired, suggesting a loss of interest income, though one that can be minimized by sending orders close to the auction date. Placing bids through a brokerage avoids this lost interest, but adds a commission cost. Even so, this fee is generally low – on the order of 5 basis points.[8] The amount of this commission is as narrow as the yield spread between large time deposits and Treasuries should get.

In summary, the two security types offer similar cash flow streams and full default protection. Treasuries should receive a yield advantage (implying, all else the same, a positive CD-Treasury spread) based on their local/state tax exempt status, lower minimum investment requirements, and more extensive secondary market (greater liquidity.) CDs should receive a yield advantage because of their variety of payment frequencies (a comparatively minor advantage) and their potentially lower costs of acquisition.

4. The Data.

The CD yield series examined in this paper were gathered from the survey of effective annual yields conducted by the Banxquote division of Masterfund, Inc. This national survey of 100 large commercial banks is conducted each week and published in the *Wall Street Journal* the following day under the title "Banxquote® Money Markets." Average effective annual yields for eight maturities and two minimum deposits levels are provided. We gathered yields for fixed rate deposits with a minimum balance of $90,000 and maturities of three months, one year, and five years. Although we also gathered and analyzed the yields for deposits with minimum balances of $500, those results are only briefly summarized in order to

[8]On 04/22/97, the commission for trading any volume of Treasury securities through Charles Schwab, a discount broker, was $49, or 5.4 basis points for $90,000 in Treasuries.

concentrate on the clearer evidence provided by the larger balance sample. Yields for these large deposits were first available on June 26, 1986, while those of smaller deposits were first published on January 6, 1986. They were collected through the last week of 1995, providing almost ten years of homogenous data.

U.S. Treasury yields were gathered from the "Treasury Bonds, Notes, and Bills" listing in the *Wall Street Journal*, as provided by the Federal Reserve Bank of New York, for T-bills with remaining maturities of three months and one year and for the T-note with a remaining maturity closest to five years. The Treasury yields reflect closing ask prices from the same day that Banxquote performed its deposit survey.[9] Monthly aggregate time deposit balances were gathered from table 1.21 ("Money, Stock, Liquid Assets, and Debt Measures") of the *Federal Reserve Bulletin* for 1986-95. Seasonally adjusted *small denomination time deposits* for commercial banks and for thrift institutions were joined to provide the aggregate retail CD balance for each month.

5. Analysis.

The core purpose of this study is to examine the relationship between yields on large balance, fully insured, bank-originated time deposits and those of U.S. Treasury securities. We first summarize the size of time deposit-Treasury yield spreads over our full sample period and a selection of subperiods. Next, we see how closely, and at what lags, large CD yields tracked Treasury yields, as evidence that direct comparison of these yields is warranted. We then test for upward yield stickiness, as a measure of relative supply-side power in the CD market. Finally, we analyze the effects of changes in large CD yields and CD-Treasury yield spreads on changes in aggregate CD balances, in order to determine the extent to which investors responded to the widening negative spreads.

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[9]Because of the arcane way that T-bill yields are reported, the three-month and one-year ask rates used herein are systematically less than the effective yield an investor would earn. Thus, the chance of finding a negative deposit-Treasury yield spread is understated. The five-year Treasury yields and all of the time deposit yields are true annual yields.

5.1 The relationship between Treasury and Deposit Yields.

Table 2 provides summary statistics for three maturities over 1986-95.

Table 2: Yield Series Summary Statistics (1986-95)

Yield Series		Mean (μ)	Avg. Spread to Treasury
3-month			
	Treasury	5.70	
	Large Retail CD	5.53	-0.17
	Small Retail CD	5.29	-0.41
1-year			
	Treasury	6.14	
	Large Retail CD	5.94	-0.20
	Small Retail CD	5.86	-0.28
5-year			
	Treasury	7.27	
	Large Retail CD	7.02	-0.25
	Small Retail CD	6.89	-0.38

This information is given for small-balance retail CDs, as well as for the large-balance retail CDs and Treasury securities that are the focus of this study. On average, during that time all CD categories offered lower yields than Treasuries, with mean negative spreads of 28-41 basis points for small CDs and 17-25 basis points for large CDs. After taxes, this spread would be larger for an investor paying local or state income taxes, because income from U.S. Treasury securities is exempted from such. Chart 1 compares the weekly percentage change in Treasury and large and small retail CD yields for the one-year maturity.[10]

[10]In order to avoid duplication (and to conserve trees), we provide visual evidence only for the one-year maturity (charts 1-3). The three-month and five-year maturities provide similar pictures and are available from the authors upon request.

This visual evidence clearly indicates that Treasury yields exhibit the most volatility, followed by large-retail and then small-retail CD yields, which suggests that CD yields are less subject to market forces than Treasury yields. Summary statistics for three subperiods, 1986-89, 1990-92, and 1993-95, are provided in panels a through c of table 3. During the first subperiod, CD yields remained close to those offered by Treasuries, with small retail yields averaging slightly less and large retail yields slightly more. These relationships make sense because the conditions on small retail CDs are less limiting, particularly with respect to minimum balances, than those on large retail CDs. The yield volatilities seen during this subperiod conform to expectations: Treasuries are most volatile, followed by large and then small retail CDs.

Table 3: Yield Series Summary Statistics by Subperiod

Maturity	Yield Series	Mean (μ)	Standard Deviation (σ)	Avg. Spread to Treasury
Panel a: (1986-89)				
3-month	Treasury	6.81	1.15	
	Large Retail CD	7.08	1.11	+0.27
	Small Retail CD	6.73	0.94	-0.08
1-year	Treasury	7.30	1.06	
	Large Retail CD	7.40	1.07	+0.10
	Small Retail CD	7.30	0.93	0.00
5-year	Treasury	8.09	0.75	
	Large Retail CD	8.15	0.67	+0.06
	Small Retail CD	7.98	0.62	-0.11

Panel b: (1990-92)

3-month	Treasury	5.57	1.79	
	Large Retail CD	5.47	1.85	-0.10

	Small Retail CD	5.32	1.82	-0.25
1-year	Treasury	5.85	1.71	
	Large Retail CD	5.79	1.77	-0.06
	Small Retail CD	5.69	1.77	-0.16
5-year	Treasury	7.34	1.01	
	Large Retail CD	7.08	1.04	-0.26
	Small Retail CD	6.95	1.01	-0.39

Panel c: (1993-95)

3-month	Treasury	4.32	1.17	
	Large Retail CD	3.73	1.04	-0.59
	Small Retail CD	3.29	0.78	-1.03
1-year	Treasury	4.85	1.27	
	Large Retail CD	4.33	1.17	-0.52
	Small Retail CD	4.07	1.07	-0.78
5-year	Treasury	6.07	0.93	
	Large Retail CD	5.60	0.79	-0.47
	Small Retail CD	5.35	0.74	-0.72

During the second subperiod, the average small retail-Treasury spread became more negative, and the average large retail-Treasury spread became negative. The volatilities exhibited by each yield series for a given maturity were roughly the same. During the third subperiod, both negative CD-Treasury spreads widened further, and the volatilities resumed their expected relationship. Chart 2 also provides visual evidence of the changing relationship between Treasury and CD yields (for the one-year maturity). The first panel shows the Treasury yield over time. The second shows the large retail-Treasury spread, while the third shows the small retail-Treasury spread.

5.2 CD Yields as Smoothed Treasury Yields.

Movements in the yields of large retail CDs continued to closely mimic those of Treasuries, despite the widening negative spread of CDs to Treasuries. Bankers acknowledge that they are sometimes slow to respond to changes in market interest rates, waiting to see what the longer-term trend will be. If this “smoothing” exists, it would account for the lower volatility in CD yields over some periods relative to Treasury yields. To measure the similarities between CD and Treasury yield changes, we performed the following regression for each of the three maturities.

$$CD_t = \quad + \bar{\ } (L) \quad T_t + \quad _t \tag{1}$$

where *CD* is the weekly percentage change in the large retail CD yield, *T* is the weekly percentage change in the same maturity Treasury yield, and (L) is the lag function. We allowed for twelve lags in the Treasury series in order to capture the full effects, if any, of smoothing. The results of this analysis are presented in table 4.

Table 4: CD Yield Smoothing (Relative to Treasury Movements)

$$CD_t = \quad + \bar{\ } (L) \quad T_t + \quad _t$$

Results for large balance retail CDs

	3-month	1-year	5-year
Intercept	-0.0005 (0.4687)	-0.0005 (0.3908)	-0.0004 (0.2301)
Treasury t = 0	**0.2419** (0.0001)	**0.3007** (0.0001)	**0.2801** (0.0001)

Treasury t = -1	**0.1976** (0.0001)	**0.2341** (0.0001)	**0.2285** (0.0001)
Treasury t = -2	**0.1320** (0.0001)	**0.0920** (0.0001)	**0.0700** (0.0001)
Treasury t = -3	**0.1099** (0.0001)	**0.0891** (0.0001)	**0.0400** (0.0159)
Treasury t = -4	**0.0832** (0.0014)	**0.0728** (0.0003)	**0.0420** (0.0093)
Treasury t = -5	0.0308 (0.2383)	0.0381 (0.0562)	0.0272 (0.0914)
Treasury t = -6	-0.0258 (0.3212)	0.0058 (0.7709)	0.0173 (0.2812)
Treasury t = -7	0.0082 (0.7515)	0.0185 (0.3529)	0.0077 (0.6321)
Treasury t = -8	0.0213 (0.4121)	0.0200 (0.3135)	0.0278 (0.0838)
Treasury t = -9	0.0335 (0.1971)	0.0053 (0.7875)	0.0204 (0.2046)
Treasury t = -10	0.0067 (0.7946)	-0.0010 (0.9579)	0.0162 (0.3085)
Treasury t = -11	**0.0891** (0.0006)	0.0360 (0.0682)	**0.0532** (0.0009)
Treasury t = -12	-0.0497 (0.0526)	0.0141 (0.4692)	0.0065 (0.6815)
Adj. R^2	0.2803	0.4665	0.5416
$_{0} + \ldots + _{-4}$	0.7646	0.7887	0.6606

P-values provided in ()'s below parameter estimates.
Coefficient estimates in **bold** are significant at the 5% level, two-sided test.

Contemporaneous changes in the Treasury yield, as well as the first four lagged changes, have a significant effect on changes in CD yields for each of the three maturities. The results suggest that the one-month cumulative effect of a 1 percent increase in the Treasury yield was a 0.66-0.79 percent increase in the CD yield over the next five weeks (see "$_{0} + \ldots + _{-4}$" at the bottom of the table.) Further, movements in Treasury yields explain a significant part (28 percent to 54 percent) of the variation in CD yield changes. Lags after the fourth have no significant impact on CD yields (other than the eleventh for reasons we cannot explain beyond "Type II" error) and the constant term, , is negative and insignificant for all maturities. In summary, this analysis confirms that CD yields can be reasonably thought to follow those of Treasuries.

5.3 Supply Side Power: Upward CD Yield Stickiness.

To say that a particular yield is sticky is to say that it responds to movements in some market or reference yield asymmetrically. If the reaction of the yield to an increase in the reference yield is less substantial than its reaction to a decrease in the reference yield, the yield is said to be "upward sticky." If the reaction is more substantial, the yield is said to be "downward sticky." Evidence of upward deposit yield stickiness was found in some markets by previous researchers (e.g., Hannan and Berger (1991) and Neumark and Sharpe (1992)). If such asymmetric yield reactions are indicated by our national sample, it suggests that every market for large retail CDs may be characterized by a form of supply-side power (or, equivalently, demand-side weakness.) In other words, such a finding would suggest that banks in the aggregate have demonstrated the ability to control relative deposit yields to their advantage (i.e., lowering yields quickly and raising them slowly), while investors in the aggregate have shown themselves to be somewhat yield insensitive.

As shown in the previous section, Treasuries provide a good reference yield for large CDs, because changes in CD yields mimic those of Treasuries, though with some substantial lags. Intuitively, then, we want to find evidence such as "for each 10 bps that Treasury yields rise, CD yields rise 5 bps, but for each 10 bps that Treasury yields fall, CD yields fall 8 basis points," which would suggest that CD yields are upward sticky with respect to Treasury yields. Our approach is to separate the full sample into two parts. One part includes all weeks during which the Treasury yield was increasing; the other part includes the remaining weeks (during which were Treasury yields were decreasing or remained constant.) We re-estimate equation (1) for each subsample and compare parameter estimates across the two regressions.

If the slope parameters for the "treasury decreases" subsample are larger than those for the "treasury increases" subsample, the upward stickiness hypothesis is supported.

However, the lagged relationship between CD and Treasury yields complicates matters as follows. Suppose the Treasury yield increased by a small amount over week *t*, but had decreased substantially during the previous weeks (weeks *t-1*, *t-2*, etc.) According to the full sample slope parameter estimates for equation (1), which are summarized in table 4, the CD yield would be expected to have decreased during week *t*, even though the Treasury yield had increased contemporaneously. The question is whether week *t* should then be included in the "treasury increased" or "treasury decreased" subsamples. The Treasury yield may have increased during the week, but its trend (and its effect on CD yields) is clearly a decrease.

This translates into a question of how to split the full sample. We chose to split it according to the cumulative change in Treasury yield over the last *n* weeks. The cumulative change over *n* weeks is equal to the Treasury yield at week *t* less the Treasury yield at week *t-n*. Because there is no common understanding about how long the Treasury yield must trend in a particular direction in order to cause an asymmetric reaction in CD yields, we ran this test three times; for *n* equal to one week, four weeks (≈ one month), and twelve weeks (≈ one quarter). Equation (1) was re-estimated for each subsample, for the number of lags in the Treasury yield changes that significantly helped to explain changes in the CD yield.[11] The results of this analysis are provided in Tables 5a-c. Each table provides a side-by-side comparison of the paired regressions for each of the three maturities. In each of the nine paired regressions, the slope on the contemporaneous change in the Treasury yield ($t=0$) was larger for the "treasury decreased" subsample. In eight of nine cases, the slope on the first lag ($t=-1$) was also larger (the exception is the three-month yield using the four week split.)

[11]The fifth lag is included in the one-week split, three-month maturity and four-week split, one-year maturity tests because the p-value of its slope estimate was very close to the 5% cutoff for one of the subsamples.

Table 5a: Large Retail CD Yield Stickiness

$$CD_t = \quad + \; \overline{} \; (L) \quad T_t + \quad {}_t$$

Split Based on *Current Week* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from the previous week. These are referred to as the “treasury increased” and “treasury decreased” subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	-0.0010	0.0019	0.0002	0.0013	0.0003	-0.0005
	(0.4793)	(0.1341)	(0.7230)	(0.3235)	(0.7435)	(0.5748)
Treasury	**0.2125**	**0.3277**	**0.2541**	**0.3797**	**0.2442**	**0.2807**
t = 0	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Treasury	**0.1096**	**0.2641**	**0.2034**	**0.2671**	**0.1916**	**0.2667**
t = -1	(0.0077)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Treasury	**0.1048**	**0.1747**	**0.0796**	**0.1226**	**0.0791**	**0.0542**
t = -2	(0.0010)	(0.0001)	(0.0001)	(0.0009)	(0.0004)	(0.0313)
Treasury	**0.1338**	0.0519	**0.0834**	**0.1010**	0.0287	**0.0611**
t = -3	(0.0001)	(0.2376)	(0.0001)	(0.0054)	(0.2075)	(0.0123)
Treasury	**0.0691**	**0.1246**	**0.0974**	**0.0749**	**0.0546**	0.0430
t = -4	(0.0409)	(0.0020)	(0.0001)	(0.0232)	(0.0119)	(0.0769)
Treasury	0.0747	0.0095	0.0086	**0.0740**	0.0085	**0.0636**[*]
t = -5	(0.0561)	(0.7885)	(0.6569)	(0.0269)	(0.6888)	(0.0106)
’s	0.7045	0.9525	0.7265	1.0193	0.6067	0.7693
Adj. R^2	0.1969	0.3308	0.5246	0.3642	0.4097	0.4416
“Chow”	**2.84**		**1.87**		**1.67**	
statistic	(0.0000)		(0.0000)		(0.0000)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). "Chow" statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Table 5b: Large Retail CD Yield Stickiness

$$CD_t = \quad + \overline{} \; (L) \;\; T_t + \quad {}_t$$

Split Based on *Four-Week Cumulative* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from four weeks before. (This is equivalent to asking whether the cumulative four-week change in the Treasury yield was positive or negative.) These are referred to as the "treasury increased" and "treasury decreased" subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	0.0005	-0.0007	0.0010	0.0002	0.0009	-0.0002
	(0.7999)	(0.5192)	(0.3088)	(0.8785)	(0.3139)	(0.7977)
Treasury	**0.1874**	**0.2811**	**0.2441**	**0.3639**	**0.2481***	**0.2855**
t = 0	(0.0008)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Treasury	**0.2182**	**0.1747**	**0.1997**	**0.2606**	**0.1969**	**0.2452**
t = -1	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Treasury	**0.1304**	**0.1328**	**0.0868**	0.0836	**0.0686**	0.0519
t = -2	(0.0192)	(0.0001)	(0.0003)	(0.0619)	(0.0104)	(0.0601)
Treasury	0.0924	**0.1153**	**0.0771**	**0.1024**	0.0028	**0.0650**
t = -3	(0.0786)	(0.0003)	(0.0010)	(0.0151)	(0.9174)	(0.0214)
Treasury	**0.0795**	**0.0773**	**0.0874**	**0.0772**	0.0397	**0.0545**
t = -4	(0.0418)	(0.0139)	(0.0001)	(0.0166)	(0.0871)	(0.0180)

Treasury			0.0386	0.0452	0.0146	**0.0553**
t = -5			(0.0570)	(0.1697)	(0.5309)	(0.0160)
’s	0.7079	0.7812	0.7337	0.9329	0.5707	0.7574
Adj. R^2	0.0943	0.3177	0.4401	0.2765	0.3538	0.3630
“Chow” test	0.70		1.18		1.12	
statistic	(0.9968)		(0.1008)		(0.1837)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). “Chow” statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Table 5c: Large Retail CD Yield Stickiness

$$CD_t = \quad + \; \overline{} \; (L) \;\; T_t \; + \quad _t$$

Split Based on *12-Week Cumulative* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from twelve weeks before. (This is equivalent to asking whether the cumulative 12-week change in the Treasury yield was positive or negative.) These are referred to as the “treasury increased” and “treasury decreased” subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	0.0003	-0.0008	0.0002	-0.0004	**0.0015**	**-0.0021**
	(0.8358)	(0.3370)	(0.7489)	(0.7552)	(0.0054)	(0.0006)
Treasury	**0.1611**	**0.3046**	**0.2424**	**0.3892**	**0.2525**	**0.2706**
t = 0	(0.0020)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)

Treasury t = -1	**0.2396** (0.0001)	**0.1597** (0.0001)	**0.1994** (0.0001)	**0.2778** (0.0001)	**0.1752** (0.0001)	**0.2725** (0.0001)
Treasury t = -2	**0.1603** (0.0033)	**0.1303** (0.0001)	**0.1042** (0.0001)	0.0704 (0.0735)	**0.0702** (0.0017)	0.0414 (0.1118)
Treasury t = -3	**0.1125** (0.0355)	**0.0962** (0.0004)	**0.1065** (0.0001)	0.0626 (0.1149)		
Treasury t = -4	**0.0609** (0.2363)	**0.0888** (0.0010)	**0.0735** (0.0001)	**0.0777** (0.0470)		
Treasury t = -5			**0.0469** (0.0122)	0.0211 (0.5773)		
’s	0.7324	0.7796	0.7729	0.8988	0.4979	0.5845
Adj. R^2	0.1310	0.3824	0.5381	0.3559	0.4322	0.4757
“Chow” test statistic	**1.89** (0.0000)		**2.61** (0.0000)		**7.60** (0.0000)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). “Chow” statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Of particular interest is the sum of the slope coefficients (’s.) In each paired regression, the sum of the betas for the “treasury decreased” regression is larger. This means that, when the one-, four- or twelve-week trend in the Treasury yield is a decreasing one (when market interest rates are generally declining), large CD yields react more quickly to a change in Treasury yields than when the trend is an increasing one. In other words, the evidence suggests that large retail CD yields are upward sticky.

As a test of the significance of these differences, we employed the “Chow” test described in section 5.4 of Kennedy (1985). A significant “Chow” statistic rejects the null hypothesis that the parameter estimates from two unconstrained regressions, each employing the same model but using different data, are the same. For the one-week or twelve-week subsamples, the “Chow” statistic is significant for all maturities, suggesting that the aggregate differences in the slopes are significant (i.e., that CD yields are significantly upward sticky.) The "Chow" statistic was insignificant for any maturity using the four-week subsamples.

5.4 Changes in Yields, Yield Spreads, and Balances.

Chart 3 compares the aggregate retail CD balance over time to the contemporaneous Treasury and large retail CD yields, showing that aggregate balances tended to follow the nominal Treasury yield, rising and falling with or near the long-term yield trends. The advent of persistent, negative large CD-Treasury yield spreads in and of themselves do not *appear* to have lowered investors' aggregate demand for CDs. What cannot be determined from the visual evidence is whether the size or sign of the CD-Treasury yield spread had a marginal impact on changes in aggregate balances. The question is whether investors have reacted only to the general level of risk-free yields (the Treasury yield) or also to the decreasing level of CD yields relative to Treasuries (by withdrawing existing CDs, adding fewer new ones, or both.)

In order to test for these effects, we regressed the change in the aggregate retail CD balance on current and lagged changes in the Treasury yield and current and lagged changes in the CD-Treasury yield spread. To improve the efficiency of the parameter estimates in the presence of contemporaneous cross-correlations between the Treasury yields and CD-Treasury yield spreads, we employed a three-stage least squares system. For each of the three sets of Treasury yield, CD yield, and CD balance series, the following equation was estimated

$$CDBal_t = \quad + \; ^{-}\,(L)\;\; T_t \; + \; ^{-}\,(L)\;\; YS_t \; + \quad {}_t \qquad (2)$$

where $\Delta CDBal_t = \ln(CDBal_t/CDBal_{t-1})$ is the monthly change in the aggregate retail CD balance, $T_t = \ln(T_t/T_{t-1})$ is the monthly change in the Treasury yield, and $YS_t = [CD_t - T_t]/[CD_{t-1} - T_{t-1}]$ is the monthly change in the CD-Treasury yield spread. As before, (L) is the lag function. In log form, the series were stationary and suggest an ARIMA(1,0,1) model. The results of these tests are summarized in table 6.

Table 6: Effects of CD-Treasury Yield Spreads on Retail CD Balances

Three-Stage Least Squares Estimates

$$CDBal_t = \quad + \; ^{-}\,(L)\;\; T_t \; + \; ^{-}\,(L)\;\; YS_t \; + \quad {}_t$$

	3-month	**1-year**	**5-year**
Intercept	0.0009	0.0009	0.0014
Treasury t=0	-0.0029	-0.0110	0.0030
t=-1	0.0058	-0.0044	0.0145
t=-2	0.0150	0.0160	**0.0364**

t = -3	**0.0440**	**0.0381**	**0.0471**
t = -4	**0.0401**	**0.0278**	**0.0486**
t = -5	**0.0411**	**0.0465**	**0.0663**
t = -6	**0.0318**	**0.0307**	**0.0426**
t = -7	**0.0355**	**0.0383**	**0.0557**
t = -8	**0.0289**	**0.0334**	**0.0476**
t = -9	**0.0316**	**0.0413**	**0.0557**
t = -10	**0.0427**	**0.0430**	**0.0609**
t = -11	**0.0296**	**0.0375**	**0.0637**
t = -12	**0.0327**	**0.0404**	**0.0627**
t = -13	0.0114	0.0241	**0.0495**
t = -14	-0.0001	0.0054	0.0284
t = -15	-0.0117	-0.0014	0.0145
Yld Sprd t = -1	0.43 E-5	0.99 E-7	0.57 E-6
t = -2	3.00 E-5	9.74 E-7	1.72 E-6
t = -3	0.43 E-5	0.15 E-7	1.37 E-6
t = -4	2.80 E-5	4.77 E-7	2.08 E-6
t = -5	3.16 E-5	3.80 E-7	1.29 E-6
System R^2	0.6809	0.7154	0.6580

Coefficient estimates in **bold** are significant at the 5% level, two-sided test.

For no maturity did lagged changes in the yield spread have a significant impact on changes in the aggregate CD balance. On the other hand, changes in the same maturity Treasury yield had a strong impact on retail CD balances. The results suggest that a change in the Treasury yield began to affect investors' decisions to purchase retail CDs two to three months after it occurred and continued to have an impact over an additional eight to ten months. The evidence strongly suggests that CD balances rose and fell with the general level of interest rates (as proxied by the Treasury yield), but that investors ignored the (widening) spread between the two substitutes.

6. Concluding Remarks

Positing that U.S. Treasury securities represent very close investment substitutes for large-balance, fully insured time deposits, we have shown that large-CD-Treasury yield-spreads moved from small and positive to large and negative over the period 1986-95, without a measurable reaction in deposit balances. This lack of an inverse price-quantity relationship cannot be explained by differences between the securities; indeed, the differences between large CDs and Treasuries, particularly in tax treatment and liquidity, generally favor Treasuries, implying that a spread in favor of Treasuries should exist. While a negative spread for small retail deposits could be due to banks providing value to depositors that is unrelated to interest rates, nothing in the literature or in basic price theory explains investors' willingness to accept yields significantly below comparable-maturity Treasuries for time deposits of $90,000 to $100,000. This difference was on the order of 50 basis points during 1993-95, or the equivalent of more than $1,600 per $100,000 over this period, compounded annually.

Our explanation is that continued investor migration from insured CDs into higher-yielding, uninsured (and marginally riskier) products since the early 1980s has left a core of investors who are only marginally sensitive to rates or who have very high switching costs. In other words, the markets for large CDs and Treasuries became more segmented during the early 1990s.

Consequently, as banks have learned more about these core investor's relative unwillingness to migrate, they have rationally moved to extract the available surplus. Our evidence reveals that banks have begun to take greater advantage of this source of funds by decreasing CD rates relative to those of Treasuries in recent years. The motive for banks is clear: during an era in which many lines of business have been lost to nonbanks (e.g., short-term commercial lending) or are increasingly competitive (e.g., mortgage banking), negative deposit yield spreads provide a profit source unique to the bank charter. What remains to be answered is why investors purchasing large denomination CDs remain willing to accept such inferior yields in the presence of such a close substitute.

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Table 1: Comparing Time Deposit and Treasury Security Characteristics

Characteristic	Large Retail CDs	U.S. Treasuries	Expected Effect on Relative Yields
Default Protection:	federally insured	federal guarantee	none
Minimum Investment:	$90,000	$10 / 5 / 1,000 for varying maturities	CDs > Treasuries
Tax Status:	fully taxed	local tax exemption	CDs > Treasuries
Secondary Market:	withdrawal penalty	deep, low cost secondary market	CDs > Treasuries
Reinvestment:	varying policies	costless rollover	CDs ≥ Treasuries
Acquisition Costs:	time	lost interest or commission	Treasuries ≥ CDs
Acquisition Ease:	any day/amount	fixed auction schedule / $1,000 increments.	Treasuries > CDs

The discussion summarized in the table above compares bank-originated, FDIC-insured time deposits requiring balances between $90,000 and 100,000 with U.S. Treasury Securities acquired using noncompetitive bids through the Treasury Direct program.

Table 2: Yield Series Summary Statistics (1986-95)

Yield Series	Mean (μ)	Avg. Spread to Treasury
3-month		
Treasury	5.70	
Large Retail CD	5.53	-0.17
Small Retail CD	5.29	-0.41
1-year		
Treasury	6.14	
Large Retail CD	5.94	-0.20
Small Retail CD	5.86	-0.28
5-year		
Treasury	7.27	
Large Retail CD	7.02	-0.25
Small Retail CD	6.89	-0.38

Table 3: Yield Series Summary Statistics by Subperiod

Maturity	Yield Series	Mean (μ)	Standard Deviation (σ)	Avg. Spread to Treasury
		Panel a: (1986-89)		
3-month	Treasury	6.81	1.15	
	Large Retail CD	7.08	1.11	+0.27
	Small Retail CD	6.73	0.94	-0.08
1-year	Treasury	7.30	1.06	
	Large Retail CD	7.40	1.07	+0.10
	Small Retail CD	7.30	0.93	0.00
5-year	Treasury	8.09	0.75	
	Large Retail CD	8.15	0.67	+0.06
	Small Retail CD	7.98	0.62	-0.11
		Panel b: (1990-92)		
3-month	Treasury	5.57	1.79	
	Large Retail CD	5.47	1.85	-0.10
	Small Retail CD	5.32	1.82	-0.25
1-year	Treasury	5.85	1.71	
	Large Retail CD	5.79	1.77	-0.06
	Small Retail CD	5.69	1.77	-0.16
5-year	Treasury	7.34	1.01	
	Large Retail CD	7.08	1.04	-0.26
	Small Retail CD	6.95	1.01	-0.39
		Panel c: (1993-95)		
3-month	Treasury	4.32	1.17	
	Large Retail CD	3.73	1.04	-0.59
	Small Retail CD	3.29	0.78	-1.03
1-year	Treasury	4.85	1.27	
	Large Retail CD	4.33	1.17	-0.52
	Small Retail CD	4.07	1.07	-0.78
5-year	Treasury	6.07	0.93	
	Large Retail CD	5.60	0.79	-0.47
	Small Retail CD	5.35	0.74	-0.72

Table 4: CD Yield Smoothing (Relative to Treasury Movements)

$$CD_t \; = \quad + \; \bar{\;} \; (L) \;\; T_t \; + \quad {}_t$$

Results for large balance retail CDs

	3-month	1-year	5-year
Intercept	-0.0005 (0.4687)	-0.0005 (0.3908)	-0.0004 (0.2301)
Treasury t = 0	**0.2419** (0.0001)	**0.3007** (0.0001)	**0.2801** (0.0001)
Treasury t = -1	**0.1976** (0.0001)	**0.2341** (0.0001)	**0.2285** (0.0001)
Treasury t = -2	**0.1320** (0.0001)	**0.0920** (0.0001)	**0.0700** (0.0001)
Treasury t = -3	**0.1099** (0.0001)	**0.0891** (0.0001)	**0.0400** (0.0159)
Treasury t = -4	**0.0832** (0.0014)	**0.0728** (0.0003)	**0.0420** (0.0093)
Treasury t = -5	0.0308 (0.2383)	0.0381 (0.0562)	0.0272 (0.0914)
Treasury t = -6	-0.0258 (0.3212)	0.0058 (0.7709)	0.0173 (0.2812)
Treasury t = -7	0.0082 (0.7515)	0.0185 (0.3529)	0.0077 (0.6321)
Treasury t = -8	0.0213 (0.4121)	0.0200 (0.3135)	0.0278 (0.0838)
Treasury t = -9	0.0335 (0.1971)	0.0053 (0.7875)	0.0204 (0.2046)
Treasury t = -10	0.0067 (0.7946)	-0.0010 (0.9579)	0.0162 (0.3085)
Treasury t = -11	**0.0891** (0.0006)	0.0360 (0.0682)	**0.0532** (0.0009)
Treasury t = -12	-0.0497 (0.0526)	0.0141 (0.4692)	0.0065 (0.6815)
Adj. R^2	0.2803	0.4665	0.5416
${}_0 + \ldots + {}_{-4}$	0.7646	0.7887	0.6606

P-values provided in ()'s below parameter estimates.
Coefficient estimates in **bold** are significant at the 5% level, two-sided test.

Table 5a: Large Retail CD Yield Stickiness

$$CD_t \;=\; \quad + \;\bar{\ }\;(L)\;\; T_t \;+\; \quad_t$$

Split Based on *Current Week* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from the previous week. These are referred to as the “treasury increased” and “treasury decreased” subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	-0.0010 (0.4793)	0.0019 (0.1341)	0.0002 (0.7230)	0.0013 (0.3235)	0.0003 (0.7435)	-0.0005 (0.5748)
Treasury t=0	**0.2125** (0.0002)	**0.3277** (0.0001)	**0.2541** (0.0001)	**0.3797** (0.0001)	**0.2442** (0.0001)	**0.2807** (0.0001)
Treasury t=-1	**0.1096** (0.0077)	**0.2641** (0.0001)	**0.2034** (0.0001)	**0.2671** (0.0001)	**0.1916** (0.0001)	**0.2667** (0.0001)
Treasury t=-2	**0.1048** (0.0010)	**0.1747** (0.0001)	**0.0796** (0.0001)	**0.1226** (0.0009)	**0.0791** (0.0004)	**0.0542** (0.0313)
Treasury t=-3	**0.1338** (0.0001)	0.0519 (0.2376)	**0.0834** (0.0001)	**0.1010** (0.0054)	0.0287 (0.2075)	**0.0611** (0.0123)
Treasury t=-4	**0.0691** (0.0409)	**0.1246** (0.0020)	**0.0974** (0.0001)	**0.0749** (0.0232)	**0.0546** (0.0119)	0.0430 (0.0769)
Treasury t=-5	0.0747 (0.0561)	0.0095 (0.7885)	0.0086 (0.6569)	**0.0740** (0.0269)	0.0085 (0.6888)	**0.0636*** (0.0106)
’s	0.7045	0.9525	0.7265	1.0193	0.6067	0.7693
Adj. R^2	0.1969	0.3308	0.5246	0.3642	0.4097	0.4416
“Chow” statistic	**2.84** (0.0000)		**1.87** (0.0000)		**1.67** (0.0000)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). “Chow” statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Table 5b: Large Retail CD Yield Stickiness

$$CD_t = \quad + \;\overline{}\; (L) \;\; T_t + \quad {}_t$$

Split Based on *Four-Week Cumulative* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from four weeks before. (This is equivalent to asking whether the cumulative four-week change in the Treasury yield was positive or negative.) These are referred to as the "treasury increased" and "treasury decreased" subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	0.0005 (0.7999)	-0.0007 (0.5192)	0.0010 (0.3088)	0.0002 (0.8785)	0.0009 (0.3139)	-0.0002 (0.7977)
Treasury t = 0	**0.1874** (0.0008)	**0.2811** (0.0001)	**0.2441** (0.0001)	**0.3639** (0.0001)	**0.2481*** (0.0001)	**0.2855** (0.0001)
Treasury t = -1	**0.2182** (0.0002)	**0.1747** (0.0001)	**0.1997** (0.0001)	**0.2606** (0.0001)	**0.1969** (0.0001)	**0.2452** (0.0001)
Treasury t = -2	**0.1304** (0.0192)	**0.1328** (0.0001)	**0.0868** (0.0003)	0.0836 (0.0619)	**0.0686** (0.0104)	0.0519 (0.0601)
Treasury t = -3	0.0924 (0.0786)	**0.1153** (0.0003)	**0.0771** (0.0010)	**0.1024** (0.0151)	0.0028 (0.9174)	**0.0650** (0.0214)
Treasury t = -4	**0.0795** (0.0418)	**0.0773** (0.0139)	**0.0874** (0.0001)	**0.0772** (0.0166)	0.0397 (0.0871)	**0.0545** (0.0180)
Treasury t = -5			0.0386 (0.0570)	0.0452 (0.1697)	0.0146 (0.5309)	**0.0553** (0.0160)
’s	0.7079	0.7812	0.7337	0.9329	0.5707	0.7574
Adj. R^2	0.0943	0.3177	0.4401	0.2765	0.3538	0.3630
"Chow" test statistic	0.70 (0.9968)		1.18 (0.1008)		1.12 (0.1837)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). "Chow" statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Table 5c: Large Retail CD Yield Stickiness

$$CD_t = \quad + \bar{\ } (L) \; T_t + \quad {}_t$$

Split Based on *12-Week Cumulative* Treasury Yield Change

For this test, the sample of weekly changes in the CD yields was split into two parts, based on whether the Treasury yield for the week was higher or lower than the yield from twelve weeks before. (This is equivalent to asking whether the cumulative 12-week change in the Treasury yield was positive or negative.) These are referred to as the "treasury increased" and "treasury decreased" subsamples. Equation (1) was estimated using each subsample of the data set. The parameter estimates from each estimation were compared using a standard Chow test and the results of the full sample (constrained) regression. The number of lags in the full sample regression is equal to maximum significant lags for either subsample (unconstrained) regression.

	3-month CDs		**1-year CDs**		**5-year CDs**	
	Treasury Increased	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**	**Treasury Increased**	**Treasury Decreased**
Intercept	0.0003 (0.8358)	-0.0008 (0.3370)	0.0002 (0.7489)	-0.0004 (0.7552)	**0.0015** (0.0054)	**-0.0021** (0.0006)
Treasury t = 0	**0.1611** (0.0020)	**0.3046** (0.0001)	**0.2424** (0.0001)	**0.3892** (0.0001)	**0.2525** (0.0001)	**0.2706** (0.0001)
Treasury t = -1	**0.2396** (0.0001)	**0.1597** (0.0001)	**0.1994** (0.0001)	**0.2778** (0.0001)	**0.1752** (0.0001)	**0.2725** (0.0001)
Treasury t = -2	**0.1603** (0.0033)	**0.1303** (0.0001)	**0.1042** (0.0001)	0.0704 (0.0735)	**0.0702** (0.0017)	0.0414 (0.1118)
Treasury t = -3	**0.1125** (0.0355)	**0.0962** (0.0004)	**0.1065** (0.0001)	0.0626 (0.1149)		
Treasury t = -4	**0.0609** (0.2363)	**0.0888** (0.0010)	**0.0735** (0.0001)	**0.0777** (0.0470)		
Treasury t = -5			**0.0469** (0.0122)	0.0211 (0.5773)		
’s	0.7324	0.7796	0.7729	0.8988	0.4979	0.5845
Adj. R^2	0.1310	0.3824	0.5381	0.3559	0.4322	0.4757
"Chow" test statistic	**1.89** (0.0000)		**2.61** (0.0000)		**7.60** (0.0000)	

Notes: P-values provided in ()'s below parameter estimates. Coefficient estimates in **bold** are significant at the 5% level, two-sided test. * after coefficient estimate indicates evidence of serial correlation based on Durbin-Watson statistic (significance at 5% level). "Chow" statistic tests the null hypothesis that the parameter estimates are the same across the split sample (unconstrained) regressions.

Table 6: Effects of CD-Treasury Yield Spreads on Retail CD Balances

Three-Stage Least Squares Estimates

$$CDBal_t = \quad + \overline{}\ (L)\ \ T_t + \overline{}\ (L)\ \ YS_t + \quad _t$$

		3-month	1-year	5-year
Intercept		0.0009	0.0009	0.0014
Treasury	**t = 0**	-0.0029	-0.0110	0.0030
	t = -1	0.0058	-0.0044	0.0145
	t = -2	0.0150	0.0160	**0.0364**
	t = -3	**0.0440**	**0.0381**	**0.0471**
	t = -4	**0.0401**	**0.0278**	**0.0486**
	t = -5	**0.0411**	**0.0465**	**0.0663**
	t = -6	**0.0318**	**0.0307**	**0.0426**
	t = -7	**0.0355**	**0.0383**	**0.0557**
	t = -8	**0.0289**	**0.0334**	**0.0476**
	t = -9	**0.0316**	**0.0413**	**0.0557**
	t = -10	**0.0427**	**0.0430**	**0.0609**
	t = -11	**0.0296**	**0.0375**	**0.0637**
	t = -12	**0.0327**	**0.0404**	**0.0627**
	t = -13	0.0114	0.0241	**0.0495**
	t = -14	-0.0001	0.0054	0.0284
	t = -15	-0.0117	-0.0014	0.0145
Yld Spread	**t = -1**	0.43 E-5	0.99 E-7	0.57 E-6
	t = -2	3.00 E-5	9.74 E-7	1.72 E-6
	t = -3	0.43 E-5	0.15 E-7	1.37 E-6
	t = -4	2.80 E-5	4.77 E-7	2.08 E-6
	t = -5	3.16 E-5	3.80 E-7	1.29 E-6
System R^2		0.6809	0.7154	0.6580

Coefficient estimates in **bold** are significant at the 5% level, two-sided test.