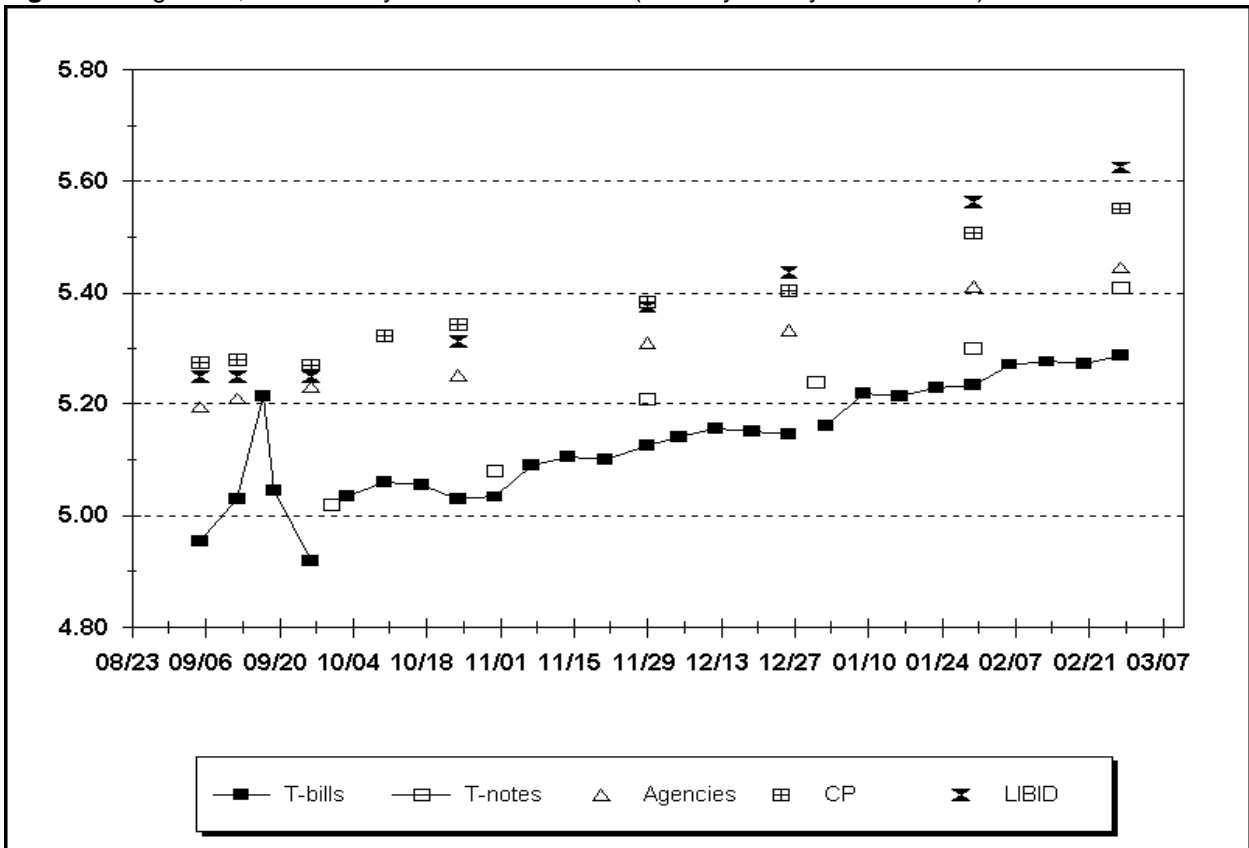


TECHNICAL FACTORS IN THE US TREASURY BILL MARKET

While yields on US Treasury bills and spreads to other money market yields are generally determined by such fundamental factors as future interest rate expectations and differential default and liquidity risk, technical factors are also important determinants. Such technical factors include special demand factors, difficulties in exploiting overpriced Treasury bills, special maturity preferences, and seasonal factors. The purpose of this note is to identify some of these factors.

Figure 1 shows several money market yield curves on August 28. All of them clearly slope upwards, reflecting the market's expectations of Fed tightening in the near future. Also, the curves layer on top of each other in order of credit quality¹, with Treasury bills on the bottom and commercial bank deposits (at LIBID) on top.² However, one of the most striking features at the short end of the spectrum are the extremely low Treasury yield levels, attributable mostly to special demand factors and difficulties in exploiting such "richness". Also noteworthy is the choppiness of the bill curve, attributable mostly to special maturity preferences. Not apparent on the graph, but very important from a trading perspective, is the impact of seasonal factors, which can affect the level of the whole curve.

Figure 1: August 28, 1996 Money Market Yield Curve (360-day money market basis)



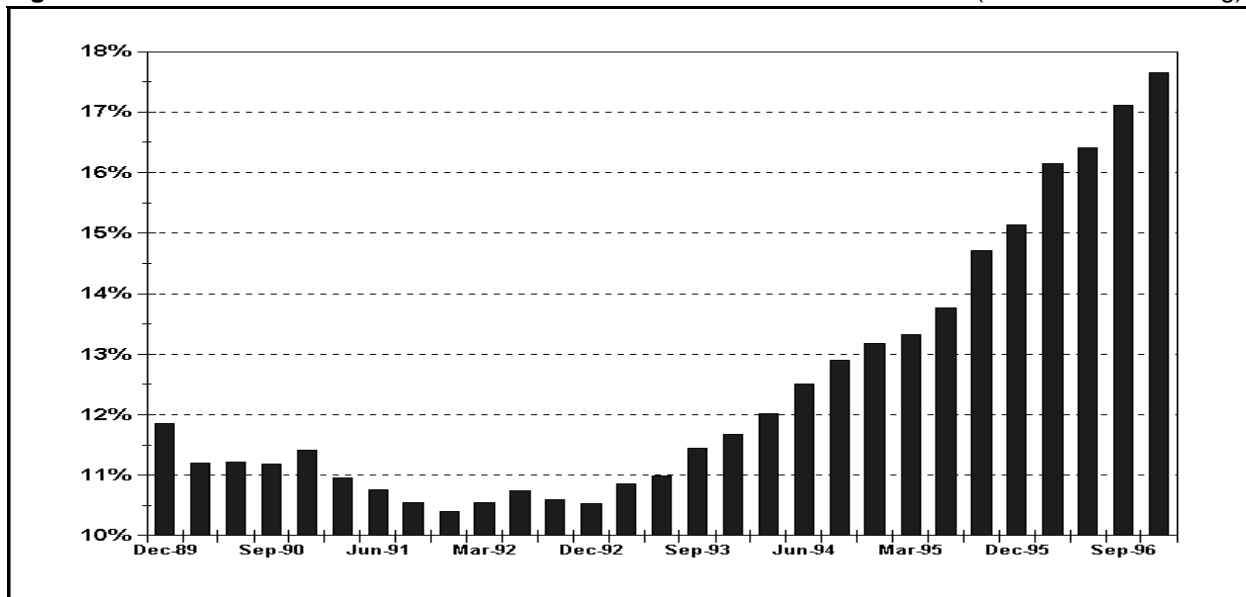
1 Appendix A outlines an alternative model for at least part of the yield spreads observed between Treasury and privately-issued securities, based on the non-taxability of Treasury interest at the state and municipal level.

2 I am a bit skeptical about the Treasury note yields, that come from a blend of NY Fed and Bloomberg data. Figure 1 shows them tracking fairly close to bill yields inside of three months, whereas my experience indicates that very short Treasury note yields track well above bill quotes inside of three months. Y. Amihud and H. Mendelson ("Liquidity, maturity, and the yields on US Treasury securities", *Journal of Finance*, September 1991), for example, concluded that bill yields were substantially below coupon-paying Treasury note yields inside of three months, the differential out to six months being a decreasing and convex function of term to maturity. In addition, they found that any profitability of arbitraging these spreads was generally eliminated by transaction and shorting costs.

Special demand factors and arbitrage obstacles

Most of the steep slope of the short end of the Treasury curve is probably due to the presence of "inelastic" investors who are obliged to hold minimum amounts of Treasury bills³. Such investors, said to include money market funds and central banks⁴, tend to be "buy and holders" who sell securities only when liquidity needs make it absolutely necessary. In addition, central banks tend not to lend out their securities⁵. Figure 2 shows that Fed holdings on behalf of such "official institutions" have soared in recent years from less than 10% of outstanding marketable Treasury debt in the early nineties to over 17% more recently. If one assumes that most of these Fed holdings are comprised of Treasury bills, they soared from about 50% of outstanding bills to 75% over the same period. Also, Treasury bills are popular as collateral for short positions in various other financial securities, and as initial margin on futures positions. In addition, it is said to be difficult, if not impossible, for dealers to short Treasury bills with less than two weeks remaining to maturity⁶.

Figure 2: Government Marketable Securities Held at the Fed for Official Institutions (as a % of outstanding)



It is difficult for market participants to arbitrage away any apparent richness on the bill curve. In private money markets (like those for commercial paper and bank deposits) to any extent that yields are too low they can be arbitrated away because the participants can borrow and lend at about the same yield. For example, large banks face borrowing-lending spreads of about 1/16 in the interbank market, so arbitraging "low" yields is quite feasible by simply borrowing at these low yields. However, the Treasury itself is hardly an opportunistic borrower, and no one else can borrow at Treasury yields and it can be costly to short Treasuries⁷.

3 See Appendix B for a discussion of the potentially minor impact of Rule 2a-7 of the Investment Company Act.

4 See G.Duffie, "Idiosyncratic variation of Treasury bill yields", Journal of Finance, June 1996.

5 Even those central banks that do lend out securities tend to do so only when they are very "special" in the repo market. For example, we have heard that some such banks will lend only when the collateral-specific repo rate trades more than 50 basis points below the rate on general collateral. For more on "specials" see D.Duffie, "Special repo rates", Journal of Finance, June 1996.

6 For bills maturing inside of two weeks, for instance, the Fed does not provide its last-resort lending facility.

7 B.Gendreau ("Carrying costs and treasury bill futures", Journal of Portfolio Management, Fall 1985) introduced the concept of "revealed forward rates" as a way of measuring richness and cheapness incorporating realistic shorting costs. One of his measures calculates the implicit m-day forward yield (n days hence) by assuming that a purchase of (n+m) day bills is financed for m days at the general collateral repo rate. Alternatively, he assumes that the purchase is financed by a short sale of m-day bills, but adding an (apparently) market conventional 50 bps short sale fee to the shorting cost. However, dealers generally establish and cover short positions via reverse repos, but as such shorts are pursued against rich bills, they will become "special" in the repo market, thereby increasing the cost of shorting. The Duffie paper models the "special" repo market and shows that specialness increases as short and short-hedging demands increase relative to the quantity of securities available.

On the question of shorting, relatively speaking, it is easier to short old one-year bills, especially when they trade inside of three months (at which point they have been re-opened as six- and then three-month bills).

Maturity factors

Table 1 takes a closer look at August 28 bill curve data, identifying some of the special maturity factors that make the bill curve so choppy. It shows that month-end maturities tend to trade at lower yields than the first maturities of the following month, because they often coincide with the cash flow needs of many money managers. For example, corporations like to show cash on their balance sheets at quarter ends, and regular cash payments often coincide with month ends⁸. Also, investment dealers prefer to lighten their inventories of securities and show healthy cash balances at quarter ends. In addition, although not shown in Table 1, the last maturity in June is a popular bill with municipalities that typically have June 30 fiscal year-ends. For example, on April 23, 1997, The June 26 bill closed at a 5.12% yield, versus 5.20% on the July 3 maturity. On the other hand, bills that mature early in the new year tend to trade at higher yield levels, due to occasional year-end funding pressures (i.e., the "turn"), although the first maturity of the new year can be quite well bid due to its tax deferral potential.

Treasury bills that mature after big tax payment dates⁹ tend to trade at higher yields, because they are often re-opened as cash management bills, as the Treasury tries to bridge short-term cash requirements until after the tax payment dates. In Table 1, the September 17 (post-tax payment) bill clearly yields more than the September 12 (pre-tax payment) cash management bill. However, the December 19 (post-tax) bill yielded less than the December 12 (pre-tax) bill, and the January 16 (post-tax) bill yielded less than the January 9 bill. The January 9 bill was an old year bill, so supply may have played a role in its higher yield. Also, the prescribed yield differentials often appear only as the maturity dates are approached. For example, although the yield gap between the April 10, 1997 and April 17, 1997 bills traded as wide as about 75 bps in early April, they were trading at roughly even yield through most of February.

Table 1: August 28 Treasury Bill Data

Maturity	Yield	Comments	Maturity	Yield	Comments
05-Sep	4.95		05-Dec	5.14	
12-Sep	5.03		12-Dec	5.16	Deliverable
17-Sep	5.21	Cash management	19-Dec	5.15	Post-tax
19-Sep	5.04	Deliverable	26-Dec	5.15	Year-end
26-Sep	4.92	Quarter-end	02-Jan	5.16	First New Year bill
03-Oct	5.03		09-Jan	5.22	Old year bill
10-Oct	5.06		16-Jan	5.21	Post-tax
17-Oct	5.05	Old year bill	23-Jan	5.23	
24-Oct	5.03		30-Jan	5.23	Month-end
31-Oct	5.03	Month-end	06-Feb	5.27	Old year bill
07-Nov	5.09		13-Feb	5.28	
14-Nov	5.11	Old year bill	20-Feb	5.27	
21-Nov	5.10		27-Feb	5.29	Month-end
29-Nov	5.13	Month-end "Turkey"			

⁸ See J. Ogden, "The end of the month as a preferred habitat: a test of the operational efficiency in the money market", Journal of Financial and Quantitative Analysis, September 1987.

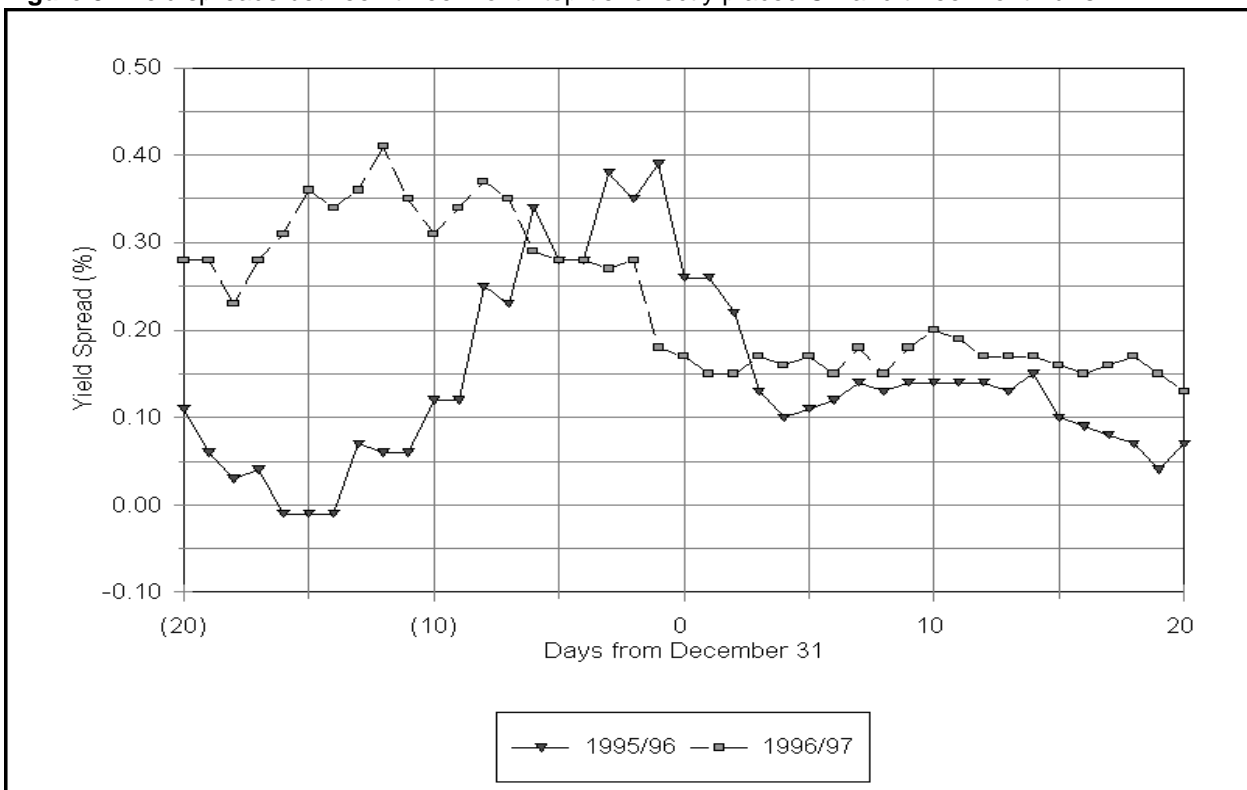
⁹ April 15 is the big individual income tax remittance date, but there are also sizeable individual installment payments on January 15, June 15 and September 15, and a small quarterly corporate tax installment on March 15 and fairly large ones on June 15, September 15 and December 15.

Also, the so-called "turkey bill" that matures on the Friday after Thanksgiving Thursday used to tend to trade at a higher yield level, because that Friday is a popular day to take off as a holiday.¹⁰ In addition, it is said that Treasury bills that are deliverable against the bills futures contract tend to trade at lower yield. Only one-year bills are eligible for delivery against three-month Treasury bill futures contracts, and when two one-year bills mature in a given month, only the first maturing bill in the contract expiry month is deliverable. Contracts expire in March, June, September and December. However, neither the "turkey" bill or deliverable bill effects were evident on August 28. The turkey bill effect may have been muted by its month end status, but the increasing participation of central banks in the bill market may also be attributable for such smoothing¹¹. Basically, many of the maturity factors discussed here are quite irrelevant to such investors, who tend to simply buy the highest yielding bill in the preferred term to maturity area and shun the lower yielding ones.

Seasonal Effects

Aside from the maturity-related factors outlined above, a couple of seasonal patterns are quite evident. Firstly, there is frequently observed a December "window dressing" effect that pushes down bill yield levels relative to private money market yields every December and snaps them back up again every January. Figure 3 illustrates this pattern quite clearly, showing how the spread between top-tier commercial paper and treasury bill yields widened into late December and narrowed in through January. This data is not available for previous years, but similar data (Eurodollar deposits versus bills) shows the same pattern every year-end since 1993/94. 1991-92 data is somewhat distorted by the effects of the funding of the savings and loan bailout. Typically, the spread has peaked right at the end of December as it did in 1995/96, but in 1996/97 it would appear that the window dressing trade occurred earlier in December, resulting in a spread compression at the end of December, instead of the usual widening.

Figure 3: Yield spreads between three-month top-tier directly placed CP and three-month bills

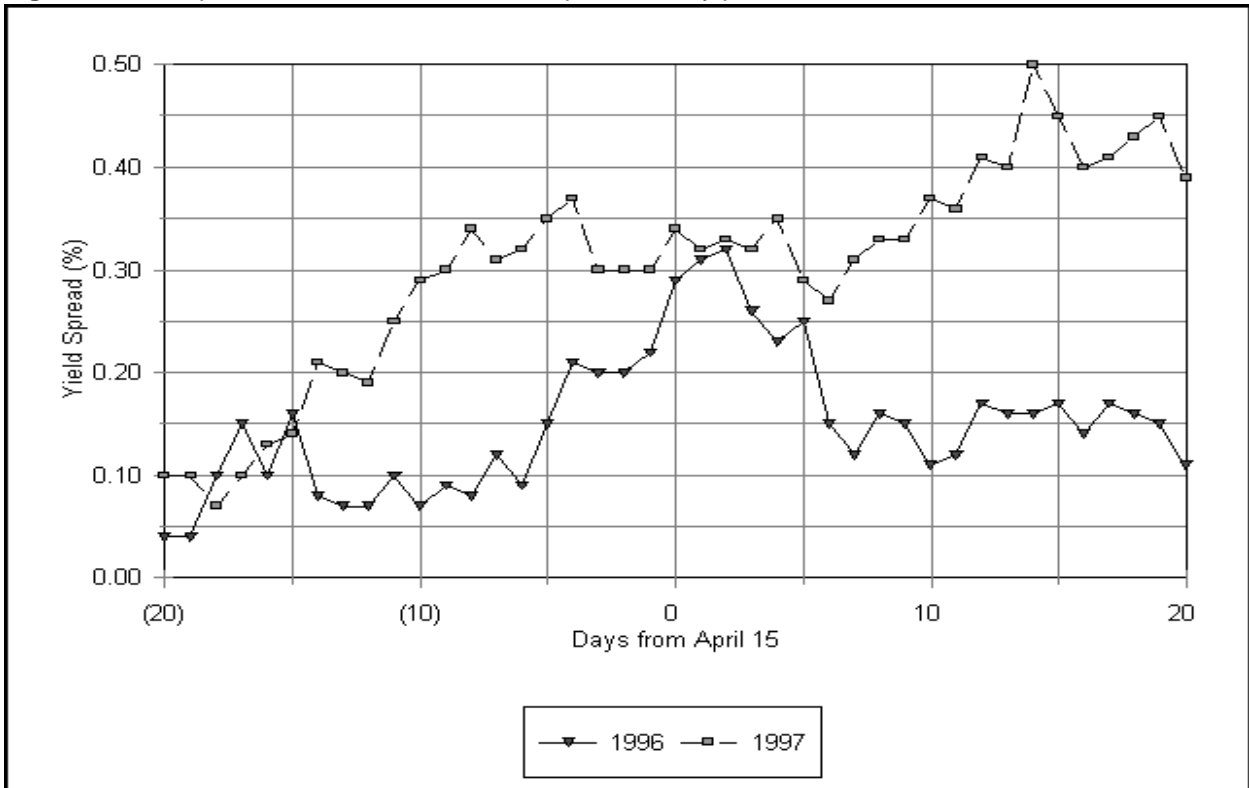


10 Treasury bills are usually auctioned on Monday for Thursday settlement and Thursday maturity.

11 In fact, we have been told that the turkey bill has become a popular short sale candidate, so it has tended to become quite special in the repo market and trade below the surrounding maturities.

After spreads compress in January, they tend to remain narrow throughout the first quarter as the Treasury increases bill supply during the heavy individual tax refund period in February and March and into the April 15 tax date. They then tend to widen after April 15, as the Treasury's borrowing needs contract, bills are paid down and bill yields move downward. In addition, a firm bid reportedly comes from the reinvestment flow out of the maturing CMBs, and the collateral squeeze that stems from the need for commercial banks to collateralize Treasury Tax and Loan ("TT&L") balances between the April 15 tax payment deadline and the big May 15 interest payment¹². Figure 4 confirms the essence of this story, showing that narrow spreads come out of the tail end of the first quarter, then they widen dramatically into the April 15 tax date, and then they narrow back in after the April 15 date. It has also been said that the supply/collateral trade favours the short end of the bill curve relative to the long end, but it is difficult to isolate this technical effect from the impact of interest rate expectational factors on the slope of the bill curve.

Figure 4: Yield spreads between three-month top-tier directly placed CP and three-month bills



¹² Banks pay interest on their TT&L accounts at a rate of 25 bps below the weekly average Fed funds rate. Eligible collateral against such deposits include Treasury securities and agency paper.

APPENDIX A

Differential Tax Treatment and Money Market Spreads

The exemption of interest on Treasury and some federal government agency securities¹³ from state and local taxation, may result in wider-than-expected yield spreads to fully-taxed securities that are similar in most other respects (like commercial paper and bankers' acceptances). Fabozzi and Thurston¹⁴ have shown that, in an efficient market where the state tax is t_s , the pre-tax yield on a fully-taxed money market security (r_h) should exceed that of a tax-exempt security with the same term to maturity (r_b) by:

$$(r_h - r_b) = r_b \times (t_s / (1 - t_s))$$

In fact, during the late eighties, most US states passed legislation that allowed taxable MMF to pass through this special tax-free status to their shareholders, thereby increasing MMF demand for Treasury securities.

However, the yield spreads between taxable and tax-exempt securities come nowhere near the theoretical levels, because the market is so dominated by investors who are full exempt from tax (like central banks and 401K funds). In the agency discount market for instance, primary and secondary offer levels on tax exempts (the Federal Farm Credit Banks and Federal Home Loan Banks, for example) differ very little (if at all) from those on fully taxables (Fannie Mae and Freddie Mac).

APPENDIX B

Money Market Fund Investment Restrictions and the Bill Curve

It has been said that the SEC's June 1991 amendments to "Rule 2a-7" of the Investment Company Act, which gave special status with money market mutual funds to high quality paper maturing inside of ninety days¹⁵, provides a special bid to the bill curve. Basically, Rule 2a-7 governs the credit quality, diversification and maturity of taxable money market mutual funds (MMFs) that want to call themselves a "money market" fund. It specified that such funds have to invest their assets in Treasury securities and privately-issued securities with maturities not exceeding 397 days rated in the top two short-term rating categories of Moody's and S&P, and an average maturity not exceeding 90 days. In addition Rule 2a-7 required that such funds invest no more than 5% of their assets in securities of any single issuer (with exception to Treasury and agency securities) and no more than 5% in securities that are not rated in the highest short-term category of either Moody's or S&P. However, since money market funds compete on the basis of yield, those that are not required to hold Treasuries rarely do, and even those who must hold Treasuries tend to favour STRIPS. Hence, it is unlikely that Rule 2a-7 plays a major role in the steep short end of the bill curve¹⁶.

13 Securities issued by the Federal Farm Credit Banks, Federal Home Loan Banks, the Student Loan Marketing Corporation ("Sallie Mae") and the Tennessee Valley Authority ("TVA") may be exempt from state and local taxes, but not those issued by the Federal National Mortgage Association ("Fannie Mae") or the Federal Home Loan Mortgage Corporation ("Freddie Mac").

14 F.Fabozzi and T.Thurston,"State taxes and reserve requirements as major determinants of yield spreads among money market instruments", Journal of Financial and Quantitative Analysis, December 1986.

15 See T.Cook and J.Duffield,"Money market mutual funds and other short-term investment pools", Instruments of the Money Market, 7th edition, Federal Reserve Bank of Richmond. Basically 2a-7 funds are those that the SEC allows to use the "amortized cost" or "penny rounding" methods of accounting (as opposed to a "market value" method), which essentially allow the fund to maintain its share value at a constant \$1.

16 JP Morgan estimates that, based on IBC Financial Data's Money Market Report data, "Treasury-related" money funds in aggregate hold a maximum of 5% of all outstanding Treasury bills. However, during "flight-to-quality" episodes money fund demand for bills can increase to the point that they become a significant factor in the bill market.