Enhancing the Liquidity of U.S. Treasury Securities in an Era of Surpluses[*]

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Abstract

This paper presents three proposals intended to enhance liquidity in the market for U.S. Treasury debt: making principal and interest STRIPS maturing on a common date fungible with each other, aligning the maturity of 2-year debt with either bill maturities or the maturities of longer-term debt, and establishing a facility to allow market participants to exchange (with the Department of the Treasury) single-payment securities with similar, but not identical, maturities. The proposals would enhance liquidity by improving the substitutability of identical and very nearly identical Treasury liabilities, and by increasing the integration of the markets for bills, notes, bonds and STRIPS. The proposals would be complementary to, rather than a substitute for, the initiative to buy back outstanding debt announced in August, 1999.

1. Introduction and Summary

The market for U.S. Treasury debt provides a highly liquid underpinning for the broader markets in dollar-denominated fixed income securities. However, liquidity in the Treasury market has become an increasing concern as the federal government's funding needs have lessened, because - as shown in Figure 1 - trading is concentrated in recently issued, "on-the-run," securities. Last August, the Department of the Treasury ("Treasury") outlined a strategy to maintain the supply of new notes and bonds by repurchasing off-the-run debt.[1] This paper describes several additional, complementary, approaches to enhancing liquidity.

The first suggestion is to reduce fragmentation of trading in STRIPS by assigning the same CUSIP number to all STRIPS maturing on a common date - thus making those STRIPS fungible with each other. In addition to enhancing the liquidity of the STRIPS market, this action would ensure that STRIPS promising to pay the same amount on the same future date trade at the same price, and it would enhance the internal integration of the market for notes and bonds as well as the integration of that market with the STRIPS market. More particularly, it would result in very nearly identical market prices for identical cash flow streams, regardless of whether the cash flows are derived from notes or bonds or portfolios of STRIPS.

We also suggest a re-examination of the structure of issue maturities, because heterogeneity with respect to maturity date can fragment trading and reduce liquidity. In particular, we suggest eliminating end-of-month maturities for 2-year debt and integrating that debt with either bills (by issuing 104-week bills on a quad-weekly basis) or longer-term notes and bonds (by issuing 2-year notes with mid-month maturities on a monthly or quarterly basis). It would also be desirable to enhance the integration of bills with longer-term notes and bonds, but aligning the maturity dates of those securities may be impractical.

The first two proposals can be viewed as extensions of steps taken previously by Treasury.

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[1] "U.S. May Buy Back Bonds to Trim Debt," *Wall Street Journal*, August 5, 1999, p. A2 and "Government Plans to Buy Back Bonds and Save Interest," *New York Times*, August 5, 1999, p. A1.

The third proposal, a facility to allow market participants to exchange (with Treasury) single-payment securities with similar, but not identical, maturities, is a more adventurous approach to enhancing liquidity. The proposal would result in more similar prices for securities with similar, but not identical, cash flows and would further integrate the markets for Treasury debt. In particular, it would materially enhance the integration of the markets for bills and coupon-bearing notes and bonds.

The paper proceeds as follows. Section 2 defines liquidity, identifies its determinants, and comments on its benefits. Section 3 describes how recent Treasury debt management practices have promoted the goal of a liquid government securities market. Section 4 presents our proposal for the STRIPS program, Section 5 outlines two alternatives for reducing heterogeneity of issue maturity dates, and Section 6 describes the exchange facility. Section 7 concludes.

2. Liquidity and Asset Pricing

Asset pricing models commonly assume that markets are competitive and frictionless. Continuous time versions of such markets are perfectly liquid: an investor can purchase or sell as much as she wants at any time, instantaneously and at equilibrium prices. Real markets, however, are not perfectly liquid. An investor has to pay for the service of immediate order execution (in the form of a spread between the offer price at which she can buy and the bid price at which she can sell),[2] she faces wider spreads on larger orders, and if she chooses to search for a more favorable transaction price she must bear the costs of search and the risks of delay.[3]

Securities traded in markets where bid-ask spreads are narrow and relatively insensitive to the size of a transaction, where an acceptable counterparty can be located quickly and at low cost, and where prices are not volatile, are said to more liquid than securities traded in markets where

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[2] Demsetz (1968) and Tanner and Kochin (1971).

[3] Stigler (1961), Garbade and Silber (1976), Lippman and McCall (1986), and Amihud, Mendelson and Lauterbach (1997).

spreads are both wider and more sensitive to transaction size, search is costly and time-consuming, and prices are volatile. For example, short-term Treasury securities are more liquid than longer term Treasury debt,[4] bills are more liquid than short-term notes and bonds,[5] larger issues are more liquid than smaller issues,[6] on-the-run securities are more liquid than seasoned obligations,[7] and, more generally, liquidity declines with the age of a security.[8]

Financial analysts concerned with minimizing capital costs have begun to pay more attention to liquidity in the wake of a series of papers establishing a connection between liquidity and asset pricing.[9] Amihud and Mendelson (1986) show that the return on common stock listed on the New York Stock Exchange is, *inter alia*, an increasing function of the bid-ask spread on the stock. Silber (1991) observes that companies issue unregistered stock (that can not be resold in open market transactions for two years and that is relatively illiquid during that interval) at an average discount of more than 30% relative to the price of registered, but otherwise identical, stock. Several authors, including Garbade (1984), Amihud and Mendelson (1991a) and Kamara (1994), point out the connection between (a) the yield spread between short-term Treasury notes and Treasury bills and (b) the superior liquidity of bills compared to notes. Warga (1992) examines the premium return on seasoned Treasury notes and bonds compared to on-the-run issues,[10] and Boudoukh and Whitelaw (1991, 1993) discuss the premium pricing of "benchmark"

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4 Tanner and Kochin (1971), Garbade and Silber (1976), Garbade and Rosey (1977), and Elton and Green (1998).

5 Garbade (1984), Amihud and Mendelson (1991a), Kamara (1994), and Elton and Green (1998).

6 Tanner and Kochin (1971), Garbade and Silber (1976), Garbade and Rosey (1977), Sarig and Warga (1989), and Warga (1992).

7 Garbade and Silber (1976), Garbade and Rosey (1977), Sarig and Warga (1989), Warga (1992), and Elton and Green (1998).

8 Warga (1992) and Elton and Green (1998).

9 See, generally, Amihud and Mendelson (1991b).

10 See also, Sarig and Warga (1989).

bonds in the Japanese government bond market. All of the papers conclude that liquidity is an important determinant of asset pricing and that more liquid issues have higher prices and lower returns.[11]

3. Liquidity and Treasury Debt Management

Minimizing the cost of funding the federal debt is a leading objective of Treasury debt management policy.[12] Since liquidity is an important determinant of borrowing costs, one could imagine a funding program designed to maximize the liquidity of the securities issued. In the most extreme form, Treasury could finance any current deficit, and refinance maturing debt, with frequent sales of large quantities of short-term bills. This would concentrate Treasury

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[11] More recently, Elton and Green (1998) suggested that the effect of liquidity on the price of a Treasury security is not as large as previously reported and is restricted to longer maturity bonds with high trading volume, but those authors measured the liquidity of an issue by the volume of trading in the inter-dealer market, rather than by the cost of transacting in the public market. Although the transactions costs of trading, e.g., a 6 month old 10-year note are certainly higher than the transactions costs of trading the on-the-run 10-year note, the ratio of transactions costs is not nearly as large as the reciprocal of the ratio of the volume of trading in the two notes. Dealers are willing to make fairly liquid markets for relatively infrequent transactions in an old 10-year note because order flow and transaction prices in the highly liquid and actively traded on-the-run 10-year note provide information on the value of the off-the-run note, and because they can hedge much of their risk with the on-the-run note. (Price and yield changes for an on-the-run note or bond are very highly correlated with price and yield changes for other notes and bonds of a similar maturity and coupon rate. Amihud, Mendelson and Lauterbach (1997) present evidence on the existence of liquidity spillovers across securities with highly correlated returns.) Thus, there may not be any simple relationship between the cost of liquidity for a particular Treasury security and the volume of trading in the security.

[12] In 1996, the Secretary of the Treasury remarked that, "The Treasury Department has through its history focused on the most cost-effective ways to finance the federal debt." "Statement of Treasury Secretary Robert E. Rubin, Inflation Indexed Bonds Press Conference," *Treasury News*, May 16, 1996. The Assistant Secretary for Financial Markets recently characterized "lowest cost financing" as one of the three main goals of Treasury debt management. (He described the other two as ensuring that adequate cash balances are available at all times and promoting efficient capital markets.) Statement of Lee Sachs, Assistant Secretary, Financial Markets, before the House Committee on Ways and Means, Hearing on Treasury's Debt Buyback Proposal (September 29, 1999).

indebtedness in the most liquid sector of the market: large, short maturity, and unseasoned discount obligations.

However, borrowing costs are affected by factors other than the liquidity of the securities issued. Most prominently, issuing exclusively in a narrow maturity sector might distort the shape of the yield curve and lead to more than minimal overall funding costs, and Treasury has historically chosen to issue at a variety of short, intermediate, and long maturities.[13] This policy has ancillary benefits: it provides market participants with regular new issues of "benchmark" securities whose yields reflect the cost of credit for a default-proof borrower at a variety of maturities,[14] and it facilitates budget planning because it enhances the predictability of interest expenses during a fiscal year and over longer intervals.

Issuing securities at maturities beyond the money market sector undoubtedly reduces to some extent the liquidity of the Treasury market. Longer maturity debt is inherently less liquid than short-term debt, and a note or bond becomes more illiquid with the passage of time - as it

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[13] The Assistant Secretary for Financial Markets recently described "financing across the yield curve" as one of five principles of Treasury debt management, observing that "A balanced maturity structure enables us to appeal to the broadest range of investors and mitigates refunding risks." (The other four principles are maintenance of the credit risk-free status of Treasury debt, predictable issuance schedules, maintenance of market liquidity, and unitary financing of all Federal government programs.) Statement of Lee Sachs, Assistant Secretary, Financial Markets, before the House Committee on Ways and Means, Hearing on Treasury's Debt Buyback Proposal (September 29, 1999).

The sensitivity of Treasury to the effect of its debt management program on the shape of the yield curve is illustrated by the statement (in May, 1993), of the Acting Assistant Secretary for Domestic Finance that the shift to greater issuance of securities with maturities of less than three years, the elimination of the 7-year note and the change from quarterly to semi-annual issuance of 30-year bonds, "wasn't intended to manipulate long-term interest rates." "Treasury Slashes Sales of Long-Term Bonds," *Wall Street Journal*, May 6, 1993, p. C1.

[14] Fleming (forthcoming) discusses the benchmark role of Treasury debt. See also, "Quirk in Yields is Making Bonds More Attractive," *Wall Street Journal*, February 2, 1999, p. C1 (describing changes in market practices that followed the appearance of a substantial liquidity premium in on-the-run Treasury securities in the fall of 1998).

migrates from on-the-run to off-the-run status.[15] Additionally, issuing longer term debt results in a greater number of issues and a smaller average size per issue, further reducing liquidity. These adverse consequences are, however, outweighed by the advantages of diffusing issuance across the curve.

Innovations in Debt Management

Financing the federal debt by issuing securities at a variety of maturities means that Treasury has to choose the maturities at which it will issue, the amount to be issued at each maturity, and the frequency of issue, e.g., weekly, monthly, or quarterly. Treasury's choices have changed from time to time in light of evolving market conditions, the size of the deficit, and refinancing requirements.

Treasury has adjusted its funding program several times during the past fifteen years with the explicit objective of minimizing borrowing costs. It cancelled the 20-year bond in April, 1986,[16] the 4-year note in December, 1990,[17] and the 7-year note in May, 1993,[18] and it increased

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[15] The *net* effect of the passage of time (after an issue is no longer on the run) for the liquidity of intermediate- and long-term securities is unclear. We are unaware of any empirical assessment of the relative liquidity of, say, a note that has been outstanding for 8 years but has only 2 years remaining to maturity compared to a note that has been outstanding for only 2 years but has 8 years remaining to maturity.

[16] In deciding to cancel the 20-year bond, Treasury concluded that "it would be more cost-effective for the Treasury to issue larger amounts of 10- and 30-year securities rather than 20-year issues." "Treasury Announces Elimination of 20-year Bond and Consideration of Reduction in Savings Bonds Interest Rate," Circular No. 10,030, Federal Reserve Bank of New York, May 2, 1986, and "Treasury Plans Note, Bond Sale of $27 Billion," *Wall Street Journal*, May 1, 1986, p. 44. The Treasury yield curve had exhibited a persistent hump between the 10-year sector and the 30-year sector, and Treasury decided it should stop incurring the higher interest rates required to issue near the hump. One market participant also commented that "The 20-year issue seemed to be a bond without a natural home," and that it was "too long for investors who sought to reduce the risk of falling prices when interest rates rise, but too short for other investors and speculators who want to earn the highest possible profits by correctly guessing changes in interest rates." "U.S. Plans Its Biggest Financing," *New York Times*, May 1, 1986, p. D1.

[17] The 4-year note was canceled when Treasury decided to reduce its reliance on bills and

the frequency of issuing 5-year notes from quarterly to monthly in December, 1990.[19]

Although Treasury has, from time to time, adjusted its funding program for strategic reasons, it has not usually varied the size of individual offerings tactically, in response to short-run changes in investor demand for particular maturities. For example, it has not attempted to benefit systematically from unusually strong demand for bills maturing at the end of a calendar month, quarter, or year, or for bills maturing immediately before a tax payment date, or for bills deliverable on a futures contract.[20] Instead, it has maintained fairly steady issue sizes and regular

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increase its use of intermediate-term debt. Contemporaneously, Treasury moved the more popular 5-year note cycle from quarterly to monthly. "Treasury Announces Change in Regular Quarterly Auction Cycles Beginning in 1991," *Treasury News*, December 11, 1990.

[18] Prior to 1993, the yield curve had not inverted significantly for any material length of time since the early 1980s. Treasury canceled the 7-year note after concluding that it could realize long-term savings by shifting to shorter-term issues. "Treasury Slashes Sales of Long-Term Bonds," *Wall Street Journal*, May 6, 1993, p. C1 and "Treasury Maturities Shortened," *New York Times*, May 6, 1993, p. D1. In 1996, the Secretary of the Treasury observed that the decision to cancel the 7-year note cycle "was initially looked on with some skepticism, but … since has won considerable praise and is saving the taxpayers $7 billion." "Statement of Treasury Secretary Robert E. Rubin, Inflation Indexed Bonds Press Conference," *Treasury News*, May 16, 1996.

[19] In May, 1998, Treasury reduced the frequency of issuing 5-year notes for reasons noted in the text at footnote 30 below.

[20] Premium pricing of bills deliverable on a futures contracts, or maturing at the end of a calendar period or immediately before a tax payment date, is discussed in Garbade (December, 1985), Simpson and Ireland (1985), Park and Reinganum (1986), and Ogden (1987). See also, "Seeing Signals from Investors on Year 2000: Treasury Bill Auction Shows Concern on Risk," *New York Times*, July 27, 1999, p. C1 (describing unusually strong demand for bills maturing after the end of 1999).

In the course of the 1979 Treasury/Federal Reserve study of futures contracts on Treasury securities, the Commodities Futures Trading Commission and officers of commodity exchanges that sponsored trading in futures contracts on Treasury securities asked "why, in situations where a potential shortage of deliverable supply against a futures contract [on 3-month bills] appeared to be creating a strong demand for the part of this supply that was about to offered in a cash auction, would the Treasury not want to expand the size of the auction and take advantage of what would likely be a relatively low borrowing cost?" Department of the Treasury and Federal Reserve System (1979, Vol. II, pp. 83-84). For reasons discussed in the study (Vol. II, pp. 84 – 91), the study concluded that "having the Treasury … act directly to modify potential squeezes on the deliverable supply of 3-month bills … through a Treasury increase in the size of the new bill auction … is not acceptable.

terms.[21] One consequence of this policy is the tendency for exceptionally large bill issues - including cash management issues and bills first issued as 52-week bills and then reopened as 26-week bills and again as 13-week bills - to trade at higher yields compared to yields on nearby bills with smaller outstanding issue sizes.[22]

Debt Management Practices Intended to Reduce Borrowing Costs by Enhancing Liquidity

Some features of Treasury debt management practices have been adopted with the specific objective of reducing borrowing costs by enhancing the liquidity of Treasury securities. The most prominent example is the modification of the 52-week bill cycle initiated in late 1979.

Up to and including the issue, on October 16, 1979, of the bill maturing October 14, 1980, 52-week bills were issued (once every four weeks) on a Tuesday and matured on a Tuesday.[23] As

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While there may be occasions when the Treasury should add to the share of its marketable debt represented by 3-month bills, such actions ought to be taken only as needed to implement the Treasury's general debt management objectives; they should not be initiated to help resolve the particular needs of the commodity exchanges." Department of the Treasury and Federal Reserve System (1979, Vol. I, p. 26).

[21] However, Treasury has reacted to unusual market situations at least three times since 1990.

The first was the reopening of the 6-3/8% note of August 15, 2002 (originally issued as a 10-year note in August, 1992) in the 10-year note auction in November, 1992. In announcing the reopening, Treasury stated that the reopening was intended to "alleviate an acute, protracted shortage of [the] security." "Treasury November Quarterly Financing," Treasury press release dated November 3, 1992.

The second was the offering of a 30-1/4 year bond (the 7-1/2% bond of November 15, 2024) in the August, 1994 quarterly financing. The four preceding issues of 30-year bonds had increased the supply of STRIPS maturing in February and August (see Table 1 below), and the unusual 30-1/4 year maturity was chosen to accommodate market demand for STRIPS maturing in May and November.

The third was the decision to offer more 26-week bills than 13-week bills in the weekly auctions from Monday, March 9, 1998 to Monday, September 14, 1998 as a result of unusually strong foreign central bank demand for 26-week bills. See "U.S. Sets Uneven Split in Coming T-Bill Sale to Maintain Liquidity," *Wall Street Journal*, March 4, 1998, p. C21.

[22] Simon (1991, 1994).

[23] This 52-week bill cycle was adopted in the summer of 1972, when Treasury switched from the previous practice (adopted in August, 1963) of monthly auctions of 1-year bills issued at the end of a month and maturing at the end of a month - similar to the current 2-year note

a result, 52-week bills were not fungible with subsequent issues of 26-week and 13-week bills (which matured on Thursdays).[24] On November 1, 1979, Treasury announced that 52-week bills would henceforth mature on a Thursday and that they would be fungible with subsequent issues of 26-week bills and 13-week bills with the same maturity date.[25] Treasury stated that the change would "reduce the number of separate bills outstanding … and *improve liquidity* [emphasis added] for the 52-week bills." [26]

Similarly, Treasury has taken advantage of opportunities to reopen outstanding notes and bonds in lieu of issuing new securities. The most important and frequent examples are reopenings of the most recently auctioned 10-year note and 30-year bond.[27] Table 1 shows new issues and

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cycle. *Treasury Bulletin*, July, 1963, p. A-1, September, 1963, pp. A-4 and A-5, and September, 1972, p. II.

[24] 26-week bills were first auctioned in December, 1958 and, from inception, were fungible with subsequent issues of 13-week bills. *Treasury Bulletin*, December, 1958, p. A-2, and January, 1959, p. A-2.

[25] The first bill issued under the new procedure was the 359-day bill issued Tuesday, November 13, 1979 to mature Thursday, November 6, 1980. That bill was issued on a Tuesday to refinance an old 52-week bill maturing on the same date. The last 359-day bill was issued Tuesday, October 14, 1980 - to mature on Thursday, October 8, 1981 - to refinance the last of the 52-week bills with a Tuesday maturity date. The first 52-week with a Thursday issue date as well as a Thursday maturity date was the November 5, 1981 bill issued November 6, 1980. *Treasury Bulletin*, June, 1980, p. 28, and June, 1981, p. 33.

In June, 1981, the Chicago Mercantile Exchange amended the delivery provisions on its 13-week Treasury bill futures contract to provide that, beginning with the contract settling in June, 1983, the deliverable bill would be an old 52-week bill with 13 weeks remaining to maturity. "90-day U.S. Treasury Bill Amendment Approved by CFTC," Special Executive Report S-848, Chicago Mercantile Exchange, June 2, 1981. The change reduced the likelihood of a squeeze or corner in the bill contract; an issue discussed in Department of the Treasury and Federal Reserve System (1979, Vol. I, pp. 13-14 and Vol. II, pp. 66 - 72.). See also, Commodity Futures Trading Commission (1981, Pt. 3, pp. 56 - 61) for an analysis of Treasury bill prices prior to the June, 1979 settlement of the 13-week bill contract on the Chicago Mercantile Exchange.

[26] *Treasury Bulletin*, November, 1979, p. VII.

[27] On one occasion, Treasury reopened a 30-year bond that was not the most recently issued bond in the series. In the February, 1988 quarterly financing, Treasury reopened the 8-3/4% bond of May 15, 2017 that had been issued on May 15, 1987 and that had 29-1/4 years remaining to maturity. The most recently auctioned 30-year bond at the time of the February,

reopenings of those securities over the past decade.

Additionally, Treasury has reopened an old 5-year note in a shorter-term cycle on three occasions:

- in May, 1988, the 8-1/2% note of May 15, 1991 (issued as a 5-year note on March 5, 1986) was reopened as a 3-year note,
- in October, 1994, the 6-7/8% note of October 31, 1996 (issued as a 5-year note on October 31, 1991) was reopened as a 2-year note, and
- in February, 1996, the 5-1/8% note of February 28, 1998 (issued as a 5-year note on March 1, 1993) was reopened as a 2-year note.

Treasury also stated that it was prepared to reopen an old 5-year note in the 2-year note auctions in April, July, September and October, 1995.[28]

During 1998, Treasury altered its debt management practices on two occasions to maintain the liquidity of Treasury securities. In early March it announced that, contrary to past practice, it would offer a larger face amount of 26-week bills than 13-week bills in the auctions to be held on Monday, March 9. The change was in response to strong demand for 26-week bills from foreign central banks and the desire to insure that sufficient bills reached the hands of

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1988 financing was the 8-7/8% bond of August 15, 2017 that had been issued on August 17, 1987 and reissued on November 16, 1987.

[28] Notes and bonds issued before July, 1984 could not be reopened after that date because of changes in the treatment of market discount and the 30% foreign withholding tax mandated by the Tax Reform Act of 1984. "Questions and Answers on STRIPS," p. 6, an addendum to "Treasury Announces New STRIPS Program," *Treasury News*, January 15, 1985. On several occasions, including the auctions of 5-year notes in May and November, 1988 and May, 1989, and the auction of 10-year notes in August, 1991, Treasury was consequently unable to reopen an old bond in a note auction. To minimize the possibility of confusion, Treasury announced prior to each auction that, regardless of auction results, it would not issue the new note with the same coupon rate as the coupon rate on the old bond with the same maturity date. See, for example, "Treasury August Quarterly Refunding," Treasury press release dated July 31, 1991 (noting that, "If, under Treasury's usual auction procedures, the auction of 10-year notes results in the same interest rate as on the outstanding 8% bonds of August 15, 2001, the new notes will be issued with either a 7-7/8% or an 8-1/8% coupon.").

domestic investors. The Deputy Assistant Secretary for Federal Finance characterized the change as "an effort to *maintain liquidity* [emphasis added] in the market." [29] Treasury continued to offer unequal amounts of 13- and 26-week bills until the auction of Monday, September 21, 1998.

In May, 1998, Treasury announced that the 3-year note cycle would be eliminated and that those notes would be replaced in the quarterly financings by 5-year notes.[30] The action was taken in response to substantial budget surpluses and to avoid reducing the issue sizes of 2-, 5- and 10-year notes and 30-year bonds out of concern that smaller issues would be less liquid. The Assistant Secretary for Financial Markets remarked that, "We chose to concentrate on having fewer, larger, issues." [31]

Initiatives Undertaken to Reduce Borrowing Costs that May Have Adversely Affected the Liquidity of Conventional Notes and Bonds

Although Treasury has shown great sensitivity to the importance of maintaining and enhancing the liquidity of Treasury securities, it has sometimes undertaken initiatives intended to reduce borrowing costs that may have affected liquidity adversely. These initiatives reflect the principle, noted in the beginning of this section, that liquidity is only one factor affecting borrowing costs and that, in some cases, it can be outweighed by other considerations.[32]

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29 "U.S. Sets Uneven Split in Coming T-Bill Sale to Maintain Liquidity," *Wall Street Journal*, March 4, 1998, p. C21.

30 The monthly cycle of 5-year notes was cancelled at the same time.

31 "It's Two Steps Back for Short-term Treasurys," *New York Times*, May 7, 1998, p. C1. The Assistant Secretary for Financial Markets observed that Treasury decided to stop issuing 3-year notes because the continuing issues of 2-year notes and 5-year notes would offer similar investment opportunities, and because the 10-year note and 30-year bond series "provide a critical service to overall capital markets that would be hard for anybody else to fill." See also, "Bonds Stay Put as Traders Wait for Jobs Report; Fannie Mae to Offer Additional Benchmark Bonds," *Wall Street Journal*, May 5, 1998, p. C25 (noting that "drastically reducing the … amount of [Treasury] securities sold [in a single auction] … would likely hurt liquidity in the issues.").

32 This characterization is consistent with the recent statement of the Assistant Secretary for Financial Markets that minimizing borrowing costs is one of three "goals" of Treasury debt

Treasury introduced novel securities intended to appeal to investors with specialized interests on two occasions. Between 1984 and 1986 it sold a total of four Foreign-Targeted Treasury Notes,[33] and in January, 1997 it introduced Inflation-Indexed Securities. (Table 2 shows details on the offerings of Inflation-Indexed Securities.) Both programs were undertaken with the intent of reducing borrowing costs by issuing securities tailored to exploit specific market niches.[34] However, both programs also led to issuing securities that turned out to be materially less liquid than conventional Treasury issues,[35] and both led to reduced issuance of conventional

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management (the other two goals are noted in footnote 12), while maintenance of market liquidity is one of five "guiding principles" (the other four principles are noted in footnote 13). Statement of Lee Sachs, Assistant Secretary, Financial Markets, before the House Committee on Ways and Means, Hearing on Treasury's Debt Buyback Proposal (September 29, 1999).

[33] The four issues were the Foreign-Targeted 11-3/8% 4-year note of September 30, 1988 (issued October 31, 1984), the Foreign-Targeted 11% 5-year note of February 15, 1990 (issued December 3, 1984), the Foreign-Targeted 9-7/8% 5-year note of August 15, 1990 (issued June 4, 1985), and the Foreign-Targeted 8-7/8% 10-year note of February 15, 1996 (issued February 18, 1986).

[34] Foreign-Targeted notes were sold only to United States Aliens or foreign branches of United States financial institutions. See, for example, Foreign-Targeted Treasury Notes of September 30, 1988, Offering Circular dated October 10, 1984, Public Debt Series No. 31-84, Department of the Treasury. The notes were intended to appeal to nonresident aliens and foreign corporations that did not care to own Treasury securities in a conventionally registered form.

In announcing the intent of Treasury to issue Inflation-Indexed Securities, the Secretary of the Treasury cited the potential contribution of the new asset class to reducing the cost of funding the federal debt, and noted the belief of the Department that the securities would be most attractive to individuals saving for their retirement or other long term purposes. "Statement of Treasury Secretary Robert E. Rubin, Inflation Indexed Bonds Press Conference," *Treasury News*, May 16, 1996.

[35] The limited liquidity of the Foreign-Targeted notes was mitigated by the convertibility of each of the notes into a conventional note with the same coupon rate and maturity date. See, for example, Foreign-Targeted Treasury Notes of September 30, 1988, Offering Circular dated October 10, 1984, Public Debt Series No. 31-84, Department of the Treasury and Garbade (January, 1985).

Market participants made active use of the conversion option. For example, in February, 1986, Treasury issued $1 billion of the Foreign-Targeted 8-7/8% 10-year note of February 15, 1996 and $7.5 billion of the conventional 8-7/8% note maturing on the same date

notes and bonds, and thus reduced the liquidity of the markets for those securities.[36]

The STRIPS Program. Similar comments apply to the STRIPS program, introduced in early 1985, that provided for the separation of the interest and principal payments on a note or bond into single-payment, or "zero-coupon," obligations.

The new obligations were patterned on private sector zero-coupon custodial receipts that had appeared in August, 1982.[37] The statement announcing the STRIPS program observed that, "Zero-coupon securities … have become very popular for those who wish to avoid reinvestment risk or seek greater certainty in matching the maturities of their assets and liabilities. They have been particularly attractive investments for Individual Retirement Accounts and pension funds," and noted that the private receipts had "broadened the market for Treasury securities" and produced "significant savings in financing costs." [38] The statement further remarked that "STRIPS will greatly reduce … financing costs … and facilitate further expansion of the zero-

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(*Treasury Bulletin*, Spring, 1986, p. 28). By March 31, 1986, $217 million of the Foreign-Targeted note had been converted into the conventional note (*Treasury Bulletin*, Spring, 1986, p. 23). By the end of 1986, the outstanding amount of the Foreign-Targeted note was down to $188 million (*Treasury Bulletin*, Winter, 1987, p. 28), and by the end of 1995 the outstanding amount of the Foreign-Targeted note was only $125 million (*Treasury Bulletin*, March, 1996, p. 35).

[36] Only $4 billion of Foreign-Targeted notes were issued, and all were issued at a time of large budget deficits, so the impact on the liquidity of other Treasury securities was likely *de minimis*. In contrast, over $97 billion of Inflation-Indexed Securities have been issued through the end of 1999, at a time of significant surpluses and substantial net redemptions of conventional Treasury debt.

[37] The first private sector receipt programs included Certificates of Accrual on Treasury Securities ("CATS") introduced by Salomon Bothers Inc., Treasury Investment Growth Receipts ("TIGR's") introduced by Merrill Lynch White Weld Capital Markets Group, and Zero Coupon Treasury Obligations, introduced by Lehman Government Securities, Inc. These "private-label" programs were later joined by Treasury Receipts (TRs"), a generic, or open, receipt program initially sponsored by Goldman, Sachs & Company and the First Boston Corporation. "Zero Coupon Selling Revised, Dealers Seek One Receipt," *New York Times*, January 10, 1984, p. D7.

[38] "Treasury Announces New STRIPS Program," *Treasury News*, January 15, 1985.

coupon market. The savings made possible by STRIPS will be reflected in the competitive bidding for Treasury securities." [39] At the same time, however, stripping led to the creation of relatively less liquid single-payment Interest Component STRIPS and Principal Component STRIPS, and may have reduced the liquidity of underlying notes and bonds by reducing the outstanding stocks of those securities.[40]

Two Innovations that Mitigated the Impact of the STRIPS Program on the Liquidity of Conventional Notes and Bonds. Two subsequent modifications to the STRIPS program mitigated whatever adverse impact that program may have had on the liquidity of the Treasury market.

Effective July 29, 1985, all Interest Component STRIPS payable on a common date were assigned a common CUSIP number and became fungible with each other. Under the original program, Interest Component STRIPS payable on a common date had different CUSIPs (and, therefore, were not fungible) if they were derived from securities with different CUSIPs. The

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[39] Treasury modified its issuance practices to enhance stripping-based auction demand for 10-year notes and 30-year bonds by issuing the securities with a full first coupon (and positive accrued interest) when the issue date did not fall on a semi-annual anniversary date. The first securities issued with positive accrued interest were the 9-1/2% note of November 15, 1995 and the 9-7/8% bond of November 15, 2015, sold in the November, 1985 quarterly financing. Both securities were issued November 29, 1985, but both were dated November 15, 1985. The modification was important because the STRIPS program provided that a security could not be stripped if it had an unpaid short or long first coupon. (This restriction delayed stripping a 20-year bond until the bond paid its first coupon. For example, the 10-3/4% bond of August 15, 2005 was issued on July 2, 1985, but did not become eligible for the STRIPS program until a few days after it paid its (long) first coupon on February 15, 1986.)

To accommodate market demand for long-term STRIPS and further enhance stripping-based demand for new issues of 30-year bonds, Treasury also eliminated the call option that had heretofore been embedded in those bonds. "Treasury Announces New STRIPS Program," *Treasury News*, January 15, 1985.

[40] However, STRIPS proved to be far more liquid than private sector custodial receipts, because private sector receipts payable on a common date were fragmented by sponsor and series, and because private sector receipts were not direct obligations of the U.S. government and were not eligible for book-entry accounts at Federal Reserve banks.

statement announcing the change noted that it would "further *increase the liquidity* [emphasis added] of the STRIPS program … thereby reducing transactions costs and at the same time broadening the marketability of STRIPS." [41]

The second modification became effective May 1, 1987, and provided that Principal Component STRIPS could be "reconstituted" with Interest Component STRIPS into the notes or bonds from which they were derived. The statement announcing the change observed that the new facility would "*enhance the … liquidity* [emphasis added] … of Treasury securities." [42]

Remaining Limitations on the Fungibility of <u>All</u> STRIPS Maturing on a Common Date. Although the STRIPS program has, since July, 1985, provided for fungibility of Interest Component STRIPS maturing on a common date, it has not provided for comparable fungibility of Principal Component STRIPS derived from different coupon-bearing securities maturing on the same date, or of Interest Component STRIPS and Principle Component STRIPS maturing on a common date.

As illustrated in Table 3, this has resulted in numerous cases of pairs of STRIPS - and four cases of triplets of STRIPS - trading at different prices and yields, even though they mature on the same future date.[43] It is not unreasonable to assume that fragmentation of trading in STRIPS with identical payment characteristics has led to higher transactions costs and lower liquidity than would otherwise be the case.[44]

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41 "Treasury Announces Change to Generic CUSIPs for STRIPS," *Treasury News*, June 14, 1985.

42 "Treasury Announces Date for Reconstitution of Securities in STRIPS Program," *Treasury News*, March 31, 1987. Reconstitution would have been much more difficult in the absence of the provision for fungibility of Interest Component STRIPS maturing on a common date.

43 Daves and Ehrhardt (1993) examine why Interest Component STRIPS and Principal Components STRIPS maturing on the same date trade at different yields.

44 Grieves and Sunner (1999) emphasize the importance of fungiblity of STRIPS maturing on a common date for market liquidity.

4. A Proposal to Reduce Heterogeneity in the STRIPS Market

Our first proposal is to reduce the fragmentation, and enhance the liquidity, of trading in STRIPS by eliminating distinctions among Principal Component STRIPS derived from different coupon-bearing securities maturing on the same date, as well as the distinction between Principal Component STRIPS and Interest Component STRIPS paying on the same date. In particular, we propose that all STRIPS maturing on a common date should be fungible with each other and should be assigned a common CUSIP number.

Figure 2 shows STRIP yields on October 6, 1999. The dispersion of yields on STRIPS maturing on common dates is evident. By eliminating distinctions among STRIPS other than maturity date, the proposal would collapse STRIP yields onto a single curve of yield as a function of time to payment, and would thereby enhance the integration of the STRIPS market.

Because notes and bonds can be stripped quickly and at little cost, and because STRIPS can be similarly reconstituted into notes and bonds, arbitrage keeps the price of a note or bond very nearly equal to the sum of the prices of its component STRIPS.[45] Our proposal to reduce heterogeneity in the STRIPS market would thus result in very nearly identical market prices for identical cash flow streams - regardless of whether the cash flows are derived from portfolios of notes and bonds or from portfolios of STRIPS promising to make the same future payments - and would thereby enhance the integration of the market for notes and bonds as well as the integration of that market with the STRIPS market.

Recent Characteristics of Note and Bond Market Integration

The implication of our proposal for the integration of the market for notes and bonds is especially significant in light of evidence that the internal cohesion of that market deteriorated in the fall of 1998 and has not subsequently recovered.

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[45] Transactions costs incurred in purchasing and selling STRIPS and coupon-bearing securities prevent arbitrage from keeping the price of a note or bond *identically* equal to the sum of the prices of its component STRIPS.

Figure 3 shows yields on coupon-bearing securities on October 6, 1999 as a function of time to maturity. There is no reason to expect the yields to lie on a curve, because yield can vary with coupon rate as well as with time to maturity.

However, we might expect that, at least to a first approximation, the market prices the individual payments on notes and bonds from a common "spot," or single-payment, yield curve, so the price of a portfolio of cash flows does not depend on the particular notes and bonds used to construct the portfolio. To examine this proposition, a cubic spline approximation to a spot yield curve pricing the underlying cash flows was fitted to the note and bond prices observed on October 6, 1999,[46] and the predicted prices were converted to yields. The median absolute difference between model yields and market yields was 1.9 basis points. This is a measure of the dispersion of the difference between the market values of the notes and bonds and the aggregate present values of the constituent future payments discounted with the fitted spot yield curve.

Figure 4 shows similar measures over the interval from July 1, 1993 to October 6, 1999. The increase in the median absolute difference in the fall of 1998, and the absence of any subsequent reversal, is evident. Since our proposal would result in very nearly identical market prices for identical cash flows, it would greatly reduce the median absolute difference between market yields and the yields computed from a spot yield curve fitted to yields on STRIPS, and it would thereby help to reverse the increase in yield dispersion in the note and bond market.

Elasticity in the Supply of Individual Notes and Bonds

A second significant implication of our proposal is that when there is unusually strong demand for a security, market participants could use the reconstitution facility to create more of the security than Treasury originally issued. The proposal would not permit market participants to alter Treasury's *aggregate* liabilities on any future date, including both interest liabilities and principal liabilities, but it would allow market participants to alter the *packaging* of the liabilities.

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[46] Fleming (forthcoming) describes the methodology in detail.

For example, as illustrated in Example 1, the market could convert a higher coupon security into STRIPS and a lower coupon security.

The decision of market participants to buy and strip a relatively cheap security, add or remove some STRIPS, and then reconstitute and sell a relatively expensive security, is not undesirable, because (as described above) it would keep the prices and yields of outstanding notes and bonds in line with each other. In particular, it would provide a mechanism for expanding the supply of a security "on special" in the financing market for specific collateral [47] and, consequently, expensive in the cash market.[48] It would provide a "relief valve," not unlike the delivery options specified in futures contracts,[49] and would limit the prospect of squeezes and corners.[50]

Figure 5 illustrates (on a cash flow basis) how much non-callable Treasury debt with mid-quarter maturities has been stripped and how much more could be stripped. Table 4 shows (on a principal basis) the outstanding amounts and the maximum additional amounts that could be created by reconstituting STRIPS derived from other securities The amounts are substantial, suggesting that "uncapping" the reconstitution feature could have a material impact on relative issue supplies and prices. However, as shown in Table 4, the potential addition to supply would be smaller the more distant the maturity date of a security, because there are fewer other cash

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47 Duffie (1996) and Jordan and Jordan (1997) describe and characterize the financing market for specific collateral.

48 It would, therefore, supplement the mid-1998 changes in the management of the System Open Market Account intended to "enhance liquidity in the financing market." Letter dated June 16, 1998 from Peter Fisher, Executive Vice President, Federal Reserve Bank of New York, to Primary Dealers.

49 Delivery options on futures contracts are discussed in Paul, Kahl and Tomek (1981, pp. 110 - 112), Commodity Futures Trading Commission (1981, pp. 98 - 117), Kilcollin (1982), Garbade and Silber (1983), Gay and Manaster (1984, 1986), Kane and Marcus (1986), Arak and Goodman (1987), Kamara and Siegel (1987), Boyle (1989), and Manaster (1992).

50 The potential contribution of eliminating distinctions among STRIPS maturing on a common date to alleviating squeezes is examined in Department of the Treasury et. al., (1992, pp. B11 - B16).

flows available to expand the supply of a longer dated bond. In particular, the supply of the bond with the most distant maturity date would be limited to the amount issued.

Tax Implications

Conversion of higher coupon notes and bonds into STRIPS and lower coupon notes and bonds, as illustrated in Example 1, could lead to lower Treasury tax receipts on interest income. Assessing the magnitude of this effect is beyond the scope of the present paper. However, we observe that what is important is the *net* effect on Treasury tax revenues, including:

- foregone taxes on interest income from the higher coupon securities converted into lower coupon securities and STRIPS,
- increased taxes on the interest income from the lower coupon securities created by conversion,
- increased taxes on the annual accretions of discount on the STRIPS created by conversion, as well as
- the tax consequences of any capital gains or losses associated with the sale (for conversion) and conversion of higher coupon securities into lower coupon securities and STRIPS.

Among other things, the magnitudes of these tax effects depend on the tax brackets of the investors who sell and convert higher coupon debt, and the tax brackets of the investors who acquire the lower coupon debt and STRIPS created by conversion.[51]

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[51] A similar issue arises in the context of Treasury's proposal to repurchase off-the-run securities (see footnote 1). To the extent Treasury elects to repurchase securities with high coupon rates trading at prices in excess of principal value (to maintain issuance of new debt with current coupon rates and prices close to principal value), tax revenues on interest income could decline. However, as with the conversion of high coupon debt into low coupon debt that could result from our proposal, the magnitude of any such effect will depend on the tax brackets of the investors selling the high coupon debt and the tax brackets of the investors buying the new (current coupon) debt, as well as any offsetting tax revenues derived from capital gains on the sale of the high coupon debt.

Capping the Amount of a Note or Bond That Can be Reconstituted

To limit any prospective loss of Treasury tax revenue, it would not be unreasonable to "cap" the amount of a note or bond that could be reconstituted. The cap could be set at the original issue size of the security (including any reopenings), less the currently outstanding stock of the security, plus an additional amount that could vary from security to security. The additional amount could, for example, be relatively generous for an issue priced substantially above its principal value, and smaller for an issue priced at a material discount. Similarly, it could vary over time as market yields rise and fall.

Such a cap would not materially vitiate any of the benefits of the proposal related to fungibility and liquidity. However, it would allow the possibility of a note or bond becoming more expensive than the sum of the prices of the STRIPS that can be derived from the security. This would happen if reconstitution had expanded the supply of the security to its original issue size plus the additional amount prescribed by Treasury, so that no additional supplies could be created through further reconstitution in spite of the economic incentive.

5. A Proposal to Reduce Maturity Date Heterogeneity

The proposal presented in the preceding section was premised on the notion that fragmentation of trading in STRIPS with identical payment characteristics degrades liquidity, reduces the attractiveness of Treasury securities, and increases the cost of funding the federal debt.[52] Liquidity can also be degraded by fragmentation of trading in securities with heterogeneous payment characteristics. We observed in Section 3 that Treasury has reduced the heterogeneity, and enhanced the liquidity, of its debt during the past 20 years by integrating 52-week bills with 26- and 13-week bills, by reopening outstanding notes and bonds whenever

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[52] Treasury recognized explicitly that fragmentation of trading in Interest Component STRIPS with identical payment characteristics degrades liquidity and reduces the attractiveness of those STRIPS and, in mid-1985, acted to eliminate that fragmentation. See text at footnote 41.

possible, and - as illustrated in Table 5 - by pruning selected offerings, including 3-year, 4-year and 7-year notes and 20-year bonds.[53]

Currently, bills mature on Thursdays, 2-year notes mature at month-end, and 5-year and 10-year notes and 30-year bonds mature at mid-quarter. Further simplification would be welcome.

One possibility is to alter the maturity of 2-year notes to mid-month. In combination with our proposal to reduce heterogeneity in the STRIPS market, this would increase the integration of 2-year notes maturing in the middle of the second month of each quarter with old 5-year and 10-year notes and 30-year bonds maturing on the same dates. In some cases it may be possible to reopen a seasoned security in the 2-year note auction in the second month of a quarter.[54] However, unless the frequency of 2-year issuance is reduced to once a quarter, the reduction in heterogeneity would be limited because there would still be cycles of 2-year notes maturing in the middle of the first month and the third month of each quarter.

Alternatively, Treasury could integrate the 2-year debt program with the bill program, paralleling the change from monthly offerings of 1-year bills to quad-weekly offerings of 52-week bills maturing on Thursday.[55] In particular, Treasury could replace its monthly offerings of 2-year notes with quad-weekly offerings of 104-week bills. The cycle of 104-week bills could be timed so the maturity dates of the bills fall midway between the maturity dates of subsequent offerings of 52-week bills.[56]

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53 Eliminating 7-year notes also eliminated an odd cycle of notes maturing in the middle of the first month of each quarter.

54 This would be similar to the reopenings described in the text at footnote 28.

55 As noted in footnote 25 and in the text at footnotes 23, 24 and 25, the integration of 1-year bills with 26- and 13-week bills was accomplished in two separate steps, in 1972 and in 1979-80.

56 For example, on January 22, 1998, Treasury could have issued a 104-week bill maturing on January 20, 2000. That bill would mature midway between the maturity dates of two subsequent issues of 52-week bills: the January 6, 2000 bill (issued on January 7, 1999) and the February 3, 2000 bill (issued on February 4, 1999).

Integrating Bills with Notes and Bonds

Closer integration of the 2-year debt program with either the bill program or the longer-term note and bond program would reduce fragmentation and enhance liquidity, but the benefits of integrating bills with notes and bonds are, potentially, far greater.

Figure 6 shows that outstanding stocks of bills and short-term notes and bonds are of roughly similar magnitude. However, bills are priced quite differently from coupon-bearing securities maturing only a few days earlier or later, or even on the same day. This is illustrated by the yield spreads of 20 to 30 basis points between bills and short-term notes and bonds shown in Figure 7. The greater value (lower yield) of bills is commonly attributed to the greater liquidity of those securities compared to notes and bonds of a similar maturity.[57] Closer integration of the two classes of securities could materially enhance the liquidity (and market value) of the latter securities. The prospect of improved liquidity and higher prices in the market for short-term coupon-bearing securities would, in turn, enhance the liquidity and value of intermediate-term securities and consequently lower the cost of funding the federal debt.

However, integrating bills and coupon-bearing securities more closely would appear to require that coupon payments be changed from intervals of 6 calendar months to intervals of 182 days. This would create unusual maturity sequences - 5-year and 10-year notes and 30-year bonds would mature every 91 days, rather than every 3 calendar months - and would constitute a significant departure from present practice. In short, while 2-year debt can be integrated with bills (by converting monthly issues of 2-year notes to quad-weekly issues of 104-week bills) or with longer-term notes and bonds (by converting 2-year notes to mid-month maturities), directly integrating bills and coupon-bearing securities may be impractical.

In view of the substantial benefits that would follow from closer integration, it is worth examining an indirect approach to integrating the bill program with the note and bond program. The next section describes how the markets for bills and coupon-bearing securities could be more

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[57] Garbade (1984), Amihud and Mendelson (1991a), and Kamara (1994).

closely integrated - without departing from present issuance practices - as an ancillary consequence of a facility designed to enhance further the liquidity of the markets for notes, bonds and STRIPS.

6. A Third, More Adventurous, Proposal to Enhance Liquidity

The contrast between yields on bills and yields on short-term notes and bonds shows that Treasury securities with similar payment characteristics, but in different classes, may be priced quite differently by market participants. Minor differences in security characteristics can also lead to anomalous yield structures within a security class.

For example, on July 22, 1999, Treasury bills maturing on September 23, September 30, and October 7, 1999, were offered at yields of 4.48%, 4.43% and 4.51%, respectively. The 5 basis point decline in yield from the September 23 bill to the September 30 bill, and the relatively sharp 8 basis point increase in yield from the September 30 bill to the October 7 bill, are notable for a maturity sector where (as shown in Table 6) the bill yield curve generally had a mildly positive slope.[58]

On the same date, Interest Component STRIPS maturing on August 15 and November 15, 2006, and on February 15, 2007, were offered at yields of 5.99%, 5.96% and 6.02%, respectively. The 3 basis point decline in yield from the August, 2006 obligation to the November, 2006 obligation, and the more-than-off-setting 6 basis point increase in yield from the November, 2006 obligation to the February, 2007 obligation, are notable in a market where (as shown in Table 3) the yield curve for Interest Component STRIPS maturing between 2005 and 2010 was moderately positively sloped.

The proposal outlined in Section 4 would enhance the liquidity of the Treasury market by making STRIPS with *identical* maturities *perfect* substitutes. Liquidity can be further enhanced

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[58] The September 30 bill was an end-of-quarter bill as well as an end-of-month bill. Garbade (December, 1985), Park and Reinganum (1986), and Ogden (1987) discuss the premium pricing of such bills.

by improving the substitutability of single-payment securities (including *both* STRIPS *and* Treasury bills) with similar, but not identical, maturities. In particular, while Treasury can not - and, indeed, should not - make STRIPS maturing in August and November, 2006 and in February, 2007 perfect substitutes for each other (in the sense of ensuring that they always trade at fixed yield spreads), it can make the securities better substitutes by permitting some elasticity in relative supplies that would reduce the prospect of more extreme variations in the relationships among the yields on the three securities.

The Proposal

Our third proposal is for an "exchange facility" that would allow market participants to exchange - with Treasury - two single-payment securities (with very similar maturities and with face values of $1,000 each) for a single-payment security with an intermediate maturity and a $2,000 face value, and vice versa.

Suppose, for example, a November, 2006 STRIP is expensive relative to the August, 2006 and February, 2007 STRIPS - as was the case with Interest Component STRIPS on July 22, 1999 (see Table 3). Market participants could then exchange $1,000 face amount of each of the cheaper STRIPS for $2,000 face amount of the more expensive November, 2006 STRIP. Conversely, if the November, 2006 STRIP was relatively cheap, market participants could exchange $2,000 face amount of that security for $1,000 face amount each of the August, 2006 and February, 2007 STRIPS.

As described in more detail below, the exchange facility would bound very short-range irregularities in the structure of yields on single-payment securities, but it should be structured to avoid influencing the over-all level and shape of the yield curve. To preclude any effects on the curve, we suggest that Treasury impose a fee on exchanges and limit exchanges to "nearby" securities.[59]

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[59] Left in the simple form described in the preceding paragraph, the exchange facility would result in an equilibrium where the price of any single-payment security would be equal to the

An Exchange Fee. We suggest that Treasury impose a fee - specified in terms of yield and amounting to several, perhaps 2 or 3, basis points - on an exchange of single-payment securities. For purposes of computing the fee in dollar terms, the shorter and longer securities involved in an exchange would be valued at prevailing market yields. The intermediate security would be valued at the average, or interpolated, yield on the shorter and longer securities, plus or minus the prescribed fee.

Suppose, for example, the exchange fee is set at 2-1/2 basis points. For illustrative purposes, let us use the yields on Interest Component STRIPS on July 22, 1999 from Table 3 and a settlement date of July 23, 1999. Since the average yield on the August, 2006 and February, 2007 STRIPS was 6.005% (6.005% is the average of 5.99% and 6.02%), a market participant could exchange $1,000 face amount of each of those STRIPS (priced at their respective market yields) for $2,000 face amount of November, 2006 STRIPS priced at a yield of 5.98% (5.98% = 6.005%, less the 2-1/2 basis point exchange fee). As shown in Example 2, this would result in a cash payment to Treasury of $2.27.

Alternatively, a market participant could exchange $2,000 face amount of November, 2006 STRIPS priced at a yield of 6.03% (6.03% = 6.005%, plus the 2-1/2 basis point exchange fee) for $1,000 face amount of August, 2006 STRIPS and the same face amount of February, 2007 STRIPS (priced at their respective market yields). As shown in Example 3, this would result in a cash payment to Treasury of $2.34.[60]

Appendix A discusses whether the size of the cash payment to Treasury resulting from an exchange is sensitive to the yields used to value the obligations exchanged. We conclude that the size of the payment is relatively insensitive to modest variations in both the *levels* of the yields and

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average price of a pair of shorter and longer term single-payment securities. If positive amounts of single-payment securities of all maturities remained outstanding, the price of a single-payment security would be a linear function of its time to maturity.

[60] The payment to Treasury is slightly larger for the exchange of the intermediate STRIP into the shorter and longer STRIPS, because the price of a STRIP is a convex function of both its yield and time to maturity.

the *difference between the yields* on the shorter and longer securities involved in the exchange. It does not appear that Treasury, or its agent, would have to maintain unreasonably close contact with evolving market conditions to price an exchange with acceptable accuracy. Thus, it would not be impractical for Treasury to announce a schedule of yields on single-payment securities at the end of the day, and to receive requests for exchanges pursuant to that schedule up to the opening of the market the following morning.

The proposed exchange facility would bound very short-range irregularities in the structure of yields on single-payment securities such as those described in the introduction to this section. The market yield on a single-payment security could never differ by more than the exchange fee from the average of the market yields on a pair of shorter and longer term single-payment securities for which it can be exchanged. Thus, for example, the market yield on a November, 2006 STRIP would have to be in the interval from 5.98% to 6.03% if the market yields on the August, 2006 and February, 2007 STRIPS were 5.99% and 6.02%, respectively.

Limiting Exchanges to "Nearby" Securities. To preclude the possibility that the exchange facility might do more than bound short-range irregularities in the structure of yields on single-payment securities, the difference between the maturities of the longer and shorter securities that can be exchanged for an intermediate maturity security should be limited, possibly as suggested in Table 7. Appendix B discusses the implications of the limitations in Table 7 for the shape of the yield curve in more detail.[61]

Other Limitations. In addition to limitations like those in Table 7, it may be desirable to

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[61] In the absence of limitations like those prescribed in Table 7, the exchange facility would result in an equilibrium where the yield on any single-payment security could not differ from the average of the yields on a pair of shorter and longer term single-payment securities by more than the exchange fee. If positive amounts of single-payment securities of all maturities remained outstanding, the yield on a single-payment security would be very nearly a linear function of its time to maturity. This issue is discussed further in Appendix B.

limit the maximum increase or decrease in the amount payable on a given date to prevent the development of large variations in rollover financing requirements. This cap would be similar to the cap on reconstitution discussed in Section 4, but it would here limit the increase or decrease in aggregate Treasury liabilities payable on a given date, rather than the principal amount of a note or bond that can be created by reconstituting STRIPS derived from other securities.

To facilitate Treasury planning for rollover financings, it may also be desirable to prohibit exchanges involving any security with less than a month or six weeks remaining to maturity.

Benefits of the Proposal

We believe the proposed exchange facility would enhance the liquidity of STRIPS and off-the-run Treasury notes and bonds, and would increase the integration of the bill market with the markets for short-term STRIPS and coupon-bearing securities.

Liquidity Enhancement. The proposal would improve the substitutability of substantially similar single-payment securities by limiting the range of relative variation of yields on securities with very nearly identical payment characteristics. This can have important consequences for the liquidity of Treasury securities.

For example, a dealer could satisfy a customer's interest in purchasing $10 million face amount of a STRIP that the dealer did not already own by selling the STRIP short, and then hedging the risk of loss on the short sale (to not more than twice the exchange fee) by purchasing $5 million each of a somewhat shorter STRIP and a somewhat longer STRIP.[62] We believe that limiting basis risk on hedged short sales will lead to a more liquid STRIPS market with narrower

[62] The maximum loss of twice the exchange fee would occur if the dealer sold the intermediate STRIP short at a yield close to the average yield on the shorter and longer STRIPS *plus* the fee, and then liquidated the hedged short position when the yield on the intermediate STRIP was close to the average yield on the shorter and longer STRIPS *minus* the fee. The maximum loss will be smaller the smaller the difference between (a) the yield at which the intermediate STRIP is sold short and (b) the average yield on the shorter and longer STRIPS.

bid-ask spreads. Similar comments apply to the markets for notes and bonds, because those securities are linked to STRIPS through stripping and reconstitution.

Market Integration. The proposal would also lead to a sharp reduction in the yield spread between STRIPS and bills, as well as between short-term coupon-bearing securities and bills.

Large spreads between yields on STRIPS and yields on bills of a similar maturity can not persist if - as illustrated in Example 4 - market participants can exchange (for a modest fee) $2,000 face amount of a STRIP maturing on November 15, 1999 for $1,000 face amount each of bills maturing on November 12 and November 18, 1999. The exchange facility would greatly enhance the integration of the (relatively illiquid) markets for short-term STRIPS and coupon-bearing securities with the (much more liquid) bill market. In particular, the spread between the yield on a short-term note or bond and the yield on a bill with a similar maturity would be limited to not more than the prescribed exchange fee (2-1/2 basis points in the foregoing example). The prospect of improved liquidity and higher prices in the markets for short-term coupon-bearing securities would, in turn, enhance the liquidity and value of intermediate-term securities and consequently lower the cost of funding the federal debt.

Enhanced integration of the markets for short-term STRIPS and bills would not necessarily lead to exchanges of STRIPS for bills on a wholesale basis. Since positions in short-term STRIPS could be priced and hedged more reliably with bills of a comparable maturity (see text at footnote 62), the superior liquidity of the bill market would spill over into the STRIPS market, making STRIPS more valuable and reducing the economic incentive for any actual exchange.[63] Phrased another way, the stated willingness of Treasury to exchange bills for STRIPS at a modest fee would itself limit the incidence of such exchanges.

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[63] Liquidity spillovers are discussed in Amihud, Mendelson and Lauterbach (1997, pp. 378 - 380). See also the related analysis in Amihud and Mendelson (1996, pp. 1455 - 1464).

Other Benefits. The proposed exchange facility would allow market conditions to influence, within limits prescribed by Treasury, the amount of Treasury debt maturing on different dates. In contrast to present debt management practices, the amount payable on a particularly desirable date, such as the end of a calendar quarter, could expand in response to market demand, while the amounts payable on nearby dates contract dollar-for-dollar.

Our proposal can be viewed as a market-driven substitute for tactical variations in primary market offerings in response to unusually strong investor demand for particular maturities. It is analogous to the philosophy that motivated the 1985 decision of Treasury to facilitate bond stripping rather than to issue zero-coupon securities itself:

> The investment community will be better able [than Treasury] to offer zero-coupon instruments that meet particular needs in a timely manner. The market for zero-coupon securities is a rapidly changing one. The demand varies substantially for particular maturities and with changes in interest rates and in the needs of various investor classes… This changing demand for zeros will be best accommodated by the STRIPS program of making a broad range of maturities eligible for stripping but *leaving it to the market to decide* when and how much of an issue it will separate and market as zero-coupon instruments.[64] [Emphasis added.]

As a related matter, by partially endogenizing the face amount of single-payment securities maturing on a particular date, the exchange facility - taken in conjunction with the proposal in Section 4 and the existing provision for reconstituting STRIPS into coupon-bearing securities - would provide another mechanism for expanding the supply of a security on special in the financing market for specific collateral. Additionally, the supply of a new, on-the-run, issue could increase beyond the original issue amount in response to demand for the security, and then contract as the security migrated from on-the-run to off-the-run status.

And last, but not least, the revenue generated by the exchange fee would benefit directly Treasury's objective of minimizing the cost of funding the federal debt.

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64 "Treasury Announces New STRIPS Program," *Treasury News*, January 15, 1985.

A Precedent for the Proposal

The proposed exchange facility is novel, but it is not without precedent.

Each Foreign-Targeted Treasury Note sold in the mid-1980s (see footnote 33 above) was exchangeable (throughout its life) for an equal principal amount of a conventional note with the same coupon rate and maturity date.[65] (Conventional notes issued in exchange for Foreign-Targeted notes increased the amount outstanding of a note originally sold contemporaneously with the Foreign-Targeted note.) Depending on when an exchange was made, a market participant electing to exchange a Foreign-Targeted note made a cash payment to Treasury or received a cash payment from Treasury. The payment accounted for the difference in value between annual payment of interest on the Foreign-Targeted note and semi-annual payment of interest on the conventional note.

Thus, it is not unprecedented for Treasury to issue additional amounts of an outstanding security, in exchange for a different security, in a transaction that results in a change in the timing of its future liabilities (but leaves the aggregate quantity of liabilities unchanged) and that involves a cash payment to account for the present value of the change in the timing of the future liabilities.[66]

A Trial

We are not unaware that the proposed exchange facility may be viewed by some as a risky policy initiative. Therefore, we suggest the possibility of a limited trial.

Treasury could adopt the facility, but limit its initial availability to bills and STRIPS with less than one year to maturity. If the program is deemed useful and in the public interest, it could be extended to securities with longer maturities. If, on the other hand, experience indicates that

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[65] See footnote 35 for an example of the use of the exchange option by market participants.

[66] The exchange facility may also be analogized to a "tap," or continuing, offering of new securities (in this case, single-payment securities), where payment is made largely with other securities - rather than with cash only.

the program is ineffective or has unforeseen adverse consequences, the program could be terminated. The subsequent passage of time and redemption of debt would eradicate its effects within a year.[67]

7. Conclusion

The starting point for this paper is the belief that reducing limitations on the fungibility and substitutability of Treasury securities can enhance liquidity and lead to higher prices for those securities.[68]

We discussed three ways to expand the fungibility of identical cash flows and the substitutability of nearly identical liabilities. The fungibility of identical cash flows can be enhanced by allowing market participants who reconstitute STRIPS to substitute interest payments and principal payments due on the same date. Aligning the maturity dates of 2-year debt with either the maturity dates of bills or the maturity dates of longer-term debt would also reduce heterogeneity and enhance fungibility. The third proposal, to establish an exchange facility, would directly enhance the substitutability of Treasury securities with nearly identical cash flows.

The market environment created by traders executing arbitrage and relative value transactions in light of expanded opportunities for reconstitution and exchange would complement efforts to maintain liquidity through buybacks of old issues and expanded offerings of new issues. The enhanced liquidity and market integration associated with improved substitutability and fungibility would increase demand and reduce the cost of funding the debt. Allowing the supply of a security to expand beyond its original issue size would provide for some

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[67] The authors are grateful to Yakov Amihud for suggesting such a trial.

[68] Liquidity (and security prices) can also be enhanced by improving the microstructure of a market. See, for example, Amihud, Mendelson and Lauterbach (1997). Amihud and Mendelson (1996) suggest that an issuer should have a property right to determine the market or markets in which its securities are traded as a way to incentivize the innovation of liquidity-enhancing market microstructures.

elasticity in the supply of on-the-run securities and reduce the risk of a squeeze. More generally, greater liquidity and market integration, reduced scarcity risk, and elasticity in the supply of on-the-run debt would help ensure the continued attractiveness of Treasury securities for investing, trading and hedging in an era of surpluses.

Appendix A. Sensitivity of the Cash Payment on an Exchange to the Yields on the Shorter and Longer Securities

This appendix examines whether the size of the cash payment to Treasury resulting from an exchange like that proposed in Section 6 is sensitive to the yields used to value the obligations exchanged. In particular, do small changes in the yields on the shorter and longer securities result in very different cash payments, so that Treasury, or its agent, would have to maintain close contact with evolving market conditions to price an exchange with reasonable accuracy?

Example A1 examines the same exchange as in Example 2, but prices the shorter and longer STRIPS (and hence the intermediate STRIP) at yields that are 10 basis points *lower* than the yields in Example 2. The cash payment to Treasury is $2.29; a difference of less than 1% from the $2.27 payment calculated in Example 2.

Example A2 also examines the same exchange as in Example 2, but in this case using a yield for pricing the shorter STRIP that is 5 basis points *lower* than the yield in Example 2 and a yield for pricing the longer STRIP that is 5 basis points *higher* than the yield in Example 2. The cash payment to Treasury is $2.34; a difference of a bit more than 3% from the $2.27 payment calculated in Example 2.

We conclude that the payment to Treasury is relatively insensitive to moderate variations in (a) the levels of the yields and (b) the difference between the yields on the securities involved in the exchange.

Appendix B. Implications of the Exchange Facility for the Shape of the Yield Curve

We observed in Section 6 that the proposed exchange facility would bound short-range irregularities in the structure of yields on single-payment securities. The yield on a single-payment security could never differ by more than the prescribed exchange fee from the average of the yields on a pair of shorter and longer term single-payment securities for which it can be exchanged.

To preclude the possibility that the exchange facility might affect the over-all shape of the yield curve, we suggested that the difference between the maturities of the longer and shorter securities that can be exchanged for an intermediate maturity security should be limited as shown in Table 7. The limitations are important because if market participants can, without limitation, exchange short-term, e.g., 1-year, STRIPS and long-term, e.g., 25-year, STRIPS for intermediate-term, e.g., 13-year, STRIPS, and vice versa, at an exchange fee of, for example, 2 or 3 basis points, then (in an equilibrium where positive amounts of short-, intermediate-, and long-term STRIPS remain outstanding) the STRIPS yield curve would have to be very close to a straight (but not necessarily flat) line.

The limitations in Table 7 will not preclude *indirect* exchanges of much longer and much shorter securities for an intermediate maturity security, but such indirect exchanges will be prohibitively expensive. We show in this appendix how two STRIPS maturing a year apart could be exchanged for an intermediate maturity STRIP maturing in more than 2 years by combining three exchanges permitted by Table 7, and we also show that the triplet of exchanges is equivalent to a direct exchange for a fee four times larger than the fee prescribed for an exchange that falls within the limitations in Table 7. We conclude that the rapidly escalating costs of more dispersed, indirect, exchanges will, as a practical matter, preclude such exchanges and that the exchange facility can be structured to avoid affecting the over-all shape of the yield curve.

Combining Three Exchanges to Effect an Exchange That Can Not be Done Directly

Suppose the fee on an exchange that falls within the limitations in Table 7 is 2-1/2 basis

points. Using the yields on Interest Component STRIPS on July 22, 1999 from Table 3, we demonstrate how a market participant could indirectly effect an exchange of $1,000 face amount of STRIPS maturing May 15, 2006 and $1,000 face amount of STRIPS maturing a year later, on May 15, 2007, for $2,000 face amount of STRIPS maturing November 15, 2006, for a fee of about 10 basis points. (Note that this exchange can not be done directly for a fee of 2-1/2 basis points, because the difference in the maturities of the shorter and longer STRIPS exceeds the limits in Table 7.)

Exchange 1. Consider first the exchange of:

a) $1,000 face amount of STRIPS maturing May 15, 2006, quoted on July 22, 1999 at a yield of 5.97% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing November 15, 2006, quoted on July 22, 1999 at a yield of 5.96% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing August 15, 2006.

The shorter obligation has an invoice price of 66.98146% of face value,[69] and the longer obligation has an invoice price of 65.08622% of face value.[70] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.940% (5.940% = ½ of 5.97% and 5.96%, minus 2-1/2 basis points) or at an invoice price of 66.13553% of face value.[71]

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[69] $66.98146 = 100.\cdot(1+\frac{1}{2}.0597)^{-(13+115/184)}$, where the obligation has 115 days plus 13 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

[70] $65.08622 = 100.\cdot(1+\frac{1}{2}.0596)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity.

[71] $66.13553 = 100.\cdot(1+\frac{1}{2}.0594)^{-(14+23/181)}$, where the obligation has 23 days plus 14 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

The net funds due Treasury at the time of the exchange on July 23, 1999 is $2.0338, computed as:

- 66.13553% of $2,000 for the intermediate obligation, less
- 66.98146% of $1,000 credit for the shorter obligation, less
- 65.08622% of $1,000 credit for the longer obligation.

Exchange 2. Consider next the exchange of:

a) $1,000 face amount of STRIPS maturing November 15, 2006, quoted on July 22, 1999 at a yield of 5.96% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing May 15, 2007, quoted on July 22, 1999 at a yield of 6.03% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing February 15, 2007.

The shorter obligation has an invoice price of 65.08622% of face value,[72] and the longer obligation has an invoice price of 62.86808% of face value.[73] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.970% (5.970% = ½ of 5.96% and 6.03%, minus 2-1/2 basis points) or at an invoice price of 64.08659% of face value.[74]

The net funds due Treasury at the time of the exchange is $2.1888, computed as:

- 64.08659% of $2,000 for the intermediate obligation, less

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[72] $65.08622 = 100.\cdot(1+\frac{1}{2}.0596)^{-(14+115/184)}$, where the obligation has 115 days plus 13 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

[73] $62.86808 = 100.\cdot(1+\frac{1}{2}.0603)^{-(15+115/184)}$, where the obligation has 115 days plus 15 full semi-annual periods remaining to maturity.

[74] $64.08659 = 100.\cdot(1+\frac{1}{2}.0597)^{-(15+23/181)}$, where the obligation has 23 days plus 15 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

- 65.08622% of $1,000 credit for the shorter obligation, less
- 62.86808% of $1,000 credit for the longer obligation.

Exchange 3. Finally, consider the exchange of:

a) $2,000 face amount of STRIPS maturing August 15, 2006, quoted on July 22, 1999 at a yield of 5.99% for settlement on July 23, 1999, and

b) $2,000 face amount of STRIPS maturing February 15, 2007, quoted on July 22, 1999 at a yield of 6.02% for settlement on July 23, 1999,

for:

c) $4,000 face amount of STRIPS maturing November 15, 2006.

From the calculations in Example 2, the net funds due Treasury at the time of the exchange is $4.5374 ($4.5374 = 2 times $2.2687).

Summary. The *net* effect of the three exchanges is an exchange of:

a) $1,000 face amount of STRIPS maturing May 15, 2006, quoted on July 22, 1999 at a yield of 5.97% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing May 15, 2007, quoted on July 22, 1999 at a yield of 6.03% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing November 15, 2006.

The total payment due Treasury at the time of the composite exchange is $8.7600, computed as:

- $2.0338 for $1,000 face amount of the May, 2006 STRIP and $1,000 face amount of the November, 2006 STRIP exchanged for $2,000 face amount of the August, 2006 STRIP,
- $2.1888 for $1,000 face amount of the November, 2006 STRIP and $1,000 face amount of the May, 2007 STRIP exchanged for $2,000 face amount of the February, 2007 STRIP, and

- $4.5374 for $2,000 face amount of the August, 2006 STRIP and $2,000 face amount of the February, 2007 STRIP exchanged for $4,000 face amount of the November, 2006 STRIP.

Example B1 shows that this combination of exchanges is essentially equivalent to a direct exchange of $1,000 face amount of the May, 2006 STRIP and $1,000 face amount of the May, 2007 STRIP for $2,000 face amount of the November, 2006 STRIP at an exchange fee of 10 basis points, or four times the 2-1/2 basis point fee for an exchange that falls within the limitations in Table 7.

The foregoing calculation implies that the proposed exchange facility would bound the yield on a single-payment security maturing in more than two years to a range of about ± 10 basis points around the average yield on a pair of single-payment securities maturing 6 months earlier and 6 months later. Similar calculations show that if the shorter and longer securities mature 18 months apart, then the range around the average yield is about ± 22-1/2 basis points. If the shorter and longer securities mature 2 years apart, then the range around the average yield is about ± 40 basis points. If the securities mature 3 years apart, the range is about ± 90 basis points, and if the securities mature 4 years apart the range is about ± 160 basis points.[75]

These bands are so wide that it is unlikely that the curvature of the yield curve will be large enough to induce market participants to undertake indirect exchanges of securities maturing more than 6 months apart for an intermediate-term security maturing in more than 2 years, and hence unlikely that the proposed exchange facility will have any effect on the overall shape of the yield curve beyond two years. Since the limits in Table 7 shrink with the maturity of the intermediate security in an exchange, similar conclusions apply to the front end of the curve as

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[75] It can be shown that the magnitude of the range is twice the exchange fee, times the square of the number of half years between the maturities of the shorter and longer STRIPS. For example, if the fee is 2-1/2 basis points and the shorter and longer STRIPS mature 2 years apart, the magnitude of the range is 80 basis points (80 = 2 times 2-1/2 times 4^2, where 2 years is equivalent to 4 half-years).

well.

If, on further examination, the bounds on the curvature of the yield curve described above appear to be too tight, the bounds can be expanded by raising the exchange fee. For example, raising the fee from 2-1/2 basis points to 3-1/2 basis points would expand the band on the yield on a single-payment security around the average yield on a pair of single-payment securities maturing 6 months earlier and 6 months later from 10 basis points to 14 basis points. Similarly, the band around the average yield on a pair of single-payment securities maturing 1 year earlier and 1 year later would expand from 40 basis points to 56 basis points.

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Table 1. 10-year Note and 30-year Bond Offerings in the Quarterly Financing Auctions, 1990 to 1999 (reopenings in boldface)

		10-year Note	30-year Bond
1990	Feb	8-1/2% of Feb 15, 2000	8-1/2% of Feb 15, 2020
	May	8-7/8% of May 15, 2000	8-3/4% of May 15, 2020
	Aug	8-3/4% of Aug 15, 2000	8-3/4% of Aug 15, 2020
	Nov	8-1/2% of Nov 15, 2000	**8-3/4% of Aug 15, 2020**
1991	Feb	7-3/4% of Feb 15, 2001	7-7/8% of Feb 15, 2021
	May	8% of May 15, 2001	8-1/8% of May 15, 2021
	Aug	7-7/8% of Aug 15, 2001	8-1/8% of Aug 15, 2021
	Nov	7-1/2% of Nov 15, 2001	8% of Nov 15, 2021
1992	Feb	**7-1/2% of Nov 15, 2001**	**8% of Nov 15, 2021**
	May	7-1/2% of May 15, 2002	**8% of Nov 15, 2021**
	Aug	6-3/8% of Aug 15, 2002	7-1/4% of Aug 15, 2022
	Nov	**6-3/8% of Aug 15, 2002**	7-5/8% of Nov 15, 2022
1993	Feb	6-1/4% of Feb 15, 2003	7-1/8% of Feb 15, 2023
	May	**6-1/4% of Feb 15, 2003**	**7-1/8% of Feb 15, 2023**
	Aug	5-3/4% of Aug 15, 2003	6-1/4% of Aug 15, 2023
	Nov	**5-3/4% of Aug 15, 2003**	not offered
1994	Feb	5-7/8% of Feb 15, 2004	**6-1/4% of Aug 15, 2023**
	May	7-1/4% of May 15, 2004	not offered
	Aug	7-1/4% of Aug 15, 2004	7-1/2% of Nov 15, 2024 [a]
	Nov	7-7/8% of Nov 15, 2004	not offered

a. 30-1/4-year bond, see footnote 21 to text.

Table 1. (continued)

		10-year Note	30-year Bond
1995	Feb	7-1/2% of Feb 15, 2005	7-5/8% of Feb 15, 2025
	May	6-1/2% of May 15, 2005	not offered
	Aug	6-1/2% of Aug 15, 2005	6-7/8% of Aug 15, 2025
	Nov	5-7/8% of Nov 15, 2005	not offered
1996	Feb	5-5/8% of Feb 15, 2006	6% of Feb 15, 2026
	May	6-7/8% of May 15, 2006	not offered
	Aug	**7% of Jul 15, 2006** [b]	6-3/4% of Aug 15, 2026
	Nov	**6-1/2% of Oct 15, 2006** [c]	6-1/4% of Nov 15, 2026
1997	Feb	6-1/4% of Feb 15, 2007	6-5/8% of Feb 15, 2027
	May	6-5/8% of May 15, 2007	not offered
	Aug	6-1/8% of Aug 15, 2007	6-3/8% of Aug 15, 2027
	Nov	**6-1/8% of Aug 15, 2007**	6-1/8% of Nov 15, 2027
1998	Feb	5-1/2% of Feb 15, 2008	**6-1/8% of Nov 15, 2027**
	May	5-5/8% of May 15, 2008	not offered
	Aug	**5-5/8% of May 15, 2008**	5-1/2% of Aug 15, 2028
	Nov	4-3/4% of Nov 15, 2008	5-1/4% of Nov 15, 2028
1999	Feb	**4-3/4% of Nov 15, 2008**	5-1/4% of Feb 15, 2029
	May	5-1/2% of May 15, 2009	not offered
	Aug	6% of Aug 15, 2009	6-1/8% of Aug 15, 2029
	Nov	**6% of Aug 15, 2009**	not offered

b. Reopening of a 10-year note first offered in July, 1996.
c. Reopening of a 10-year note first offered in October, 1996.

Table 2. Inflation-Indexed Securities (reopenings in boldface)

Auction date	Description	Issue size and date
Jan 29, 1997	3-3/8% of Jan 15, 2007	$7.7 billion on Feb 6, 1997
Apr 8, 1997	**3-3/8% of Jan 15, 2007**	$8.4 billion on Apr 15, 1997
Jul 9, 1997	3-5/8% of Jul 15, 2002	$8.4 billion on Jul 15, 1997
Oct 8, 1997	**3-5/8% of Jul 15, 2002**	$8.4 billion on Oct 15, 1997
Jan 8, 1998	3-5/8% of Jan 15, 2008	$8.4 billion on Jan 15, 1998
Apr 8, 1998	3-5/8% of Apr 15, 2028	$8.4 billion on Apr 15, 1998
Jul 8, 1998	**3-5/8% of Apr 15, 2028**	$8.4 billion on Jul 15, 1998
Oct 7, 1998	**3-5/8% of Jan 15, 2008**	$8.4 billion on Oct 15, 1998
Jan 6, 1999	3-7/8% of Jan 15, 2009	$8.5 billion on Jan 15, 1999
Apr 7, 1999	3-7/8% of Apr 15, 2029	$7.4 billion on Apr 15, 1999
Jul 7, 1999	**3-7/8% of Jan 15, 2009**	$7.4 billion on Jul 15, 1999
Oct 6, 1999	**3-7/8% of Apr 15, 2029**	$7.4 billion on Oct 15, 1999

Table 3. Yields, on July 22, 1999, on Non-fungible STRIPS Maturing on the Same Date

Maturity Date	Interest Component STRIPS	Note Principal Component STRIPS	Bond Principal Component STRIPS
Feb 15, 2004	5.80%	5.69%	na
May 15	5.82	5.75	na
Aug 15	5.79	5.78	na
Nov 15	5.86	5.81	5.89%
Feb 15, 2005	5.91	5.84	na
May 15	5.93	5.83	5.95
Aug 15	5.95	5.86	5.97
Nov 15	5.93	5.86	na
Feb 15, 2006	5.96	5.86	5.91
May 15	5.97	na	na
Aug 15	5.99	na	na
Nov 15	5.96	na	na
Feb 15, 2007	6.02	na	na
May 15	6.03	na	na
Aug 15	6.03	na	na
Nov 15	6.00	na	na
Feb 15, 2008	6.09	na	na
May 15	6.11	na	na
Aug 15	6.12	na	na
Nov 15	6.13	na	na
Feb 15, 2009	6.14	na	na
May 15	6.16	na	na
Aug 15	6.16	na	na
Nov 15	6.17	na	6.27 (callable)
Feb 15, 2010	6.19	na	na
May 15	6.20	na	na
Aug 15	6.21	na	na
Nov 15	6.22	na	na

Table 4. Principal Amount Outstanding and Maximum Additional Amount that Could be Reconstituted from the Principal and Interest Liabilities in Figure 5, Treasury Notes and Non-callable Bonds Maturing in Mid-quarter, as of October 6, 1999

Original Term	Coupon Rate	Maturity Date	Principal Amount Outstanding, $ billions	Maximum Additional Amount, $ billions	Maximum Additional as a Percent of Outstanding
10-yr	7.875	Nov 15, 1999	10.77	17.13	159.0
10-yr	8.500	Feb 15, 2000	10.67	20.94	196.3
10-yr	8.875	May 15, 2000	10.50	16.61	158.2
10-yr	8.750	Aug 15, 2000	11.08	20.45	184.5
10-yr	8.500	Nov 15, 2000	11.52	31.55	273.9
3-yr	5.750	Nov 15, 2000	16.04	27.61	172.2
10-yr	7.750	Feb 15, 2001	11.31	34.92	308.6
3-yr	5.375	Feb 15, 2001	15.37	31.40	204.3
10-yr	8.000	May 15, 2001	12.40	27.66	223.1
3-yr	5.625	May 15, 2001	12.87	27.65	214.8
10-yr	7.875	Aug 15, 2001	12.34	19.25	156.0
10-yr	7.500	Nov 15, 2001	24.23	14.10	58.2
10-yr	7.500	May 15, 2002	11.71	13.67	116.7
10-yr	6.375	Aug 15, 2002	23.86	18.65	78.2
10-yr	6.250	Feb 15, 2003	23.56	17.95	76.2
10-yr	5.750	Aug 15, 2003	28.01	36.50	130.3
5-yr	5.250	Aug 15, 2003	19.85	44.82	225.8
5-yr	4.250	Nov 15, 2003	18.63	13.50	72.5
10-yr	5.875	Feb 15, 2004	12.96	33.27	256.8
5-yr	4.750	Feb 15, 2004	17.82	28.66	160.8
10-yr	7.250	May 15, 2004	14.44	31.07	215.1
5-yr	5.250	May 15, 2004	18.93	27.03	142.8
10-yr	7.250	Aug 15, 2004	13.35	32.43	243.0
5-yr	6.000	Aug 15, 2004	18.09	27.97	154.6
20-yr	11.625	Nov 15, 2004	8.30	25.20	303.5
10-yr	7.875	Nov 15, 2004	14.37	19.73	137.3
10-yr	7.500	Feb 15, 2005	13.84	13.94	100.7
20-yr	12.000	May 15, 2005	4.26	24.72	580.2
10-yr	6.500	May 15, 2005	14.74	15.02	101.9
20-yr	10.750	Aug 15, 2005	9.27	27.49	296.5
10-yr	6.500	Aug 15, 2005	15.00	22.51	150.0
10-yr	5.875	Nov 15, 2005	15.21	10.24	67.3

Table 4. (continued)

Original Term	Coupon Rate	Maturity Date	Principal Amount Outstanding, $ billions	Maximum Additional Amount, $ billions	Maximum Additional as a Percent of Outstanding
20-yr	9.375	Feb 15, 2006	4.76	27.83	585.2
10-yr	5.625	Feb 15, 2006	15.51	17.67	113.9
10-yr	6.875	May 15, 2006	16.02	9.66	60.3
10-yr	6.250	Feb 15, 2007	13.10	12.39	94.5
10-yr	6.625	May 15, 2007	13.96	9.22	66.1
10-yr	6.125	Aug 15, 2007	25.64	11.63	45.4
10-yr	5.500	Feb 15, 2008	13.58	11.31	83.2
10-yr	5.625	May 15, 2008	27.19	8.52	31.3
10-yr	4.750	Nov 15, 2008	25.08	7.98	31.8
10-yr	5.500	May 15, 2009	14.79	7.55	51.1
10-yr	6.000	Aug 15, 2009	14.76	10.85	73.5
30-yr	11.250	Feb 15, 2015	12.67	9.91	78.2
30-yr	10.625	Aug 15, 2015	7.15	9.57	133.9
30-yr	9.875	Nov 15, 2015	6.90	7.07	102.5
30-yr	9.250	Feb 15, 2016	7.27	9.32	128.2
30-yr	7.250	May 15, 2016	18.82	6.50	34.5
30-yr	7.500	Nov 15, 2016	18.86	5.81	30.8
30-yr	8.750	May 15, 2017	18.19	5.02	27.6
30-yr	8.875	Aug 15, 2017	14.02	8.74	62.3
30-yr	9.125	May 15, 2018	8.71	4.63	53.1
30-yr	9.000	Nov 15, 2018	9.03	4.24	46.9
30-yr	8.875	Feb 15, 2019	19.25	7.92	41.1
30-yr	8.125	Aug 15, 2019	20.21	7.16	35.4
30-yr	8.500	Feb 15, 2020	10.23	6.73	65.8
30-yr	8.750	May 15, 2020	10.16	3.82	37.6
30-yr	8.750	Aug 15, 2020	21.42	5.82	27.2
30-yr	7.875	Feb 15, 2021	11.11	5.43	48.8
30-yr	8.125	May 15, 2021	11.96	3.36	28.1
30-yr	8.125	Aug 15, 2021	12.16	4.94	40.7
30-yr	8.000	Nov 15, 2021	32.80	2.10	6.4
30-yr	7.250	Aug 15, 2022	10.35	4.60	44.5
30-yr	7.625	Nov 15, 2022	10.70	1.72	16.0
30-yr	7.125	Feb 15, 2023	18.37	3.97	21.6
30-yr	6.250	Aug 15, 2023	22.91	3.30	14.4
30-yr	7.500	Nov 15, 2024	11.47	1.30	11.3

Table 4. (continued)

Original Term	Coupon Rate	Maturity Date	Principal Amount Outstanding, $ billions	Maximum Additional Amount, $ billions	Maximum Additional as a Percent of Outstanding
30-yr	6.750	Aug 15, 2026	10.89	1.71	15.7
30-yr	6.500	Nov 15, 2026	11.49	0.95	8.2
30-yr	6.625	Feb 15, 2027	10.46	1.37	13.1
30-yr	6.375	Aug 15, 2027	10.74	1.04	9.7
30-yr	6.125	Nov 15, 2027	22.52	0.28	1.2
30-yr	5.500	Aug 15, 2028	11.78	0.73	6.2
30-yr	5.250	Nov 15, 2028	10.95	0.00	0.0
30-yr	5.250	Feb 15, 2029	11.35	0.33	2.9
30-yr	6.125	Aug 15, 2029	11.18	0.00	0.0

Table 5. Number of New Treasury Securities Offered, fiscal year, excluding reopenings

	Oct 1, 1984 - Sep 30, 1985	Oct 1, 1991 - Sep 30, 1992	Oct 1, 1998 - Sep 30, 1999
Bills			
Cash management	0	0	6
26-week	39	38	40
52-week	13	13	13
Sub-total	52	51	59
Conventional Notes and Bonds			
2-year	13	12	12
3-year	4	4	0
4-year	4	0	0
5-year	4	12	4
7-year	4	4	0
10-year	4	3	3
20-year	3	0	0
30-year	3	2	3
Sub-total	39	37	22
Foreign-Targeted Notes			
4-year	1	0	0
5-year	2	0	0
10-year	0	0	0
Sub-total	3	0	0
Inflation-Indexed Notes and Bonds			
5-year	0	0	0
10-year	0	0	1
30-year	0	0	1
Sub-total	0	0	2
Total	94	88	83

Table 6. Treasury Bill Yields on July 22, 1999

Maturity Date	Discount Rate	Yield
Jul 29, 1999	3.96%	4.02%
Aug 5	4.24	4.31
Aug 12	4.33	4.40
Aug 19	4.33	4.40
Aug 26	4.32	4.40
Sep 2	4.39	4.47
Sep 9	4.38	4.47
Sep 16	4.37	4.46
Sep 23	4.39	4.48
Sep 30	4.33	4.43
Oct 7	4.41	4.51
Oct 14	4.44	4.55
Oct 21	4.46	4.57
Oct 28	4.47	4.59
Nov 4	4.50	4.62
Nov 12	4.51	4.64
Nov 18	4.50	4.63
Nov 26	4.50	4.64
Dec 2	4.51	4.65
Dec 9	4.54	4.69
Dec 16	4.55	4.70
Dec 23	4.56	4.71
Dec 30	4.50	4.66
Jan 6, 2000	4.44	4.60
Jan 13	4.44	4.60
Jan 20	4.46	4.63
Jan 27	4.51	4.68
Feb 3	4.41	4.57
Mar 2	4.51	4.68
Mar 30	4.51	4.69
Apr 27	4.54	4.73
May 25	4.59	4.80
Jun 22	4.66	4.88
Jul 20	4.71	4.95

Table 7. Suggested Limitations on Exchanges of Single-payment Securities

If the intermediate maturity security in a proposed exchange has a remaining term to maturity of less than…	…then the difference between the maturities of the shorter and longer securities that can be exchanged for the intermediate maturity security should be no more than …
13 weeks	2 weeks
26 weeks	4 weeks
52 weeks	6 weeks
2 years	4 months
longer than 2 years	6 months

Example 1. Converting a Higher Coupon Security into a Lower Coupon Security and STRIPS

This example describes how a market participant could convert $1.6 million principal value of the 11-5/8% bond of November 15, 2004 into (a) $1.6 million principal value of the 7-7/8% note of November 15, 2004 and (b) a portfolio of STRIPS, with a face amount of $30,000 each, payable every six months until and including May 15, 2004.

Following the interest payment on November 15, 1999, $1,600,000 principal amount of the 11-5/8% bond of November 15, 2004 promised to pay $93,000 interest every six months from May 15, 2000 to November 15, 2004, inclusive, and to repay principal of $1,600,000 at maturity. Assuming that all STRIPS maturing on the same date are fungible, $1,600,000 principal amount of the 11-5/8% bond could be stripped into nine STRIPS with a face amount of $93,000 each, payable every six months from May 15, 2000 to May 15, 2004, inclusive, and a tenth STRIP with a face amount of $1,693,000, payable on November 15, 2004.

Also following the interest payment on November 15, 1999, $1,600,000 principal amount of the 7-7/8% note of November 15, 2004 promised to pay $63,000 interest every six months from May 15, 2000 to November 15, 2004, inclusive, and to repay principal of $1,600,000 at maturity.

It follows that $1,600,000 principal amount of the 7-7/8% note could be reconstituted from the STRIPS derived from the 11-5/8% bond, and that ten STRIPS, with a face amount of $30,000 each, payable every six months from May 15, 2000 to November 15, 2004, inclusive, would remain outstanding.

Example 2. Exchange of Shorter and Longer Maturity STRIPS for an Intermediate Maturity

Consider the exchange of:

a) $1,000 face amount of STRIPS maturing August 15, 2006, quoted on July 22, 1999 at a yield of 5.99% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing February 15, 2007, quoted on July 22, 1999 at a yield of 6.02% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing November 15, 2006.

The shorter obligation has an invoice price of 65.90911% of face value,[76] and the longer obligation has an invoice price of 63.85172% of face value.[77] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.98% (5.98% = ½ of 5.99% and 6.02%, minus 2-1/2 basis points) or at an invoice price of 64.99385% of face value.[78]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $2.2687, computed as:

- 64.99385% of $2,000 for the intermediate obligation, less
- 65.90911% of $1,000 credit for the shorter obligation, less
- 63.85172% of $1,000 credit for the longer obligation.

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[76] $65.90911 = 100.\cdot(1+\frac{1}{2}.0599)^{-(14+23/181)}$, where the obligation has 23 days plus 14 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

[77] $63.85172 = 100.\cdot(1+\frac{1}{2}.0602)^{-(15+23/181)}$, where the obligation has 23 days plus 15 full semi-annual periods remaining to maturity.

[78] $64.99385 = 100.\cdot(1+\frac{1}{2}.0598)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

Example 3. Exchange of an Intermediate Maturity STRIP for Shorter and Longer Maturities

Consider the exchange of:

a) $2,000 face amount of STRIPS maturing November 15, 2006,

for

b) $1,000 face amount of STRIPS maturing August 15, 2006, quoted on July 22, 1999 at a yield of 5.99% for settlement on July 23, 1999, and

c) $1,000 face amount of STRIPS maturing February 15, 2007, quoted on July 22, 1999 at a yield of 6.02% for settlement on July 23, 1999.

The shorter obligation has an invoice price of 65.90911% of face value,[79] and the longer obligation has an invoice price of 63.85172% of face value.[80] For purposes of the exchange, the intermediate obligation is valued at a yield of 6.03% (6.03% = ½ of 5.99% and 6.02%, plus 2-1/2 basis points) or at an invoice price of 64.76355% of face value.[81]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $2.3373, computed as:

- 65.90911% of $1,000 for the shorter obligation, plus
- 63.85172% of $1,000 for the longer obligation, less
- 64.76355% of $2,000 credit for the intermediate obligation.

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[79] $65.90911 = 100.\cdot(1+\frac{1}{2}.0599)^{-(14+23/181)}$, where the obligation has 23 days plus 14 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

[80] $63.85172 = 100.\cdot(1+\frac{1}{2}.0602)^{-(15+23/181)}$, where the obligation has 23 days plus 15 full semi-annual periods remaining to maturity.

[81] $64.76355 = 100.\cdot(1+\frac{1}{2}.0603)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

Example 4. Exchange of an Intermediate Maturity STRIP for Shorter and Longer Bills

Consider the exchange of:

a) $2,000 face amount of STRIPS maturing November 15, 1999,

for

b) $1,000 face amount of bills maturing November 12, 1999, quoted on July 22, 1999 at a discount rate of 4.51% for settlement on July 23, 1999, and

c) $1,000 face amount of bills maturing November 18, 1999, quoted on July 22, 1999 at a discount rate of 4.50% for settlement on July 23, 1999.

The shorter bill has a yield of 4.638% and an invoice price of 98.59689% of face value,[82] and the longer bill has a yield of 4.631% and an invoice price of 98.52500% of face value.[83] For purposes of the exchange, the intermediate STRIP is valued at a yield of 4.660% (4.660% = ½ of 4.638% and 4.631%, plus 2-1/2 basis points) or at an invoice price of 98.53322% of face value.[84]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $.1583, computed as:

- 98.59689% of $1,000 for the shorter bill, plus
- 98.52500% of $1,000 for the longer bill, less
- 98.55303% of $2,000 credit for the intermediate STRIP.

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[82] $98.59689 = 100 - \frac{112}{360}4.51$, where the bill has 112 days remaining to maturity. The yield is the value of R that satisfies the equation $98.59689 = 100 \cdot (1 + \frac{112}{365}R)^{-1}$, or R = .04638.

[83] $98.52500 = 100 - \frac{118}{360}4.50$, where the bill has 118 days remaining to maturity. The yield is the value of R that satisfies the equation $98.52500 = 100 \cdot (1 + \frac{118}{365}R)^{-1}$, or R = .04631.

[84] $98.55303 = 100 \cdot (1 + \frac{115}{365}.04660)^{-1}$, where the STRIP has 115 days remaining to maturity. Note that, for consistency, we here relate the yield and invoice price of the STRIP using the same equation used to relate the yield and invoice price of a bill with less than 183 days remaining to maturity.

Example A1. Exchange of Shorter and Longer Maturity STRIPS for an Intermediate Maturity When the Level of Yields is 10 Basis Points Lower

Consider the exchange of:

a) $1,000 face amount of STRIPS maturing August 15, 2006, priced at a yield of 5.89% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing February 15, 2007, priced at a yield of 5.92% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing November 15, 2006.

The shorter obligation has an invoice price of 66.36279% of face value,[85] and the longer obligation has an invoice price of 64.32239% of face value.[86] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.88% (5.88% = ½ of 5.89% and 5.92%, minus 2-1/2 basis points) or at an invoice price of 65.45708% of face value.[87]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $2.2898, computed as:

- 65.45708% of $2,000 for the intermediate obligation, less
- 66.36279% of $1,000 credit for the shorter obligation, less
- 64.32239% of $1,000 credit for the longer obligation.

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[85] $66.36279 = 100.\cdot(1+\frac{1}{2}.0589)^{-(14+23/181)}$, where the obligation has 23 days plus 14 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

[86] $64.32239 = 100.\cdot(1+\frac{1}{2}.0592)^{-(15+23/181)}$, where the obligation has 23 days plus 15 full semi-annual periods remaining to maturity.

[87] $65.45708 = 100.\cdot(1+\frac{1}{2}.0588)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

Example A2. Exchange of Shorter and Longer Maturity STRIPS for an Intermediate Maturity When the Difference Between the Yields on the Longer and Shorter STRIPS is 10 Basis Points Larger

Consider the exchange of:

a) $1,000 face amount of STRIPS maturing August 15, 2006, priced at a yield of 5.94% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing February 15, 2007, priced at a yield of 6.07% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing November 15, 2006.

The shorter obligation has an invoice price of 66.13553% of face value,[88] and the longer obligation has an invoice price of 63.61776% of face value.[89] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.98% (5.98% = ½ of 5.94% and 6.07%, minus 2-1/2 basis points) or at an invoice price of 64.99385% of face value.[90]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $2.3441, computed as:

- 64.99385% of $2,000 for the intermediate obligation, less
- 66.13553% of $1,000 credit for the shorter obligation, less
- 63.61776% of $1,000 credit for the longer obligation.

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88 $66.13553 = 100.\cdot(1+\frac{1}{2}.0594)^{-(14+23/181)}$, where the obligation has 23 days plus 14 full semi-annual periods remaining to maturity, and where there are 181 in the semi-annual interval from February 15, 1999 to August 15, 1999.

89 $63.61776 = 100.\cdot(1+\frac{1}{2}.0607)^{-(15+23/181)}$, where the obligation has 23 days plus 15 full semi-annual periods remaining to maturity.

90 $64.99385 = 100.\cdot(1+\frac{1}{2}.0598)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

Example B1. Exchange of Shorter and Longer Maturity STRIPS for an Intermediate Maturity When the Exchange Fee is 10 Basis Points

Consider the exchange of:

a) $1,000 face amount of STRIPS maturing May 15, 2006, quoted on July 22, 1999 at a yield of 5.97% for settlement on July 23, 1999, and

b) $1,000 face amount of STRIPS maturing May 15, 2007, quoted on July 22, 1999 at a yield of 6.03% for settlement on July 23, 1999,

for:

c) $2,000 face amount of STRIPS maturing November 15, 2006.

when the fee for the exchange is 10 basis points. The shorter obligation has an invoice price of 66.98146% of face value,[91] and the longer obligation has an invoice price of 62.86808% of face value.[92] For purposes of the exchange, the intermediate obligation is valued at a yield of 5.90% (5.90% = ½ of 5.97% and 6.03%, minus 10 basis points) or at an invoice price of 65.36415% of face value.[93]

The net funds due Treasury at the time of the exchange on July 23, 1999 is $8.7876, computed as:

- 65.36415% of $2,000 for the intermediate obligation, less
- 66.98146% of $1,000 credit for the shorter obligation, less
- 62.86808% of $1,000 credit for the longer obligation.

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91 $66.98146 = 100.\cdot(1+\frac{1}{2}.0597)^{-(13+115/184)}$, where the obligation has 115 days plus 13 full semi-annual periods remaining to maturity, and where there are 184 in the semi-annual interval from May 15, 1999 to November 15, 1999.

92 $62.86808 = 100.\cdot(1+\frac{1}{2}.0603)^{-(15+115/184)}$, where the obligation has 115 days plus 15 full semi-annual periods remaining to maturity.

93 $65.36415 = 100.\cdot(1+\frac{1}{2}.0590)^{-(14+115/184)}$, where the obligation has 115 days plus 14 full semi-annual periods remaining to maturity.