

Development of the Market for U.S. Treasury STRIPS

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In the 1980s, large amounts of coupon-bearing U.S. Treasury securities were stripped. The process of stripping involves selling the individual coupons and the par values separately as zero-coupon bonds. These so-called STRIPS appeal to investors who want to lock in a terminal value without incurring the risk associated with reinvesting intervening cash flows. Because the prices of STRIPS are highly sensitive to interest rate changes, STRIPS also appeal to investors who feel they can benefit from forecasting changes in interest rates.

Many factors affect the value of STRIPS. These include the shape of the term structure of interest rates, tax rules and rates, bond maturities, and the relative demand for zero-coupon bonds.

A bond that has been stripped can be put back together, or rebundled. Arbitragers continually monitor the prices of STRIPS and underlying coupon-bearing bonds, looking for profitable opportunities to strip or rebundle. Because of their actions, the prices of STRIPS and their underly-

ing bonds will tend to converge.

When the stripping of U.S. Treasury bonds first began in 1982, the resulting zero-coupon derivatives generated a great deal of attention. The market for these stripped securities is still strong, and the Treasury continues to issue bonds that can be used for the purpose of stripping. Examining these securities in some detail enables us to understand why they continue to play an important and unique role in portfolios today.

Corporate versus Treasury Zeros

Zero-coupon bonds serve as an excellent investment for individuals who wish to immunize their portfolios against the interest rate risk associated with the reinvestment of coupons from coupon-bearing bonds. "Zeros" allow the investor to lock in today some terminal value to be received at a specific date in the future, because they pay a single face value at maturity with no intermediate coupon payments. This feature of zero-coupon securities makes them an attractive investment for portfolios geared toward retirement and tuition, which require a fixed sum of money at a future date.

Most corporate and municipal bonds with maturities exceeding one year pay semiannual coupons. Only a small proportion are zero-coupon bonds. Of the \$326 billion of corporate bonds issued in 1987, only about \$432 million were zero-coupon bonds. Issuance of zeros has increased since then, but they still remain a small proportion of total issues. Of the

\$353 billion of new corporate bonds issued in 1988, \$925 million were zeros (some convertible) and in 1989, when approximately \$319 billion of corporate bonds were issued, \$2,715 million were zeros (some convertible). For many investors, corporate zeros are undesirable because of default risk, call features and limited marketability.

In recent years, however, a sizable portion of U.S. Treasury bonds has been transformed into zero-coupon bonds. The transformation process decomposes coupon bonds into zero-coupon bonds by "stripping" them. (Prior to stripping, Treasury zeros were available only in the form of Treasury bills, which have maturities of one year or less.) Investors who wish to immunize portfolios against reinvestment risk find Treasury zeros superior to corporate zeros for several reasons. First, there is no risk of default, as the underlying bonds are backed by the government. Second, Treasury zeros are noncallable. Third, they are highly marketable, an active market having developed for these so-called Treasury STRIPS (Separate Trading of Registered Interest and Principal of Securities).

Treasury Stripping

Suppose there is a 10-year bond available for stripping. That means there are 20 semiannual coupon payments plus the final payment at maturity, resulting in a total of 21 individual cash flows over the life of the bond. Each of these can be sold separately when they are stripped from the coupon bond.

Suppose this 10-year bond has a par value of \$1000, is currently selling at par, and has a coupon

Glossary

► **Book Entry System:**

A computerized record for registering ownership of Treasury securities maintained by the Federal Reserve.

► **Rebundling:**

A coupon-bearing bond decomposed into STRIPS may be put back together (i.e., rebundled) into the original bond.

► **Constant-Yield Method:**

For STRIPS, the Internal Revenue Service requires that the discount from the face (par) value must be amortized as taxable income over the life of the STRIPS. For a bond held t periods after it is originally purchased, the amount amortized for period t is the basis at time t minus the basis at time $t - 1$. Let the purchase price of a STRIPS per dollar of par value be S for a STRIPS purchased with n years to maturity. The original yield to maturity is the rate y satisfying $S = 1/(1 + y)^n$. The basis for period t is $S[(1 + y)^t - (1 + y)^{t-1}]$.

► **Term Structure of Interest Rates:**

The interest rates for all maturities (or terms to maturity).

rate of 8% (implying semiannual interest payments of \$40). Table I gives the prices for the stripped components of this bond, assuming a flat term structure of interest rates. In this case, the portfolio of STRIPS has the same present value as the original coupon bond.

The Mechanics

Originally, Treasuries that were stripped had to be put in trust, and claims were then sold on the coupons and par value. These strips had many acronyms, including TIGRs (Treasury Investment Growth Receipts, issued by Merrill Lynch) and CATS (Certifi-

Table I Prices for Stripped Components of 8%, 10-Year Coupon-Bearing Bond

Time to Maturity (years)	Payment	Price of Stripped Component
0.5	\$ 40	\$ 38.46
1.0	40	36.98
1.5	40	35.56
2.0	40	34.19
2.5	40	32.88
3.0	40	31.61
3.5	40	30.40
4.0	40	29.23
4.5	40	28.10
5.0	40	27.02
5.5	40	25.98
6.0	40	24.98
6.5	40	24.02
7.0	40	23.10
7.5	40	22.21
8.0	40	21.36
8.5	40	20.54
9.0	40	19.75
9.5	40	18.99
10.0	40	18.25
10.0	1000	456.39
		<u>\$1000.00</u>

cates of Accrual on Treasury Securities, issued by Salomon Brothers). Over the four-year period 1982-85, approximately \$57 billion in par value of Treasuries were stripped in this fashion (see Table II).

Table II End-of-Year Cumulative Total Par Values of Bonds Underlying Stripped Treasuries (billions of dollars)

Year	CATS, TIGRS & TRs	STRIPS
1982	1.67	*
1983	6.57	*
1984	24.74	*
1985	56.74	22.95
1986	+	32.44
1987	+	44.77
1988	+	70.21
1989	+	81.59
1990	+	113.59

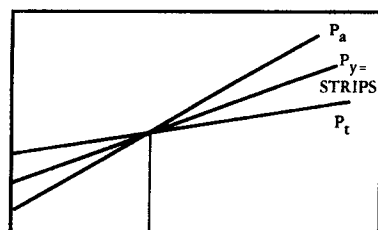
Source: Monthly statement of the public debt.
* STRIPS were not available until 1985.
+ CATS and TIGRS formed directly from STRIPS.

The procedure involved setting up trust accounts, marketing the stripped securities, and bearing the risk of possible losses from interest rate changes. The latter risk relates to the possibility that the underlying bonds could decline in value before the strips were sold. While issuers of stripped securities could hedge this risk using Treasury bond futures, the costs of hedging, together with the costs of administration and marketing, may have restricted the size of the early market for strips.

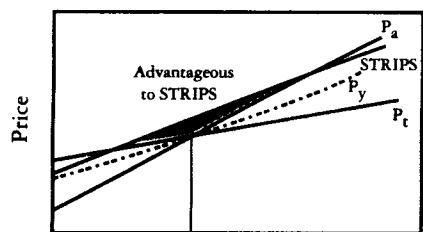
Beginning in 1985, the U.S. Treasury allowed stripping through book entry in the so-called STRIPS program. The **book en-**

Figure A Effects of Term Structure

Flat Term Structure



Rising Term Structure



Declining Term Structure

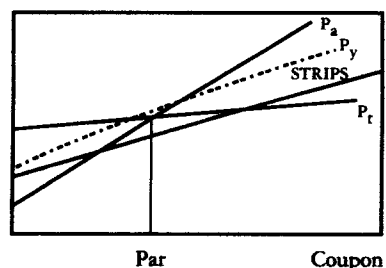
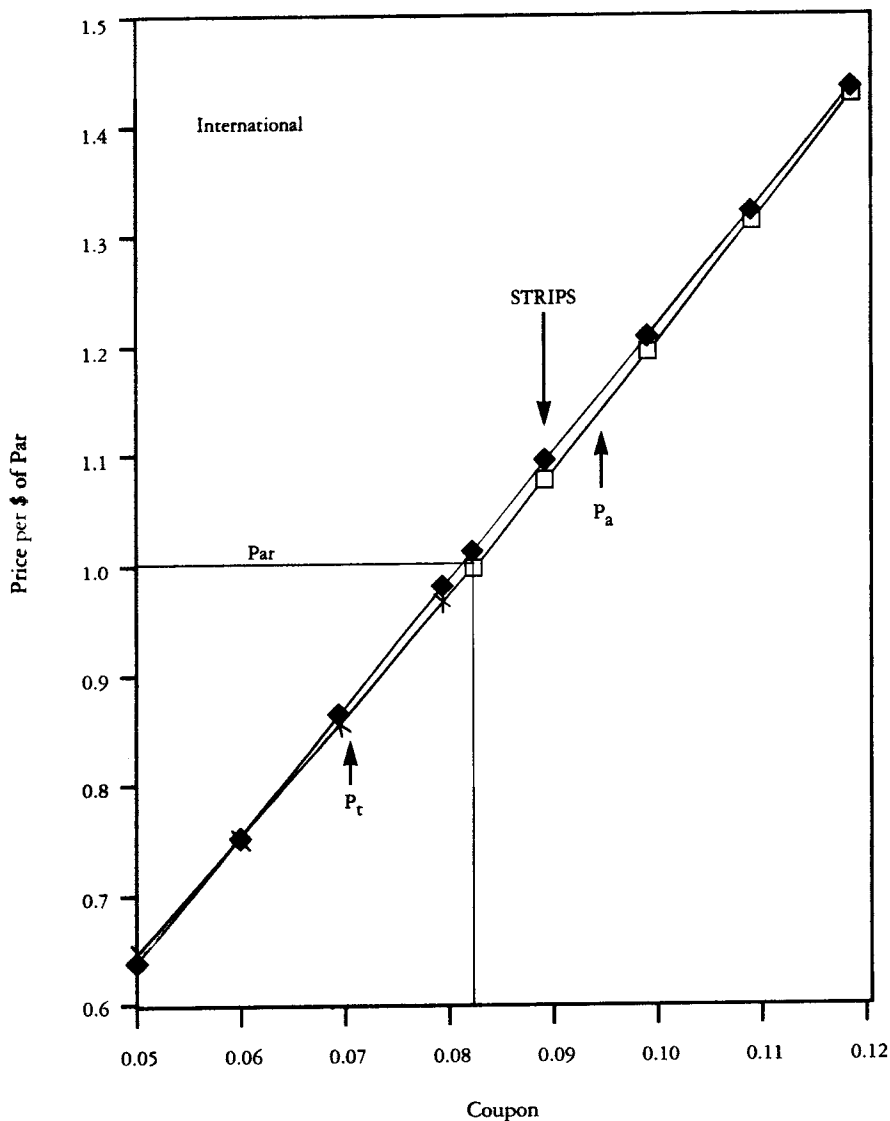


Figure B STRIPS vs. Underlying Bond at Low Tax Rate



number in the event the bond is stripped.¹ Institutions are allowed to rebundle, or reconstitute, bonds. The CUSIP numbers force bundlers to reconstitute the bond into its original form.² Table III shows the amounts rebundled for July and December of each year through 1990 since **re-bundling** has been permitted.

Why Treasury Stripping Began

The most plausible explanation for the sudden emergence of coupon stripping in 1982 is the change in the tax laws for original-issue discount securities. When a zero-coupon bond is purchased, the discount from par is amortized over time as taxable income. Prior to July 1982, the entire discount from par was amortized using the linear method, which requires that an equal amount of the discount be taxed in each year of the bond's life. The amortization schedule under the linear method was disadvantageous to the buyer, because taxes were paid relatively soon.

The method for amortizing the discount from par was changed in mid-1982. Under the new tax law, amortization proceeds geometrically. The amount amortized at the beginning is much less than the amount amortized toward the end of the life of the bond. This postpones the payment of taxes, a desirable feature for bond purchasers.

try system allows members of the Fed to hold securities directly in a computerized system. This system is much less expensive than using private trust accounts, and STRIPS have come to dominate completely the stripped-bond market, as Table II shows.

Traditionally, Treasuries were callable during the last five years of their maturity. Selling the strips from this part of the bond was difficult, because of the possibility of a call before final maturity. Since the introduction of the

STRIPS program, the government has been issuing noncallable bonds, which are more amenable to stripping.

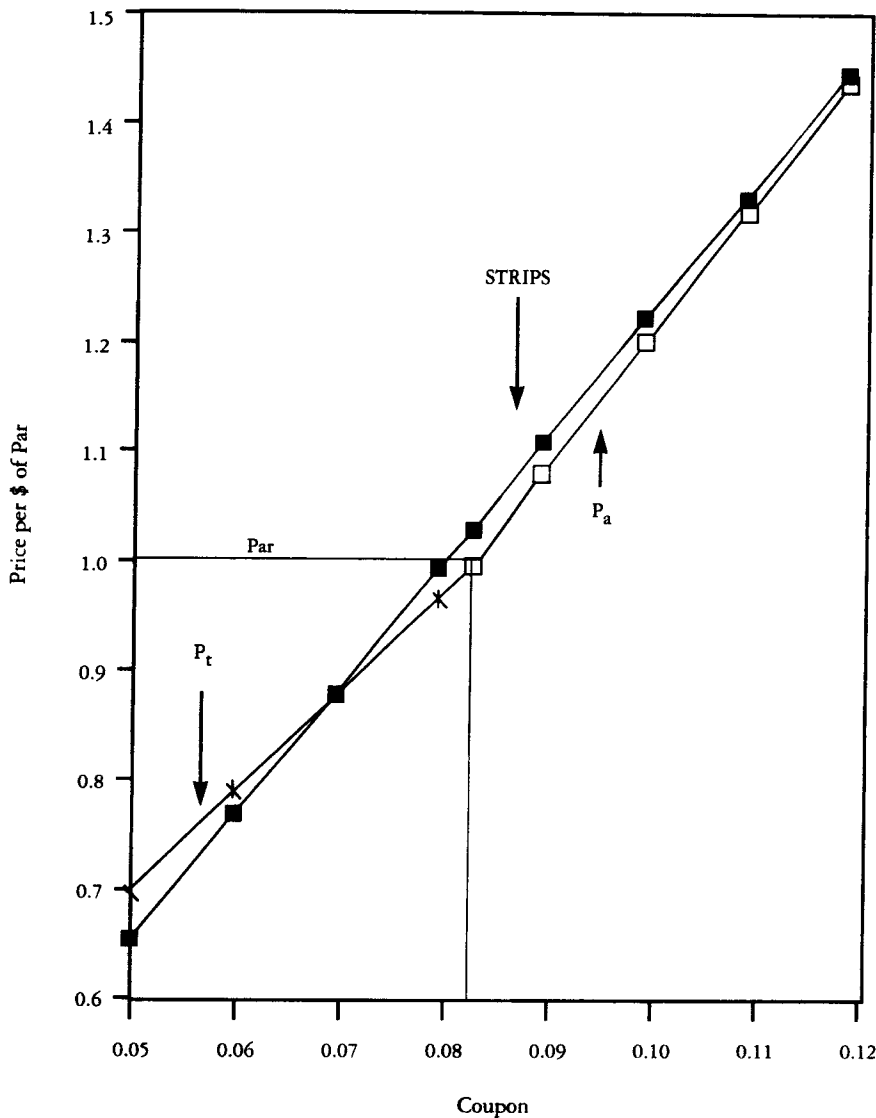
Any financial institution that is registered with the Fed's computer may strip designated Treasury bonds. All bonds are assigned a CUSIP number for identification, but those eligible for stripping are assigned multiple CUSIP numbers so that each interest payment and the principal payment will have its own

Table III Volume of Rebundling for Selected Months

Date	Gross Amount Reconstituted (\$ billions)
July 1987	2.52
December 1987	0.75
July 1988	0.45
December 1988	1.07
July 1989	2.09
December 1989	1.28
July 1990	3.46
December 1990	5.08

Source: Monthly statement of the public debt

Figure C STRIPS vs. Underlying Bond at High Tax Rate



Advantages of Stripping

There are two reasons why the STRIPS of a bond may have a higher combined value than the underlying bond itself. First, when investor demand for zeros is strong, decomposing an underlying bond into STRIPS and selling these to a variety of different investors may be more profitable than selling the bond intact. Second, because of differences in taxation, a portfolio of STRIPS may have a higher value than the underlying bond when the term structure is rising. The bond strip-

per can benefit in both of these scenarios.

Arbitrage between Zeros and Underlying Bonds

The actions of bond strippers will tend to force the value of underlying bonds to be the higher of their value as a portfolio of STRIPS or their value as intact bonds. Consider the hypothetical case of two types of coupon-bearing bonds—one that can be stripped only once and one that can never be stripped (i.e., an unstrippable bond). One can

then construct from the strip-able bond a portfolio of STRIPS that resembles a coupon-bearing bond.

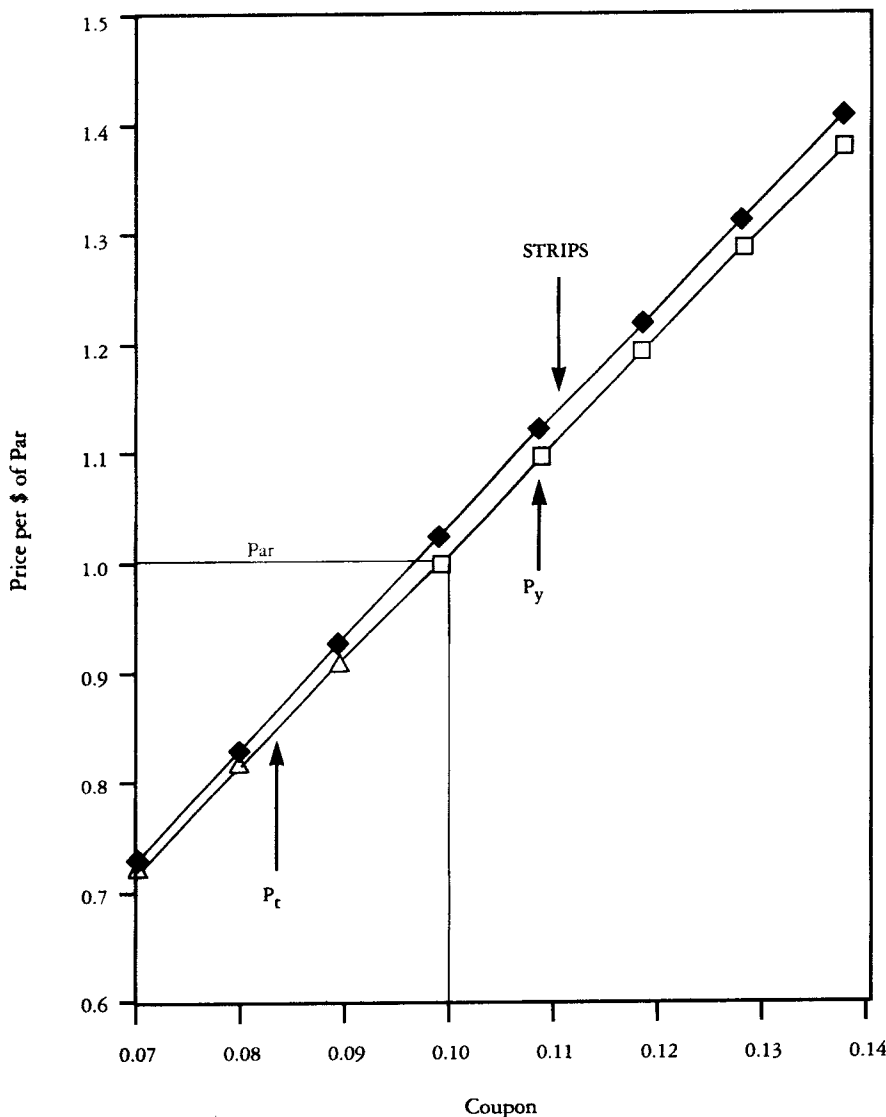
The value of the strip-able bond should not differ from the value of the portfolio comprising its STRIPS. If the portfolio of STRIPS is selling for more than the strip-able bond, the underlying bond will be stripped for an arbitrage profit. The actions of arbitrageurs will force the prices to be equal. Furthermore, the strip-able bond must have a value at least as great as the value of the unstrippable bond, because the strip-able bond entitles the owner to the same cash flows as the unstrippable bond, *plus* it provides an option to strip. This option will have a positive value.

Suppose, for example, that an underlying bond had a value of \$100 and that the STRIPS from this bond could be sold for \$102. Arbitrageurs would step in, buy the underlying coupon-bearing bond for \$100, decompose it into STRIPS and sell them for \$102 to obtain a risk-free arbitrage profit of \$2. This arbitrage opportunity will force the price of the underlying bond to be no less than the price of the portfolio of STRIPS.

STRIPS may be rebundled (or reconstituted) into the original underlying bond. Thus, if the market value of the underlying bonds is higher than the value of the portfolio of their STRIPS, the STRIPS will be rebundled to form the original bonds. Arbitrage will again cause prices to converge. As Table III indicates, rebundling occurs quite often. This is consistent with arbitrageurs taking advantage of temporary price disparities between STRIPS and their underlying bonds.

The Treasury can reap the advantages of zeros without actually issuing zeros itself. Assume, for example, that a nonstrippable bond had a market value of \$98, but that a portfolio of STRIPS from a comparable bond would have a market value of \$100. The

Figure D STRIPS vs. Underlying Bond when Interest Rates are Low



July 1984, regular income tax rates are applied to losses and gains; holders of bonds issued after that date have the option of amortizing the discount over the life of the bond. Holders of premium bonds issued before September 1985 are permitted to use linear amortization; the constant-yield method may be applied to premium bonds issued after September 1985.

Factors Influencing the Value of STRIPS

Tax treatment differentials and demand for zeros may make a portfolio of STRIPS more valuable than the underlying bond. Other factors that can increase the advantages of STRIPS include (1) a rising term structure, (2) higher income tax rates, (3) a higher level of interest rates, (4) longer bond maturities and (5) a steeper yield curve.

Term Structure

Figure A illustrates the impact of taxes and the term structure of interest rates on the value of STRIPS relative to underlying bonds.⁴ It shows, for a given maturity, the relation between bond prices and coupon levels under flat, rising and declining term structures. P_t represents bond prices assuming regular tax rates, P_y represents prices assuming a constant-yield tax method, and P_a represents prices using the linear amortization tax treatment.

Treasury could sell a strippable underlying bond for \$100—the higher of the two values—and reap the advantage of stripping for itself.

Taxes and Stripping

The tax advantage of stripping depends upon the tax treatment of the underlying bond and the tax treatment of the portfolio of STRIPS.³ Different methods may be applied in taxing the two securities.

The constant-yield method is used to determine taxes on orig-

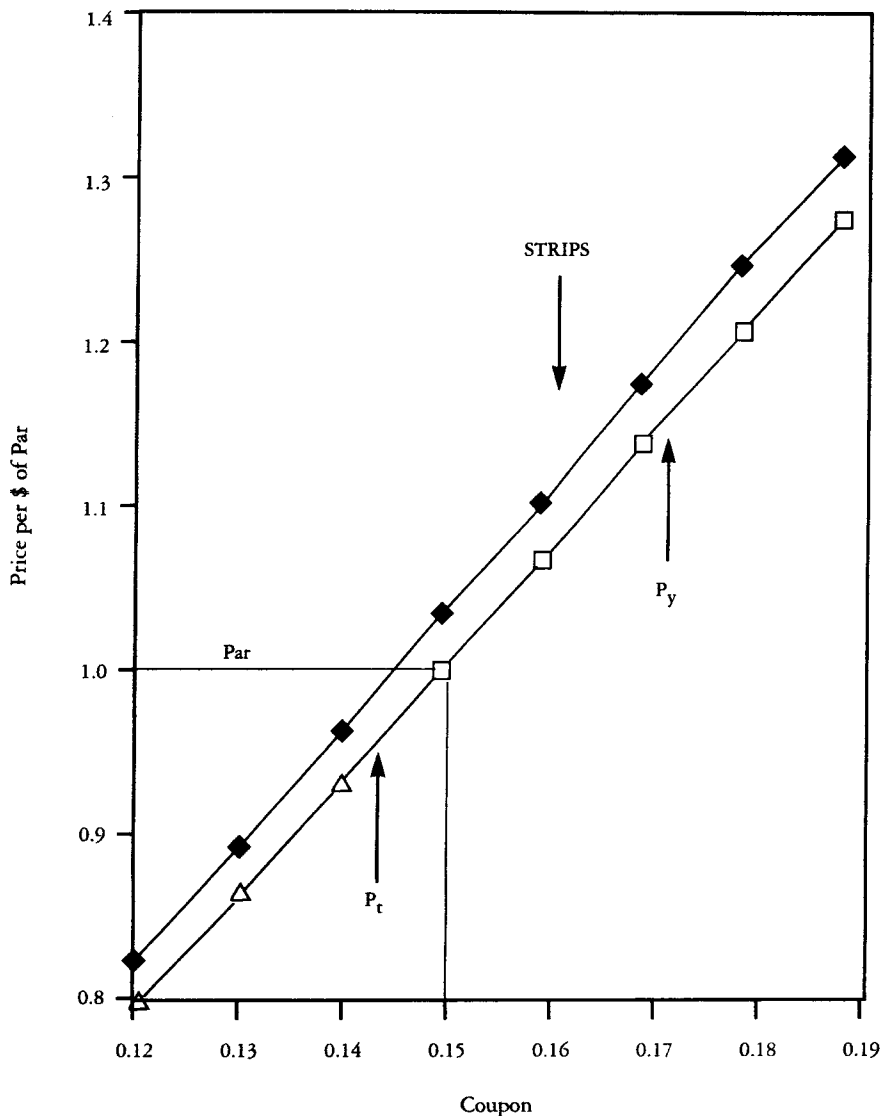
inal-issue discount securities and stripped securities. This method implicitly assumes that the yield to maturity at the time of purchase is constant over the life of the bond. The tax basis is assumed to increase at this yield over the STRIPS' life. Taxes are paid at regular income rates, even though no interest is received.

For underlying bonds originally sold at par, the tax treatment depends on whether the bond is selling at a premium to or a discount from par. For discount bonds that were issued before

In the case of a flat term structure, given the tax treatment options, the value of STRIPS can never exceed the value of the unstripped coupon-bearing bond.⁵ In fact, only in the case of a par bond do STRIPS have the same value as the unstripped bond.

For a rising term structure, a portfolio of STRIPS typically has a higher value than the underlying unstripped bond at coupon levels in an interval around par. This is because STRIPS enjoy a more favorable tax treatment when the term structure is rising. Use of the constant-yield method, which

Figure E STRIPS vs. Underlying Bond when Interest Rates are High



postpones tax payments on STRIPS, may create a tax advantage of several percentage points.

Under a declining term structure, taxes will tend to disadvantage STRIPS. The present value of tax liabilities are relatively high for STRIPS with a declining term structure. Rebundling may be advantageous in such an environment.

Tax Rates

As tax rates increase, the value of STRIPS increases relative to the underlying bond because the tax

differential between the two securities becomes more pronounced. Figures B and C illustrate this point, using tax rates of 28% and 50%, respectively. The term structure is assumed to increase at a proportionate rate of 10% for the first 10 years but to remain flat for the remaining 20 years.

In both figures, the underlying bond is priced at the regular tax rate when it is below par (P_t) and with linear amortization when it is above par (P_a). Both figures show the advantage of stripping

to be greatest around par. It is also greater at the higher tax rate.

Level of Interest Rates

Increases in the level of interest rates increase the advantages of stripping. Figures D and E compare two 30-year bonds. Figure D assumes a par-value coupon of 10% and Figure E a par-value coupon of 15%. The term structure is assumed to increase proportionately at a rate of 5%.

Here we assume the underlying bond at discount is taxed at a regular income tax rate of 28% (P_t) and that the underlying bond at premium is taxed using the constant-yield method (P_y). These treatments would apply to bonds issued after September 27, 1985.

The portfolio of STRIPS has a higher value than the underlying bond at all coupon levels considered. This is because the constant-yield method applied to premium bonds results in a lower price than with linear amortization. Furthermore, the differences between the STRIPS portfolio and the underlying bond are greater in the high interest rate environment than in the low interest rate environment.

Bond Maturities

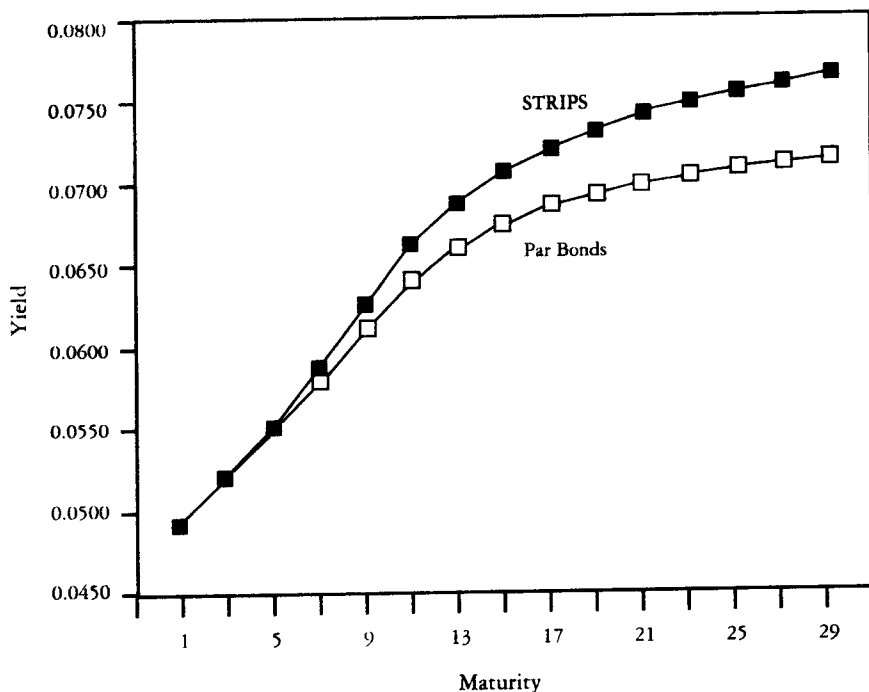
The longer the maturity of the underlying bond, the higher the value of the STRIPS will be, everything else equal. (Stripping also becomes more profitable, the wider the range of coupon levels.) This can be demonstrated by comparing a five-year with a 25-year bond.

Assume that the regular tax rate is 28% and that the term structure increases proportionately at a rate of 6%, becoming flat after 10 years. In this case, the profit from stripping a five-year par bond is 0.0037%, but the profit from stripping the 25-year par bond is 0.804%.

Yield Curve

If the term structure is flat, the yields to maturity on STRIPS and on par bonds will be identical.⁶

Figure F Yields on STRIPS and Par Bonds



With nonflat term structures, the yields on fairly priced STRIPS will differ from the yields on fairly priced par bonds.

In the case of a rising term structure, the STRIPS yield curve will lie above the par bond yield curve. Figure F assumes forward rates increase geometrically at a rate of 6% for 10 years, then remain flat. (A regular tax rate of 28% is also assumed.) Even though the bonds are fairly priced to eliminate all arbitrage opportunities, a sizable difference exists between the STRIPS yield curve and the par bond yield curve.

The difference in yields is a purely mathematical result and does not mean the bonds are mispriced. Assume, for example, that an investor buys a portfolio of STRIPS with the same pretax cash flows as an n-year par bond. The yield to maturity on this portfolio will be identical to the yield to maturity on the n-year par bond.

Conclusion

The growth of the STRIPS market has dramatically increased the opportunities available to investors. Investors who wish to lock in a fixed dollar payout at a future date can now easily achieve their goal by buying STRIPS.

Many factors can affect the value of STRIPS. These factors include the shape of the term structure, tax rules and rates, bond maturities and the demand for zeros. Even small percentage differences between STRIPS and underlying bonds can cause stripping or rebundling because the dollar profits to large-scale strip-pers can be sizable and risk-free.⁷

Footnotes

1. The American Banking Association Committee on Uniform Securities Identification Procedures provides a unique number to identify every security issued.
2. Coupon STRIPS with the same maturity are interchangeable when reconstituting a bond.
3. For a more comprehensive discussion, see M. Livingston and D. Wright

Gregory, "The Stripping of U.S. Treasury Securities" (New York University Salomon Brothers Monograph Series 1989-1).

4. Ibid.
5. Ibid. See Appendix A, p. 61 for proof.
6. Ibid.
7. We thank Joseph Sinkey for his helpful comments.

Ankrim footnotes concluded from page 82.

however, will miss any ability of the manager to engage in Fama-type timing (i.e., moving into higher-risk sectors in anticipation of market rises).

11. Once again, using only current values in this analysis will miss any ability of the manager to engage in security timing (i.e., departing from standard security betas within a sector to take on riskier stocks within the sector). Considering only current portfolios, will not distinguish between a manager who takes riskier positions in anticipation of market moves and a manager who consistently holds such a position. The value of recognizing this difference must be balanced against the substantial increase in data required to capture the effect.
12. See the appendix for a complete description of the variables.
13. Christopherson and Turner, "Manager Alpha Volatility," op. cit.
14. This level of aggregation is used only for illustration. Changing the categories doesn't alter the results.

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