STRIPPING OF TREASURY SECURITIES AND SEGMENTATION IN THE TREASURY SECURITIES MARKET

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In the mid-1980s the U.S. Treasury began to allow designated Treasury bonds and notes to be stripped into separate coupon and principal components.[1] The resulting securities are called STRIPS. Most STRIPS can be reconstituted into their underlying bonds. Since the process of stripping Treasury securities into STRIPS or reconstituting STRIPS into underlying bonds can be done at minimal cost by book-entry, arbitrage should force identical prices for underlying bonds and a portfolio of STRIPS with the same coupon and principal.

A large proportion of Treasury securities are not strippable through the STRIPS program. These securities can be stripped by trust arrangements, but at much higher costs than the Treasury STRIPS program. For these non-strippable bonds, no cost-free arbitrage exists between the non-strippable underlying bonds and a corresponding portfolio of STRIPS.

Thus, a priori, there appear to be two segments of the Treasury securities market created by the lower cost of stripping through the Treasury STRIPS program: 1) a segment composed of STRIPS and strippable bonds, and 2) a segment composed of non-strippable Treasury securities.

Our purpose here is to test for evidence of segmentation. We find two interesting empirical results. First, the average prices of strippable Treasury securities are slightly below a corresponding portfolio of STRIPS. These price differences are consistent with the assumption that transaction costs slightly impede the arbitrage process. Second, the average prices of non-strippable securities are higher than the corresponding portfolio of STRIPS because no straightforward arbitrage exists between STRIPS and non-strippable securities.

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These two findings are consistent with the notion of segmentation in the Treasury securities market. There appear to be two segments of the market for Treasury securities — the market for strippable securities and the market for non-strippable securities.

I. INTRODUCTION

In 1985, the Treasury began to allow coupon-bearing Treasury securities to be stripped by the Federal Reserve's book-entry accounting system into zero-coupon components called STRIPS.[2] Since February 1985, all newly issued ten-year notes and thirty-year bonds have been designated as strippable through the book-entry system.[3] Strippable securities issued after February 1987 can be rebundled or reconstituted into the original securities. Consequently, arbitrage by dealers should eliminate disparities between the prices of STRIPS and the underlying securities.[4]

Other Treasury securities cannot be stripped by book entry but can be stripped by security dealers setting up trust accounts. The costs of stripping by the book-entry method are much lower than the costs of stripping securities through trusts. In addition, reconstituting bonds into underlying bonds would be difficult. Hence, STRIPS have come to dominate the market. Since 1985, Treasury STRIPS constitute virtually all new strips.

II. EMPIRICAL TESTS

To test for segmentation in the Treasury securities market, the prices of strippable (non-strippable) Treasury securities are compared to the prices of a portfolio of STRIPS with the same coupon and par value.

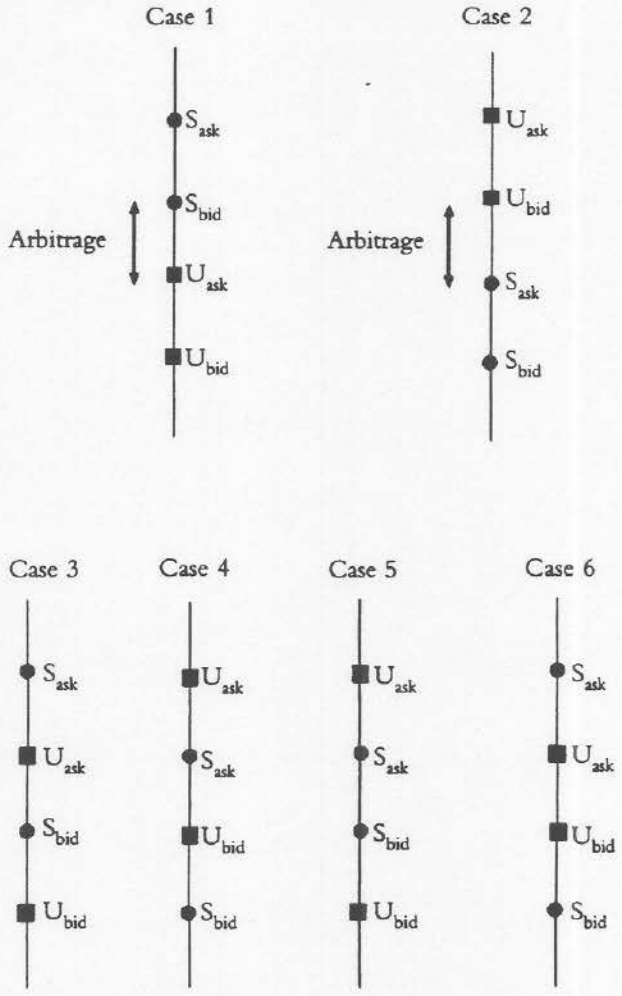
The value of a portfolio of STRIPS with coupon C, par value of Par, and maturity n is

$$S_{port} = C\left[\sum_{i=1}^{n} S_{ci}\right] + Par(S_{pn}) \qquad (1)$$

where

S_{port} = value of a portfolio of STRIPS;
C = coupon;
S_{ci} = coupon STRIPS price per dollar of par for period i; and
S_{pn} = principal STRIPS price per dollar of par.

EXHIBIT 1 ■ Six Cases



Definitions:
S_{ask} = STRIPS asked price.
U_{ask} = Underlying security asked price.
S_{bid} = STRIPS bid price.
U_{bid} = Underlying security bid price.

The bid and asked prices of the portfolio of STRIPS are denoted as S_{bid} and S_{ask}. The bid and asked prices of underlying securities are denoted as U_{bid} and U_{ask}.[5]

There are six possible relationships between the bid and asked prices of STRIPS and underlying securities, as shown in Exhibit 1. There are arbitrage opportunities in Cases 1 and 2:

Case 1: $S_{ask} > S_{bid} > U_{ask} > U_{bid}$
Arbitrage: Buy the underlying security at the asked, strip it, and sell the portfolio

EXHIBIT 2 ■ Number of Strippable and Non-Strippable Treasury Securities Included in the Sample on a Particular Trading Day

Treasury Securities	Maturity Months: February and August	Maturity Months: May and November
40 Strippable	19	21
6 Non-Strippable	2	4
5 Strippable*	2	3

*These five strippable securities have the same maturity as the six non-strippable securities.

of STRIPS at the bid price.

Case 2: $U_{ask} > U_{bid} > S_{ask} > S_{bid}$
Arbitrage: Buy the portfolio of STRIPS at the asked price, reconstitute them into the underlying security, and sell the underlying at the bid price.

Case 3: $S_{ask} > U_{ask} > S_{bid} > U_{bid}$

Case 4: $U_{ask} > S_{ask} > U_{bid} > S_{bid}$

Case 5: $U_{ask} > S_{ask} > S_{bid} > U_{bid}$

Case 6: $S_{ask} > U_{ask} > U_{bid} > S_{bid}$

In looking for arbitrage opportunities between STRIPS and coupon-bearing securities, dealers do not have to be concerned with the taxation of coupons or capital gains. Dealers are taxed only on the profit they make from the arbitrage. Thus, Cases 1 and 2 are independent of taxation.

The source of our data for the prices of Treasury securities is the *Wall Street Journal* for sixteen trading dates studied. The *Wall Street Journal* reports the prices of both principal STRIPS and coupon STRIPS.[6] The principal STRIPS prices are used when calculating the price of the par value in the portfolio of STRIPS.

The price quotes in the *Wall Street Journal* are representative bid and asked quotes and not actual trading prices. This lack of actual trading prices may introduce errors for individual observations, but there is no reason to expect bias in a sample of observations (see, for example, Daves and Ehrhardt [1993]).

The numbers of strippable and non-strippable Treasury securities included in the sample on a particular trading day are shown in Exhibit 2.

III. STRIPPABLE SECURITIES VERSUS STRIPS

Exhibit 3 shows the percentage price differences between the portfolios of STRIPS and the underlying strippable securities for both bid and asked prices. In panel A, the mean difference is positive for both bid and asked prices, meaning that the underlying strippable securities have lower prices on average than the portfolio of STRIPS. For bid prices, the portfolios of STRIPS have a mean price 1.7 cents higher per $100 of par value than the underlying securities. For asked prices, the portfolios of STRIPS are about 12 cents higher per $100 of par value.

Panels B and C break the sample into bonds and notes. The results are quite similar, with the exception of a negligible difference for bid prices of notes.[7] These results are consistent with the argument that taxation increases the relative value of the portfolio of STRIPS compared to the underlying strippable securities with a rising term structure (see Livingston and Gregory [1989]).

Exhibit 4 shows a frequency distribution for Cases 1 through 6. Pure arbitrage opportunities occur only in Cases 1 and 2. Case 1 occurs 27% of the time;

EXHIBIT 3 ■ Percent Price Differences ■ Strips Minus Underlying Per $100 of Par Value

A. Sample of 40 Strippable Securities

	Strippable	
	Bid	Ask
Mean	0.017343	0.119741
Standard Deviation	0.168	0.200
t	2.61*	15.11**
B. 18 Strippable Bonds		
Mean	0.04152	0.22048
Standard Deviation	0.188	0.200
t	3.74**	18.73**
C. 22 Strippable Notes		
Mean	−0.0024386	0.037317
Standard Deviation	0.147	0.159
t	−0.312	4.40**

Notes:
*Significant at the 1.0% level.
**Significant at least at the 0.5% level.

EXHIBIT 4 ■ Strippable Securities versus Portfolio of Strips

Trading Day	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Sum
Aug. 15 90	3	13	13	6	0	5	40
Aug. 27 90	4	10	13	7	1	5	40
Nov. 15 90	11	1	15	8	0	5	40
Nov. 23 90	9	3	17	5	0	6	40
Dec. 10 90	6	2	14	1	0	17	40
Dec. 24 90	12	1	19	7	0	1	40
Dec. 31 90	24	1	10	3	0	3	40
Jan. 14 91	7	7	20	6	0	0	40
Jan. 28 91	4	7	19	7	0	3	40
Feb. 1 91	21	10	4	3	0	2	40
Feb. 15 91	10	2	22	4	0	2	40
Feb. 25 91	5	3	19	2	0	11	40
Mar. 4 91	2	1	17	8	1	11	40
Apr. 15 91	4	3	11	5	0	17	40
May 10 91	28	1	4	1	0	6	40
May 28 91	25	3	8	0	0	5	40
Total	175	68	225	73	2	97	640
% of Grand Total	27.34	10.63	35.16	11.41	0.31	15.16	100

Notes:
Case 1: $S_{bid} > U_{ask}$.
Case 2: $U_{bid} > S_{ask}$.
Case 3: $S_{ask} > U_{ask} > S_{bid} > U_{bid}$.
Case 4: $U_{ask} > S_{ask} > U_{bid} > S_{bid}$.
Case 5: $U_{ask} > S_{ask} > S_{bid} > U_{bid}$.
Case 6: $S_{ask} > U_{ask} > U_{bid} > S_{bid}$.

Case 2 occurs 11% of the time. For the remaining 62% of the time, there are no arbitrage opportunities.

Exhibit 5 shows the size of the arbitrage opportunities in Cases 1 and 2. The overwhelming majority of the arbitrage opportunities are quite small. This evidence is consistent with integration of the markets for STRIPS and strippable securities as a result of close monitoring of markets by dealers searching out arbitrage opportunities.

IV. NON-STRIPPABLE SECURITIES VERSUS STRIPS

Prices of principal STRIPS must be used to compute the value of the portfolio of STRIPS. Principal STRIPS exist for only a limited number of maturities, and our sample includes only six non-strippable securities (all notes) because these are the only ones having the same maturity as the strippable securities.

Exhibit 6 compares the pricing of five strippable notes with six non-strippable notes. For strippable notes, the portfolios of STRIPS have prices statistically the same as the underlying securities. For non-strippable notes, the portfolios of STRIPS have lower prices than the underlying securities, 8 cents for bid prices and 6 cents for asked prices per $100 of par value.

Exhibit 7 classifies the price differences into Cases 1 through 6. Case 1 occurs 17% of the time. The arbitrage required to profit from Case 1 is to buy the underlying security and strip it. Since these non-strippable notes cannot be stripped by book entry, the costs of stripping would reduce arbitrage profits. Case 2 occurs 41% of the time.

The arbitrage strategy of buying the STRIPS and reconstituting them into the underlying securities is impossible with non-strippable notes. The strategy of buying the STRIPS, shorting the non-strippable notes, and holding both positions until maturity would result in a profit if no collateral is necessary. But if significant collateral is required to establish and maintain these

EXHIBIT 5 ■ Strippable Securities ■ Size Distribution of Arbitrage Profits for Cases 1 and 2 per $100 of Par Value

Trading Date	$0 < p \leq 0.05$	$0.05 < p \leq 0.10$	$0.10 < p \leq 0.20$	$0.20 < p \leq 0.30$	$0.30 < p \leq 0.40$	$p > 0.40$	Sum	Mean of Profit ($)
8/15/90	5	3	4	2	1	1	16	0.123
8/27/90	1	5	6	2	0	0	14	0.128
11/15/90	8	3	1	0	0	0	12	0.038
11/23/90	9	2	1	0	0	0	12	0.035
12/10/90	4	2	0	0	0	2	8	0.169
12/24/90	5	5	2	1	0	0	13	0.085
12/31/90	10	8	5	1	1	0	25	0.084
1/14/91	5	5	4	0	0	0	14	0.079
1/28/91	5	4	2	0	0	0	11	0.067
2/1/91	5	9	12	4	0	1	31	0.135
2/15/91	7	2	1	0	1	1	12	0.149
2/25/91	4	1	2	0	1	0	8	0.102
3/4/91	1	0	1	0	1	0	3	0.148
4/15/91	3	1	1	0	1	1	7	0.168
5/10/91	5	14	9	1	0	0	29	0.088
5/28/91	13	6	6	2	1	0	28	0.084
Total	90	70	57	13	7	6	243	
% of 640 Observations	14%	11%	9%	2%	1%	1%	38%	

positions, profitable arbitrage can be eliminated.

Exhibit 7 also includes the strippable securities for comparison. Case 1 occurs frequently for strippable securities, while Case 2 occurs often for the non-strippables. This difference happens because STRIPS have slightly higher prices than strippable bonds and lower prices than non-strippable notes.

Exhibit 8 presents a frequency distribution of the arbitrage profits for Cases 1 and 2 for non-strippable notes.

V. DETERMINANTS OF PRICE DIFFERENCES

The empirical evidence indicates differences between the prices of the portfolio of STRIPS and the underlying securities. Four factors might affect the percentage differences.

A STRIP must have at least $1,000 par value. Consequently, the number of bonds necessary to make a $1,000 STRIP varies with the coupon level. Daves and Ehrhardt [1993] show that the required number of bonds can affect the pricing of STRIPS. Therefore, the required number of bonds is included as an explanatory variable.

The maturity of a bond and the coupon level can affect the valuation of it as STRIPS because of different taxation of STRIPS and underlying bonds. Gregory and Livingston [1992] and Livingston and Gregory [1989] show a larger tax advantage of STRIPS for longer maturities for rising term structures. Therefore, maturity and coupon are included as explanatory variables.

The earlier evidence shows high prices for non-strippable notes compared to STRIPS and relatively low prices for strippable securities compared to STRIPS. To

EXHIBIT 6 ■ Percentage Price Differences versus Strips ■ 5 Strippable and 6 Non-Strippable Notes

	Five Strippable Notes		Six Non-Strippable Notes	
	Bid	Ask	Bid	Ask
Mean	+0.000814	+0.002385	−0.0850973	−0.062003
Std. Dev.	0.0976	0.109	0.182	0.178
t	+0.0746	+0.196	−4.540**	−3.377**

*Significant at the 5.0% level.
**Significant at least at the 0.5% level.

EXHIBIT 7 ■ Comparison of 6 Non-Strippable Notes with Strippable Securities

		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Total
6 Non-Strippable Notes	Number of Observations	15	39	17	20	0	3	94
	(%)	17%	41%	18%	21%	0	3%	100%
40 Strippable Securities	Number of Observations	175	68	224	73	2	98	640
	(%)	27%	11%	35%	11%	1%	15%	100%
5 Strippable Notes*	Number of Observations	12	10	32	19	1	6	80
	(%)	15%	13%	40%	24%	1%	8%	100%

*The five strippable notes are a subset of the forty strippable securities.

examine the effect of this factor we use a dummy variable: 1 for strippable and 0 for non-strippable.

The regression results are reported in Exhibit 9. The dependent variable is the percentage difference between STRIPS and underlying securities. The regression coefficients for bid prices and asked prices are quite similar. As the number of securities required for stripping increases, the relative value of STRIPS increases by a small (but statistically significant) amount. As maturity increases, the STRIPS value increases. As coupon rises, STRIPS have a higher value. If a security is strippable, the relative value of STRIPS increases.

VI. SUMMARY

Our tests for segmentation in the market for Treasury securities examine the differences between the prices of portfolios of STRIPS with the same coupons, maturities, and par value as underlying Treasury securities. Portfolios of STRIPS have slightly higher prices than underlying strippable securities. Portfolios of STRIPS have significantly lower prices than underlying non-strippable Treasury notes.

ENDNOTES

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[1]The *Monthly Statement of the Public Debt of the United States* gives a listing of strippable Treasury securities.

[2]There were a few bonds issued in 1984 that were designated as strippable, e.g., the twenty-year 11 5/8% bonds due November 15, 2004, issued on October 30, 1984. These bonds are strippable after their first interest payments.

EXHIBIT 8 ■ 6 Non-Strippable Notes versus Strippable Securities ■ Size of Arbitrage Profits (p) for Cases 1 and 2 per $100 of Par Value (% of total observations)

		$0 < p \leq 0.05$	$0.05 < p \leq 0.10$	$0.10 < p \leq 0.20$	$0.20 < p \leq 0.30$	$0.30 < p \leq 0.40$	$p > 0.40$	Total Observations $p > 0$*
6 Non-Strippable Notes	Number	17	13	11	8	2	2	94
	%	18%	14%	12%	9%	2%	2%	94%
40 Strippable Securities	Number	90	70	57	13	7	6	640
	%	14%	11%	9%	2%	1%	1%	40%
5 Strippable Notes	Number	10	7	4	1	0	0	80
	%	13%	9%	5%	1%	0%	0%	28%

*For the remaining cases p = 0; i.e., Cases 3-6 occur.
p = profits per $100 of par value.

EXHIBIT 9 ■ Regression Results (t-statistics in parentheses)

	Independent Variables					
Dependent Variable	Intercept	Minimum Number of Securities	Strippable = 1 Non-Strippable = 0	Maturity (years)	Coupon	Adjusted R^2
$[(S_{bid} - U_{bid}) \times 100]/S_{bid}$	−0.1337	+3.68 E-05	0.0597	0.0041	0.0306	0.1274
	(−6.42	(3.78)	(2.86)	(6.31)	(8.14)	
$[(S_{ask} - U_{ask}) \times 100]/S_{ask}$	−0.1390	+3.23 E-05	+0.0571	0.0119	0.0311	0.3664
	(−6.82)	(3.23)	(2.80)	(17.78)	(7.87)	

[3]Since March 1986, the Treasury has not issued twenty-year bonds.

[4]Dealers incur no tax obligation from arbitrage apart from income tax on the profit.

[5]The accrued interest is added to the quoted bid or ask prices, when trading days do not fall on the semiannual coupon dates.

[6]The *Wall Street Journal* obtains these price quotations from Bear Stearns.

[7]When the prices of coupon STRIPS are used in place of the prices of the principal STRIPS, the direction of the price differences reverses (these results are not reported). The prices of the portfolios of STRIPS are on average significantly higher than the prices of the underlying securities except for the group of strippable bonds and portfolios of STRIPS with asked prices used in the calculations. For this group of strippable bonds and portfolios of STRIPS, the average price increase of the portfolios of the STRIPS over the price of the underlying bonds is less than when the prices of the principal components are used.

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