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A Note on Taxes and the Pricing of Treasury Bill Futures Contracts

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I. The Tax Treatment of Treasury Bill Futures: Implications for Pricing

FUTURES CONTRACTS IN GENERAL, and Treasury bill futures in particular, are taxed in a manner that provides individual investors with an apparent opportunity.¹ The IRS currently considers all futures contracts to be capital assets. Unlike other capital assets, however, the holding period for long-term gains is six months for futures contracts, but only long positions qualify. All gains and losses on short positions are short term regardless of the holding period.

The asymmetrical tax treatment of short and long positions gives individual investors the opportunity to profit at the expense of the government. The investor takes a long position in a futures contract with over six months to maturity and holds the position for six months. If at that time he has a loss, he sells the position, recording a short term loss. If he has a gain he holds the position another day, and records a long term gain. By this strategy all gains are taxed as long term gains, and all losses are short term.

The opportunity is even greater in the Treasury bill futures market. Cash Treasury bills are not treated as capital assets, so that all gains and losses are ordinary. To take advantage of this fact the investor takes a long position in a futures contract with over six months to maturity. If he has a gain on the last trading day, he liquidates his futures contract and records a long term gain. If he has a loss, he waits until the contract matures and takes delivery of the bills. When delivery is taken the IRS treats it as if the investor had purchased the cash bills at the price at which he entered into the futures contract. After taking delivery, the investor immediately sells the bills in the cash market, realizing an ordinary loss.

It should be added that the IRS did not formally decide to tax Treasury bill futures in this fashion until November 1978. Prior to that time confusion existed as to whether bill futures would be capital assets, like other futures contracts, or whether they would be taxed like cash Treasury bills. It is possible, therefore, that bill futures were priced differently after November 1978. This issue is investigated in the empirical section.

An example of the tax strategy is shown in Figure 1. The example assumes that

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¹ All the information regarding the taxation of interest rate futures reported in this paper was taken from the pamphlet "Interest Rate Futures Contracts: Federal Income Tax Implications," prepared by Arthur Andersen & Co. and published by the Chicago Mercantile Exchange.

Time 0

IMM index = 92
Futures price of Treasury bills = \$980,000

Time 1

State 1

IMM index = 94
Price = \$985,000

Close position
Long-term gain = \$5,000
After tax income = $5,000(1 - \tau_g)$

State 2

IMM index = 90
Price = \$975,000

Take delivery
Sell cash bills
Ordinary loss = \$5,000
After tax income = $-5,000(1 - \tau_p)$

If states equally likely expected gain = $2,500(\tau_p - \tau_g)$

Figure 1. Treasury Bill Trading Example

the investor goes long one contract which calls for the delivery of \$1,000,000 par value of 90-day Treasury bills. At the time the futures position was taken the IMM index was 92.00, so the futures price of the bills was \$980,000. (The IMM index is equal to 100 minus the banker's discount rate on the bill. Thus the discount rate on the bill in the example is 8%).

Assume, for simplicity, that there are only two possible states of the world and ignore all transaction costs. In State 1 the discount on bills falls to 6% in six months, so that the IMM index increases to 94, while in State 2 the discount rate increases to 10%. If State 1 occurs the investor closes out his futures position and reports a long term gain of \$5,000. If State 2 occurs, he takes delivery of the bills and sells them in the cash market for an ordinary loss of \$5,000.² If the two states are equally likely, the investor's expected gain is

$$\begin{aligned} E(\pi) &= 1/2(5,000)(1 - \tau_g) - 1/2(5,000)(1 - \tau_p) \\ &= 2,500(\tau_p - \tau_g), \end{aligned}$$

where

τ_p = the personal tax rate on ordinary income,

τ_g = the tax rate on long-term capital gains.

No initial cost is deducted in computing expected profits because no initial investment is required to take a position. The fact that futures contracts are settled daily with all profits paid and losses collected by the clearing house of the exchange is ignored in this example. The effect of daily settling up on valuation has been theoretically analyzed by Cox, Ingersoll, and Ross [6], and recent work

² If the discount rate is 6%, the price of one million dollars par value bills is \$985,000; if the discount rate is 10% the price is \$975,000.

by Cornell and Reinganum [4], and Rendleman and Carbini [9] indicates that the empirical impact of the settling up procedure is small.

The simple example can be generalized to approximate the potential gains offered by the tax strategy over the period from September 1976 to March 1980. Denote by P_0 the futures price at time zero, and denote by P_1 the futures price six months later. Then the expected gain is

$$E(\pi) = (1 - \tau_g) \int_{P_0}^{\infty} (\tilde{P}_1 - P_0) f(\tilde{P}_1 | P_0) d\tilde{P}_1 + (1 - \tau_p) \int_{-\infty}^{P_0} (\tilde{P}_1 - P_0) f(\tilde{P}_1 | P_0) d\tilde{P}_1 \quad (1)$$

where $f(\tilde{P}_1 | P_0)$ is the density function for $\tilde{P}_1$ given P_0 .

To approximate Equation (1), I assume that $f(\tilde{P}_1 | P_0)$ is normal with mean P_0 and constant variance σ^2 . Of course, the normal distribution has the problem that negative prices have positive probability. Nevertheless, the distribution of weekly changes in the banker's discount on new 91-day bills was found to be nearly normal with mean close to zero and a standard deviation of 24 basis points over the period from September 1976 to March 1980. I assume, therefore, that

$$f(\tilde{P}_1 | P_0) \sim n(P_0 | \sigma = 24 \cdot \sqrt{26} \cdot \$25) \quad (2)$$

In Equation (2) the standard deviation is expressed in semi-annual terms, and the \$25 reflects the fact that each change of one basis point represents a gain or loss of \$25 per contract on a futures position. Substituting (2) into (1) and evaluating the integral for a truncated normal yields,

$$E(\pi) = (\tau_p - \tau_g) \frac{2}{\pi} \sigma \quad (3)$$

If $\tau_p = .70$ and $\tau_g = .28$, then

$$E(\pi) = \$1,025.24 \text{ per contract.}$$

The example does not provide a closed form solution to the valuation problem so the present value of the expected profit cannot be computed. Recent work by Cox, Ingersoll, and Ross [5] does provide such solutions, but they are complicated. The sole point of the example is to demonstrate that the expected gains are likely to be large in comparison with transaction costs which, including commissions, bid-ask spreads, and the cost of taking delivery, should come to no more than \$350 per contract.³

These potential gains led Arak [1] to argue that my assumption that $f(\tilde{P}_1 | P_0)$

³ This assumes that the investor can get short-term financing to take delivery of the bills. Since the bills will be immediately resold, the interest cost is small. The problem is that the funds may be difficult to obtain for some investors. Other assumptions are that the commission in the futures market is \$50, the bid-ask spread in the futures market is four basis points, and the bid-ask spread in the cash market is six basis points. Remember that the investor only takes delivery when he has a loss, so not all costs must be paid each time. All contracts are in units of one million dollars.

has a mean of P_0 is incorrect. According to Arak, investors bid up the futures price, thereby reducing, if not eliminating, the expected gain. One implication of this hypothesis is that the futures price will be higher, on average, than the subsequently observed spot price. Secondly, because there is no comparable tax asymmetry in the cash market, the futures price will exceed the comparable forward price implicit in the term structure of interest rates.

There is another side to the story, however. For dealers in Treasury bills, gains and losses on futures trades are always taxed as ordinary income. If the activity of individual investors pushes the futures price above the forward price, these dealers will have profitable arbitrage opportunities. For example, if the three-month forward price were less than the three-month futures price, the dealer would buy a six-month bill and sell a three-month bill (thereby going long in the forward market), while simultaneously going short in the futures market.⁴

The effect of the tax law on the pricing of Treasury bill futures is thus an empirical question. It depends on whether individual investors or dealers are the marginal investors. The next section presents evidence which indicates that dealers are the marginal investors. This implies that tax effects cannot be used to explain the divergence of forward and futures prices. It also implies that the Treasury bill futures market provides individual investors with a valuable opportunity.

II. Empirical Tests and Results

Arak [1] attempted to measure the impact of taxes on the pricing of Treasury bill futures by comparing forward and futures price. The problem is that both positive and negative differences have been observed between forward and futures prices.⁵ It is evident, therefore, that several factors are involved in determining the relationship forward between futures prices. To focus exclusively on the tax effect, new tests are required.

In this paper I employ a methodology which does not require the computation of implicit forward prices. My approach is similar to the approach used to study the effect of taxes on stock prices by examining ex-dividend day returns. If individuals are the marginal investors, then the futures price should drop when the maturity of a bill futures contract falls from six months and one day to six months. Henceforth, I will refer to the day six months before maturity as ex-gain day. The drop occurs because individuals lose the possibility of long-term gains on ex-gain day. On the other hand, if dealers are the marginal investors, then no unique price behavior should occur on ex-gain day. If prices were to drop, dealers could make arbitrage profits by going short the day before ex-gain day, and then covering their position on ex-gain day.

Denote by SIX_t the IMM index on the Treasury bill futures contract with approximately six months to maturity on Date t , and by $THREE_t$ the IMM index for the three-month contract on Day t . If Day t is ex-gain day and individuals are

⁴ Once again I ignore the effect of the daily settlement procedure for futures contracts.

⁵ Compare, for example, Capozza and Cornell [3], Lang and Rasche [7], Rendleman and Carbin [9], and Vignola and Dale [10].

the marginal investors, it follows that

$$E_{t-1} (\text{SIX}_t - \text{SIX}_{t-1}) < 0$$

Rather than testing this hypothesis directly, I use the three-month contract to adjust for moves in the level of interest rates. Since no tax event occurs for the three month contract on ex-gain day, it should be the case that⁶

$$E_{t-1} (\text{THREE}_t - \text{THREE}_{t-1}) \approx 0$$

By using,

$$\text{DELTA}_t = (\text{SIX}_t - \text{SIX}_{t-1}) (\text{THREE}_t - \text{THREE}_{t-1})$$

in the tests, the effect of changes in the level of rates is eliminated and the power of the test is increased. If the tax effect exists, then

$$E(\text{DELTA}_t) < 0$$

The values of DELTA over the period from September 1976 to March 1980 are shown in Table I. The table also reports the standard deviation of DELTA measured using data from ten days on either side of ex-gain day.

The results are striking in that there is absolutely no evidence of abnormal price changes on ex-gain day. Of the fifteen observations, six are negative, four are positive, and five are zero. The mean value is 0.13 basis points, or about one-thousandth of a percentage point. Turning to the *t*-statistics, only one of fifteen is significant at the five percent level, which is what would be predicted from random variation alone.

A discrete jump in the price of the six-month contract on ex-gain day would provide dealers and other speculators with an obvious profit opportunity. By shorting the six month contract and going long, the three-month contract one day before ex-gain day and liquidating the position on ex-gain day, a speculator could profit from the price drop a while bearing little risk.⁷ It is possible, therefore, that prices trickle down in the period preceeding ex-gain day rather than jumping. If this were the case, speculators would have to bear the risk of holding their position over a period of time.

This hypothesis is explored in Table II, which presents the mean value of DELTA and its standard deviation for the ten days preceeding ex-gain day. Once again there is no evidence of a tax effect. In fact, ten of the fifteen observations points have a sign opposite to that predicted by the theory. In no case does an observation exceed three basis points.

To put these results in perspective, the gain of \$1,025.24 approximated in the first section amounts to 41 basis points. Thus the mean value for DELTA of 0.13 basis points reported in Table I is economically as well as statistically insignificant. It comes to \$3.25 per million dollar contract. It should be remembered, though, that the example calculation assumed marginal tax rates of 70 percent on

⁶ Contango or normal backwardation may exist for reasons other than the tax effect. I am implicitly assuming, therefore, that the impact of any other effects on *daily* price changes is small.

⁷ The risk minimizing hedge ration would be $\alpha = \frac{\text{cov}(\Delta(\text{SIX}), \Delta(\text{THREE}))}{\text{var}(\Delta(\text{THREE}))}$.

Table I
Ex-gain Day Price Behavior
 $\text{DELTA}_t = (\text{SIX}_t - \text{SIX}_{t-1})$
 $- (\text{THREE}_t - \text{THREE}_{t-1})$

Ex-gain day	DELTA (in basis points)	$\sigma(\text{DELTA})$	<i>t</i> -statistic
9-23-76	-3	3.31	-0.91
12-23-76	0	3.46	0.00
3-21-77	1	2.91	0.34
6-21-77	-1	2.19	-0.46
9-22-77	2	1.64	1.22
12-21-77	-2	1.28	1.56
3-20-78	0	1.59	0.00
6-20-78	0	2.27	0.00
9-21-78	-1	2.89	-0.35
12-20-78	-7	2.37	-2.95 ^a
3-19-79	0	2.70	0.00
6-19-79	-3	4.18	-0.72
9-19-79	7	5.50	1.27
12-18-79	9	5.28	1.70
3-17-80	0	6.56	0.00
Mean(DELTA) =			
0.13			

^a Significant at the five percent level.

Table II
Price Behavior Prior to Ex-gain Day

Ex-gain Day	Mean of Delta for Preceding Ten Days	Standard Deviation of the Mean	<i>t</i> -Statistic
9-23-76	1.33	1.05	1.27
12-23-76	-0.22	1.09	-0.20
3-21-77	0.89	0.92	0.97
6-21-77	0.44	0.69	0.64
9-23-77	0.44	0.52	0.85
12-21-77	-0.44	0.40	-1.09
3-20-78	-0.44	0.50	-0.88
6-20-78	-0.33	0.72	-0.46
9-21-78	1.22	0.91	1.33
12-20-78	-0.22	0.75	0.29
3-19-79	0.89	0.85	1.04
6-19-79	0.11	1.32	0.08
9-19-79	2.67	1.74	1.53
12-18-79	0.78	1.67	0.47
3-17-80	0.78	2.07	0.38
Average = 0.53			

income and 28 percent on capital gains. If investors had engaged in other transactions to convert income into capital gains as described by Miller and Scholes [8], or had used alternative tax shelter vehicles, these marginal rates would overstate the value of strategy analyzed in this paper.

In addition, there is no observable shift in the results after November 1978, when the IRS officially ruled that Treasury bill futures were capital assets. This is in contrast to the results reported by Arak[1]. She found an apparent shift in the relationship between forward and futures bill prices in December 1978, and attributed the shift to the tax ruling.

Finally, the results reported here imply that taxes cannot be the explanation for the discrepancy between forward and futures prices found in the Treasury bill market (see Footnote 5). In combination with the previously cited work of Rendleman and Carbini [9] and Cornell and Reinganum [4] which showed that the effect of the settling up procedure on prices was small, the results indicate that the discrepancies exist primarily because of the cost of shorting cash bills. (See Capozza and Cornell [3] for a detailed discussion of the cost of shorting bills and its impact on potential arbitrage). While short selling costs eliminate profitable arbitrage, they do not prevent portfolio managers from exploiting the futures market to increase the return from holding Treasury bills. For example, if the futures price for delivery three months hence exceeded the forward price, a portfolio manager could buy six-month bills, go short in the futures market, and then deliver the bills three months hence against the short futures position. By so doing, he creates a Treasury bill position with a maturity of three months and a contractually-determined return whose yield is greater than the three-month bill rate. Thus, the Treasury bill futures market appears to offer a unique opportunity for the individual investor to save tax dollars and for the astute portfolio manager to increase his return from holding bills.

III. Summary and Conclusions

Current tax rules make investment in long positions in Treasury bill futures with a maturity of more than six months particularly attractive to individuals. If losses are sustained on such positions, they can be converted to ordinary losses by taking delivery and selling the bills in the cash market. Profits, on the other hand, are taxed as long-term gains if the investor closes his position in the futures market.

These tax benefits increase the demand for bill futures by individual investors. Prices need not be affected, however, because dealers, who pay ordinary income tax on all profits and losses, will have an incentive to provide an offsetting increase in supply. The empirical results presented indicate that this is what happens. There is no tendency for futures prices to fall when the maturity of a contract drops from six months and one day to six months. If individuals were the marginal investors, such a drop should be observed because it is no longer possible to make long-term capital gains.

In conclusion, this study indicates that the Treasury bill futures market offers individual investors a unique opportunity. They are provided, free of charge, with the option to take ordinary losses on the downside while making long-term gains on the upside. Since futures prices are apparently not affected by this tax treatment, the discrepancies observed between forward and futures rates are apparently due to the cost of shorting cash bills. Though this cost prevents profitable arbitrage, it is still possible for alert portfolio managers to exploit these discrepancies to increase their return from holding bills.

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