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TAXES AND THE PRICING OF
TREASURY BILL FUTURES CONTRACTS

by

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1. 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 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 just over six months to maturity. If he has a gain six months and one day hence 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

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."

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.

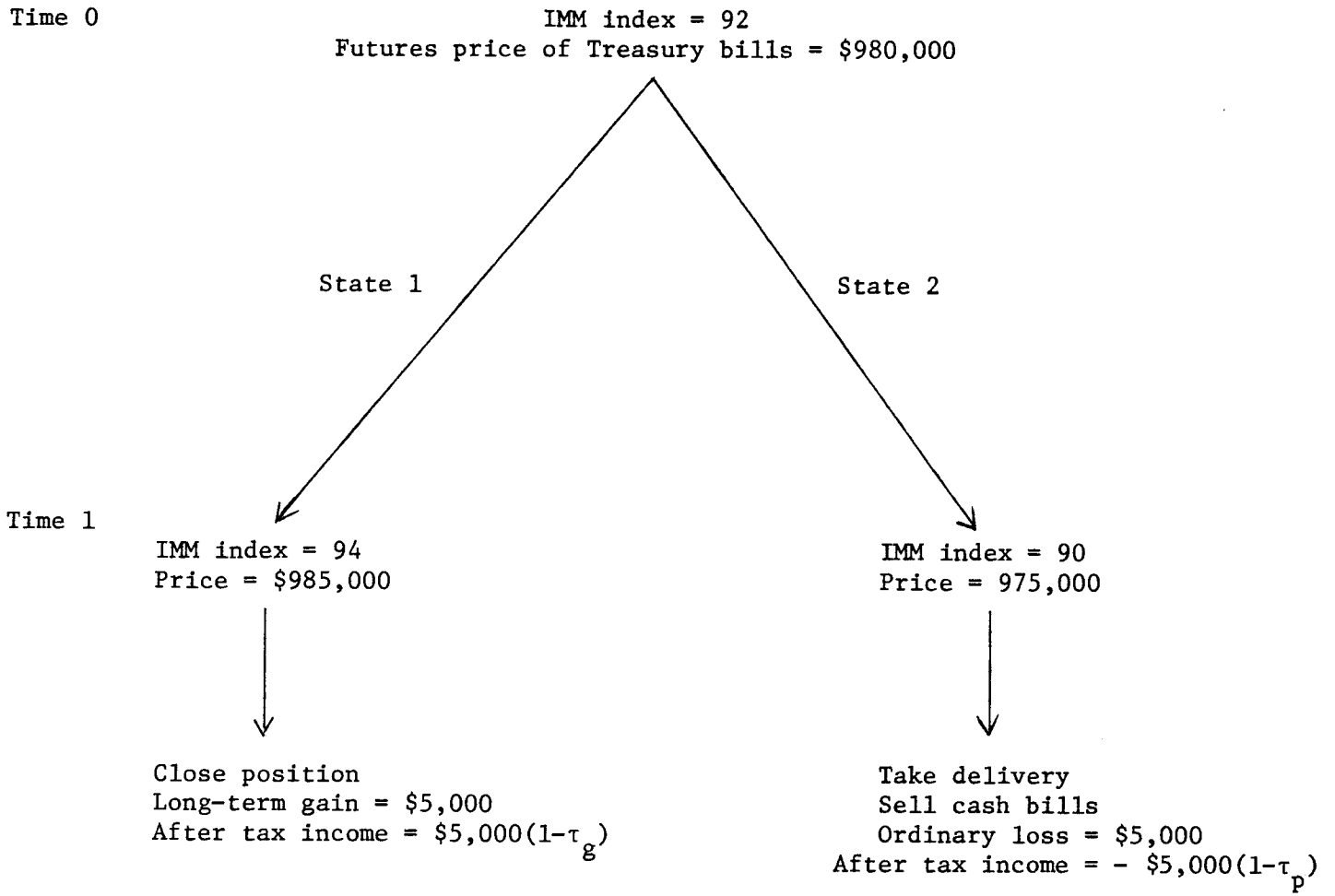
An example of the tax strategy is shown in Figure 1. The example assumes that the investor goes long one contract which calls for the delivery of \$1,000,000 par value of 90 day Treasury bills. At the time the futures position was taken the IMM index was 92.00, so the futures price of the bills was \$980,000. (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

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.

Figure 1

Treasury Bill Trading Example



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

are equally likely, the investor's expected gain is

$$E(\pi) = 1/2(5,000)(1-\tau_g) - 1/2(5,000)(1-\tau_p)$$

$$= 2,500(\tau_p - \tau_g),$$

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. The effect of daily settling up on valuation has been theoretically analyzed by Cox, Ingersoll and Ross (1980). Recent work by Cornell and Reinganum (1980) and Rendleman and Carbini (1979) indicates that the empirical impact of the setting up procedure is small.

The simple example can be generalized to approximate the potential gains offered by the tax strategy over the period for 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 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

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

The \$25 reflects the fact that each change of one basis point represents a \$25 change in the price of ninety day bills. Substituting (2) into (1) and doing 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

$$E(\pi) = \$1,025.24$$

The example is not meant to provide a closed form solution to the valuation problem. Recent work by Cox, Ingersoll and Ross (1980) 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. Transaction costs, which include commissions, bid-ask spreads, and the cost of taking delivery, should come to no more than \$350 per million.³

These potential gains led Arak (1980) to argue that my assumption that $f(\tilde{P}_1 | P_0)$ 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 subsequently observed spot price, so that the market will exhibit contango. Another implication is that

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 the investor only takes delivery when he has a loss, so not all costs must be paid each time.

the futures price will exceed the comparable forward price implicit in the term structure of interest rates, since transactions in cash bills never qualify for long-term gain treatment.

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 affect 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 unique opportunity.

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

2. Empirical tests and results

Arak (1980) attempted to measure the impact of taxes on the pricing of Treasury bill futures by comparing forward and futures price. As Capozza and Cornell (1979) show, however, there are a number of other reasons why forward and futures prices may diverge. In addition, the empirical studies of the relationship between forward and futures prices prior to Arak's work found no consistent pattern.⁵

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 the marginal investors, it follows that

⁵ The papers include Capozza and Cornell (1980), Lang and Rasche (1978), Rendleman and Carhini (1979) and Vignola and Dale (1979).

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

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 1. The table also reports the standard deviation of DELTA measured using 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, less than one-tenth 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.

It is possible that prices behave abnormally over a number of days preceding ex-gain day. This hypothesis is explored in Table 2, which presents the mean value of DELTA for the ten days preceding ex-gain day.

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.

Table 1

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)	$\sigma(\text{DELTA})$	t-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*
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

*significant at the five percent level

Table 2

Price behavior prior to ex-gain day

Ex-gain day	Mean of Delta for preceding ten days
9-23-76	1.33
12-23-76	-0.22
3-21-77	0.89
6-21-77	0.44
9-23-77	0.44
12-21-77	-0.44
3-20-78	-0.44
6-20-78	-0.33
9-21-78	1.22
12-20-78	-0.22
3-19-79	0.89
6-19-79	0.11
9-19-79	2.67
12-18-79	0.78
3-17-80	0.78

Average = 0.53

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 basic 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 1 is economically as well as statistically insignificant. It comes to \$3.25 per million dollar contract.

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 (1980). 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 Carhini (1979) and Cornell and Reinganum (1980) 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 (1979) 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. In summary, therefore, 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.

3. 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. The discrepancies that remain 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 the discrepancies to increase their return from holding bills.

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