"Golden Turtle Tracks": In Search of Unexploited Profits in Gold Spreads*

Geoffrey Poitras

A conventional "turtle" trade involves buying (selling) a tailed T-bond spread and selling (buying) a position in T-bill futures.[1] A variation on this trade occurs when the tailed T-bond spread is replaced with a tailed gold spread. These trades are designed to exploit deviations from expected relationships between the T-bill rate and either: (1) the implied repo rate reflected in the tailed T-bond spread, or (2) the implied carry return reflected in the tailed gold spread.

A "golden turtle" trade differs from these trades by replacing the T-bill futures position with a futures position in Eurodollar CDs (Euros). The golden turtle further differs from the conventional turtle by having the tailed T-bond spread replaced by a tailed gold spread. While both the turtle and golden turtle trades appear similar in composition, there is considerable difference in the fundamentals determining the profitability of the two trades. In the following article Section I outlines the fundamentals which determine the profitability of the golden turtle trade. Examining the fundamentals of the golden turtle trade reveals that the implied carry return in gold futures prices is weakly bounded, above and below, by other interest rates. In Section II, these boundary restrictions provide the basis for specification of a novel trading strategy. Finally, in Section III, empirical evidence is presented on the trading strategy's performance. The evidence supports the hypothesis that there are unexploited profits in gold spreads.

*The comments of the anonymous referees are gratefully acknowledged. The author would also like to thank the Center for the Study of Futures Markets for data support and Anne Finlayson for technical assistance. The views presented here are solely my own and are not intended to represent the position of the Bank of Canada.

[1]This terminology and a discussion of this and other spread trading strategies can be found in Frank Jones (1981). For a recent examination of the theory and potential profitability of the turtle trade see Rentzler (1986) and Easterwood and Senchack (1986). An evaluation of the trade which combines a tailed gold spread with a T-bill position is covered in Monroe and Cohn (1986).

Geoffrey Poitras, Ph.D. is with the Securities Department at the Bank of Canada, Ottawa, Canada.

CCC 0270-7314/87/040397-16$04.00

I. THE FUNDAMENTALS

In the turtle trade, the objective is to compare the implied repo rate in the T-bond spread with T-bill rates as reflected in the T-bill future. Both rates are derived from trading in the U.S. government securities markets. Such is not the case with the golden turtle trade. The rates being compared are the implied carry return (ICR) derived from the gold spread and the Euro rate. More specifically, the annualized gold ICR is defined to be:

$$\text{ICR}(0) = \frac{(F(0, T) - F(0, N))}{F(0, N)} \cdot \frac{365}{tsm}$$

tsm = The time from delivery on the front gold contract to delivery on the deferred gold contract

$F(0, t)$ = The futures price at time 0 for delivery at time t, T is the date for deferred delivery, N is date for nearby delivery

Because the gold ICR is derived on a simple interest basis, in order to make an unbiased comparison to instruments expressed on a discount basis the discount rate has to be converted to a 365 day simple interest basis.[2] However, for purposes of evaluating trading strategies of the type examined here this correction is unnecessary because of the method by which the trades are designed.

Unlike the implied repo rate for T-bonds, the implied carry cost for gold is based on the Eurodollar rate.[3] This is due to the financing arrangements common for cash-and-carry arbitrages involving gold. To see how Eurodollar financing enters, consider a common cash and carry trade involving three participants: a commercial bank involved in the gold trade, a South African mining house, and a central bank.[4] On behalf of an individual mine, the South African mining house decides to sell a certain amount of gold output forward, say three months. The mining house engages the services of an overseas commercial bank which borrows the corresponding amount of gold from a central bank (for an annualized charge of from 75 to 175 basis points). This gold is then sold on the spot market and the funds invested in three month Eurodollars. The transaction is hedged either by the commercial bank or the mining house by going long three month gold futures. Hence, excluding the central bank's margin on borrowed gold and the commercial bank's margin on the trade, the futures (or forward) price must reflect the rate earned on the Eurodollar investment.

Of course, the trade described above is profitable only if the futures price falls below the spot price plus the net cost of carry. The cash and carry arbitrage which prevents the futures price from rising above the spot price plus the net cost of carry

[2]See Rentzler (1986) or Stigum (1981) for the appropriate formula.

[3]This is not strictly correct because some cash and carry trades are done with B.A. financing. B.A. financing is useful because warehouse receipts for the physical gold can act as the underlying collateral making the cash and carry largely self financing. Of course, a "haircut" is usually required on the collateral which will necessitate some capital from the trader. The haircut will affect the all-in cost of borrowing. (This point was missed in Monroe and Cohn (1986).) While the relationship between Eurodollars and B.A.s varies over time, for the past two years B.A.s have averaged 20–50 basis points below Eurodollar rates on a yield equivalent basis.

[4]Background on the hedging practices of the South African mining industry can be found in R. Gidlow (1983). South African mines have been permitted to hedge gold output since 1981, subject to Reserve Bank approval. Such transactions are subject to exchange controls.

is the more familiar trade, where funds are borrowed—say at the Eurodollar or B.A. rate—to purchase spot gold. The spot purchase is simultaneously covered in the futures market with a contract maturity equal to (or greater than) the maturity dating of the borrowed funds. However, in this case the net carry costs do not involve a margin attributable to borrowing gold. This trade will generate arbitrage profits whenever the futures price rises above the carry cost boundary. Hence, there are cash-and-carry trades bounding the ICR in gold futures prices. The ICR should reflect the money market interest rates available to the relevant gold market participants; i.e., the Eurodollar rate. However, due to the differential net costs between the long and short cash-and-carry trades, the futures price should generally be somewhat below full carry as reflected by the Eurodollar rate.

Given the relationship between the gold ICR and the Euro rate, it is useful to combine this result with previous work on gold ICRs by Monroe and Cohn (1986) who examine the relationship between gold ICRs and T-bill rates. Their evidence indicates that there is an identifiable "equilibrium" relationship between T-bill rates and gold ICRs with gold ICRs consistently trading at a premium relative to T-bills.[5] Introduction of the Eurodollar rate to the analysis produces a relationship between three rates: Eurodollars, gold ICR and T-bills. As is well known, because Eurodollars are essentially a bank liability and T-bills are a U.S. Treasury liability, Eurodollar rates will bound T-bill rates from above. While the differential between T-bill and Eurodollar rates varies depending on factors such as the level of rates, foreign exchange variables, and the like, for the 1980–1985 period a 100–200 basis point difference between the two rates was typical. Assuming all other things equal, the key point to notice is that for fundamental reasons the differential between Eurodollar and T-bill rates will generally be greater than the differential between gold ICRs and Eurodollar rates. Hence, the gold ICR will be weakly bounded below by the T-bill rate and weakly bounded above by the Eurodollar rate, as reflected in Figures 1 and 2.[6] As is evident from these graphs, the gold ICR exhibits substantial movement within the T-bill/Euro boundaries. It is this movement which provides the basis for the trading strategy.

While the gold ICR is usually at a discount to the Euro rate (at a premium to the T-bill rate), the precise relationship between the two rates will be affected by market conditions and the contracts selected to derive the ICR. Among futures market participants, it is commonly held that the ICR/Euro differential will be affected by the level and change in gold prices; i.e., the premium on the Euro over the gold ICR will narrow in bull markets. This phenomenon can be at least partially attributed to the activities of spread traders making a play on rising gold prices by going long the deferred and short the nearby. This will tend to bid up prices of the more distant contracts relative to the nearbys, thereby increasing the ICR. The reverse occurs in bear markets; i.e., the ICR/Euro differential will widen due, at least partially, to the activities of spreaders going short the deferred and long the nearby.

The gold ICR/Euro differential is also affected by the contracts selected to derive the ICR. Specifically, the use of the more distant contracts produces ICRs which,

[5] Monroe and Cohn's empirical analysis was based on transaction-to-transaction data and, hence, from a trading standpoint is not directly comparable to the evidence presented here which is based on daily settlement prices.

[6] The term "weakly bounded" is used here in a colloquial and not a strict mathematical sense. It is possible for gold ICRs to both exceed the Eurodollar rate and to fall below the T-bill rate at any point in time. What is meant by weakly bounded is that, in general, the gold ICR should fall between the two rates.

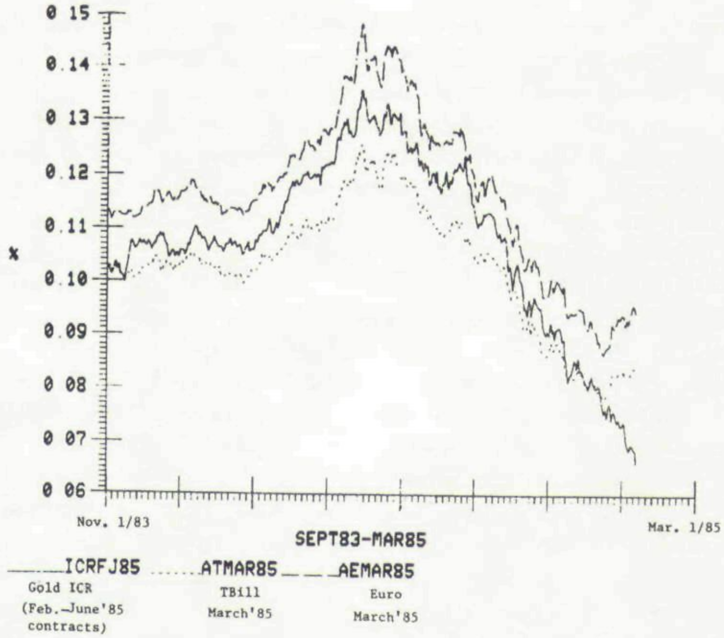

Figure 1
Golden Turtle Trade, March 1985[1] Maturity

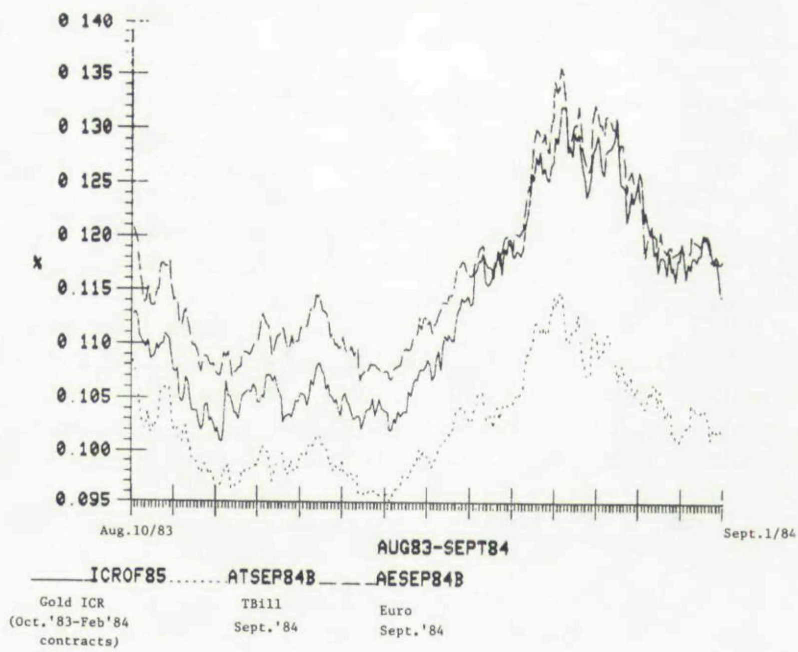

Figure 2
Golden Turtle Trade, September 1984[1] Maturity

in general, differ somewhat from ICRs computed from the nearby contracts. Typically, the more distant contracts result in ICRs that trade closer to the T-bill rate than ICRs derived from nearby contracts, which tend to be closer to the Euro boundary. While the precise reason for this result is not clear, for the distant contracts it is possibly related to the trading strategies of the market makers who provide the liquidity in the more distant months. The movement of the ICR to the Euro boundary as the life of the contract decreases could be attributed to the increased participation of more fundamentally motivated traders. These traders would be influenced by the types of arbitrage activity described previously.

Distortion also appears in the ICRs when the front contract used in calculating the ICR is the delivery or near-delivery contract. In this case, the ICRs tend to fall substantially below the T-bill rate as the delivery period progresses. This is reflected in Figure 1 where the ICR moves through the T-bill rate at the end of the time series (i.e., as March 1, 1985 approaches). In Figure 1 the front contract in the gold spread is February 1985. For near-delivery month contracts, this problem is probably created largely by speculative shorts bidding up prices on the delivery contract in order to close out their futures positions and avoid the need to acquire metal for delivery. When the contract enters the delivery period, the behavior of the ICR is further complicated by the delivery process which allows for differing delivery dates within the delivery month. This dropping off of the ICR during delivery/near-delivery of the front gold contract occured for all the gold contracts examined. However, the problem is not significant when the front contract in the gold ICR is for the month following the delivery on the Euro and T-bill contracts, as reflected in Figure 2 where the front gold contract is for October and the T-bill/Euro contracts are for September delivery.

II. DESIGNING A TRADING STRATEGY

Devising a golden turtle trading strategy presents two general problems: specifying the "trading triggers," and determining the appropriate futures positions in gold and Euros. Obviously, any profitability analysis will be contingent on the solutions selected to these two problems. The strategies examined here are based on the relationship between the gold ICR and the (weak) boundaries provided by the Eurodollar and T-bill rates. Specifically, when the gold ICR comes within a predetermined number of basis points of one of the boundary rates, a golden turtle trade is established and held until the gold ICR comes within a predetermined number of basis points of the other boundary. At this time the position is closed out and profit on the trade calculated. This approach to defining a trading strategy differs from other studies (e.g., Monroe and Cohn, 1986; Rentzler, 1986) which use techniques such as moving averages and standard deviations to generate trading decisions. The trading strategy developed here is based solely on contemporaneous data.

Trade Triggers

The trading strategy evaluates the relationship between the three relevant rates for a period starting approximately 15 months prior to the delivery date of the front gold contract and lasting until two months prior to the last delivery date on the front gold contract. If at any time during this period the gold ICR trades within a predetermined number of basis points of a boundary rate the appropriate trade is initiated. The trade is then examined daily to assess whether it should either be reversed or closed out. The reverse/close out decision is again made according to whether the gold ICR trades within a predetermined number of basis points of the other boundary rate. At this time, if there are more than six months left in the trading period, the trade is reversed and the daily evaluation process is restarted. Otherwise, trading for that trading horizon is complete. If the trade has not been closed out by the end of last month of the trading period, the trade is arbitrarily closed out.[7]

An unanswered question in the trading strategy outlined above is the determination of the number of basis points from a boundary rate the gold ICR must be in order for a trade to be initiated or closed out. The problem of specifying a strict rule is further complicated by the occasional convergence of the boundaries, i.e., where the Eurodollar rate approaches the T-bill rate.[8] With this in mind, a censored-percentage-trigger-rule was selected. This rule works by determining the number of basis points from the boundary the gold ICR must be to trigger a trade. The number is expressed as a percentage of the size of the T-bill/Euro differential. For example, if the Eurodollar/T-bill differential is 80 basis points, a 10% rule would initiate or close a trade if the gold ICR came with eight basis points of a boundary. Regarding censoring of trading activity when the boundaries converge, for the trading periods examined here the boundaries were generally well-behaved except very early in a few of the trading periods. This allowed for large, fixed censoring values to be used throughout. In the empirical work reported here, a fixed censoring level of 80 basis points was found to produce acceptable results.[9]

Calculating the Tail

In order to determine the number of gold and Euro contracts to be used in the trade it is necessary to specify the tailing procedure and the method of determining the hedge ratio between gold spreads and Euro contracts. As is well known, the objective of tailing is to immunize spread profits against changes in spot price levels, so that for a tailed spread profits are solely dependent on changes in ICRs. While there is some disagreement about the most precise method of determining the tail, the

[7]The reason for avoiding the delivery month is that the gold ICR drops well below the T-bill rate as the delivery period progresses (see Figure 1).

[8]While convergence of the boundaries is a problem for the specific trades examined here, boundary convergence provides for other, potentially profitable, trades; e.g., a T-bill-Euro (TED) spread. Hence, a more sophisticated trading program than the one examined here would initiate, say, a TED spread if the boundary locations did not allow a golden turtle to be established. In practice, however, for the trading periods considered here boundary convergence was not a problem.

[9]In devising this trigger strategy, two types of rules were considered: censored percentage rules and censored fixed rate rules. Fixed rate rules establish the trade if the gold ICR approaches the boundaries by an ad hoc number of basis points, say 20 for both the upper and lower boundary, but restricts (censors) trades if the Eurodollar/T-bill differential is less than an ad hoc number of basis points, say 80. The main difficulty with this approach is that it does not account for variations in the differentials due to changes in the level of rates and other related factors. Censoring can occur either by specifying an ad hoc number of basis points for the T-bill/Eurodollar differential or by specifying the differential to be greater than some percentage, say 1%, of the T-bill rate. Given the relatively stable relationship between T-bills and Euros, in practice the selection of a censoring method was not significant.

various feasible approaches appear to differ only marginally.[10] For present purposes, the tailed spread will be specified such that for every long (short) deferred contract there will be $F(0, T)/F(0, N)$ short (long) nearby contracts. For every unit of the deferred contract, there will be $(1 + \text{icr}(0))$ units of the nearby contract where $\text{icr}(i)$ is the implied carry return at time i without the annualizing factor ($\text{icr}(i) = \text{ICR}(i)(tsm/365)$).

To see the effect this has on the spread profit function, consider the profit function for a tailed bear spread; i.e., a spread with one unit long the deferred contract and short $(F(0, T)/F(0, N))$ units of the nearby contract:

$$\frac{\text{Profit (1)}}{100} = \frac{(F(0, T))}{F(0, N)}(F(0, N) - F(1, N)) + (F(1, T) - F(0, T))$$

(In this case, profit has been divided by 100 to express it on a per ounce basis.)[11] Noting the previous result that $F(0, T)/F(0, N)$ equals $1 + \text{icr}(0)$ implies $F(i, T) = (1 + \text{icr}(i))\, F(i, N)$, substituting and manipulating gives:

$$\frac{\text{Profit (1)}}{100} = F(1, T)\,(\text{icr}(1) - \text{icr}(0))$$

In other words, if the spread is tailed appropriately spread profits will, operatively, depend on the change in implied carry returns. Referring to this spread as a bear follows the convention that a bear spread makes money when interest rates rise. In what follows, establishing a bear spread will be equivalent to going short a tailed gold spread. Obviously, establishing a bull spread would involve going long a tailed gold spread.

The Hedge Ratio

As with the problem of how best to tail a spread, there is some disagreement about the best method of deriving hedge ratios. In the case of a golden turtle, the issue is further complicated by one leg of the trade being a tailed spread. The basic problem is to derive the number of tailed gold spreads that, for a given basis point change, will (locally) have the same dollar value change as the corresponding dollar value change in the Euro contract.

$$\text{Number of gold spreads} = Q^* = \frac{(\$2500)}{F(1, T)} \cdot \frac{(365)}{tsm}$$

While not exact, this formula is sufficiently precise for present purposes. When used to determine the number of gold spreads, the formula defines a profit function for the golden turtle which is solely dependent on rate differentials.[12]

[10] The following discussion on tailing and hedge ratios is similar to that found in Monroe and Cohn. A more mathematical analysis of tailing and hedge ratios in the context of the turtle trade can be found in Rentzler. While written for a somewhat different context, the nature of the disagreements about tailing can be found in Rolfo and Sosin (1981). Further background on the effects of tailing can be found in Jones (1981) and Poitras (1985).

[11] For ease of exposition, variation margin, transactions costs and other incidental expenses have been ignored.

[12] The formula is derived by comparing, say, a 100 basis point change in the tailed gold spread and Euro position. The change in the value of the Euro position in this case will be \$2500, or \$25/basis point. The change in the value of the gold spread follows from deriving the profit function for a tailed spread as $(100)F(1, T)(\text{ICR}(0, N, T) - \text{ICR}(1, N, T))$ where $\text{ICR}(t, N, T)$ is the ICR at time t for a spread defined for contract deliveries at N and T. The 100 follows from the number of ounces per contract. Noting that the ICRs involve an annualizing factor to make them yield comparable to the Euro rates, simple manipulation gives the formula in the text.

To see this, consider the profit function for a golden bear turtle—long one Euro contract and short Q^* tailed gold spreads:

$$\begin{aligned} \text{Profit (1)} &= \$2500(\text{EU}(0, T) - \text{EU}(1, T) \\ &\quad + 100Q^*F(1, T)(\text{icr}(1) - \text{icr}(0)) \\ &= \$2500[(\text{EU}(0, T) - \text{ICR}^*(0)) - (\text{EU}(1, T) - \text{ICR}^*(1))] \end{aligned} \tag{1}$$

where:

EU(i, T) is 100 minus the quoted Euro contract price at time i, i.e., EU is expressed as an interest rate; ICR*(i) is equal to 100(ICR), i.e., ICR* is dimensioned comparably to EU.

The golden bear turtle will be profitable when the differential between the gold ICR and the Euro rate narrows. The converse would hold for the golden bull turtle; the trade will be profitable when the differential between the gold ICR and the Euro rate widens.

Benchmarks and Trade Definition

While the above approach to defining Q^* leads to a desirable theoretical result, it does create difficulties from a trading standpoint. This is because the use of $F(1, T)$ in specifying the spread implies that the number of tailed gold spreads per Euro contract has to be adjusted over the life of the trade to account for changes in the level of gold futures prices. While theoretically this does not create substantial difficulties, operationally it raises at least two problems for the types of trading strategies considered here: the difficulty of discretely incrementing a tailed spread position when futures price levels change, and the need for some degree of active management to improve trade performance. The need to accurately account for the Q^* adjustments is either neglected or assumed away in other studies of similar trades (Rentzler, 1986; Easterwood and Senchack, 1986). The problem of accounting for Q^* increments leads to three types of trade outcomes being considered: the passive trade, where the number of tailed spreads is unchanged over the life of the trade; the optimal trade, where it is assumed that the number of tailed spreads is incremented without reference to the trading problems associated with fractional contract positions; and the operational trade, where the number of tailed gold spreads is incremented as contract restrictions permit.

Each of these approaches to trading the golden turtle presents drawbacks. In practice, the passive trade identifies the impact that incrementing Q^* has on the profitability of the trading strategy. The passive trade determines Q^* using $F(0, T)$; i.e., the number of tailed spreads per Euro position is determined by using the gold futures price at $t = 0$ instead of $t = 1$. Referring to Equation (1), the value for Q^* at $t = 0$ is used in determining profits for the passive trade. Hence, the passive trade produces an outcome where the ICR*s are biased by a factor of $F(0, T)/F(1, T)$. This follows because the actual number of gold spreads established is scaled by $F(0, T)$ when $F(1, T)$ is the more exact scaling factor. It is not likely that trades based on $F(0, T)$ will lead to the same result as trades based on $F(1, T)$.

Profit calculations for the optimal trade are based directly on Equation (1). While the optimal trade gives the correct theoretical result, it raises the problem of fractional contract trading. For example, if Q^* equals 20 and the tailing ratio is 10.5 to 10, then the tailed spread would be 21 to 20. If Q^* rises to 23, then the tailed spread would be 24.45 to 23. Of course, it is not possible to establish .45 of a contract. This problem is further exacerbated because, to achieve a precise result, the optimal trade dictates that the trade be determined each trading day. In defense of the optimal contract approach, the fractional portion of the spread positions often are not of significance (e.g., a tailed spread of 24.01 to 23). Further, the fractional contract problem can be offset somewhat by establishing large positions (e.g., 200+ spreads). Hence, at least in the case of actively managed positions of large traders, the optimal trade profit provides a quick approximation to actual trade profits.

The operational trade is designed to deal with the practical inapplicability of the passive and optimal trade cases. In other words, the operational trade is designed to approximate the outcome of actual trading behavior. As a consequence, the operational trade needs to define rules for incrementing spread positions as Q^* changes over the life of the trade. The rule used for the trade simulations in Section III is to increment the spread position when Q^* changes by plus or minus one from its previous value. For example, if at the start of the trade $Q^* = 16.5$, the spread would be incremented when Q^* increased to 17.5 or fell to 15.5. The value of Q^* on the day the trade is incremented becomes the new Q^* and the process is repeated; i.e., the trade is incremented when Q^* changes by plus or minus one from its "new" value. This process is continued until the trade is terminated. The number of Q^* increments will depend on the change in gold futures prices over the trading horizon.

A final operational problem concerns the impact that the rounding of both Q^* and the tail have on the trade's profitability. In the case of large trades—e.g., 10 Euros against $10Q^*$ tailed gold spreads—the rounding problem is relatively unimportant compared to the costs of monitoring and adjusting the trade on a daily basis. For small trades—e.g., one Euro against Q^* tailed gold spreads—the issue of rounding is crucial. In both cases, it is assumed that trades will be incremented when Q^* increments by plus or minus one. For large traders, this reduces the trade adjustment and monitoring requirements. For small traders, while this addresses the issue of incrementing the number of spreads, it does not address the issue of how to determine the size of the tailed position. While for large traders this issue is not significant, for small traders it should substantially affect the profitability of the trade. Given this, an additional sub-case is considered: the small trade case, where the resulting tail is rounded to the nearest whole number. The small trade outcome is compared to results for the large trade case, where the tail is not rounded. The idea behind comparing these two cases is to see if there are unexploited profits for all potential market participants and not just a select subset.

III. EMPIRICAL ANALYSIS

Empirical analysis of the trading strategies proposed here is restricted somewhat by the limited trading period associated with Eurodollar CDs which commenced trading on the IMM on Dec. 12, 1981. Data examined here cover settlement prices for the period April 3, 1982 to March 15, 1985.[13] A total of eight trading horizons are examined. Both the T-bill and Eurodollar data are for the IMM contracts while gold data are for COMEX contracts. The use of contracts from different exchanges raises a number of problems. One problem is the lack of price synchronization due to different physical trading locations and exchange closing times. This is dealt with by calculating the trade profit using the settlement prices for the day following the relevant trading decision. In this fashion, there are reasonable grounds for believing that the trade could actually be done at the prices used in calculating the trade profit. Another problem concerns the timing of the contracts on the two exchanges.[14]

While the trading strategy outlined in Section II has a fundamental basis, the profitability of a given trade depends crucially on an arbitrary input—the trigger percentage. Further, the number of trades for a given trading horizon is increased (and holding periods shortened) when a higher percentage trading trigger is used. This follows because the lower is the trigger percentage the closer the ICR must come to a boundary before a trade is initiated. The effect of trigger selection and associated "operational trade" profits over the eight trading horizons examined is given in Table I.[15] It is apparent in Table I that trade profitability and activity increase as the trigger percentage increases. However, it is not clear from the simulations whether the 35% or 40% trigger generates higher trading profits. While a 40% trigger results in more trades compared to the 35% trigger, the overall profitability of each trade is reduced due to the smaller allowable basis point movement. Higher percentage triggers also have a secondary effect on trade profits by reducing the number of Q^* increments per trade. As well as affecting the number of trades and the profitability of the trade strategy, increasing the trigger percentage also tends to decrease the probability of ending the trade with a "K"; i.e., a trade close-out trigger is more likely to be encountered over the close-out period (the last four months of the trading horizon) for higher trigger percentages.

[13]The use of settlement prices for the simulations creates a number of problems. For example, settlement prices are determined by committee when no trades occured that day. Hence, settlement prices do not always represent prices at which trades actually took place. To correct for this problem, volume figures were checked for each day on which a trade was indicated to ensure that trading actually took place. Further, settlement prices correspond most closely with closing prices. In this case it is not always possible to do a trade at the price indicated. For this reason, in calculating trade profits settlement prices for the day following the trade signal were used to ensure that trades could be done at the prices indicated. When actual simulations were done based on same-day settlement prices, trade profitability exhibited substantial upward bias compared to next-day settlement price results. This would indicate that, directly or indirectly, market particpants are reacting to the profit opportunities presented by the boundary constraints imposed on the gold ICR by T-bill and Euro rates.

[14]Both the Eurodollar and T-bill contracts trade for March, June, September and December delivery. Delivery months for COMEX gold contracts are February, April, June, August, October and December. For purposes of evaluating the trades described in Section II, only these contract months are available for calculation of ICRs. This implies that the ICRs will be for multiples of two month intervals while the Eurodollar and T-bill rates will be for three months. Only for June and December do the delivery months for all three instruments coincide. The problem this raises is handled by calculating the four month ICRs using the gold contract for the month before the delivery on the interest rate futures contracts as the method for selecting the front contract. Hence, in the case of June and December, the front month selected is the same as the Eurodollar and T-bill contracts. In the case of March and September, the front gold contract selected is the February gold contract in the case of March T-bills/Euros and the August gold contract in the case of September.

[15]The results for Table I examine only symmetric triggers. Another possible variation would involve introducing asymmetric triggers. For example, if a 25% trigger to establish and 35% trigger to close out were used, then the results of the trades would be altered somewhat. Clearly, a more complete analysis would identify the profit maximizing triggering and censoring levels.

Table I

SUMMARY OF SIMULATED GOLDEN TURTLE TRADES FOR SELECTED TRIGGER PERCENTAGES [a,b]

(80 bp Censoring Level)

Euro Contract Used for Trade	15%		25%		30%		35%		40%	
	Number of Trades[b]	Operational Profit	Number of Trades	Operational Profit	Number of Trades	Operational Profit	Number of Trades	Operational Profit	Number of Trades	Operational Profit
June 1985	1	$ 52	1	$ 63	1	$ 115	3	$1559	5	$ 2527
March 1985	–	–	1	$ 427	2	$1284	4	$4514	4	$ 3354
December 1984	1	$ 668	1	$1117	3, *K*	$2228	4	$2754	8	$ 3860
September 1984	–	–	2	$1997	5	$2653	8	$5475	13	$ 4984
June 1984	*K*	$ 1733	*K*	$ −7	2, *K*	$4589	3	$3527	3	$ 3463
March 1984	*K*	$ 5837	1, *K*	$1704	1, *K*	$1174	1, *K*	$ 41	2	$ −422
December 1983	1, *K*	$ −1798	1, *K*	$2068	3, *K*	$1191	3, *K*	$2169	5, *K*	$ 4148
September 1983	1	$ 4641	1	$4389	1	$4406	1, *K*	$4916	2	$ 4366

[a]Operational Profit is the combined operational profits for all trades over the trading horizon for that contract and trigger percentage. *K* is explained in the notes to Table II.

[b]No triggers encountered for March 1985 and September 1984 contracts.

In order to provide a more detailed analysis of how the trade strategy works, a summary of results for trades with 25% and 35% trading triggers (80 basis point censoring level) over the eight trading horizons is given in Tables II and III. Clearly, the 25% parameter generated a smaller number of trades with longer holding periods than the 35% trigger. Trades based on the 25% trigger ranged from 2–13 months, averaging about 6.5 months per trade, while the 35% trigger trades ranged from less than a week to 9.5 months, averaging about 2.5 months. While the number of Ks did not differ between the two strategies, the 35% trigger was able to generate at least one complete trade for every trading horizon. In the 25% case, for two of the trading periods no close out triggers were generated; i.e., the only trading activity was a K. In 4 periods only 1 trade was recorded. In the remaining two periods, in one case 2 trades were generated and in the other one successful trade plus a K. This contrasts sharply with the 35% case where substantial trading activity was evident.

Given the trading parameters selected in Tables II and III, trade profitability was dependent on adjusting the trade to account for changes in Q^* as the level of gold prices changed. This can be seen by examining the profit outcomes from the three types of trades—passive, optimal and operational.[16] Recalling that the passive strategy leaves the number of tailed spreads unchanged (at $Q^*(0)$) over the life of the trade, in periods where gold prices moved substantially, profits from the passive strategy differed substantially from the other two types of trades. In the passive trade case, the golden turtle was successful only 50% of the time for the 35% trigger. For both the 25% and 35% cases, passive trade results differed substantially from the optimal and operational trades. For the operational trade, the gold spread positions are appropriately incremented when Q^* increases/decreases by one from its previous value. The profits stated for the operational trade avoid the rounding problem; i.e., the profits correspond to those of a trader taking large positions. In the case of these large operational trades, it is apparent that trading profits roughly corresponded to those of the optimal case. In the optimal and operational cases, profitable outcomes were observed for seven of eight trading horizons for the 25% case and for all trading horizons in the 35% case. Hence, in practical applications the boundary-behavior-based golden turtle trading strategy proposed here has to be adjusted as Q^* changes to ensure potential profits are realized.

Two supplementary issues remain to be discussed: the sensitivity of the simulation results to the use of T-bill contracts versus Euros, and the difference in trade profitability between small and large operational trades. These results are given in Table IV. Regarding the use of T-bill contracts, there is nothing inherent in the boundary-behavior-based trade strategy examined here that dictates the use of Euros instead of T-bills. Hence, it is possible that, on average, one type of contract may produce more profitable trades. However, the large trade outcomes for T-bills and Euros given in Table IV do not show a consistently preferred contract. While T-bills tended to do better for the later trading horizons, the overall results were close—in four cases T-bills were superior, in three Euros were superior, and one was about even. The slight preference for T-bills could be due to the tendency for

[16]Recall that profits are calculated using settlement prices for the next trading day following the trading signal to ensure that the trades could actually be executed. Of course, the value for Q^* and for the tail are based on prices prevailing on the same day the signal is received. This is because Q^* and the size of the tail must be determined on the signal day in order to specify the contract positions to be executed the following day.

Table II
SIMULATED GOLDEN TURTLE TRADES: 25% TRIGGER
(80 bp Censoring Level)

Euro Contract Used for Trade	Number of Trades[a]	Length of Trade(s) Month(s)	Start Month	Number of Q^* Increments	Passive[e]	Total Profit[b] Optimal	Operational[d]
June 1985	1	7.5	5/84	2	$ −1677	$ 1231	$ 63
March 1985	1	8.0	1/84	2	$ 522	$ 1167	$ 427
December 1984	1	7.0	9/83	2	$ 744	$ 1321	$1117
September 1984	2	2.0, 5.5	8/83	6	–	$ 2523	$1016, 1997[c]
June 1984	*K*	10.5	6/83	6	$ 345	$ −271	$ −7
March 1984	1, *K*	5.5, 8.0	11/82	8	–	$ 1975	$1333, 1704[c]
December 1983	*K*	13.0	9/82	11	$ 218	$ 1941	$2068
September 1983	1	7.0	6/82	13	$ 2678	$ 5016	$4389

[a] *K* means trade was initiated but was closed out at the end of the period because no close out trigger was encountered.

[b] Profits are calculated using next day settlement prices; values quoted are for one Euro contract/Q^* spreads; transactions and variation margin costs excluded. Unless otherwise noted, all profits are cumulative.

[c] The second value is for total profit for both trades combined.

[d] Tail values not rounded.

[e] Values are not given for Passive trades involving reversals.

Table III[a]
SIMULATED GOLDEN TURTLE TRADES: 35% TRIGGER
(80 bp Censoring Level)

Euro Contract Used for Trade	Number of Trades	Average Length of Trade (Months)	Start Month	Number of Q^* Increments	Total Profit[b]		
					Passive	Optimal	Operational
June 1985	3	2.5	4/84	3	$ −529	$ 2032	$1559
March 1985	4	2.5	1/84	6	$ 340	$ 4081	$4514
December 1984	4	2.5	9/83	3	$ −25	$ 2886	$2754
September 1984	8	1.0	8/83	4	$ 820	$ 5732	$5475
June 1984	3	2.5	3/83	2	$ 774	$ 3554	$3527
March 1984	1, *K*	5.5	3/83	3	$ −3788	$ −295	$ 41
December 1983	3, *K*	2.0	10/82	7	$ 2385	$ 2648	$2169
September 1983	1, *K*	3.5	6/82	12	$ −821	$ 4918	$4916

[a]See Table II for explanatory notes.
[b]All profits given are cumulative for all trades over that trading horizon.

spread traders in gold to favor Euros over T-bills in intercommodity spreads. Hence, Euro rates may have a greater tendency to be "dragged down" than the T-bill has to be "dragged up" as the ICR moves away from the boundary. However, as noted, this effect is slight.

Finally, consider the difference between the outcomes for small and large operational trades given in Table IV. To interpret these results, recall that the small trade involves rounding of the spread positions such that the trade corresponds with one Euro position. When this is done, at various times the tail on the spread is 'rounded out,' causing the number of nearby positions to be equal to the number of deferred positions. This was the main cause of the variation of the small trade results from those for the large trade. (The other factor involves the rounding of Q^*, and this effect did not appear too significant). While on the basis of evidence provided in Table IV the golden turtle was profitable five times in eight for small traders, the profitability was decidedly more variable. This result was independent of whether T-bills or Euros were used in the trade. As a result, combined with other incidental costs, it does not appear that the type of golden turtle trading strategy examined here could be recommended for the small speculator.

Regarding overall profitability and risk of a trading strategy based on the boundary behavior of the gold ICR, the success rate was noteworthy: over all the trading horizons and triggers considered, only three losing outcomes were reported, versus 35 profitable outcomes. These results are consistent with the low risk of the trading strategy considered here. By construction, there are only three sources of downside risk in the trade: firstly, that the underlying fundamentals determining the relationship between the gold ICR and the boundary rates will change during a given trading horizon; secondly, that the possible loss incurred because of a K will outweigh other trading gains (if any) realized over the trading horizon; and, finally, that there is an adverse movement of prices between the time the trigger is encountered and the time the associated trades are executed.

If the fundamentals underlying the trade are correct, the first point is not of practical importance. Complete analysis of the second case would require sub-

Table IV
GOLDEN TURTLE TRADING PROFITS: SMALL VERSUS LARGE OPERATIONAL TRADES AND T-BILLS VERSUS EUROS

	Total Profit			
	T-Bills		Euros	
Euro/T-Bill Contract Used for Trade	Large	Small	Large	Small
June 1985	$1213	−$1010	$63	−$2160
March 1985	$1327	$3505	$427	$3600
December 1984	$2142	$4585	$1117	$3560
September 1984	$1167, 2722	$1665, 3110	$1016, 1997	$1441, 2385
June 1984	−$1181	−$4195	−$7	−$3020
March 1984	$1408, 1755	−$1340, −3425	$1333, 1704	−$1415, −4475
December 1983	$1843	$1575	$2068	$1800
September 1983	$2390	$1319	$4389	$3319

stantially more trading periods than are available. For the trades examined here, this factor resulted in two of the losses reported and reduced profits in a number of other cases. However, it is not always the case that a K will generate a loss (e.g., the Mar/84 horizon for the 15% and 25% triggers). Finally, while adverse movements in prices between trigger and trade times tends to reduce profits, these movements are not large enough to affect the overall profitability of the trading strategy. In general, adverse movement in prices is of more importance when high percentage triggers are used. (The one case where this factor resulted in a loss was for the 40% trigger.)

Hence, on balance, there appears to be prima facie evidence of unexploited profits in gold turtle trades for large traders willing to invest the resources necessary to monitor the relevant markets for boundary-behavior-based trade opportunities.

Bibliography

Easterwood, J, and Senchack, A. (1986, Fall): "Arbitrage Opportunities with T-bill/T-bond Futures Combinations", *Journal of Futures Markets*, 5: 433–442.

Gidlow, R. (1983, June): "Hedging Policies of the South African Gold Mining Industry", *South African Journal of Economics*, 5: 270–282.

Jones, F. (1981, Winter): "Spreads: Tails, Turtles and all That", *Journal of Futures Markets*, 1: 565–596.

Monroe, M., and Cohn, R. (1986 Fall): "The Relative Efficiency of the Gold and Treasury Bill Futures Markets", *Journal of Futures Markets*, 6: 477–494.

Poitras, G. (1985): "A Study of Gold Futures Price Spreads", unpublished Ph.d. thesis, Columbia University.

Rentzler, J. (1986, Spring): "Trading Treasury Bond Spreads against Treasury Bill Futures—A Model and Test of the Turtle Trade", *Journal of Futures Markets*, 6: 41–62.

Rolfo, J., and Sosin, H. (1981, April): "Alternative Strategies for Hedging and Spreading", Columbia Center for the Study of Futures Markets: Working Paper #22.

Stigum, M. (1981): *Money Market Calculations*, Dow Jones-Irwin, Homewood, IL.