Lecture 5

Speculative Trading Strategies

- Trading Naked (Uncovered) –Trade #1
- One-to-One (Calendar) Spreads #2
- Tailing the Spread #2
- Butterflies and Tandems #3
- Stereos and Turtles #3
- Other Intercommodity Spreads #3

Profit Function Basics

- The profit function is an essential theoretical tool in the analysis of derivative security trading strategies, for both risk management and speculative trading purposes.
- Once the basic profit function is specified, it is possible to do manipulations and substitutions that can be used to identify relevant features of the trading strategy.
- One important substitution often used is to replace the deferred contract prices with the cash and carry arbitrage conditions

The simplest case: a naked long position
(See Chap. 2 RSD)

Figure 2.1 **Profit Function for a Long Futures Position**

DATE	***Cash Position***	***Futures Position***
$t=0$	None	Long Q units @ $F(0,T)$
$t=1$	None	Close out position by going short Q units @ $F(1,T)$

The profit function, $\pi(1,T)$, can now be defined by observing that change in value of the futures position is calculated by subtracting the purchase price from the sales price:

$$\pi(1,T) = Q\ \{F(1,T) - F(0,T)\}$$

The position is profitable, $\pi > 0$, when prices rise.

A similar profit function can be defined for ***short*** positions:

$\pi(1,T) = Q\ \{F(0,T) - F(1,T)\}$ In this case, $\pi > 0$ occurs when prices fall.

The Basic Long Hedger Profit Function

Figure 2.2 **Profit Function for a Grain Elevator Hedge using Futures Contracts**

DATE	***Cash Position***	***Futures Position***
$t = 0$	Buy Q_A units of grain at $S(0)$ for storage in grain elevator	Short Q_H units at $F(0,T)$
$t = 1$	Q_A units are sold at S(1) and loaded for shipment	Close out position with Long Q_H units at $F(1,T)$

If costs associated with carrying the commodity are ignored, the profit function for this type of hedge can be specified:

$$\pi(1,T) = \{S(1) - S(0)\}\, Q_A + \{F(0,T) - F(1,T)\}\, Q_H$$

Extending the Basic Hedger Profit Function to a 1-1 Calendar Spread

Figure 3.3 **Profit Function for an One-to-One Intra-commodity Futures Spread Position**

DATE	***Nearby Position***	***Deferred Position***
$t=0$	Short Q units at $F(0,N)$	Long Q units at $F(0,T)$
$t=1$	Close out position with Long Q units at $F(1,N)$	Close out position with Short Q units at $F(1,T)$

Taking Q to be always positive, the profit function (π) can be specified by observing that the profit for each leg of the spread is equal to the contract selling (short) price minus the purchase (long) price:

$$\begin{aligned} \pi/Q &= \{F(0,N) - F(1,N)\} + \{F(1,T) - F(0,T)\} \\ &= \{F(1,T) - F(1,N)\} - \{F(0,T) - F(0,N)\} \qquad (3.1) \end{aligned}$$

Extending to the 1-1 Calendar Spread to the Case where the Position sizes are not equal

Figure 3.4 **Profit Function for a General Intra-commodity Futures Spread Position**

DATE	***Nearby Position***	***Deferred Position***
t=0	Short Q_N units at $F(0,N)$	Long Q_T units at $F(0,T)$
t=1	Close out position with Long Q_N units at $F(1,N)$	Close out position with Short Q_T units at $F(1,T)$

In this case, the profit function can be specified:

$$\pi(1,T) = \{F(0,N) - F(1,N)\}\, Q_N + \{F(1,T) - F(0,T)\}\, Q_T \tag{3.4}$$

Solving the Profit Function for the Calendar Spread

($\pi > 0$ for Short N, Long T; $\pi < 0$ for Short T, Long N)

$$\frac{\pi}{Q} = (F(1,T) - F(1,N)) - (F(0,T) - F(0,N))$$

$$where \quad F(t,T) = F(t,N)\ (1 + ic(t,T-N))$$

$$\rightarrow \ ((F(1,N)(1 + ic(1)) - F(1,N)) - ((F(0,N)(1 + ic(0)) - (F(0,N)) = F(1,N)\ ic(1) - F(0,N)\ ic(0)$$

$$\Delta X = X(1) - X(0) \ \rightarrow \ X(1) = X(0) + \Delta X$$

$$\rightarrow \ F(1,N)\ ic(1) - F(0,N)\ ic(0) = (F(0,N) + \Delta F)\ (ic(0) + \Delta ic) - F(0,N)\ ic(0)$$

$$(F(0,N) + \Delta F)\ (ic(0) + \Delta ic) - F(0,N)\ ic(0)$$

$$= F(0,N)\ ic(0) + \Delta F\ ic(0) + F(1,N)\ \Delta ic - F(0,N)\ ic(0) = \ ic(0)\ \Delta F + F(1,N)\ \Delta ic$$

Tailing the Spread

- Midterm Question 2a)

Derive the profit profile for a tailed spread and explain how this trade is different from one with one-to-one position sizes.

- The tailed spread is dollar equivalent not quantity equivalent.

- Reading: RSD, p.181-191; Poitras (1997).

Tailed Spread Profit Function

- The tailed spread profit function is:

$$B(1) = \{F(0,N) - F(1,N)\}\ Q_N + \{F(1,T)-F(0,T)\}\ Q_T$$

- In order to be dollar equivalent on the two legs of the spread the following condition has to be satisfied: $Q_N\ F(0,N) = Q_T\ F(0,T)$

- To solve this let $Q_T = 1$ to get the result that $Q_N = \{F(0,T) / F(0,N)\} = \{1 + ic(0)\}$

Solving the Profit Function

- Substituting the restriction on Q_N into the profit function and using the cash and carry arbitrage condition gives the final form of the profit function:

$$\pi(1) = F(1,N)\ \Delta\ ic$$

Compare to the one-to-one case and observe that the impact of ΔF has been eliminated.

- Note: Some tails are not dollar equivalent (e.g., RSD, p.268)

Application to Tbond futures spreads

Figure 3.3 **Profit Function for a Tailed Tbond Spread**

DATE	***Nearby (N) Position***	***Deferred Position (T)***
$t=0$	Short $[F(0,T)/F(0,N)]\ Q$ Tbonds at F(0,N)	Long Q Tbonds at $F(0,T)$
$t=1$	Long $[F(0,T)/F(0,N)]\ Q$ at $F(1,N)$	Short Q at $F(1,T)$

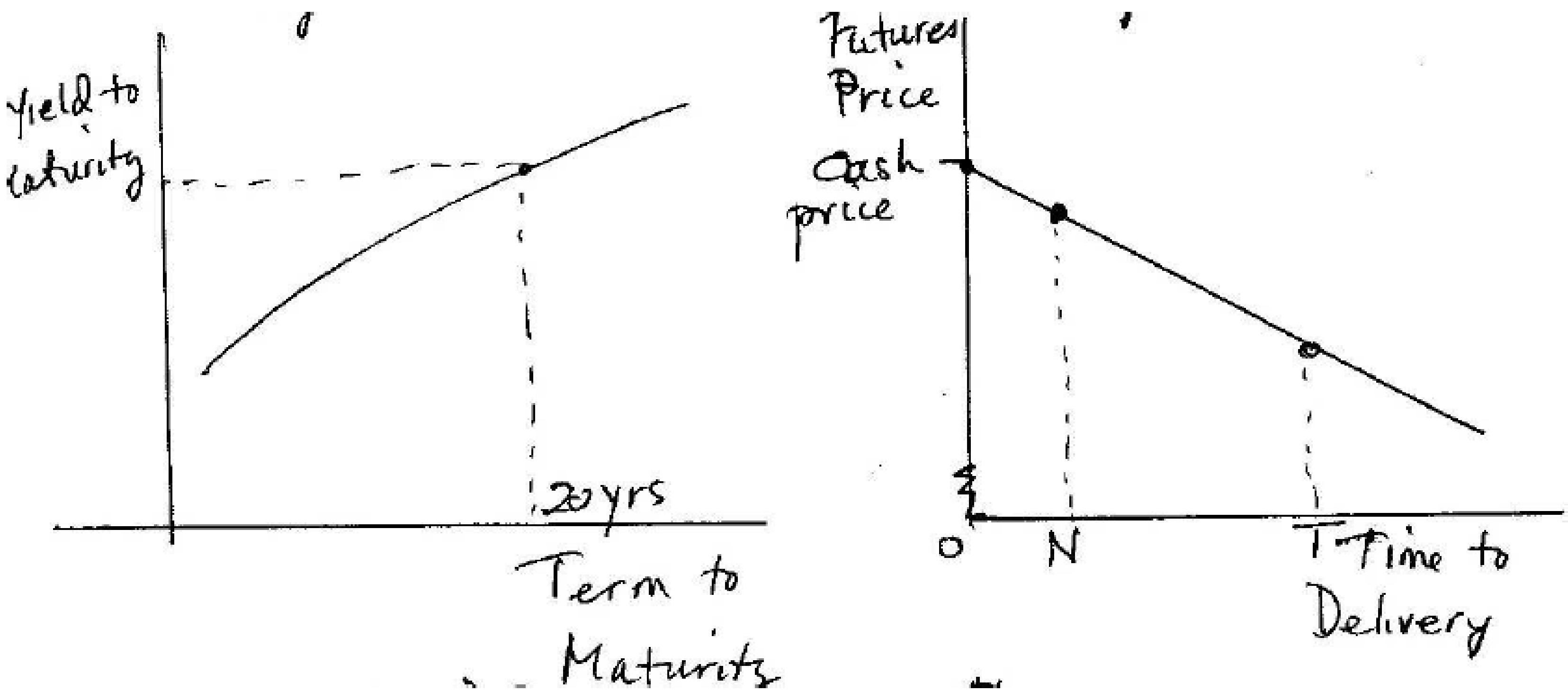
From (3.5), the profit function for the short-the-nearby, long-the-deferred tailed Tbond spread takes the form:

$$\pi(1) = F(1,N)\ \Delta\ ic = F(1,N)\ \{\Delta\ irr(N,T) - \Delta\ R(N,T)\}$$

where *irr* is the implied repo rate *(irr)*, the repurchase agreement financing rate implied in Tbond futures prices, and R is the return earned on the cash Tbond position during the period between the two delivery dates, *N* and *T*. With suitable modification, this type of profit function also applies to all other debt futures contracts.

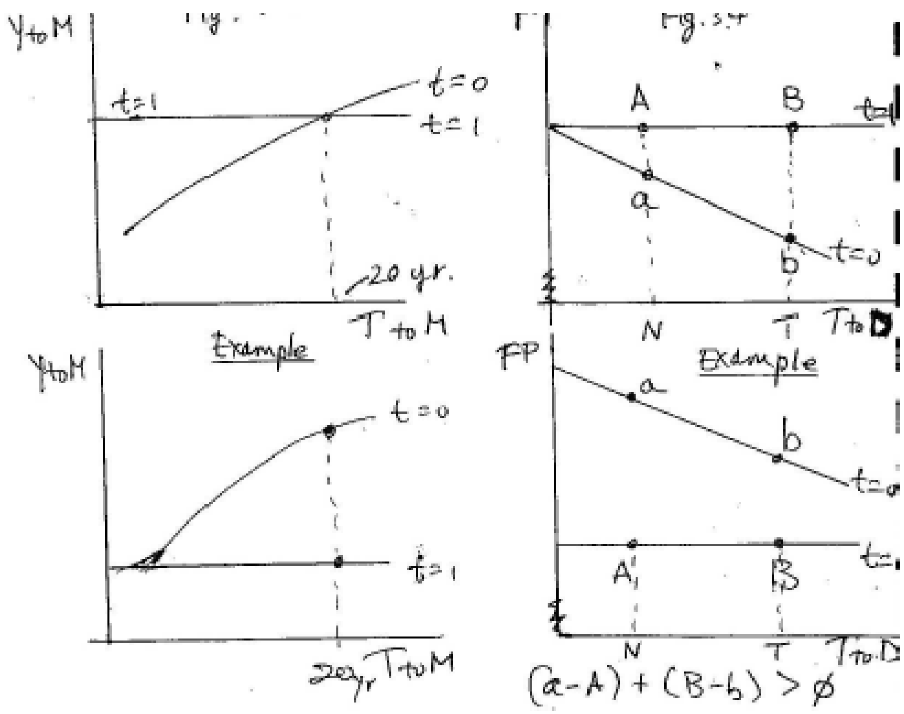
Relation between Tbond term structure of futures prices and the yield curve

Graphs 3.1 and 3.2 **The Relationship between the Cash Yield Curve and the Futures Term Structure**

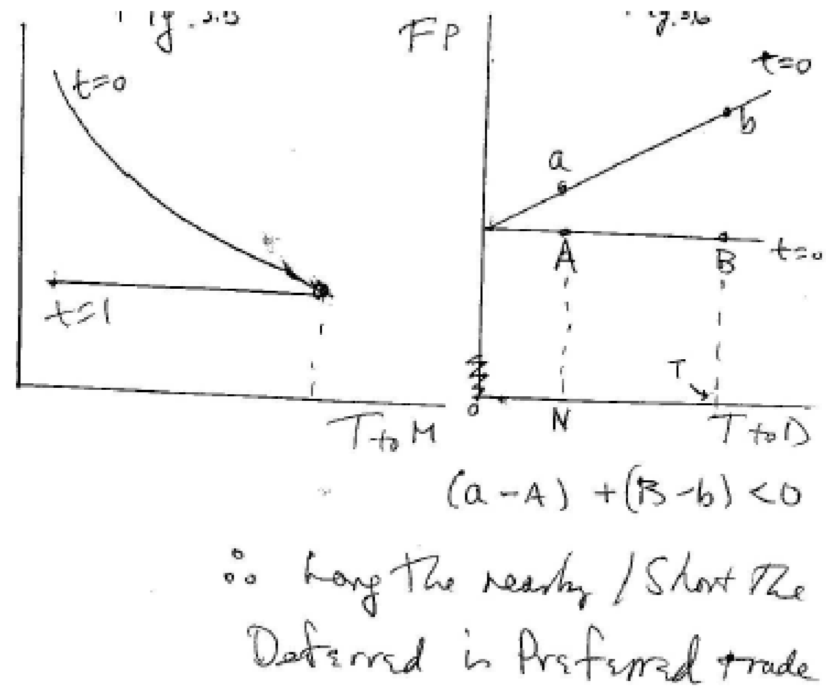


For Tailed Tbond spread the level of the yield curve does not matter only the slope and shape (see RSD chap. 3)

Graphs 3.3 and 3.4 (with examples)



Graphs 3.5 and 3.6



Comparing tailed and untailed

- Midterm Question 2a)

Does your answer depend on the commodity under consideration?

Tailed and untailed spreads will be the same when there is no need to tail. When does this happen and for what commodities?

Butterflies

- The ‘butterfly’ is used to describe both an options strategy and a futures strategy (same word, different trades). Reading, RSD, p.263-5.

- The profit function for a quantity equivalent butterfly is:

$$B/Q = [\{F(1,T)-F(1,N)\} - \{F(0,T)-F(0,N)\}] + [\{F(1,T)-F(0,T^*)\} - \{F(0,T)-F(0,T^*)\}]$$
$$= \{F(0,N)-F(1,N)\} + 2\{F(1,T)-F(0,T)\} + \{F(0,T^*)-F(1,T^*)\}$$

Where N is nearby, T is intermediate and T* is deferred

Figure 5.1 **Profit Function for a Butterfly Spread**

DATE	***Nearby (N) Position***	***Intermediate (T)***	***Distant Position (T*)***
$t=0$	Short *1* at $F(0,N)$	Long 1 at $F(0,T)$	
		Long 1 at $F(0,T)$	Short 1 at $F(0,T^*)$
$t=1$	Long *1* at $F(1,N)$	Short 1 at $F(1,T)$	
		Short 1 at $F(1,T)$	Long 1 at $F(1,T^*)$

The profit function for the short-long-short butterfly is:

$$\pi_b/Q = [\{F(1,T)-F(1,N)\} - \{F(0,T)-F(0,N)\}] + [\{F(1,T)-F(0,T^*)\} - \{F(0,T)-F(0,T^*)\}$$
$$= \{F(0,N)-F(1,N)\} + 2\{F(1,T)-F(0,T)\} + \{F(0,T^*)-F(1,T^*)\} \qquad (5.1)$$

More on the butterfly

- The butterfly can be conceptualized as a ‘spread of spreads’ – a short (long) ‘nearby’ one-to-one spread is combined with a long (short) deferred one-to-one spread (where a short spread is short the nearby, long the deferred).

- It is possible to create dollar equivalent butterflies – making it possible to derive the profit function:

$$B/Q = F(1,N)\,\Delta\, ic(N,T) - F(1,T)\,\Delta\, ic(T,T^*)$$

Tandems: Intercommodity Butterflies

- The tandem is a butterfly where the spreads are in different commodities.

- Unlike the butterfly where the problem of dollar equivalence is generally not an issue, the tandem requires a ‘hedge ratio’ to be determined – i.e., the number of spreads in one commodity relative to the other commodity spread.

Tandem Profit Function

- The tandem profit function is:

$$B = \{Q1\ [F(1,T)-F(1,N)] - Q2\ [G(1,T)-G(1,N)]\}$$
$$-\{Q1\ [F(0,T)-F(0,N)] - Q2\ [G(0,T)-G(0,N)]\}$$

Solving this gives:

$$B^* = \Delta\ ic_F - (Q2\ G(1,T) / Q1\ F(1,T))\ \Delta\ ic_G$$

Reading: RSD, p.265-6 and p.284-7.

The Currency Tandem starts with a Tailed Currency Spread

$$\Delta\,[F(T)\text{-}F(N)] = \theta(0)\,\Delta F + F(1,N)\,\Delta\theta$$

Using the discrete time version of the differential in Sec. 4.2, evaluating the $\Delta\,\theta$ term gives:

$$\Delta\theta = \frac{\Delta\,(i - i*)}{(1 + i*)} + (i - i*)\,\Delta\frac{1}{(1 + i*)}$$

$$= \frac{(\Delta i - \Delta i*)}{(1 + i*)} - (i - i*)\frac{\Delta i*}{(1 + i*)^2}$$

Substituting this result into (3.3) and collecting terms gives:

$$\pi_{ct} = \Delta\{F(T) - F(N)\} = F(1,N)\left[\frac{\Delta i - \Delta i*}{(1 + i*)}\right] + \frac{i - i*}{1 + i*}\,\Delta F(N)$$

Solving the Profit Function for the tailed currency spread → if the term structure of currency futures prices is flat ($i = i^*$) then no need to tail

Observing that $(i - i^*)\,\Delta\, i^*$ is a product of differences in interest rates, it follows that this term on the lhs is, to a first approximation, second order and can be set equal to zero. If the spread is tailed, or tailing is unnecessary, the ΔF term is removed and this leaves only the first term on the lhs to determine the spread:

$$\pi_{ct} \cong \frac{F(1,N)}{1 + i*} \{\Delta i - \Delta i*\}$$

The upshot is that *the profitability of an intra-commodity currency spread depends on the relative change in the appropriate interest rates for the US and the foreign country*. This result for a one-to-one currency spread extends naturally for a tandem, which can be used to speculate on changes in interest rates that are not US. The tandem permits speculation on relative foreign interest rate changes even when there is no liquid foreign currency futures contracts directly quoted in terms of the two foreign currencies.

Extending to the Currency Tandem → combine (tailed) spreads in different currencies → short the spread in currency A and long the spread in currency B to produce the profit function → need to solve for the 'hedge ratio'

$$\pi_{ct}^* = (\Delta i - \Delta i_F) - \frac{Q_G\, G(1,N)\, (1 + i_F)}{Q_F\, F(1,N)\, (1 + i_G)} [\Delta i - \Delta i_G]$$

Solving for the currency tandem 'hedge ratio' → set

$$[Q_G\, G(1,N)(1 + i_F) = Q_F\, F(1,N)(1 + i_G)]\,;$$

In practice, calculation of the hedge ratio involves solving the approximation $[Q_2\ G(0,N)] = [Q_1\ F(0,N)]$. This requires equalizing dollar value on both legs of the tandem at $t=0$. To see how this is accomplished for the currency tandem, consider a trade where the objective is to speculate on relative changes in Canadian and British interest rates using currency futures denominated in terms of US\$. In this case the US\$ value of the Canadian dollar contract is: *{US\$/C\$} \$100,000* $= F(0,N)\ Q_1$. And the US dollar value of the £ contract is: *{US\$/£) (£62,500)* $= G(0,N)\ Q_2$. Hence: $(G(0,N)Q_2/\ F(0,N)\ Q_1)$ = *[{US\$/£) (£62,500)]/{US\$/C\$} \$100,000 = (C\$/£) (62,500/100,000)*. The hedge ratio is the product of the current Canadian to British exchange rate times .625.[12]

Profitability of the Currency Tandem

- While the 1-1 CME futures spread speculates on Δi_{US} -Δi_F the currency tandem speculates on changes in the difference between two foreign rates using CME futures Δi_G -Δi_F where for B > 0 has *G* for short N-long T and *F* has long N-short T (the opposite trade for B < 0

- B > 0 → $(i_G(1) - i_G(0)) – (i_F(1) - i_F(0))$ →

$(i_G(1) - i_F(1)) > (i_G(0) - i_F(0))$ for profitability

Difference in G and F interest rates will widen (G above F at t=0) or become less negative (G below F at t=0)

Stereos Defined

- Tailed spreads have a profit function of the form: B$(1) = F(1,N)\,\Delta\, ic$

- Stereos are intercommodity trades where the $F(1,N)\,\Delta\, ic_F$ for one commodity is traded against the $G(1,N)\,\Delta\, ic_G$ for another commodity to produce profit function of the form:

$$B(1) = \Delta\, ic_F - \Delta\, ic_G$$

Reading: RSD, p.263-9

Stereo Example

- Midterm Question 2c): Assume that you are convinced that the spread between the implied carry return in gold futures will narrow relative to the return implied in silver futures. How would you design a trade to profit on your predictive ability in this case?

- The solution to this question is a metal stereo. The question is asking the (S/L) positions in each commodity and the **hedge ratio**.

- Reading: RSD, p.272-73 for calculating basis point value needed to determine the hedge ratio.

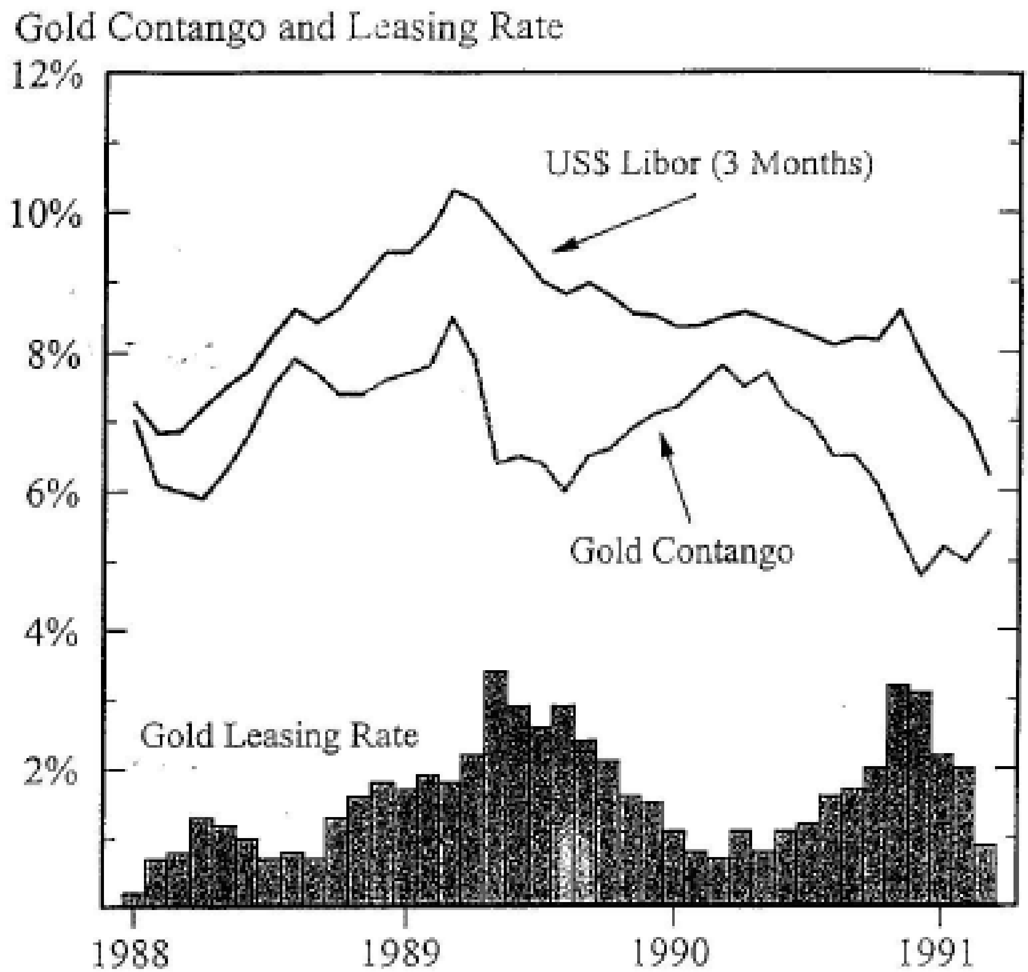
Turtles Defined and Examples

- A turtle trade is constructed to speculate on the difference between the interest carrying charge in a (tailed) spread and some reference interest rate

- Examples: a) gold ic vs. Eurodollar (see Fig. 5.1)

b) Implied repo rate (irr) in Tbonds vs. Tbills or Fed funds (Note: this requires a different tailing procedure, see RSD, p.267-9)

Illustration of a Golden turtle trade



Source: Consolidated Gold Fields, Gold 1991

Turtles Extended

- It is possible to extend the notion of turtles to trades that combine a tailed spread in one commodity with a naked position in another commodity.

- Midterm Question 2b): What factors determine the profitability of: a copper turtle trade? (Reading: RSD, p.274-6). This question involves setting the correct hedge ratio to find the implied interest rate.

Determining the Hedge Ratio for a Stereo or Turtle Trade

function. On a per contract basis this produces:

$$\pi_{TGS} = (100)\ G(1,N)\ (.0001) = (.01)\ G(1,N)$$

Because $G(1,N)$ is not known at $t=0$ when the trade is initiated, a proxy is required. In the absence of a better value, $G(0,N)$ is appropriate. Recalling that this value for the Oct 1994 delivery on Aug. 8/94 is, \$379.30, then \$3.793 is the value of one basis point (***per contract***) in a tailed gold spread. Relating this basis point value to a Euro again provides the appropriate hedge ratio for the golden turtle:

$$Q^* = HR = \$25/\$3.793 = 6.591 = \#\ of\ tailed\ gold\ spreads\ per\ Euro$$

This number can now be used to construct the trade.

Other Intercommodity Spreads

- Many possible variations for intercommodity spread trades
- **Production Spreads**: profitability depends on predicting changes in production relationships
- Examples: Soy Crush spread; Feeder cattle spread; Oil Crack spread; Electricity Spark spread

More Intercommodity Spreads

- TED Spread – (T)reasury Bills against (E)uro(D)ollars

- The TED trade can be done as a **credit** spread, combining naked positions in bills and euros

- The TED can also be done as a tandem where differing rates of **arbitrage convergence** determine profitability

- Reading: RSD, p.276-282.

Intro to Hedging and Risk Mgmt.

- Will examine both **theory** and **practice** of corporate risk management

- Final Exam question #2 deals with theory. Three elements to consider:

1) **equilibrium** properties of derivative market with hedgers and speculators
2) What is the optimal hedge ratio?
3) What are the rationales for risk mgmt.?

Final Exam Questions #1+2

- The final exam question #1 will cover presentations from 23-2. Question #2 deals with the theoretical rationales for corporate risk management and hedging.

Reading: RSD, p.99-103 (review); p.111-116 (equilibrium and optimal hedging; p.139-51 (risk management rationales).