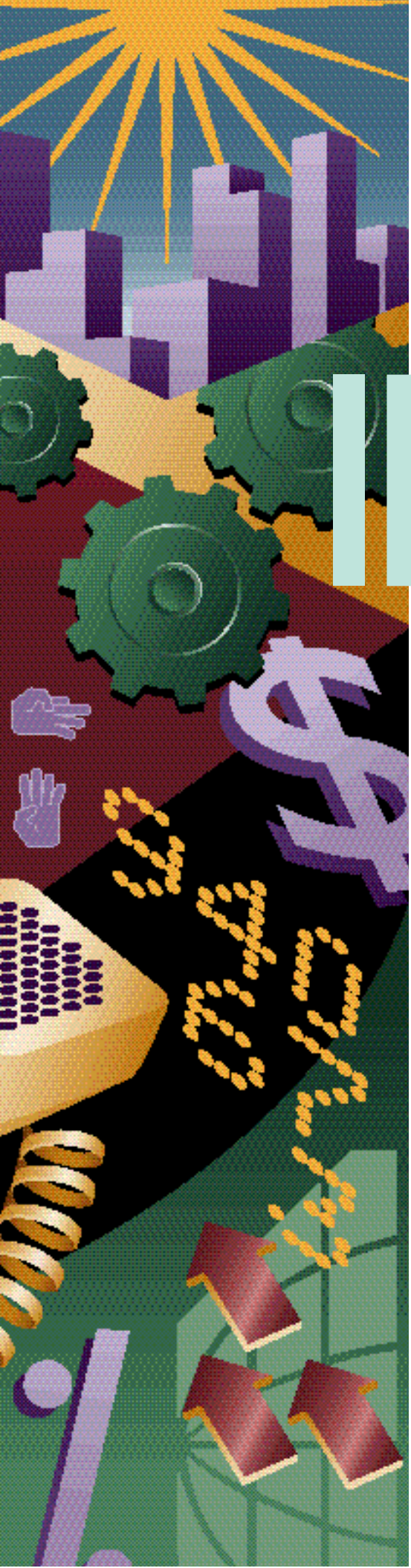

CME OPEN INTERESTS

One Good Turn

By Galen Burghardt and Susan Kirshner

Dean Witter Institutional Futures

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ONE GOOD TURN

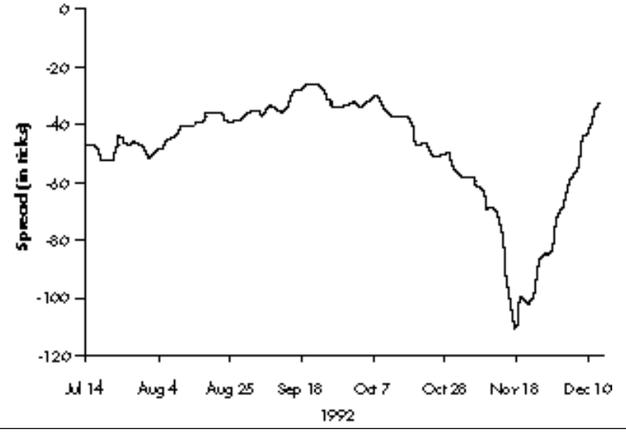
Galen Burghardt **and** Susan Kirshner **explain how taking advantage of anomalies in borrowing costs around the year end can make for a happy new year**

It has been eight years since there was last any serious pressure on year-end dollar financing rates. But 1986 lives on in people's memory because the spike in the fed funds rate that year – and the year before – was so large and so expensive for those who had to borrow. As a result, "the turn", a two-, three- or four-day period from the last business day of one year to the first business day of the next, still has a profound effect on the way people think about year-end financing.

Figures 1 and 2 show both how much and how quickly the market's perceptions of the possible premium in turn financing rates can change. They chart the spread between the December and January one-month Libor futures prices for year-end 1992 and 1993 respectively. The December Libor futures price is 100 less the value of a one-month forward rate that spans the end of the year while the January futures price is 100 less the value of a one-month forward rate that does not. This means that any increase in the turn premium will decrease the value of the spread. Using the rules of thumb developed in this article, the 60-tick drop in the spread in November 1992 was evidence of a 500-basis-point increase in the turn premium. The 20-tick drop in the spread in October 1993 suggested a 200bp increase in the expected turn premium. The subsequent rise in the spread largely reflects a fading of the market's concern over the turn premium as the year drew to a close.

The purpose of this article is to explain what the turn is and how it affects spot and forward dollar interest rates that span the end of a calendar year. We also draw out the implications for trading Libor and Eurodollar futures and options on futures. In doing so, we derive some useful rules of thumb for translating turn premiums into futures market spreads and show how volatility in the turn premium translates into additional volatility in the December Libor and Eurodollar futures prices. One of the things we find is that options traders regularly seem to pay far too much for the extra volatility.

1. Libor futures calendar spreads: Dec 1992 contract v Jan 1993 contract



The turn

"The turn" is the period between the last business day of the current calendar year and the first business day of the new year. As New Year's Day is a holiday, the number of days in the turn is at least two calendar days and can be three or four.

The turn lasts two days if December 31 falls on a Monday, Tuesday or Wednesday. In each of these cases, the next calendar day is a holiday so that money borrowed on Monday would be paid back on Wednesday, two days later. Money borrowed on Tuesday is paid back on Thursday, and money borrowed on Wednesday is paid back on Friday.

If December 31 falls on a Friday or Saturday, so that January 1 falls on a weekend, the number of days in the turn depends on whether the Fed wire is open on the following Monday. In 1993, December 31 fell on a Friday and the Fed wire was open on the following Monday (January 3). Since money borrowed on the Friday was paid back three days later on the Monday, 1993/1994 was a three-day turn. This year, December 31 falls on a Saturday and the Fed wire will be closed on the Monday (January 2), making 1994/1995 a four-day turn.

If December 31 falls on a Thursday, the turn will last four days since money borrowed on Thursday will be paid back the following Monday.

Figure 3 shows a time line of the turn for the end of 1994. The last business day is Friday, December 30. A bank looking to borrow overnight funds on Friday would normally repay those funds the following Monday, which is the next business day. But this year, as New Year's Day falls on Sunday, the Fed wire is closed on Monday, January 2.

Rate behaviour around the turn

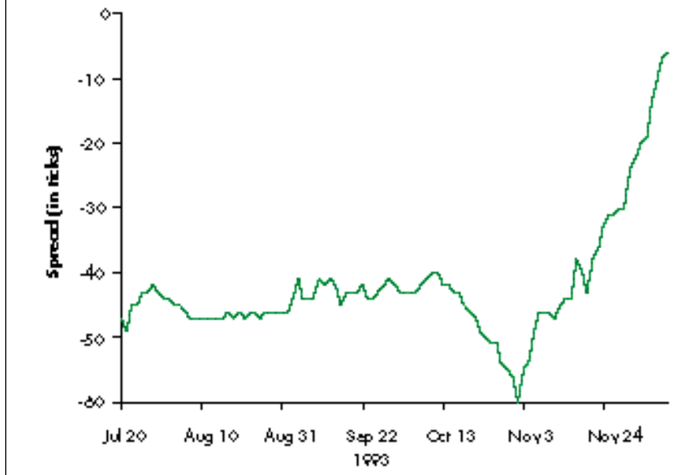
The turn has gained notoriety among bankers because of the pressures that have been brought to bear on year-end financing rates in years past. The source of this pressure is said to be the demand by banks for cash that can be used to dress up their balance sheets at the end of the calendar year. Although the Fed does what it can to accommodate this year-end increase in demand for liquid balances, and does an excellent job most of the time, it appears to have misjudged the size of the shift at least twice since 1984.

Figure 4 shows that the turn rate and the average rate around the turn appear to have been fairly close to one another in most of the past 10 years. In 1984, for example, normal financing rates during the five days before and after the turn were around 8.37%. For the turn between 1984 and 1985, the turn rate increased to 8.74%, for a turn premium of 0.37%. The "turn ratio", which is simply the ratio of the turn rate to the non-turn rate and which we will use later when we examine the effect of the turn on rate volatility, was only 1.04.

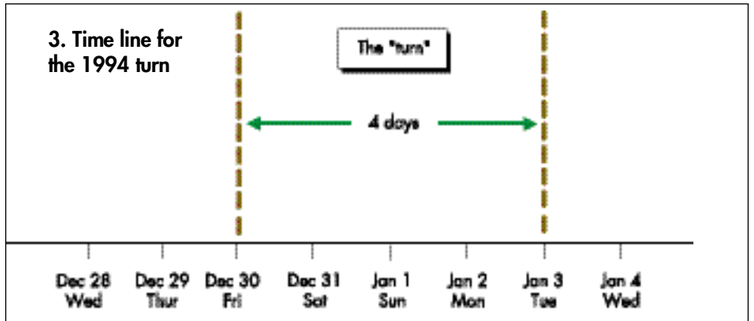
At the end of 1985, however, the turn premium was more than five percentage points, and at the end of 1986, nearly seven. The effect of a seven percentage point turn premium on the cost of funding $1 billion over the year end, even for a turn period as short as two days, is $389,000. This is serious money in anybody's book.

Since 1986, realised rate behaviour around the turn has been unremarkable. Even so, the possibility of a large premium still looms large, and wide swings in the market's expectations about turn financing rates can have dramatic effects on forward deposit rates.

2. Libor futures calendar spreads: Dec 1993 contract v Jan 1994 contract



3. Time line for the 1994 turn



Effects on Eurodollar and Libor futures prices

As the one-month Libor and three-month Eurodollar futures contracts that expire in December settle to deposit rates that span the end of the year, changes in the turn rate affect the final settlement value of these two contracts. This year, for example, the December Libor and Eurodollar contracts expire on December 19. The final settlement price of the one-month Libor contract on that day will be $100 - R_{1m}$, where R_{1m} is the one-month deposit rate on December 19 for the 33-day deposit period that runs from Wednesday, December 21, through Monday, January 23 (see Figure 5). The final settlement price of the three-month Eurodollar contract will be $100 - R_{3m}$, where R_{3m} is the three-month deposit rate on December 19 for the 90-day period that runs from December 21 through Tuesday, March 21.

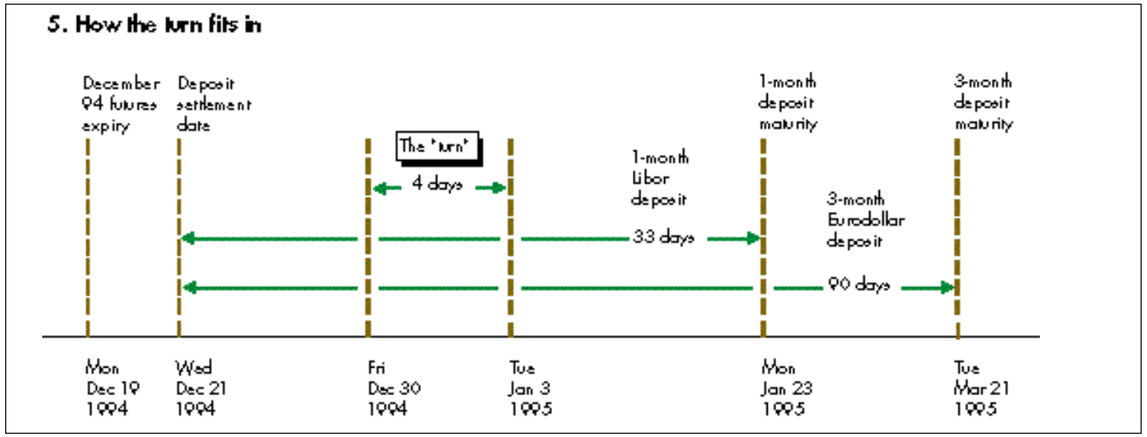
The relationship between the turn rate and the deposit rates to which the Libor and Eurodollar futures contracts will settle can be determined by comparing two borrowing transactions. In the first, money is borrowed for the full term at a term lending rate. In the second, money is borrowed in three legs – one that runs from December 21 through December 29, one that runs from December 30 through January 3, and one that runs from January 4 through the end of the term. Under the first strategy for borrowing one-month money, one dollar borrowed on December 21 would call for

$$\$1\left[1 + R_{1m}\left(\frac{33}{360}\right)\right]$$

4. Fed funds behaviour around year end

Year	Average rate around the turn (1)	Turn rate (2)	Turn premium (3)	Turn ratio [1] [2] (4)
1984	8.37	8.74	0.37	1.04
1985	8.14	13.46	5.32	1.65
1986	7.57	14.35	6.78	1.90
1987	6.96	6.89	−0.07	0.99
1988	9.14	9.04	−0.10	0.99
1989	8.52	7.97	−0.55	0.94
1990	7.73	5.53	−2.20	0.72
1991	4.25	4.09	−0.16	0.96
1992	3.16	2.66	−0.50	0.84
1993	3.04	2.85	−0.19	0.94
mean	**6.69**	**7.56**	**0.87**	**1.10**
std. dev.	**2.31**	**4.05**	**2.84**	**0.37**

[1] =(2)-(1); [2] =(2)/(1)



to be repaid on January 23. Under the second strategy, one dollar borrowed on December 21 would require a repayment of

$$\$1\left[1 + R_b\left(\frac{D_b}{360}\right)\right]\cdot\left[1 + R_t\left(\frac{D_t}{360}\right)\right]\cdot \left[1 + R_a\left(\frac{D_a}{360}\right)\right]$$

where R_b, R_t and R_a are the rates that apply to the days before, during and after the turn and where D_b, D_t and D_a are the actual number of days in the periods before, during and after the turn. For a bank financing a position over this period to be indifferent between the two strategies, the two amounts of money must be the same. If we collapse the rates before and after the turn into a single, non-turn deposit rate, R_{nt}, the two strategies cost the same if

$$R_{1m} = \left[\left(1 + R_{nt}\left(\frac{D_{nt}}{360}\right)\right)\left(1 + R_t\left(\frac{D_t}{360}\right)\right) - 1\right]\left(\frac{360}{33}\right)$$

The three-month term deposit rate can be expressed the same way. The only difference is that the non-turn rate for the 90-day period would be different from the non-turn rate for the 33-day period.

To get a sense of how large an effect the turn can have on December Libor and Eurodollar futures prices, suppose first that the turn and non-turn rates are the same, say 6%. In this case, both one-month and three-month deposit rates would be (except for a trivial amount of compounding) 6%. December Libor and Eurodollar futures prices would both be 94.00 [= 100.00 − 6.00].

Suppose now that the turn rate increases by 200bp to 8%, while the non-turn rate stays at 6%. At these rates, and given the day counts shown in Figure 5, the one-month forward deposit rate for December 19 would be

$$F_{1m} = \left[\left(1 + 0.060\left(\frac{29}{360}\right)\right)\left(1 + 0.080\left(\frac{4}{360}\right)\right) - 1\right]\left[\frac{360}{33}\right] = 0.0625$$

which is 25bp higher than the one-month forward rate with the turn rate at 6%. The three-month or 90-day forward deposit rate would be

$$F_{3m} = \left[\left(1 + 0.060\left(\frac{86}{360}\right)\right)\left(1 + 0.080\left(\frac{4}{360}\right)\right) - 1\right]\left[\frac{360}{90}\right] = 0.0609$$

which is 9bp higher than the three-month forward rate with the turn at 6%. At these rates, the fair value of the December Libor contract would be 93.75 [= 100.00 − 6.25], and the fair value of the December Eurodollar contract would be 93.91 [= 100.00 − 6.09]. Thus, the effect of a 200bp spread between the turn and non-turn rates is to decrease the fair value of the December Libor contract by 25bp and the fair value of the December Eurodollar contract by 9bp.

Although the effect of any given turn/non-turn rate spread on the fair value of the December Libor and Eurodollar futures contracts depends to some extent on the actual number of days in the forward periods and on the level of rates, we have what we need for excellent working rules of thumb:

■ With a four-day turn, the effect of each 100bp increase in the spread between the turn and non-turn forward deposit rates is a 12-tick decrease in the fair value of the December Libor contract and slightly more than a 4-tick decrease in the fair value of the December Eurodollar contract.

■ With a three-day turn, the effect of each 100bp increase in the spread between the turn and non-turn forward deposit rates is a 9-tick decrease in the fair value of the December Libor contract and just over a 3-tick decrease in the fair value of the December Eurodollar contract.

■ With a two-day turn, each 100bp increase in the spread between the turn and non-turn forward deposit rates reduces the fair value of the December Libor contract by about 6 ticks and the fair value of the December Eurodollar contract by just over 2 ticks.

These rules of thumb are borne out by Figure 6, which shows the effect of various rate spreads on the fair value of both the December Libor and Eurodollar futures contracts given a four-day turn. For example, if the non-turn forward deposit rate were 5% and the turn rate 11%, the effect of the 600bp spread would be a 73-tick reduction in the fair value of the December 1994 Libor futures contract. The same spread would produce a 27-tick reduction in the fair value of the December 1994 Eurodollar futures contract. As the effect of the turn rate is roughly proportional to the length of the turn, the effects of these rate spreads given two-day and three-day turns can be determined easily enough from the data in Figure 6.

With these rules of thumb, it is easy to get a reading on the spread between turn and non-turn rates by looking at the pattern of rates implied by the one-month Libor contracts, which have serial expirations extending out 12 months at any one time. On October 3, 1994, for example, there were one-month Libor futures with expirations ranging from October 1994 through September 1995. Figure 7 shows the strip of one-month forward deposit rates implied by their October 3 settlement prices. The effect of the turn on the pattern of rates stands out clearly. The one-month deposit rate for the November contract, which spans the period from mid-November to mid-December, was 5.47%. The one-month deposit rate for the January contract, which spans the period from mid-January to mid-February, was 5.86%. In between, the one-month deposit rate for the December contract was 6.17%, about 50bp higher than the 5.67% that the surrounding rates would suggest for a one-month December deposit rate.

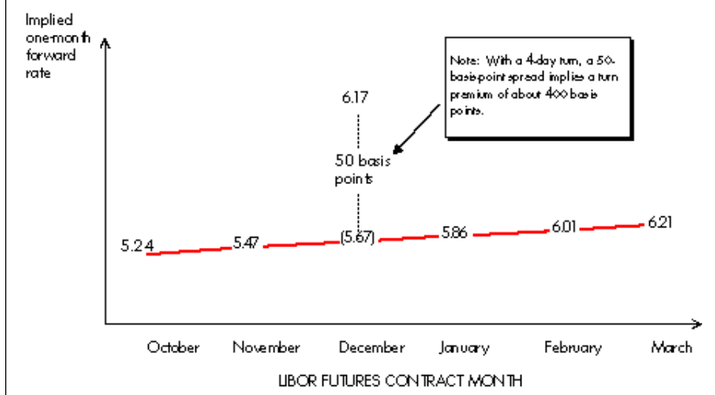
From this 50bp differential, we can determine the spread between turn and non-turn financing rates that is implied by the Libor futures contract. Using the rule of thumb that each 100bp in the spread reduces the fair value of the December Libor contract by about 12bp, the 50bp differential in the December contract implies a spread of about 400bp between the turn and non-turn rates.

This implied rate spread can be compared easily with the spreads quoted in the forward deposit market as a way of comparing the pricing of the turn in the two markets. If you find, for example, that the implied turn rate differential is larger than the actual, then you know that the December Libor contract is cheap relative to cash.

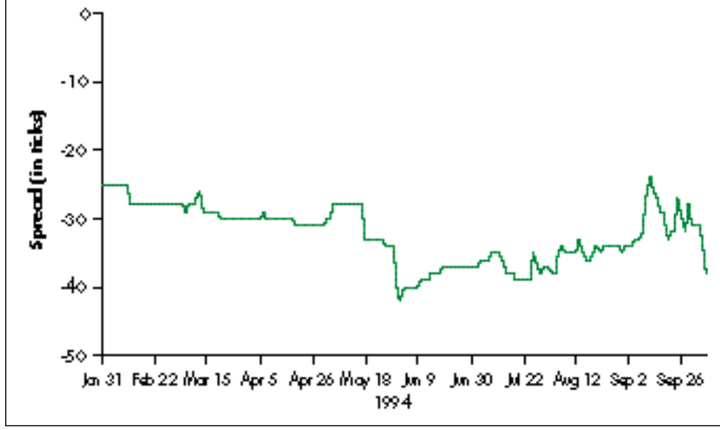
6. Effect of turn rates on the fair values of December 1994 Libor and Eurodollar futures prices (four-day turn)

Turn rate	Libor futures			Eurodollar futures		
	Non-turn rates			Non-turn rates		
	3%	5%	7%	3%	5%	7%
3%	0	24	49	0	9	18
5%	−24	0	24	−9	0	9
7%	−49	−24	0	−18	−9	0
9%	−73	−49	−24	−27	−18	−9
11%	−97	−73	−49	−36	−27	−18
13%	−122	−97	−73	−45	−36	−27

7. Implied one-month forward deposit rates on October 3, 1994



8. Libor futures calendar spreads: Dec 1994 contract v Jan 1995 contract



Implications for futures spreads

As the turn rate affects both the December Libor and Eurodollar futures contracts, it affects the values of several key futures spreads including the:

■ **December LED spread** In this spread, you are long the Libor contract and short the Eurodollar contract. Given the rule of thumb for a four-day turn, each 100bp increase in the turn premium translates roughly into an 8-tick decrease in the value of this spread. Thus, the December LED spread is about 32 ticks

9. Add-on turn volatility premium (3% forward rate)

Volatility of the turn ratio	Base rate volatility for: One-month Libor, Two-day turn, 15%	25%	Four-day turn, 15%	25%	Three-month Eurodollars, Two-day turn, 15%	25%	Four-day turn, 15%	25%
25%	0.40	0.56	0.86	1.10	0.33	0.53	0.68	1.04
35%	0.48	0.60	1.12	1.25	0.35	0.54	0.76	1.08
45%	0.62	0.68	1.51	1.49	0.39	0.56	0.90	1.17

10. Add-on turn volatility premium (6% forward rate)

Volatility of the turn ratio	Base rate volatility for: One-month Libor, Two-day turn, 15%	25%	Four-day turn, 15%	25%	Three-month Eurodollars, Two-day turn, 15%	25%	Four-day turn, 15%	25%
25%	0.72	1.05	1.46	2.00	0.65	1.04	1.30	1.99
35%	0.83	1.11	1.81	2.20	0.69	1.05	1.51	2.07
45%	1.02	1.23	2.33	2.52	0.76	1.10	1.69	2.21

lower than it would be if the turn premium were zero.

■ December/January Libor spread In this spread, you are long the December and short the January Libor contracts. As the turn premium affects only the December contract, each 100bp increase in the turn premium is worth about 12 ticks in this spread. As shown in Figure 7, this spread is 50 or so ticks lower than it would be if there were no turn premium.

■ **December/March Eurodollar spread** Here you are long the December and short the March Eurodollar contracts. With a four-day turn, each 100bp increase in the turn premium decreases the value of this spread by about 4 ticks.

■ **December TED spread** In this spread, you are long the three-month December Treasury bill contract and short the December Eurodollar contract. As you are short the Eurodollar contract, each 100bp increase in the turn premium *increases* the value of this spread by about 4 ticks. One can work out similar implications for the November/ December/January Libor butterfly and the December/March TED tandem.

Of the various spreads, the December/January Libor spread is one of the better vehicles for trading the turn because the effect of the turn premium on the December contract price is both large and fairly direct, and the calendar risk in the trade is about as small as it can be without actually trading the cash deposits themselves. If the turn premium falls to zero by the time the December Libor contract expires on the 19th, a long position in the spread would gain 50 ticks, or $1,250 per spread. Figure 2 (page 47) shows how this spread behaved last year, and Figure 8 shows how the spread has performed so far this year.

The dangers in this spread are threefold. One is that the turn rate is not realised until two weeks after the December contract expires. A second is that there is considerable fluctuation in the market's perception of the turn premium throughout the months leading up to the end of the year. A third is that you are exposed to a flattening of the near-term yield curve.

The other spreads may be less attractive for trading the turn premium, but the effect of the turn on them cannot be ignored when evaluating trades that involve them. The December TED spread, for example, as well as the December/March TED tandem, are greatly influenced by the turn premium. With an implied turn premium of around 400bp, December Eurodollar futures trade 16 ticks or so lower than they would without the turn. Thus, we know that about 16 ticks of the current December TED spread can be attributed to the turn. By the same token, the December/March Eurodollar calendar spread is 16 ticks lower than it would be without the turn.

Effect of the turn on Libor and Eurodollar volatilities

Uncertainty about financing rates over the turn is an additional source of volatility for the one-month and three-month deposit rates to which the December Libor and Eurodollar futures contracts will settle. How can the effect of turn-rate volatility on the volatilities for options on December Libor and Eurodollar futures be determined?

The biggest hurdle to calculating this is how to represent turn-rate volatility. The few observations that we have on the turn, which are shown in Figure 4 (page 47), suggest fairly strongly that turn rates are not lognormally distributed.

With so few observations, however, we only have what we think are two reasonable guides to choosing an alternative distribution. The first is that the size of the turn rate premium should be related to the level of interest rates. The second is that the chance of getting a huge turn premium should be fairly large even though most turn premiums will be close to zero.

One way to satisfy the first reasonableness check is to allow the *ratio* of the turn rate to the non-turn rate to be the random variable so that the turn premium is directly proportional to the level of rates. For example, a turn/non-turn ratio of 1.5 would produce a turn rate of 9% if base rates were 6%. If the base rate were 3%, the turn rate would be 4.5%. The turn premium in the first case would be 3%, while the turn premium in the second case would be 1.5%.

We can satisfy the second reasonableness check by allowing the behaviour of the ratio of turn to non-turn rates to be described by the gamma distribution, which has fat enough tails to allow for a comparatively high number of very large outcomes.

Using this approach, we can simulate the distribution of the one-month and three-month deposit rates that span the turn using various levels of volatility for non-turn rates and for the turn/non-turn ratio. From these simulated distributions, we can determine the effect that turn-rate volatility should have on the volatility of the December one-month Libor and three-month Eurodollar futures contracts. The results of these simulations are shown in Figures 9 and 10.

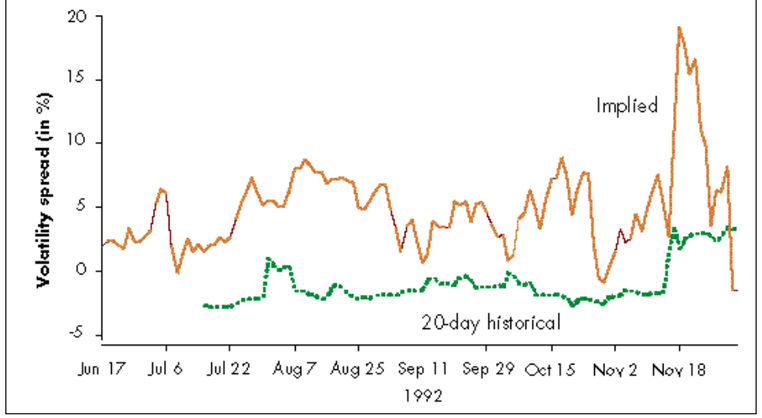
How much is turn-rate volatility worth for options on December Libor and Eurodollar futures? The results shown in Figures 9 and 10 suggest that it should be fairly small. Consider the case in which the volatility (ie, standard deviation) of the turn/non-turn ratio is 0.45; forward deposit rates are around 3%; the base rate volatilities of one-month Libor and three-month Eurodollar rates are 25%; and the turn period lasts four days.

As shown in Figure 9, the contribution of volatility in the turn rate would add 1.49% to the volatility of the December Libor futures contract, and 1.17% to the volatility of the December Eurodollar futures contract. The contribution is smaller for lower levels of volatility. And, at any given set of volatilities, the contribution is smaller for a two-day turn than for a four-day turn.

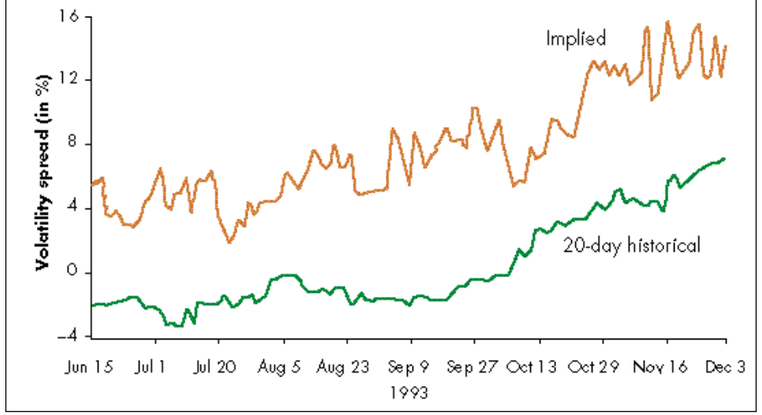
The effect of turn-rate volatility is higher if the level of non-turn interest rates is higher. This is shown in Figure 10, where everything is the same as in Figure 9 except that the level of non-turn rates is 6% rather than 3%. At this level of rates, we reckon that the effect of 0.45 volatility in the turn/non-turn ratio combined with 25% base rate volatility is an increase of 2.52% in December Libor and 2.21% in December Eurodollar volatility for a four-day turn.

These results may not seem very exciting at first glance because they cannot shed much light on whether December Libor or Eurodollar options are expensive or cheap.

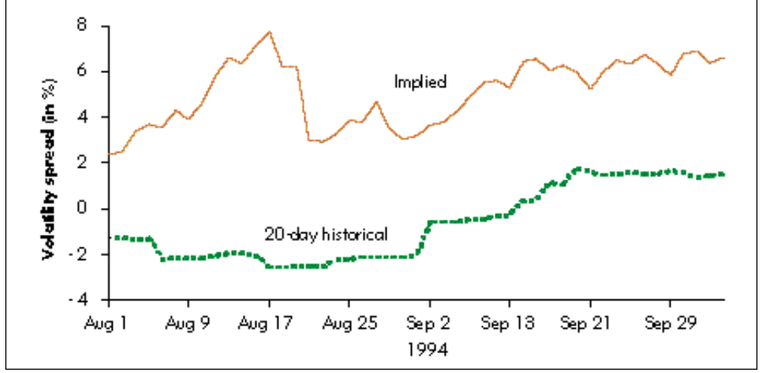
11. LED volatility spreads: December 1992 contracts



12. LED volatility spreads: December 1993 contracts



13. LED volatility spreads: December 1994 contracts



INTEREST RATES

But they can be a powerful tool in evaluating spread trades between December Libor and Eurodollar options.

For instance, even in the extreme case – rates at 6% , turn ratio volatility at 0.45, base rate volatility at 25% and a four-day turn – the effect of turn-rate volatility on the *difference* between Libor and Eurodollar volatilities would only be about 0.3% (the difference between 2.52 and 2.21, as shown in Figure 10). In less extreme cases, and with a three-day turn, the effect would be smaller.

On this basis, we would expect the spread in implied volatilities for the Libor and Eurodollar options to be quite small. But in Figures 11, 12 and 13 we see that in 1992, 1993 and 1994 the options market has paid a hefty premium for the LED volatility spread. In 1993, for example, the implied volatility spread was consistently about 8% greater than the historical volatility spread. At the time of writing, the LED-implied volatility spread for the December 1994 contracts is trading around 6.5% – about 5% greater than the historical volatility spread.

We view this as an opportunity to take advantage of an apparent mispricing. For example, to sell December 1994 Libor volatility and buy December 1994 Eurodollar volatility on October 3, 1994, one could have:

■ sold 100 of the December 94.00-93.75 Libor strangles at 35 ticks per strangle and sold 10 December Libor futures to make the position delta neutral (futures at 93.83) and

■ bought 100 of the December 94.00 Eurodollar straddles at 30 ticks per straddle and bought 11 December Eurodollar futures to make the position delta neutral (futures at 93.96).

Thus, the spread position could have been established for a net credit of 500 ticks.

A position like this would have some interesting and desirable characteristics. As the spread is long the low-volatility options and short the high-volatility options, the net position provides a rare opportunity to be long gamma and to have time decay work in your favour at the same time.

Figures 11 and 12 show how highly variable the implied LED volatility spread is. Thus, even though the additional premium paid for Libor volatility seems not to be justified by either the theory or the evidence, a position that is short Libor volatility and long Eurodollar volatility can produce large swings in a trader's profit and loss from day to day. Also, a sharp increase in the turn rate can be costly for anyone who is short Libor volatility. In late November 1990, for example, such a spike in the turn rate increased the 20-day historical volatility spread to around 14%.

Even so, there are two ways the trader can make money on the trade. The first is a collapse in the implied volatility spread so that it accords more closely with what it should be. This is the best outcome because it avoids the need to actually work for a living by managing the position until the December expiration of the options.

If the implied volatility spread does not collapse, the trader can still make money if the realised difference between December Libor and Eurodollar volatilities proves to be less than 6.5%. In this case, if the position is properly managed, the trader can profit from the relatively higher time decay that would be taken in on the Libor options than would be paid out on the Eurodollar options. ■

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