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10-Year Agency Note Futures and Options

Hedging Swap Risk

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Abstract

CBOT agency note futures are based on a deliverable basket of noncallable, fixed-coupon debt issued by Fannie Mae® and Freddie Mac. Both of these Government Sponsored Enterprises are rated AAA, reasonably close to the long-term debt rating embedded in most plain vanilla LIBOR swaps. For this reason, CBOT agency note futures offer a clean and easy way of hedging long-dated swap rates and swap spreads. This paper explores why and shows how.

First Things First: What Is a Swap Rate?

In a plain vanilla swap, the swap rate is the interest rate at which one market participant agrees to pay a stream of fixed payments to another in exchange for a stream of floating interest rate payments. The following example illustrates with a typical LIBOR swap.

Example: On January 28, 2000, Tom indicates he is willing to pay Fred the 6-month London interbank offered rate (LIBOR) every six months for the next 10 years, starting January 31, 2000, on $100 million notional principal. Since 6-month LIBOR for value January 31, 2000, is 7.317%, Tom already knows his first payment to Fred (on July 31, 2000) will be $3,699,150.

$$\$3,699,150 = \$100,000,000 \times 0.07317 \times 182 \text{ days} / 360 \text{ days}$$

In late July 2000, Tom will recheck the level of 6-month LIBOR to determine the floating payment he will make to Fred on January 31, 2001. And so it will go, with Tom resetting LIBOR at the end of every January and July until he makes his last payment to Fred on January 31, 2010.

What fixed rate will Fred pay Tom for this sequence of payments? The answer comes from the swap market, where 7.439% is the going swap rate for 10 years worth of floating 6-month LIBOR payments. If Fred agrees to the terms of this transaction, he will be obligated to pay Tom $3,719,500.

$$\$3,719,500 = \$100,000,000 \times 0.07439 / 2$$

This will be the amount he pays, not only on July 31, 2000, but at the end of every January and July until his final payment on January 31, 2010.

Note the key features of this transaction:

- Tom's payments to Fred (apart from the first one) are uncertain—by definition they float—while all of Fred's payments to Tom are known in advance.

- No principal changes hands. The only cash flows that move are interest or coupon payments (based on the $100,000,000 notional principal).
- Payments net. In practice, there is apt to be only one net cash flow on each payment date. In this example, instead of Tom and Fred crossing payments on July 31, 2000, Fred will simply pay Tom a difference check of $20,350 ($3,719,500 - $3,699,150). The general rule for this particular example is that whenever 6-month LIBOR is more than 7.317%, Tom will make net payment to Fred. Otherwise, Fred will make net payment to Tom. (Note that 7.317% is just 7.439% x (360/366)—that is, the bond-equivalent swap rate converted into money-market terms.)

What is a Swap Spread?

An abiding peculiarity of the swap market is its mix of day-count conventions. In the plain vanilla swap above, the LIBOR that determines the floating payment stream is measured in money-market terms, with a day count of actual/360. The swap rate that determines the fixed payment stream, however, is gauged in bond-equivalent yield terms (actual/actual).

Though this looks like an inconvenience, it is rooted in a market convention that actually facilitates quotation and transaction. A plain vanilla swap rate is typically quoted not as a stand-alone rate but as a bond-equivalent yield spread over the corresponding on-the-run Treasury yield. Thus, the 7.439% fixed rate that Fred agrees to pay Tom is quoted in the market not as 7.439% but rather as a swap spread of 76.5 bond-equivalent basis points over the current 10-year Treasury note yield, which in this case is 6.674%.

Where Does Swap Rate Volatility Come From?

The swap spread represents the credit risk in the swap relative to the corresponding risk-free Treasury yield. It is the price tag on the actuarial risk that one of the parties to the swap will fail to make a payment. The Treasury yield provides the foundation in computing this spread, because the U.S. Treasury is a risk-free borrower. It does not default on its interest payments.

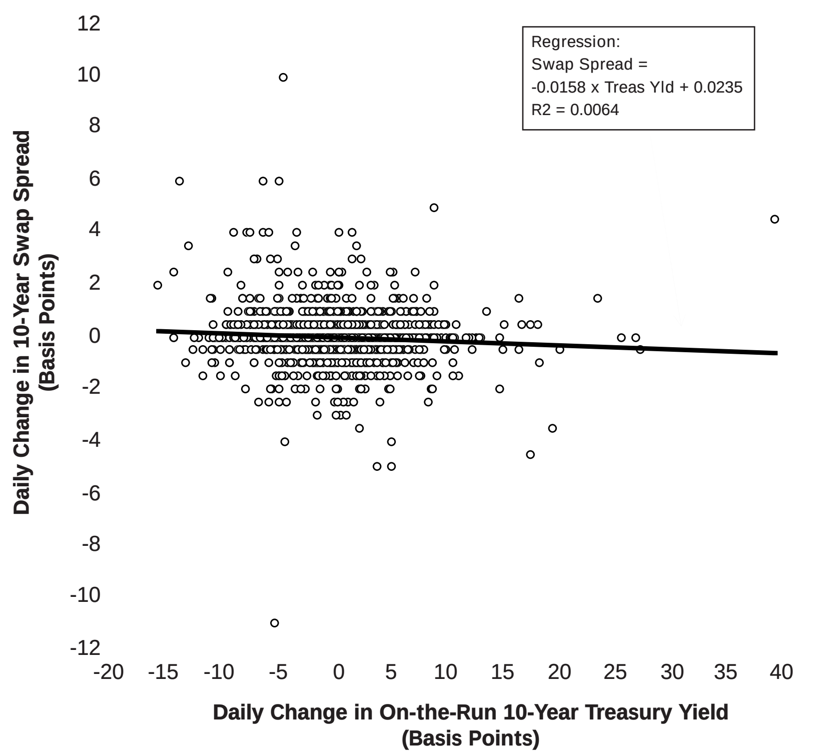
Since the swap rate is the sum of the Treasury yield and the swap spread, a well-known statistical rule breaks its volatility into three components:

Swap Rate Variance =

Treasury Yield Variance
+ Swap Spread Variance
+ 2 x Covariance of Treasury Yield and Swap Spread

Taken over long time spans (e.g., quarter-to-quarter or annual), changes in the 10-year swap spread exhibit a small but reliably positive covariance with changes in the 10-year Treasury yield. For practical purposes this means that as

Figure 1
Swap Spreads Are Approximately Uncorrelated with Treasury Yields, 1993-99



Treasury yield levels rise and fall over, say, the course of the business cycle, the credit risk in interest rate swaps tends to rise and fall with them.

However as Figure 1 illustrates, high-frequency (e.g., day-to-day or week-to-week) moves in swap spreads and Treasury yields tend to be uncorrelated. Their covariance is close to zero. Thus, for holding periods that cover very short time spans, this stylized fact allows simplification of the preceding formula into the following approximation:

Swap Rate Variance ≅ Treasury Yield Variance + Swap Spread Variance

This rule of thumb allows attribution of the variability in swap rates in ways that are useful for hedgers. For example, during the five years from 1993 through 1997, 99% of week-to-week variability in 10-year swap rates derived from variability in the 10-year Treasury yield. Variability in the 10-year swap spread accounted for just 1%.

Hedging Swap Rates: Treasuries Fold . . .

As long as the swap spread is reasonably steady or, what amounts to the same thing, as long as it accounts for a small fraction of the swap rate's variance, as it did between 1993 and 1997, market practitioners can safely rely upon either Treasury securities or CBOT Treasury futures to hedge the fixed-rate market risk exposure in plain vanilla swaps.

However since the Asian financial meltdown in 1997, and more particularly since the double debacle of Russia's default and Long Term Capital Management's demise in late 1998, this approach to hedging has proved problematical. This point is illustrated in Figure 2, which depicts daily history for the 10-year swap spread, as well as the 10-year Treasury–Agency (TAG) yield spread. Not only have 10-year swap spreads doubled from their 1993-97 average, but, more importantly, their volatility has exploded. The standard deviation of week-to-week changes in the 10-year swap spread during 1998-99 was 4.5 basis points, more than triple the standard deviation of its week-to-week changes during 1993-97. That is, during 1998-99 the swap spread's variance accounted for 13% to 14% of the variance in the swap rate, versus the slim 1% share of swap-rate variance it represented during 1993-97.

As a direct consequence, the formerly reliable hedging relationship between Treasuries and swaps has loosened. Figure 3 (next page) compares the experience of 1993-97 with 1998-99.

Notice that during 1993-97, the correlation between changes in 10-year Treasury yields and changes in 10-year swap rates was exceptionally tight, around 99.5%, regardless of whether changes were measured over short time spans (e.g., day to day) or long ones (e.g., quarterly).

However, since 1997, the correlation between Treasuries and swaps has plunged into the low 90s. Moreover, the longer the time span over which yield changes are measured, the worse the deterioration in their relationship. If Treasuries have become a mediocre hedge for swap rates over a horizon of one day, they're an even worse hedge over a horizon of four weeks.

. . . while Agencies Hold

The turmoil of the last two years has likewise loosened up the relationship between swap rates and yields on federal agency notes. However, the damage here has not been nearly as great as for Treasuries. Figure 4 (next page) underscores the point.

During 1993-97, the correlation between changes in 10-year agency note yields and changes in 10-year swap rates was in the neighborhood of 99%, almost as tight as the relationship between 10-year Treasury yields and swap rates.

Figure 2
10-Year TAG Spread versus 10-Year Swap Spread

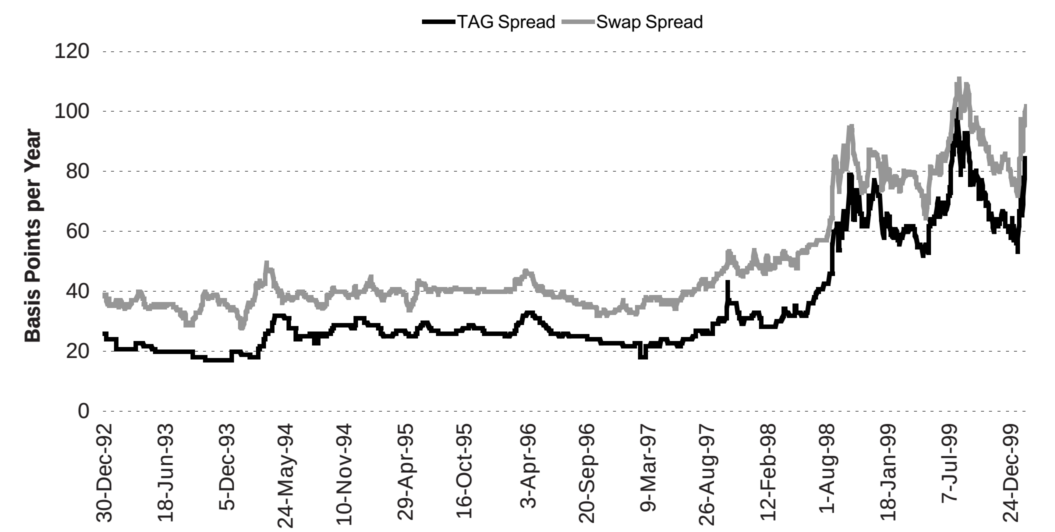


Figure 3
Declining Correlation Between Changes in 10-Year Treasury Yields and Changes in 10-Year Swap Rates

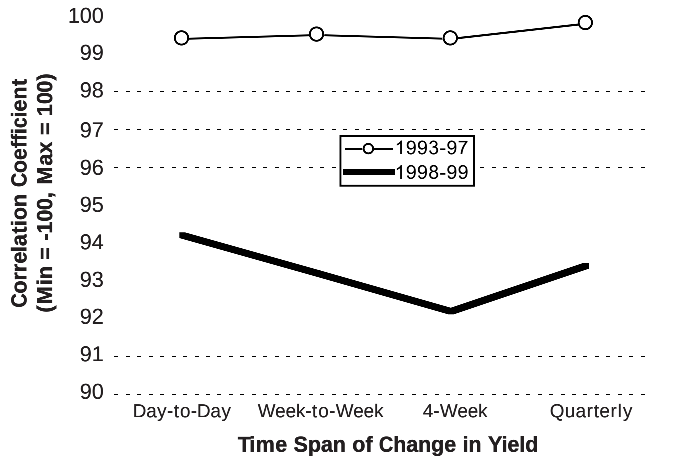
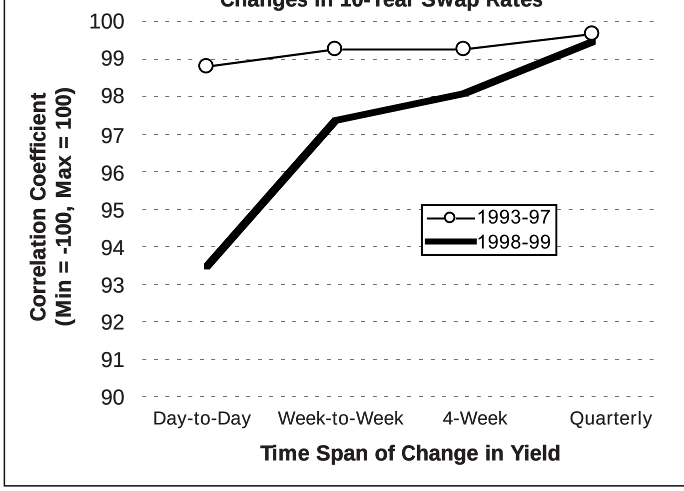


Figure 4
Correlation Between Changes in 10-Year Agency Yields and Changes in 10-Year Swap Rates



Since then, as with Treasuries, the correlation between agencies and swaps over very short time horizons (e.g., day to day) has dropped off noticeably.

Unlike Treasuries, however, agency yields have maintained a relatively tight relationship with swap rates over longer time spans (e.g., week-to-week changes or longer). At the four-week horizon, for example, the reduction in correlation has been all but imperceptible—98% for 1998-99 versus just over 99% for 1993-97.

The lesson in this is straightforward. Whenever credit spreads turn volatile, agency securities (or CBOT agency note futures) should do a better job of hedging swap rates than Treasuries (or CBOT Treasury futures).

Example: How to Use Agency Futures to Hedge a Swap

The deliverable basket of securities underlying the CBOT agency note futures contract comprises noncallable, fixed-coupon debt issued by Fannie Mae and Freddie Mac. Both enterprises enjoy a AAA long-term debt rating from Standard & Poor's, close to the long-term debt rating embedded in most plain vanilla LIBOR swaps (lately around AA- on the S&P scale). Thus, CBOT agency note futures offer market participants a convenient tool for hedging swap rates.

To see how, return to Tom and his 10-year swap. Because he pays 6-month LIBOR and receives a semiannual fixed payment every six months, Tom effectively has a long position in a fixed-coupon bond and a short position in a floating-rate note. To hedge his fixed-rate exposure in this transaction, he can sell either 10-year Treasury note futures or 10-year agency note futures.

The hedge ratio that will tell him how many futures contracts he should sell (whether agency note futures or 10-year Treasury futures) is determined by the relative interest rate sensitivity of swaps and futures. Specifically, it is the ratio of the DV01 (dollar value of a one-basis-point move) associated with the swap rate to the DV01 associated with the agency or Treasury note yields.

$$\text{Hedge Ratio} = \text{DV01}_{\text{Swap}} / \text{DV01}_{\text{Futures}}$$

To begin, the first line of the table below summarizes market conditions at the close on January 28, 2000, when Tom and Fred enter into their swap agreement. The going rate on 10-year swaps is 7.439%, March 10-year agency note futures are priced at 90-29, and March 10-year Treasury futures are priced at 94-285 (the 285 notation indicates 28.5/32; an alternative notation is 28+). This puts the March Treasury-Agency (TAG) price spread at 3-315 (94-285 - 90-29).

	10-Year Swap ($100 mln Notional Principal)	**10-Year Agency Note Futures (March 2000)**	**10-Year T-Note Futures (March 2000)**
Price, Jan. 28, 2000 (Swap settlement on Jan. 31, 2000)	7.439%	90-29/32	94-28.5/32
Dollar Value of an 01	$64,850	2/32 or $62.50 per contract	2.125/32 or $65.83 per contract
Hedge Ratio Against Swap	NA	1,038 contracts (= 64,850/62.50)	985 contracts (= 64,850/65.83)
Price Shock! Interest rates rise. Note prices fall.	7.601%	90-04.5/32	94-06.5/32
Change in Rates/Prices	+16.2 basis points	-24.5/32	-22/32
Dollar Value of Price Change	-$1,042,487	-$794,719	-$677,188
Profit/Loss on Hedged Swap Position	NA	-$247,768	-$365,300

The hypothetical, but entirely plausible, March 2000 agency note futures prices used here are derived from a four-step process.

First, assume the cheapest-to-deliver (CTD) issue into a hypothetical March agency note futures contract is the 6 5/8% of September 2009. Both Freddie Mac and Fannie Mae recently have sold 10-year notes with these terms. Since these would have the longest duration within the deliverable basket for a hypothetical March futures contract, they are odds-on candidates for CTD.

Second, since high-grade 10-year agency debt was yielding 7.31% on January 28, it is possible to infer a cash-market price of the CTD issue of around 95-10.

Third, given conversion factors based on a 6% coupon, the conversion factor for this note (6 5/8% coupon, 9 years 6 months to maturity) is 1.0448. That means its futures-equivalent price is 91-075 (95-10 / 1.0448).

Fourth, assume that the basis, converted into futures price terms, is worth 10.5 (because bond basis is normally quoted in 32nds this is equivalent to 0-105). That means the futures price should be 90-29 (91-075 - 0-105). This assumption has no direct impact on the outcome of this example, because we assume at the same time that the basis holds steady, that is, that any price change in the futures contract is entirely attributable to price change in the underlying CTD agency note.

To keep things simple, assume the term structure of both LIBOR and swap rates is flat at a bond-equivalent yield of 7.439%, and these yield curves make only parallel shifts up or down.

To get the numerator of the hedge ratio—the DV01 for the 10-year swap rate—begin by noting that the notional value of a plain vanilla interest rate swap is:

$$V = N_{Fix} - N_{Float}$$

where N_{Fix} is the notional value of a 10-year bond paying interest semiannually at a fixed rate of 7.439% per annum

N_{Float} is the notional value of a floating rate note paying 6-month LIBOR semiannually, with the first interest rate payment set at 7.317% per annum (or 7.439% in bond-equivalent terms)

Given that both the LIBOR rate curve and the swap yield curve will always be flat at a bond-equivalent rate of, say, r, and given that they make only parallel shifts up and down, the approximate algebra for valuing N_{Fix} and N_{Float} on settlement day is:

$$N_{Fix} = 0.07439 \times [\, (1/r) \times (\, 1 - (1 + r/2\,)^{-20}\,)\,] + (1 + r/2\,)^{-20}$$

$$N_{Float} = (\, 1 + 0.07439/2\,) / (1 + r/2\,)$$

If these two expressions are valued at their par yield (that is, with r = 7.439%), they both equal 100. Trivially, this means that V, the par value of the swap, is zero. By perturbing the swap rate, r, up or down one basis point, the DV01 for a $100 million notional principal swap turns out to be $64,850. (For a more extensive discussion of swap pricing, see Chapter 4 of John C. Hull, *Options, Futures, and Other Derivatives*, 3rd ed, Prentice Hall 1997.)

To get the denominator of the hedge ratio—the DV01 for either 10-year agency note futures or 10-year Treasury futures—make the rough-and-ready assumption that the basis will hold steady, regardless of how cash-market note prices might change. This allows approximation of the futures DV01 as the DV01 for the cheapest-to-deliver note, divided by the appropriate conversion factor (CF).

$$DV01_{Futures} \cong DV01_{CTD} / CF_{CTD}$$

Remember that for a hypothetical March 2000 agency note futures contract, the CTD issue is the 6 5/8% of September 2009, and the relevant conversion factor is 1.0448. By pricing the note at the prevailing 7.31% yield, and perturbing the yield up or down one basis point, this rule of thumb shows the futures DV01 to be 2/32nds. A similar exercise with March 2000 10-year T-note futures produces a futures DV01 of 2.125/32nds.

These results are summarized in the second line of the table. They allow computation of the hedge ratios for either an agency note futures hedge or a T-note futures hedge which appear on the third line of the table.

Now suppose that immediately after Tom and Fred have struck their swap agreement, market yields rise and note prices decline as shown in the fourth line of the table. Specifically, a jump of 16.2 basis points in the 10-year swap rate causes the market price of Tom’s swap agreement to drop $1,042,487.

If Tom has protected himself by hedging with futures, then two conclusions are apparent. First, he achieves substantial (though not total) protection against the rate increase. Second, he does modestly better by hedging with agency note futures than 10-year Treasury futures. The bottom two lines of the table summarize these alternative outcomes.

With a hedge position of 1,038 10-year agency note futures and based on a futures contract tick value of $31.25, Tom recoups more than three quarters of the setback on his swap position:

$$\$794{,}719 = -1{,}038 \text{ contracts} \times -24.5 \text{ ticks} \times \$31.25$$

That holds the net loss to just $247,768.

If instead he has hedged by selling the recommended 10-year Treasury note futures hedge of 985 contracts, then he makes back a bit less than two-thirds of his loss on the swap:

$$\$677{,}188 = -985 \text{ contracts} \times -22 \text{ ticks} \times \$31.25$$

That holds the net loss to $365,300.

It is interesting to note that the interest rate and futures price moves shown in the table actually occurred during the two weeks between January 28 and February 10, 2000. For ease of illustration, this market action has been compacted into one day. However, the move in the hypothetical March 10-year agency futures contract is consistent with an actual rise in on-the-run 10-year agency yields from around 7.31% on January 28 to approximately 7.43% on February 10.

TAG Spread versus Swap Spread

Instead of hedging the swap rate itself, Tom might prefer to hedge only his exposure to the swap spread. He could have several motives for this decision. For example, he might already have a short position in 10-year Treasury notes sufficient to hedge the Treasury component of his long exposure to the fixed-payment side of the swap.

The data plots shown in Figure 2 suggest that Tom can use the TAG (Treasury over Agency) futures spread to hedge this exposure. Closer scrutiny confirms that this is indeed so, as long as Tom's holding-period horizon is reasonably long (that is, on the order of a quarter or more). For extremely short holding periods, however, the TAG makes a rather loose hedge for the swap spread, one that would require a fair amount of supervision. While hedgers might find this annoying, swap traders are apt to find a rich field of opportunity playing the TAG spread against the swap spread.

Figure 5 suggests why this is so. It depicts the difference between the swap spread and the TAG yield spread. Two features of this plot warrant mention. One is that, as a long-term proposition, the difference between these two credit spreads is not directional. It appears to be tethered to an average level of +14.5 basis points or so. The second point is that, as a short-term proposition, it wanders freely—and at times wildly—within a range spanning from +5 basis points to +25 basis points.

Figure 6 dramatizes this long-term versus short-term distinction. Quarterly changes in the 10-year TAG yield-spread and the 10-year swap spread exhibit a correlation in excess of 96.5%—high enough to meet the standards of many hedgers. By contrast, day-to-day changes in the TAG spread and the swap spread feature a correlation between 50% and 55%. While this is a statistically reliable positive number, it is far too low to offer much comfort to a hedger. To a trader, however, this is precisely the degree of decorrelation that betokens profitable opportunities. Thus, the looseness in the short-term link between the two spreads, when combined with the underlying mean-reverting character of their relationship shown in Figure 5, is apt to draw swap-market speculators.

Figure 6
Longer Horizon Means Higher Correlation: Correlation Between Changes in 10-Year TAG Spread and Changes in 10-Year Swap Spread
1998-99

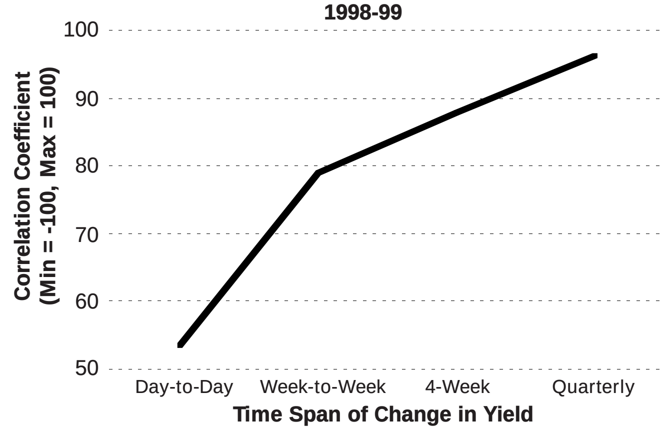
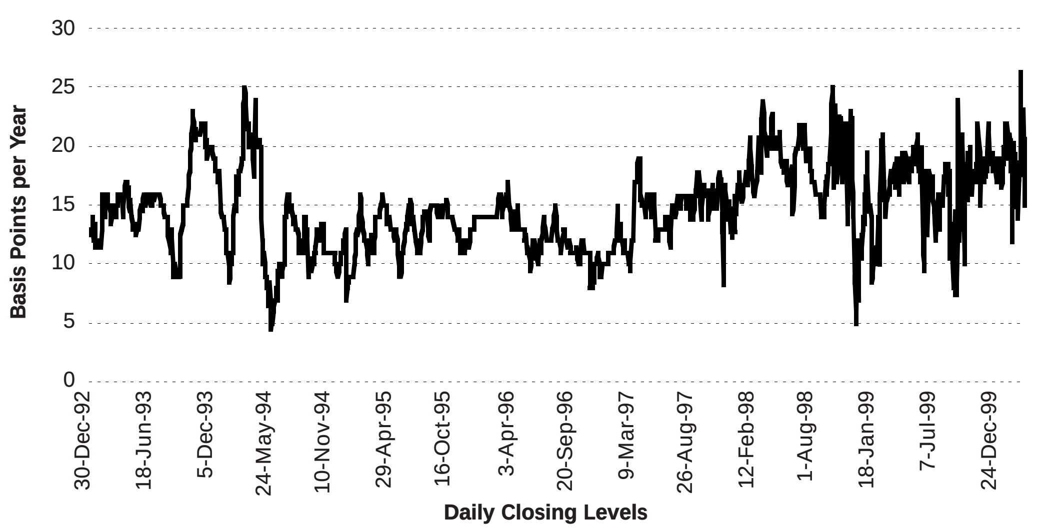


Figure 5
10-Year Swap Spread minus 10-Year TAG Spread



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