MIT SLOAN SCHOOL OF MANAGEMENT
PROSEMINAR IN FINANCIAL ENGINEERING

Sponsored by: ***Morgan Stanley Dean Witter***

MODELING INTEREST RATE SWAP SPREADS

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November 19, 1999

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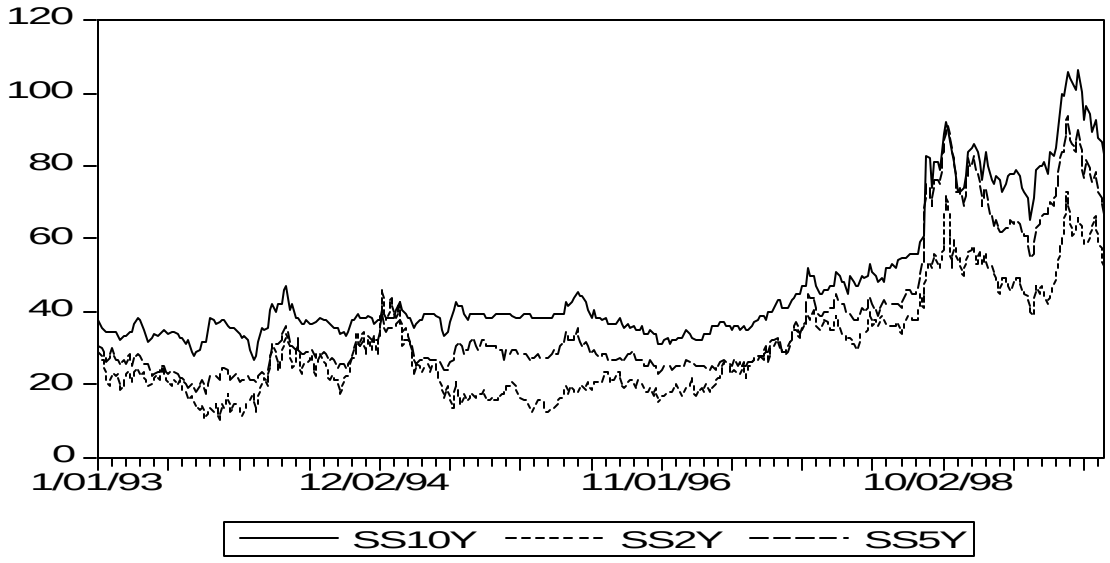
INTRODUCTION

The swap curve is the term structure of fixed rates that the market is willing to pay in exchange for floating LIBOR payments. Each tenor, or final maturity, corresponds to a different fixed "swap rate". For any given tenor, the swap spread is defined as the difference between the fixed rate on the swap curve and the yield on the most recently issued (on-the-run) Treasury bond (the benchmark) with similar maturity.

For the vast majority of interest rate swaps, one or both of the counter parties is a major financial institution. The pricing of interest rate swaps is fairly well understood and well discussed in both the academic and practitioner literature. However, the modeling of swap spreads and the pricing of related products is less developed.

Before July 1998, swap spreads tended to oscillate around a relatively low mean and demonstrated very little variation. The financial crisis of Fall 1998 changed this regime. Since then, swap levels have remained at much higher levels and have demonstrated much higher volatility. Many theories have arisen regarding the drivers behind this regime shift and behind current swap spread behavior.

2-Year, 5-Year, 10-Year Swap Spreads



The goals of this paper are to address such recent concerns by:

- Defining the swap curve and swap spread in greater detail
- Identifying market dynamics influencing swap spreads
- Presenting an econometric model tying swap spreads to macroeconomic variables
- Present case studies utilizing swap spread derivatives

This paper begins by examining which factors most strongly relate to swap spreads. Potential drivers evaluated include: swap curve volatilities, treasury auction timing, credit perceptions, stock market returns, eurodollar futures, and corporate bond issuance.

The factors with the strongest correlation have been integrated into a four-factor linear regression model to provide a reference point on current changes. This model is then evaluated on its predictive power.

The two swap spread derivative products considered are spread locks and spread caps. After defining the mechanics of these instruments, the paper provides examples of their use.

MARKET DYNAMICS

Swaps lie at the center of the global fixed income markets, integrating capital investors and users across currencies, maturities and interest flows. Active users of swaps include corporations, governments, institutional investors, hedge funds, and market makers. Given this ubiquity, the factors influencing swap rates and swap spreads are numerous, and have proven quite difficult to isolate.

General Equilibrium

In simplest terms, swap rates are the fixed prices that the market is willing to pay to receive floating interest payments that reflect contemporaneous borrowing costs and credit risks. As in other competitive markets, this price is determined by supply and demand. In the case of interest rate swaps, one must consider the demand for floating interest rates (the supply of fixed interest payments) and the supply of floating interest payments (the demand for fixed interest payments).

When supply of fixed interest payments is high, demand for floating rates rises, and the equilibrium swap rate price of such floating payments also rises. Conversely, when the demand for fixed interest payments is high, supply of floating rates is high, and the equilibrium swap rate price of floating rates fall. This is the essential dynamic through which all putative drivers flow.

Below the swap spread lies the Treasury curve. In many respects, the Treasury curve may be viewed as the cost of risk-free lending. In fact, however, the yield of Treasury bonds may often lie below the true risk-free rate. Prices of treasury bonds are influenced by variables, including demand for safe-haven securities, available collateral for repurchase agreements, and size and frequency of treasury auctions, among others. This reliance on the benchmark treasury substantially complicates the task of parameterizing swap spreads.

Demand for Floating / Supply of Fixed

There are many sources of fixed rate payers in the market. For example, market makers may wish to hedge their inventory of fixed rate bonds by swapping out fixed coupon receipts into cash flow streams that more closely track their floating funding costs. (This ties in closely with the repo market, as explained in Appendix III.) Additionally, many banks fund themselves through floating rate liabilities but may have fixed rate assets. Financial institutions in such a position may wish engage in an "asset swap," synthesizing floating rate assets from fixed receiving bonds by swapping out the fixed payments through interest rate swaps.

Other reasons to supply (pay) fixed rates:

- Expectations of rising short term interest rates (curve flattens) will lead investors to prefer to pay fixed and receive LIBOR, increasing the swap rate.

- Investors uncertain and concerned about rate trends may shorten duration by selling bonds. However, when there is large supply of corporate bonds, the market becomes very thin and no one wants to take their positions. Then some investors can use swaps wanting to pay fixed as a rough substitute to selling bonds.

- Recently, banks holding more Treasuries than usual for Y2K liquidity have reduced interest rate exposure by paying fixed rates through swaps.

Supply of Floating / Demand for Fixed

In an environment of high interest rates, corporate bond issuers may prefer to avoid locking in high-rate funding liabilities if they believe rates will fall. Such potential issuers might wish to receive fixed rate against fixed rate bonds and pay floating rates in the belief that nominal rates will fall in the future. One might anticipate that this supply of floating payments would place downward pressure on swap rates.

Similarly, corporations that prefer floating rate liabilities may find that they can issue debt relatively less expensively by selling fixed rate bonds and entering into a swap to receive fixed rate payments. The classical example of this is the case where Company A issues fixed rate debt and enters into a swap with Company B that prefers fixed rate liabilities but whose credit profile only qualifies it for floating rate funding.

Investment managers with fixed future liabilities may also engage in swaps to receive fixed income streams. Many life insurance companies, for example, may make floating rate loans (generally secured) to property developers or real estate companies and then enter into a swap to reduce volatility on the cash flow stream.

Market Segmentation

One should be careful to note that different investors are active at different tenors (maturities) on the swap curve. Differences in focus are driven principally by differences in how corporations, institutions and money managers structure time their assets and liabilities:

- Treasury desks of corporate and investment banks dominate the short end of the swap market. These institutions use maturities out to three years to manage interest rate risk in their own books. As a result, the short end of the swap market is very liquid and tends to be correlated with alternative interest rate contracts available (e.g., Eurodollar futures).

- Five to seven year swaps are used regularly by actors in the corporate debt market. Corporate bonds tend to have weighted average maturities in a comparable range. Hence, asset swappers and fixed rate loans issuers are active in this segment.

- Swap maturities of ten years and over are not as liquid as other segments. Potential credit exposure emerges as an overriding concern. Consequently, strong credits such as supra-nationals and dominant corporations tend to dominate this end of the swap term structure. Anecdotal evidence holds that market makers in Agency bonds and mortgage securities are utilizing this tenor with increasing frequency.

Volatility

High swap curve volatility makes investors feel uncertain about future rate trends. As a result, fixed rate receivers may feel pressured to shorten the duration of their portfolios to protect themselves against "more probable" unfavorable interest rate movements that would lesson the value of their portfolios. (Even positive movements may appear unattractive to the extent that irregular portfolio returns may prompt fund outflows.) Hence, fixed income investors will wish to swap fixed payments for floating, pushing swap rates upward.

A potential way to measure swap volatility is through the implied volatility expressed in swaptions prices and extracted using the Black-Scholes formula. Swaptions are contracts that give the buyer the right to enter into a swap (either as a fixed payer or receiver) at a future point in time. The implied volatility in the swaption is the perceived future volatility of the underlying swap of a given tenor. Presumably, as the implied volatility of the swap curve rises, swap rates will rise in response. Assuming that movements in the Treasury curve do not completely compensate for changes in the swap rates, swap spreads would also rise.

Treasury Auction Timing

Referencing on-the-run Treasuries can heavily influence the swap spread. On-the-run bonds often command relatively high prices due to their high liquidity, hedging value and specialness premia (in the repo market). This, in turn, reduces yield on benchmark government securities and generally increases the spread between the swap and reference curves.

One hypothesis is that this extra value (and low yield) on the treasury diminishes as the on-the-run treasury ages and the next benchmark approaches auction. Additionally, market makers might shy away from aging on-th-run bonds in anticipation at new benchmarks. If this is true, one would expect that as a new issue draws near, liquidity premium of the on-the-run bond would decay quite rapidly, tightening swap spreads.

Credit Spreads

Given that substantially all swap counter parties are large institutions, swap rates are often viewed as measures of the cost of debt for AA issuers. As a result, the swap spread between the swap curve and the treasury curve may serve as a proxy for the credit spreads between corporate bond yields and the treasury curve. As a result, when credit

concerns arise, the credit spread (premium) rises, and swap spreads should move out as well.

Stock Market Returns

On one hand, equity portfolio managers generally do not employ interest rate swaps in their investing strategies. On the other hand, stock market returns may be viewed as indicators of the perception of the health of the economy. This, in turn, links with credit quality. It is presumed that in a bull economy credit quality will rise, reducing the premium that issuers may pay over benchmarks to borrow in the capital markets. Conversely, in soft economies of times of crisis, one might expect credit spreads and swap spreads to widen.

Eurodollar Futures

Spreads on short term swaps (up to three years) are determined also by hedging costs in the Eurodollar futures market. The reason is that Eurodollar futures can also be used to hedge the exposure on short-term floating-rate assets or liabilities as a series of these contracts for different maturities creates the same effect as an interest rate swap. For example, a borrower wishing to fix the exposure on a two-year liability indexed to LIBOR could either enter into a two-year interest rate swap paying fixed and receiving floating LIBOR payments or, alternatively, could sell a series of Eurodollar contracts matching the payment dates on the underlying liability. In either case, the borrower has effectively locked in fixed-rate financing: if LIBOR rises, higher financing costs are offset either by higher floating-rate payments in the swap or by gains realized on the futures contracts.

Corporate Issuance

As more corporate bonds come to market, dealing desks will hedge their credit exposure on their inventory by selling fixed rates to receive floating rates. (Historically, corporate traders have used Treasuries, but these do not properly account for changes in credit quality.) With increased bond issuance, and higher demand for floating interest payments, swap spreads, as the compensation for floating cash flows, will rise.

Alternatively, some corporations, especially financial institutions that have floating assets, prefer to fund on a floating basis. Although many will issue fixed rate bonds, they will seek to receive fixed rate and pay floating. This, presumably, would increase the supply of floating payments and place downward pressure on swap rates.

It is difficult to estimate the overall impact of these two factors. However, market observers suggest that the equilibrium over the past year has shifted as increasing numbers of market makers and fixed income fund managers are shifting to hedging with swaps instead of Treasuries.

POTENTIAL DRIVERS

Overview

This previous section provided an overview of swap market dynamics within the context of the supply and demand of floating rate payments (equivalently, the demand and supply of fixed rate payments). This section evaluates potential swap spread drivers drawn from anecdotal observation against historical data. The first step is to calculate the correlations between the levels of the swap spreads and the levels of the proxy driver data. The second step is to run regressions on the changes in the swap spreads as the dependent variable against the changes in the external factors as the independent variables. This paper does not regress the levels of the swap spreads against the levels of the external factors since both show evidence of being non-stationary.

At this stage the paper focuses on the swap spread of the 5-year maturity in an attempt to preliminarily identify which drivers posses the most explanatory power. On the basis of this analysis, the next section will select the most significant drivers and develop a multi-factor linear model to estimate changes to swap spreads under certain market conditions. It is important to note that all factors considered in this section are evaluated on a standalone basis, whereas those chosen for the econometric model in the following section are evaluated concurrently.

The following table highlights which potential drivers were suggested by anecdotal evidence and indicates which data was available.

Data	*Range*	*Freq*[1]
(LIBOR) Swap Spreads against US Treasury Yields	Jan-93 : Nov 99	W
US Treasury Yields	Jan-93 : Nov 99	W
Timing of US Treasury Auctions	Jan-93 : Nov 99	W
Corporate Bond Issuance	Jan-93 : Nov 99	Q
Implied Volatility from 5-year Swaptions	Jun-97 : Nov 99	W
Eurodollar Futures	Jan-93 : Nov 99	W
AA Corporate Yields	Jan-94 : Sep 99	W

[1]Frequency: W=Weekly, M=Monthly, Q=Quarterly

The table below summarizes the results obtained through the analyses of the individual perceived drivers. Note that the results are presented in relation to the entire data sample and then with the subset of the data from July 1, 1998 to the present. The motivation behind the double set of results is to evaluate the impact of the regime shift that took place in the third quarter of 1998, raising mean swap spreads and increasing volatility.

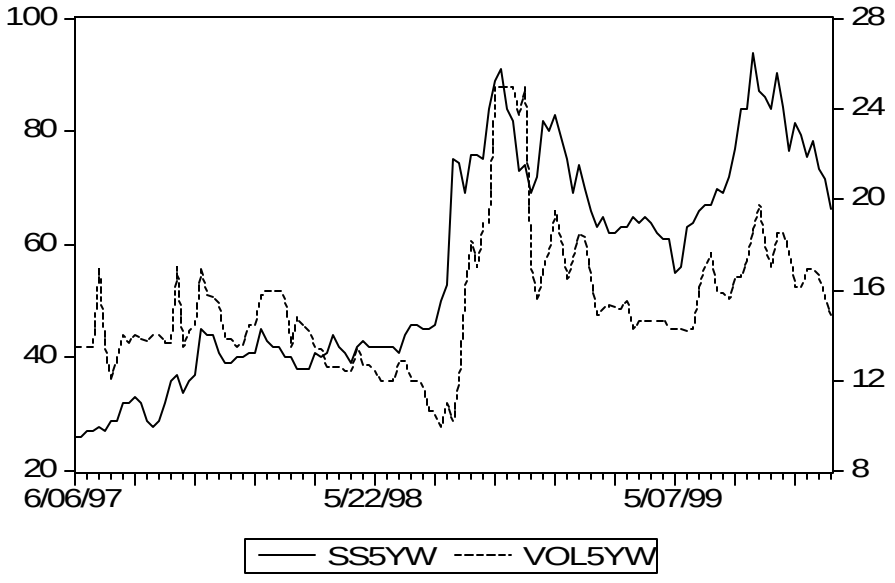
Factor Significance

Factor	*Correlation*		*b*[1]		R^2 (%)	
	Full	*2nd*	*Full*	*2nd*	*Full*	*2nd*
Implied Volatility[2]	.660	.722	**.638**	.632	5.40	4.23
Eurodollar Futures[3]	-.249	-.116	**-.517**	3.289	4.06	.57
Treasury Issuance (DTN)[4]	.597	.161	**.030**	.039	3.96	4.20
Corporate Issuance	.548	-.591	**-.0002**	**-.0004**	22.3	70.7
Treasure Curve Slope	-.504	.477	2.156	11.203	.29	3.06
Equity Market Returns[5]	-.170	-244	**-24.137**	**-42.634**	2.91	5.94
Credit Spreads[6]	.959	.883	**.228**	**.421**	16.75	27.32

[1] Bold numbers significant at 95% level
[2] Data available since Jun 97
[3] Analysis done with 2-year swap spreads
[4] "Days to Next" Treasury auction
[5] Analysis on percentage returns
[6] Analysis on 10-week moving averages for both credit spreads and swap spreads

Swap Curve Volatility

This analysis compares on a weekly basis the spread of the 5 year swap and the implied volatility of 3 month swaptions on the 5 year swap.

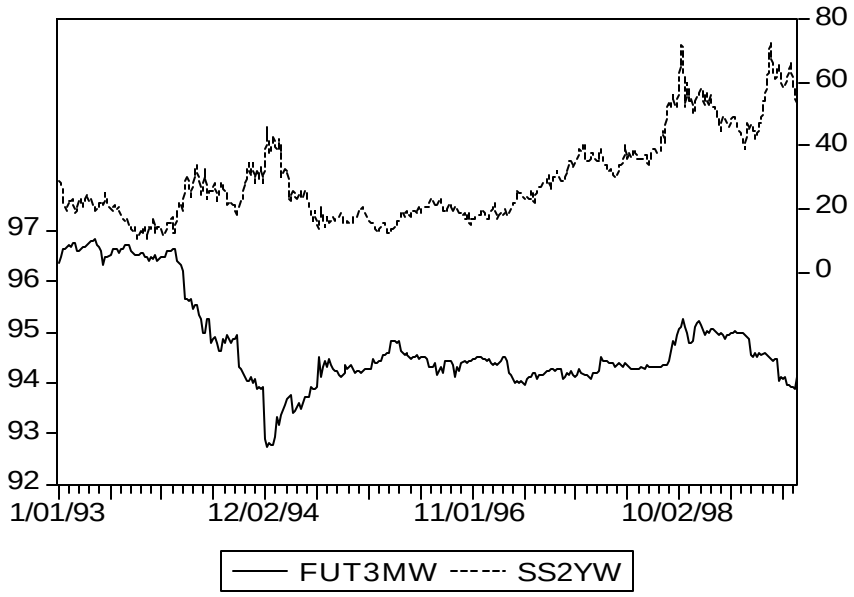


The graph above illustrates that there is some correlation between these two variables. However, there is some concern around causality. Instead of implied volatility driving swap spreads, it appears that changes in swap spreads themselves drive changes in implied volatility. Implied volatilities follow the trend of swap spreads with some lag.

The regression of contenporaneous changes indicates that implied volatility on the spreads explains only 5.4% of the total variance of the changes in the spreads. Furthermore, when one focuses on the period July 98 (when volatility increased) to present, the results do not improve, with R^2 only at 4.23%.

Eurodollar Futures

This paper considers the relationship between the Eurodollar futures contracts with 3 month maturity and the 2-year swap spreads. Because the futures contracts are priced at 100 – LIBOR, a higher LIBOR rate will lower the price of the contract while pushing the swap spread upward. Indeed, the following graph presents some negative correlation between the two variables.



The results indicate that the correlation between both variables was stronger before the Fall 1998 crisis than afterwards. The explanation for this may be that since July 1998 too many other variables have come into play, diluting the influence of Eurodollar futures prices.

On-The-Run Treasuries

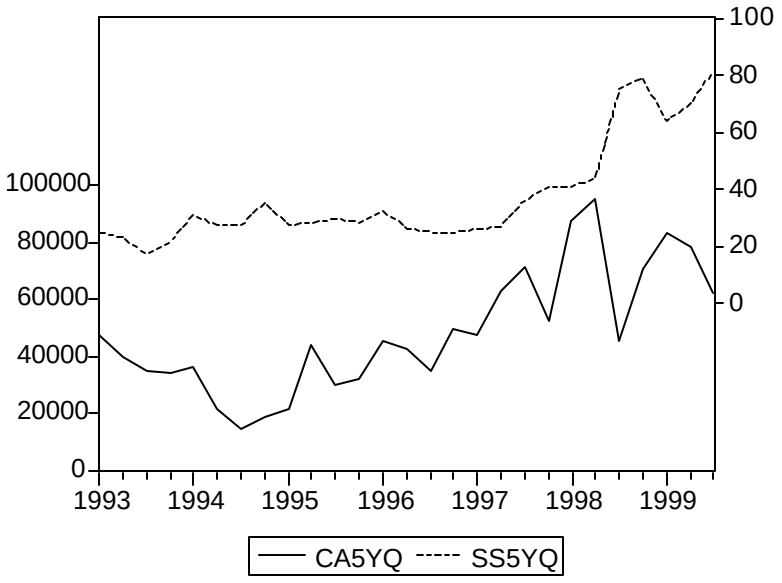
This section attempts to capture the relationship between the swap spread and the timing of Treasury auctions. As the government posts tentative auction schedules, http://www.treas.gov/domfin/auction.htm, traders can identify the number of days to next auction (DTN). The goal is to evaluate how decreased treasury issuance has affected swap spread movements by impacting the "specialness" of on-the-run Treasuries.

In late 1998, the Treasury Department reduced the bonds issuance and timed auctions auctions on a quarterly basis instead of on a monthly basis. (This change occurred for 5-year maturities but not 2- or 10-year maturituies.) The data under consideration incorporates this shift with an increase in the days to next (DTN) auction.

The results show that DTN has lost statistical significance since the capital markets shakeout in the third quarter of 1998. Again, this may be an indication that other factors are now playing a stronger role in determining swap spreads.

Corporate Bond Issuance

Bond issuance affects swap spreads to the extent that it alters the shape of the Treasury and swap curves. This analysis evaluates the dollar value of corporate issuance in the three to five year maturity range since 1993 and compares it with 5-year swap spreads. This analysis is inconsistent with the other analysis in the sense that data was only available on a quarterly basis rather than a weekly basis. Nevertheless, it is hoped that this will provide some sense of this potential driver's significance.



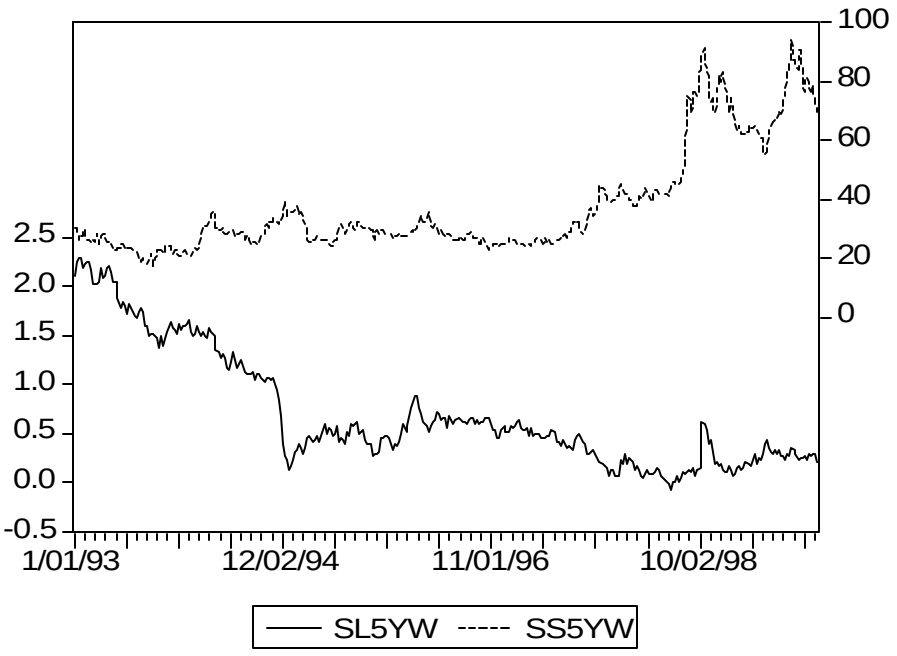
The graph suggests a positive correlation between both variables.

The numerical analysis provides unticipated results. First, there is high correlation both at the full sample level and at the second period level, but whereas the first one is positive the second one is negative. Second, the R^2 are unusually large, and even reach levels that are difficult to believe (70% for the second period). Although both coefficents are close to zero, they are statistically significant. This is reasonable once one considers the scaling of the two variables, basis points versus millions of dollars.

It appears that the cause of this unusual outcome is the limited availability of reliable data. Utilizing quarterly data points reduces the number of data points for the analysis (e.g., there are only 5 quarters in the second period, July 98 to present!). Therefore, the inclination is to avoid drawing conclusions from this analysis, even though it may provide anecdotal indications.

Treasury Curve Slope

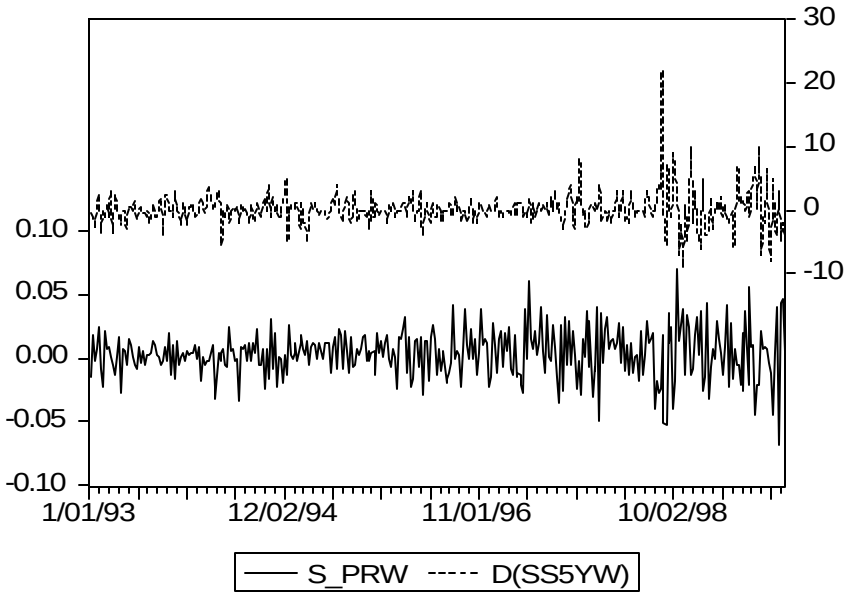
As part of the study of the influence of Treasury slope curve, the paper examines the slope of the yield curve at the 5-year maturity and regresses it against the 5-year swap spread. A rough estimation of the 5-year slope is estimated from the differences between the 10-year and the 2-year yields.



The graph above suggests a negative correlation between both variables along the whole period of observation. However, in the second time interval under study (after the Fall 1998 crisis) spreads have been widening to unprecedented levels, whereas the 5-year Treasury slope has remained quite constant at levels around 15 to 50 basis points. In fact, the regression analysis indicates that the coefficients are not statistically significant.

Equity Market Returns

As an approximation to the average state of the economy, one may consider the relationship between swap spreads and the returns on the stock market.



Although it is not very clear in the graph, one can see that stock market volatility increased before swap spread's volatility and it may help to explain part of the changes.

The correlation between changes in swap spreads and percentage return on stock market is negative. This make sense if one argues that positive returns on the equity market will drive the economy up and improve credit quality of borrowers. Hence swap spreads should go down.

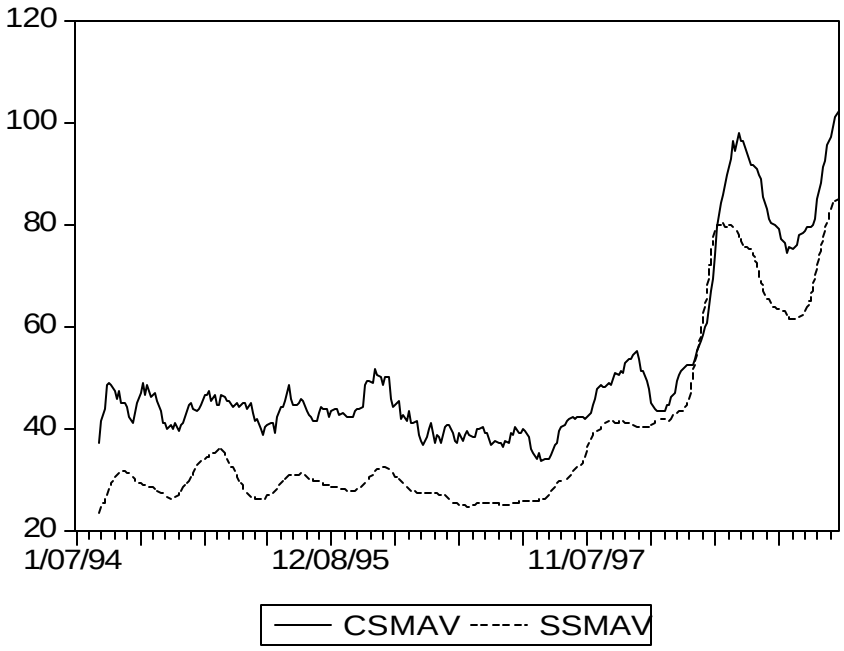
This variable seems to be the most successful in explaining changes in swap spreads. The regression coefficients are significant for both time intervals.

Credit Spreads

Perhaps the primary factor driving swap spreads would be the credit spreads of corporate yields over the Treasury benchmark. An increase of these spreads would indicate a deterioration of general credit quality and thus would broaden swap spreads.

The most consistent corporate credit data available was taken from from Bloomberg on AA financial institutions bond yields in the five year maturity basket from January 94 to September 99. (This information was available on a weekly basis.) To obtain credit spreads, the corresponding Treasury benchmark yield was subtracted from the Bloomberg index yield.

The data points appeared somewhat erratic with substantial noise. However, when looking at the 10-week moving averages there emerged a very smooth pattern that resembled the moving average behavior of swap spreads. Thus, the paper considers the analysis of credit spread influence based on moving averages rather than based on levels.



This transformation offers substantial results. It is clear that there is strong correlation between both swap spreads and credit spreads and that changes in the later help explain changes in the former.

The reduction of noise resulting from using moving averages provided statistically significant coefficients with strong explanatory power.

ECONOMETRIC MODEL

Methodology

This section synthesizes some of the findings from the driver analysis section and attempts to develop a model that helps explain the changes in the swap spreads based on current market dynamics.

The following explanatory variables have been chosen:

1. The credit spread is the difference between the AA financial institution bond and the corresponding Treasury yields. Changes in 10-week moving averages instead of changes in level spreads have been used to reduce sample noise. (Δ cs_ma$_t$)
2. Equity market returns are the returns on the S&P500 on a percentage basis. (stock_ret$_t$)
3. Days to the next auction is the number of days remaining until the next Treasury auction. (dtna$_t$)

Other variables that could have been included are:

- Implied volatility of swaptions (insuffcient data on 2 and 10-year maturities).
- Size of corporate issuance (it would not have made sense to convert quarterly data into weekly data).
- Eurodollar futures contracts (they only make sense for the 2-year maturity).

Econometric model

The econometric analysis consists of estimating a multi-variate linear model of changes in swap spreads. In this model, spread changes are explained in terms of coincidental values of changes of explanatory variables discussed in the previous sections and a lagged value of the level of the spread:

$$\Delta sw\_spr_t = \alpha_t + \beta_1\, sw\_spr_{t-1} + \beta_2\, \Delta cs\_ma_t + \beta_3\, stock\_ret_t + \beta_4\, dtna_t + \varepsilon_t$$

The lagged value is included to account for the mean-reversion present in swap spreads. The coefficients β measure the sensitivity of changes in swap spreads to the level of the swap spreads in the previous week and the other explanatory variables. The random shock (ε_t) accounts for omitted factors. The method of estimation of the parameters is minimized least squares. All series are weekly data. Finally, the period of observation has been shortened to January 94 – September 99 due to the data constraint in corporate yields.

Results

Change in 2-Year Swap Spreads

	α_t	Sw_spr_{t-1}	ΔCs_ma_t	$Stock\_ret_t$	$dtna_t$	R^2 (%)
Full sample	-.770	-.017	-.160	**-38.650**	**.095**	12.30
Jan94 – Jun98	-.496	-.039	**-.495**	**-42.559**	**.104**	21.31
Jul98 – Sep99	**10.095**	**-.204**	.409	-27.272	.037	14.71

Bold numbers significant at 95% level

Change in 5-Year Swap Spreads

	α_t	Sw_spr_{t-1}	ΔCs_ma_t	$Stock\_ret_t$	$dtna_t$	R^2 (%)
Full sample	.485	**-.032**	-.035	**-23.480**	**.046**	9.06
Jan94 – Jun98	.278	-.027	-.015	-11.154	**.041**	7.11
Jul98 – Sep99	7.213	**-.125**	.216	-32.817	.043	15.00

Bold numbers significant at 95% level

Change in 10-Year Swap Spreads

	α_t	Sw_spr_{t-1}	ΔCs_ma_t	$Stock\_ret_t$	$dtna_t$	R^2 (%)
Full sample	-.065	-.003	.156	**-22.955**	.011	3.99
Jan94 – Jun98	.566	-.017	-.175	-10.963	.006	4.23
Jul98 - Sep99	**9.092**	**-.139**	**.759**	-33.232	**.056**	18.49

Bold numbers significant at 95% level

Main observations

- The intercept term increases in the second period, confirming the previous commentary the 1998 regime change raised swap spreads.
- The lagged swap spread always has a negative coefficient that is particularly significant after July 1998. This indicates increased mean reversion tendencies in swap spreads after the crisis of Fall 1998.
- Changes in credit spreads do not show consistent behavior and are not always significant. This may be attributed to the quality of the data sample or changes in the utilization of swaps in connection with corporate issuance. However, there is a significant positive correlation with swap spreads after July 1998, indicating increased impact of credit spreads during/after the crisis of Fall 1998.
- Changes in stock returns also have negative sign, meaning that as the equity markets rise, swap spreads fall. As we explained before this is reasonable as positive returns should indicate better economy performance and thus lower credit risk.
- Days to the next auction seem to be positively correlated with the swap spreads. This is as the time to next auction gets closer market participants anticipate the issue of new Treasuries, existing bonds trade less, prices drop and swap spreads narrow.

- R^2 are higher in the second period regressions for 5 and 10-year swap spreads. This indicates that in times of high volatility there are a few drivers that are explaining the movements whereas in the long run many different factors come into play.

Evaluation

The results obtained from the econometric model does not allow for the drawing of definitive conclusions. Even in the best case (with the 10-year) swap, this model only explains 18.49% of the movements of the swap spreads (around the average change). Nevertheless, this incremental information may assist traders or money managers in generating profits. Some aspects, such as the mean reverting tendencies of the 2-year and 10-year, are easy to understand and implement. Even if this model assisted a trader in making the correct decisions 55% of the time, these incremental profits may very well justify the use of risk capital.

In general, econometric models have limited success in explaining market movements. This is especially true in cases, such as the case of swap spreads, in which many different factors come to bear. Now linear models may be more appropriate to describe swap spread dynamics. Nevertheless advanced models have not proved to be much better at predicting swap spreads.

At the very least, this linear model provides a "sanity" check on one's intuition. Large deviations from the model, for example, might suggest profit opportunities or reconsideration of the factors assumed to propel the market.

SWAP SPREAD PRODUCTS

Spread Lock

A spread lock is an over-the-counter derivative transaction that specifies the maturity of the swap whose spread is being measured and the term over which (i.e. the maturity date before which) the customer expects that spread to shift. The dealer will offer to set the lock at the end of the term at a certain spread, which may be wider or narrower than the spot spread at that time.

At the end of the term the value of the contract is settled in one payment. If the spread is wider than the lock, the dealer owes money to the customer. If the spread is narrower than the lock, the customer owes money to the dealer. The amount owed is typically equal to the product of three terms: the notional amount of the transaction, the spread difference (actual level vs. the lock), and the duration of a swap of that tenor.

Spread Cap

A spread cap is an option that sets a maximum swap spread over the corresponding Treasury. If the option finishes in the money the buyer will receive the difference between the prevailing swap spread at that time and the cap spread times the notional amount times the duration of the underlying swap contract (in a fashion similar to the settlement at a spread lock). This product can be used to hedge widening of spreads over the benchmark government bond.

A spread cap is another instrument that can be used to hedge swap spread exposure. It provides the buyer with an upper protection against swap spread widening beyond the cap. The cost of the instrument is an up-front premium and the payoff at expiration is the max [0, (swap spread – cap spread) * notional * duration of underlying swap].

Whereas a spread lock contract does not limit downside, with a spread cap the maximum to the purchaser is the initial premium.

Case 1: Portfolio Hedging

Portfolio Hedging (February 1997)

Lincoln Investment Management, a life insurer, holds $100M portfolio of A-rated corporate bonds with an average duration of 5.9 years. The life insurer is concerned that corporate spreads will widen because they are currently very narrow (70 bps) versus historical levels, and because Lincoln expects the Federal Reserve to raise interest rates in the near term, settling the credit markets.

Lincoln decides to enter into a swap spread lock to hedge against widening corporate spreads based on significant historical level correlation (above 90%) between swap spreads and A-rated credit spread levels. With spot 10-year swap spreads at 35 bps,

Lincoln puts a spread lock of $100 million notional amount on the 10-year swap spread for one year at a strike spread of 38 bps.

After a year, corporate spreads and swap spreads have widened by 20 bps to 90 and 55 respectively. This results in a positive payoff for Lincoln on the spread lock. The payoff is based on a favorable spread of 55-38 = 17 bps over the lock and amounts to: $100M*0.0017*6.85 = $1,164,500, where 6.85 is duration of the 10-year swap.

That payoff offsets most off the effect on the market value of the 20 bps widening of $100M of the customer's corporate bonds that amounts to $100M*0.0020*5.9=$1,180,000.

Case 2: Proprietary Trading

Proprietary Trading (November 98)

Quantum Inc., a hedge fund, believes that swap spreads will narrow in the nearest term. They had recently widened substantially due to the Russian default and major instability in the global financial markets in the September and October. However, the situation seems to be in control now and Quantum wants to take a bet that swap spreads will tighten. Quantum does not want to use swaps directly because of uncertainty of the movement of treasuries in the nearest future.

Quantum decides to use swap spread lock to monetize their view that swap spreads will tighten. With spot 10-year swap spreads at 95 bps, Lincoln sells a spread lock of $100M notional amount on the 10-year swap spread for three months at a strike spread of 95 bps.

After three months (February 1999), swap spreads tighten by 17 bps to 78 bps. This results in a positive payoff for Quantum on the spread lock. The payoff is based on a favorable spread of 95 - 78 = 17 bps below the strike spread and amounts to: $100M*0.0017*6.85 = $1,164,500, where 6.85 is duration of the 10-year swap.

Case 3: Corporate Issuance

Imagine a corporation that is planning to issue $100 million floating rate notes in a month with maturity 10 years. The corporation wants to limit the risk that the spread it will have to pay over the 10-year Treasury (credit spread) will widen before it issues because that would raise its financing costs. The initial credit spread is 150 basis points. The company does not wish to hedge Treasury movements.

To achieve this goal the corporation can buy an at-the-money 10-year swap spread cap of 70 basis points on a $100 million notional from a dealer to partly offset credit spread risk. The 10-year swap contract is assumed to have a duration of 6. Then, when the option matures after one month, the 10-year swap spread is 80 basis points, the corporation will receive:

(.0080 – .0070) * $100M * 6 = $600K

If, on the other hand, the swap spread ends up below 70 basis points the option will expire unexercised.

The reasoning behind this hedge is the belief that swap spreads and credit spreads are correlated, so that a widening of swap spreads will lead to a widening of credit spreads in similar amount. In our example, the 10 basis points widening in swap spreads (14% increase) will be immediately transferred to the corporate issuance market where spreads will also widen by around 14% (21 basis points). This way, the loses caused by higher financing costs from the new issue will be at least partly offset by a gain in the swap spread cap transaction.

CLOSING REMARKS

The swaps market has grown substantially since the products first emerged in the early 1980's. From the first currency swaps, the product evolved into interest rate swaps, commodity swaps, equity asset swaps, and total return swaps, among others. Swaps, as baskets of forwards that minimize balance sheet employment, have established themselves as the preeminent derivative product.

Although interest rate swaps initially took root in the United States as a means of reconciling differences fixed versus floating assets and liabilities, they have recently gained credibility as a vehicle to participate in rate markets and hedge portfolios.

An analysis of potential market drivers indicated that mean reversion, credit spreads, stock returns, and treasury auction timing provides some explanation of swap spread movements. Although the econometric model does not provide complete reassurance, it does provide some guidance. An important factor to consider is that market participants differ depending on the swap tenor, perhaps justifying separate models for separate maturity baskets.

Although there may be many exotic derivatives based on swap spreads in the market, the two most broadly utilized are the spread lock and spread cap. The majority of applications, for both hedging and speculation, rely on the correlation between swap spreads and general corporate credit quality.

Further analysis of swap spreads (and the swaps market in general) might take the following into account:

- Data on the general collateral rates, as a proxy for the true risk free rate, would permit one to isolate the liquidity premium of on-the-run bonds and more accurately evaluate how this premium behaves.
- Weekly corporate issuance data might permit one to incorporate the strong (if somewhat uncertain) correlation between new bond volume and widening spreads.
- Accurate information on the shift from Treasuries to swaps as a hedging instrument for corporate and Agency bonds might prove very enlightening. (Presumably, this information is very difficult to acquire.)

Another point to consider is that even a highly explanatory model should not be accepted on face value. As the regime shift of 1998 illustrates, major market movements often reflect (or perhaps initiate) major revolutions in market dynamics. A wise money manager or market manager would do well to keep her ear to the floor.

APPENDIX I - DEFINITIONS

Swap

Swaps are private (i.e. over the counter) agreements between two companies to exchange cash flows in the future according to a prearranged formula. They may be regarded as portfolios of forward contracts.

London Interbank Offering Rate (LIBOR)

The floating rate in many interest rate swap agreements is the London Interbank Offering Rate (LIBOR), which is the rate offered by banks on deposits from other banks in Eurocurrency markets. LIBOR rates change continuously and are determined by trading between banks. For example, one-month LIBOR is the rate offered on one-month deposits.

Just as Prime is often the reference rate of interest for floating-rate loans in the US financial markets, LIBOR is the principal interest reference rate for loans in international financial markets. Interest is generally paid on a quarterly basis.

The Importance of Interest Rate Swaps

Interest rate swaps are the dominant interest rate transaction in the European market, being much more widely used than European bonds. In the US, interest rate swaps are quickly becoming the vehicle of choice for investors and hedgers who wish to take positions in the interest rate market.

There are several reasons behind the growing dominance for the swaps market:

- The growth in the budget surplus has diminished the supply of US Treasury bonds
- Swap's diminishing bid – offer spreads make them relatively inexpensive trading vehicles
- The absence of principal repayment reduces credit risk

An Example: Interest Rate Swap

Often companies use swaps to transform a liability. For example, a swap could be used to transform Company A's floating-rate loan into a fixed-rate loan. Suppose that Company A has arranged to borrow $100 million at LIBOR plus 100 basis points. After Company A has entered into the swap to pay fixed 5.5% (the swap rate assumed here) it has three sets of cash flows:

1. It pays LIBOR plus 1.0% to its outside lenders
2. It receives LIBOR under the terms of the swap
3. It pays 5.5% fixed under the terms of the swap

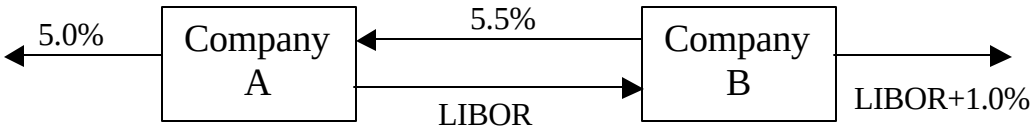
These three sets of cash flows net out to an interest rate payment of 6.5%. Thus for Company A the swap has the effect of transforming borrowings at a floating rate of LIBOR plus 100 basis points into borrowing at a fixed rate of 6.5%.

For Company B the swap could have the effect of transforming a fixed-rate loan into a floating-rate loan (this would be a more frequent application). Suppose that Company B has a three-year $100 million loan outstanding on which it pays 5.75%. After it has entered into the swap it has three sets of cash flows:

1. It pays 5.75% to its lenders
2. It pays LIBOR under the terms of the swap
3. It receives 5.5% under the terms of the swap

These three sets of cash flows net out to an interest rate payment of LIBOR plus 0.25%, transforming fixed to floating rate debt.

The potential uses of the swap by Companies A and B are illustrated below.



Cash payments are netted at each payment period. There is no loss in generality in assuming that the notional amount is exchanged at maturity. The floating payer may almost be considered as being long a fixed coupon bond which is financed by issuing a floating coupon bond. If a counter-party goes bankrupt, the net value of the swap contract is an asset or liability of the bankrupt counter-party. Counter-parties often exchange collateral to reduce (presumably unequal credit risk).

Yield Curve

Bond traders and financial managers often speak in terms of the *yield* on a bond rather than the price of a bond. The yield-to-maturity ("YTM") on a bond is the discount rate which would make the present value of the promised coupon and principal payments equal to the current market price of the bond.

Credit Risk

Swap contracts between two companies entail credit risks. To illustrate, consider a financial institution that has entered into equally offsetting contracts with Company A and Company B. The financial institution remains fully hedged if neither company defaults and normally a decline in the value of one will be offset by an increase in the other. If one party defaults, the financial institution then still has to honor the contract it has with the other.

Swap Spread

The swap spread is defined as the spread between the swap rate and the Treasury bond yield for the same maturity. The maturity dates for swaps are continuous whereas Treasury maturities are fixed. This create certain difficulties:

- Discontinuities when benchmarks shift
- Swap spreads based on on-the-run benchmarks are much wider than spreads based on off-the-run Treasuries with the same final maturity
- Stable maturity spreads over the Treasury curve can be viewed as either a proxy for off-the-run swap spreads or liquidity-adjusted spreads

Swap rates for maturities for which the government does not regularly issue bonds are quoted as a spread to an interpolated rate between on-the-run benchmarks. The five year dollar swap rate would be quoted as a spread over the current five year US Treasury bond. The four year dollar swap rate would be quoted as a spread to the interpolated two and five year US Treasury yields.

APPENDIX II – HEDGING SWAPS

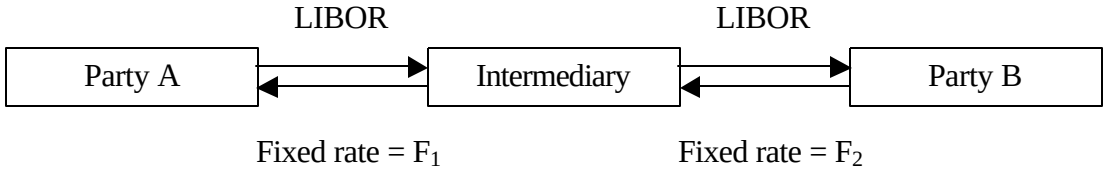
Relationship of Swap Value to Forward Rate Agreements

An interest rate swap can be decomposed into a series of forward rate agreements. Forward rate agreements (FRA) are agreements that a certain interest rate will apply for a certain period of time in the future. A swap is a portfolio of FRAs and can be valued as such:

1. Calculate forward rates for each of the LIBOR rates that will determine swap cash flows
2. Calculate swap cash flows on the assumption that the LIBOR rates will equal the forward rates
3. Set the swap value equal to the present value of these cash flows.

Swaps as Hedge Instruments for Swaps

Swaps are good hedge instruments for hedging other swaps and ideally, a dealer would hedge a swap transaction with another transaction of exactly opposite direction:



The intermediary enters into two offsetting swap positions with parties of equivalent credit quality with the same notional amount and maturity. The intermediary gets rid off any swap risk, regardless of direction of change of interest rates or swap spreads he collects the difference between F_2 and F_1.

Such a "perfect hedge" is rarely attainable. The difficulty is in finding two counterparties with equal credit ratings. Therefore the perfect hedge is not a scenario that a trader would expect in the course of a normal day.

Treasuries as Instruments for Hedging Swaps

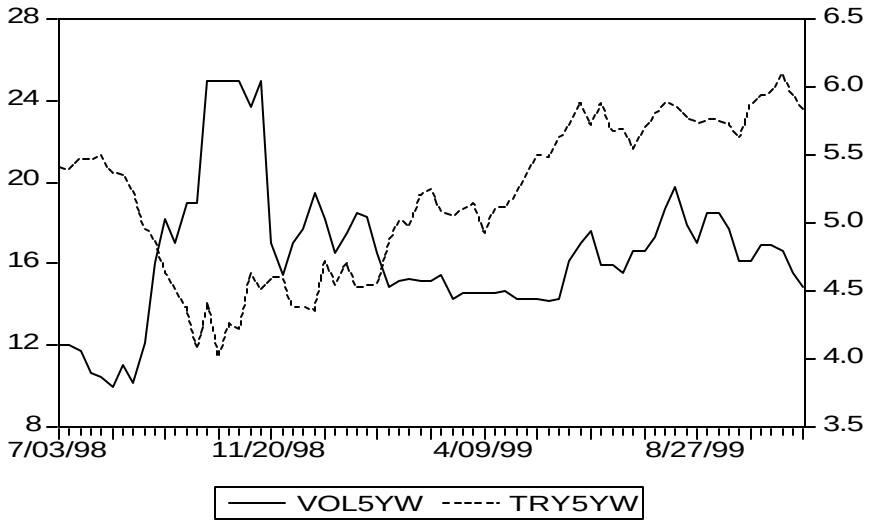
Treasuries have traditionally been very common instruments for hedging swaps. They are the benchmark in pricing swaps, their market is liquid, and for medium and long term maturities there are not many other liquid hedging instruments.

For example, if a trader needs to hedge a $50 million long position in a swap where he receives fixed payments with a duration of 4.3 years, he can short a basket of Treasuries with duration of 4.3 years to offset the interest rate risk.

The severest limitation of using Treasuries to hedge swaps is that in times of severe credit uncertainly the flight-to-quality syndrome may drive Treasury yields down while swap yields rise. This would effectively compound a market-maker's losses.

Additionally, Treasuries have fixed coupon, maturity and payment frequency that are unlikely to coincide with those of the swap they are hedging. This mismatch creates both basis (risk of change in the swap spread) and reset risk (risk of change in term structure between a cash inflow and an outflow due to different maturities). If large enough, these risks must be hedged by other instruments like spread locks. In fact, our analysis shows since July 98 swap spreads have become much more volatile reducing the effectiveness of Treasury hedges.

Implied volatility of 5 year swaps vs. 5 year Treasury yield (July 98 up to date)



Eurodollar Futures as Hedging Instruments for Swaps

These are contracts for future delivery of Eurodollar time deposits with $1 million principal amount. Although there exist for maturities of one to three months, quarterly contracts are the benchmark. They are quoted in the International Money Market index that is equal to 100 – LIBOR. The purchaser of a futures contract is committed to borrowing $1 million with the nominal rate of 100 minus the futures price. Additionally, Eurodollar futures can be purchased in strips or series of consecutive maturities obtaining a longer maturity instrument that can be used to hedge a fixed rate leg in a swap contract. The depth and liquidity of Eurodollar futures make them ideal instruments for hedging against interest rate movements.

APPENDIX III – SWAPS AND THE REPO MARKET

Repurchase Agreement

A repurchase agreement (repo) is an agreement by which the owner of a security agrees to sell to a counterparty and buy it back at a slightly higher price later. The counterparty is providing a loan with the security as collateral. If structured properly a repo involves very little risk to either side. The repo rate should only be slightly higher than the Treasury rate, and is often viewed as the true risk free rate.

The counterparty is said to enter into an inverse repo agreement.

The difference between LIBOR and repo rate is the difference between the cost of a bank borrowing with full credit risk to the lender and the cost of a bank borrowing with "risk free" collateral.

Special Repo Rates

A "special" is a repo rate that is significantly below current riskless market interest rates. Specialness increases the equilibrium price for the underlying instrument by the present value of savings in borrowing costs associated with the repo specials.

The repo "specialness" of a given instrument is the difference between the general collateral rate and the specific collateral rate of that instrument.

For a given supply of the instrument, is increasing in the demand for short positions and in the degree to which owners of the instrument are inhibited from supplying it as a collateral; specialness also depends on the liquidity of the instrument: more liquid more likely to go on special (like on-the-run Treasury bonds).

Swap Spreads and the Repo Market

The more Treasuries that are outstanding in the market, the greater the repo rates due to the fact that there is plenty of collateral and, subsequently the spread repo/LIBOR (the so-called collateral spread or credit spread) tightens.

A bank that wants to hold a Treasury bond and remove the interest rate risk might fund it using (1) the repo market to borrow at a 'risk free' rate putting up a collateral (repo rates are slightly higher than Treasury rates) and (2) enter into a swap in which it pays fixed and receives LIBOR.

Buy Treasury	Receives Treasury yield	+ T
Fund position with repo with collateral	Pays repo rate	- (LIBOR – collateral spread)
Swap	Pays fixed rate	- (T + swap spread)
	Receives LIBOR	+ LIBOR
NET		+ Collateral spread - Swap spread

The bank ends up receiving the difference between the collateral rate minus the swap spread. When the collateral spread is higher than swap spread, there is a positive carry which attracts arbitrageurs who want to lock the positive carry. They go long Treasuries and fund them with repos, pushing repo rates upward (collateral spread declines) and Treasury rates downward (swap spread increases) thus eliminating the positive carry. When there is a negative carry (repo rates are higher than Treasury rates and thus collateral spread is smaller than swap spread) arbitrageurs will do the opposite transaction: short the Treasury and lend it through a repo.

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DATA SOURCES AND SOFTWARE

Data Sources

Datastream
Bloomberg
US Federal Reserve Board: www.bog.frb.fed.us
US Government Treasury: www.fmns.tres.gov/mts
National Bureau of Economic Research: www.nber.org

Regression software

Microsoft Excel 97/2000
Eviews 3