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Swap rates and economic conditions

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Contents

1) Motivation

Ten-year dollar swap spreads peaked at the end of May at 140 basis points –a higher spread than ever before (Fig. 1). They had since narrowed, but were still wider than at the height of the financial crisis that followed Russia's default in August 1998. At

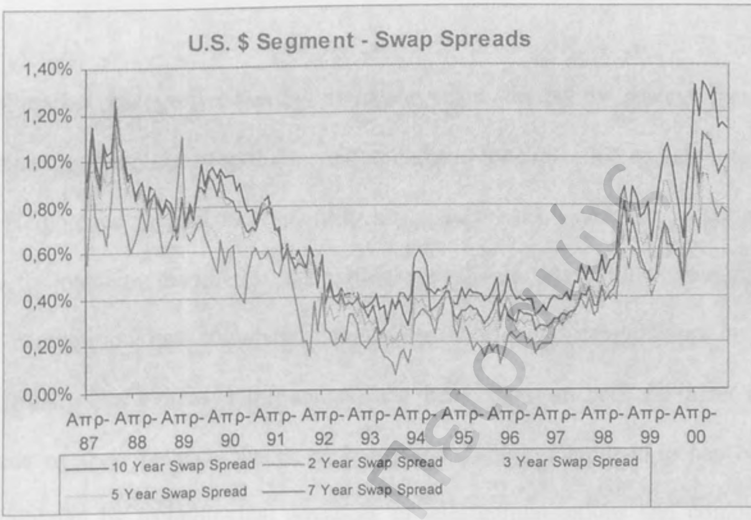
Figure 1: 10-year SWAP SPREAD - U.S. $ Segment

times, the swaps market had shut down completely; nobody was willing to receive a fixed rate. The swap rate is calculated at a spread over government bonds and reflects, among other things, the willingness of the market to accept corporate debt rather than government debt.

According to informed market observers (The Economist, 11/6/2000), there are, broadly, two possible explanations for the rise in swap spreads, one relatively benign, the other emphatically not. The benign explanation is that the rise in swap spreads is explicable by rising interest rates, greater default risk, and the relative sizes of government- and corporate-bond markets. The American government is issuing fewer bonds and plans to buy back all its debt by 2010, while American companies are borrowing hugely. That makes government bonds more valuable, compared with corporate debt. Rising interest rates, too, are partly to blame for widening swap spreads. When the market expects that interest rates will rise, there is more of an incentive to pay, rather than receive, a fixed rate. That incentive is greater at times when long term rates are lower than short term ones (an "inverted yield curve"). This means that anybody receiving a fixed (long-term) rate and paying a floating one loses money. Another reason is that there is an increase in corporate debt. American firms are issuing bonds in order to buy back their shares. So, American companies are becoming ever more highly geared, and hence less creditworthy.

The less benign explanation is that there are growing worries about the riskiness of the swaps market, based on fears about the health of the financial firms –by far the biggest participants. The market has grown so much that potential risks of swaps are becoming huge. People are starting to fret about the banking system. This might be a problem, because banks are taking ever more risk to generate the returns demanded by shareholders. Bank lending is growing by 10% at an annual rate, and property lending by 13.5%, its highest rate since 1989. These rates are accelerating because, after nine years of growth and few defaults, banks' backward-looking risk models tell them that lending is a fine business. And not just in America. In Europe, too, banks are taking more risk to generate higher returns. At best, the swap market is merely reflecting this increase in risk. At worst, it might be signalling that the world's financial system is in danger of becoming unglued.

While the 10-year swap spread has attracted a lot of attention in the financial press, similar developments have taken place in shorter-maturity swaps as well. This is eloquently illustrated in Fig. 2 that depicts the spreads for 2, 3, 5, 7 and 10-year swap spreads.



Thus motivated, this thesis will investigate the factors determining the spread of swap rates over those of government bonds.

2) Interest Rate Swaps – The Basics

2.1) Market Size

The swap market has grown rapidly in recent years, driven by several factors. Prominent among them has been the increased demand for protection against interest rate risk. Heightened interest rate volatility has caused bank customers to try new techniques for matching the interest rate exposures of their assets and liabilities. Also, increased competition has stimulated innovation. Worldwide deregulation in the banking industry has increased the competition banks face on both the asset and liability side of their balance sheets, at home and abroad. Competition has been further stimulated by technological advances in telecommunications and computer systems that have increased international financial mobility. As a result, banks have tried to find new ways of generating income, while borrowers have sought lower borrowing costs and protection from interest rate risk.

Data released on November 13th 2000 by the BIS on positions in the global over the counter (OTC) derivatives market showed that the interest rate segment expanded by 28% since end-June 1998, to $64.1 trillion in end-June 2000. With the stock of forward rate agreements (FRAs) and options stagnating, growth was concentrated in swaps (by 32%, to $48 trillion).

Swaps have increased at a more robust pace than other interest rate instruments in recent years. This may have been related to the following factors. First, the growing variety of structures on offer has enabled the swaps market to respond in a more flexible way to the risk management requirements of market participants than exchange-traded markets. Secondly, the introduction of the euro has led to a rapid expansion of European capital market issuance, with some of the resulting exposure likely to have been hedged in the interest rate swaps market. Thirdly, net repayments or reduced net issuance of securities by central governments in some of the major countries (with the notable exception of Japan) have affected the liquidity of government bond markets and the effectiveness of traditional hedging vehicles, such as government bond futures. This has encouraged market participants to switch to more effective hedging instruments, such as interest rate swaps. This shift seems to be confirmed by the stagnation of interest rate business on derivatives exchanges.

2.2) Product Description

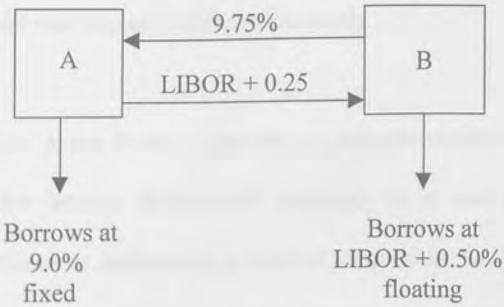
An interest rate swap is a financial transaction in which fixed interest is exchanged for floating interest of the same currency. Swaps are originally liability based exchanges of interest payment streams on debt obligations. More recently, however, asset based swaps have been arranged as well, exchanges of interest income streams on assets. Swaps are among the most versatile of all financial instruments. They can be used to obtain cheaper funds or to manage interest rate risks. All swaps are based on one central principle: one participant exchanging an advantage in one credit market for an advantage available to another participant in a different credit market. The advantage can be reduced costs or greater availability of funds. Swaps enable borrowers to tap markets where they can obtain the best relative terms and then swap obligations to obtain the desired interest rate structure.

To illustrate how interest rate swaps work, an example would be useful. Suppose that two firms, A and B can issue a US$ denominated bond in either fixed-rate or floating-rate terms. The annual interest costs are assumed to be 9.0 percent and 10.5 percent respectively, for A and B in the fixed-rate bond market. In addition, each firm can arrange floating-rate financing, perhaps through bank lending or a commercial paper (CP) program. We assume that firm A pays six-month LIBOR plus zero basis points, while firm B pays six-month LIBOR plus 50 basis points. This example assumes that interest is paid semiannually and the floating interest rate is reset every six months.

It is apparent that firm A enjoys an absolute advantage in both the fixed- and floating-rate credit markets. Firm A is able to borrow on better terms than firm B in both markets, most likely because firm A represents a better overall credit risk.

But, it appears that A's credit advantage differs across the two markets. In the fixed-rate market, A is granted a 1.5 percent lower interest rate cost while in the floating-rate market the interest rate advantage is only 0.50 percent. Thus, firm A enjoys a comparative advantage in the floating-rate bond market. Once again, we can reason that it may be possible for A and B to engage in mutually beneficial trade. Both A and B appear to benefit by borrowing in their comparative advantage markets and then swapping to obtain lower cost financing in their preferred method of long-term financing.

Figure 3: Typical Swap Cash Flows



To explain the transactions in an interest rate swap, assume that in period t_0, firm A issues a seven-year bond for $100 million at a fixed rate of 9 percent and B obtains bank financing for $100 million at a floating rate equal to six-month LIBOR+0.5 percent. In the aforementioned example, the principal amounts are identical, so there is no need to actually exchange principal. However (and as if there were an exchange of principal), A agrees to pay LIBOR+0.25 percent interest on $100 million to A. In years t_1 until t_7, firms A and B make interest payments to each other as stipulated in the swap agreement, plus paying interest on the original bonds they have issued. At time t_7, the swap contract matures. A and B make their final interest payments to each other, A retires its outstanding bond issue, and B pays off its bank loan.

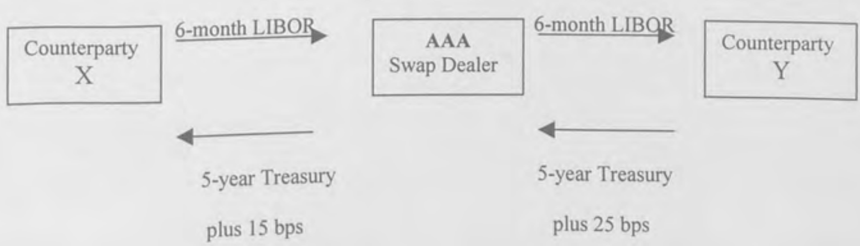
What is the result of this strategy? Firm A pays LIBOR + 0.25 percent (to B) and 9.0 percent on its fixed-rate bonds, while receiving 9.75 percent interest from B –or a net interest cost of LIBOR –0.50 percent. Thus, A saves 0.50 percent in relation to its own cost of floating-rate funds. Firm B pays 9.75 percent (to A) and LIBOR + 0.50 percent on its outstanding floating-rate bonds, while receiving LIBOR + 0.25 percent interest from A –or a net interest cost of 10.0 percent. Thus, B saves 0.50 percent in relation to its own cost of fixed-rate funds.

Together, A and B save 1 percent, an amount which could be determined in advance from the interest differentials assumed. In a real transaction, if A and B are corporations or institutions, a bank or swap dealer would intermediate the transaction and charge a fee, thus reducing the aggregate interest savings available to A and B.

•Bid-offer spreads

Swap dealers charge bid-offer spreads for their services: they pay less on the bid side and receive more on the offer side. The dealer that makes fixed payments and receives floating payments is said to be on the bid side of the transaction. Conversely, the dealer that pays a floating rate and receives a fixed rate is said to be on the offer side of the transaction. The bid-offer spreads depend on the swap dealers' credit reputations. The credit reputations of swap dealers differ widely, with some dealers enjoying an **AAA** credit rating and others a rating of **A** or less.

Figure 4: Cash Flows of Dealer-Arranged Swaps



Default risk has a significant impact on the bid-offer spreads of swap dealers with different credit ratings. Suppose that the credit quality of the counterparties is the same for different swap dealers, and that the swap contracts do not differ in other characteristics such as the up-front fee and collateral. Then, the swap bid rates of **AAA**-rated dealers should be lower than the those of **A**-rated dealers. On the other hand, the swap offer rates of **AAA**-rated dealers should be higher than those of **A**-rated dealers.

As far as the pricing of bid and offer swap rates is concerned, empirical evidence (Sun, Sundaresan and Wang, 1992) shows that the swap offer rates of both **AAA** and **A** rated dealers are significantly less than the LIBOR par bond yields. The deviations of **AAA** swap offer rates from the par bond yields vary on average from about 8 to 12 basis points, and the deviations of **A** swap offer rates vary from about 12 to 15 basis points. The average deviations for each dealer are, for most part, within the bid-offer spread in the interbank market, which is about 12.5 basis points. The par bond yields on average are greater than swap rates, albeit the differences are less pronounced. A comparison of swap offered rates with LIBID par bond yields indicates a sharp contrast between **AAA** and **A** swap quotes. The **AAA** swap offer rates exceed LIBID par bond yields in three out of four swap maturities, whereas the **A** swap offer rates are below the LIBID par bond yields in three out of four maturities.

2.3) Why Do Interest Rate Swaps Exist? - The Source of Gains.

But, why does the swap market exist? Interest rate swaps appear, like other derivative products, to be redundant securities. They have become a common device that replicates the function of bundles of interest rate futures contracts. For example, a financial firm that has acquired floating-rate accounts receivable may hedge its exposure through an interest rate swap instead of using a strip of interest rate futures.

Originally, the precursors of swap contracts were back-to-back and parallel loans. They were a useful device but they also presented certain drawbacks. First, identifying a counterparty was time consuming and costly. Second, the initial capital market barrier was circumvented by two loans. These loans were legally separate and distinct loans. Therefore, default on one loan by one counterparty would not release the other counterparty from fulfilling its commitments under the second loan. Finally, as these transactions are indeed loans, they would appear on the counterparties' accounting statements or "on balance sheet" for accounting and regulatory purposes. Thus, there could be repercussions on the firm's unused borrowing capacity, the credit rating, and so on.

In the early 1980s, swaps evolved as a way to simplify and speed the exchange of cash flows between counterparties. Lower transaction costs is a basic, but critical, ingredient in the introduction of a new financial product. In addition, the swap effectively linked the two cash flows. The counterparties to a swap compare the cash flow moving to each direction and pay only the net difference between the two cash flows. Finally, as a new financial product, the swap was not covered by any accounting disclosure or security registration requirements. A firm could treat a swap as an off-balance sheet item, in this case representing a contingent responsibility to make (or receive) payments.

The aforementioned discussion suggests that a swap reduces transaction costs by allowing the counterparties to arrange in one transaction (the swap) what would take many transactions (using forward contracts) to replicate. In addition, the legal structure of a swap transaction may have advantages that reduce the risk to each counterparty in the event of a default by the other counterparty.

An important function of swaps remains their role in connection with borrowing. It is often presumed that capital markets are at least partially segmented, meaning that investors from different markets are willing to pay different prices for the same securities. This may present firms with an opportunity to exploit their comparative advantage in a capital market and swap into their desired unit of account. A firm's own borrowing strategy may produce a temporary market saturation effect, leading to windows of opportunity in other financial markets. There are opportunities for financial arbitrage when borrowing costs for the same borrowers differ across various credit markets. While a firm with a lower credit rating has a comparative advantage in raising short-term floating-rate debt, a firm with a high credit rating has a comparative advantage in raising long-term fixed-rate debt. As a result, a bond issue in conjunction with an interest rate swap can lower the cost of floating-rate funds for a highly creditworthy company. The lower rated firm that must pay a relatively large premium for borrowing in the bond market can use a swap to lower its costs by borrowing short-term floating rate funds and swapping for the fixed-rate payments of the more creditworthy firm.

The strategy of floating-rate finance combined with a swap has an alternative interpretation based on asymmetric information. Sheridan Titman (1992) argued that all firms would prefer to borrow long-term to avoid interest rate risk. But in so doing, "good firms" with sound projects are pooled with "bad firms", so lenders (who are unable to distinguish between good and bad firms) raise the interest cost to all. "Good firms" who expect their credit quality to improve will opt for short-term financing and then hedge the interest rate risk with a swap. The strategy benefits the firm since it obtains lower-cost funds initially and in the future if higher credit quality is achieved. The lending bank is protected since it can monitor the firm closely and refuse, if necessary, to roll over its short-term loan. The additional risk of the interest rate swap is small relative to the principal risk of the loan. Consistent with Titman's model, it is observed that most firms that borrow short term and swap to obtain fixed-rate terms have only A or BBB credit rating, while higher-rated firms generally issue fixed-rate debt and swap into floating-rate terms. In this context, Titman shows that lower-rated firms, in effect, pay for the opportunity to swap, which amounts to a transfer to higher-rated firms (and intermediaries).

Interest rate swaps can also be used to reduce interest rate risk. For example, all depository institutions have traditionally funded fixed-rate mortgage loans with short-term deposits. The danger of this kind of maturity mismatch was demonstrated in the late 1970s and early 1980s by the heavy losses S&L's sustained as a result of the rise in interest rates. A depository institution can now swap its floating-rate interest payments on short-term deposits for fixed interest payments, or it could swap its fixed-rate interest income on loans for floating-rate interest income. By doing so, it better matches the income stream on its assets to the payment stream on its liabilities, thereby reducing the risk of a capital loss due to an unexpected increase in interest rates.

Additionaly, swaps offer a mechanism for the firm to transform its capital structure without incurring the expense of redeeming its existing debt and issuing new debt.

Moreover, interest rate swaps, similar to currency swaps, may be used as a means to enhance sales or to develop new financial products. It may be advantageous for financial institutions to offer their customers financing on either fixed- or floating-terms at their preference. Whichever terms they pick, financial institutions can aggregate these positions and then use interest rate swaps to manage their overall exposure to interest rate risk.

Also, a firm could enter into a swap as a pure speculation on the direction of interest rates magnifying, in this way, risk and return.

In short, a swap can be used to speculate, to hedge an exposure, or to replicate another security in an effort to enhance investment returns or to lower borrowing costs.

2.4) Swap Users & Concerns

There are two classes of participants in the swap market: end-users and intermediaries. End-users are those who want to swap their interest payment stream for a different type of payment stream. Intermediaries help arrange the swaps, collect and disburse the payments that are swapped, and assume the risk of default by end-users.

A variety of end-users participate in the swap market. International lending agencies were among the first to engage in swaps. Sovereign governments and their agencies also were early participants. Most recently, nonfinancial corporations and many financial institutions have begun participating in the swap market as well.

The role of large commercial banks and securities firms as intermediaries has increased in recent years. Recognizing the limitation of arranging swaps that required a "double coincidence of wants", intermediaries began playing a larger role. Intermediaries now maintain inventories of standardized swaps and some even quote prices at which they will buy and sell swaps from qualified end-users. Instead of just arranging swaps between end-users, intermediaries themselves now enter into swaps with end-users even before finding offsetting swaps with other end-users. Intermediaries have, thus, come to play the role of dealers, increasing the liquidity of the swap market and making it more convenient for end-users to arrange swaps.

Intermediaries earn fees for arranging and servicing swaps. The fees depend on the complexity of the swap agreement and, therefore, on the amount of services the intermediary provides. Fees on a standard interest rate swap usually range from 7 to 12 basis points a year but can be higher for more complex swaps, especially those tailored specifically to the needs of the customer. Since swaps are frequently arranged in conjunction with the initial borrowing of funds, the intermediary may cut fees on the swap to get other business from the customer.

Banks are the major users of swaps, which constitute one of the fastest growing "off-balance sheet" activities. Such activities have given rise to a number of concerns in recent years, for they create commitments that are not reflected on banks' balance sheets as either assets or liabilities. As a result, it is often difficult for investors, regulators, and even bank managers to determine the risk exposure of banks engaging in such activities. Bank regulators are concerned that the role played by banks in the swap market may lead them to incur too much risk or risk for which they are not adequately compensated. Current regulatory capital requirements for banks apply only to risks arising from a bank's assets. And since swaps are not considered an asset and do not affect the balance sheet, they can lead to increased risk exposure without requiring the bank to hold additional amounts of capital. Therefore, the potential may exist for excessive risk-taking and underpricing of this highly leveraged instrument. Bank regulators have recently proposed revising capital guidelines to help control these risks.

On the other hand, concerns about the risk exposure of banks engaging in swap activities are eased due to the existence of market discipline in the swap market. According to the findings of Julapa Jagtiani (1996), the level of swap activities that banks can engage in is also determined by their creditworthiness. The market uses

S&P ratings as a highly visible sign of creditworthiness. Specifically, banks with higher S&P ratings are viewed as more creditworthy, and experience higher swap market shares. Conversely, banks with lower S&P ratings do not have complete freedom to increase swap risks. Money center banks seem to be an exception and are probably not limited by their S&P rating due to the market's belief that regulators will bail out money center banks' creditors.

3) Issues

3.1) Risk in swaps and measurement

Since swaps can be used for two generic purposes-to lay off risks (to hedge) and to take on risks (to speculate)- a counterparty should consider two categories of risks.

The hedger faces default risk in the case of a swap. Default of the counterparty means that the hedger retains the right-of-offset. To recover his hedged position, the hedger needs to find a substitute counterparty to agree to a new swap. In this case, he faces market risk because interest rates and the spot rate may have changed.

So, if the motive in the swap is hedging, then risk depends on the probability of default by the counterparty. Once default has occurred, the hedger's risk depends on (1) how far market prices have moved since entering into the swap, and (2) how much time remains in the swap.

When the speculative motive lies behind a swap transaction, the purpose of the swap is to earn income for the treasurer if his or her interest rate forecast is correct. If the treasurer's forecast is not correct, then the swap has "negative" value or it is "out of the money". The value of the swap is its mark-to-market value based on current expectations of the floating-rate interest receipts. Had interest rates risen rather than fallen, the swap would have "positive value" and be "in the money". So, the treasurer, like any speculator, needs to keep track of the mark-to-market value of his or her swap in order to decide whether to continue the bet or close out the position. The treasurer (as speculator) is primiraly concerned about market risk, which in an interest rate swap depends critically on the anticipated time path of the underlying floating-rate interest and the maturity of the swap contract. The treasurer also is concerned about default risk by the counterparty, but this risk can be minimized by selecting a AAA-rated swap counterparty.

•Measuring the Risks of Swaps

We focus primarily on market risk, which plays a role for the speculator and the hedger (in the event of a default).

A naïve approach to measure the market risk of a swap is based on asking what happens to the value of a swap if underlying interest rates take on particular values at specified times during the swap. To make this "what if" approach practical, the analyst might consider several particular scenarios. While it may be interesting to examine the market risk of the swap under a variety of special scenarios, each one suffers from having been selected in an ad hoc way. To measure the market risk of the swap in a manner consistent with the actual underlying volatility of interest rates, the specification of the process that governs the time series evolution of the market interest rate is required. If we can specify such a process, then it is possible to estimate the market risk throughout the life of a swap. These estimates are based on the **simulation approach**.

Starting from its initial level, the market interest rate is subject to changes driven by unexpected events. These changes can be modeled as small upward or downward moves in the market interest rate. For descriptive purposes, it is reasonable to model the interest rate as a diffusion process. In the short run, the interest rate is likely to remain near its original value, but in the longer run, there is an increasing likelihood that it will deviate. This potential for an interest rate change represents a risk labeled **the diffusion effect**. This risk increases along with the maturity of the swap.

However, time plays another role in the risk of a swap that carries a negative effect. As time passes, the swap requires fewer exchanges between the counterparties. Thus, a large interest rate swing far into the future is not so damaging since fewer payments remain in the swap. In addition, the present value of these payments is lower simply because they are assumed to take place farther in the future. This decline in risk with the passage of time is called the **amortization effect**.

The overall risk of a swap reflects a combination of these two elements. The specific shape of the curve, in particular the shape of the diffusion effect, depends on a number of factors: the maturity of the swap, the volatility of interest rates, and the initial level of the interest rate.

A study by Katerina Simons (1989) illustrates the simulation approach and shows how certain variables affect the amount at risk in an interest rate swap. Simons assumes that the market interest rate (i_t) evolves so that:

$$i_t = i_{t-1} \exp(x)$$

where x is normally distributed with mean zero and standard deviation σ. The simulation approach uses random numbers to trace out how interest rates might evolve conditional on the process specified in the above equation. Simons uses 5,000 trials and can thus measure the **expected exposure** averaged across all 5,000 simulations. And she can also estimate the risk associated with unusual or atypical interest rate patterns.

The maximum potential exposure increases with longer-term swaps. Greater interest rate volatility (σ) would also increase the risk of swaps.

The simulations produced show the expected exposure. About half of the simulations produced amounts at risk that were greater than the amount traced by graphs. A more conservative approach to measuring the amount at risk might focus on the 90 percent or 95 percent confidence limits which are substantially greater than the expected values.

As in any empirical exercise, it is important to mention some of the limitations of the analysis. First, the simulation method assumes that interest rates evolve in a smooth process. Second, it assumes that the evolutionary shocks to interest rates are normally distributed. These two points suggest that the simulations may understate actual exposure, since interest rates are sometimes nonnormally distributed and subjected to jumps, much like other financial assets. Finally, simulations are based on historical estimates of interest rate volatility that may not accurately reflect prospective volatility during the life of the swap.

Despite these limitations, the simulation approach offers many useful insights into the nature of exposure facing swap market participants.

3.2) Swap Risks and risk management

The phenomenal growth in the volume of transactions in the swap market has led to increased scrutiny of the credit risk being borne by the major banks that are the principal swap dealers.

The role of banks as intermediaries in swap transactions has exposed them to new and varied risks. The risks arise because, under certain circumstances, swaps can cause banks to suffer capital losses. There is also concern that banks may be underpricing their services and are not being adequately compensated for the risks they bear. However, banks have developed methods for limiting the risks involved in intermediating swaps.

Intermediation of a swap requires that the bank enter into a financial contract with each of the end-users. Instead of the two end-users agreeing to exchange interest payments with one another directly, they each enter into separate contracts with the bank acting as intermediary. Neither end-user has any obligation to the other. They may not even know the other's identity. The intermediary, in effect, enters into two separate contracts that are offsetting except for the fee earned for serving as the intermediary. Their role as intermediaries between end-users in interest rate swaps exposes banks to two types of risk, price risk and credit risk.

Price risk

Price risk occurs from banks "warehousing" swaps –from arranging a swap contract with one end-user without having arranged an offsetting swap with another end-user. Until an offsetting swap is arranged, the bank has an open swap position and is vulnerable to an adverse change in swap prices.

The most common reason for a change in swap prices is a change in interest rates –a change that could cause a bank to suffer a loss on its swap. For example, if the bank has an open swap in which it pays XYZ a variable interest rate in exchange for a fixed rate, an increase in market interest rates would lead to an increase in the payments the bank makes but no change in the payments it receives. In this case, the bank incurs a capital loss just as it would if it were funding long-term fixed-rate loans with floating-rate deposits. Banks warehouse only a small amount of swaps outstanding, however. As a result, only a small proportion of a bank's total swap portfolio is subject to price risk.

Banks hedge to limit the price risk of an open swap. The predominant means of hedging is to offset an open swap position through the purchase or sale of Treasury securities. Because bying Treasury securities outright requires the bank to commit capital, however, banks often use the futures market rather than the cash market to hedge their open swap positions with maturities short enough to be offset with a futures contract.

Although hedging through the use of Treasury securities is widespread, it is difficult to entirely offset the risk of an open swap position in this way. It is difficult to design a position in Treasury securities –cash or futures- that exactly offsets the interest rate risk of a swap. In practice, banks can offset only a portion of the price risk of a swap through hedging in the Treasury securities market. For this reason, banks are usually reluctant to have substantial open swap positions on their books for long periods.

Credit risk

Credit risk is the main concern of regulators and banks. Banks' credit risk exists in all swaps in which the bank is the intermediary between two end-users. Suppose a bank enters into two perfectly matched, offsetting swaps with XYZ and Eurobank. If interest rates change, the value of one swap will fall while the value of the other rises by an equal amount, providing the bank with a hedge against price risk. But if one of the end-users defaults, the bank loses the hedging value of the offsetting swap and may suffer a capital loss. Changes in interest rates can cause losses on bank's swap activities even if the bank immediately offsets one swap with another. Because losses can be incurred in this case only if one of the end-users defaults, this type of risk is called credit risk.

Two of the most critical aspects of managing credit risk in the swap market are the banks' pricing procedures and the degree of portfolio diversification. Banks must make sure that the price of the service they provide adequately reflects the risk inherent in the arrangement. Just as investors demand a higher yield on bonds issued by a firm with a Baa credit rating than on commercial paper issued by a firm with a

Aaa rating, banks must charge more for long-term swaps with end-users that have a low credit rating than for short-term swaps with end-users that have a high credit rating. In both cases, the risk of entering into a financial contract varies directly with the length of the contract and the creditworhiness of the other party of the contract. An individual risky swap need not endanger the financial position of the bank as long as the bank is adequately compensated for the risk and has diversified its swap portfolio so that default by any one customer or group of customers does not substantially impair the bank's earnings or capital position.

The credit risk of interest rate swaps can also be limited by the enforcement of strict credit standards. Perhaps the most important means of limiting risk is to enter into swaps only with creditworthy customers. Typically, the credit department of a bank must agree to the swap before the contract is made. Moreover, banks ordinarily monitor the customer's financial position throughout the life of the swap. Banks may require less creditworthy customers to post collateral or use other credit enhancements that further reduce the risk to the bank in case of a default. The amount of protection collateralization provides is uncertain, however, because the legal status of collateral posted against swaps has not been tested in court. And as the swap market continues to grow, regulators are concerned that credit standards may deteriorate as banks try to accommodate more and often less creditworthy customers.

4) Pricing Swaps – Theory & Evidence

As a derivative instrument, the intuition underlying swap pricing is straightforward. A swap is a contract that we enter into today for a collection of exchanges that will take place in the future. The swap price, therefore, should be based on the net present value of the cash flows expected in these future exchanges.

4.1) The Fundamental Determinants of Swap Prices

The fixed-floating interest rate swap is priced using arbitrage to equate the expected present value of the cash inflows and outflows. The expected values of the floating interest rate may be taken from the yield curve or from interest rate futures prices, if a futures contract is traded on the particular floating rate index. Given values for the floating interest rate, the fixed rate is selected as the internal rate of return that renders the expected present value of the floating rate cash flows equal to the expected present value of the fixed rate cash flows.

By convention, dealers quote only the fixed side of the market. This method allows a dealer to issue a quote that can be valid for one hour or longer and afford some protection against interest rate risk. In practice, the dealer would of course include a spread ranging from as little as 2 basis points to 20 basis points or more depending on the market place and market conditions.

The key insight from swap pricing theory is the implication that, under certain assumptions to be discussed, the rate for a generic interest rate swap must equal the yield on a par bond issued by the counterparty that is making the fixed payments.

Sun, Sundaresan and Wang (1993) establish the swap pricing proposition under the following assumptions:

(A.1) Reset dates precede the payment dates with a lag equal to the floating index maturity.

(A.2) There are no transaction costs, taxes, or other frictions.

(A.3) There are no arbitrage opportunities.

(A.4) There is no default risk.

Generic interest rate swaps satisfy assumption (A.1). Assumption (A.2) implies perfect market conditions, and assumption (A.3) implies that the swaps are priced identically to a replicating portfolio that duplicates the cash flows of the swap. Assumption (A.4), which ignores default risk, is clearly restrictive: Sun, Sundaresan and Wang examine whether the major pricing implication derived under this assumption is broadly consistent with the data on swap quotes. They also explore the directional bias introduced when this assumption is relaxed.

Swap Pricing Proposition. Under assumptions (A.1)-(A.4), the arbitrage-free swap rate on the settlement date should equal the yield on a par bond that makes fixed payments on the same dates as the floating leg of the swap.

The intuition behind this result is easy to understand. Consider a five year generic interest rate swap between the swap dealer and counterparty Y. Counterparty Y is long in the floating leg and short in the fixed leg. On the settlement date, the position of the counterparty Y can be replicated as follows: issue at par a five-year fixed-rate note with a principal amount equal to the notional principal and invest the notional principal in the LIBOR maturing on the next reset date. The interest to be received on the next reset date equals the principal amount times LIBOR. The interest is withdrawn and the principal is rolled into LIBOR that matures on the next reset date and so on. On the last date, the maturing notional amount is used to cover the balloon payment of the fixed-rate note. This strategy replicates all the cash flows of the generic swap. Therefore, if credit risk is ignored, the swap rate on the settlement date must be the yield (or the coupon) on the fixed-rate note issued at par.

Swap rate versus par bond yields

Sun, Sundaresan and Wang, in order to investigate the implications of swap pricing theory, they sustain that they can either compare the par bond yield of the counterparty with the swap offer rate or the par bond yield of the swap dealer with the swap bid rate. On the swap offer side, the relevant benchmark is the par bond yield based on LIBOR. This follows from their assumption that the counterparty participates in the interbank market and must issue a par bond in that market as an alternative to paying the swap offer rate. Hence, the comparison of swap offer rates with the LIBOR par bond yields makes most sense. It is found that both **AAA** and **A** swap offer rates are significantly lower than the LIBOR par bond yields. The differences are on average from 7.8 to 12 basis points for the **AAA** swap offer rates and from 12.1 to 14.6 basis points for the **A** rates.

It is also found that the par bond yields are higher than the swap bid rates. The differences are on average from 5.5 to 9.7 basis points for the **AAA** swap bid rates and from 4.5 to 7 basis points for the **A** rates.

Sun, Sundaresan and Wang are also interested in whether the comparison of swap offer rates and LIBID par bond yields any insight. In the absence of asynchronous observations and default risk, swap offer rates and par bond yields cannot differ by more than bid-offer spreads in the interbank market. This is a no-arbitrage requirement. To see why this must be so, they provide a simple arbitrage recipe. They suppose that the swap offer rate is less than the corresponding LIBID par bond yield. The counterparty obliged to pay a fixed swap offer rate can borrow the notional amount in a floating loan and deposit it in the interbank market. The fixed interest received from the interbank market should at a minimum be equal to the LIBID par bond yield. Hence, the floating proceeds from the swap should exactly cover the interest payment on the floating loan, while the fixed proceeds from the interbank market are more than the fixed swap offer rate. Thus, swap pricing theory also implies that the offer rates can be less than the LIBID par bond yields when there is default risk.

Sun, Sundaresan and Wang also compare LIBID par bond yields with the swap offer rates. The swap offer rates for the **A** dealer are lower than the LIBID par bond yields for all swap maturities except the two-year, where the deviation is insignificantly different from zero. In contrast, the swap offer rates of the **AAA** dealer are higher than the LIBID par bond yields for all swap maturities except the five-year, where the deviations are not significantly different from zero.

The proposition that swap offer rates should below the LIBID par bond yields is based not on averages but on the principle of no arbitrage. 51% of the **AAA** swap offer rates are lower than the LIBID par bond yields. 12% of the differences are more than 10 basis points, the bid-offer spreads of the **AAA** swap rates. The deviations are much more significant for the **A** offer rates, which are less than the LIBID par bond yields between 48 and 61% of the time. The comparison of swap offer rates and LIBID par bond yields indicates that swap rates reflect default risk.

In the absence of credit or liquidity risks, standard ("plain vanilla") interest rate swaps can be priced using the current term structure of interest rates based on Treasury bond quotations. However, credit risk adds an important dimension to the pricing of over-the-counter derivative instruments. The important characteristic of over-the-counter derivatives that distinguishes them from exchange-traded products is that they are not backed by the guarantee of a clearing corporation or exchange. Hence, each of the two counterparties to the transaction is exposed to the default risk of the other. This default risk is particularly important for long-dated instruments such as interest rate swaps.

Swaps are typically negotiated as zero-value transactions when they are initiated, with the swap rate being defined as the fixed rate to be exchanged for a floating rate such as LIBOR. However, their value changes over time as interest rates fluctuate. In the case of a fixed-for-floating interest rate swap, as long-term interest rates rise, the fixed rate payer benefits from being locked into the lower interest rate. Consequently, the value of the fixed side moves "in-the-money". By the same token, the floating rate payer receives flows that are lower than the changed interest rates would dictate, and hence, the value of the floating side moves "out-of-the-money". The opposite occurs when long-term interest rates decline. Default risk arises when the entity for which the swap is out-of-the-money is unable to meet its commitments to the counterparty for which the swap is in-the-money.

In an efficient market, one would expect market swap rates to incorporate the risk of default, if the counterparties rationally anticipate this possibility. Hence, one would expect the swap rates to be sensitive to the credit ratings of the counterparties. For instance, a swap dealer who pays a floating rate and receives fixed payments in exchange would require a **BBB**-rated counterparty to pay a higher fixed rate compared to a **AAA**-rated counterparty. Hence, the swap spread, defined as the difference between the swap rate and the yield on a par Treasury bond with the same maturity, should be greater for the **BBB**-rated counterparty than the **AAA**-rated counterparty, and so should be the differences between the bid and the offer rates.

As discussed by Litzenberger (1992), this is not always observed explicitly in the market swap rates. Several reasons have been suggested for this phenomenon. First, the swap contract is neither an asset nor a liability for either counterparty, since it is based on the difference between two streams of cash flows, (including the principal amounts, which net out to zero for interest rate swaps). Hence, the differences between the swap rates for counterparties with different credit ratings should be much less than the differences between the rates for the corresponding debt of the same maturity. Second, there may be credit enhancement devices (collateral, margining, credit triggering clauses, etc.) for the lower-quality counterparties that effectively reduce the differences in credit quality across borrowers. Lastly, there may be credit rationing which implies that poorly-rated firms are simply rationed out of the swap market. These explanations suggest that market swap spreads over default-free instruments ought to be smaller than the spreads in the debt market for comparable maturities.

However, swap spreads should, at least partly, be determined by credit risk considerations. Counterparties with poorer credit ratings should be quoted higher spreads, while dealers with better credit ratings should demand smaller spreads. In addition, since the market swap rates reflect the weighted average of the credit ratings of the various counterparties, they should include a positive spread to the default-free rates.

The other factor that may influence the pricing of swaps is liquidity risk. Liquidity effects influence the yields in the fixed income securities market. Positive swap spreads may be at least partly explained by liquidity considerations, if the Treasury market is more liquid than the swap market.

4.2) Credit Risk and Swap Spread: The Hypotheses

As mentioned above, in the absence of credit risk, as well as of market frictions such as illiquidity and tax effects, a standard interest rate swap can be thought of as the exchange of a fixed bond for a floating bond. Pricing the swap in this simple setting is fairly straightforward. Since the floating rate bond on the reset date is valued at par when there is no risk of default, the mark-to-market value of an existing swap on a reset date is simply the difference between par and the present value of the cash flows on the fixed side.

If there is some risk of default, the simple decomposition of the swap into the difference between a fixed- and a floating-rate bond breaks down, since the cash flows are subject to the risk of default. In order to price swaps in the presence of default risk, it is necessary to model the default risk explicitly. The precise impact of default risk on the swap rates depends on the parameterizations of the stochastic processes governing the probability of default. Regardless of modeling assumptions, however, the swap rates should, in general, be different from the par yield for the riskfree bond if default risk is present. In other words, the swap spread is, in general, non-zero. Conversely, in the absence of credit risk and market frictions, swap spreads should always be zero.

There are only a few empirical papers in the academic literature that test the impact of credit risk on the pricing of swaps, and most of them deal with U.S. dollar interest rate swaps. In the case of U.S. dollar interest rate swaps, Sun, Sundaresan and Wang (1993) empirically test the null hypothesis that swap rates over par yields of Treasury bonds are all zero. Using swap rates and par yields on corresponding Treasury bonds for the period October 11, 1988 to April 15, 1991, they find that swap spreads are significantly positive for all maturities irrespective of the shape of the yield curve. Furthermore, they find that term premiums of swap spreads increase significantly with maturity, although the increase is smaller when the yield curve is inverted. The second issue that Sun, Sundaresan and Wang investigate is the proposition that while the default risk of a counterparty increases both the coupon rate on a par bond yield based on LIBOR rates as well as the swap rate, the effect is more pronounced on the bond yields than on the swap rates. In order to test this hypothesis, they take the difference between LIBID par bond yields and swap offer rates, and test whether the differences are zero. Their overall empirical results confirm that dollar swap rates reflect credit risk.

Mozumdar (1996) also tested whether quoted swap rates reflect the counterparty credit risk. His broad conclusion is that the default risk parameter is positive and statistically significant, in the case of dollar swaps. However, the effect is weaker for longer maturities, which he attributes to the use of credit enhancement devices.

Rather than measuring the swap yield spreads over Treasury yields, Duffie and Singleton (1997) calculate the swap spreads over Treasuries using zero-coupon yields ("spot spreads"). In order to estimate the swap zero-coupon yields, they use a specific two-factor square-root model along the lines proposed by Cox, Ingersoll and Ross (1985), where the factors are extracted from the two-year and the ten-year swap rates, which are assumed to be observed without error. Hence, in their empirical specification, the model exactly fits two points on the observed swap yield curve, and is estimated using the joint likelihood of swap yields at several maturities. They find that swap spreads are positive at all maturities, and the term structure of swap spreads is on average upward sloping from 22 basis points for the six-month spread up to about 42 basis points for the five-year spread, while the spreads are nearly constant beyond five years to ten years at about 41-42 basis points.

If credit risk is reflected in market swap rates, one way to measure empirically the importance of credit risk is to examine the relationship between proxies of default risk and the market swap spreads. The theoretical models of Duffie and Huang (1996), Jarrow and Turnbull (1997), Li (1998) and Huge and Lando (2000) suggest that swap rates should change with respect to changes in the default risk premium of corporate bonds. However, the magnitude of the change in swap rates should be much smaller due to the differences in contractual features of swaps and corporate bonds. For instance, Jarrow and Turnbull (1997) calibrate their model in an upward-sloping default spread environment and find that a 100 basis-point yield difference between counterparties results in less than 2 basis points difference for a five-year swap, which is consistent with the results of Duffie and Huang (1996) and Huge and Lando (2000). So, in the absence of credit risk in the market, swap spreads should be unrelated to the default risk premium on corporate bonds.

In a recent study, Minton (1997) examines the pricing of U.S. dollar interest rate swaps based on two alternative models. The first is related to the prices of Eurodollar futures contracts, and the second to corporate bond prices. She finds that market swap rates are highly correlated with rates implied by Eurodollar futures prices, although the two series do not move one-for-one. She also finds that swap rates are significantly related to par corporate bond yields. Her empirical results, based on dollar interest rate swaps, indicate that a 100 basis point increase in corporate bond spread over the ten-year treasury yield implies about a 15 basis point increase in ten-year swap spread.

Instead of using corporate bond yields as a measure of the expected credit risk, Brown, Harlow and Smith (1994) test whether swap rates reflect the probability of counterparty default by using the Treasury-Eurodollar (TED) spread in the context of a pure expectations model. They first regress the swap spread on the Treasury yield and the Treasury-Eurodollar (TED) spread and find that the explanatory power of this variable, while significant, is low.

Duffie and Singleton (1997) also find that a higher spread between rates on AA and AAA rated commercial paper, the proxy for default risk, increases the spread for zero coupon swap rates. Furthermore, they find that credit shocks play an important role over a long horizon in explaining the variations of swap spreads, while the impact of liquidity factors is more short-lived. They conclude, however, that a substantial proportion of the variation in the swap spreads is explained by their own shocks, indicating that swap rates may be influenced by swap market-specific activity.

Eom, Subrahmanyan and Uno (2000) measure the importance of credit risk by explaining the swap spread with the slope of the term structure of interest rates. As pointed out by Sorensen and Bolier (1994) and Mozumdar (1996), there is a positive probability of each counterparty having a negative value position in the future, given the uncertainty in the term structure of interest rates. This suggests the possibility of default on the payments by the counterparty for whom the swap is out-of-the-money (i.e., has negative value) to the counterparty for whom the swap is in-the-money (i.e., has positive value). This can be illustrated in the context of an upward sloping term structure as discussed by Mozumdar (1996). In an upward sloping term structure environment, the fixed-rate payer bears more default risk, on average, and hence demands a risk premium through a lower rate. So, in the absence of counterparty credit risk, swap spreads should be unrelated to the slope of the term structure of interest rates.

Koticha (1993) empirically tests a negative relationship between the slope of the term structure and the spread between the swap rate and the yield on a Treasury bond of comparable maturity, using data from five currencies, $, yen, £, DM and FF. The study uses first-differenced daily swap quotes over the period January 1990 to July 1992, for maturities between 2 years and 10 years. By regressing the swap spreads on the slope of the term structure and a credit risk proxy, Koticha finds that the coefficient of the slope term is negative and significant. Minton (1997) finds that swap rates are related to proxies for the shape of the yield curve and that swap rates are positively related to short-term interest rate volatility, thus suggesting that the option to default is priced in the swap market. Contrary to the results of Koticha (1993), however, she finds that changes in ten-year swap rates are positively related to changes in the slope of the term structure measured by the difference between 30-year Treasury bond yield and 3-month Treasury Bill yield, i.e., swap rates increase as the yield curve steepens.

5) Testable Hypotheses

The "swap spread" is an indicator which has the potential to convey useful information on, among other things, the likelihood of default. Assuming that financial market agents entering into a swap contract are risk neutral and have the same degree of creditworthiness, the fixed swap rate is determined as the rate that equates the present value of the expected series of floating-rate payments with the present value of the future fixed-rate payments. As a result, it can be shown that factors such as the steepness of the yield curve and expected changes in the future differential between the short-term reference money market rate used in the swap agreement and the corresponding default-free interest rate will influence the swap rate and hence the swap spread.

Factors associated with the default risk of the agents in the swap market are likely to affect the swap rate, and thereby the swap spread, once the assumptions of risk neutrality and identical creditworthiness are dropped. In principle, the observed swap spread can be expected to vary according to, inter alia, changes in the aggregate likelihood of default, as perceived by the market. In other words, when the probability that any given firm will default is seen by the market as having increased, the swap spread will tend to widen, other things being equal. Since the likelihood of default typically increases in anticipation of or during a recession, the swap spread may also convey information with regard to changes in expectations of future economic activity. In addition, it is possible that perceived changes in liquidity risk may influence the swap spread from time to time, while variations in supply and demand of corporate and government bonds may induce temporary changes in the swap spread as well.

The purpose of this thesis is to determine the factors explaining the swap spreads. The determinants of US swap spreads examined in this analysis are based on the findings of Eom, Subrahmanyam and Uno (2000) who analyse the relation between interest rate factors and the Japanese yen swap spreads. Swap spreads are usually negatively related to the corresponding default-free interest rates, and the negative relation is stronger for swaps of longer maturities. To better understand the impact of interest rate factors on the swap spreads, they decompose the movements of interest rates into factors that explain the default-free term structure.

The level ($r_{3,t}$), slope ($Slope_t$) and curvature ($Curve_t$) of the yield curve, used in the regression performed below (p.40) for the determinance of US swap swap spreads, explain most of the time series variations of yield movements. In addition to these three factors that explain the movements in the default-free term structure, other factors have an important role in swap pricing. For example, when the credit quality of the counterparties of a swap is asymmetric, the swap rate is negatively related to the slope of the yield curve. This is because of the possibility of default by the counterparty for whom the swap is out-of-the-money (i.e., has negative value) to the counterparty for whom the swap is in-the-money. Additionally, the slope of the term structure is procyclical, but the default spread shows counter-cyclical behavior over the business cycle. Thus, the swap spreads may be negatively related to the slope of interest rates due to expected future economic growth. The level and the curvature of the term structure of default-free rates are also important when the credit quality of the counterparties is asymmetric. As argued by Sorensen and Bollier (1994), swap counterparties own a series of European-style options, exercisable when they default on their payments. They argue that the swap rate should be negatively related to the level of interest rates and positively to the curvature factor which is a proxy for volatility.

In line with the findings of Eom, Subrahmanyam and Uno (2000), apart from interest rate factors, the spread between three-month LIBOR and three-month Prime rates (LIP_t) is used in the regression performed below as a measure of the short-term default risk of corporate issuers.

Taking into account that banks are the principal swap users, in this thesis the effect of another factor in the determinance of the swap spread is also examined. It is intended to show that the spread of the S&P Stock Market Index percentage change over the S&P Bank Stock Market Index percentage change ($\%\Delta S\&P_t - \%\Delta S\&P_t Banks$), a proxy of the credit risk of banks, is positively related to interest rate swap spread. So, we perform the following regression:

$$\Delta SWSP_t(m) = \beta_o + \beta_1 \Delta r_{3,t} + \beta_2 \Delta Slope_t(m) + \beta_3 \Delta Curve_t + \beta_4 \Delta LIP_t + \beta_5 (\%\Delta S\&P_t - \%\Delta S\&P_t Banks) + \varepsilon_t$$

where $\Delta SWSP_t(m)$ denotes the change in the swap spread of maturity m-year, $\Delta r_{3,t}$ the change in the three-month Prime rate, $Slope_t(m)$ the difference between the m-year US Treasury Bond spot rate and the 1 year US Treasury Bond spot rate, $\Delta Curve_t$ the change in the curvature factor measured by (ten-year US Treasury Bond spot rate

+ three month Prime rate)/2 – the one-year spot rate and ΔLIP_t the difference between the three-month LIBOR rate and the three month Prime rate.

All data were collected from Datastream. They include swap rates for maturities of two-, three-, four-, five-, seven- and ten-years. The data are available for the period April 1, 1987 to present.

In order to estimate the swap spreads, prices of US Treasury [illegible] bond were collected for the different maturities from Datastream. Three-month LIBOR and three-month Prime rates are also collected from Datastream in order to measure the short-term default risk of corporate issuers.

Finally, the S&P Stock Market Index and S&P [illegible] Stock Market Index prices were collected from Datastream for the sample period, so as to examine the effect of a credit risk proxy on US swap spreads.

6.1) Main Results

At the following table the results of the regression performed are presented for maturities of [illegible] 5, 7 and 10 years respectively. In the first column the independent variables of the regression as well as R^2 and Durbin-Watson Statistic are listed. ($\%\Delta S\&P_t$ – $\%\Delta S\&P$ [illegible]) denotes the change in the spread of the S&P Stock Market Index percentage change over the S&P [illegible] Stock Market Index percentage change, Δr_t denotes the change in the three-month Prime rate, ΔSlope(10) denotes the change in the 10-year slope, $\Delta Curve_t$ denotes the change in the curvature factor and ΔLIP_t

6) Empirical Analysis

All data were collected from Datastream. They include swap rates for maturities of two-, three-, four-, five-, seven-, and ten-years. The data are available for the period April 1, 1987 to present.

In order to estimate the swap spreads, prices of US Treasury Benchmark bond were collected for the different maturities from Datastream. Three-month LIBOR and three-month Prime rates are also collected from Datastream in order to measure the short-term default risk of corporate issuers.

Finally, the S&P Stock Market Index and S&P Banks Stock Market Index prices were collected from Datastream for the sample period, so as to examine the effect of a credit risk proxy on US swap spreads.

6.1) Main Results

In the following table the results of the regression performed are presented for maturities of 2, 3, 5, 7 and 10 years respectively. In the first column the independent variables of the regression as well as R^2 and Durbin-Watson Statistic are listed. ($\%\Delta S\&P_t$ -$\%\Delta S\&P_t Banks$) denotes the change in the spread of the S&P Stock Market Index percentage change over the S&P Bank Stock Market Index percentage change, $\Delta r_{3,t}$ denotes the change in the three-month Prime rate, $\Delta Slope_t(m)$ denotes the change in the m-year slope, $\Delta Curve_t$ denotes the change in the curvature factor and ΔLIP_t

denotes the change in the difference between the three-month LIBOR rate and the three month Prime rate. Figures in brackets show the t-statistic, while two asterisks imply a significance level between 5% and 1% and three asterisks imply a significance level of 1% or less.

Table 1: The Determinants of Swap Spreads

$\Delta SWSP_t(m) = \beta_o + \beta_1 \Delta r_{3,t} + \beta_2\, \Delta Slope_t(m) + \beta_3\, \Delta Curve_t + \beta_4 \Delta LIP_t + \beta_5\, (\%\Delta S\&P_t - \%\Delta S\&P_t Banks) + \varepsilon_t$

	2 years	3 years	5 years	7 years	10 years
Constant	-0.0002 (-0.27)	-0.0002 (-0.304)	-0.0001 (0.19)	-0.0003 (-0.466)	-0.0003 (-0.51)
(%ΔS&P$_t$ - %ΔS&P$_t$Banks)	0.0005 (0.97)	0.0004 (0.92)	0.0005 (1.22)	0.0004 (0.92)	0.0003 (0.73)
Δr$_{3,t}$	-0.067 (-2.27)**	-0.116 (-4.37)***	-0.182 (-7.28)***	-0.216 (-8.76)***	-0.2832 (-10.47) ***
ΔSlope$_t$(m)	-0.577 (-17.43)***	-0.611 (-19.53)***	-0.608 (-20.402)***	-0.669 (-24.29)***	-0.7696 (-23.26) ***
ΔCurve$_t$	0.437 (11.68)***	0.459 (12.92)***	0.483 (13.98)***	0.553 (16.05)***	0.6791 (17.31)***
ΔLIP$_t$	0.157 (9.22)***	0.131 (8.63)***	0.0924 (6.58)***	0.088 (6.67)***	0.0866 (6.478)***
R^2	0.394	0.417	0.427	0.456	0.449
D.W.	1.99	1.96	1.92	1.93	1.83

Notes: 1. Data Source: *Datastream*

2. Variable Definitions:

(%ΔS&P$_t$ - %ΔS&P$_t$Banks) is the spread of the S&P Stock Market Index percentage change over the S&P Bank Stock Market Index percentage change.

$\Delta r_{3,t}$ is the change in the three-month Prime rate.

$\Delta Slope_t(m)$ is the difference between the m-year US Treasury Bond spot rate and the 1 year US Treasury Bond spot rate.

$\Delta Curve_t$ is the change in the curvature factor measured by (ten-year US Treasury Bond spot rate + three month Prime rate)/2 – the one-year spot rate.

ΔLIP_t is the difference between the three-month LIBOR rate and the three month Prime rate.

3. The estimation was done with a heteroskedasticity-consistent variance/covariance matrix.

The results for 10-year swap spreads indicate that the constant variable and ($\%\Delta S\&P_t$ $-\%\Delta S\&P_t Banks$) variable are not statistically significant, whereas $\Delta r_{3,t}$, $\Delta Slope_t(m)$, $\Delta Curve_t$ and ΔLIP_t variables are significant at the 1 per cent level. The same results hold for maturities of 2, 3, 5 and 7-year swap spreads. So, the econometric analysis of the data fails to prove that ($\%\Delta S\&P_t$ $-\%\Delta S\&P_t Banks$) variable is positively related to interest rate swap spread. On the contrary, $\Delta r_{3,t}$, $\Delta Slope_t(m)$, $\Delta Curve_t$ and ΔLIP_t variables explain the change in interest rate swap spread and they have the expected sign.

In greater detail, the coefficient of $\Delta r_{3,t}$ for 10-year swap spreads is negative (-0.283). Suppose that the prime rate falls by 3%, i.e. $\Delta r_{3,t}$ is equal to –0.03, the implied impact on the change in swap spread will be positive ($\Delta SWSP_t(10) = (-0.283)*(-0.03) = +$ 0,00849). It is noted that the coefficient of $\Delta r_{3,t}$ is negative for all swap spreads maturities. It is thus shown that the swap spreads are negatively related to the level of interest rates. Taking into account that the coefficient of the $\Delta Slope_t(m)$ is negative, if the 10-year interest rate curve is downsloping (i.e. $\Delta Slope_t(10)$ is negative), the implied impact on the change in swap spread will be positive. It should be noted that the coefficient of $\Delta Slope_t$ has negative sign for all swap spreads maturities. So, swap spreads are negatively related to the slope of interest rates. Considering that the coefficient of $\Delta Curve_t$ is positive, if the curvature factor of the 10-year interest rate curve is negative, the implied impact on the change in swap spread will be negative. It is mentioned that the coefficient of $\Delta Curve_t$ is positive for all swap spread maturities. So, it is concluded that the curvature factor, a proxy for volatility, is positively related to the swap spreads. Finally, taking into account that the coefficient of ΔLIP_t is positive for all swap spread maturities, if the change in the difference between the three-month LIBOR rate and the three month Prime rate is negative, the implied impact on the change in swap spread will be negative. Considering the spread between three-month LIBOR and three-month Prime rates as a measure of the short-term default risk of corporate issuers, it is observed that the higher the default risk of corporate issuers, the higher the spread.

Through the examination of the variables' coefficients over time, it is concluded that the longer the maturity, the higher the absolute value of the $\Delta r_{3,t}$ coefficient. The same approximately pattern holds for $\Delta Slope_t(m)$ and $\Delta Curve_t$ coefficients. Finally, the coefficient of ΔLIP_t decreases for longer maturities.

6.2) Refinements

At this stage of the study, the effect of another coefficient in the determinance of the swap spread is examined. Instead of using the spread of the S&P Stock Market Index percentage change over the S&P Bank Stock Market Index percentage change ($\%\Delta S\&P_t$ -$\%\Delta S\&P_t Banks$), the S&P Bank Stock Market Index percentage change ($\%\Delta S\&P_t Banks$) is used as a proxy of the credit risk of banks. That is, the following regression is performed:

$$\Delta SWSP_t(m) = \beta_o + \beta_1 \Delta r_{3,t} + \beta_2 \Delta Slope_t(m) + \beta_3 \Delta Curve_t + \beta_4 \Delta LIP_t + \beta_5 (\%\Delta S\&P_t Banks) + \varepsilon_t$$

The results of the empirical analysis for all maturities do not diverge from the previous analysis and indicate that the constant and ($\%\Delta S\&P_t Banks$) variables are not statistically significant, whereas $\Delta r_{3,t}$, $\Delta Slope_t(m)$, $\Delta Curve_t$ and ΔLIP_t variables are significant at the 1 per cent level.

Finally, the effect of (%ΔS&P_t -%ΔS&P_tBanks) and (%ΔS&P_tBanks) variables in the determinance of the swap spread is examined for subperiods of the sample of our data. But, for once more, the econometric analysis of the data fails to prove that either (%ΔS&P_t -%ΔS&P_tBanks) or (%ΔS&P_tBanks) variable is positively related to interest rate swap spread.

7) Conclusions

The analysis of this study, based on data for the period April 1, 1987 to present in the US interest rate swap market, shows that US swap spread is significantly related to proxies for the long-term credit risk factor. The swap spread is negatively related to the level and slope of the term structure and positively related to the curvature, indicating that the credit "optionality" is priced in the swap rate. Furthermore, it is found that a credit risk factor influencing the swap spread is the short-term default risk of corporate issuers. The results of the econometric analysis show that the higher the default risk of corporate issuers, the higher the spread. So, this study comes to confirm the findings of Eom, Subrahmanyam and Uno in their study for "Credit Risk and the Yen Interest Rate Swap Market" (2000).

On the other hand, the variables used as a proxy of the credit risk of banks {(%ΔS&P_t -%ΔS&P_tBanks) and (%ΔS&P_tBanks)} were not found to be positively related to the interest rate swap spread. This could be attributed either to the fact that the above mentioned variables are not good proxies of the credit risk of banks, or to the possibility that the credit risk of banks does not affect the swap spread. In future work, the issue of the credit risk determinants of swap spreads should be examined more thoroughly.

References

- Bank for International Settlements, "Central Bank Survey of Foreign Exchange and Derivatives Market Activity, 1998, Basle, May 1999.

- Bank for International Settlements, "Principles for the Management of Credit Risk", July 1999.

- Bank for International Settlements, "Best Practices for Credit Risk Disclosure", July 1999.

- Bansal, Vipul K., James L. Bicksler, Andrew H. Chen, and John F. Marshall. "Gains from Synthetic Financings with Interest Rate Swaps: Fact or Fantasy?" Journal of Applied Corporate Finance 6, no. 3 (Fall 1993), pp. 91-94.

- Didier Cossin, Hugues Pirotte, University of Lausanne, Switzerland, "Swap credit risk: An empirical investigation on transaction data", Journal of Banking and Finance 21 (1997) 1351-1373.

- ECB Monthly Bulletin,

•September 2000, "Recent developments in long-term interest rate differentials between the United States and the euro area",

•May 2000 "The information content of interest rates and their derivatives for monetary policy".

- The Economist,

• "The bond market. Giltless", 13/5/00.

• "Danger signs. The swaps market is behaving very oddly. Why?", 11/6/00.

- Gregg Whittaker, "Interest Rate Swaps: Risk and Regulation", Federal Reserve Bank of Kansas City, Economic Review, March 1987.

- Jagtiani, Julapa. "Characteristics of Banks That Are More Active in the Swap Market." Journal of Financial Services Research 10, no. 2 (June 1996), pp.131-41.

- Katerina Simons, Economist, Federal Reserve Bank of Boston, "Measuring Credit Risk in Interest Rate Swaps", New England Economic Review, November/December 1989.

- Kent T. Saunders, "The interest rate swap: Theory and evidence", Journal of Corporate Finance 5 (1999) 55-78.

- Rendleman, Richard J., Jr. "How Risks Are Shared in Interest Rate Swaps". Journal of Financial Services Research; 7(1), January 1993, pages 5-34.

- Sheridan Titman, "Interest Rate Swaps and Corporate Financing Choices", The Journal of Finance, VOL. XLVII, No 4, September 1992.

- Tong-sheng Sun, Suresh Sundaresan, and Ching Wang, Columbia University, New York, "Interest rate swaps. An empirical investigation", Journal of Financial Economics 34 (1993) 77-99.

- Young Ho Eom, Yonsei University, Marti G. Subrahmanyam, New York University, Jun Uno, Nikkei QUICK Information Technologies, Inc., "Credit Risk and the Yen Interest Rate Swap Market", March 2000, Working Paper.