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Journal of Finance, Volume 41, Issue 3, Papers and Proceedings of the Forty-Fourth Annual Meeting of the America Finance Association, New York, New York, December 20-30, 1985 (Jul., 1986), 645-655.

THE JOURNAL OF FINANCE • VOL. XLI, NO. 3 • JULY 1986

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ABSTRACT

Interest rate swaps, a financial innovation in recent years, are based upon the principle of comparative advantage. An interest rate swap is a useful tool for active liability management and for hedging against interest rate risk. The purpose of this paper is to provide a simple economic analysis of interest rate swaps. Alternative uses of and the appropriate valuation procedure for interest rate swaps are described.

THE SIGNIFICANT INCREASE in both the levels and the volatilities of market interest rates since the late 70's has resulted in substantially higher interest-rate risks faced by business firms and financial institutions. The problem and consequences of interest-rate risk exposure are particularly serious for firms in which the duration of assets does not match the duration of the liabilities. For instance, most financial institutions and many corporations financed long-term fixed-rate assets with short-term floating-rate liabilities. Such firms lose when the short-term interest rates in the market rise unexpectedly, because for given fixed rates of return on their assets, the short-term interest costs that they have to pay rise with the market interest rates. Conversely, these firms gain from an unexpected decline in short-term market interest rates. In recent years, the introduction and the development of new financial products in the capital markets—such as interest rate futures, interest rate options and interest rate swaps—represent logical responses to the increased need to reduce firms' exposure to interest rate risk.

Since the early 1980's, interest rate swaps have become one of the most popular vehicles utilized by many companies and financial institutions to hedge against interest rate risk. The growing popularity of interest rate swaps is due, in part, to the fact that the technique is simple and easy to execute. Although there is no published figure showing the exact magnitude of the market value of interest rate swaps, it has been estimated that a total of more than $150 billion of interest rate swaps had been completed in the United States by the end of 1985. Further, the transactions in this market are growing at an astounding rate.

The purpose of this paper is to provide a simple economic analysis of interest rate swaps. In Section I, the basic interest rate swap and its economic rationale are briefly discussed. Alternative uses of interest rate swaps are described in Section II. In Section III, the valuation procedure appropriate for interest rate swaps is sketched and a simple comparison of two swaps is presented. The final section provides a brief summary.

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I. The Basic Interest Rate Swap

An interest rate swap, or simply a rate swap, is an agreement between two parties to exchange a series of interest payments without exchanging the underlying debt. In a typical fixed/floating rate swap, the first party promises to pay to the second at designated intervals a stipulated amount of interest calculated at a fixed rate on the "notional principal"; the second party promises to pay to the first at the same intervals a floating amount of interest on the notional principle calculated according to a floating-rate index. The first party in a fixed/floating rate swap, that which pays the fixed amount of interest, is known as the *fixed-rate payer*, while the second party, that which pays the floating amount of interest, is known as the *floating-rate payer*[1].

Interest rate swaps are voluntary market transactions by two parties. In an interest swap, as in all economic transactions, it is presumed that both parties obtain economic benefits. The economic benefits in an interest rate swap are a result of the principle of comparative advantage. Further, in the absence of national and international money and capital market imperfections and in the absence of comparative advantages among different borrowers in these markets, there would be no economic incentive for any firm to engage in an interest rate swap.

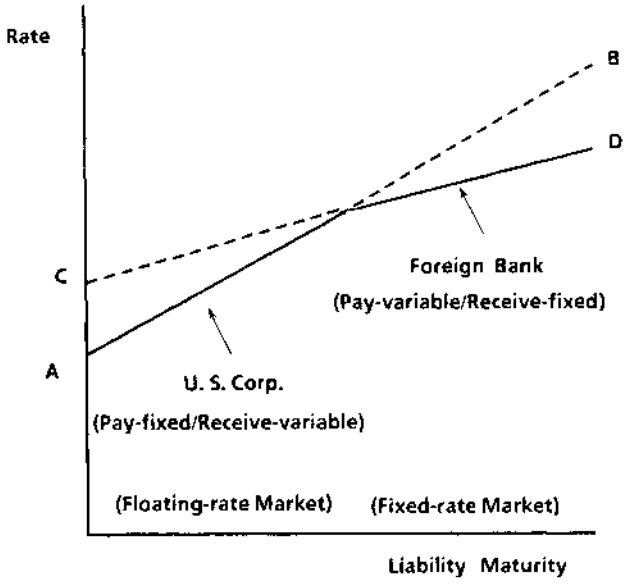
Differential information and institutional restrictions are the major factors that contribute to the differences in transactions costs in both the fixed-rate and the floating-rate markets across national boundaries which, in turn, provide economic incentive to engage in an interest rate swap. For example, in contrast to the U.S. corporate bond market, there is virtually no registration or disclosure requirement for issuing new corporate bonds in the Eurobond market[2]. As a result, it takes much less time to place a new bond issue in the Eurobond markets. However, issuing a new bond in the Eurobond markets requires a larger underwriting cost and a larger credit premium. Thus, it is generally more difficult for a relatively small and unknown bank or business firm to issue new bonds in the Eurobond markets. In the floating-rate markets, the U.S. short-term interest rates are usually lower than those in the European money markets due, in part, to the presence of government insurance on deposits.

These institutional differences suggest the presence of some market imperfections and the presence of comparative advantages among different borrowers in these markets. These market imperfections provide an economic rationale for interest rate swaps between U.S. corporations desiring medium-term fixed-rate funds in the Eurobond market and some Eurobanks desiring short-term floating-rate U.S. funds. Figure 1 depicts the imperfections between the U.S. and the European floating-rate and fixed-rate markets, the comparative advantages the market participants possess, and their likely roles in a swap agreement. As shown in Figure 1, the U.S. corporation is assumed to be able to borrow at a lower rate

[1] See Kopprasch *et al.* [8] and ISDA [7] for detailed discussions of interest rate swap terminology and conventions.

[2] To issue a new domestic bond, a firm has to register with the Security Exchange Commission and meet its disclosure requirements. SEC Rule 415 has reduced the length of time in the registration procedure for large corporations.

Figure 1.
International Money and Capital Markets and Interest Rate Swap



Explanation:

1. AB represents the costs of borrowing in the floating-rate and the fixed-rate markets for the U.S. corporation.
2. CD represents the costs of borrowing in the floating-rate and the fixed-rate markets for the foreign bank.

Figure 1. AB represents the costs of borrowing in the floating-rate and the fixed-rate markets for the U.S. corporation. CD represents the costs of borrowing in the floating-rate and the fixed-rate markets for the foreign bank.

than the Eurobank in the floating-rate markets, and it has to borrow at a higher rate than the Eurobank in the fixed-rate Eurobond markets. Thus, the U.S. corporation has a comparative advantage in the floating-rate markets, while the Eurobank has a comparative advantage in the fixed-rate Eurobond markets. Through a fixed/floating rate swap, the U.S. corporation pays the fixed-rate interest and receives the floating-rate interest while the Eurobank pays the floating-rate interest and receives the fixed-rate interest. As will be shown later, both parties in the interest rate swap obtain economic benefits from the transaction.

II. Many Uses of Interest Rate Swaps

An interest rate swap is essentially a *strip* of forward contracts exchanging interest payments. Thus, interest rate swaps, like interest rate futures or interest

rate forward contracts, offer a mechanism for restructuring cash flows and, if properly used, provide a financial instrument for hedging against interest rate risk. Some illustrative examples of the economic uses of interest rate swaps are described below.

A. *Using Rate Swaps In Gap Management*

Different institutional requirements and different market conditions have resulted in distinctly different compositions of balance sheets for depository institutions in the U.S. and abroad. For instance, many U.S. financial institutions have assets the returns of which are denominated in fixed rates of interest, with relatively long maturities (e.g., mortgage and consumer installment loans) and liabilities with relatively short maturities (e.g., money market deposit accounts and variable-rate certificates of deposit) which are repriced frequently[3]. On the other hand, some typical European financial institutions have assets with relatively short maturities and liabilities with relatively long maturities. These differences in inter-firm asset/liability composition represent opposite kinds of gaps in balance sheets. Interest rate swaps provide an economic mechanism whereby both financial institutions can benefit from a reduction in their respective balance-sheet gaps and a decrease of exposure to interest-rate risks.

Even within the same national boundary, balance-sheet compositions and the opportunity set of borrowing rates can be quite different. For example, the Student Loan Marketing Association (Sallie Mae) has a portfolio of floating-rate student loans and advances for student loans. Furthermore, Sallie Mae can raise the capital required for its portfolio of student loans at a reasonable cost in the medium-term fixed-rate market. Thus, similar to European financial institutions, Sallie Mae has a gap management problem wherein there is an economic need to shorten the duration of its liabilities to reduce the mismatch of its balance sheet. Specifically, it has fixed-rate funds readily available but prefers floating-rate liabilities to fund its assets. Thus, there is the potential scenario whereby Sallie Mae and another financial institution can enter into an interest rate swap under which Sallie Mae agrees to periodically pay a floating amount of interest payments calculated on a floating-rate index such as Treasury-bill rate or the London Interbank Offered Rate (LIBOR) to the financial institution; while the financial institution promises to periodically pay a fixed amount of cash flows calculated on stipulated fixed interest rate to Sallie Mae. Accordingly, Sallie Mae was one of the first domestic users of the interest rate swaps. Through an interest rate swap, the financial institution can convert its floating-rate liabilities into fixed-rate liabilities, while Sallie Mae can convert its fixed-rate liabilities into floating-rate liabilities. Thus, both parties can reduce their balance-sheet gaps with a subsequent decrease in their exposures to interest rate risk. Sallie Mae has completed billions of dollars of rate swaps in the recent past.

[3] The Federal Home Loan Bank Board announced in February, 1984 that it would allow the Federal Home Loan Banks to write interest rate swaps for its savings and loan members. The purpose was to assist the S & L's to hedge the interest rate risk on their fixed-rate mortgages through interest rate swaps.

B. Using Rate Swaps To Lower Fixed-Rate Cost

Interest rate swaps can be a very useful tool for lowering a company's cost of long-term fixed interest rate borrowing. It has particular appeal for a company with a relatively low credit rating. In both floating-rate and fixed-rate markets, a borrower with lower credit rating has to pay a quality spread over what a borrower with a higher credit rating has to pay. However, the quality spreads in the long-term fixed-rate markets and that in the short-term floating-rate markets are not necessarily identical. As shown in Table I, the average quality spreads between Aaa– and Baa–rated firms in the fixed-rate corporate bond market were 2.33% in 1982, 1.51% in 1983, 1.48% in 1984, and 1.31% in 1985. The average quality spreads in the floating-rate markets have been about .5% in the past few years. Figure 2 illustrates the differential quality spreads in the floating-rate and the fixed-rate markets. The quality spread is narrower in the floating-rate market than in the fixed-rate market. This difference in the quality spreads presents a market arbitrage opportunity via the emergence of the interest rate swap market. The technique of fixed/floating rate swap was indeed developed in order to take advantage of the differential quality spreads between the long-term corporate bond market and the short-term credit market.

To illustrate, assume that a Baa corporation can borrow from banks at a floating rate equal to the T-Bill rate plus one-half percent and that an Aaa corporate borrower can borrow at a floating rate equal to the T-Bill plus one-fourth percent. Also assume that in the bond market the quality spread between the two firms is 1½% for a five-year bond. The Aaa firm would pay a fixed rate of 11½% while the Baa firm would have to pay a fixed rate of 13%. That is, the corporate bond market requires a quality spread 1¼% larger than the short-term credit market. Thus, the two corporate borrowers can enter into an interest rate

Table I

Quality Spread (Baa − Aaa)

Date	1982	1983	1984	1985
JAN	1.92	2.15	1.45	1.18
FEB	1.91	1.94	1.51	1.10
MAR	2.24	1.88	1.42	1.13
APR	2.32	1.78	1.50	1.28
MAY	2.38	1.63	1.46	1.43
JUN	2.11	1.63	1.50	1.46
JUL	2.19	1.24	1.71	1.46
AUG	2.61	1.13	1.76	1.45
SEP	2.69	1.18	1.69	—
OCT	2.61	1.21	1.31	—
NOV	2.62	1.20	1.19	—
DEC	2.31	1.18	1.27	—
AVG	2.33	1.51	1.48	1.31
MIN	1.91	1.13	1.19	1.10
MAX	2.69	2.15	1.76	1.46

Source: *Federal Reserve Bulletin*

Figure 2.

Quality Spreads

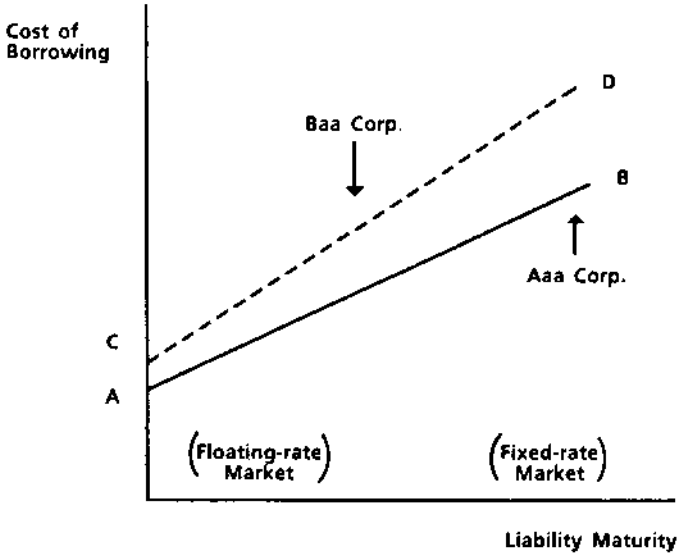


Figure 2. AB represents the costs of borrowing in the floating-rate and the fixed-rate markets for the Aaa corporation. CD represents the costs of borrowing in the floating-rate and the fixed-rate markets for the Baa corporation.

swap agreement and capture the economic benefits that result from savings in their costs of borrowing. The illustrative swap is detailed in Figure 3. The Aaa corporation issues a bond of $100 million at 11½% and enters into a rate swap under which it is paid 12% in exchange for paying a six-month T-Bill rate. The net cost to the Aaa firm is the six-month T-Bill rate minus one-half percent, representing a saving of ¾% in raising the required amount of money in the floating-rate market.

The Baa company borrows floating rate funds at the six-month T-Bill rate plus one-half percent and enters into the rate swap under which it pays fixed rate of 12% and receives the T-Bill rate. Thus, the net fixed-rate cost to Baa is 12½%. In other words, the Aaa firm is raising 5-year money at the T-Bill rate minus one-half percent instead of having to pay one-fourth percent over the T-Bill rate, a net saving of ¾%. The Baa firm is effectively raising 5-year money at a fixed rate of 12½% (12% paid to the Aaa firm plus the ½% arbitrage cost on the floating rate funds). The combined savings of 1¼% shared by the two firms represent the quality spread differential (that is, the arbitrage opportunity) between the two markets.

C. Using Rate Swaps To Restructure Debt Mix

Interest swaps are a useful tool for active liability management. Financial managers can use interest rate swaps to change the debt mix of a firm. For example, the existing debt mix of a firm may not be optimal because it consists

Figure 3

Fixed/Floating Rate Swap

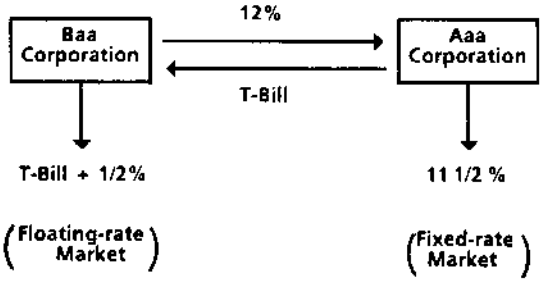


Figure 3. In fixed/floating rate swap, the Baa corporation raises funds in a floating-rate market and promises to pay the Aaa corporation a fixed-rate interest, while the Aaa corporation raises funds in a fixed-rate market and promises to pay the Baa corporation a floating-rate interest.

of too much high-coupon fixed-rate liabilities. The firm can issue floating-rate liabilities and use the proceeds to buy back the existing high-coupon fixed-rate debt. However, the transaction costs associated with refinancing are usually higher than the costs of using interest rate swaps. Furthermore, there could be some restrictions that might prevent the firm from engaging in the refinancing activities.

The following example will be used to illustrate how a rate swap can be used to unlock the high-coupon fixed-rate debt. Suppose that a company has $50 million of noncallable debt outstanding, which carries a fixed rate of 14% and has five years to maturity. The company enters into an interest rate swap agreement under which it agrees to pay the prime rate (9½% as of December 1, 1985) plus 50 basis points and to receive 13% from the fixed-rate payer in the interest-rate swap in return. This interest rate swap results in a net floating-rate cost of 11%. Thus, through an interest rate swap, the company has converted its high-cost fixed-rate corporate debt into a cheaper floating-rate liability. This transaction has resulted in an economic gain of 3 percentage points in the cost of borrowed funds.

D. Using Swaps To Manage Basis Risk

Interest rate swaps can also be used as an effective tool for financial institutions to manage the basis risk in the balance sheets. Under a floating/floating interest rate swap, both parties pay floating rates of interest based on different floating-rate indices. Suppose that the bank has an asset yielding a return of the LIBOR rate plus three-quarter percent, which has been financed with floating-rate CD at a cost of the T-Bill rate minus one-quarter percent. The counterparty has floating-rate funds at one-quarter percent above the LIBOR rate. As illustrated in Figure 4, under the floating/floating interest rate swap, the bank pays to the counterparty floating-rate interest equal to the LIBOR rate (reset every six

Figure 4

Floating/Floating Rate Swaps

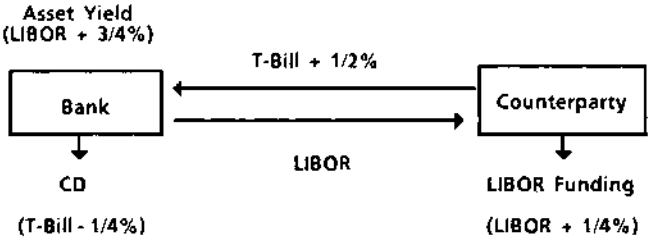


Figure 4. In a floating/floating rate swap, the bank raises funds in the T-Bill rate market and promises to pay the counterparty a periodic interest based upon the LIBOR rate, while the counterparty raises funds in the LIBOR rate market and promises to pay the bank a periodic interest based upon the T-Bill rate.

months) and receives from the counterparty floating-rate interest equal to the T-Bill rate plus one-half percent (reset weekly). The economic implication of this transaction is that the bank has transformed its T-Bill-rate-based CD liability into a liability with a cost three-quarter percent below the LIBOR rate and has locked in a positive spread of 150 basis points against its LIBOR-rate-based assets. The effective cost of the floating-rate funds to the counterparty after the swap transaction is equal to the T-Bill rate plus ¾%.

IV. The Valuation of Swaps

A. Valuation Procedure

The valuation of interest rate swaps is of interest for a number of reasons. Including the enormous dollar value and the high rate of growth of the market for swap transactions, the negotiated nature as well as the relative infancy of the transactions, the lack of public economic information about the pricing parameters and valuation procedures of these transactions. Thus, a proper valuation procedure for interest rate swaps is of obvious relevance to decision makers such as market makers and corporate financial officers participating in the structuring and financial evaluation of the swap transactions.

The simplest way to structure the financial valuation of an interest rate swap is to view it as an exchange of two hypothetical securities: a fixed-rate bond and a floating-rate note (the floater). The fixed-rate payer in a fixed/floating rate swap can be viewed as the seller of a fixed-rate bond and the buyer of the floater; while the floating-rate payer can be viewed as the seller of the floater and the buyer of a fixed-rate bond. Thus, pricing an interest rate swap is essentially the same as determining the value of a floater.[4]

[4] Kopprasch *et al.* [8] recognize that an interest rate swap can be viewed as two hypothetical securities. Unfortunately they have not incorporated the stochastic movements of short-term interest rates into their market valuation. Hence, their valuation approach is not correct.

The valuation of floating-rate instruments has recently attracted a greal deal of attention in the finance literature. For instance, the recent work of Cox, Ingersoll and Ross [4] and Ramaswamy and Sundaresan [10] has attempted to derive the equilibrium value of a floating-rate contract under certain assumptions about the interest rate movements.

Since the discrete time approach to the valuation of a floater is more appropriate for the valuation of an interest rate swap, it will be employed here. It is first assumed that the short-term interest rate evolves according to a discrete-time two-state process as follows:

$$r_{t+1} = \begin{cases} ur_t & \text{with probability } q(r_t) \\ dr_t & \text{with probability } 1 - q(r_t) \end{cases}$$

where $u > d > 0$, $0 < q(r_t) < 1$, and

r_t = the current interest rate;
u = the "up" value of the short-term interest;
d = the "down" value of the short-term interest;
$q(r_t)$ = the probability that the short-term rate in the next period will move up, given the current short-term rate is r_t. To simplify, let q_t be $q(r_t)$.

Thus, the evolution of the term structure is fully determined by the movements of the short-term rate of interest. Under the additional assumptions that there is no arbitrage opportunity and that all bonds are priced according to the local expectations hypothesis, one can derive the following equilibrium valuation model for a floater[5]:

$$F(r_t, x_t; s, R_t^k) = x_t + \frac{q_t F(ur_t, x_{t+1}; s-1, R_{t+1}) + (1-q_t)F(dr_t, x_{t+1}; s-1, R_{t+1})}{1+r_t} \tag{1}$$

where

$F(\cdot)$ = the cum-coupon value of the floater at date t,
r_t = the current interest rate,
x_t = the current coupon, a function of some previous short-term rates of interest,
s = the maturity of the floater, and
R_t^k = the vector of the relevant historical rates of interest.

Equation (1) says that the floater's value is the current interest rate coupon plus the expected future value discounted at the current one period rate of interest. Given particular parameter values, one can derive the equilibrium market value of any specific floaters. The above valuation model can be modified to capture any unique contractual features in an interest rate swap—such as payment frequency mismatch or reset frequency mismatch, and short or long first floating-rate period—and to derive the equilibrium market value of the floating-rate note in an interest rate swap.

[5] See Ramaswamy and Sundaresan [10] for detailed derivation of the model.

B. Simple Comparison of Alternative Swaps

As indicated above, interest rate swaps involve exchanging two hypothetical securities—a floating-rate note and a fixed-rate bond. The equilibrium market value of a swap is determined by the values of these two particular securities. The relation between the prices and the values of the two securities will determine the net gain to the participants in the swap. The choice between two interest rate swaps with different floating-rate indices should be based on the same economic criterion. Specifically, the economic decision rules for choosing between alternative swaps are the minimization of the present value of interest costs, or equivalently, the one that results in the largest (incremental) value.

In the following, we shall compare the partial ex post performance of two swaps ($100 MM) completed in August, 1982. The prices of the swaps were as

Table II

Swap Payment Schedule

Date	LIBOR	Floating-Rate Payment 1/2 (LIBOR)	Fixed-Rate Payment 1/2 (T + .75%)	Net Payment of Fixed-Rate Payer
Aug '82	12.51%	—	—	—
Feb '83	9.88%	$4,940[a]	$6,905	$1,965
Aug '83	10.69%	5,345	6,905	1,560
Feb '84	10.57%	5,285	6,905	1,620
Aug '84	12.08%	6,040	6,905	865
Feb '85	9.57%	4,785	6,905	2,120
Aug '85	8.33%	4,165	6,905	2,740
			Average	$1,812

Note: The floating-rate index is six-month LIBOR.
[a] All figures in thousands of dollars.

Table III

Swap Payment Schedule

Date	T-Bill	Floating-Rate Payment 1/2 (T-Bill)	Fixed-Rate Payment 1/2 (T − .80%)	Net Payment of Fixed-Rate Payer
Aug '82	9.80%	—	—	—
Feb '83	8.23%	$4,115[a]	$6,130	$2,015
Aug '83	9.51%	4,755	6,130	1,375
Feb '84	9.18%	4,590	6,130	1,540
Aug '84	10.61%	5,305	6,130	825
Feb '85	8.39%	4,195	6,130	1,935
Aug '85	7.32%	3,660	6,130	2,470
			Average	$1,693

Note: The floating-rate index is six-month T-Bills.
[a] All figures in thousands of dollars.

follows:

1. 10-year Treasury Bond rate + .75% against 6-month LIBOR rate
2. 10-year Treasury Bond rate − .80% against 6-month T-Bill rate

The ten-year Treasury rate was 13.06% in August, 1982 and the four-year average spread between the 6-month LIBOR rate and the 6-month T-Bill rate for 1978 through 1982 was 158 basis points. The fixed rate difference was 155 basis points between the two swaps, so they were comparable. The ex post results up to 1985 of the two swaps are presented in Tables II and III. It is clear from these tables that the fixed-rate payers of the two swaps incurred different interest payments due to changes in the spread between LIBOR and T-Bill rates. Comparing alternative swaps based upon the historical spreads between the indices is simple but not totally accurate.

V. Conclusions

Interest rate swaps, a capital market innovation introduced only a few years ago, have become a very popular and effective interest rate hedging instrument and liability management tool. Interest rate swap transactions are based upon a simple economic principle of comparative advantage. Using swaps, financial managers can readily transform the economic characteristics of their liabilities. Interest rate swaps are more effective than financial futures and financial options in hedging against the interest rate risk for horizons beyond two or three years. We would expect that in the next few years there will be increasing attention on the analytic valuation and empirical study of interest rate swaps.

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