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Innovation in the International Money and Bond Markets: A Source of Lower Borrowing Costs?

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ABSTRACT

Two Eurobond issues are analyzed as potential sources of lower issuer borrowing costs. These issues are the Student Loan Marketing Association indexed currency option note and the Federal National Mortgage Association dual-currency bond. These issues were brought to the market on November 1, 1985. Our analysis of these issues centers on the definition and examination of market institutions prevailing around the issue date and on an all-inclusive cost of funds criterion. From this examination, it appears that the issuers did lower their borrowing costs relative to U.S. domestic or other, less-complex Eurobond issues that were available at the time.

When one reads in the trade press that a corporation is able to borrow at "an astonishing LIBOR minus 200" basis points, a first reaction is that this opportunity is too good to be true (see "Global Swaps Market," 1986). The lucky borrower must have underestimated some potentially costly aspect of the complex transaction generating the low cost of funds. However, such claims have been made consistently in the Eurocurrency market. We seek to verify them.

We will carry out this verification exercise in a rudimentary fashion. We analyze in depth two recent Eurobond issues by the Student Loan Marketing Association (Sallie Mae) and the Federal National Mortgage Association (Fannie Mae). These U.S. agencies are among the more innovative borrowers.

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in this market. The two specific issues evaluated are a dual-currency bond and an indexed currency option note (ICON). Both of these issues were sold on November 1, 1985.

Like most recent issues in the Eurobond market, the bonds made up only a part of a complex transaction. Currency forward, currency swap, and interest rate swap transactions were directly linked to the issues. The complex transaction provided the agencies with the floating rate funds they sought from the capital market. We will attempt both to illustrate and to evaluate these combined transactions.

The criterion we will use for our evaluation of the relative benefits of the ICON and dual-currency bond issues is the all-inclusive cost of funds. This cost of funds is the internal rate of return that equates the present value of the proceeds received by the bond issuer with their promised payments to the bond buyers. Our calculation of the all-inclusive cost of funds is more complicated than in the usual bond case. This is because the bond issuers receive options in addition to cash from the ICON buyers and must pay the cost of principal redemption to the dual-currency bond buyers. However, once the fair values of the options and the redemption amount are determined, an equivalent bond proceeds amount may be calculated directly. Calculation of the all-inclusive cost of funds is then a simple exercise. Our conclusions discuss the benefits and potential problems that arise from using this criterion.

As background to this analysis, we will also review developments in the Eurobond and swap markets that may explain the apparent reduction in the cost of funds. Possible explanations might be that particular risks in the transactions were not appropriately priced in practice or that the issuers had specific advantages in accessing segments of the market that have reduced investment opportunities. The specific advantages would have arisen from the ability to overcome funds flow constraints or from technical expertise in valuation and hedging. A truly reduced cost of funds could reasonably result only from these specific advantages.

The next section of this chapter is devoted to discussion of important international capital market developments and of the particular financing objectives of the issuers. Due to the structure of the subsidies that they may receive from the U.S. Treasury, both Sallie Mae and Fannie Mae face a problem in managing floating-rate assets.

The following two sections define and explain the alternative sources of capital available to the issuers and determine the costs of these alternative and simpler sources of capital at the time of the issues. These costs of capital are used as the relative pricing benchmarks for the dual-currency bond and ICON issues. The next two sections of our analysis are devoted to valuing the dual-currency and ICON issues, respectively. This relative valuation is done by constructing portfolios of other traded financial claims that match the cash flows of the actual issues. A matching portfolio should cost the same amount as the associated issue. The derived price of the appropriate matching portfolio provides the direct relative pricing benchmark for each issue. This approach to valuation also clearly illustrates both the components of the complex bond issues and their associated sources of risk.

Our conclusions are presented in the final section. The findings are reviewed and integrated with the discussion of market developments. This evaluation indicates that the lowered costs of capital obtained by Sallie Mae and Fannie Mae do not appear to be due to misinterpretation of the risks in their respective bond issues.

Institutional Factors

Both the Eurocurrency market and the Eurobond market have gone through three major stages of growth. They now appear to be entering a fourth. All of these stages have been driven by large demands for international financial intermediation. The onset of each market development stage has provided both lower-cost borrowing and higher-yield investment opportunities for innovative market participants. Such gains seem to be bid away relatively quickly, and the Euromarkets might best be viewed as part of the process of bringing the supply and demand for funds into equilibrium. We will define any short-term market opportunities arising from this process as flow of funds advantages. In addition, innovative banks and issuers may create new types of contingent claims that are valued incorrectly by some market participants for some period of time. These types of market opportunities will be defined as technical advantages (see Khoury, 1984; Nachman, 1985). We will attempt to identify Sallie Mae's and Fannie Mae's potential advantages during the recent stage of market development.

The first stage of Eurocurrency market development was in response to the UK and U.S. governments' restrictions and taxes on capital outflows and resulting income. The OPEC surplus led to a second stage of growth. Much of the resulting investment demand came from investment accounts in Switzerland, leading to the historical predominance of the Swiss institutions as purchasers of Eurobond issues (see "The World," 1985). The third stage of growth came with the third world debt crisis and the increase in transaction-led issues, which were largely swap-driven or based on differential tax and regulatory environments. The current stage of development emerges with the opening of many of the world's domestic sources of capital to the Euromarkets. Regulatory changes during this time have also enabled net borrowers of funds to access the Euromarkets for the first time. These changes have led to possible flow of funds advantages. Regulatory changes have also led to the development of securitized contracts, futures, options, and other more complicated contingent claims. The growing experience in valuing and hedging these contracts...
is rapidly transferred between domestic markets and the Euromarkets. Innovative issuers might benefit from technical advantages in either or both of these markets.

Since the first two stages of Euromarket growth and the impact of the third world debt crisis on the market have been examined in detail (see Dufey & Giddy, 1978; Eiteman & Stonehill, 1986; Stigum, 1983), we concentrate our attention on the latest Eurobond and swap market developments. Of particular importance in this analysis will be the identification of the sources of potential flow of funds and technical advantages potentially affecting the issues we value. These relevant developments will be dichotomized as either swap-related or bond-related.

The Swap Market

The world swap market had grown to roughly $23 billion in 1985. The growth of this market resulted from market participants' comparative advantages in borrowing in a particular market segment where they did not need funds. These borrowers then lent to counterparties with a comparative borrowing advantage in another segment of the market where the initial borrower needed funds. Generally, the best credits borrowed long term at fixed rates and swapped with less creditworthy firms that borrowed at floating rates. Roughly 95 percent of the swaps transacted were related to new Eurocurrency or Eurobond issues (see "Variations on a Theme," 1986). Whether or not the gains from swapping floating-rate and fixed-rate funds compensate for the risk in the transaction is an open question.

The currency and interest rate swap markets have become extraordinarily competitive. Profits on swap deals will generally be found only when integrated with other financing components in a package tailored to the issuer(s) and purchaser(s). The ability to tie up numerous transactions and matched cash flows in one bundle across many firms has been supported by the success of most swaps and the development of the long-dated swap and forward markets. To date, only one swap deal has actually been in default. Only two additional ones have gone through negotiated workouts. Eurodollar and currency swap rates are widely quoted for maturities up to ten years.

During this time, major players in the swap market have come to integrate their counterparty risk across many swaps with master agreements. These agreements treat default of any of the counterparty's swap contract provisions as default on all. This increased security and the low default rates on swaps have led many market participants to consider that they have overestimated the riskiness of their swap positions. As a result, they have increased the number of parties to a particular transaction and decreased the pricing of credit risk associated with the parties borrowing (see "Swaps," 1985; "Why Swaps," 1986). The ability of an issuer or bank to package swaps relatively efficiently should earn a rent that might lead to what we have termed technical advantages. A case of particular interest for our evaluation of the Sallie Mae and Fannie Mae bond issues will be the market for yen-dominated claims.

Beginning in 1985, top corporations were permitted to issue Euroyen bonds. Competition among expanding Japanese investment banks was especially severe in the bond and related yen swap market. Their aggressive pricing led to many of their deals being called "bara kiri swaps" (Ollard, 1985). However, another incentive lurked behind these deals. This incentive was related to the Glass-Steagall-type separation of investment banking and commercial banking in Japan, a split mandated by Article 65 of the Securities and Exchange Law. The Ministry of Finance reported that future quotas to underwrite domestic securities issues will be determined by past Eurobond market activity (see "WA Means Harmony," 1986). During the first three months that foreign corporations could issue Euroyen Bonds, over 80 percent of issues were swap linked (see Ollard, 1985). Since a swap market presence was necessary to develop market share in the Euroyen bond market, and since the requisite Eurobond business was necessary to earn an underwriting quota domestically, aggressive swap pricing by Japanese institutions was not surprising.

Besides market-related phenomena, swap market growth also resulted from regulatory and macroeconomic changes. Major changes occurred in Japan and the United Kingdom. United Kingdom Building Societies were permitted to enter into swap contracts in March 1986. Since these Building Societies could borrow at low rates from the U.K. Public Works Loan Board, they became a source of floating-rate funds for pound swaps. Similarly, Japanese corporations were allowed to swap in 1986 (see "Why Swaps," 1986). Given low-cost yen in Japan, they could provide the floating-rate side of the yen swaps.

However, a more important source of growth for the yen market resulted from the macroeconomic effects of the yen's rise through 1986. As Japanese firms' profits and employment came under pressure from the high value of the yen, the Ministry of Finance relaxed international investment restrictions on Japanese corporations and financial institutions. Though the Japanese were already under pressure to open their markets, the surge of Japanese investment at that time probably stemmed in good part from the innovations permitted and encouraged by the Ministry of Finance.

The Eurobond Market

The development of the Euroswap market has been inexorably linked with the growth of the Eurobond market. The well-developed swap market has allowed corporations to avail themselves of a comparative advantage in any Eurocurrency market sector, while ending up with the debt maturity and currency
risk they prefer. A particular source of growth in this area has come from taxation and other regulatory differences across countries. These differences have led to true arbitrage gains for the most creditworthy issuers. Some important examples are as follows:

1. **Bearer bonds**: Eurobonds are unregistered. Foreign investors holding their bonds in nonresident accounts prefer bearer bonds generally. They evade domestic taxation by holding these bonds offshore. Since the bonds are in bearer form, there is no chance that their ownership can be traced. All else equal, the demand for unregistered bonds should tend to lower the yields that investors require on Eurobonds. (See Dufey & Giddy, 1978.)

2. **Eurobond zero-coupon issues**: Top-rated U.S.-based corporations could issue non-interest-paying debt while deducting “accrued” interest payments even though none were made. Some foreign investors were not taxed or taxed at capital gains rates on these issues. (See “Zero Coupons,” 1982.)

3. **Withholding taxes**: Domestic issuers of debt prior to 1984 were required to withhold some proportion of interest payments to foreigners (30 percent in the United States and 20 percent in Japan, for example). These taxes have been largely repealed. (See Eitman & Stonehill, 1986.)

4. **Defeasance**: Many governments, such as the United States, did not issue Eurobonds that were free from withholding taxes. Top-rated corporations could actually borrow in currencies in the Euromarkets through captive finance subsidiaries at rates below those at which the associated governments could borrow domestically. In the United States, defeasance was the accounting technique by which the arbitrage profits of matched corporate Euro-borrowing and offsetting government debt purchased were kept off balance sheet. (See “An Accounting Shift,” 1984; Winkler, 1985.)

5. **Restricted access to the yen bond markets**: Until 1984, only governments and supranational agencies were permitted by the Japanese Ministry of Finance to issue Euroyen and Samurai bonds. Samurai bonds were domestic yen issues. In 1984, highly rated multinational corporations were allowed to make such issues; in 1986, large money center banks could do so. The ability to issue dollar-denominated issues in Japan, Shogun bonds, was similarly restricted. (See “Tapping,” 1985; Japan Gives Foreign Banks,” 1986.)

6. **Restrictions on investments in foreign bonds**: The most important case is again Japan. Until recently, only 10 percent of Japanese pension and insurance fund assets could be in foreign currency-denominated bonds. This will rise to 30 percent in 1987. Furthermore, the bonds must be traded, or “locked up,” for six months before they can be placed in these portfolios. Depending on trust provisions of collateral, this requirement can prevent foreign bond ownership. Foreign currency Euro issues by Japanese firms, Sushi bonds, did not count against these limits. (See “Call for New Investment Rates,” 1986; “Japanese Insurers,” 1986.)

Large investment institutions—such as Goldman-Sachs, Salomon Brothers, Merrill Lynch, Morgan Stanley, Citibank, DeutscheBank, Nomura, and Credit Suisse First Boston—have led their corporate and agency clients around, through, and over these restrictions. Furthermore, they have attempted to access new market openings quickly following regulatory changes. For example, the aforementioned lockup requirements of 180 days have been finesse, even though they are still in existence. They have been also reduced to 90 days.

The success of the leading institutions in the Eurobond and swap markets seems to result from technical, economic, and the preference of Eurobond investors to take their placements from the top-tier “name” institutions. The name institutions or franchises appear to have grown stronger while the second-tier institutions have fallen behind. Profits from Eurobond placements are directly related to the offering institutions’ relative position in the syndicate. Institutions that want to enter the top-tier of investment banks have often had to discount severely the issues in which they take a large role (see Ollard, 1985). This phenomenon has been alluded to in our identification of the need for Japanese banks to seek market share in the Eurobond and swap market. Borrowers may benefit in the short term from any resulting strategic pricing decisions. Another important factor that came into play at the same time as the overhang of yen swaps was an overhang of Euroyen bond issues. These bonds were finally placed in Japan directly by the Japanese institutions. Little of the oversupply was handled by franchise or second-tier foreign institutions.

It seems that the Japanese institutions may have learned from this experience. Their placement power for yen issues appears relatively strong. Given the large source of funds in Japan and the increased willingness of the Japanese institutions to syndicate issues without foreign partners, a major realignment of the Eurobond market may be signaled (see “WA Means Harmony,” 1986). Japanese investors will potentially equal the Swiss banks as a final repository for Eurobond issues. As a result, franchise institutions will find it hard to continue to earn fees from a syndication without being committed to taking down part of the issue. Also likely is a further shakeout of the second-tier non-Japanese institutions that cannot place their share of an issue in Japan or elsewhere.

A final development that portends even more activity in the Eurobond and swap markets is the growing pressure on Japanese mutual, insurance, and pension funds and on corporations’ earnings margins. This pressure has been caused by the high value of the yen and relatively low yen interest rates. In 1985, most of the high yen coupon issues in Japanese fund portfolios were maturing. To replace these high-yielding yen-denominated bonds, high-coupon foreign bonds were purchased. A potential explanation for these purchases is that the implications of exchange rate risk may not have been fully valued in these issues. Other evidence of such a failure to account for exchange
rate risk by a relatively new player in the game was the recent set of low-coupon Swiss franc issues by Australian firms (see "Zaitoku-Warrant," 1986; "As the Currency Sinks," 1986). With the large rise in the value of the yen and the fall in value of the Australian dollar relative to the Swiss franc, these Australian corporations may have learned an expensive lesson about exchange rate risk. However, in the case of the Japanese funds, other important factors existed.

Japanese pension funds have only been permitted to pay dividends out of income. Therefore, monitored investment performance in Japan is calculated from interest and dividends plus realized capital gains. Unless the dollar or some other foreign currency bonds are sold, a fall in the value of the currency that denominates the bond will not generally affect the investment manager's performance until the maturity of the bond issues. Depending on the manager's time horizon and his expectation of the long-run exchange rate, these purchases at relatively low foreign currency redemption values may not be at all irrational.

During 1986, straight Euroyen bonds were also issued at severe premiums. An example was a recent five-year note priced at 115.25 and paying an 8.5 percent coupon. The yield to maturity on this bond was 100 basis points below market (Crabbe, 1985). The existence of these issues at large premium and of similarly priced dual-currency bonds clearly indicates that a potential benefit existed for issuers that satisfied Japanese fund demands for high current income. Furthermore, only the best credits could make these issues.

Another important reason for the continued interest of the Japanese in foreign bond investments was a March 1986 tax ruling that allowed Japanese investors to write off any capital loss on foreign currency denominated bonds against current income (see "Zaitoku-Warrant," 1986). A purpose of this rule was to allow the Japanese funds that have experienced capital losses on the foreign currency bond holdings to write off this loss. Future offsetting gains will not result in an increased tax liability. All else equal, this rule should increase Japanese demand for foreign currency bonds because it provides a subsidy to offset the possible loss from holding foreign currency bonds. Japanese overseas long-term investment was $81.7 billion in 1985 and grew to $132.4 billion in 1986. By the end of 1986, Japanese long-term foreign assets reached $397 billion, a total surpassing OPEC's highest level of holdings (see "Hooked on T-Bonds," 1987; "New Japanese Investments," 1987).

The potential for continued Japanese net foreign investment remains large. Evidence of this potential can be found in the investment allocation made through 1985 by Kampo, the Japanese Post Office Insurance Fund. Kampo was one of the first institutions in Japan permitted to invest in foreign bonds. In 1985, the Kampo Post Office Insurance Fund had $5.5 billion of $25 billion in funds invested abroad, an amount roughly equal to their foreign investment limit. In 1985, the Japanese Post Office Savings Funds held roughly $360 billion in deposits. Should they be permitted to invest abroad and do so as aggressively as Kampo, the required financial intermediation would be staggering (see "How Long," 1985; "Japan: A Giant," 1985).

Japanese multinational corporations have also made large purchases of Eurobonds. Having seen their profit margins and incomes squeezed by the high value of the yen in 1986, they used finance techniques, zaiteku, to improve earnings. Zaiteku is the borrowing of funds at a low rate to be invested in a bond paying a higher rate. Given the low cost of funds in Japan, there has been a rash of Euroyen and other Eurocurrency issues purchased by Japanese firms. Unlike Japanese corporate domestic bond issues, the Eurobond issues could be made on an unsecured basis. It has been estimated that roughly 50 percent of Japan's 500 largest corporations engaged in these transactions. At a macro level, the ability to preserve their earnings levels with zaiteku income allowed the issuing corporations to hold foreign currency export prices below what would have been otherwise possible. With the Japanese tax subsidy on foreign currency bonds, a major risk shifting was encouraged between secured domestic yen bond issues and the unsecured international bonds. Whether based on investment fund or corporate demand for foreign bonds, a flow of funds advantage did seem to exist for those bond issuers that could sell to Japanese bond buyers in 1985 and 1986.

Large Japanese corporations also issued bond-warrant packages with very low coupons and relatively rich conversion ratios to generate zaiteku profits. Though deep in the money rights offerings can be a low-cost means to raise capital, these warrant issues appear to have been purchased relatively inexpensively by agents that did not already own shares. Some termed these issues the great warrant giveaway. It was estimated that exercise of the outstanding warrants, many of which were in the money, would have added 5 percent to the Japanese equity market capitalization of $2 trillion (see "Zaitoku-Warrant," 1986). The potential misvaluation of these warrants may also provide evidence of a general misvaluation of many option-related issues. In this case, the technical expertise of the top-tier franchise institutions provided a comparative advantage in contingent claims valuation and hedging. The application of this expertise may provide evidence of technical advantages.

Summary

Generally, our review of swap and Eurobond market developments has emphasized potential sources of low-cost funds. We have seen that numerous regulatory and longer-term competitive pressures exist that might well result in effective discounts in certain market segments. Also, innovation in long-dated swap, forward, and option contracts by more technically sophisticated institutions may provide a producers' surplus from which to price discounts.

During the 1984-86 period that is relevant for the Sallie Mae and Fannie...
Mae bond issues we examine here, Japanese yen domestic and Euromarkets seem to have contained the most interesting and potentially economical financing alternatives. Both flow of funds and technical advantages seem to have existed in this market segment. It appears that these advantages may continue to exist for some time.

Nonetheless, two additional factors should be considered. The first is the threat of a Ministry of Finance crackdown on the market. The second is market entry by smaller and potentially less informed firms.

Japanese macroeconomic policy at the time implicitly indicated that the cost of the tax subsidies to owners of foreign currency denominated bonds was viewed as being lower than the potential costs of a higher value for the yen. The development created the possibility that Japanese investors might cause a free fall in the value of the dollar. The actions necessary to set off such a dollar depreciation could have occurred on their own or in concert with a government initiative.

One additional area of technical concern during the 1985-86 period was the narrowing of spreads between short-term and long-term rates. To the extent that fixed-rate foreign currency bond purchases were funded through swaps of floating-rate funds, decreased demand for bonds denominated in currencies with relatively high long-term yields could have occurred abruptly (see “New Japanese Investments,” 1987).

The potential restriction of Japanese capital flows in the future might also have led, in the short run, to an increase in the number of yen-denominated bond issues and the associated swap deals. The larger number of Japanese firms and institutions able to go to the international market and the potential for a lessened degree of coordination and restraint by these entities as a group suggest that an increase in the number of issues was likely (see “Zaiteku-Warrant,” 1986). The entry of these firms directly into thecome transactions portended a decreased need for swap management by the banks. Instead, a roaring securitization boom could await the Eurobond market and especially the Euroyen market, an upswing that would follow trends in the U.S. markets (see Donal, 1984; “The World,” 1985; “Zaiteku-Warrant,” 1986). Market participants attempting to compete solely in swap-related banking would be hard pressed by broad-based corporate financial institutions.

With regard to the environment surrounding the two U.S. agency issues in November 1985, the potential for both flow of funds and technical advantages existed. Therefore, some reduction in their cost of funds from these issues was feasible. Our analysis would have to show that unpriced risks that exist in these transactions were insignificant relative to the cost saving. If we are able to do this and find that a low cost of funds did exist, then, on a dynamic basis, it will indicate that innovative borrowing initiatives on the Euromarkets may be quite beneficial. Though the source of this benefit may be a gain from trade arising from a flow of funds advantage of fair rent for

expertise derived from a technical advantage, large reductions in the cost of funds will indicate that those entities with borrowing and lending opportunities in these markets should pursue them as Sallie Mae and Fannie Mae have. We now turn to define the specific financing needs facing Sallie Mae and Fannie Mae.

Financing Needs of Sallie Mae and Fannie Mae

Both Sallie Mae and Fannie Mae faced an interesting problem in managing asset-liability maturity. Their problem arose from the subsidies paid to them by the U.S. Treasury when the rates on their assets—the outstanding loans in their portfolios—fell below the average three-month Treasury-bill rate for any quarter of the year. Though it would seem that the value of these loans would behave like the value of fixed-rate assets, the high interest rate environment prevailing during the late 1970s and early 1980s caused the income from long-term loans to behave as though it was generated by floating-rate assets: loan rates were below the three-month Treasury-bill average rate, because loan income was largely derived from subsidies. Notably, the usual arguments about the irrelevance of financial structure may not apply to Fannie Mae and Sallie Mae, since constraints on their activities and issued securities may not allow the requisite unbundling of their risks.

Since Sallie Mae's and Fannie Mae's debt is not guaranteed by the U.S. government, the floating rates at which they can borrow are above the Treasury-bill rate, and they would generally lose money by funding their floating-rate assets with floating-rate borrowing. This asset funding situation occurs generally, but it was particularly problematic with the run-up in rates in the early 1980s.

The resolution of their asset-funding problem came through the agencies' use of their high credit rating in the long-term bond market to borrow at fixed rates, lend at fixed rates to some less creditworthy counterparty, and have this loan counterparty lend money back to the agency at a floating rate pegged below the prevailing Treasury-bill rate. The counterparty in this transaction with Sallie Mae or Fannie Mae obtained these floating-rate funds by borrowing at some premium over the Treasury-bill rate.

Such a transaction is called an interest rate swap. The swap profited Sallie Mae and Fannie Mae by allowing them to borrow at a rate below that of the U.S. Treasury. The counterparties benefited when the difference between the fixed rate they would have normally paid in the market and the rate charged them by Sallie Mae or Fannie Mae was significantly greater than the sum of the premium they paid over the U.S. Treasury-bill rate and the rate subsidy they gave to the respective agency. Such transactions were "sold" by investment banks and commercial banks to swap counterparties as "arbitrage." Par-
Participants viewed the reduced net interest rate expense for both of the counterparties to the swap as the arbitrage gain. However, the reduced interest rate expense was not truly an arbitrage gain, since each party to the swap bears the credit risk of the other party. An obvious risk is the potential default of either counterparty to the swap. The economic benefits of these swaps came about when markets were segmented by regulation and perception. In these cases, swaps or related transactions might have resulted in true gains for one or both participating counterparties.

Both Sallie Mae and Fannie Mae were particularly aggressive in borrowing foreign capital through complex financial packages. Generally, their borrowings were at fixed rates and often in foreign currency. Their foreign currency borrowings were especially noteworthy, since Sallie Mae and Fannie Mae had almost no foreign assets. Almost all of their fixed-rate issues were swapped. Their gains arose when the effective fixed rates at which they borrowed were low relative to those of their potential swap counterparties. The swap allowed them to profit from and share in these potentially advantageous fixed rates.

Another interesting factor that may further benefit Sallie Mae and Fannie Mae is their freedom from SEC regulation. They can issue new types of bonds with little regulatory delay. Therefore, they are an important client for investment banks that are developing new products. However, they lack this specific advantage in the Euromarkets.

We will now turn to examine the fixed-rate borrowing alternatives used by Sallie Mae and Fannie Mae during 1985. By linking these fixed-rate issues to the associated swap transactions, we will seek to determine how these agencies succeeded in managing their cost of funds internationally.

Borrowing Alternatives

Both Sallie Mae, a student loan company, and Fannie Mae, a federal mortgage association, wanted to raise money in November 1985. They needed a total of $250,000,000 and $217,360,000, respectively.

At that point, several borrowing alternatives, which could be considered as having approximately the same credit risk on the market, were available to the companies. The companies could have borrowed at floating rates, domestically or in Eurodollars; issued straight dollar bonds on the domestic market at a rate slightly above Treasury-bond rates; or considered fixed-rate funds in the Eurobond market.

The direct borrowing opportunities in the floating-rate market were at rates linked to U.S. Treasury-bills or Fed Funds domestically and Eurodollars internationally. However, borrowing at these rates implied a loss for the agencies on their subsidized loans, and discussed earlier in this chapter. Therefore, they were more likely to issue long-term bonds and swap fixed-rate funds for floating-rate funds with a counterparty. Actually, Fannie Mae issued a ten-year yen/dollar dual-currency bond, and Sallie Mae issued a ten-year yen/dollar indexed currency option note (ICON) to fund their cash needs. Both of these issues netted fixed-rate yen for the agencies. Therefore, they converted these fixed-rate yen for floating-rate dollars in a currency swap.

Since direct floating-rate borrowing by Sallie Mae and Fannie Mae was not optimal over any length of time, we will emphasize simple dollar-denominated long-term bond issues as the benchmarks for evaluating the more complex bond issues undertaken by the agencies. Any additional savings that the agencies generated by swapping out of bonds into floating rates should have been available for all the bond issues analyzed. (The references to this chapter provide sources of information for gaining an understanding of the potential savings in these swaps.)

Since the dual-currency bond and ICON we analyze here have interest and principal payments that differ from usual bond issues, we will have to estimate our relative pricing benchmarks from information available on dollar- and yen-denominated bonds and dollar-denominated zero-coupon bonds. Based on this information, we will estimate yield curves for future payments of Eurodollars and Euroyen. The estimated rates in the yield curves will provide us with discount rates for the yen and dollar payments to be paid by Sallie Mae and Fannie Mae to the bond buyers.

Relative Pricing Benchmarks

The Fannie Mae dual-currency bond and the Sallie Mae ICON were issued on November 1, 1985. The prices and rates of other debt issues relevant for their pricing are presented in table 2-1. Short-term U.S. Treasury-bill and London Interbank (LIB) rates are listed, along with estimates of the swap savings earned by the agencies on the reference floating rates. Long-term bond yields are listed for comparable-maturity U.S. Treasury-bonds; domestic, Eurodollar, and Euroyen bond issues by Sallie Mae and Fannie Mae; and Eurodollar zero-coupon bonds issues by large corporations. Looking over these rates, it appears that the two agencies could have issued dollar-denominated debt in the U.S. domestic market at rates of 10.4 to 10.5 percent and Eurodollar bonds yielding from 10.7 to 10.8 percent. Should the all-inclusive cost of funds that we estimate for the dual-currency bond and ICON issues fall significantly below these rates, benefits to the complex issues would be substantiated.

Eurodollar and Euroyen Yield Curves and Yen Forward Prices

The dual-currency bond and ICON issues provide investors with more complex yen and dollar payments streams than the benchmark relative pricing in
Table 2-1
Benchmark Pricing Issues, November 1, 1985

<table>
<thead>
<tr>
<th>Issuer</th>
<th>Market</th>
<th>Maturity</th>
<th>Yield</th>
<th>Coupon</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Treasury</td>
<td>Bill</td>
<td>2/85</td>
<td>7.41</td>
<td>.3</td>
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<tr>
<td>Fannie Mae/Fannie Mae</td>
<td>LIB</td>
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<td>8.0625</td>
<td>.3</td>
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<td>Bond</td>
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<td></td>
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<td>Fannie Mae</td>
<td>U.S. bond</td>
<td>9/95</td>
<td>10.41</td>
<td>10.5</td>
</tr>
<tr>
<td>Fannie Mae</td>
<td>Eurodollar</td>
<td>1992</td>
<td>10.18</td>
<td>10.5</td>
</tr>
<tr>
<td>Fannie Mae</td>
<td>Euroyen</td>
<td>11/92</td>
<td>6.87</td>
<td>6.375</td>
</tr>
<tr>
<td>Arco</td>
<td>Euro</td>
<td>2/92</td>
<td></td>
<td>10.375</td>
</tr>
<tr>
<td>J.C. Penney</td>
<td>Zero coupon</td>
<td>2/94</td>
<td>11.00</td>
<td></td>
</tr>
<tr>
<td>Prudential</td>
<td>Zero coupon</td>
<td>1/99</td>
<td>11.25</td>
<td></td>
</tr>
<tr>
<td>Exxon</td>
<td>Zero coupon</td>
<td>5/04</td>
<td>10.94</td>
<td></td>
</tr>
</tbody>
</table>

Note: Suggests straight domestic bond cost, 10.4 to 10.5 percent; Eurodollar bond cost, 10.7 to 10.8 percent.

issues presented in table 2-1. To value these more complex issues, it will be useful to construct the ten-year semiannual yield curves that existed on November 1, 1985, for dollar and yen claims. We carried this out as follows. First, the U.S. Treasury yield curve was obtained from the Wall Street Journal. Then Eurodollar bond swap rates of matching maturity were added to the Treasury yields. For maturities of less than a year, these rates were supplied by Citibank. For maturities longer than a year, the two-, three-, four-, five-, seven-, and ten-year swap rates were obtained from Eurobrokers. Swap rates of other maturities were linearly interpolated from these rates. These data are reported in table 2-2. The resulting bond yields were then stripped to create the zero-coupon yield curves depicted in figure 2-1. The Eurodollar zero-coupon rates are used to discount future dollar cash flows paid to buyers of the Fannie Mae and Fannie Mae bond issues.

Figure 2-1 also presents the stripped Euroyen zero-coupon yield curve. This set of rates is calculated from the Euroyen bond swap rates quoted by Eurobrokers against six-month yen offer rates in London. These swap rates, along with Citibank Euroyen rates for maturities less than a year, are also presented in table 2-2. The Euroyen zero-coupon rates are used together with the Eurodollar zero-coupon rates and the November 1, 1985, spot rate, 209.7 Y/$, to create yen forward prices out to ten years of maturity. These forward prices are depicted in figure 2-2. The yen forward prices are used to convert future yen cash flows into equivalent dollar cash flows.

Based on our yield curve and yen forward price estimates, we will turn to determine the value and all-inclusive cost of funds for the ICON and dual-currency bond issues. However, we will first define the criterion we use to estimate the all-inclusive cost of funds on these issues.

The All-Inclusive Cost of Funds Criterion

Kopprasch et al. (1986) have defined the all-inclusive cost of funds for interest swaps. Lynn and Hein (1985) have also suggested its use for interest rate caps and collars. We will use this criterion for our Eurobond offerings pricing analysis.

We define the all-inclusive cost of funds as the rate that equates the present value of promised coupon payments with the total value received by the issuer. The total value received by the issuer will be equal to an adjusted issue amount. For the ICON issuer, Sallie May, the adjusted issue amount will
include the value of the option to pay back less than full redemption principal and the actual cash issue amount. In turn, the dual-currency bond issuer, Fannie Mae, has an adjusted issue amount equal to the cash issue amount less the cost of getting another party to assume the principal redemption risk. Therefore, these and any other complex bond claims will have all-inclusive costs of funds, r, determined by the rate that satisfies the following equation:

\[ 0 = \text{Issue cash} \pm \text{Option/redemption - Risk-adjusted present value position of promised coupons (r)} \]

(acquired, +; laid off, -)

Since it is clearest to calculate the value of the option/redemption position components of the actual issues amount directly, the implied all-inclusive cost of funds is used to adjust future coupon values to present values only. Given values for the option/redemption positions, calculation of the all-inclusive cost of funds is straightforward. Therefore, as we analyze the effects of different market perceptions for yen direction and volatility, we can readily determine the effect on the all-inclusive cost of funds that will have to be paid by the issuers.

Finally, we will calculate the all-inclusive cost of funds under the assumption of no further profits for the issuers from swapping out of the fixed-rate coupons. As a result, our estimates of the all-inclusive cost of funds are potentially biased upward. Without information on these nongeneric swap opportunities, we feel that it is best not to contaminate our analysis with conjectural swap rates. Nonetheless, the swap all-inclusive cost of funds methodology suggested by Kopprasch et al. (1986) can be easily appended to our bond all-inclusive cost of funds criterion. Of course, if we find significantly lower all-inclusive costs of funds given our criterion, consideration of a further swap profit opportunity can only lower it further.

The Dual Currency Bond Issue

A dual-currency bond is a Eurobond that is denominated and pays interest in one currency and is redeemable in another, generally U.S. dollars. The coupon and principal payments are fixed. Because of the potential for foreign exchange and interest rate arbitrage built into the dual-currency bond structure, the bonds could pay a higher coupon than buyers could get from straightforward investments in the currency denominating the coupon.
For issuers that did not want to bear the foreign exchange rate risk associated with coupon payments, forward contracts were bought to fully hedge the coupons. The forward purchases fixed the dollar value of the coupons. Since issuers such as Sallie Mae and Fannie Mae had little use for fixed-rate funds, the converted dollar coupons were swapped into floating-rate dollars. Finally, the foreign currency issue amount and the obligation to pay the dollar principal redemption amount were swapped for cash. Therefore, the dual-currency bond could be converted into floating-rate funds by three transactions.

We now turn to value the Fannie Mae dual-currency bond by reconstructing these transactions. By doing this, we will create a portfolio of yen and dollar cash flows that duplicate the dual-currency bond cash flows. This duplicating portfolio will allow us to determine an implied market value for the bond and the all-inclusive cost of funds associated with the Fannie Mae dual-currency bond.

The Terms of the Fannie Mae Dual-Currency Bond Issue

Nomura International Limited was the lead-manager of the syndicate that issued the Fannie Mae dual-currency bonds on November 1, 1985. The bonds mature in 1995. The coupon rate of this ten-year issue was set at 8 percent, payable in yen. However, the principal will be redeemed on the maturity date in dollars. The issue price was set at 101 percent of the issue amount, which means that the investor paid ¥101,000 for each ¥100,000 par value bond. Therefore, ¥40.4 billion were received from the issue. At the .004769 $/¥ spot price, this was $192,656,175.

Since the issue amount was ¥40 billion and the principal repayment amount at maturity date was US$217,360,000, the implied redemption exchange rate was 184.0265 $/¥. A higher redemption rate would have meant that investors would receive fewer dollars in principal at maturity. Once the redemption rate was set and the bonds were issued, investors benefited from a stronger yen for the coupon payments and a stronger dollar for the principal repayment. As the bond moves closer to maturity, the investors would more and more prefer a strong dollar. After the last coupon payment, they would hold dollar risk only in the form of a dollar zero-coupon issue.

Duplicating Portfolio of the Dual-Currency Bond

The two sides to the exchange rate risk manifest in the dual-currency issue lead us to value it in two parts. The coupon component can be valued as a straight yen annuity. The dollar principal repayment can be analyzed separately as a dollar zero-coupon bond. The summed value of these two positions must equal the value of the dual-currency bond or an arbitrage opportunity will exist.

The coupon component of the dual-currency bond was equal to a ten-year annuity paying .08 (¥40 billion), or ¥3.2 billion, each period. The principal redemption was equal to a zero-coupon bond paying $217,360,000 at maturity. We will now seek to value these component parts of the dual-currency bond and infer its all-inclusive cost of funds.

From this issue, Fannie Mae initially received yen for the promise to pay both annual yen coupon for ten years and dollar principal. Since Fannie Mae had no use for yen and certainly did not want to be paying yen interest, they sold the yen from the issue spot for $192,652,175 and did something to eliminate the exchange rate risk of the yen interest payments. The hedging of this risk could have been done with long-term forward contracts. After hedging the yen interest payments, they could have issued the equivalent of a long-term Eurodollar bond. If the fair market value of this equivalent bond was less than the value of the yen they received from the issue, then this would be an "arbitrage" opportunity. However, an additional opportunity existed for Fannie Mae in the dollar redemption amount. Like yen coupon payment risk, they had no desire to bear the long-term redemption risk. A potential buyer of this obligation would be a Japanese trading firm with dollars in the future that did not have other opportunities to lay off its risk. Given its view of the dollar/¥ rate, a potential gain might come from transferring the dollar redemption risk to this firm for a current payment in yen. Therefore, the equivalent Eurodollar bond created by hedging the yen coupon payments has two value components: the dollar annuity related to the yen interest payments when hedged with forward contracts and a Eurodollar zero-coupon bond for the dollar principal redemption amount.

Value of the Dual-Currency Bond

Value of the Yen Interest Payments. Fannie Mae would have hedged its ¥3.2 billion annual interest payments forward. This fact will allow us to translate the yen payments into dollars, which can be discounted at an appropriate rate to determine the value of the annuity. Fannie Mae had access to Eurorates similar to the rates presented in table 2-2. Based on covered interest rate parity, Fannie Mae would have been able to hedge at forward prices similar to those depicted in figure 2-2. We assume that they hedged their yen coupon payments at these forward prices. Table 2-3 lists the forward prices and resultant dollar coupon values related to these transactions (third and fourth columns, respectively). The fourth column of table 2-3 also contains the dollar issue cash amount received, the redemption principal amount, and the all-inclusive cost of funds on all of these dollar cash flows from the bond issue.
Table 2-3
Value of the Yen Interest Payments Associated with the Fannie Mae Dual-Currency Bond Issue, November 1, 1985

<table>
<thead>
<tr>
<th>Date</th>
<th>Yen Payments (millions)</th>
<th>Spot or Forward</th>
<th>Dollar In/Outflow (millions)</th>
<th>Eurodollar Rate</th>
<th>Cash Flow Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-85</td>
<td>-3200</td>
<td>209.70</td>
<td>192.65620</td>
<td>14.2542</td>
<td></td>
</tr>
<tr>
<td>Nov-85</td>
<td>-3200</td>
<td>207.40</td>
<td>13.4912</td>
<td>8.1300</td>
<td>-14.2542</td>
</tr>
<tr>
<td>Nov-87</td>
<td>-3200</td>
<td>199.74</td>
<td>16.0292</td>
<td>9.3187</td>
<td>-13.4000</td>
</tr>
<tr>
<td>Nov-88</td>
<td>-3200</td>
<td>190.30</td>
<td>16.81544</td>
<td>10.2818</td>
<td>-12.5337</td>
</tr>
<tr>
<td>Nov-89</td>
<td>-3200</td>
<td>185.74</td>
<td>17.22849</td>
<td>10.2026</td>
<td>-11.6779</td>
</tr>
<tr>
<td>Nov-90</td>
<td>-3200</td>
<td>176.37</td>
<td>18.14369</td>
<td>10.7624</td>
<td>-10.8803</td>
</tr>
<tr>
<td>Nov-91</td>
<td>-3200</td>
<td>169.23</td>
<td>18.90931</td>
<td>10.8931</td>
<td>-10.1769</td>
</tr>
<tr>
<td>Nov-93</td>
<td>-3200</td>
<td>157.69</td>
<td>20.29302</td>
<td>10.8166</td>
<td>-8.9179</td>
</tr>
<tr>
<td>Nov-94</td>
<td>-3200</td>
<td>152.13</td>
<td>21.03400</td>
<td>10.7670</td>
<td>-8.3750</td>
</tr>
<tr>
<td>Nov-95</td>
<td>-3200</td>
<td>147.29</td>
<td>21.72618</td>
<td>10.9409</td>
<td>-7.6881</td>
</tr>
<tr>
<td>Nov-95</td>
<td>-4000</td>
<td>147.29</td>
<td>217.36000</td>
<td></td>
<td>-107.4823</td>
</tr>
</tbody>
</table>

Net present value of coupons: $107,4823
All-inclusive cost of funds: 10.1166

We see that the all-inclusive cost of funds of 10.12 percent was below Fannie Mae's benchmark Eurodollar bond alternative of 10.7 percent.

The last two columns of table 2-3 report the Eurodollar interest rates appropriate for discounting each future dollar payment. The present values of the payments when discounted at these rates and the present value of the coupon payments are also reported. The present value of the coupon payments is the value of the coupon annuity component of the Fannie Mae dual-currency bond.

Value of the Principal Redemption Amount. We can value the dollar principal redemption amount in two ways. The first is to find the appropriate discount rate for these dollars and to discount the $217,360,000 redemption principal at this rate. Then, if Fannie Mae could somehow have gotten out of this obligation for less than the present value of the principal, they would have profited.

To determine the appropriate discount rate, we look to table 2-1 for Eurodollar zero-coupon issue rates. Since Fannie Mae was of roughly the same risk class as the firms listed, we infer that an 11 percent rate might have been reasonable for them. The present value of the principal repayment was

$76,959,595 = \frac{217,360,000}{(1.11)^{10}}$

Therefore, Fannie Mae effectively received the cash issue amount, $192,656,175, less the value of the redemption principal for the yen coupon annuity portion of one issue. Thus, they received $115,696,580 for an annuity that we have valued to be worth $107,482,300, so they effectively made $8,214,280 on the issue.

However, it turns out Fannie Mae may have done better than this. If Fannie Mae was able to pay some party less than $76,959,595 to take on the obligation to pay $217,360,000 after ten years, they profited even more. It appears that they actually did this by selling both the proceeds of the issue, Y40.4 billion, and the obligation to repay the principal, Y40 billion, to a Japanese trading firm. This was a currency swap (see Crabbe, 1985). (We thank M. Yasuda for helpful discussions on this point.)

The Japanese swap counterparty was certainly more bullish on the yen than is implied by the redemption rate of 184.05, and it was potentially more bullish than the 147.3 forward price.

To analyze the opportunities provided by such a swap counterparty, we have generated the current dollar payment that would have to be made to the counterparty to leave the dollar redemption liability constant based on its view of the yen in ten years. For example, if the counterparty felt that the yen would be 140 to the dollar, its yen cost would only be 140/147.3 percent of its cost at the forward price. This potential "saving" would result in Fannie Mae's having to pay the counterparty fewer yen and, hence, fewer dollars out of the issue amount. The yen payment amount is calculated by discounting back the yen redemption amount at the ten-year Euroyen zero-coupon rate of 6.95 percent. The yen present value of this amount is translated into dollars at the spot price. Table 2-4 presents our estimates of these payments. For example, if Fannie Mae sold the 40.4 billion spot yen for $192,656,175, and if they sold

Table 2-4
Potential Payment Based on Bullish Japanese View of Yen Cost of $217,360,000 Principal Repayment

<table>
<thead>
<tr>
<th>Spot Yen 11/1/85</th>
<th>Equivalent Principal</th>
<th>All-Inclusive Funds Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>-66195.65</td>
<td>7.12</td>
</tr>
<tr>
<td>130</td>
<td>-68843.48</td>
<td>7.55</td>
</tr>
<tr>
<td>135</td>
<td>-71491.31</td>
<td>8.00</td>
</tr>
<tr>
<td>140</td>
<td>-74139.13</td>
<td>8.46</td>
</tr>
<tr>
<td>145</td>
<td>-76786.96</td>
<td>8.94</td>
</tr>
<tr>
<td>150</td>
<td>-79434.79</td>
<td>9.44</td>
</tr>
<tr>
<td>155</td>
<td>-82082.61</td>
<td>9.95</td>
</tr>
<tr>
<td>160</td>
<td>-84730.44</td>
<td>10.48</td>
</tr>
<tr>
<td>165</td>
<td>-87378.26</td>
<td>11.04</td>
</tr>
<tr>
<td>170</td>
<td>-90026.09</td>
<td>11.61</td>
</tr>
<tr>
<td>175</td>
<td>-92673.92</td>
<td>12.21</td>
</tr>
</tbody>
</table>
the obligation to pay the redemption amount for $74,000,000 to a Japanese corporation that was bullish on the yen, their net was $118,656,175 as opposed to $115,696,580. Then their "profit" would have risen from $8,214,280 to $11,173,875. By splitting up the dual currency into parts, Fannie Mae may have done quite well.

All-Inclusive Cost of Funds on the Dual-Currency Issue

The all-inclusive cost of funds on the dual-currency issue is the internal rate of return on the cash flows made. Table 2-4 presents the estimates of these rates as a function of the unknown redemption principal swap rate. The all-inclusive cost of funds is quite sensitive to this swap rate, as can be seen clearly in figure 2-3.

Based on these values, we see that Fannie Mae would have reduced its borrowing cost by an additional 1.04 percent at a redemption rate of 150. Given the ten-year yen/dollar forward price, this swap may have been feasible. The ability to buy out of the yen principal redemption risk at low cost could have lowered the all-inclusive cost of funds below the 10.12 percent that we calculated without considering this opportunity.

Finally, Fannie Mae needed to swap the fixed-rate interest payments into floating-rate payments. This held out the possibility of further lowering their all-inclusive cost of funds.

We are left with the question of how this could occur. Our discussion of the institutional characteristics of this market leads to a potential explanation. Basically, the Japanese Ministry of Finance strictly regulates the Japanese financial markets. Some foreign firms, such as Sallie Mae and Fannie Mae, were able to gain access to this market, and it appears that they may have reaped some significant gains from this access. Nonetheless, we must remember that all of these swaps faced both credit risk and sovereign risk. To the extent that these issues bore increased portions of these risks, the gains may not have been as great as they appear at first glance.

Sallie Mae ICON Value and All-Inclusive Cost of Funds

Just as we did for the Fannie Mae dual-currency bond, we will attempt to value the Sallie Mae ICON as the sum of its parts. We split the ICON into its straight Eurodollar bond and currency option components. We then value these components separately. The Eurodollar bond can be valued easily relative to its traded comparables (see French, 1985). However, the ten-year currency options that Sallie Mae received from investors at the time of issue are more problematic. We will try to value these options carefully as an example of our proposed method and as an illustration of some of the problems inherent in its use. For those not interested in such detail, the discussion of the all-inclusive cost of funds later in this section may be of more interest.

Redemption Principal Sensitivity to the Value of the Yen

The option component of the ICON would have value at maturity only if the dollar costs less than ¥169 at maturity, or ¥1 = $0.0059176. In that case, the principal repayment would be less than the face amount of each bond, $1,000. However, the issuer contracted that the principal paid would fall with the value of the yen, until the yen reached 84.5 to the dollar. At that point, the repayment of the principal would be zero. This principal repayment option can be directly related to two yen-denominated European call options.

If the yen was between ¥169/$ (or Y1 = $0.0059176) and ¥84.5/$ (or Y1 = $0.0118343), the principal repayment, PR, would be:

\[ PR = \left(1 - \frac{169}{Y/Y} \right) \times \text{face amount} \]

or, in dollars:

Figure 2-3. Selling $217,360,000 Redemption Amount: Effect on All-Inclusive Cost of Funds
\[ PR = \left[ 1 - \left( \frac{\$/Y}{169} \times \frac{169}{\$/Y} \right) \right] \times \text{face amount} \]

\[ PR = \left[ 1 - \frac{\$/Y - 0.0059176}{0.0059176} \right] \times \text{face amount} \]

Therefore,

principal repayment \(=\) face amount \(-\) \([\$/Y - 1/169] \times \text{face amount} \times 169\]

where \([\$/Y - 1/169]\) is the intrinsic value of one call option and face amount \(\times 169\) is the number of call options at the exercise price \(Y_{169} = 1\). Thus, each $1,000 bond bought was to be related to 169,000 yen call options.

Based on the full range of values for the yen at the maturity of the ICON, the principal payments promised to investors were as follows:

1. If \(1 > Y_{169} \Rightarrow \$/Y < 0.0059176\), then the investor would get the face amount at maturity. (As a result, Sallie Mae would have an option that is worth nothing.)
2. If \(Y_{84.5} < 1 < Y_{169} \Rightarrow 0.0118343 < \$/Y < 0.0059176\), then the investor would get at maturity: face amount \(-\) \([\$/Y - 0.0059176] \times \text{face amount} \times 169\), which is equal to the value of the .0059176 exercise price call option at maturity.
3. If \(1 < Y_{84.5} \leq 0 \Rightarrow \$/Y > 0.0118343\), the investor would get back no principal at all.

**ICON Cash Flow Duplicating Portfolio**

We can see that the ICON is closely related to a straight bond and option-like positions. It will turn out that the cash flows at maturity for one $1,000 ICON could be exactly duplicated by a portfolio made up by buying a $1,000 straight bond with the same coupon (10.5 percent) as the ICON; selling 169,000 yen calls with ten-year maturity and $0.0059176 \$/Y exercise price; and buying 169,000 yen calls with ten-year maturity and $0.0118343 \$/Y exercise price. We will show this graphically by first plotting the cash flows for the three parts of the ICON separately and then plotting the combined portfolio maturity cash flow, which is also the ICON cash flow.

Figure 2-4 depicts the cash flow received at maturity for a straight Euro-dollar bond paying a coupon of 10.5 percent. This bond would actually yield 10.79 percent, since it was priced at a slight discount and had biannual interest payments. We can see that the cash flow received from this bond at maturity was unaffected by the yen/dollar exchange rate.

Figure 2-4. Straight Bond Principal Repayment at Maturity, Given Yen/$ Rate

Figure 2-5 shows the cash flow that would be paid at maturity by selling 169,000 yen calls with an exercise price of $0.0059176 and ten-year maturity. By selling one of these options, the writer of the options gave the option buyer the right to buy a yen for $0.0059176 (Y_{169} = 1). If the yen were 180 to the dollar at maturity, a yen would cost $0.055556. The right to buy it at $0.0059176 would be worth nothing in this eventuality. A total of 169,000 such options would also be worth nothing if Y_{180} equal $1 at maturity. This set of potential payments is depicted in figure 2-5. In fact, for all values of the yen at maturity less than $.0059176, the calls would be worthless. A $1/Y price less than $.0059176 corresponds to a Y/$ price greater than 169. However, consider what would happen if $1 were equal to Y_{150} at maturity. A yen could be bought for $.0059176 by exercising the call. The yen would be worth $.0066667. Therefore, a profit of $.0007495 would be realized on each of the 169,000 call options, or a total of $126,6667. As the yen increased in value, the number of yen it would take to buy a dollar would fall and the options would be worth more. At an exchange rate of Y_{84.5} to the dollar, or $0.0118343, a call is worth $.0059172. The 169,000 calls associated with one bond would be worth $1,000. As the yen increased beyond this level at maturity, the options would be more valuable. However, bond buyers are protected from losses associated with Y/$ prices below 84.5. At worst, they can lose only the ICON face value amount. To adjust the cash flows associated with the
ICON at its maturity to account for this maximum loss, we can insure bond buyers against these losses. Since an 84.5 Y/$ price equals a .0118343 $/Y price, a .0118343 exercise price yen European call option will provide the required protection.

Figure 2-6 depicts the cash flows received by the owner of 169,000 yen calls with an exercise price of $.0118343, or Y84.5/$. If the yen were below this value at maturity, the options expire worthless. At higher values, they would be worth their intrinsic value, 169,000($/Y - $.0118343).

Figure 2-7 shows the net cash flow at maturity from all three of these positions. Looking at these cash flows, we can see that they are exactly the same as those defined for the ICON. At all values of the yen below $.0059176 (Y169/$), the ICON would pay the full $1,000 in principal. In the matching portfolio, the straight bond would provide this and the call options would all expire worthless. For values of the yen between $.0059176 (Y169/$) and $.0118343 (Y84.5/$) the ICON would pay declining principal equal to $1,000 - ($/Y - $.0059176) × 169,000. This cash flow would also be received by the purchaser of a $1,000 bond that had simultaneously sold 169,000 yen calls with an exercise price of $.0059176. Therefore, at yen values below $.0118343, we see that the straight bond and sold option portfolio cash flow did match the ICON cash flow.
At values of the yen above $0.0118343, the owner of the ICON would receive no principal but would also pay out no cash. The owner of the $1,000 straight bond that also sold 169,000 $0.0059176 exercise price yen calls would pay out cash in these eventualities. However, if this investor purchased 169,000 $0.0118343 exercise price calls as insurance against large losses, these options would appreciate in value to directly compensate the loss on the $0.0059176 exercise price calls in this range of exchange rates. By buying 169,000 of the $0.0118343 exercise price calls—the straight bond—and selling 169,000 $0.0059176 exercise price calls, no net cash would change hands at maturity for high values of the yen. This three-asset portfolio cash flow matched the ICON maturity cash flow. Furthermore, if the straight bond had the same coupon as the ICON, the two positions were equivalent. The only major potential complication for this type of analysis is asymmetric tax treatment for the issues. Though it was not in place in 1985, one example is the foreign currency bond income tax loss provision for capital losses in Japan.

We will now see whether the price paid by investors for the ICON is above, below, or equal to the sum of its parts. Since the value of the straight bond component can be inferred from close substitutes in the Eurobond market, we will analyze the option values in depth. To do this we will first review some basic results in pricing currency options (see Bodurtha & Cour- tadon, 1986, 1987).

Pricing the ICON Option Component

Call Option Pricing Formula. The purpose of this section is to review the models generally used to value European currency options. Our discussion will focus on the Black-Scholes approach and similar approaches to European call option valuation.

The original Black-Scholes option pricing model cannot be applied here, since it assumes that the underlying deliverable instrument is a non-dividend-paying asset. In our case, the underlying deliverable instrument is a foreign currency that pays interest daily as its "dividend." The term European option means that the option can be exercised only at maturity; it has nothing to do with where it is traded. The parameters associated with valuation of a currency option are as follows:

\[ S = \text{spot price of the deliverable currency (domestic units per foreign unit)} \]
\[ F = \text{forward price of the currency delivered at option maturity} \]
\[ X = \text{exercise price of option (domestic units per foreign unit)} \]
\[ T = \text{time remaining until maturity} \]

\[ r_D = \text{domestic (riskless) interest rate} \]
\[ r_F = \text{foreign (riskless) interest rate} \]
\[ \sigma = \text{volatility of the spot currency price} \]
\[ N(.) = \text{cumulative normal distribution function} \]

Garman and Kohlhagen (1983) derived the following option pricing formula for European spot foreign exchange call options:

\[ G(S, T) = e^{-r_F T} N(x + \sigma \sqrt{T}) - e^{-r_D T} N(x) \]

where

\[ x = \frac{\ln(S/X) + (r_D - r_F - (\sigma^2/2)) T}{\sigma \sqrt{T}} \]

This formula is the same as the Black-Scholes model for the case when \( r_F \) is zero. Of additional interest to us are the partial derivatives of this formula. They help in understanding what the effect on the value of the option will be if one parameter is changed but all the others remain the same. Before stating each of these partial derivatives, we will relate the intuition behind the effects of parameter changes on the value of the European call options.

Sensitivity of the Call Option Value To Parameter Changes.

Sensitivity to Volatility Changes. The volatility, \( \sigma \), of a currency is by definition the standard deviation of the change in the natural logarithm of the spot price of the currency over a given time. Under the assumptions of the option pricing model, the volatility is the standard deviation of the rate of return on holding the currency.

Therefore, an increase in the volatility should lead to an increase in the call option value. This is because more risk means that the currency is more likely to be much higher or much lower. Since the magnitude of decreases in value below the exercise price are all worth zero to the call buyer, more risk only increases the range of potential profits. This increased profit range means that the call options are more valuable if the underlying currency is riskier. The definition of the partial derivative of the call option value with respect to the volatility is as follows:

\[ \frac{\partial G}{\partial \sigma} = -e^{-r_F T} X N'(x) > 0 \]

Sensitivity to Changes in the Spot and Exercise Prices. The exercise price is the value of the currency at which the option can be exercised. Since the owner
of a call will receive $S - X$ at maturity, a higher spot price, $S$, or a lower exercise price, $X$, means more money at maturity. Hence lower (higher) spot (exercise) prices lower the call options value. Call options with a high spot price relative to the exercise price are termed "in the money." Prices of options that are in the money tend to move directly with the price of the underlying currency. This comovement is measured by the hedge ratio. Theoretically, if you buy an option and continuously borrow the foreign currency in an amount equal to the changing hedge ratio, your position should be riskless. Hedge ratios on currency options are always below one. When interest rates are not too different on the currencies, a high spot price to exercise price ratio means that the buyer of a call will have a hedge ratio. Effectively, when the hedge ratio is adjusted for the interest rate differential, it indicates how close a substitute the option is to an investment in the underlying currency with the same maturity as the option. The call option hedge ratio is defined as follows:

$$\frac{\partial C}{\partial S} = e^{-rT}N(x + \sigma \sqrt{T}) > 0$$

The definition of the partial derivative of the option value with respect to the exercise price is as follows:

$$\frac{\partial C}{\partial X} = -e^{-rT}N(x) < 0$$

**Sensitivity to Changes in Interest Rates.** A call option can be hedged because it is possible to take specific positions of foreign currency lending and domestic currency borrowing that duplicate the option cash flows. When this hedge portfolio is created, it can be bought or sold against the option. To avoid arbitrage, both the hedge portfolio and the option must have the same price. Therefore, to duplicate a call, you borrow the present value of the exercise price and buy spot to invest. At high domestic interest rates, the amount that must be borrowed to cover the potential exercise price payment at maturity is relatively low. Hence, a call option is worth more when domestic interest rates are high. However, buyers of a call do not benefit from the interest paid on an investment in the foreign currency. This relative loss is obviously greater the higher the level of foreign interest rates. Therefore, as foreign interest rates rise, call option values fall. The partial derivatives of the call option value with respect to U.S. and foreign interest rates are as follows:

$$\frac{\partial C}{\partial r_d} = T e^{-mT}KN(x) > 0$$

$$\frac{\partial C}{\partial r_f} = -T e^{-rT}SN(x + \sigma \sqrt{T}) < 0$$

**Determination of the Yen Volatility.** To estimate the value of the call options related to the Sallie Mae ICON, we can use the currency option pricing model. The required inputs are the option model parameters mentioned in the preceding section, adapted for the yen options in the Sallie Mae ICON. All of these parameters, except the volatility of the yen, are given either as contract terms or as market prices that can easily be found in financial newspapers.

The volatility of the yen is of central importance to our analysis. Estimates of the yen volatility may be done on a historical or implied basis. Estimates of historical volatility are based on the history of spot, forward, and futures prices, whereas implied volatility is derived from an option or a set of option prices. Therefore, the implied volatility reflects the option market's implicit estimate of the yen volatility. It is important to know these two estimates in order to evaluate and manage risk.

**Historical Estimates of the Yen Volatility.** Calculation of historical volatilities from the history of yen prices is straightforward. We take the natural logarithm of prices and subtract the last price from the current price. We then calculate the volatility, or standard deviation, of this series. Algebraically, $\sigma = \sqrt{\frac{1}{n} \sum_{i=2}^{T} (R_i - \bar{R})^2}$:

$$\sigma = \sqrt{\frac{1}{T-1} \sum_{i=2}^{T} (R_i - \bar{R})^2}$$

where

$$R_i = \ln \left( \frac{S_i}{S_{i-1}} \right)$$

$$\bar{R} = \frac{1}{T} \sum_{i=1}^{T} R_i$$

We can calculate a variance for spot and forward prices. Theoretically, it is better to use the forward price volatility since it incorporates interest rate changes. Grabbe's (1983) derivation of the European currency option pricing model with interest rate risk highlights this fact. We have the following sample volatilities based on daily data from Citibank. (A daily volatility is adjusted to an annual volatility by multiplying daily volatility by the square root of the number of calendar days or business days in the year. We adjusted by the number of calendar days.)

<table>
<thead>
<tr>
<th>Period</th>
<th>Spot</th>
<th>6 Months Forward</th>
<th>1 Year Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/75-11/85</td>
<td>11.607</td>
<td>12.35</td>
<td>N/A</td>
</tr>
</tbody>
</table>

We now turn to obtain estimates of the market's implicit volatility estimate.
Implied Volatility Estimation. The implied volatility conveys the market’s most current assessment of risk over the life of the traded options. In addition, the use of an implied volatility estimate will partially correct for biases in option pricing models.

The option contract terms and its price, spot price, and interest rates can be used to derive an implied option volatility. Our data sources are the Philadelphia Stock Exchange (PHLX) for the option-related inputs and the Wall Street Journal for the interest rates.

On November 1, 1985, the December 13, 1985, maturity PHLX currency options were traded and priced as follows:

\[ C(X = 0.0048) = 0.00074 \]
\[ C(X = 0.0047) = 0.000128 \]

The Eurodollar rate is used as the short-term U.S. interest rate because this rate should be the cost of funds for the low-cost market participant engaged in hedging an options position. Of course, this rate should be quoted for funds matching the option maturity. Another alternative is to use the rate on the U.S. Treasury-bill that delivers cash at the same time the options do. As the PHLX options from which our implied volatility will be calculated had roughly one and a half months to maturity, the relevant one-month and two-month Eurodollar rates were 8 percent bid and 8½ percent offered. Therefore, an average rate of 8¾ percent will be used in our implied volatility calculations. The following yen spot and futures prices prevailed at the time of the option trades:

\[
\begin{align*}
\text{spot} &= 0.004788 \quad (or \quad 1 = \text{Y}208.855) \\
\text{Dec. future} &= 0.004797 \quad (or \quad 1 = \text{Y}208.464)
\end{align*}
\]

As spot currency options mature on the Friday preceding the third Wednesday of their listed maturity month, the PHLX December calls we are analyzing matured on December 13, 1985. On the other hand, futures contracts mature in September, December, March, and June of each year, on the third Wednesday of these months. Therefore, we need to interpolate the futures price for the December 13, 1985, maturity from the spot rate and the December 18, 1985 maturity future. This futures price was 0.00479661. From covered interest rate parity, we imply the forty-two-day Euroyen rate of 6.512 percent.

At this point we have all the necessary inputs to calculate the yen implied volatility. However, there is one remaining complication. The options from which we are calculating the implied volatility were American options, since they were traded on the PHLX. European options were traded only on the Chicago Board Options Exchange (CBOE). Therefore, we will infer the implied volatility from an American option pricing model. For the PHLX \( C(X = 0.0048) \), the implied volatility estimate was 0.12; for the \( C(X = 0.0047) \), the estimate was 0.11 (see Financial Labs, 1986).

The Impact of Volatility on the ICON Value. Volatility is the one unknown in the option pricing model. Therefore, we will examine the sensitivity of the value of the option component in the ICON to changes in the volatility estimate. This analysis is presented in figure 2-8. We can see that the combined value of the two options was relatively insensitive to the level of volatility. This is because the yen forward price of 147.3 implies that the 169 exercise price call that was sold to the issuer by the buyers of the bond was already quite valuable. Relative to the forward price, this call option was already deep in the money. Hence, its value was not sensitive to volatility. Similarly, the 84.5 exercise price option, which served as the ICON buyers’ insurance against losing more than the bonds’ redemption principal, was worth nothing at low levels of volatility and compensated for any increases in the value of the 169 exercise price call at the range of volatilities that we have estimated. As a result, the combined value of the ICON currency option component was relatively insensitive to the volatility level. It was worth between $80 and $90 per $1,000 ICON issued. We now turn to determine the all-inclusive cost of funds of the issue based on these price estimates.

![Figure 2-8. Option Position Value Analysis](image-url)
### Table 2-5
**Pricing Analysis for the Sallie Mae ICON Issue**

<table>
<thead>
<tr>
<th>Date</th>
<th>Straight Bond IRR</th>
<th>Straight Bond NPV</th>
<th>ICON IRR</th>
<th>Cash Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-85</td>
<td>976.0</td>
<td>976.0</td>
<td>48.0</td>
<td>Options value</td>
</tr>
<tr>
<td>Nov-85</td>
<td>-52.5</td>
<td>-50.522</td>
<td>-52.5</td>
<td>Total issue value</td>
</tr>
<tr>
<td>May-86</td>
<td>-52.5</td>
<td>-48.502</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-87</td>
<td>-52.5</td>
<td>-46.011</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-88</td>
<td>-52.5</td>
<td>-43.931</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-89</td>
<td>-52.5</td>
<td>-41.478</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-88</td>
<td>-52.5</td>
<td>-39.132</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-89</td>
<td>-52.5</td>
<td>-37.646</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-89</td>
<td>-52.5</td>
<td>-35.586</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-90</td>
<td>-52.5</td>
<td>-33.161</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-90</td>
<td>-52.5</td>
<td>-31.483</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-91</td>
<td>-52.5</td>
<td>-29.463</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-91</td>
<td>-52.5</td>
<td>-28.239</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-92</td>
<td>-52.5</td>
<td>-26.248</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-92</td>
<td>-52.5</td>
<td>-25.927</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-93</td>
<td>-52.5</td>
<td>-24.657</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-93</td>
<td>-52.5</td>
<td>-23.072</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-94</td>
<td>-52.5</td>
<td>-20.763</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-94</td>
<td>-52.5</td>
<td>-20.904</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>May-95</td>
<td>-52.5</td>
<td>-19.355</td>
<td>-52.5</td>
<td></td>
</tr>
<tr>
<td>Nov-95</td>
<td>1052.5</td>
<td>372.442</td>
<td>1052.5</td>
<td>Redemption plus coupon</td>
</tr>
</tbody>
</table>

**Sallie Mae ICON All-Inclusive Cost of Funds**

**Rate of Return on the ICON Investment.** The ICON yield from an investor's point of view can be evaluated by calculating the yield on a comparable straight bond. The second column of table 2-5 shows that the internal rate of return (IRR) on this comparable straight bond was 11.12 percent. Based on our estimate that the comparable bond should have paid roughly 10.7 percent, we can see that the purchaser of the ICON gained the possibility of getting a 0.42 percent higher return as compensation for bearing the exchange rate risk associated with the principal redemption amount. This premium seems quite low, given the yen forward price of 147.3.

**All-Inclusive Cost of Funds Paid by Sallie Mae.** Sallie Mae's point of view was quite different from that of the investors. Issuing the ICON was a potential means to lower their borrowing costs. The fourth column of table 2-5 indicates how this lower cost would have occurred. On each $1,000 bond issued, First Boston paid Sallie Mae the issue amount, $976, and some further compensation for the option not to pay back the full principal redemption amount should the dollar be worth less than ¥169 in ten years. Sallie Mae promised to pay First Boston $1,000 at maturity for each bond. Therefore, First Boston would profit in ten years from the appreciation of the yen by paying the bond holders less than $1,000. Table 2-5 reports the all-inclusive cost of funds on the issue if First Boston paid Sallie Mae only an additional $48 over the $976 issue amount for the option component of the ICON. This estimate is probably too low. Nonetheless, the all-inclusive cost of funds was only 10.37 percent, as opposed to the 10.7 percent required for the straight Eurobond alternative issue.

In the previous section, we estimated the value of the repayment option to be worth between $80 and $90. Based on these values, we have estimated how the all-inclusive cost of funds was affected by volatility. This analysis is presented in figure 2-9. We see that Sallie Mae was likely to have significantly reduced their all-inclusive cost of funds from the ICON issue. A cost of 9.8 percent seems about right. To the extent that First Boston paid them less than the $80 to $90 we have estimated, the costs depicted in figure 2-9 provide a lower bound for Sallie Mae's borrowing costs. However, we will examine one

![Figure 2-9. ICON Cost-of-Funds Analysis](image-url)
two curves in Figure 2-10. We see, in this case, that the all-inclusive cost of funds curves, which are based on 15 percent and 11.5 percent volatilities, cross. The fact that these curves cross implies that a lower level of volatility actually lowers the all-inclusive cost of funds for large yen forward premia. Relatively high Eurodollar rates are the cause of these high yen forward premia. However, at lower forward premia, which correspond to the 9 percent Eurodollar rate, the ICON all-inclusive cost of funds is lower at the 15 percent volatility level than at the 11 percent volatility level.

This phenomenon highlights the fact that when one component of a combined option position is deep in the money relative to the forward price, more volatility is not necessarily a good thing. In the ICON case, a high forward premium on the yen would make the 169 exercise price call relatively deep in the money and the 84.5 exercise price call relatively close to the money. The resulting volatility effect in this case would be more pronounced on the 84.5 exercise price call, which was sold to the investors, than on the 169 exercise price call, which was sold by investors to the issuer. Hence, the ICON would actually be worth less at higher volatility levels. However, it is unlikely that Euroyen rates were as low as 5 percent; moreover Eurodollar rates were not as high as 12 percent. Our analysis of this case only highlights a potential concern for issuers of financial instruments similar to the ICON.

In the end, it seems that a relatively large reduction in Sallie Mae’s all-inclusive cost of funds resulted from the ICON issue. Importantly, any pricing of the credit risk associated with the issue should not have concerned Sallie Mae. Unlike the case of Fannie Mae’s dual-currency bond, no counterparties existed for Sallie Mae on the ICON. Though buyers of the bonds bore Sallie Mae’s credit risk, Sallie Mae bore no additional credit risk. Hence, the all-inclusive cost of funds gains that we have estimated does not seem to have been contaminated by credit risk or sovereign risk. Furthermore, the reduction in Sallie Mae’s all-inclusive cost of funds was independent of any further gains that might have been generated by swapping out of the fixed-rate dollar coupon payments that were associated with the ICON. Though a swap would entail credit risk for Sallie Mae, an even lower all-inclusive cost of funds would appear to have been attainable. The major caveats associated with this view are the potential for fixed or extremely volatile Y/$ exchange rates and the possibility of currency exchange controls that would eliminate the ICON’s hedging cash flows. Though a subjective judgment, it seems that First Boston did fairly well by Sallie Mae.

Conclusion

Putting aside the problems of sovereign and credit risks, we find that Sallie Mae and Fannie Mae lowered their borrowing cost by accessing the international bond market in an innovative manner. We have documented this
savings by constructing portfolios that match the required future cash outflows of the debt instruments issued. Since the cash received for each issue was greater than the cost of the fully hedging comparable, the issues were worth doing. Equivalently, the ability of Sallie Mae and Fannie Mae to sell their complex issues at prices above the duplicating portfolio's value implies that the issues bore a lower all-inclusive cost of funds than their well-known alternatives.

An additional level of risk did exist when one of the hedging transactions for the issues included multiple forward contracts and swaps across national boundaries and corporations. Nonetheless, our introductory analysis of international financial market evolution suggests that the agencies have considered had an international comparative advantage based on flow of funds advantages. Effectively, their comparative advantage was a subsidy granted to them by the governments regulating these markets. To the extent that they could not capture this subsidy directly, the swap mechanism allowed them to capture a portion of the subsidy's implicit value. The swap counterparty then shared in this gain. Since Sallie Mae and Fannie Mae had no use for foreign currency borrowing but could borrow at advantageous rates, our analysis provides a good example of how international market barriers can be overcome. Whether or not the risk was fairly priced cannot be definitely answered. All potential change is impossible to model and price. Nonetheless, the agencies did lower the borrowing costs that we have modeled.

As markets evolve, we expect to see more complex contracts like the ICON issued. Investment banks should have relative expertise in the valuation of these contracts, yielding technical advantages; and during a learning period, they should earn rents on this expertise. Sharing this rent on expertise with their clients is effectively a discounting of their services. Competition suggests that these investment bankers will attempt to stay on the leading edge of the learning curve for these complex issues to derive a greater share of the linked underwriting business and its associated fees. The creation of variable redemption ("Heaven and Hell") bonds, variable redemption dual-currency bonds, international equity and debt warrant bonds, commodity option bonds, note insurance facilities, and many other financing vehicles points to the continuation of this phenomenon (see "How Nomura," 1986). Generally, these innovations will be variants of straight bonds, equity, and options. Therefore, the valuation techniques used in the ICON case can be applied to other issues.

The approach we have taken to the valuation of these complex bond issues is certainly tractable. However, it is important to remember that our use of the all-inclusive cost of funds benchmark for evaluating reduced borrowing costs is subject to the same problems as the internal rate of return method. In cases where problems arise with this method, a direct net present value calculation should be used to determine the cash gain or loss from an issue. Importantly, we have also assumed that no tax advantages or disadvantages exist for the issue or the duplicating portfolio. The implications of this assumption merit further analysis.

Though the methods we have proposed are relatively simple, they may do quite well in practice, relative to more sophisticated "multistate" contingent claims pricing methodologies (see Feigen & Jacquillet, 1982; Stultz, 1982; Magrabe, 1978; Brennan & Schwartz, 1977). Such multistate methodologies attempt to consider and model the interactions of risk from yield curve shifts, credit quality, sovereign restrictions, and exchange rate movements. The multistate methodologies would be most important in valuing options that may be exercised prior to their maturity. The need to model these interactions will be especially great when the price changes of the commodity underlying the option component of the issue are highly correlated with interest rates and the yield on the commodity. In these cases, an attempt could be made to model the interaction in yield curve movements and commodity price movements. However, so much error is likely to exist in the parameter estimates required to define the processes for these rates of change that a carefully constructed and simpler model may work even better. Nonetheless, it is essential that the yield curve, swap rates, and commodity price volatility parameters used to value these claims reflect market prices (see Busc, Hendershot, & Sanders, 1986).

From our analysis of the ICON, we see that a critical determinant of the option values related to the complex claim was the forward price. Though this forward price may be quoted, it will often have to be inferred from interest rates and the yield on the commodity underlying the option component of the issue. We feel that a necessary condition for the development of more option-related bond issues, like the ICON, will be forward claim markets of at least the same maturity as the bonds. These claims may be traded directly or implicitly created, just as forward currency prices are determined by the spot price and two interest rates. Should these markets develop, they are likely to be over-the-counter dealer markets. Exchange markets are likely to offer a smaller set of generic claims for forward delivery of financial claims or other commodities. Many commodity dealers already quote the required forward prices for the development of new complex claims. However, information on these forward prices may not be freely disseminated. In fact, these prices themselves have value. They are a potential source of comparative advantage to some market participants that trade the associated commodities and interest rate claims. The difficulty we had in putting together the data needed to estimate the yen and dollar yield curves for this study is evidence of this estimation problem. For a market participant, access to such data on a timely basis may constitute a significant comparative advantage in pricing and hedging the complex issues. This comparative advantage would be another example of a technical advantage (see "Brokers and Dealers," 1987).

In the end, the approach we have developed can produce only an approxi-
mation to the value of the claims analyzed. Since the contracts we have analyzed have not traded for any period of time, only experience will reveal how good this approximation is. Nonetheless, we feel that the approach is useful because it focuses attention on the value of the option, swap, and forward components of an issue. It appears that these components may have been misvalued by some market participants during the innovation stage of an issue type.

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