JOURNAL OF FINANCIAL INTERMEDIATION 1, 362–384 (1991)

Intermediation and the Market for Interest Rate Swaps*

TIM S. CAMPBELL

Graduate School of Business, University of Southern California, Los Angeles, California 90089

AND

WILLIAM A. KRACAW

Smeal College of Business, Pennsylvania State University, University Park, Pennsylvania 16802

Received November 30, 1990

This paper analyzes the role of financial intermediaries as marketmakers in the market for interest rate swaps. We argue that intermediaries which hold large nontraded portfolios of swaps are efficient alternatives to direct hedging by counterparties in publicly traded cash and futures instruments. The efficiency afforded by the swap marketmaker derives from reduction in transactions costs, diversification of basis risk, and reduced agency costs of debt. The analysis provides an explanation for the existence and success of the swaps market as a means for spreading risk and for its dominance by large financial institutions. *Journal of Economic Literature* Classification Numbers: 020, 310, 520.

I. INTRODUCTION

The market for swaps, principally interest rate swaps, has experienced tremendous growth since its inception in the early 1980s. From a negligible base in 1981, the market grew to an estimated volume in excess of $600 billion in outstanding notional principal in 1989. While the impor-

* We thank Yuk-Shee Chan, Larry Harris, Dave Mauer, David Shimko, the *JFI* editors, and an anonymous referee for helpful comments on earlier versions of this paper. Earlier versions of this paper were completed while Kracaw was at the Krannert School of Management, Purdue University.

1042-9573/91 $3.00

tance of the swaps market is now widely acknowledged, there is still considerable debate regarding the underlying reasons why this market has grown so dramatically. The existing academic literature focuses on the benefits to a swap counterparty from unbundling the timing of interest rate adjustments on its debt from the other terms of the debt, such as the credit risk premium or restrictive covenants.[1] According to this reasoning, a borrower choosing to engage in a swap will share the gain from unbundling in order to induce another counterparty (e.g., another firm) to take the opposite side of the swap. Hence, the swaps market redistributes the gain from unbundling interest rate adjustments on debt, and this redistribution is responsible for the market's growth. We concur that such unbundling will generate demand for efficient hedging of interest risk exposure. We argue that swap marketmakers provide relatively efficient hedging of interest rate and/or exchange rate risk by maintaining private swap portfolios and that the organizational structure of the swaps market has evolved to minimize the information and agency costs inherent in such hedging.

Explanations for swaps often presume that for every counterparty who prefers one position, say to pay fixed and receive floating in a "plain vanilla" swap, there is another counterparty who can be induced to accept the exact opposite or offsetting position. Hence, the swap is essentially a complete trade of positions between counterparties—or a "one-off transaction." An alternative scenario is that the marketmaker executes a swap with one counterparty even though there is no immediate counterparty wanting an offsetting position, and then uses available cash and futures markets to hedge the resulting risk exposure. In its early years, the swaps market could be characterized as one involving largely one-off transactions. But as marketmakers developed their hedging capability, the market increased its capacity to handle transactions which are not immediately offsetting. Our argument pertains to the source of value derived from intermediation in the swaps market when swaps are not one-off transactions.

The essence of our argument is that it is more efficient for individual participants in the swaps market, or counterparties, to trade with marketmakers who hold large portfolios than to hedge their positions "directly" with alternatives like interest rate futures and options. The improved efficiency derives from three major sources, which are discussed in depth later. First, by trading with the marketmaker, counterparties can realize lower transactions costs than if they hedged their positions directly. In this regard, economies are realized in lower fixed setup costs of establish-

[1] See Bicksler and Chen (1986), Brown and Smith (1988), Smith *et al.* (1986), Turnbull (1987), Wall (1989), and Wall and Pringle (1988, 1989).

ing a hedging program and in lower variable costs of executing the appropriate hedge position. Second, counterparties benefit from the reduction in basis risk due to the diversification afforded by the marketmaker's portfolio of swap agreements. It is relatively efficient for marketmakers to hold private portfolios—that is, collections of risks which are not publicly traded—rather than for counterparties to form a mutual fund of risks, since the information costs incurred by counterparties are reduced by the interposition of a marketmaker. Third, the swap intermediary provides an efficient mechanism to reduce agency costs associated with the issuance of fixed-rate debt by counterparties. Our arguments focus on the value added from these sources during the marketmaking process which is characterized by a number of competing intermediaries which hold (non-traded) portfolios of swaps. Throughout our analysis, we take as given that there is a demand for hedging from firms for the benefit of shareholders which makes the swap agreement a viable product for sharing risk.[2]

The paper is organized as follows. Section II contains a brief description of the essential features of the swap market, including a clarification of terms which will facilitate the development of our argument, and a brief summary of the previous "demand-side" arguments regarding the value of the swaps market. Section III contains our analysis of the value of the swaps market. Section IV contains a brief conclusion.

II. OVERVIEW OF THE SWAPS MARKET AND ITS GROWTH

A. *Description of the Swaps Market*

In order to provide a basis for a concise presentation of our argument regarding the role of marketmakers in the swaps market, it is useful to clarify terminology and describe the function of a marketmaker. A swap is

[2] Several lines of reasoning have been pursued in the literature on hedging. The first argument (see Aron, 1988; Campbell and Kracaw, 1987; Smith and Stulz, 1985; Ramakrishnan and Thakor, 1991) relies on the fact that, under optimal contracting between managers and shareholders, managers are less diversified than are shareholders. Hedging or diversification by the firm which reduces the manager's exposure to risk can improve on the optimal compensation contract between the manager and equityholders. This argument may be applied to a firm with any capital structure or any degree of leverage. The other arguments apply to firms which are financed with risky debt. Smith and Stulz show that hedging may be useful in reducing expected bankruptcy costs. They also show, as does MacMinn (1985), that hedging by the firm may reduce the probability that depreciation tax shields may be lost due to financial distress. Additionally, Diamond (1984) demonstrates that monitoring costs may be reduced through diversification. Finally, Campbell and Kracaw (1990) show that hedging at the firm level may also reduce agency costs associated with issuing fixed-rate debt, and DeMarzo and Duffie (1991) show how, when firms have private information about future dividends, financial hedging may be beneficial to uninformed shareholders.

a portfolio of forward contracts. Each forward contract in a swap is implicitly assumed to refer to a contract to pay or receive single cash flows on a specific date. For example, one forward contract within a swap agreement might be to pay LIBOR and receive 10% fixed of notional principal, on a specific date 5 years hence. A 5-year swap would generally involve a sequence of similar forward contracts to pay LIBOR and receive 10% fixed at semiannual intervals over the 5-year period.

The swaps market consists of two types of participants, counterparties and marketmakers. A marketmaker maintains a portfolio of swaps, and hedges the risk of that portfolio in the cash and/or futures markets. It bears any residual risk of the portfolio which cannot be hedged. Counterparties engage in swaps to gain some efficiency in financing their operations or manage some risk while marketmakers seek to generate profit from their swap portfolio. Swaps are executed between counterparties and marketmakers or between marketmakers, but not generally between counterparties. Hence, a swap involves only one counterparty.

Marketmakers provide swaps to counterparties that are tailor-made to suit their needs. For example, a firm may chose to issue short-term debt because it wants the ability to recontract the credit quality spread frequently. But, it also wants to avoid frequent changes in the contract interest rate on the debt. Therefore, this firm seeks a swap that *perfectly* offsets the interest rate exposure associated with short-term debt. This means that the amount and timing of the floating payments it receives on the swap exactly match and offset the amount and timing of its interest obligations on its (sequence of) short-term debt obligations. By undertaking a tailor-made swap, the firm bears no residual risk.

Offsetting swaps are two swaps, each between a counterparty and the marketmaker, where the cash flows received by the marketmaker from one swap provide at least a partial hedge of the cash flows the marketmaker must pay in the second swap. A pair of perfectly offsetting swaps would deliver equal, but opposite, cash flows which match both in amount and timing. A marketmaker may or may not have a portfolio of swaps which are highly offsetting. When swaps are traded on a one-off basis, marketmakers add one swap position to their portfolios only when a matching (opposite) swap can be added as well. A pair of perfectly offsetting swaps are often called "matched swaps." A marketmaker that engages solely in matched swaps functions much like the clearinghouse of a futures exchange.[3] Being interposed between the two sides of a matched

[3] An important implications of the way we have characterized the swap market is that an explanation of why firms utilize swaps need not go so far as to explain why two prospective counterparties might engage in offsetting swaps. Instead, it is necessary to see why swap marketmakers can offer more efficient hedging to firms that choose to unbundle interest rate risk from the credit terms in their debt financing, than those firms can find through other available alternatives.

swap causes the marketmaker to bear no market risk. It must, however, bear the risk associated with default on promised swap payments.[4]

B. Demand-Side Explanations for Unbundling

The most commonly cited reason for the existence and recent proliferation of interest rate swaps is that they allow swap counterparties to "arbitrage" credit quality spread differentials in debt markets and thereby reduce their funding costs.[5] For example, a low-rated borrower that requires long-term fixed-rate funding may find it cheaper to borrow on floating-rate terms and swap floating for fixed, than to borrow on fixed-rate terms. At the same time, a high-rated borrower requiring variable-rate financing may find it cheaper to issue fixed-rate debt and swap fixed for variable, than to issue floating-rate debt. Under this reasoning, an explanation of the swaps market depends directly on how the persistence of quality spread differentials are explained.[6]

Several arguments have been advanced recently to explain why quality spreads could exist. The most commonly cited is that each counterparty to the swap agreement has a comparative advantage in raising funds in a different debt market or for a different maturity.[7] However, Turnbull

[4] Since there is no principal balance involved, the default risk borne by the marketmaker is the market risk associated with holding an unmatched position. When one side of a matched swap defaults, the marketmaker must locate another offsetting counterparty or bear the risk associated with an unmatched position. Default by a swap counterparty will leave the marketmaker exposed to risk temporarily until a similar counterparty can be located or the exposure is hedged in some other way.

[5] See, for example, Bicksler and Chen (1986).

[6] There are other "demand-side" explanations for the existence of swaps which do not depend on quality spread differentials. Arak *et al.* (1987) suggest that a firm may choose short-term debt to exploit inside information that the firm's credit rating may improve in the future, and then swap variable for fixed to hedge the firm against interest rate risk over the longer term. Another view advanced by Smith *et al.* (1986) is that swaps allow arbitrage of differences between tax and regulatory regimes in different countries and provide flexibility regarding future debt and capital structure decisions.

[7] Loeys (1985) argues that short-term debt better protects lenders from unexpected increases in the risk of the borrower's assets. This protection would be relatively more valuable for a lower-rated credit and thus, could lead to differences in the quality spread between low- and high-rated borrowers according to the maturity of the debt. Thus, a low-rated borrower could issue short-term debt, combined with a swap of fixed for floating at a lower cost than it could issue straight fixed-rate debt. However, Wall and Pringle (1989) note, to the extent that the quality spread differential is due to the potential for risk changes, swaps will not allow counterparties to capture the savings. The reason is that as the low-rated borrower reduces its interest rate with short-term debt, the risk borne by equityholders is increased. A concomitant increase in the equity capitalization rate would offset interest savings on debt. Yet another explanation for quality spread differentials is provided by Smith *et al.* (1986). They note that long-term debt may have higher interest rates because of call provisions which give the issuer an option to prepay the debt before maturity. Such options should be more valuable for lower-rated borrowers and hence, a differential between

(1987) and Smith *et al.* (1986) argue that as counterparties exploit the cheaper debt source, prices should adjust such that the credit quality differential is eliminated.[8]

By contrast, Wall (1989) asserts that quality differentials exist because of differences in agency costs associated with issuance of long-term debt. Such agency costs may derive from the "underinvestment problem" discussed by Myers (1977) in which equityholders' incentives to pass up positive net present value investments will increase the ex ante cost of long-term debt. Similarly, agency costs can result from the incentive of equityholders to shift to riskier assets once long-term debt is in place, often referred to as the "asset substitution problem." Anticipation of such incentives results in higher debt costs, ex ante. Wall suggests that the combination of short-term debt (which avoids the agency cost of long-term debt) and an agreement to swap variable for fixed, would allow a borrower to fix funding costs over a long period of time, but avoid the agency costs associated with issuing long-term bonds, per se. This represents a real saving to the swap counterparty—a gain which might be shared with another counterparty to provide the incentive to swap.

III. A SUPPLY-SIDE EXPLANATION FOR SWAPS

In this section we state our case for three sources of efficiency generated by marketmakers in the swaps market. We begin by specifying a

quality spreads is feasible. However, as Smith *et al.* observe, such differentials are not expoitable via interest rate swaps. The reason is that, in an efficient market, the value of the option to prepay should be equal to the value of the difference in interest payment streams. Flannery (1986) and Diamond (1989) examine reasons why different debt maturities may be efficient for high- vs low-quality firms. As explained by Flannery, the process of more frequent reissuance associated with short-term debt may provide a reliable signal to the debt market as to the quality of the issuer's assets. At the same time, long-term debt may provide better internal hedging of asset–liability exposures to interest rate changes. The swap arrangement allows the firm to issue the preferred maturity of debt and to be better hedged against interest rate changes. Titman (1990) also shows how the introduction of interest rate swaps affects the firm's decisions to borrow short term vs long term. A swap market creates a tendency for firms expecting their credit quality to improve to borrow short term and use the swap market to hedge interest rate risk. His model shows that in the absence of a swap market, an increase in interest rate uncertainty can lead firms to substitute long-term financing for short-term financing.

[8] The persistence of a comparative advantage in debt markets to explain the demand for swaps goes against the "law of one price" in that the combination of a cheaper form of debt plus a swap will be equivalent to the alternative form of debt in terms of the timing and nature (fixed vs variable) of the cash flows, but at a lower overall interest rate. Under the law of one price, two systems of indentical cash flows cannot be priced differently in equilibrium. The persistence of such comparitive advantages requires that the bond market is inefficient.

simple model of the swap market which will allow us to succinctly develop our arguments.

A. A Simple Model of the Swap Market

Let the market be composed of n counterparties designated by $i = 1, \ldots, n$, where each counterparty, i, is exposed to a sequence of uncertain future cash flows equal to $C_i(\tau)$, τ periods in the future, where $\tau = 1, \ldots, T$.[9] For example, a company might be committed to a cash payment indexed to LIBOR once per year for 5 years. Then $\tau = 1, \ldots, 5$. Assume there exist $j = 1, \ldots, M$ possible instruments (either futures contracts or cash-market instruments) which can be used to hedge these exposures. Let the price of each such instrument at time t be $x_{j,t}$. Some possible hedge positions may involve futures contracts that mature prior to the date of the exposure they are intended to hedge. A hedging strategy might involve rolling over such contracts. Then the market value of the hedge position on the exposure date will be the accumulated value of the sequence of contracts which have been "rolled." Note that the best hedge will generally depend upon the length of time before the exposure occurs, τ. This may often be simply because many available hedging instruments have shorter maturities than do the exposures that need to be hedged. Hence, a near-dated exposure to a particular source of risk may require a different hedge than a long-dated exposure to the same risk.

Recall that we have assumed that shareholders of the firm derive real benefits from risk reduction for one or more of several reasons previously documented in the literature—e.g., to improve on the optimal compensation contract between managers and shareholders. Given that *some* real benefit to hedging interest rate risk has been identified by the firm, assume that each prospective counterparty seeks to hedge *all* of its risk. Therefore, it seeks to identify a vector of hedge ratios for each of the instruments that may be used to hedge the risk of a specific exposure. The gains from such risk reduction will be referred to as reductions in the "agency costs of bearing risk." Let the set of hedge ratios that minimizes the variance of firm i's exposure at date τ be $B_i(\tau)$, where $B_i(\tau)$ is a $1 \times (M + 1)$ vector of hedge ratios. The minimum-variance hedge position will be the vector of hedge ratios, $B_i(\tau)$, that minimizes the variance of the error term, $e_{i,t}(\tau)$, in the time-series regression

$$C_{i,t}(\tau) = b_{i,0}(\tau) + b_{i,1}(\tau)x_{1,t} + b_{i,2}(\tau)x_{2,t} + \cdots + b_{i,M}(\tau)x_{M,t} + e_{i,t}(\tau)$$

[9] At this point, the cash flows are best viewed as prospective costs, where positive (negative) values indicate payments (receipts) from the perspective of counterparty, i.

or

$$C_{i,t}(\tau) = B_i(\tau)X_t + e_{i,t}(\tau), \tag{1}$$

where X_t is the $(M + 1) \times 1$ vector of prices of cash and futures hedge instruments at time t. We refer to var$[e_{i,t}(\tau)]$ as "basis risk" or residual risk: that which cannot be hedged with available instruments.

For most prospective counterparties, identifying the appropriate hedge is an expensive task. Not only must they acquire knowledge of the general procedure for their entire set of exposure, but they must also acquire the data and generate estimates of the appropriate hedge ratios. Finally, they must monitor any hedges which require rolling over. Assume that each counterparty must incur a fixed setup cost, Q, which we label the cost of becoming informed, in order to identify the minimum-variance hedge of $C_i(\tau)$. This entails estimation of the appropriate vector of hedge ratios for the set of available instruments. Also, assume that the prospective counterparty incurs a variable dollar transactions cost per contract. Let q be the $(M + 1) \times 1$ vector of the variable transactions costs per dollar for each cash and futures instrument,[10] such that a hedge comprised of the vector of hedge ratios, $B_i(\tau)$, would generate a total variable transactions cost of $|B_i(\tau)|q$, where $|B_i(\tau)|$ is the vector of absolute values of the elements of $B_i(\tau)$. Finally, let the function $A_i(\cdot)$ be the cost to counterparty i of bearing unhedged risk. So, $A_i[\text{var } e_i(\tau)]$ is the cost incurred by counterparty i, from bearing the residual risk associated with hedging $C_i(\tau)$, given that a minimum-variance hedge has been identified and implemented. The total cost incurred by the prospective counterparty, if $C_i(\tau)$ is hedged directly, is

$$|B_i(\tau)|q + A_i[\text{var } e_i(\tau)] + Q.$$

Now suppose counterparty i engages in a swap wherein it agrees to swap each $C_i(\tau)$ for a fixed payment $f_i(\tau)$. For simplicity of notation we refer to each such exchange as a swap, so that in our example the counterparty executes T swaps. However, note that the bundle of all T exchanges is generally referred to as a single swap. Assume that all swap contracts are perfectly tailored to fully hedge the risk exposure of the counterparty. Then, the random payment from the marketmaker to counterparty i, τ periods in the future, is $C_i(\tau)$. Let the payment from counterparty i to the marketmaker be fixed at $f_i(\tau)$, so that the net payment from the marketmaker is $C_i(\tau) - f_i(\tau)$. Let $v_i(\tau)$ be the premium in excess of the expectation

[10] Since $B_i(\tau)$ is a $1 \times (M + 1)$ vector with unity as the first element, q is a $(M + 1) \times 1$ vector with zero as the first element.

of $C_i(\tau)$ required by the marketmaker to bear the residual risk associated with $C_i(\tau)$. Then, by definition,[11]

$$f_i(\tau) \equiv E\{C_i(\tau)\} + v_i(\tau).$$

Hence, the counterparty prefers a swap of $C_i(\tau)$ for $f_i(\tau)$ to direct hedging if

$$v_i(\tau) < |B_i(\tau)|q + A_i[\text{var } e_i(\tau)] + Q, \tag{2}$$

or if the premium demanded by the marketmaker is less than the cost of directly bearing the basis risk, plus the fixed and variable transactions costs of identifying and executing the appropriate hedge.

In the remainder of this section we identify three sources of efficiency involved in marketmaking which can lead the marketmaker to offer a premium that satisfies condition (2). Our analysis relies on three additional assumptions:

(i) Each prospective counterparty can observe its own minimum-variance hedge and hence $A_i[\text{var } e_i(\tau)]$ after incurring the cost of becoming informed, Q.

(ii) Each prospective counterparty cannot observe the minimum-variance hedge ratios of other prospective counterparties without incurring the associated setup cost.

(iii) Residual (basis) risks generated by direct hedging are not perfectly positively correlated across all prospective counterparties.

B. Avoidance of Transactions Costs

The first source of gain from engaging in a swap agreement with a marketmaker is that both the fixed and variable transactions costs, which would be incurred in direct hedging of the cash flow risk, can be reduced. Because the swaps marketmaker knows that its hedging technology will be applied to a number of different counterparties, it has an incentive to seek more efficient hedges than would any individual counterparty. This means that a counterparty may be able to obtain a hedge in publicly available instruments which will result in lower basis risk, or lower setup

[11] Note that the usual procedure in a bundle of swaps composed of T individual transactions is to determine a single interest rate, or single value f_i, which determines the fixed payment for all T transactions, whereas we have allowed here for these fixed payments to be unique for each τ. When the "constant f_i" is priced equivalently, the present value of the resulting level fixed-cash flows will be equal to the present value of fixed-cash flows determined by the sequence of T individual $f_i(\tau)$'s. We have chosen our terminology purely to simplify the exposition.

costs, through the intermediary than would be incurred by hedging on its own. Such gains are expected to be larger for counterparties who have cash positions that are less standard—e.g., by the size, timing, and source of the risky cash flows to be hedged.

To formalize this argument, assume that there are n counterparties, each of whom has T cash flows to hedge, so that there are $n \times T$ swaps in the marketmaker's portfolio. Let Q_I be the setup costs, incurred by the marketmaker or intermediary, generated by hedging a portfolio composed of a group of n counterparties. Assume that direct hedging of each counterparty's position has an identical setup cost, Q. We posit that the marketmaker's setup cost is less than the aggregate setup cost of n counterparties, or that $Q_I < nQ$. If the marketmaker spreads its setup costs equally across all counterparties, then their pro-rata share of the marketmaker's cost is less than their own setup cost, or $[Q_I/n] < Q$. As long as there is competition among marketmakers for counterparties' business, at least part of this gain in efficiency will be captured by the counterparties, vis-à-vis the price of the swap, $f_i(\tau)$.

Our argument about the gains from avoiding fixed setup costs is similar to the argument made by Hirshleifer (1988a) with respect to the role of intermediate processors in the commodities market. Hirshleifer contends that growers of commodities often arrange forward contracts with intermediate processors rather than hedging their positions directly in the futures markets in order to avoid the fixed costs of learning about the appropriate futures hedging strategies. Since these fixed costs will differ across growers, those with the lowest fixed costs can be expected to participate directly in the futures markets while those with relatively high transactions costs choose to contract with intermediate processors. The intermediate processor then hedges its combined positions with growers (and any additional positions derived from other activities) in the futures market.

By contracting with a swap marketmaker, counterparties can also reduce the variable transactions costs or brokerage fees incurred in implementing a hedge. This saving arises from the fact that the marketmaker need hedge only the net exposure that results when individual counterparties' exposures are combined in a portfolio, taking account of all "natural hedges" in the portfolio. In terms of the model above, we define a natural hedge to exist between the cash positions of two counterparties, i and h, when at least one corresponding element of B_i and B_h has the opposite sign; i.e., where one counterparty would take a long position in a given hedge instrument, the other counterparty would take a short position in the same instrument. This is to say that their hedgeable risks are, to some extent, mutually offsetting.

The total variable cost incurred by the marketmaker in order to hedge its exposures at date τ, comprised of the combined positions (risks) of n counterparties, is

$$\left|\sum_{i=1}^{n} [B_i(\tau)]\right| q.$$

Here, the hedge ratios of individual counterparties are first offset against each other—taking advantage of natural hedging opportunities—and then multiplied by the vector of per-unit variable costs of hedging, q.[12] If there are any natural hedges, the resulting cost is clearly less than the aggregate cost that would be incurred by all n counterparties if they hedged on their own. In other words,

$$\left|\sum_{i=1}^{n} [B_i(\tau)]\right| q < \sum_{i=1}^{n} [|B_i(\tau)|\ q].$$

The average, or per-counterparty, variable cost incurred by the marketmaker for the exposure at date τ is determined by dividing the left-hand side of the above expression by n. As the degree of internal hedging by the marketmaker increases, the marketmaker's hedge portfolio approaches a collection of perfectly offsetting positions. That is, every element in the marketmaker's vector of optimal hedge ratios, $B_I(\tau)$, would equal 0. No variable cost would be incurred since all of the hedgeable risk is "naturally" hedged.

C. Reduction of Residual (Basis) Risk

The second source of efficiency generated by marketmakers is that they can diversify counterparties' basis risk or residual risk. They will do this more efficiently than other mechanisms, such as publicly trading portfolios of such risks. This is because marketmakers can economize on the information or transactions costs which would otherwise be incurred by prospective counterparties who attempted to take positions in such portfolios. Counterparties will benefit from this reduction in their total risk exposure as long as the agency costs of bearing the residual risks fall accordingly.

Consider the position of two prospective counterparties, i and h, who can either hedge their exposure on their own, or arrange swaps with a

[12] As was the case earlier in the paper, the absolute value signs are used here to indicate that *each element* in the enclosed vector of hedge ratios should be transformed to its absolute value.

marketmaker. For simplicity, let these counterparties comprise the entire prospective swap market. Suppose that each counterparty executes its own minimum-variance hedge and then decides how to rearrange its individual exposure to basis risk in an optimal manner by trading with the other counterparty. The source of diversification gain to the two prospective counterparties in this market is identical to that which arises when equity investors diversify their portfolios in the stock market—i.e., it is beneficial for investors who are concentrated in individual securities to trade, or share risk, at fair prices as long as they receive some of the resulting gain from diversification.

To illustrate the source of this gain more clearly, consider an exchange of basis risk between two counterparties, i and h. Let the variances associated with the basis risks of each counterparty be $\sigma^2(e_i)$ and $\sigma^2(e_h)$, respectively. Then let each counterparty create a portfolio of basis risk comprised of

$$x_i e_i + (1 - x_h)e_h \qquad \text{for counterparty } i$$

and

$$x_h e_h + (1 - x_i)e_i \qquad \text{for counterparty } h,$$

where $0 \leq x \leq 1$; x equals the portion of own basis risk retained by each counterparty; and $1 - x$ equals the portion of the opposite counterparty's risk acquired by each counterparty.

Assume that counterparties agree to exchange equal proportions of their own basis risks, or $x_i = x_h$. Also, assume that the variance of counterparty i's basis risk is larger than that of counterparty h, such that

$$\sigma^2(e_i) = \sigma^2(e_h) + \lambda, \qquad \text{where } \lambda > 0.$$

If the correlation coefficient between e_i and e_h is ρ, the variance of counterparty i's "basis portfolio," $\sigma^2(p_i)$, for a given x_i, is

$$\sigma^2(p_i) = [1 - 2(1 - \rho)(x_i - x_i^2)]\sigma^2(e_h) + [x_i^2 + 2x_i(1 - x_i)\rho\sigma^2(e_h)]\lambda. \tag{3}$$

As long as $\rho < 1.0$, interior values of x_i, $0 < x_i < 1$, will always result in a gain from diversification (as compared to the case where x_i is equal to either 1 or 0) as captured by a reduction in the first term in Eq. (3). Note that in the special case where $\sigma^2(e_i) = \sigma^2(e_h)$, the second term in (3) vanishes since $\lambda = 0$. In this case, diversification unambiguously leads to a reduction in total variance. Otherwise, the second term in (3) shows how the additional risk contained in $\sigma^2(e_i)$, represented by λ, is shared between the two counterparties.

By exchanging basis risk, the counterparty with lower-variance basis risk trades a portion of his own low-variance risk for a portion of the other counterparty's high-variance risk. If the two sources of basis risk are perfectly positively correlated, such transactions would clearly increase the variance of the "low-risk" counterparty's basis portfolio. When basis risks are less than perfectly correlated, those who exchange low-variance basis risk for high-variance basis risk will also benefit from the risk-reducing effect of diversification. The net effect will be to decrease the low-risk counterparty's basis risk if the effect of diversification dominates the effect of substituting low-variance basis risk for high-variance basis risk. In general, it is not possible to say which effect will be larger. However, if each counterparty can costlessly observe the basis risk of the other counterparty, such that the exchange of risk can be priced fairly, then the overall gain from diversification will be shared—i.e., trading of basis risks will be Pareto-optimal.

At first glance, it would seem that a natural way to generate this gain from diversification would be for prospective counterparties to form a mutual fund or a diversified portfolio of basis risk. This is how gains from diversification are usually allocated in securities markets. Diversification in this situation simply means that each counterparty has lower total risk if he holds a share of the diversified portfolio of basis risk rather than if he holds the basis risk resulting from his own minimum-variance hedge. However, the difficulty with utilizing this traditional procedure in the swaps market is that, even after incurring the setup cost required to construct their hedge, counterparties do not observe the basis risks of other counterparties. Since these individual basis risks are not directly observable, the portfolio that the marketmaker constructs is not directly observable by the counterparties either. Hence, any arrangement whereby marketmakers provide pro-rata shares of their portfolio of basis risk to other counterparties would entail substantial information costs for these counterparties.

To formalize this point suppose that, as an alternative to swapping with a marketmaker, prospective counterparties consider hedging on their own account, and then offering their basis risk as a security so that all counterparties might acquire a diversified portfolio, or "mutual fund" of basis risks. Assume that each of n prospective counterparties, whose positions would comprise the portfolio of a specific marketmaker, could observe the basis risks of other counterparties at the same per-unit setup cost incurred when determining its own optimal hedge. This would require that each prospective counterparty incur a cost of nQ and that all counterparties collectively incur a cost of n^2Q. It is apparent that this cost would exceed the setup cost incurred by the intermediary, since $Q_I < nQ$ by assumption. Hence, the cost of observing or screening the positions of other prospective swap counterparties is likely to make it inefficient to form publicly traded portfolios to achieve the benefits of diversification. By contrast, such information costs are not as large in the traditional portfolio or mutual fund of traded securities where the securities themselves are directly observable.[13]

As an alternative, it might also be possible for counterparties to share basis risk by forming a mutual fund under what we might term "greater ignorance," where they could avoid incurring the cost of becoming informed about the other counterparties' positions, but they would know their own optimal hedge position. For example, if the mean residual risk of all counterparties were common knowledge, a price for basis risk could be set which is "fair" ex ante, assuming all prospective counterparties participate in the fund. In these circumstances, such a fund could diversify basis risk as effectively as any intermediary. However, as we noted above, when the variance of residual risk is different across counterparties, those with below-average risks may demand a sharing rule which compensates them to trade their risk into a diversified portfolio. Such trades are Pareto-improving under full information since the risk-sharing rule can be priced fairly.

The successful formation of basis risk portfolios under greater ignorance is subject to a serious limitation. The problem derives from the fact that as long as counterparties privately observe their own basis risk, they will use this information to their own advantage in deciding whether, and under what terms, to participate in a public fund, given any pricing or risk-sharing arrangement for that fund. Low-risk counterparties cannot reliably communicate their true risk to other counterparties without incurring information or screening costs. Therefore an arbitrary sharing rule—say one based on the average attributes of the fund's participants—will be mispriced so as to "undercompensate" low-risk counterparties and "overcompensate" high-risk counterparties, relative to a full-information-sharing rule. If the redistributive effects are severe enough, low-risk counterparties may withdraw from the fund causing the fund to unravel and become dominated by high-risk counterparties. This kind of market breakdown is similar to that described by Akerlof (1970) in the context of the market for used cars. One scenario where this is likely to occur is where there exist *potential* marketmakers who can form sufficiently well-diversified portfolios by attracting low-risk counterparties who might otherwise participate in greater ignorance mutual funds. If the loss associated

[13] See Allen (1990) and the references cited therein for a treatment of screening costs and the theory of intermediation.

with such mispricing is sufficiently great to swamp the benefit derived from improved diversification, low-risk counterparties will withdraw from the fund and switch to a private marketmaker so that the fund will eventually be dominated by counterparties with higher basis risks. The key problem here is that, under any "pooled" sharing arrangement in a public fund, counterparties will use private information regarding their own basis risks to their own advantage in deciding whether to participate in the fund, so that the fund can unravel as in the Akerlof case.

There is, however, an important difference between Akerlof's model and the mutual fund described here. In Akerlof's model, trade never generates a positive externality or surplus. In this paper, by pooling basis risks, trade generates a surplus from the improved risk sharing afforded by diversification. The positive "surplus" from risk sharing could exceed the negative redistributive effects among counterparties due to an arbitrary sharing rule. Thus, it is possible for there to be a risk-sharing rule under which all prospective counterparties choose to participate, even though some (say, low-risk) counterparties get lower expected utility and some get higher expected utilities than under the full-information-sharing rule.

We elaborate on this point with a simple numerical example.[14] Consider two agents, 1 and 2, coming together to form a portfolio. Agent 1 has an asset (call it A_1) that will yield \$80 with probability (w.p.) 0.5 and \$40 w.p. 0.5 at the end of the period. Agent 2 has an asset (call it A_2) that will yield \$120 w.p. 0.5 and zero w.p. 0.5 at the end of the period. Neither agent knows precisely what the other agent has. Agent 2 believes that there is a 0.5 probability that agent 1 has asset A_1 and a 0.5 probability that he has asset B_1, where B_1 yields \$100 w.p. 0.5 and \$20 w.p. 0.5 at the end of the period. Similarly, agent 1 believes that there is a 0.5 probability that agent 2 has asset A_2, and a 0.5 probability that he has asset B_2, where B_2 yields \$240 w.p. 0.25 and zero w.p. 0.75 at the end of the period. Both agents are risk averse with quadratic utility of wealth, w, i.e., $U(w) = (w)^{1/2}$. Assume that the payoffs on the assets of the two agents are uncorrelated. Note that all assets have identical means and *each* agent is endowed with an asset that is superior to (has a lower variance than) the "average" based on the *other* agent's priors.

Define the reservation utility as $\overline{U}_1$ and $\overline{U}_2$, that which each agent could get if no trade took place. Then

$$\overline{U}_1 = 0.5\,(80)^{1/2} + 0.5\,(40)^{1/2} = 7.63$$

$$\overline{U}_2 = 0.5\,(120)^{1/2} = 5.48.$$

[14] We are grateful to Anjan Thakor for guiding us toward this example and the generalization of it that follows.

Now take an arbitrary sharing arrangement in which agents agree to pool their assets in a portfolio from which 60% of the cash flows accrue to agent 1 and 40% accrue to agent 2. Consider agent 1 first. He knows that if agent 2 has asset A_2, then the portfolio cash flow distribution is:

Cash flow	200	160	80	40
Probability	0.25	0.25	0.25	0.25

Since he gets 60% of this, the distribution of the cash flow stream that he gets is:

Cash flow	120	96	48	24
Probability	0.25	0.25	0.25	0.25

Thus, agent 1's expected utility is 8.14. But if agent 2 has asset B_2, then a 60% claim to the portfolio cash flow means that agent 1 has a cash flow stream with the following distribution:

Cash flow	192	168	48	15
Probability	0.125	0.125	0.375	0.375

In this circumstance, agent 1's expected utility is 7.4. Since agent 1's prior belief is that there is a 0.5 probability of getting an expected utility of 8.14 and a 0.5 probability of getting 7.4, his overall expected utility (evaluated with respect to his own priors) is $0.5 \times 8.14 + 0.5 \times 7.4 = 7.77 > \overline{U}_1$, so agent 1 will participate.

Now consider agent 2. He has a 40% claim to the portfolio cash flow. If agent 1 has asset A_1, then agent 2's expected utility is 7.64, and if agent 1 has asset B_1, then agent 2's expected utility is 6.51. Thus, his overall expected utility is $0.5 \times 7.64 + 0.5 \times 6.51 = 7.075 > \overline{U}_2$. Thus, agent 2 will also participate.

Note that, in the example above, the effect of adverse selection is swamped by the benefits of diversification, making it optimal for both agents to participate in the fund. However, this will not always be the case. For instance, if agent 1's prior belief was that the probability that agent 2 has asset B_2 is 0.9, then agent 1 would value his expected utility as $7.474 < \overline{U}_1$, and no trade would occur. The key role of the marketmaker is to eliminate the possibility of no trade.

The effect of the no-trade possibility can be seen by augmenting the example as follows. We previously assumed that the prior beliefs of each agent about the other's type are common knowledge, so that both agents know that trade will occur with the 60–40 sharing rule. But in practice, even that may not be true. Suppose that agent 1 really had the 0.5/0.5

priors about agent 2, but agent 2 believes that the probability is 0.5 that agent 1 will have the 0.5/0.5 (optimistic) priors, and 0.5 that he will have the 0.9/0.1 (pessimistic) priors. Then agent 2 knows that there is a 50% chance that trade will occur and a 50% chance that it will not occur. If agent 2 has to incur a sufficiently high search cost, S, to locate agent 1, he will not search, even though he himself would always benefit from trade.

We formalize this reasoning below. Suppose there are n counterparties coming together to form a fund. Each agent knows his own "type" (the probability distribution of the cash flow stream he brings to the swap transaction), but others do not. Let $E_i = \{e_i\}$ be the set of possible types for agent i, i.e., $e_i \in E_i$, and e_i is the basis risk of agent i. Let ω_K be the sharing rule adopted in the swap transaction, i.e., ω_K describes fully the cash flow stream each agent is entitled to from the total portfolio cash flow. Let $\omega_K \in \Omega$, where Ω is the set of all possible sharing rules. Let U_i be the expected utility of agent i, and $\mathbf{R}$ be the real line. Then

$$U_i\colon \Omega \times E_1 \times E_2 \times \cdots \times E_n \rightarrow \mathbf{R},$$

i.e., $U_i(\omega_K, e_1, e_2, \ldots, e_n)$ is the expected utility agent i would get if $\omega_K \in \Omega$ were chosen as the sharing rule and $(e_1, e_2, \ldots, e_n)$ were the true vector of agent types.

Now define $P_i(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{i-1}, e_i, \varepsilon_{i+1}, \ldots, \varepsilon_n)$ as the (prior) probability, as judged by agent i, that the true vector of agent types is $(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{i-1}, e_i, \varepsilon_{i+1}, \ldots, \varepsilon_n)$ when his own type is e_i. Writing the vector $\bar{\varepsilon} = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_i, \ldots, \varepsilon_n)$, we write

$$\bar{\varepsilon}_{-i} = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{i-1}, \varepsilon_{i+1}, \ldots, \varepsilon_n) \quad \text{and} \quad (\bar{\varepsilon}_{-i}, e_i) = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_{i-1}, e_i, \varepsilon_{i+1}, \ldots, \varepsilon_n).$$

Thus, if a sharing rule ω_K is adopted, agent i judges his expected utility to be

$$Z_i(\omega_K, e_i) = \sum_{(\bar{\varepsilon}_{-i}, e_i) \in E_1 \times \cdots \times E_n} P_i(\bar{\varepsilon}_{-i}, e_i)\, U_i(\omega_K, (\bar{\varepsilon}_{-i}, e_i)).$$

Let $\mathbf{Z}_i$ be the reservation utility of agent i for participating in the fund. Then, for all n agents to participate, for some fixed sharing rule $\omega_K \in \Omega$, we must have

$$Z_i(\omega_K, b_i) \geq \mathbf{Z}_i, \qquad i = 1, \ldots, n. \tag{4}$$

Note that (4) represents a system of n inequalities. Define $\Omega^* = \{\omega_K \mid$ the n inequalities in (4) are satisfied$\}$ as the set of sharing rules for which all agents participate. Then it is possible that for many families of probability distributions $\mathbf{P} = \{P_i(\bar{\varepsilon}_{-i}, e_i) \mid i = 1, \ldots, n\}$, Ω^* is empty.

The important observation is that the $P_i(\bar{\varepsilon}_{-i}, e_i)$ distributions may not be common knowledge. Thus it would be difficult for agents to know if Ω^* will be empty or not and compute the likelihood of trade. With a sufficiently high search cost, it may not pay to search. So the nonintermediated swap market breaks down. The benefit of the marketmaker is that he can learn each agent's true type and then act as an impartial, benevolent arbitrator (given the assumption of competition among marketmakers) to implement the first-best (symmetric information) allocations. Of course, information (setup) costs will be incurred, but these costs will be covered by a sufficiently large surplus generated by trade.

The alternative to the formation of a public mutual fund of basis risks is for swap marketmakers to construct private, or internal, mutual funds and pass on the benefits they generate by demanding fixed prices from counterparties in exchange for streams of payments that offset their risk exposures.[15] This eliminates the unraveling which plagues a public fund. The swap transaction passes on the gains from diversification to the counterparty as long as there is price competition among marketmakers and avoids incurring the information costs that would be generated if the marketmaker's basis portfolio were publicly traded. Moreover, the counterparty can rely on the swap price without determining its own optimal hedge or basis risk, or duplicating the work of the marketmaker.

The counterparties who deal with a competitive marketmaker realize benefits from the reduction in total risk arising from diversification in the form of reduced agency costs. This follows from our assumption that the benefit for a (publicly held) company that is realized from engaging in hedging arises from the agency costs of bearing risk. Let an individual counterparty's pro-rata share of the agency costs at date τ borne by the marketmaker who holds a diversified portfolio of basis risk be defined as $A_I[\text{var } e_I(\tau)]/n$, where $A_I[\text{var } e_I(\tau)]$ represents the marketmaker's agency cost from bearing the risk at date τ. Note that this allows for the possibility that a counterparty and the marketmaker any have *different* agency costs for bearing the *same* risk. Then, our argument about diversification can be summarized as follows: Diversification provided by the marketmaker will be valuable to prospective counterparties as long as

$$A_i[\text{var } e_i(\tau)] > \frac{A_I[\text{var } e_I(\tau)]}{n},$$

[15] This is not the only reason to appoint a middleman to arrange transactions between privately informed and strategically motivated agents. Fershtman *et al.* (1991) show how players in a noncooperative game can gain a strategic advantage by having someone with different incentives (or preferences) play the game on their behalf.

i.e., as long as each counterparty's pro-rata share of the marketmaker's agency cost is less than its own agency cost.

D. *Factors Affecting the Agency Costs of Counterparties versus Swap Marketmakers*

Since we have focused on the role of swap marketmakers in lowering the total agency costs of risk bearing by creating diversified portfolios of basis risk, it is useful to explore why swap marketmakers may have relatively lower agency costs than would many counterparties for bearing any given level of risk.

This focus on the relative agency costs of risk bearing is not entirely new within the literature addressed specifically to the swaps market. Recall from the previous section that Wall (1989) has shown how swaps may be useful in avoiding agency costs of issuing long-term, fixed-rate debt. Some of these costs, specifically those identified with the asset substitution problem, arise because of opportunities for equityholders to increase the risk of the firm's assets after the terms of fixed-rate debt are set.[16] Short-term debt will mitigate the incentive of equityholders' to shift risk since debtholders are in a position to reprice debt more frequently than with long-term debt. Hence, a firm can reduce the agency costs of long-term financing by using a combination of short-term debt and an interest rate swap wherein it pays fixed to receive variable. As a result, agency costs associated with the debt issue are reduced while the swap hedges the variation in the firm's short-term debt cost.

Wall's argument is based on the idea that there exists another counterparty who agrees to take the offsetting position, i.e., receive fixed and pay floating, and this counterparty must fund itself with long-term debt in lieu of the initial firm doing so. Hence, the actual gain from such a one-off swap is the *net* reduction in agency costs accomplished by substituting one firm's borrowing in the long-term market with that of another. Wall's point is that such net gains can be shared between the two counterparties.

However, our argument is that an alternative sharing arrangement is possible whereby the agency costs of the initial counterparty, who prefers to borrow short and swap fixed for floating, are eliminated. The difference is that this counterparty swaps with a marketmaker who does not unwind his position in a one-off fashion with another swap counterparty. Instead, the marketmaker hedges at least part of his side of the swap through the futures market and bears the agency costs associated with the resulting

[16] As formalized in Green (1984), such shifts in asset risk result in wealth transfers from debtholders to equityholders. As a result, when opportunities to shift risk are rationally anticipated by bondholders, debt is priced accordingly and becomes more costly to the firm—perhaps so costly as to exclude otherwise positive net present value projects.

basis risk. Why would the marketmaker be better positioned to manage the agency costs of debt associated with the increase in residual risk?

The first reason is that the marketmaker will generally be able to offset some of its marginal risk against other swaps. That is, some of the (publicly) unhedgable (basis) risk will be eliminated as it is added to the marketmaker's portfolio. Therefore, the amount of total risk borne by the marketmaker will be less than that which would be borne by a prospective counterparty so that, all else the same, the marketmaker would realize lower agency costs.

The second reason derives from the unique nature of the financial structure of many swap intermediaries. For example, commercial banks rely much less on long-term financing like bonds and notes than do other corporate forms. As the agency cost of debt associated with the incentive to shift risk are more pronounced for long-term, as opposed to short-term, debt the marginal contribution of observable risk to agency costs should be less. In addition, a large proportion of bank debt is federally insured. Insured debt will not be penalized by debtholders for potential risk shifting by equityholders, and if such shifts do take place, the FDIC absorbs the consequences under the present system of fixed-premium insurance. Finally, banks have an incentive to organize their swap operations in such a way that the risks borne by the bank through its swap operations are separated from the bank's other investment and financing decisions. This reduces the extent to which decisions about swap risk can be used in concert with financing decisions to expropriate the bank's uninsured creditors. Hence, this limits the agency problems due to risk shifting in the bank's financing arrangements. Such "Chinese walls" have long been argued to be an important part of mechanisms used by financial firms to erect effective barriers to minimize agency costs and thereby lower their costs of providing the marketmaking function. This argument about the value of separating swap operations from a bank's other activities is analogous to the economic rationale for so-called "project financing."[17]

E. *Integration of the Arguments for Swap Intermediation*

The potential sources of efficiency arising from marketmaking in the swaps market are summarized in this section. First, swap marketmakers generate aggregate efficiencies in setup costs for each of the n counterparties in the amount $Q - [Q_I/n]$, or on a per-exposure (τ) basis,

$$\frac{Q}{T} - \frac{Q_I}{nT}.$$

[17] Shah and Thakor (1987) provide a similar economic rationale for project financing which entails organizing marginal projects as entities which are legally distinct from the firm's other assets.

Second, each of n counterparties realizes an average reduction in variable transactions costs for the exposure at date τ due to natural hedges in the swap marketmaker's portfolio equal to

$$|B_i(\tau)|q - \frac{1}{n}\left|\sum_{i=1}^{n} B_i(\tau)\right| q.$$

Third, the diversification of basis risk which is afforded through the marketmaker's portfolio reduces the agency costs of risk bearing, for the exposure occurring at date τ, by $A_i[\text{var } e_i(\tau)] - A_I[\text{var } e_I(\tau)]/n$ for each of the n counterparties. Moreover, swap marketmakers have a strong incentive to organize themselves in such a way that the agency costs they bear from any given level of risk is less than the agency costs borne by prospective counterparties for an equivalent level of risk. The transactions and agency costs incurred under direct vs intermediated hedging, expressed on a per-exposure (τ) basis, are summarized below:

	Direct hedging without the use of swaps	Hedging with intermediated swaps
Fixed setup costs	Q/T	Q_I/nT
Variable transactions costs	$\lvert B_i(\tau)\rvert q$	$\frac{1}{n}\left\lvert\sum_{i=1}^{n} B_i(\tau)\right\rvert q$
Agency costs of bearing unhedged risk	$A_i[\text{var } e_i(\tau)]$	$A_I[\text{var } e_I(\tau)]/n$

IV. CONCLUSIONS

During the substantial growth of the market for swaps in the 1980s, there have been many papers written to explain their extensive use by firms. In general, these studies provide various perspectives on how swaps may be used by the firm to unbundle interest rate- or exchange rate-related cash flows. While some of these theories are appealing, they have not provided a logical rationale for the use of swaps, per se, but rather for the unbundling of cash flows in general. None of the theories to date provide an adequate explanation of the source of value added by swaps, which could not be replicated through other markets—say, by a sequence of sufficiently long-dated forward contracts.

This paper provides an explanation for the use of swaps which is distinct from those which have already appeared in the literature. We argue that the growth of the swaps market derives from the fact that swap marketmakers provide relatively efficient hedging of interest rate and/or exchange rate exposures by maintaining private swap portfolios and that the organizational structural of the swaps market has evolved to minimize information and agency costs inherent in such hedging.

REFERENCES

AKERLOF, G. (1970). The market for "lemons": Qualitative uncertainty and the market mechanism, *Quart. J. Econ.* **84,** 488–500.

ALLEN, F. (1990). The market for information and the origin of financial intermediation, *J. Finan. Interm.* **1,** 3–30.

ANDERSON, R., AND DANTHINE, J. (1981). Cross hedging, *J. Polit. Econ.* **89,** 1182–1196.

ARAK, M., ESTRELLA, A., GOODMAN, L., AND SILVER, A. (1987). Interest rate swaps: An alternative explanation, *Finan. Mgmt.* **17,** 12–18.

ARON, D. (1988). Ability, moral hazard, firm size, and diversification, *Rand J. Econ.* **19,** 72–87.

BICKSLER, J., AND CHEN, A. (1986). An economic analysis of interest rate swaps, *J. Finance* **41,** 645–655.

BROWN, K., AND SMITH, D. (1988). Recent innovations in interest rate risk management and the reintermediation of commercial banking, *Finan. Mgmt.* **18,** 45–58.

CAMPBELL, T., AND KRACAW, W. (1987). Optimal managerial incentive contracts and the value of corporate insurance, *J. Finan. Quant. Anal.* **22,** 315–328.

CAMPBELL, T., AND KRACAW, W. (1990). Corporate risk management and the incentive effects of debt, *J. Finance* **45,** 1673–1686.

DEMARZO, P., AND DUFFIE, D. (1991). Corporate financial hedging with proprietary information, *J. Econ. Theory* **53,** 261–286.

DIAMOND, D. (1984). Financial intermediation and delegated monitoring, *Rev. Econ. Stud.* **51,** 393–415.

DIAMOND, D. (1989). "Debt Maturity Structure and Capital Structure," Working Paper, University of Chicago.

FERSHTMAN, C., JUDD, K., AND KALAI, E. (1991). Observable contracts: Strategic delegation and cooperation, *Int. Econ. Rev.* **32,** 551–559.

FLANNERY, M. (1986). Asymmetric information and risky debt maturity choice, *J. Finance* **41,** 19–38.

GREEN, R. (1984). Investment incentives, debt, and warrants, *J. Financ. Econ.* **13,** 115–136.

HIRSHLEIFER, D. (1988a). Risk, futures pricing, and the organization of production in commodity markets, *J. Polit. Econ.* **96,** 1206–1220.

HIRSHLEIFER, D. (1988b). Residual risk, trading costs and commodity futures risk premia, *Rev. Finan. Stud.* **1,** 173–193.

LOEYS, J. (1985). Interest rate swaps: A new tool for managing risk, Federal Reserve Bank of Philadelphia, *Bus. Rev.* **(May/June),** 17–25.

MACMINN, R. (1985). Forward markets, stock markets, and theory of the firm, *J. Finance* **40,** 1167–1185.

MYERS, S. (1977). Determinations of corporate borrowing, *J. Finan. Econ.* **5,** 147–176.

RAMAKRISHNAN, R., AND THAKOR, A. (1991). Cooperation versus competition in agency, *J. Law Econ. Org.*, in press.

SHAH, S., AND THAKOR, A. (1987). Optimal capital structure and project financing, *J. Econ. Theory* **42,** 209–243.

SMITH, C., SMITHSON, C., AND WAKEMAN, L. (1986). The evolving market for swaps, *Midland Corp. Finance J.* **3,** 20–32.

SMITH, C., AND STULZ, R. (1985). The determinants of a firm's hedging policies, *J. Finan. Quant. Anal.* **20,** 391–403.

STULZ, R., AND JOHNSON, H. (1985). An analysis of secured debt, *J. Finan. Econ.* **14,** 501–521.

TITMAN, S. (1990). "Interest Rate Swaps and Corporate Financing Choices," Working Paper, UCLA.

TURNBULL, S. (1987). Swaps: A zero-sum game? *Finan. Mgmt.* **15,** 15–21.

WALL, L. (1989). Interest rate swaps in an agency theoretic model with uncertain interest rates, *J. Banking Finance* **13,** 261–270.

WALL, L., AND PRINGLE, J. (1988). Interest rate swaps: A review of the issues, Federal Reserve Bank of Atlanta, *Econ. Rev.* **(Nov./Dec.),** 22–37.

WALL, L., AND PRINGLE, J. (1989). Alternative explanations of interest rate swaps: A theoretical and empirical analysis, *Finan. Mgmt.* **18,** 59–73.