Interest Rate Swaps and Economic Exposure

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Abstract: The interest rate swap market has grown rapidly. Since the inception of the swap market in 1981, the outstanding notional principal of interest rate swaps has reached a level of $12.81 trillion in 1995. Recent surveys indicate that interest rate swaps are the most commonly used interest rate derivative by nonfinancial firms and that nonfinancial firms are major users of interest rate swaps. In this paper, we provide an economic rationale for the use of interest rate swaps by such nonfinancial firms. In a global economy, given the floating exchange rate regime, nonfinancial firms face economic exposure in the presence of foreign competition. Asymmetric information about economic exposure leads to mispricing of the firms' debt, and the firm chooses either short-term or long-term debt to minimize the cost of debt. We show that when there is a favorable (unfavorable) exchange rate shock, an exposed firm chooses short-term (long-term) debt together with fixed-for-floating (floating-for-fixed) interest rate swaps. Given interest rate expectations, interest rate swaps enable the firm to minimize the cost of fixed or floating rate debt.

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INTEREST RATE SWAPS AND ECONOMIC EXPOSURE

I. INTRODUCTION

As of December 31, 1995, the outstanding notional principal of interest rate and currency swaps ($ equivalent) was $14 trillion, of which interest rate swaps accounted for $12.81 trillion and currency swaps accounted for the remaining $1.19 trillion.[1] The International Swaps and Derivatives Association Inc. (ISDA) indicates that the outstanding notional principal of interest rate swaps has grown consistently during the years 1987 through 1995 from $682.8 billion to $12.81 trillion. Nonfinancial firms are a major group of users of interest rate swaps. Financial firms (e.g., banks) are comparatively infrequent users of interest rate swaps and they are primarily interest rate swap dealers.[2]

Wall and Pringle (1989) surveyed a set of 250 firms which had reported the use of interest rate swaps. This study identified a number of different motives for swap usage. Wall and Pringle point out that no single explanation is adequate in explaining the behavior of all swap users. For example, the motives for using interest rate swaps may differ between financial and nonfinancial firms. This paper concentrates attention on the motives of nonfinancial firms and provides an economic rationale for their use of interest rate swaps since these firms are leading users of interest rate swaps[3].

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[1]These are aggregate global figures for interest rate swaps for both ISDA and non-ISDA categories. See Market Survey Highlights (year end 1996) by ISDA.

[2]Carter and Sinkey (1996) provide empirical evidence showing that 90% of banks whose asset values range from $100 million to $1 billion do not use any interest rate derivatives.

[3]The use of interest rate swaps by non-financial firms far exceeds (see Bodnar et al (1995), especially Figure 2) the use of other instruments such as forwards, futures and option contracts.

Recent surveys of nonfinancial firms by Phillips (1995), Bodnar et al. (1995), and Bodnar, Hayt, and Marston (1996) identify the motives of these firms for using interest rate derivatives. For all size categories of nonfinancial firms, Phillips mentions the two main motives as interest rate risk management and need for derivatives in conjunction with obtaining debt-financing. Bodnar et al.(1995), and Bodnar, Hayt, and Marston (1996) list motives for interest-rate derivative use which fall in two broad categories: interest rate risk management and reduction in the cost of funding. Thus, while interest rate derivatives are widely believed to be useful for interest rate risk management, firms also use them in conjunction with debt-financing, primarily to reduce financing costs. In this context, what accounts for the fact that nonfinancial firms[4] are major users of interest rate swaps? The economic rationale for the use of interest rate swaps, developed in the following paragraphs, answers this question. This paper shows that interest rate swaps are unique in that they *minimize* the financing cost for the firm when used in conjunction with debt-financing.

The ISDA market survey highlights for 1995 indicate that interest rate swaps are used in different countries, with the United States, Japan, France, Germany, and Great Britain being the five largest users (see Table 1). Together, they contributed 87.9% of the overall activity in interest rate swaps in 1995. During the last two decades, industrialized economies have globalized as trade barriers have been lowered, and capital and exchange controls relaxed. Globalization has increased the size of markets. Increased market size, for firms across different countries, has resulted in (i) greater exposure to interest rate risks and (ii) greater use of debt in project-financing, increasing reliance on leverage to enhance returns (see Marshall and Bansal 1992). Globalization is one major change in the environment of the firm, and the floating exchange rate regime is the other. The floating

[4]These non-financial firms could either be purely domestic, exporting, or multinational. From here onwards, by a firm we mean a non-financial firm.

exchange rate regime, especially in industrialized economies, has resulted in frequent unanticipated exchange rate changes or exchange rate shocks.

Globalization has also implied significant foreign competition. If the domestic currency is strong, foreign competitors are able to reduce prices while maintaining sales revenues as before. Given foreign competition, the revenues of firms change since these firms are not sufficiently competitive on pricing. Such indirect price-elasticity of demand effects vis-a-vis foreign competition result in economic exposure for the firm in imperfectly competitive markets. Economic exposure is defined as the sensitivity of the firm's cash flows to unanticipated exchange rate changes.[5] It tells us to what extent exchange-rate changes will affect the long-term future cash flows of a firm and thereby change the value of the firm.

In fact, as Hodder (1982) shows, even purely domestic firms with no foreign assets or liabilities face such economic exposure. The levels of economic exposure vary from one firm to another because firm-specific factors such as price-elasticity of demand vary from one firm to another. Different pricing policies adopted by different firms also result in varying levels of economic exposure. Information about the level of economic exposure of a firm is not as easily available to outside investors as it is to the managers of the firm.[6] When such a cross section of firms with exposure levels unknown to the outsider borrow debt for financing a risky project, the debt may be priced by the market uniformly for all

[5]For an excellent detailed treatment, see Adler and Dumas (1984). We define economic exposure from the perspective of a firm (for example, an exporting firm) whose cashflows increase upon any depreciation in the home currency. If there is a firm, however, whose cashflows decrease upon such a depreciation, the exact opposite argument will hold good. Such a firm will then be the counterparty in the interest rate swap transaction.

[6]Bartov and Bodnar (1994) mention that in the presence of foreign competition estimating the economic exposure of the firm is complex. It is plausible that managers of the firm have superior information about the firm's cashflows compared to that of the outside investors.

firms, irrespective of the level of economic exposure, due to the asymmetry of information. This leads to the mispricing of the firm's debt.

The paper examines how these firms choose debt maturity in conjunction with interest rate swaps in order to pay the least cost on debt consistent with interest rate expectations. It shows that these firms use interest rate swaps, because interest rate swaps not only enable efficient management of interest rate changes but also result in *minimization* of the cost of debt for the firm. To illustrate, look at McDonald's Corporation, a global company which has debt-financing needs and faces economic exposure and interest rate uncertainty in different parts of the world. In 1993, their interest rate swap portfolio included 45 interest rate swaps in 8 different currencies. To finance their assets in long-term projects, McDonald's uses 60 to 80 percent of fixed-rate debt and the remaining in floating-rate debt. To quote Carleton Pearle and Frank Hankus describing their McDonald's example,[7] "We use interest rate swaps in three ways: to change the mix of our fixed and floating-rate debt, to position the company for expected changes in interest rate levels, and to adjust the maturity of the debt portfolio." The analysis in this paper provides the economic rationale for interest rate swap use in such a context.

The earliest and most widely accepted explanation for the use of interest rate swaps is the comparative advantage argument by Bicksler and Chen (1986).[8] The comparative advantage explanation has been critiqued by Smith, Smithson, and Wakeman (1988) and Arak et al. (1988), who pointed out that even if arbitrage were possible, the

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[7]See Smith, Smithson, and Wilford (1995), pages 271-272 for details.

[8]The comparative advantage explanation suggests that while better quality firms have a comparative advantage in the long-term bond market, lower quality firms have a similar advantage in the short-term or floating-rate market. The swap market allows both types of firms to reduce the debt-funding cost.

volume of interest rate swaps should be declining as arbitrage becomes more effective.[9] Wall (1989) and Titman (1992) provide alternate explanations for the use of interest rate swaps based on agency costs and financial distress costs respectively. The analysis here focuses on the global dimension of interest rate swap use. The main contribution shows that the motivation for using interest rate swaps is related to the economic exposure of firms.

The use of interest rate swaps by firms has not only been very striking but also far in excess of the use of currency swaps (see Table 2). Any discussion on currency risk and consequent economic exposure for firms suggests examining currency swap use. If two currencies are considered for the firm's cash flows, currency risk and the economic exposure of firms can be shown to motivate the use of currency swaps by firms as well.[10] However, in this paper, the focus is only on interest rate swaps, and therefore the assumption is that of a single currency for the firm's cash flows. Specifically, it is shown that an exposed firm in an open economy uses the interest rate swap so that the firm's debt is correctly priced. Three factors and the interaction between them jointly determine the exposed firm's choice of the type of interest rate swap: (1) the level of exchange rate shock, (2) the magnitude of economic exposure, and (3) the magnitude of interest rate change. This paper is the first to provide such a justification for the use of interest rate swaps.

Section 2 describes the model in a specific economic setting. Section 3 shows how asymmetric information about economic exposure results in gains or losses for the firm

[9]Sun, Sundaresan and Wang (1993) have empirically tested the comparative advantage hypothesis for swap use and do not find sufficient evidence for the same. They document that the spreads between swap rates and Treasury yields generally increase significantly with maturities, whereas the increase is much smaller when the Treasury yield curve is inverted.

[10]We do so in a separate paper by Goswami and Shrikhande (1996) connecting currency risk, economic exposure, and currency swaps.

due to mispricing of its long-term, or short-term, debt. Section 4 provides the motivation for both fixed-for-floating and floating-for-fixed interest rate swaps when there are interest rate changes in the economy and mispricing of the debt issued by firms. Section 5 discusses some empirical implications and concludes the paper.

II. THE ECONOMIC SETTING

Consider a two-period, three date (t) world, where t = 0, 1, 2. At t = 0, the firm has access to a positive net present value (NPV) project. The project generates cash flows X(t) at t = 1, 2. The firm operates in an imperfectly competitive market. In the presence of foreign competition, the firm faces economic exposure. A perfectly competitive securities market finances the project at zero expected profits. The financing is provided by a risk-neutral market. The security buyers participating in capital markets incur no transaction cost. For simplicity and to abstract away from use of currency swaps denominate all cash flows in home currency terms. The sensitivity of cash flows to exchange rate changes, or economic exposure, differs from one firm to another.

To model this difference in exposure levels, take an extreme case. There are two types of firms: one with economic exposure and the other with no economic exposure. The firm type is denoted by $q \in Q = \{e, n\}$ where type e denotes a firm with economic exposure due to exchange rate changes and type n denotes a firm with no economic exposure.[11] The level of the firm's economic exposure is unobservable by economic agents outside the firm but known exactly to the firm's managers. All agents in the

[11]In general, firms with high economic exposure versus firms with low economic exposure will give the same results in our model. We model only positive exposure for a firm, i.e., a favorable exchange rate shock increases the cashflows. If the same shock decreases the cashflows of the firm (a negative exposure), our results will be exactly opposite.

security market have the same prior probability belief about π, the ratio of the firms of type e to the total number of firms in the economy.

The cash flows realized from the positive NPV project are independently distributed with two-point support at H and 0. In the first period, the probability of realizing a cash flow H is p for all firms. At t = 1, after the cash flows are realized, the economy experiences an exchange rate shock θ, where $\theta = \{f, u\}$. The probability of a favorable shock (f) is denoted by s, and the probability of an unfavorable shock (u) is denoted by (1 - s). A favorable (unfavorable) exchange rate shock results in an increase (decrease) in the firm's cash flows. The exchange rate shock is exogenous. The first period cash flows of either type of firm are independent of the exchange rate shock. In the second period, the probability of realizing cash flow H is denoted by $p_{q,\theta}$. For a type e firm, the cash flow H is realized with a probability of $p_{e,f} = p + \varepsilon$ in the case of the favorable shock f and with a probability of $p_{e,u} = p - \varepsilon$ in case of the unfavorable shock u. For example, consider an exporting firm. A depreciation of the home currency is a favorable shock since the cash flows of the firm increase as a result of the depreciation. For a type n firm, the second period cash flows are independently and identically distributed, i.e., the probability of realizing H after a shock f or u is given by $p_{n,f} = p_{n,u} = p$. A suitable measure for the level of economic exposure is the proportionate change in the probability of the cash flows, given by ε/p.

If the exchange rate movement follows a binomial process with s = 1/2, then the expected cash flows are the same for both types and neither dominates in the sense of first order stochastic dominance. However, the second period cash flows of the type e firm have a higher variance than that of the second period cash flows for the type n firm. When s > 1/2 (s <1/2), the type e (type n) firm dominates the type n (type e) firm in the sense of first order stochastic dominance. This deviation from s = 1/2 can be treated as a measure of the magnitude of the exchange rate shock and is denoted by (2s - 1) if s > 1/2 and by (1 - 2s) if s < 1/2.

In order to fund the project, the firm borrows I dollars by issuing debt. The financing choices, denoted by m, are limited to short-term debt (S), long-term debt (L), and a combination of debt and interest rate swaps. If short-term debt is issued, and the cash flow H is realized at date 1, the bondholders are paid in full. The first period short-term debt is paid off before the exchange rate shock. In the event that the firm realizes no cash flow at date 1, the firm has to refinance its debt. Restrict the parameter values in such a way that the firm is always able to finance both short-term debt and long-term debt at t = 0. Moreover, if the firm issues a short-term debt in the first period, it is always able to refinance at t = 1.[12] If the firm refinances its short-term debt, the original bondholders are paid off in full, and the new short-term bondholders are paid off only if the cash flow H is realized at t = 2. The long-term debt is a zero-coupon debt which is repayable after two periods. The firm follows a residual dividend policy and pays out all its cash flows at t = 1 to the equity holders. If long-term debt is issued, and the cash flow H is realized at the end of the second period, the debtholders are paid off in full. Otherwise, the firm goes bankrupt, and the debtholders receive a payoff of 0.

In a fixed-for-floating interest rate swap, the firm first issues a short-term debt and swaps the riskfree short-term interest rate with the riskfree long-term interest rate prior to the realization of an exchange rate shock. When the firm uses such a swap it must bear the credit risk inherent in the short-term debt financing but the swap enables the firm to fix the long-term riskfree interest rate. In a floating-for-fixed interest rate swap, the firm issues a long-term debt first and swaps the long-term riskfree interest rate with the short-

[12] It is easy to see that if $I < \text{Min}\{ p H, (p + (2s - 1)\varepsilon) H\}$, the firm will always be able to finance both the long term debt as well as short-term debt at the end of the first period.

term riskfree interest rate. In this case, the credit risk of the firm is determined at $t = 0$ and is not reassessed in the subsequent period. But the firm bears the interest rate risk inherent in the short-term debt.

The interest rate parity condition gives the relationship between exchange rate changes and nominal interest rate changes in equilibrium. When there is an exchange rate shock at the intermediate period, the domestic nominal interest rates adjust instantaneously in keeping with uncovered interest rate parity.[13] If the foreign nominal interest rate is set constant, all movements in the exchange rate are transmitted to the domestic nominal interest rate, reflecting the interest rate risk for domestic firms. In a two period model, if uncovered interest rate parity (UIRP) holds,[14] a favorable (unfavorable) exchange rate shock at the intermediate date which causes a depreciation (appreciation) of the home currency will result in an interest rate increase (decrease) in the home currency at the intermediate date. The exchange rate shock which creates a depreciation (appreciation) of the home currency is favorable (unfavorable) for a type e firm.[15]

Let the long-term risk-free interest rate be denoted by R_l and the first-period short-term risk-free interest rate be denoted by R_s. Let the change in the short-term risk-free interest rate be denoted by δ. Then the second-period short-term risk-free interest after a favorable exchange rate shock f is denoted $(R_s + \delta)$ and the risk-free rate after an

[13]The empirical results in Chow, Lee, and Solt (1997) indicate a negative correlation between exchange rate and interest rate changes. Their results imply that a current depreciation of the dollar is accompanied by increases in current and future domestic interest rates. This evidence provides some empirical support for our assumption.

[14]The UIRP condition is: $[E(S_1) - S_0)] / S_0 = [r - r^*] / [1 + r^*]$ where S_0 and S_1 denote the exchange rate in direct terms (HC / FC) for the first and second period respectively, r and r* denote the riskfree nominal interest rate (in the second period) in the domestic and foreign country respectively. The left hand side of the above equation is positive (negative) in the case of a depreciation (appreciation).

[15]This overall argument is consistent with a major application of interest rate swaps for the borrower mentioned by Das (1989), namely, to actively manage the cost of an organization's fixed or floating rate debt in a manner consistent with interest rate expectations.

unfavorable exchange rate shock u is denoted $(R_s - \delta)$. The relationship between the long-term and short-term interest rate can be generated by the no arbitrage condition in bond markets, i.e., the effective risk-free interest rate on a two period bond and the effective risk-free interest rate in rolling over a one period bond for two periods must be equal. The term structure of interest rates implies that

$$R_l = R_s + (2s-1)\,\delta / 2. \qquad (1)$$

Under a favorable exchange rate shock, i.e., $s > 1/2$, it is easy to see that $R_s < R_l < (R_s + \delta)$. Under an unfavorable exchange rate shock, i.e., when $s < 1/2$, $(R_s - \delta) < R_l < R_s$. This implies that the second-period short-term interest rate will be lower than the long-term interest rate.[16]

Exogenous exchange rate shocks have effects both on interest rates as well as on the cash flow of the firm. Since the effect on the cash flows of the firm is unobservable to the outsider, she can only make surmises about the type of the firm and whether the firm has any economic exposure at all. Debt-financing of such firms by the outsider (the market) can only be done by pricing the debt on a weighted-average basis, knowing the proportion of exposed firms. Such overall pricing of debt by the market is neither a correct assessment for the exposed firm nor a correct assessment for the unexposed firm. In the next section the extent to which there is mispricing of debt for both the exposed and the unexposed firm is analyzed.

III. ECONOMIC EXPOSURE AND THE MISPRICING OF DEBT

[16]To isolate the effect of the mispricing of debt due to asymmetric information, we set the expected future value of a long-term debt and that of a rolled-over short-term debt to be equal. At the firm level, the relationship between the short-term risk-free interest rate and the long-term riskfree interest rate in our set-up is given by $R_l = R_s + (1 - p)(2s - 1)\,\delta$.

Given the menu of securities, asymmetric information about the economic exposure, and the equilibrium relationship between exchange rate shocks and interest rate changes, look at the firm's choice of debt maturity. Under asymmetric information regarding the economic exposure, the firm's choice of debt maturity may cause the market to revise its prior probability beliefs. Compute the face value of debt set by the market using these revised beliefs for each possible state of the world. Next, compute the expected value of the debt for the firm at t = 0 by calculating the probability-weighted sum of the face values across different states of the world. The choice of debt maturity depends on this expected value of debt and the investment amount I.

In response to the firm's choice, m, between short-term and long-term debt (S or L), the market sets a face value for the debt and provides the firm with $I at time 0. The firm's choice of debt maturity may cause the market to revise its beliefs regarding the type of the firm. If the firm issues short-term debt, the posterior probability belief $\phi(S)$, depends on the firm's choice, m, and the date 1 cash flow. However, since the binomial probabilities of the cash flows for the two types of firms are identical in the first period it follows on application of Bayes' rule that the revised belief is no different from the prior probability belief π. This assessment of posterior probabilities is also not modified by the observation of an exchange rate shock as the conditional probability of the shock is independent of the type of the firm. If the firm issues long-term debt, the posterior probability belief $\phi(L)$ is equal to the prior probability belief π because the long-term debt, by definition, need not be priced at the intermediate period.

Let the face value of the debt be denoted by $K_{t,\theta}$ (q, m, ϕ) payable at time t, where the firm type is q, the exchange rate shock is θ, and the posterior probability belief is $\phi(m)$. At time t = 1, since the short-term debt is paid off before the exchange rate shock, K_1 (q, m, ϕ) is independent of θ. Also the face value of long-term debt K_2 (q, m, ϕ) is independent of θ, as it is not revised at date 1. Let V_t (q, ϕ, $K_{t,\theta}$ (m)) represent the market's expected payoff on debt issued at t = 0, 1. Under the assumption that the first period short-term debt is always refinanced if required, it is free of default risk when issued at time 0. The expected payoffs to the market from short-term debt issued at t = 0, and at t = 1, and long-term debt issued at t = 0 are given by:[17]

$$V_0(q, \phi (S), K_1(S)) = p\ K_1 (S) + (1\text{-}p)\ K_1 (S) = K_1 (S); \tag{2}$$

$$V_1(q, \phi(S), K_{2,\theta}(S)) = s\ p_{q,u}\ K_{2,u} (S) + (1\text{-}s)\ p_{q,f}\ K_{2,f} (S); \tag{3}$$

$$V_0 (q, \phi (L), K_2 (L)) = s\ p_{q,u}\ K_2 (L) + (1\text{-}s)\ p_{q,f}\ K_2 (L). \tag{4}$$

Given that the capital market is competitive and the agents are risk neutral, the investors will just breakeven whenever they supply the funds to the firm. Therefore, the market chooses the face value of the long term debt, K_2 (L), such that the expected value of debt equals the long-term riskfree return on the investment amount I, given by IR_l. Similarly, the market chooses the face values of the first period and the second period short-term debt, K_1(S) and $K_{2,\theta}$ (S), such that the expected values equal IR_s. Therefore, the face values K_2 (L), K_1(S), and $K_{2,\theta}$ (S) are given by:

$$K_2 (L) = IR_l / [s\ p_{q,f} + (1\text{-}s)\ p_{q,u}], \quad \text{for } q = e, n; \tag{5}$$

$$K_1(S) = IR_s; \tag{6}$$

$$K_{2,\theta}(S) = K_1(S) / [\phi(S)\ p_{e,\theta} + (1\text{-}\phi(S))\ p_{n,\theta}], \quad \text{for } \theta = f, u. \tag{7}$$

Now first compute the face values of debt for each type of firm (see Appendix), and compare the mispricing of debts as mentioned above. When a firm issues a long-term debt and the debt is priced at a pooled rate, the face value of the debt is higher than the intrinsic value of the debt if it is issued by a type e firm and lower than the intrinsic value of the debt if it is issued by a type n firm (see equations A1 to A3). In the case of a favorable shock, the face value of the second period short-term debt priced in pooled

[17]The equations (3.1) to (3.8) which follow suppress the variables q and ϕ(m) in the face values.

terms is higher than the face value of the short-term debt if priced as if it is issued by the type e firm and is lower than the face value of the short-term debt if priced as if it is issued by a type n firm (see equations A4 to A6). Similarly from equations A7 to A10, it follows that in the case of an unfavorable shock, the face value of the second period short-term debt issued by the type n firm is lower if it is correctly priced than if it is priced in pooled terms.

First, from these face values examining the result of an exchange rate shock which follows a binomial process ($s = 1/2$) is possible. Both favorable (f) and unfavorable (u) shocks can then be considered as deviations from this base case. Since the long-term debt is priced at $t = 0$ and the exchange rate shock is realized at $t = 1$, the default risk of long-term debt is independent of the exchange rate shock. The second period short-term debt is priced at $t = 1$ after realization of the exchange rate shock and has two values, one each for the favorable and the unfavorable shocks. The short-term debt priced at $t = 0$ is the weighted average of these two values. The conclusion using Jensen's inequality, is that the default risk for the type e firm is higher than the default risk of the type n firm. Therefore, the type n firm may not mimic the type e firm and issue short-term debt. This intuition is formalized in Lemma 1.

Lemma 1*: When $s = 1/2$, the default risk of a long-term debt issued by either type of firm is identical. The default risk of the short-term debt issued by the type e firm is higher than that issued by the type n firm.*

Proof: See Appendix.

The value of the firm when assessed by a risk-neutral market is equal to the sum of the expected value of debt and the expected value of equity. Under asymmetric information regarding the firm type, the firm's debt may be mispriced. This mispricing can be computed as the difference between the value of the debt V_t (q, ϕ (m), $K_{t,\theta}$ (m)) and the investment amount, IR, where R is either R_l or R_s. The intrinsic value of the outstanding equity claim of the firm is equal to the NPV of the project less this mispricing of the firm's debt. The net present value (NPV) of the project is independent of the choice of debt because the project is exogenously specified. Therefore the firm's objective of maximizing its equity claim is equivalent to the minimization of the mispricing of debt.[18] Let $V^{mis}(q, m, \phi)$ denote the mispricing of debt. A separating equilibrium implies that different types of firms choose different debt maturities. In such an equilibrium, the debt is correctly priced and $V^{mis}(q, m, \phi) = 0$. In a pooling equilibrium, both types of firms choose the same debt maturity and the debt market prices the debt accordingly. Therefore one type of firm incurs a mispricing loss when $V^{mis}(q, m, \phi) > 0$ and the other type of firm incurs a mispricing gain when $V^{mis}(q, m, \phi) < 0$. In a pooling equilibrium, the mispricing of the debt is given by

$$V^{mis}(q, L, \phi) = \Sigma_\phi V_0 (q, \phi (L), K_2 (L)) - IR_l; \tag{8}$$

$$V^{mis}(q, S, \phi) = \Sigma_\phi [\, p\, V_0(q, \phi (S), K_1(S)) + (1-p)\, V_1(q, \phi(S), K_{2,\theta}(S))] - IR_s. \tag{9}$$

The equilibrium is a Nash sequential equilibrium (NSE) as defined in Kreps and Wilson (1982). NSE is a combination of a debt maturity strategy for firms, response strategy of the market, and a set of beliefs for the market, such that the firm's and market's actions are optimal given the other player's decisions. In an NSE the market's beliefs are derived by using Bayes' rule whenever needed.

In this setup there are two separating and two pooling equilibria assuming firms follow only pure strategies. In a separating equilibrium, since the choice of debt maturity signals the type of the firm, $\phi(m)$ is 0 or 1. Both short-term and long-term debt are

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[18] Mispricing minimization has commonly been used as a normative criterion (See Myers and Majluf (1984) and Flannery (1986)). For formal proofs in the case of separating equilibria see Brennan and Kraus (1986) and for the case of pooling equilibria see Nachman and Noe (1994).

correctly priced and $V^{mis}(q, m^*, \phi) = 0$ for all q, where m^* is the equilibrium signal issued by type q. A separating equilibrium exists as long as both types of firms realize a mispricing loss by deviating from the equilibrium signal, i.e., $V^{mis}(q, m, \phi) > 0$ for both types, when $m \neq m^*$. In a pooling equilibrium, only one signal is observed by the market and the debt is priced in pooled terms. The type of firm which incurs a mispricing loss has an incentive to deviate from the equilibrium and issue an off-equilibrium signal. A pooling equilibrium exists when the type of firm that realizes the mispricing loss by issuing the equilibrium signal realizes an even higher mispricing loss by issuing an off-equilibrium signal. The minimization of mispricing of debt is equivalent to the Perfect Sequential Equilibrium refinement by Grossman and Perry (1986). This mispricing of debt argument is used to enumerate the conditions under which each of the above mentioned equilibria holds. Each of these equilibria represents a possible debt maturity decision of the firm.

IV. ECONOMIC EXPOSURE AND INTEREST RATE SWAPS

In the economic setup described above, consider a firm that needs to issue a risky debt to finance a long-term, positive NPV project. An exogenous exchange rate shock occurring in the short term affects the firm's cash flows due to economic exposure. If product-markets were efficient, the exchange rate shock would result in the same economic exposure level for all firms. However, firms' price elasticities of demand are different due to product-market inefficiencies in this economy. Such price-elasticity-of-demand effects are private information of the firm which cannot be conveyed costlessly to the security market. Therefore, the security market cannot distinguish between the levels of economic exposure faced by different firms, resulting in informational asymmetries in an otherwise efficient security market.

Let us first consider the case when $s > 1/2$. In the long-term, the high exposure firm's expected cash flows are greater than the expected cash flows of a low exposure firm. The high exposure firm should issue a long-term debt to finance the long-term project to avoid refinancing and interest rate risk in the intermediate period. At time t = 0, the security market assesses its credit risk and estimates the risk premium charged above the long-term riskfree interest rate. Given the information asymmetry regarding economic exposure, the long-term debt issued by a high exposure firm is mispriced compared to the long-term debt of a low exposure firm. The high exposure firm loses to the extent of the mispricing of its long-term debt. Therefore, by issuing long-term debt the high exposure firm is able to fix its long-term riskfree interest rate but incurs a loss due to mispricing of its credit risk.

The firm, however, has the choice of financing by issuing short-term debt where it faces both refinancing as well as interest rate risk. If the firm's economic exposure level is high, under a favorable exchange rate shock the firm expects to have higher cash flows in the future than a firm with low economic exposure. In this scenario, the firm with high economic exposure could try to signal its better future cash flows by choosing a short-term debt. If the low exposure firm mimics the high exposure firm and issues a short-term debt, the security market assesses its short-term debt as if it is issued by a high exposure firm. In Lemma 1, it has been shown that a short-term debt issued by a type e firm is riskier than that issued by a type n firm. The low exposure firm chooses short-term debt depending upon the mispricing of its default risk premium which is comprised of two components: (a) the mispricing gain by mimicking the firm with high cash flows and (b) the mispricing loss due to the higher default risk of the short-term debt. If the net gain from the mispricing is non-negative the low exposure firm issues a short-term debt to mimic the high exposure firm. If the mispricing loss due to the higher riskiness of the short-term debt exceeds the mispricing gain by mimicking the firm with high cash flows then the low exposure firm separates out from the high exposure firm by issuing a long-term debt.

If the high exposure firm is not mimicked by the low exposure firm its short-term debt is correctly priced but the high exposure firm still faces an increase in the expected short-term riskfree interest rate in the intermediate period. In the presence of the swap market, the high exposure firm can issue the short-term debt and can swap the short-term riskfree interest rate with the long-term riskfree interest rate through a fixed-for-floating interest rate swap. The low exposure firm can also mimic the high exposure firm by issuing short-term debt and using the fixed-for-floating interest rate swap. Whether it actually chooses to do so is dependent on four factors: (i) the level of economic exposure which induces the mispricing gain in (a) above, (ii) the magnitude of the exchange rate shock which induces the mispricing loss in (b) above, (iii) the level of interest rate change which also induces a loss, and (iv) the interaction effect amongst factors (i) through (iii). The high exposure firm can successfully signal its exposure level by issuing a short-term debt and using a fixed-for-floating swap only if the low exposure firm is a net loser when it mimics the high exposure firm.

Proposition 1: *Under a favorable exchange rate shock (i.e., when $s > 1/2$), the high exposure firm signals its level of economic exposure by borrowing short-term and swapping the short-term riskfree interest rate with the long-term riskfree interest rate in the swap market if and only if*

$$[\varepsilon / p - (2s-1) - \delta / R_S + (2s - 1)(\varepsilon / p)(\delta / R_S)] > 0. \qquad (10)$$

Proof: See Appendix.

The first term in equation (10) is the exposure effect (ε/p), the second term is the measure of exchange rate shock (2s-1), the third term is the change in interest rate or interest rate effect (δ/R_S), and the fourth term is the interaction effect of all these three factors. If the exposure effect is large compared to both the interest rate change and the exchange rate shock, the exposed firm separates out by issuing a short-term debt. When the exchange rate shock (2s-1) is small, ignoring the interaction effect, arrive at the condition for this separating equilibrium:

$$\varepsilon / p > (2s-1) + \delta / R_s. \tag{11}$$

Now consider the case when s < 1/2. Under such an unfavorable exchange rate shock, the expected cash flow of a high exposure firm is lower than that of a low exposure firm. If the low exposure firm issues a long-term debt to finance the project the high exposure firm mimics and also borrows long-term. Given the security market's imperfect information about economic exposure, the long-term debt of the low exposure firm is mispriced compared to that of the high exposure firm. The low exposure firm not only loses due to the mispricing of credit risk but also is unable to gain from falling interest rates in the intermediate period. Therefore, the low exposure firm prefers to issue a short-term debt.

If the low exposure firm borrows short-term, it could signal its better cash flows. The high exposure firm may adopt a mimicking strategy. The high exposure firm stands to gain from issuing short-term debt in two ways: (a) the difference in the level of exposure causing mispricing of debt and (b) the favorable change in the interest rate. The extent of this gain is dependent on the level of the exchange rate shock, i.e., the larger the shock, the larger the gain. However, if the high exposure firm mimics the low exposure firm by issuing a short-term debt it must bear the refinancing risk inherent in a short-term debt. If the net gain from (a) and (b) together is less than the loss due to the risky short-term debt, the high exposure firm separates out from the low exposure firm to issue a long-term debt.

If the high exposure firm does not adopt a mimicking strategy, the low exposure firm has its short-term debt correctly priced and benefits from a decline in the second-period interest rate. If the high exposure firm chooses a long-term debt in a separating equilibrium, its credit risk is properly assessed by the market. If a swap market is available, the high exposure firm could gain from lower interest rates by issuing a long-term debt and swapping the fixed long-term riskfree interest rate for the short-term riskfree interest rate by using a floating-for-fixed interest rate swap.

Proposition 2: *Under an unfavorable exchange rate shock, (i.e., when $s < 1/2$), the high exposure firm separates out by borrowing long-term and swapping the long-term riskfree interest rate with the short-term riskfree interest rate in the swap market if and only if*

$$(\delta / R_S)\ (\varepsilon / p) > (1-2s)\ [\varepsilon / p + \delta / R_S\ ]. \qquad (12)$$

Proof: See Appendix.

The left-hand side of the inequality signifies the refinancing risk, and the first term on the right-hand side of the inequality denotes the exposure effect and the second term, the interest rate effect. When condition (12) holds, the high exposure firm separates from the low exposure firm by issuing a long-term debt.

To summarize, provide a justification for the use of interest rate swaps when firms face economic exposure. Exchange rate shocks have a microeconomic effect on the firm's cash flows and a macroeconomic effect on the interest rate in the economy. The information asymmetry regarding the economic exposure causes mispricing of the firm's debt. The firm's choice of debt maturity together with a swap transaction enables it to not only correct its mispricing of debt but also to manage interest rate risk. Given that there is a small probability of large exchange rate shocks,[19] the exposed firm will use a swap transaction only when the economic exposure is significant. This is demonstrated specifically for both favorable and unfavorable exchange rate shocks.

[19]This is indeed how the exchange rate process for the US $ vis-a-vis other currencies has behaved over the last decade, see for example Engel and Hamilton (1990).

Under a favorable exchange rate shock, when an exposed firm issues a short-term debt and uses a fixed-for-floating interest rate swap, its debt is correctly priced and it can simultaneously manage interest rate risk. The unexposed firm chooses to issue a long-term debt. Similarly, under an unfavorable exchange rate shock, the exposed firm chooses to issue a long-term debt and uses a floating-for-fixed interest rate swap to take advantage of declining interest rates. The unexposed firm just issues a short-term debt. The firm's choice of debt maturity and the use of interest rate swaps is determined by the aggregate effect of the three factors: the level of exposure, the change in interest rates, and the magnitude of the exchange rate shock. The choice is determined not only by the magnitude of each factor but also by the interaction between them.

V. CONCLUSIONS

Globalization of industrialized economies and the floating exchange rate regime together imply that firms face economic exposure in the presence of foreign competition. In an open economy, a firm with a positive NPV project which chooses its financing alternatives from a menu of securities: a long-term debt, a short-term debt, and a combination of a debt and an interest rate swap is modeled. In a two-period world, an exchange rate shock in the intermediate period affects the firm's competitiveness in an imperfectly competitive product market and, therefore, its cash flows. The firm is better informed about its economic exposure than are the outside investors. The changes in cash flows affect the default risk of a firm borrowing short-term or long-term debt thus affecting its future credit quality. This paper shows that asymmetric information regarding its credit quality gives rise to a specific debt-maturity choice which minimizes the firm's mispricing of debt.

At the macroeconomic level, the exchange rate shocks are linked with changes in interest rates across different countries so as to permit no arbitrage. If the home currency depreciates, the firm which expects its default risk to decline in the future borrows short-term and uses floating-for-fixed interest rate swaps to avoid the effects of an increase in the interest rate. On the other hand, if the home currency appreciates, the firm which expects its default risk to increase, borrows long-term and uses fixed-for-floating interest rate swaps to take advantage of falling short-term interest rates. The analysis helps explain why interest rate swaps are often used in conjunction with short-term or long-term debt financing.

The model developed implies that the use of interest rate swaps increases with increase in exchange rate variability, level of economic exposure, and change in interest rates. The use of fixed-for floating (floating-for-fixed) interest rate swaps depends on the favorable (unfavorable) exchange rate shock as well as the level of economic exposure of the firm. One way of testing this theory would be to use the economic exposure of the firm as an independent, continuous, predictor variable. The use/non-use of interest rate swaps would be a dichotomous, dependent, dummy variable. If firm-specific data on the use of interest rate swaps are available, logit or probit models of regression can be used to verify the results of the model.

The firm's attitude to risk is not relevant to the motivation for using interest rate swaps developed in this paper. Recent surveys identified two main reasons why firms use interest rate swaps: interest rate risk hedging and cost reduction in conjunction with obtaining debt-financing. Unlike the motive of interest rate risk hedging, the motivation here applies to risk-neutral firms. It is shown that interest rate swaps minimize the cost of debt when used in conjunction with debt-financing. This benefit explains their widespread use.

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APPENDIX

We tabulate below all possible values of $K_{t,\theta}(m)$ along with the short-term (R_s) and long-term (R_l) interest rates and changes in the short-term interest rates (δ).

$$K_{2,\theta}(e,L,1) = I\ R_l / [p + \varepsilon\ (2s - 1)] \quad (A.1)$$

$$K_{2,\theta}(n,L,0) = I\ R_l / p \quad (A.2)$$

$$K_{2,\theta}(q,L,\pi) = I\ R_l / [p + \pi\ \varepsilon\ (2s - 1)] \quad (A.3)$$

$$K_1(q,S,1) = I\ R_s \text{ for all } q \quad (A.4)$$

$$K_{2,f}(e,S,1) = K_1\ (R_s + \delta) / [p + \varepsilon] \quad (A.5)$$

$$K_{2,f}(n,S,0) = K_1(R_s + \delta) / p \quad (A.6)$$

$$K_{2,f}(q,S,\pi) = K_1\ (R_s + \delta) / [p + \pi\ \varepsilon] \quad (A.7)$$

$$K_{2,u}(e,S,1) = K_1\ (R_s - \delta) / [p - \varepsilon] \quad (A.8)$$

$$K_{2,u}(n,S,0) = K_1\ (R - \delta) / p \quad (A.9)$$

$$K_{2,u}(q,S,\pi) = K_1\ (R_s - \delta) / [p - \pi\ \varepsilon] \quad (A.10)$$

Lemma 1*: When s = 1/2, the default risk of a long-term debt issued by either type of firm is identical. The default risk of the short-term debt issued by type e firm is higher than that issued by the type n firm.*

Proof: When $s = 1/2$, the expected value of the cash flows for both types of firm is the same, i.e., neither firm dominates the other in the sense of first order stochastic dominance. If the long-term debt is issued at $t = 0$, the exchange rate shock does not affect the pricing of long-term debt as it is realized at $t = 1$. Under symmetric information, the face value of long-term debt issued by type n is $I / [s\ p + (1-s)\ p] = I / p$. The face value of long-term debt issued by type e is $s.I / [s\ (p+\varepsilon) + (1-s)\ (p-\varepsilon)] = I / p$, i.e., the face value of long-term debt for both type of firms is exactly equal. In case of a short-term debt the first period debt is risk free by assumption. The face value of the second period debt depends on the realization of the exchange rate shock. Under symmetric information, the face value of the second period short-term debt issued by the type n firm is given by s (I/p) + (1-s) (I/p) = I/p. The face value of the second period short-term debt issued by the type e firm is given by [s {I/(p+ε)} + (1-s) {I/(p-ε)}] = I / (p - ε^2/p). The short-term debt when issued by type e is more risky than when it is issued by type n. This proves the lemma.♦

Proposition 1: *Under a favorable exchange rate shock (i.e., when s > 1/2), the high exposure firm signals its level of economic exposure by borrowing short-term and swapping the short-term riskfree interest rate with the long-term riskfree interest rate in the swap market if and only if*

$$[\varepsilon / p - (2s-1) - \delta / R_s + (2s - 1)(\varepsilon / p)(\delta / R_s)] > 0 \qquad \text{(A11)}$$

Proof: First we show that a separating equilibrium exists in which a type e firm issues a short-term debt and swaps the short-term riskfree interest rate with long-term risk-free interest rate and a type n firm issues a long-term debt. This implies that the short-term debt is priced at type e's terms and the long-term debt is priced at type n's terms, i.e., φ(S) = 1 and φ(L) = 0. In a separating equilibrium, since debt-maturity signals the type, both short-term and long-term debt is correctly priced for each type, i.e., V^{mis}(e,S,1) = 0 and V^{mis}(n,L,0) = 0. Whenever one type of firm deviates from the equilibrium choice of debt maturity, the debt is priced at the terms of the other type. Mispricing gain/loss expressions for both types of debt are obtained by using face values (A1) to (A10):

$$V^{mis}(e,L,0) = I\, R_l\, (2s-1)\, \varepsilon / p \qquad \text{(A12)}$$

$$V^{mis}(n,S,0) = I(1-p)\, \varepsilon/p\, R_s[\varepsilon/p - \delta/R_s - (2s - 1) + (2s-1)\, \varepsilon/p\, \delta/R_s] / [p^2 - \varepsilon^2] \qquad \text{(A13)}$$

From equation (A12) it follows that the type e firm realizes a mispricing loss (i.e., V^{mis}(e,L,0) is positive) when s > 1/2. From equation (A13) it follows that the mispricing condition V^{mis}(n,S,0) is positive only if

$$[\ \varepsilon / p - (2s-1) - \delta / R_s + (2s - 1)(\varepsilon / p)(\delta / R_s)\ ] > 0. \qquad \text{(A14)}$$

Equation (A14) can be further simplified assuming (2s - 1) is small and therefore neglecting the term $(2s - 1)(\varepsilon / p)(\delta / R_s)$. The equation (A14) then reduces to $\varepsilon/p > [(2s-1) + \delta/R_s]$. It is easy to show that a pooling equilibrium also can exist for some parameter values in which both type e and type n firms issue short-term debt and swap the short-term riskfree interest rate with the long-term risk-free interest rate.♦

Proposition 2: *Under an unfavorable exchange rate shock, (i.e., when $s < 1/2$), the high exposure firm separates out by borrowing long-term and swapping the long-term riskfree interest rate with the short-term riskfree interest rate in the swap market if and only if*

$$(\delta / R_s)(\varepsilon / p) > (1-2s)\,[\varepsilon / p + \delta / R_s\,] \qquad \text{(A15)}$$

Proof: Consider the separating equilibrium in which the type e firm issues a long-term debt and simultaneously swaps the long-term riskfree interest rate with the short-term riskfree interest rate and the type n firm issues a short-term debt. In this separating equilibrium, the short-term debt is priced at type e's terms and the long-term debt is priced at type n's terms, i.e., $\phi(L) = 1$ and $\phi(S) = 0$. Since debt-maturity signals the type, both short-term and long-term debt is correctly priced for each type, i.e., $V^{mis}(e,L,1) = 0$ and $V^{mis}(n,S,0) = 0$. If the type n firm or the type e firm deviates from the equilibrium and chooses an off-equilibrium signal, its mispricing is given by

$$V^{mis}(n,L,1) = I\, R_l\, (1 - 2s)\, \varepsilon / p; \qquad \text{(A16)}$$

$$V^{mis}(e,S,0) = I\,(1-p)\,[\,(\delta / R_S)(\varepsilon / p) - (1- 2s)(\varepsilon / p) - (1- 2s)(\delta / R_S)]. \qquad \text{(A17)}$$

For an expected appreciation i.e., $s < 1/2$, the type n firm incurs a mispricing loss by deviating from equilibrium as shown in (A16). From condition (A17), it follows that the type e firm incurs a mispricing loss by deviating from equilibrium if $(\delta / R_S)(\varepsilon / p) - (1- 2s)$

$(\varepsilon / p) - (1- 2s)(\delta / R_S) > 0$. Therefore the separating equilibrium exists when $s < 1/2$ and $(\delta / R_s) (\varepsilon / p) > (1-2s) [\varepsilon / p + \delta / R_s]$ ♦

Table 1

USE OF INTEREST RATE SWAPS BY COUNTRY

(billions of US$)

Currency	1995 YE US$ Equivalent[1]	Currency as % of Total[2]
USD	2856.5	32.8
AUD	65.0	0.7
BEL	90.3	1.0
GBP	433.4	5.0
CAD	102.9	1.2
DKK	25.4	0.3
DEM	984.5	11.3
NLG	62.3	0.7
XEU	96.4	1.1
FRF	1113.5	12.8
HKD	28.9	0.3
ITL	217.3	2.5
NZD	3.0	0.03
JPY	2259.3	26.0
ESP	91.9	1.1
SEK	45.9	0.5
CHF	159.2	1.8
Other	63.2	0.7
TOTAL	8698	100.0

Source: International Swaps and Derivatives Association, Inc.

[1] This is year-end (YE) 1995 interest rate swap activity in different countries in terms of USD equivalent value. The currencies in the first column represent the different countries.

[2] This is the contribution of the value of interest rate swap activity in any given country to the total (global) interest rate swap activity.

Table 2

USE OF INTEREST RATE SWAPS AND CURRENCY SWAPS

(billions of US$)

Year	Activity for Interest Rate Swaps[a]	Activity for Currency Swaps[b]	Total Activity for All Swaps[c]
1987	388	86	474
1988	568	123	691
1989	833	170	1003
1990	1264	213	1477
1991	1622	328	1950
1992	2822	302	3124
1993	4104	295	4399
1994	6240	379	6619
1995	8698	455	9153

Source: International Swaps and Derivatives Association, Inc.

[a]Number of new contracts initiated during the year for interest rate swaps.

[b]Number of new contracts initiated during the year for currency swaps.

[c]Number of total new contracts initiated during the year for interest rate and currency swaps.