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**IMPACT OF INTEREST RATE SWAPS ON CORPORATE CAPITAL STRUCTURE: AN
EMPIRICAL INVESTIGATION**

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Impact of Interest Rate Swaps on Corporate Capital Structure: An Empirical Investigation

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Abstract

Interest rate swaps are the most popular financial derivatives used by US firms. In this paper, the effects of swap usage on corporate financing decisions are empirically examined. Based on a dynamic capital structure theoretical model, we employ a seemingly unrelated regression model with a heteroscedasticity-consistent covariance estimator to estimate these effects. The empirical results show that the firms with higher effective tax rates reduce their optimal debt ratio range when they use interest rate swaps. We also found that the swap users may enlarge the influence of firm size on corporate dynamic debt policy, though it was not clear that it helped reduce or increase the optimal debt ratio range. No effect of swaps usage on the optimal debt ratio range was found related to bankruptcy costs and the volatility of income. The findings imply that the use of swaps can help firms stick to an initial high debt ratio and make more use of the large tax benefits of debts on debt financing decisions.

I. INTRODUCTION

An interest rate swap is a contractual agreement between two parties to exchange a series of interest rate payments without exchanging the underlying debt. Interest rate swaps are one of the major financial innovations since the 1980s and have recently experienced phenomenal growth in worldwide financial markets. According to the General Accounting Office (1994, p.187), the notional amount of interest rate swaps outstanding hit \$3.85 trillion by the end of 1992, dominating all other major derivative products in the marketplace. Furthermore, several recent surveys reveal that interest rate swaps are the most popular derivative contracts used by United States firms.¹

Interest rate swaps provide firms with greater flexibility in determining their liability streams.² This in turn may have an impact on corporate financing. This paper explores the impact of interest rate

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¹ See "Which derivatives do CFOs really use," Vol. 26, Institutional Investor (April 1992), p.141; "Wharton survey of derivatives usage by U.S. non-financial firms," Vol.24, No.2, Financial Management (Summer 1995), p.104-114; "1995 derivatives practices and instruments survey," Vol.24, No.2, Financial Management (Summer 1995), p.115-125.

² Consistent with the definition here, "interest rate swaps" are those generally referred to as plain-vanilla or generic interest rate swaps. More specifically, our discussion is placed on fixed/floating swap in which a fixed-rate payer promises to make periodic payments based on a fixed interest rate to a floating payer, who in turn agrees to make variable payments tied to some short-term interest rate.

swaps on firms' financing decision patterns by determining empirically how important interest rate swaps are for the corporate capital structure. The impact of swaps on capital structure decisions may directly affect the supply side for corporate bond markets. Also, until recently, dynamic capital structure models have not been given much attention and very few empirical tests have been conducted based on these models. The paper also employs and tests the effectiveness of a dynamic capital structure model.

The rest of this paper is organized as follows. In Section 2, we briefly discuss the underlying theoretical consideration and the dynamic capital structure theoretical model developed by Fischer et al. (1989). We then discuss the data and the empirical model in Section 3. In Section 4 we present the main results. Finally, we provide concluding remarks in Section 5.

II. THEORETICAL OVERVIEW

The typical application of interest rate swap is synthetic financing (Kuprianov, 1994). The long-term (fixed-rate) debt is synthesized by using the short-term (variable rate) debt accompanied by a swap. The short-term (variable rate) debt can also be synthesized by using long-term (fixed-rate) debt accompanied by a swap. Since firms may use synthetic fixed-rate or variable rate debts, it is difficult to identify whether those firms using swaps actually tend to use long-term or short-term debts. The often-used static debt ratio models are impractical for capturing the effects of swap usage consistently. In fact, the single-period static models have many other deficiencies. Chen (1979) pointed out that the single-period models are inadequate for analyzing the dynamic characteristics of the capital structure problem because it is impossible to make distinctions between corporate reorganization and liquidation in the single-period framework. A dynamic capital structure model is more flexible in its ability to capture the influence of swaps.

The underlying theoretical model used in this study is the dynamic capital structure choice model proposed by Fischer et al. (1989). The Fischer et al. model is based on the continuous time dynamic valuation and proved robust in their empirical tests. It is essentially a dynamic generalization of the traditional tax/bankruptcy cost theory on optimal capital structure. The model is along the lines of

the early work by Merton (1974) which addressed the capital structure issue using option-pricing theory. An important insight of the model is to refine the meaning of an optimal debt ratio and then to examine optimal dynamic capital structure choice. In the Fischer et al. model, any debt ratio lying within a set of boundaries is still optimal and hence the firm avoids carrying out costly recapitalization. So similar firms could have different leverage ratios at any point in time. The boundaries of the optimal debt ratio range are determined by recapitalizing costs. The higher financial flexibility can result from lower recapitalization costs and be reflected in the smaller optimal debt ratio range. The general conclusion of Fischer et al. (1989) is that firms with large optimal debt ratio ranges have a low effective corporate tax rate, a small asset size, a high volatility of underlying asset value, and low bankruptcy costs. However, no study other than Fischer et al. has tested the validity of this model. Our work reconsiders the validity of their results, using a data set that covers a different and longer period. In addition, our econometric model measures the swap usage effects on the capital structure.

To date, no literature directly addresses the possible influence of using financial derivatives, such as interest rate swaps, on corporate capital structure. However, a few works do provide some insights for our expectations and hypotheses testing. It is known that the use of interest rate swaps can provide a firm with additional flexibility to restructure its long-term fixed-rate obligation (e.g., Smith et al., 1986, 1988; Wall and Pringle, 1989). Swaps, as highly versatile and cost-effective instruments, have transformed corporate liability management into a more active endeavor (Goodman, 1990). Conceptually, the impact of swap usage on capital structure can be modeled as option on option, where the first option refers to the financial flexibility associated with swap usage and the second option refers to the capital structure issue (i.e., the financial flexibility of equity holders to default on debt payment) as in Merton (1974). Specifically, we expect that firms may be better able to maintain the higher debt ratios and exploit more tax benefits over time, by taking advantage of the more flexible liability management associated with the swap usage. In the context of the dynamic capital structure model, we expect that the effective tax rate may play a more significant role in determining dynamic capital structures after using swaps. It can be further expected that if a high tax rate initially reduces the debt

ratio range, as predicted by Fischer et al., then the high tax rate to larger extent will reduce the debt ratio range after using swaps.

Bankruptcy cost is also a variable of interest related to swap usage effects on capital structure. Titman (1992) argued that growth firms which are currently regarded as having a greater likelihood of bankruptcy, but also having an optimistic future outlook privately known by the management, can benefit from borrowing short-term and swapping for a fixed-rate obligation. In this way, they may correctly signal their better financial situations in the future and avoid the unfavorable consequences of currently perceived higher bankruptcy costs reflected in higher rates of interest on long-term debt. From the agency cost perspective, Wall (1989) gives a similar prediction that synthetic fixed-rate financing via interest rate swaps lessens incentives to take on more risky investment strategies. This would imply that the magnitude of bankruptcy cost on financing decisions would be diminished after using swaps.

Large firms are more likely to use swaps. Kim and Koppenhaver (1992) have found that the likelihood and extent of using interest rate swaps for banks are positively related to the firm size. Bodnar et al. (1995) reported that 65% of large firms use derivatives while only 13% small firms use them. The reasons for this difference include the existence of significant fixed costs associated with starting and managing a derivative program. Moreover, larger firms have a greater range of risk exposures, thus making the use of derivative more suitable. Hence, we may expect the firms with larger size may be more affected by the use of swaps in their capital structure decisions. Finally, since interest rate swaps are designed to manage interest rate risks, we may expect reduction in the financial risk for firms using swaps.

III. DATA AND THE EMPIRICAL MODEL

The data used in this study came from the COMPUSTAT database file. Prior to 1994, no firm

was legally required to disclose the status of their usage of derivatives.³ However, a few swap users began to voluntarily report their usage to the Security Exchange Commission (SEC) beginning in the late 1980s. We searched SEC filing (compact disclosure) records to identify the reported new swap users in the major manufacturing industries year by year since 1987. We selected 1991 as the first year to examine swaps usage for the following reasons. First, in the years before 1991, there were very few reported new swap users for every manufacture industry. Second, we require enough time to observe the impact of interest rate swaps on capital structure. The literature generally suggests a period such as five years or more to observe capital structure, due to the effects of transaction costs and fluctuations in economic activity on capital structures (Sugrue and Scherr, 1989). We found that among manufacturing industries since 1991, interest rate swaps are most widely used in the chemical industry (SIC code of 28) and the machinery industry (SIC code of 35).⁴ Following Sugrue and Scherr (1989), we used a period of five years to observe a firm's capital structure. We identified 12 firms continuously using interest rate swaps in these two industries since 1991.⁵ Consideration of more firms was prevented because of incomplete data series and because the SIC codes were switched for some companies. We also considered the five-year sample subperiod between 1985 and 1989 when none of these firms reported any use of swaps. For comparison, a simple random sampling method was used to select 12 other firms in the two industries that did not use swaps in the above two sample subperiods. In sum, two non-overlapping five-year sample subperiods were considered: 18 quarters from the first quarter of 1985 to the second quarter of 1989, and 18 quarters from the second quarter of 1991 to the third quarter of 1995. The omission of seven quarters in between is to make sure that no firms using swaps in the second subperiod used swaps in the first subperiod. The data set consists of 48 observations (24 firms in two subperiods).

³ See "SEC is seeking data on firms' derivative risk," Wall Street Journal, May 24, 1994; "FASB requires more disclosure on derivatives; Firms must say how much they own, but risks need not be received," Wall Street Journal, October 6, 1994.

⁴ The number of swap users in these two industries is far more than other manufacture industries in 1991.

⁵ The first report of usage of swaps for these firms was shown on 1991 SEC filing though many of them actually entered into swaps in 1990.

We tested the impact swap usage has on capital structure by adapting the dynamic capital structure model presented by Fischer et al. (1989). The empirical model we used is a seemingly unrelated regression (SUR). The SUR system consists of the following two regression equations:

$$LEV_n = \beta_n X + \delta_n DX + \varepsilon_1 \quad (\text{eq. 1})$$

$$LEV_s = \beta_s X + \delta_s DX + \varepsilon_2 \quad (\text{eq. 2})$$

Equation (1) is for the 12 firms not using swaps. Equation (2) is for the 12 firms using swaps. The ε_1 and ε_2 are residuals.

The dependent variable (LEV) measures the optimal debt ratio range employed by firms, and is explicitly defined as the maximum minus the minimum ratio of total liabilities divided by total liabilities plus equity market value. There are two major reasons to prefer this definition of the debt ratio. The static financial leverage is traditionally measured by the long-term debt ratio that equals the ratio of long-term debt over total liabilities plus equity market values. However, today more and more firms routinely use short-term debt to fund their long-term investments, particularly considering the role of interest rate swap. Thus, the more reasonable numerator for debt ratio may be total liability, the sum of short-term debt and long term debt, rather than long term debt alone. In addition, the underlying dynamic theoretical model is unable to discriminate between liabilities with differing maturities (Fischer et al, 1989). Another important assumption worth noting is that the observed minimum and maximum debt ratios represent the recapitalization bounds, or at least that the distance between the unobserved bounds is positively correlated with the difference between the observed minimum and maximum ratios.

The regressor matrix X includes a constant and four basic independent variables corporate tax rate (TXRT), firm asset size (SIZ), volatility of underlying asset value (SD), and bankruptcy cost (IND). The four basic independent variables are measured as follows. The TXRT is defined as the average of the ratios of quarterly reported income tax over quarterly pre-tax income. The SIZ is defined as the average of quarterly total liabilities plus equity market value, in millions of dollars.

The SD is measured by the standard deviation of the logarithm of the ratio of $SIZ(t)$ over $SIZ(t-1)$, where t is measured in quarters. Titman and Wessels (1988) argue that the machine and equipment-manufacturing firms will impose especially high bankruptcy costs on customers and suppliers. To address this, Fischer et al. (1989) introduced a dummy variable which is defined to be one for industries with a two-digit SIC code between 34-40, and zero otherwise. Similarly, in our study IND is a dummy variable that is one for all sample firms in the machinery industry and zero for all sample firms in the chemical industry.

To measure or control for the effects of time, the binary variable D is defined as zero in the first 18 quarters (when no firms used interest rate swaps), and defined as one for the next 18 quarters (when some sample firms did use interest rate swaps). The relationships between firm-specific characteristics and time effects can be captured by the interaction terms DX .

The two-equation system represented by equation (1) and (2) is not only more efficient than single equation estimation, it is also flexible in conducting hypothesis tests. The appropriate test statistics may be an individual t -statistic, an F -statistic, or an χ^2 -statistic. The null hypotheses that there is no time period effect on the parameters in the model can be tested by the hypotheses $\delta_n = 0$ and $\delta_s = 0$ in equation 1 and 2, respectively. Note that at least one of hypotheses $\delta_n = 0$ and $\delta_s = 0$ should be rejected for our following hypothesis testing on swap usage effect. Otherwise, no swap usage effect on debt ratio ranges that only possibly occurred in the second subperiod can be clearly identified and attributed to the use of swap. However, once the above premise holds, the pure time effect on the parameters were not our primary concern. Of central interest was the effect of swap usage on the optimal debt ratio range. To examine swap usage effects, we test $\beta_n = \beta_s$ and $\beta_n + \delta_n = \beta_s + \delta_s$. If $\delta_n \neq 0$ and $\delta_s \neq 0$, testing $\beta_n = \beta_s$ tells us if the determinants X have a similar influence in determining debt ratio range for both types of firms for the first subperiod. Testing $\beta_n + \delta_n = \beta_s + \delta_s$ provides similar information for the second subperiod, when one group of firms used swaps. Combining the information from test results on $\beta_n = \beta_s$ and $\beta_n + \delta_n = \beta_s + \delta_s$ may reveal the swap usage effects.

In particular, we are interested in the following hypothesis tests of $X = (\text{TRXT}, \text{SIZ}, \text{SD}, \text{IND}, 1)$, as discussed in the previous section. When calculating the parameters in the second time subperiod, the δ parameters can be omitted if they are found to be statistically insignificant using a Wald or likelihood ratio test. In addition, the corresponding parameters for both types of firms in the two time subperiods are expected to have a uniform sign. It can be reasonably assumed that the effect each variable has on the optimal debt ratio range would be similar, but not necessarily the same magnitude during the two periods. Moreover, the signs may not be the same as suggested in Fischer et al. We tested the hypothesis that the influence TXRT has on the dynamic capital structure increases when firms use swaps. If the TXRT parameter for swap firms (β_{1s}) is equal to the TXRT parameter for no swap firms (β_{1n}) in the first subperiod (i.e., $\beta_{1s} = \beta_{1n}$), the absolute value of the TXRT parameter for swap firms ($|\beta_{1s} + \delta_{1s}|$) should be greater than the absolute value of the TXRT parameter for no swap firms ($|\beta_{1n} + \delta_{1n}|$) in the second subperiod (i.e., $|\beta_{1s} + \delta_{1s}| > |\beta_{1n} + \delta_{1n}|$). Alternatively, if the TXRT parameter for swap firms is not equal to the TXRT parameter for no swap firms in the first subperiod (i.e., $\beta_{1s} \neq \beta_{1n}$), the increase in the TXRT parameter for swap firms in the second subperiod should be larger than the TXRT parameter increase for no swap firms (i.e., $|\beta_{1s} + \delta_{1s}| - |\beta_{1s}| \geq |\beta_{1n} + \delta_{1n}| - |\beta_{1n}|$). Furthermore, if all of β_{1s} , β_{1n} , $\beta_{1s} + \delta_{1s}$, and $\beta_{1n} + \delta_{1n}$ are negative (or positive), we can further argue that the increased magnitude of the effective tax rate decreases (or increases) the debt ratios range over time.

We also tested the hypothesis that the influence SIZ has on the dynamic capital structure increases when firms use swaps. We tested this hypothesis similar to the test of the TXRT parameter discussed earlier.

It was expected that the influence IND has on the dynamic capital structure is decreased when firms use swaps. When testing this hypothesis, we expected one of the following cases. If the IND parameter for swap firms (β_{4s}) is equal to the IND parameter for no swap firms (β_{4n}) in the first subperiod (i.e., $\beta_{4s} = \beta_{4n}$), the absolute value of the IND parameter for swap firms ($|\beta_{4s} + \delta_{4s}|$) in the second subperiod should be smaller than the absolute value of IND parameter for no swap firms ($|\beta_{4n} + \delta_{4n}|$).

$+\delta_{4n}|$) (i.e., $|\beta_{4s} + \delta_{4s}| < |\beta_{4n} + \delta_{4n}|$). If the IND parameter for swap firms is not equal to the IND parameter for no swap firms in the first subperiod (i.e., $\beta_{4s} \neq \beta_{4n}$), the decrease in the IND parameter for swap firms in the second subperiod should be smaller than the corresponding decrease for no swap firms (i.e., $|\beta_{4s} + \delta_{4s}| - |\beta_{4s}| < |\beta_{4n} + \delta_{4n}| - |\beta_{4n}|$). Furthermore, if all of β_{4s} , β_{4n} , $\beta_{4s} + \delta_{4s}$, and $\beta_{4n} + \delta_{4n}$ are positive or negative, we can further argue that the increased magnitude of bankruptcy increases or decrease the debt ratio range over time.

Finally, we note that the proxy for the risk in our model may not be representative of the type of financial risk associated with interest rate swaps. Thus, we do not hypothesize any significant swap usage effect related to SD in our model.

IV. EMPIRICAL RESULTS AND DISCUSSIONS

As expected, we found heteroscedasticity but no autocorrelation when running ordinary least square regression on each of two equations. We employed the heteroscedasticity-consistent covariance estimator proposed by White (1980) for the system of regression equations. The correction is robust without any assumption of type of heteroscedasticity.

We first examined the possible time effects. The interaction terms $DxSIZ_n$ in equation 1 and $DxTXRT_t$ in equation 2 were significantly different from zero. We could not reject the joint null hypothesis that the DX parameter estimates for all other interaction terms were insignificantly different from zero at the 5 percent significance level. Thus, we may exclude these independent variables from the SUR. The test statistics $\chi^2(8)$ is 6.48, much smaller than the corresponding critical values at 5% level. This means that there was no statistical difference in the parameters between the two subperiods except for SIZ_n and $TXRT_t$. Therefore, the more parsimonious SUR was estimated and the results are presented in Table I. The R^2 was 0.49 for Equation 1 and 0.68 for Equation 2.

Our results largely confirm Fischer et al.'s conclusions (Table 1). As in Fischer et al (1989),

the debt ratio range of swap user firms is inversely related to the effective corporate tax rate in the first subperiod ($TXRT_s = -0.19 < 0$). The debt ratio range for swap firms is positively related to volatility of the asset value ($SD_s = 0.89 > 0$). The coefficients of these two variables in both subperiods for no swap firms (Equation 1) are also with similar signs, but are not significant. The coefficient of SIZ for swap firms in Equation 2 is with the expected negative sign, although it is not significant. However, contradictory to Fischer et al. (1989), the size of no swap firms in Equation 1 is found to be positively correlated with the debt ratio range in the first subperiod ($SIZ_n = 0.61 \times 10^{-5} > 0$). Moreover, firms with lower bankruptcy cost tend to have a lower debt ratio range ($IND_n = 0.21 > 0$), although the relationship is not significant in Equation 2.

The two variables, i.e., $TXRT_s$ and SIZ_n , had significant time effects ($DxTXRT_s = -0.18$, $DxSIZ_n = -0.70 \times 10^{-5}$), thus we examined their different roles in determining optimal debt ratio range in the second subperiod. The relevant test results were reported in Table 2 and are consistent with the findings of $TXRT_s$ and SIZ_n in first subperiod. The debt ratio range of swap firms was inversely related to the effective corporate tax rate in the second subperiod ($TXRT_s + DxTXRT_s = -0.37$). The size for no swap firms was not found to be significantly negatively correlated with debt ratio range in the second subperiod ($SIZ_n + DxSIZ_n = 0$).

The following reasons may be largely accountable for our differences from Fischer et al. First, as Fischer et al (1989) pointed out, the predicted negative sign on bankruptcy cost variable critically relies on the possibility of issuing riskless debt, and the relationship between the debt ratio range and bankruptcy cost is reversed in a second-best world in which only risky debt is possible. Second, the White heteroscedasticity correction used here is robust against any type of heteroscedasticity, whereas Fischer et al adopted a specific form of heteroscedasticity correction. Third, the difference might also be partly due to different sampling period relative to Fischer's sample from 1977 to 1985. For example, two sample industries in this study are usually regarded as relatively capital-intensive ones, and normally have much larger sizes. Thus, in terms of relationship of debt ratio range and firm size, our estimation in equation (1) possibly fails to capture the

significant effects of typical small firms on debt ratio range.

The empirical results of swap usage effects were summarized in Table 2. The results suggest that the firms with higher effective tax rates reduced their optimal debt ratio range when they used interest rate swaps in second time subperiod ($TXRT_s - TXRT_n = 0$, $(TXRT_s + D \times TXRT_s) - TXRT_n = -0.42 < 0$). In the context of the dynamic model, the higher effective tax rate implies the increased value of tax benefits of debts, relative to the recapitalization cost. The finding may imply that the use of swaps can help the firm to have more ability to stick to initial favorable (high) debt ratio, and make more use of large tax benefits of debts.

The size-related swap usage effect on debt ratio range is also of interest. It shows that in the first time subperiod firm size has less influence on debt ratio range for prospective swap users than swap non-users ($SIZ_s - SIZ_n = -0.11 \times 10^{-4} < 0$ and $SIZ_s = 0$). However, in the second time subperiod when the swap users did use swaps, the effect of firm size on debt ratio range is the same for both types of firms ($SIZ_s - (SIZ_n + D \times SIZ_n) = 0$). The results indicate that the swap firms relatively enlarge the influence of firm size on optimal debt ratio range, and are consistent with the observations of Bodnar et al (1995) and Kim and Koppenhaver (1992). Since our estimation gives opposite sign of SIZ to that in Fischer et al, and we do not find out a very satisfactory explanation for the contradiction, it is ambiguous whether the enlarged effect may help reduce or increase the optimal debt ratio range.

The third type of swap usage effects involves bankruptcy cost. The traditional tax/bankruptcy cost capital structure theory would suggest that the tradeoff of sticking to more debts and exploiting more tax advantage for swap users should be the increase in bankruptcy cost for these firms. However, in the dynamic context, the more ability to stick to initial high debt ratio brought by using swaps (which implies the more stable debt ratio), the less would-be the change in bankruptcy cost as a tradeoff. According to the positive relationship between bankruptcy cost and debt ratio range found in our estimation, it is implied that the swap usage induces the swap users with higher bankruptcy cost to have less debt ratio range. However, although we find that the influence of

bankruptcy cost on debt ratio range is smaller for swap users than for swap non-users ($IND_s - IND_n = -0.21 < 0$, $IND_s = 0$), it appears to hold in both subperiods and we have little evidence for attributing this to the swap usage in the second subperiod (Both $Dx\ IND_n$ and $DxIND_s$ were found to be insignificant at 5 percent level, with a higher t-statistic of 1.01). In another words, the result does not verify the bankruptcy cost hypothesis based on arguments of Titman's (1992) and Wall (1989).

Noteworthy, the finding with regard to bankruptcy cost should be interpreted with much caution. As mentioned previously, one compounding factor concerning the bankruptcy cost in Fischer et al model is whether the firm can issue riskless or risky debts. There exists the possibility of switching from issuance of riskless debt in one subperiod to issuance of risky debts in the other subperiod by swap users, which implies offsetting signs in the context of the explanatory power of the bankruptcy cost to debt ratio range in the Fischer et al model. This can possibly cause insignificance of swap usage effects associated with bankruptcy cost. Furthermore, the empirical definition of bankruptcy cost here only attempts to capture the perceived bankruptcy cost difference between the industries with a two-digit SIC code between 34-40 and other manufacturing industries and thus may be too narrow to be representative. Further work based on more appropriate empirical definition of the bankruptcy cost is left for the future research.

Finally, no swaps usage effects on debt ratio range is found related to volatility of the asset value ($SD_s - SD_n = 0$). The SD is designed to be a proxy for business risk that is concerned with instability of general business performance such as earnings and incomes, while interest rate swaps only manage financial risk which is completely another kind of risk directly associated with debt leverage. Thus, it is not surprising to see no relationship identified in our test results, since the possible indirect effect of swap usage on business risk may be too weak. In sum, swaps usage makes more active debt management optimal in terms of exploiting the tax benefits, with lessening the limitation of bankruptcy cost on debt financing decisions.

V. CONCLUSIONS

This paper examines the effects of interest rate swaps on corporate capital structure decisions. Based on adapted dynamic capital structure model developed by Fischer et al, we found that the swap users with higher effective tax rate tend to reduce their debt ratio range. The firms using swaps also enlarge the magnitude of firm size on debt ratio range determination though it is not clear whether it helps reduce or increase the debt ratio range. There is no swap usage effect related to bankruptcy cost and volatility of the asset value. However, the finding with regard to bankruptcy cost may be inconclusive due to the narrow nature of its empirical definition.

The findings here provide some important implications. Firms with higher effective tax rate may benefit more from swap usage through more ability to stick to initial favorable debt ratios and exploit the larger tax benefit of debts. This implication also helps further understand the tax incentive of hedging argument (e.g. Graham and Smith, 1998), which says that hedging may reduce the firm's expected tax liability. Firms of larger size may be more influenced by swap usage, which may not only reflect the phenomena that large firms are more often involved with swap usage but also send a warning message that large firms could benefit more or suffer more from swap usage.

Finally, as a referee has suggested, future researchers may consider nesting Fischer et al model with other competing dynamic capital structure models and employing the nested model to examine the impact of derivative usage on corporate capital structure. This nested model may provide us with an opportunity of more comprehensive description of impact on capital structure, noticing that the capital structure theory is still an unresolved puzzle.

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Table 1. *Estimation Results of SUR Using Heteroscedastic-consistent covariance (t-Statistics in Parentheses)*

VARIABLE	LEV _n	LEV _s
Constant	0.10 (0.97)	0.22** (3.27)
TXRT	-0.05 (-0.27)	-0.19* (-1.93)
SIZ	0.61x10 ^{-5**} (3.15)	-0.46x10 ⁻⁵ (-1.39)
SD	0.06 (0.18)	0.89* (1.98)
IND	0.21** (3.80)	0.01 (0.26)
SIZxD	-0.70x10 ^{-5**} (-6.79)	—
TXRTxD	—	-0.18** (-2.31)
<hr/>		
R ²	0.49	0.68

Note: The coefficients with “*” indicate their statistical significance at $\alpha=10\%$ and actually almost at $\alpha=5\%$, and the coefficients with “**” indicate their statistical significance at $\alpha=1\%$.

Table 2. Hypothesis testing results based on the estimation in Table 1

Null Hypotheses	Test Value	χ^2 Statistics	Reject (R) or Fail to reject(F)
-----Time Period Effects -----			
H1: $TXRT_s + DxTXRT_s = 0$	-0.37	14.18	R**
H2: $SIZ_n + Dx SIZ_n = 0$	-0.90×10^{-6}	0.54	F
-----Swaps Usage Effects -----			
H1: $TXRT_s - TXRT_n = 0$	-0.24	1.01	F
H2: $SIZ_s - SIZ_n = 0$	-0.11×10^{-4}	5.60	R **
H3: $SD_s - SD_n = 0$	0.83	2.04	F
H4: $IND_s - IND_n = 0$	-0.21	8.75	R**
H5: $(TXRT_s + DxTXRT_s) - TXRT_n = 0$	-0.42	3.13	R*
H6: $SIZ_s - (SIZ_n + Dx SIZ_n) = 0$	-0.37×10^{-5}	0.92	F

Note: The appropriate critical value of $\chi^2(1)$ statistics is 3.84 at 5% and 2.71 at 10%. The R with “***” denote the rejection of null hypothesis at 5%, and the R with “*” denotes the rejection at 10%.