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ON THE DETERMINANTS OF DERIVATIVE HEDGING BY INSURANCE COMPANIES: EVIDENCE FROM TAIWAN

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ABSTRACT

There has been considerable growth in the derivatives holdings of Taiwanese insurance companies in recent years and this study examines the determinants of derivative use for both life and non-life companies. The determinants are different in the two insurance sectors. For the life sector, we find that large firms and firms exposed to either foreign exchange risk or interest rate risk (due to the duration of liabilities being greater than that of the assets) are more likely to participate in derivative hedging activities. In the case of foreign exchange risk, the greater the exposure, the greater the derivative holdings (as a proportion of the total assets of the firm). For the non-life sector, exposure to interest rate risk (as measured by net interest margin) and foreign exchange risk have a significant influence on the derivative participation decision. The level of derivative holdings is then positively related to foreign exchange exposure and negatively related to the level of reinsurance.

Key Words: Derivative use; Hedging; Insurance companies

JEL classification: C3; G32; M41

INTRODUCTION

Taiwanese insurance firms have been authorized to engage in derivatives activities since the mid-1990s although the insurance regulator only permits the use of derivatives for hedging purposes and not for speculative purposes. However, very few insurers were actively involved in this market prior to 2001. Table I shows that the number of derivative users and the value of derivatives held by the Taiwanese insurance industry increased substantially during the period 2001-2003, with life insurers being the main users. This finding is consistent with Cummins, Phillips, and Smith (1997) for the U.S. market and De Ceuster *et al*. (2003) for the Australian market, who find that derivative use in the non-life insurance sector is relatively low and that derivative activity is limited almost exclusively to the life sector. As shown in this table, the number of derivative users and their derivative holding increase substantially over the sample period. There were 21% (0%), 36% (11%), and 67% (25%) of life (non-life) insurers that use derivatives in the years 2001, 2002, and 2003, respectively. In our analysis, if an insurer reports a non-zero derivative position, it is classified as a derivative user. It is possible, however, that some insurers may close out their derivative positions, thus appearing not to be derivative users.

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Table-1. Number of Insurers in Life and Non-Life Sectors

	2001	2002	2003	Total
Life insurers using derivatives	6 (151)	10 (314)	19 (785)	35 (1250)
Life insurers in our sample	27	28	24	79
Life insurers in business	29	28	27	84
Non-life insurers using derivatives	0 (0)	3 (3)	6 (11)	9 (14)
Non-life insurers in our sample	23	24	24	71
Non-life insurers in business	28	27	24	79

Note: The amount (in NT$ billion) in parentheses represent the end-of-year derivative position held by insurers. US$ 1 is approximately equal to NT$ 32.5 as of June 2009.

According to the year books and annual financial reports provided by the Insurance Institute of the Republic of China, Taiwanese derivative users in the insurance industry tend to use foreign currency contracts. Non-life insurers only utilize currency forwards and for life companies they are the most popular type of contract in terms of number of users and positions held. Specifically, 67%, 80%, and 84% of life sector derivative users utilized currency forwards in 2001, 2002, and 2003, respectively. In terms of notional amounts of contracts, currency forwards accounted for 42%, 48%, and 48% of end-of-year derivative positions in 2001, 2002, and 2003, respectively. According to these users' financial statements, currency forwards are utilized to hedge currency risk arising from foreign investments or other operations. Interest rate swaps also account for significant end-of-year volume in the life sector. Although none of the life insurers used interest rate swaps in 2001, these contracts accounted for 22% and 40% in 2002 and 2003 respectively. Our results are consistent with Heaney and Winata (2005) who find that currency forward contracts and interest rate swaps are the most popular types of derivative contracts used by large Australian firms.

There are three main lines of research relating to corporate use of derivatives in the literature. The first concerns the practices of corporate derivative use (e.g. Global Derivatives Study Group, 1994; Cummins, Phillips, Smith, 1997; Bailly et al., 2003). These studies focus mainly on a descriptive analysis of derivative practices such as the number of companies employing derivative securities and the volume of trades. The second investigates the factors influencing the participation and volume decisions on derivative use (e.g. Cummins, Phillips, Smith, 1997; Cummins, Phillips, Smith, 2001; Nguyen and Faff, 2002). These papers attempt to identify the motivation for participating in derivative markets and the factors affecting the extent of their use. The last line of research examines the effect of derivative use on firm risk (Guay, 1999; Koski and Pontiff, 1999; Hentschel and Kothari, 2001). These studies attempt to ascertain whether firm risk increases or decreases with the use of derivatives.

This paper focuses on the second line of research - the determinants of derivative use in terms of the participation and extent of use decisions. We provide evidence from an emerging market which complements the existing US literature. First, we reveal the current practices of off-balance-sheet transactions in the Taiwanese insurance industry. Second, we use panel data modeling to overcome certain data and research method-based limitations such as the inability to control for unobservable differences across individual insurers that might influence derivative use. Thus, this paper should be of value to academics, practitioners and financial regulators.

The remainder of the paper is organized as follows. Section II reviews the existing literature and develops testable hypotheses. Section III describes the data and methodology employed. Section IV presents our empirical findings and conducts robustness checks. The final section concludes the paper and provides some implications of our work.

DEVELOPMENT OF HYPOTHESES

Maximization of Shareholder Wealth

Financial Distress

Smith and Stulz (1985) argue that risk management activities such as hedging enhances the expected firm value through reducing the likelihood of costly financial distress. Nance, Smith, and Smithson (1993) suggest further that small firms are more likely than large firms to hedge due to the greater potential impact of insolvency costs. Thus, firms with higher expected costs of financial distress are more likely to engage in hedging activities with derivative instruments.

One measure of potential financial distress is leverage, usually taken to be the debt to equity ratio (Nance, Smith, and Smithson, 1993; Mian, 1996; Tufano, 1996; Colquitt and Hoyt, 1997; De Ceuster, Flanagan, Hodgson and Tahir, 2003). However, the liabilities of insurers consist mainly of insurance reserves. In Taiwan, the reserve management of insurers is closely monitored by the regulatory authorities and a high reserves to equity ratio does not necessarily imply a high probability of insolvency. Hence, the leverage ratio employed in prior studies might not be a suitable indicator to capture the likelihood of insurer insolvency. As an alternative to the leverage ratio we use the total amount of insurance claims and associated interests deflated by earnings before interest and tax. We expect that insurers with a higher ratio will face greater risk of financial distress and will therefore tend to hedge more with derivative instruments.

Growth Opportunities

Highly leveraged firms with good growth opportunities tend to suffer from underinvestment due to the conflicts of interest between debtholders and shareholders. Shareholders have an incentive to forego profitable investment projects if the gains arising from the project are primarily obtained by debtholders. Hedging can be used to address the underinvestment problem (Mayers and Smith, 1987). Firms with good investment opportunities need funds on a consistent basis. If risks are unhedged and losses occur, these firms will probably have to finance the losses using internal funds which were originally earmarked for investment projects. In this case, costly external funds must be raised or else these investment opportunities will be foregone. Therefore, insurers with better growth opportunities are expected to engage more in derivative hedging. Following Ross, Westerfield, and Jaffe (2002), we define the level of growth opportunity (GROWTH) as the product of the cash reinvestment ratio and the return on equity.

Tax

Hedging can benefit firms in that expected tax payments can be reduced when corporate tax rates are progressive. Moreover, firms with higher tax preference items (e.g., tax credits) are more likely to hedge using derivatives because these items indirectly create convexity in the tax liability (Geczy, Minton and Schrand, 1997). One can therefore hypothesize that hedging benefits will be higher for firms with more tax preference items. In the empirical analysis, the tax benefit (TLCF) is proxied by the amount of tax loss carried forward scaled by net income.

RISK EXPOSURE

Foreign Exchange Risk

Insurers with overseas business and foreign investment are exposed to foreign exchange risk. In Taiwan, insurers are required to manage risks on their open foreign exchange positions, including such items as overall exposure, individual dealer's position, single transaction volume, stop loss protection strategy, and counterparty's limits. As an alternative, insurers have gradually employed derivatives to manage currency risk. Thus, we expect that large currency exposure to provide risk managers with incentives to hedge using derivative contracts. The foreign exchange (FX) risk is measured by the value of foreign asset portfolios scaled by the book value of total assets.

Interest Rate Risk

Insurance firms with a high mismatch between duration of assets and duration of liabilities will be sensitive to changes in interest rates. Carson, Elyasiani and Mansur (2008) document the prevalence of insurer exposure to interest rate risk and the dissimilarity of interest rate exposure among life, property and casualty, accident and health insurers. They also argue that the differences in interest rate exposure may result from differential use of interest rate derivatives. We therefore expect a positive relationship between derivative hedging and the gap between asset and liability durations (Cummins, Phillips and Smith, 1997; De Ceuster *et al*., 2003). Moreover, Purnanandam (2007) finds that firms with higher likelihood of financial distress will aggressively manage interest rate risk using derivatives or on-balance sheet instruments. Following Colquitt and Hoyt (1997) and De Ceuster *et al*. (2003), we measure duration gap as non-current asset duration less non-current liability duration, scaled by total assets (MISAST). The other related variable (MISLIA), non-current liability duration less non-current asset duration, scaled by total assets, is utilized to distinguish the type of duration gap affecting derivative use.

The second interest rate proxy (IM), measured by the net interest margin scaled by total assets, is also employed to capture the additional influence of interest rates on derivative use.

Substitutes for Risk Management

Corporations can avoid short-term insolvency risk by maintaining a high degree of liquidity (Nance, Smith and Smithson, 1993). Thus, insurers with higher current ratios (CR) should have less need for derivative hedging. Moreover, diversification across various types of claim payments might potentially reduce the demand for hedging instruments and, to some extent, serve as a substitute for the use of derivatives. In our analysis, the claim payments of life insurance are broadly classified into four types: life, accident, health and annuity, while those of non-life insurance are categorized into ten types: fire, hull, ship, inland marine, automobile, aviation, engineering, liability, credit and others. We utilize the Herfindahl index to measure the diversification of claim payments (HERFC).

Reinsurance is instrumental in managing underwriting and financial risks (Cummins et al, 1997) and the volatility of firm value can be decreased accordingly (Hardwick and Adams, 1999). Insurers relying heavily on reinsurance have less need for derivatives. We therefore expect a substitution effect in this hedging context. The use of reinsurance contracts (REINS) is measured by the ratio of reinsurance ceded to the sum of direct premiums written and reinsurance assumed.

Institutional ownership in Taiwan generally represents a long-term relationship between the holding institution and the underlying firm. Since close supervision by institutional shareholders can be considered a substitute for additional hedging activities, a negative association between derivative use and the level of institutional ownership is expected in our study. We measure the institutional ownership (CH) by the shareholding proportion of institutional shareholders.

CONTROL VARIABLES

Managerial ownership

Although shareholders can diversify business risk by holding well-diversified portfolios, they are unlikely to do so if they are shareholders in tightly-held companies. If the manager owns a large proportion of the company, one would expect the manager to engage more in hedging activities (Smith and Stultz, 1985), especially when the manager is rewarded with stock-related rather than option-related compensation (Tufano, 1996). In Taiwan, managers are generally compensated in the form of stocks in addition to salary. As a result, we can expect that managers with higher stock ownership would be more inclined to hedge with derivatives. In this study, managerial stock ownership (MH) is proxied by the proportion of stock held by the management.

Firm Size

Although a number of studies argue that large insurers have less need for derivative hedging from the perspective of financial distress costs and tax incentives (Warner, 1977; Altman, 1984; Nance *et al*., 1993), a majority of studies support the informational and scale economies hypothesis (e.g. Smith and Stulz, 1985; Colquitt and Hoyt, 1997; Cummins *et al*. , 1997; Hardwick and Adams, 1999; Sinkey and Carter, 2000; De Ceuster *et al*. 2003). This hypothesis suggests that large firms are more likely to use derivatives because these firms have sufficient trading volume to make derivative hedging worthwhile, and sufficient resources to recruit and train professionals in the necessary skills. We expect a positive relation between insurer size and derivative use. Firm size (SIZE) is measured by the logarithm of the book value of total assets.

Sale of Investment-Linked Insurance

In life insurance, investment-linked policies provide not only insurance protection but also investment returns. If the investment-related risks arising from such policies are not completely assumed by policyholders according to the contractual terms, insurers offering these products are exposed to these risks. Interest rate risk and currency risk increase as the proportion of the investment portfolio invested in correspondingly higher risk investments increases. It is plausible to expect that the sale of investment-linked insurance products will have a significant effect on firms' risk management policies. We use the proxy (INV), the notional value of assets of investment-linked insurance products deflated by gross written premiums, for the empirical analysis.

Investment Returns

It might be argued that firms with high investment returns are generally more skilled at investment-related activities including derivative transactions. Such firms may rely on derivatives to enhance their income or hedge their risk exposure. It can also be argued that the higher returns are the result of riskier investments, and thus the firms are using derivatives to hedge against the higher risk investments. Both arguments suggest that derivative use increases with investment returns. In our analysis, investment return (IR) is measured by the investment yield, defined as net investment income divided by total assets. However, due to different product characteristics, life insurers generally pay more attention to investment returns, while for their non-life counterparts underwriting profits are of greater significance. Thus, we only consider the investment return variable in the life insurance analysis.

Local Resources

The Taiwan insurance market used to be dominated by only a very few domestic insurers before liberalization in the early 1990s. Our study investigates whether domestic insurance firms have a greater propensity to engage in derivative hedging since they have more resources and institutional knowledge of the local market than their foreign competitors. The domestic dummy (DOMESTIC) is set equal to one for domestic insurance firms and zero otherwise.

RESEARCH DESIGN

Sample Construction

Due to the lack of an adequate database or statistical survey of derivative activities within the insurance sectors, we use the year books and annual financial reports provided by the Insurance Institute of the Republic of China as our main source of data on derivative use and firm characteristics of insurance companies. We collect annual data for both life and non-life insurance firms from 2001 to 2003 inclusive. During our sample construction process, we found that disclosure concerning derivative activities was not standardized among insurance companies. For example, some subsidiaries or branches of foreign insurance conglomerates provide simplified derivatives-use information over the period of observation, which does not allow us to gather the required data for further analysis. Therefore, those insurers with incomplete information were contacted by telephone or email so as to ascertain the derivative-use variables. Since insurers in Taiwan can only use derivatives for hedging purposes, insurers clearly disclose the use of derivatives for hedging purposes in their financial statements, which makes our study on hedging

behavior feasible. Table I shows the number of insurers operating during the period in question and the number of insurers included in our sample. Over 90 percent of insurers in business and all relatively large insurers (in terms of gross premiums written and total assets) are in the sample, so the sample is representative of the insurance industry.

Methodology

A number of firm characteristics are hypothesized as having an impact on derivative use. A list of these variables and their definitions are given in Table II. We then employ a model to investigate the use of derivatives among Taiwanese institutions in which derivative activities are formulated as the participation decision and the participation extent.

Table- 2. Variables and Their Definitions

Variable	Definition
Dependent variable	
Participation decision	Participation dummy variable taking the value one for participants, zero otherwise.
Extent decision	End-of-year derivative positions scaled by total assets
Independent variable	
Firm size	Natural logarithm of total assets
Financial distress	Sum of total insurance claims and associated interests divided by earnings before interest and tax
Interest rate risk asset	Mismatch where non-current assets outweigh non-current liabilities scaled by total assets
Interest rate risk liability	Mismatch where non-current liabilities outweigh non-current assets scaled by total assets
Growth opportunities	Cash reinvestment ratio multiplied by return on equity
Reinsurance	Ratio of reinsurance ceded to the sum of direct premiums written and reinsurance assumed
Tax	The amount of tax loss carry forward scaled by net income
Institutional ownership	Shareholding proportion of institutional shareholders
Managerial ownership	Managerial shareholdings as a percentage of all shares outstanding
FX	Total amount of foreign investment scaled by total assets
NIM	Net interest margin scaled by net income
INV	Value of underlying assets represented by investment-linked insurance deflated by gross written premiums [for life sector]
CR	Current ratio
DOMESTIC	1 if domestic insurer, 0 otherwise
HERFC	Herfindahl index reflecting concentration of claim payments
IR	Net Investment income divided by total assets [for life sector]

The general framework of the motivation model in the empirical analysis is reported as the following equation:

$$Derivatives\ usage_{i,t} = f\left(firm\ characteristics_{i,t} \right) \quad (1)$$

In the analysis of the participation decision, a company is regarded as a derivative user if the year-end derivatives balance in its financial statements is not zero. Based on the binary nature (0 for derivatives nonusers and 1 for users), probit regression is utilized to analyze the participation decision. Various approaches to the participation extent model have been proposed in prior research. The OLS model with Heckman's (1979) two-step estimation procedure suggested by Greene (2003) for correcting heteroscedasticity and inconsistency is applied in examining the magnitude of usage in insurance-related studies such as Colquitt and Hoyt (1997), Hardwick and Adams (1999) and De Ceuster et al. (2003). The generalized tobit model proposed by Cragg (1971) is employed by Cummins, Phillips, and Smith (2001) in studying the level of use among U.S. life and non-life insurers and by Shu and Chen (2002) in analyzing derivative use among firms listed on the Taiwan Stock Exchange. Sinkey and Carter (2000) argue that a tobit regression developed by Tobin (1958) is suitable for analyzing the extent of derivative use. In fact, a tobit regression can be regarded as an alternative to the Heckman two-step estimation procedure. Following Colquitt and Hoyt (1997), Hardwick and Adams (1999) and De Ceuster et al. (2003), we attempted to estimate the extent of derivative use equation using the Heckman two-step estimation procedure. However, the inverse Mills ratio obtained from the probit models was not found to be significant in any of the extent models. Thus, the extent models were estimated using ordinary least squares, fixed/ random-effects models.

Unlike the above studies which use single-year observations, our research employs cross-sectional and panel data over three years in the life and non-life insurance sectors. The results obtained from the panel data estimation can then be compared with those from the cross-sectional estimation. Lagrange Multiplier (LM) and Hausman tests are carried out to determine the most appropriate model. The former is used to examine the relative efficiency of the heterogeneous panel data models (one-factor fixed/ random-effects models) against the homogeneous pooled OLS estimation. The latter is employed to determine which panel data model should be used in the study if the computed LM test statistic argues in favor of panel data models (Hausman, 1978).

A White test for heteroscedasticity is performed. If the null hypothesis of homoscedasticity is rejected at the 0.05 level, then heteroscedasticity-corrected estimates are reported.

As regards multicollinearity, we compute variation inflation factors (VIFs) for the independent variables. All the VIFs are less than 2. According to Studenmund (2001, p. 258), the multicollinearity is severe if the largest VIF value among all independent variables exceeds five. Based on this rule-of-thumb, it seems that multicollinearity is not a problem in this study.

EMPIRICAL RESULTS

Univariate Results

To examine whether there is any difference in the firm characteristics of derivative users and nonusers in the life and non-life sectors, we conduct equality tests of means, medians, and variances. For robustness, two tests are employed for each statistic. The results are shown in Table III. To simplify the exposition, we focus on results that are significant at the five percent level in both tests. There are greater differences between derivative participants and non-participants in the life sector than in the non-life sector. In the life sector, reinsurance dependence differs between derivative users and nonusers. In the tests for means and medians, both firm size and currency exposure are found to differ between the two groups. As to the non-life sector, the users and nonusers are different in firm size and mismatch of asset and liability durations, based on the tests for mean and variance.

Table III Mean, Median and Variance Equality Tests

A: Equality Tests for Means in Life Insurance Sector

	Overall			Users			Nonusers			Equality tests of mean			
Characteristics	*N*	Mean	Std. Dev.	*N*	Mean	Std. Dev.	*N*	Mean	Std. Dev.	t-test [p-value]		Anova F-statistic [p-value]	
IZE	85	17.0319	2.1481	38	18.5908	1.4499	47	15.7716	1.7620	7.9271	[0.0000]***	62.8389	[0.0000]***
IN	84	23.6901	0.0109	37	21.8175	0.0089	47	25.1642	0.0119	1.9014	[0.0611]*	3.6152	[0.0611]*
IISAST	86	1.4767	6.3487	39	0.1668	0.5985	47	2.5636	8.4570	1.7645	[0.0813]*	3.1133	[0.0813]*
IISLIA	86	37.1963	112.7594	39	23.2742	17.3186	47	48.7486	151.4796	1.0435	[0.2997]	1.0890	[0.2997]
ROWTH	87	-0.6665	16.0945	40	-2.1095	16.4813	47	0.5615	15.8313	0.7696	[0.4437]	0.5923	[0.4437]
EINS	87	4.6779	8.9757	40	1.5440	1.9779	47	7.3450	11.4671	3.1571	[0.0022]***	9.9673	[0.0022]***
LCF	87	1.9184	6.9078	40	0.6567	1.7624	47	2.9922	9.1661	1.5854	[0.1166]	2.5136	[0.1166]
H	85	0.8757	0.3530	38	0.8521	0.4225	47	0.8947	0.2883	0.5511	[0.5831]	0.3037	[0.5831]
IH	85	0.0011	0.0031	38	0.0008	0.0026	47	0.0013	0.0035	0.8496	[0.3980]	0.7218	[0.3980]
X	81	0.1030	0.0844	36	0.1606	0.0737	45	0.0569	0.0612	6.9189	[0.0000]***	47.8709	[0.0000]***
R	84	0.0672	0.1082	37	0.0630	0.0355	47	0.0704	0.1418	0.3104	[0.7570]	0.0964	[0.7570]
NV	87	7.3085	42.0141	40	14.1807	61.0145	47	1.4597	8.2365	1.4157	[0.1605]	2.0042	[0.1605]
R	86	10.2256	13.1164	39	11.9423	16.0399	47	8.8010	10.0396	1.1071	[0.2714]	1.2258	[0.2714]
U	87	3.7836	3.0177	40	4.3210	2.3818	47	3.3262	3.4278	1.5448	[0.1261]	2.3864	[0.1261]
ERFC	87	0.5791	0.1734	40	0.5984	0.2001	47	0.5627	0.1471	0.9587	[0.3404]	0.9191	[0.3404]

B : Equality Tests for Medians in Life Insurance Sector

	Overall		Users		Nonusers		Equality tests of median			
m Characteristics	*N*	Median	*N*	Median	*N*	Median	Wilcoxon/Mann-Whitney(tie-adj.) [*p*-value]		Adj. Med. Chi-square [*p*-value]	
IZE	85	17.0834	38	18.5602	47	16.1805	6.4127	[0.0000]***	30.8229	[0.0000]***
IN	84	2.7805	37	2.7805	47	3.3555	0.4375	[0.6618]	0.0097	[0.9214]
IISAST	86	0.0000	39	0.0000	47	0.0000	1.6559	[0.0977]*	1.4735	[0.2248]
IISLIA	86	26.3849	39	23.0295	47	29.4484	0.8950	[0.3708]	0.7507	[0.3863]
ROWTH	87	0.4038	40	0.5867	47	0.3205	0.3085	[0.7577]	0.0135	[0.9075]
EINS	87	1.4555	40	0.6677	47	3.5128	3.2550	[0.0011]***	3.3757	[0.0662]*
LCF	87	0.0000	40	0.0000	47	0.1133	2.4198	[0.0155]**	4.6489	[0.0311]**
H	85	1.0000	38	0.9819	47	1.0000	1.0603	[0.2890]	0.0353	[0.8511]
IH	85	0.0000	38	0.0000	47	0.0000	0.1168	[0.9071]	0.0032	[0.9549]
X	81	0.1000	36	0.1541	45	0.0368	5.6081	[0.0000]***	22.9967	[0.0000]***
R	84	0.0561	37	0.0602	47	0.0534	1.5143	[0.1299]	1.7389	[0.1873]

Table III Mean, Median and Variance Equality tests (continued)

el C: Equality Tests for Variances in Life Insurance Sector

	Overall		Users		Nonusers		Equality tests of variance			
m Characteristics	*N*	Std. Dev.	*N*	Std. Dev.	*N*	Std. Dev.	Levene [*p*-value]		Brown-Forsythe [*p*-value]	
IZE	85	2.1481	38	1.4499	47	1.7620	1.0088	[0.3181]	0.4565	[0.5011]
IN	84	0.0109	37	0.0089	47	0.0119	1.0619	[0.3061]	1.1705	[0.2828]
IISAST	86	6.3487	39	0.5985	47	8.4570	11.3637	[0.0011]***	3.1133	[0.0813]*
IISLIA	86	112.7594	39	17.3186	47	151.4796	1.8876	[0.1731]	1.1797	[0.2805]
ROWTH	87	16.0945	40	16.4813	47	15.8313	0.0750	[0.7849]	0.5245	[0.4709]
EINS	87	8.9757	40	1.9779	47	11.4671	17.8684	[0.0001]***	9.7020	[0.0025]**
LCF	87	6.9078	40	1.7624	47	9.1661	6.1017	[0.0155]**	2.5212	[0.1160]
H	85	0.3530	38	0.4225	47	0.2883	2.8073	[0.0976]*	2.3225	[0.1313]
IH	85	0.0031	38	0.0026	47	0.0035	3.5098	[0.0645]*	0.7218	[0.3980]
X	81	0.0844	36	0.0737	47	0.0612	0.5567	[0.4578]	0.8225	[0.3672]
R	84	0.1082	37	0.0355	47	0.1418	0.7889	[0.3770]	0.3880	[0.5351]
NV	87	42.0141	40	61.0145	47	8.2365	6.2818	[0.0141]**	2.0048	[0.1605]
R	86	13.1164	39	16.0399	47	10.0396	3.4321	[0.0675]*	1.0642	[0.3052]
U	87	3.0177	40	2.3818	47	3.4278	4.5190	[0.0364]**	2.7799	[0.0991]*
ERFC	87	0.1734	40	0.2001	47	0.1471	2.7561	[0.1006]	2.8815	[0.0933]*

el D: Equality Tests for Means in Non-Life Insurance Sector

	Overall			Users			Nonusers			Equality tests of mean			
Characteristics	*N*	Mean	Std. Dev.	*N*	Mean	Std. Dev.	*N*	Mean	Std. Dev.	t-test [*p*-value]		Anova F-statistic [*p*-value]	
ZE	72	15.1673	1.6652	9	16.4419	0.9814	63	14.9852	1.6678	2.5482	[0.0130]**	6.4932	[0.0130]**
N	72	165.8123	0.0374	9	234.1009	0.0385	63	156.0568	0.0374	0.5829	[0.5618]	0.3398	[0.5618]
ISAST	74	22.4983	121.8708	11	7.7866	14.7222	63	25.0670	131.9377	0.4315	[0.6674]	0.1862	[0.6674]
ISLIA	74	23.7210	21.5923	11	26.0909	31.5014	63	23.3072	19.6906	0.3922	[0.6960]	0.1538	[0.6960]
ROWTH	74	1.8481.	4.8795	11	0.6027	1.0727	63	2.0655	5.2464	0.9164	[0.3625]	0.8398	[0.3625]
EINS	74	46.9590	28.3232	11	36.2244	20.3287	63	48.8333	29.2209	1.3705	[0.1748]	1.8783	[0.1748]
LCF	74	1.1767	3.1708	11	0.3899	0.9003	63	1.3140	3.4027	0.8907	[0.3761]	0.7933	[0.3761]
H	72	0.7121	0.3237	9	0.6909	0.3654	63	0.7151	0.3204	0.2078	[0.8360]	0.0432	[0.8360]
H	72	0.0388	0.1306	9	0.0010	0.0013	63	0.0443	0.1389	0.9281	[0.3565]	0.8614	[0.3565]
K	74	2.9280	8.0351	11	5.6500	6.2689	63	2.4527	8.2544	1.2218	[0.2258]	1.4928	[0.2258]

Table III Mean, Median and Variance Equality tests (continued)

E: Equality Tests for Medians in Non-Life Insurance Sector

m Characteristics	Overall		Users		Nonusers		Equality tests of median			
	N	Median	N	Median	N	Median	Wilcoxon/Mann-Whitney(tie-adj.) [p-value]		Adj. Med. Chi-square [p-value]	
ZE	72	15.8108	9	16.2152	63	15.6844	2.6222	[0.0087]***	2.0317	[0.1540]
N	72	174.4879	9	250.1076	63	173.9782	0.3065	[0.7592]	0.0000	[1.0000]
ISAST	74	0.0000	11	0.0000	63	0.0000	0.3028	[0.7621]	0.0179	[0.8936]
ISLIA	74	23.6491	11	5.9675	63	24.3298	0.1458	[0.8841]	0.0000	[1.0000]
ROWTH	74	0.3145	11	0.4108	63	0.3083	0.2973	[0.7662]	0.0000	[1.0000]
EINS	74	47.9776	11	37.6366	63	48.4100	1.8089	[0.0705]*	0.4271	[0.5134]
LCF	74	0.0000	11	0.0000	63	0.0000	0.6729	[0.5010]	0.0589	[0.8083]
H	72	0.8344	9	0.8344	63	0.8344	0.1065	[0.9152]	0.0318	[0.8584]
H	72	0.0000	9	0.0000	63	0.0000	0.8282	[0.4076]	0.0000	[1.0000]
K	74	0.7749	11	2.9652	63	0.4059	2.3036	[0.0212]**	1.7085	[0.1912]
l	72	0.0152	9	0.0193	63	0.0138	0.9024	[0.3668]	0.5079	[0.4760]
R	71	4.1237	10	3.5401	61	4.1267	0.7194	[0.4719]	0.0000	[1.0000]
ERFC	71	0.4376	10	0.4816	61	0.4244	0.9475	[0.3434]	0.5100	[0.4751]

el F: Equality Tests for Variances in Non-Life Insurance Sector

m Characteristics	Overall		Users		Nonusers		Equality tests of variance			
	N	Std. Dev.	N	Std. Dev.	N	Std. Dev.	Levene [p-value]		Brown-Forsythe [p-value]	
IZE	72	1.6652	9	0.9814	63	1.6678	3.1740	[0.0792]*	1.4563	[0.2316]
IN	72	0.0374	9	0.0385	63	0.0374	0.5895	[0.4452]	0.3247	[0.5706]
ISAST	74	121.8708	11	14.7222	63	131.9377	0.6942	[0.4075]	0.1862	[0.6674]
ISLIA	74	21.5923	11	31.5014	63	19.6906	8.9698	[0.0038]***	4.2723	[0.0423]**
ROWTH	74	4.8795	11	1.0727	63	5.2464	2.4644	[0.1208]	0.6529	[0.4217]
EINS	74	28.3232	11	20.3287	63	29.2209	0.0291	[0.8650]	0.0348	[0.8525]
LCF	74	3.1708	11	0.9003	63	3.4027	3.0276	[0.0861]*	0.7933	[0.3161]
H	72	0.3237	9	0.3654	63	0.3204	0.4350	[0.5117]	0.0663	[0.7976]
IH	72	0.1306	9	0.0013	63	0.1389	3.1333	[0.0811]*	0.8614	[0.3565]
X	74	8.0351	11	6.2689	63	8.2544	0.5296	[0.4440]	0.7705	[0.3830]
R	72	2.0356	9	0.0095	63	2.1762	0.5678	[0.4537]	0.1503	[0.6994]

Note：SIZE = natural logarithm of total assets; FIN = sum of total insurance claims and associated interests divided by earnings before interest and tax; MISAFT = mismatch where non-current assets larger non-current liabilities scaled by book value of firm; MISLIA= mismatch where non-current liabilities larger than non-current assets scaled by book value of firm; GROWTH = Cash reinvestment ratio multiplied by return on equity; Reins = ratio of reinsurance ceded to the sum of direct premiums written and assumed; TLCF = the amount of tax loss carry forwards scaled by net income; CH = shareholding proportion of government and corporations; MH = shareholding proportion of managers; FH = total amount of foreign investment scaled by book value of firm; NIM = Net interest margin scaled by net income; INV = value of underlying asset invested by premiums of investment linked insurance; CR = current ratio; CU = investment yields by the amount of disposable capital; HERFC = Herfindahl index reflecting concentration of claim payments.

*Significant at the 10 per cent level.

**Significant at the 10 per cent level.

***Significant at the 10 per cent level.

Significant results obtained from these univariate tests only indicate that there might be a difference between derivative users and nonusers as regards a particular firm characteristic, holding other firm characteristics constant. We now carry out a multivariate analysis.

Multivariate Results

Results of Participation Decision Model

Tables IV and V present the cross-sectional and panel data results of the participation decision analysis for the life and non-life insurance sectors over the 2001-2003 period. Note that the non-life results for the year 2001 are not reported. This is because none of the non-life insurers employed derivative instruments in 2001.

Table IV Participation Decision Model for Life Insurance Sector

Variable	Expected Sign	2001-2003		2001		2002		2003	
		Coefficient	z-statistic	Coefficient	z-statistic	Coefficient	z-statistic	Coefficient	z-statistic
Constant		-54.3887	-6.2711	-89.1173	-111.7610***	-100.3456	-129.8170***	-79.1886	-109.8440***
SIZE	+	2.9610	6.7791***	4.3887	88.9300***	-0.2459	-4.4730***	5.9948	121.9290***
FIN	+	0.0000	1.3176	0.0000	-25.4860***	0.0000	-40.3360***	0.0006	154.0110***
MISAST	+	-0.0559	-0.2447	-0.0349	-0.4040	0.3942	27.4100***	0.3286	25.9410***
MISLIA	+	0.0510	2.5690**	0.0347	7.4750***	0.2759	43.2020***	-0.1602	-18.8570***
GROWTH	+	-0.0870	-3.9503***	-0.1228	-24.8960***	-0.7200	-94.6700***	-0.2857	-125.8390***
REINS	−	0.0386	0.2677	0.2301	32.6930***	0.7243	93.5180***	-0.2752	-47.5090***
TLCF	+	-0.2209	-1.9396*	-0.1666	-10.6660***	-1.1400	-94.3760***	1.0271	21.6830***
CH	−	2.0838	3.0546***	-13.1629	-60.2730***	15.8909	93.5840***	13.2944	53.5090***
MH	+	-248.9013	-4.1696***	-117.4013	-7.3470***	126.0124	7.4290***	-221.7411	-11.9750***
FX	+	37.1100	5.1002***	83.3244	52.1130***	253.0621	166.2440***	48.6293	46.6830***

Nearly all the independent variables in the cross-sectional analysis are highly significant, while in the panel data analysis some of the independent variables are not significant. There could be two reasons for this. First, each period has its own features which may feed through to the results in the former analysis. Second, the sample size is relatively small in the cross-sectional analysis so the results may be influenced by extreme values. Note that the sign and significance of the coefficients of some of the variables change from one period to another. Relative to the panel data analysis, the cross-sectional analysis may yield less efficient estimates due to less degrees of freedom. We will concentrate on the panel data results to simplify the exposition.

The coefficient for the firm size variable is positive and significant for the life sector, which supports the notion that informational economies and economies of scale are more important than the costs associated with financial distress. This result is consistent with prior studies such as Hoyt (1989), Colquitte and Hoyt (1997) and Cummins, Phillips, and Smith (2001) which find that life insurers with greater size tend to be involved in hedging activities.

As to the impact of durations of assets and liabilities on derivative use, as expected we find that the larger the duration gap, the more likely it is that life companies use derivatives. This suggests that life companies which are more exposed to interest rate risk employ derivatives to manage this risk. This has been documented in prior studies, such as Colquitt and Hoyt (1997) and Cummins, Phillips, and Smith (1997). It is not surprising that the duration gap between assets and liabilities is not significant in the non-life sector as they write short-term insurance business and therefore duration gap is less relevant than for their life insurance counterparts.

Contrary to the underinvestment hypothesis that firms with greater growth opportunities tend to engage in more derivative transactions, the coefficient for growth opportunity is found to be negative and significant for the life sector. This evidence contradicts the findings of Nance, Smith, and Smithson (1993) and Froot, Scharfstein and Stein (1993) and may be due in part to the long-term nature of life insurance.

The sign of the tax loss carried forward coefficient is positive for non-life companies, as expected, but negative for life companies. The negative sign for life companies is inconsistent with prior studies (Colquitt and Hoyt, 1997; Cummins, Phillips, and Smith, 1997; Geczy, Minton, and Schrand, 1997; Gay and Nam, 1998) which argue that firms with higher tax preference items such tax loss carried forward and other tax credits are more likely to use derivatives. A possible reason for our result is that life insurers with greater tax losses carried forward have suffered losses in the recent past and may tend not to participate in derivative activities for fear of a further loss.

The coefficients for the managerial ownership variable are negative and significant. How can these unexpected results be explained? Since most insurers in Taiwan are small unlisted companies whose stocks are owned by a limited number of shareholders, the size effect discussed above may be the dominant factor.

The foreign exposure coefficients are positive and significant, as expected. Up to 95 percent of derivative instruments used by insurance firms are currency forward contracts designed to hedge against the volatility of foreign exchange. This finding is consistent with prior studies, such as Davies, Eckberg and Marshall (2006), which argue that firms with higher levels of foreign sales are more likely to hedge currency exposure.

The coefficients for interest rate risk exposure in the non-life sector and investment-linked insurance products sold by life insurance companies are both positive and significant. This suggests that risks associated with changes in interest rates and sale of investment-linked products are managed by derivative instruments.

Results of Participation Extent Model

All variables employed in the participation decision (probit) model are also included in the participation extent of use model. The results of the participation extent analysis for the life and non-life insurance sectors are given in Tables VI and VII. In comparison with the probit model,

there are fewer significant variables for both insurance sectors. This corresponds to the empirical studies carried out by Hoyt and Colquitt (1997) in the analysis of hedging behavior among life insurers and by Hardwick and Adams (1998) in the analysis of derivative use among life insurers in the United Kingdom. To analyze the determinant variables in the extent of use model, we focus mainly on the pooled estimation results.

Table VI Participation Extent Model for Life Insurance Sector

		2001-2003		2001		2002		2003	
		OLS		OLS		OLS		OLS	
Variable	Expected Sign	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant		0.1193	0.9120	-0.0058	-0.0739	-0.1886	-1.2601	0.2946	0.7037
SIZE	+	-0.0099	-1.2910	-0.0016	-0.3176	0.0037	0.3562	-0.0007	-0.0259
FIN	+	0.0000	0.4070	0.0000	0.0279	0.0000	2.0822*	0.0000	0.0920
MISAST	+	-0.0014	-0.4370	0.0065	0.8778	0.0018	0.5318	-0.0061	-0.6331
MISLIA	+	-0.0009	-1.2800	-0.0001	-0.1621	-0.0008	-0.9867	-0.0027	-0.4746
GROWTH	+	-0.0005	-0.8510	0.0000	0.0860	0.0007	0.6388	-0.0015	-0.5820
REINS	−	0.0010	0.9250	0.0008	1.3418	0.0016	1.1327	-0.0056	-1.1811
TLCF	+	-0.0010	-0.7350	-0.0006	-1.4798	-0.0023	-0.9757	-0.0332	-0.9499
CH	−	0.0431	1.3110	0.0232	1.2175	-0.0356	-1.1101	0.1563	0.8219
MH	+	2.5405	0.8490	1.0248	0.6857	-1.2459	-0.4180	-1.8688	-0.1451
FX	+	0.6601	5.0380**	0.2685	2.0705**	0.6431	2.7943**	0.5551	1.2058
NIM	+	0.0319	0.3900	0.0213	0.9197	-0.0289	-0.0537	-2.2562	-0.9226
INV	+/−	0.0012	1.5800	0.0426	0.3032	0.0013	1.3686	0.0014	0.5770
CR	−	0.0028	3.3660**	0.0013	3.6132**	0.0009	0.7226	0.0038	1.5328

Note: SIZE = natural logarithm of total assets; FIN = sum of total insurance claims and associated interests divided by earnings before interest and tax; MISAST = mismatch where non-current assets larger than non-current liabilities scaled by book value of firm; MISLIA = mismatch where non-current liabilities larger than non-current assets scaled by book value of firm; GROWTH = Cash reinvestment ratio multiplied by return on equity; REINS = ratio of reinsurance ceded to the sum of direct premiums written and reinsurance assumed; TLCF = the amount of tax loss carry forwards scaled by net income; CH = shareholding proportion of government and corporations; MH = shareholding proportion of managers; FX = total amount of foreign investment scaled by book value of firm; IM = Net interest margin scaled by total asset; INV = value of underlying asset invested by premiums of investment linked insurance; CR = current ratio.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table VI Participation Extent Model for Life Insurance Sector (continued)

		2001-2003		2001		2002		2003	
		OLS		OLS		OLS		OLS	
Variable	Expected Sign	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
DOMESTIC	+/−	0.0715	2.7090**	0.0269	1.7691	0.0102	0.3630	0.2732	2.3561*
HERFC	−	-0.1323	-1.5930	-0.0629	-0.9967	0.2514	2.3226**	-0.7922	-2.2881*
IR	+	0.0038	1.0620	0.0020	1.1083	-0.0048	-0.6418	0.0327	1.1138
Number of observations			79		27		28		24
adjusted R^2			0.4244		0.5031		0.4442		0.3548
F test			4.3600***		2.5188*		2.2485		1.7561
			[0.0000]		[0.0938]		[0.1096]		[0.2511]
LM test			1.4800						
			[0.2237]						
Hausman test			4.2500						
			[0.9984]						
White test			1.1743						
			[0.3103]						

Note: DOMESTIC = 1 if domestic insurer, 0 otherwise; HERFC = Herfindahl index reflecting concentration of claim payments; IR = net investment income divided by total assets.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table VII Participation Extent Model for Non-Life Insurance Sector

Variable	Expected Sign	2002-2003 OLS		2002 OLS		2003 OLS	
		Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant		0.0441	0.6330	-0.1068	-1.0357	-0.8340	-1.7776
SIZE	+	-0.0005	-0.1140	0.0042	0.7375	0.0456	1.7161
FIN	+	0.0000	0.6910	0.0000	1.2374	0.0000	1.1046
MISAST	+	0.0000	0.2250	0.0007	1.4935	-0.0009	-1.1689
MISLIA	+	-0.0003	-0.8810	0.0004	0.9275	0.0012	0.7419
GROWTH	+	-0.0007	-0.7980	0.0003	0.1956	0.0037	1.4964
REINS	−	-0.0006	-2.5780 **	0.0002	0.5071	0.0015	1.5985
TLCF	+	0.0013	0.7950	0.0013	0.3500	0.0414	2.4778 **
CH	−	0.0046	0.3120	0.0283	1.3605	-0.0665	-1.1455
MH	+	0.0042	0.1560	0.0282	0.8030	0.1512	1.4728
FX	+	0.0070	6.9680 **	-0.0011	-0.5731	0.0064	2.3268 *
NIM	+	-0.8307	-4.9400 **	0.1125	0.1810	5.2769	2.2236 *
CR	−	0.0005	0.3660	0.0016	0.6096	0.0037	0.6168
DOMESTIC	+/−	-0.0069	-0.5090	0.0011	0.0658	-0.0430	-0.6533
HERFC	−	-0.0003	-0.1640	-0.0060	-1.5209	0.0081	0.1038
Number of observations			71		24		24
adjusted R^2			0.4460		0.0571		0.6156
F test			4.7400 *** [0.0000]		1.0909 [0.4779]		3.4022 * [0.0548]
LM test			2.5800 [0.1082]				
Hausman test			0.0100 [1.0000]				
White test			2.4235 *** [0.0060]				

Note: SIZE = logarithm of book value of total asset; FIN = sum of total insurance claims and associated interests divided by earnings before interest and tax; MISAST = mismatch where non-current assets larger than non-current liabilities scaled by book value of firm; MISLIA = mismatch where non-current liabilities larger than non-current assets scaled by book value of firm; GROWTH = Cash reinvestment ratio multiplied by return on equity; REINS = ratio of reinsurance ceded to the sum of direct premiums written and reinsurance assumed; TLCF = the amount of tax loss carry forwards scaled by net income; CH = shareholding proportion of government and corporations; MH = shareholding proportion of managers; FX = total amount of foreign investment scaled by book value of firm; IM = Net interest margin scaled by total asset; CR = current ratio; DOMESTIC = 1 if domestic insurer, 0 otherwise; HERFC = Herfindahl index reflecting concentration of claim payments.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Foreign exposure is found to be an influential factor on the level of derivative use for both life and non-life insurers, indicating that insurance companies are inclined to engage in currency risk management with derivative instruments.

The result that the current ratio is positively related to the level of derivative use among life insurance firms is unexpected. It contradicts the argument that firms with higher financial limitations will hedge through derivatives (Geczy, Minton, and Schrand, 1997).

The coefficient for the domestic dummy variable is positive and significant for the life insurers. This finding reflects the current circumstances of the finance industry. Foreign branches in Taiwan tend not to hedge using derivatives for two reasons. First, due to the fact that the financial market used to be oligopolic and legally protected, market channels and related expertise have been established by native enterprises. Subsidiaries of most foreign firms are limited to a small number of businesses with relatively low currency exposure. Consequently, the need for foreign currency trading in these branches is lower than in domestic companies. Second, the small market size in Taiwan discourages foreign companies from expanding the scope of their business so the exchange risk is even lower and there is little need for derivative hedging.

The anticipated substitute relationship between reinsurance and derivative hedging is confirmed for the non-life insurance sector. This reflects the fact that catastrophic futures and options are being used increasingly as a substitute for conventional risk management methods in that sector.

Although the coefficient of the interest rate risk variable (represented by net interest margin) is negative and significant for the non-life insurance sector, the unexpected sign might imply that in practice, non-life insurers focus more on volatility of interest cost rather than interest income. This finding also suggests that non-life insurers are trying to prevent interest costs from rising by means of derivatives.

Comparing Results of Probit and Panel Analysis Estimation

Haushalter (2000) indicates that the factors affecting the likelihood of employing derivative instruments are not necessarily the same as those affecting the extent of use. The discrepancy between the two estimations would be hidden if the tobit approach is used to measure the hedging activities (Colquitt and Hoyt, 1997; Cummins, Phillips and Smith, 2001). As to the effect of size in the life and non-life insurance sectors, there are inconsistent outcomes reported in the participation and extent models. Most coefficients are positive and significant in the probit estimation but insignificant in the panel results. This suggests that although derivative utilization is gradually being accepted by insurance companies in Taiwan, the values of derivative contracts have not evolved in line with assets or revenues. Evidently, the informational economies or economies of scale do not occur among large Taiwanese insurance corporations as there are no significant differences between large and small firms in the extent of usage. This finding is consistent with the study on Taiwanese listed firms undertaken by Shu and Chen (2003)

CONCLUSION

This article examines the relationships between the use of derivatives for hedging purposes and firm-specific factors. Most prior studies on the use of derivatives employ samples for a single year and from a particular industry. This paper extends the literature by studying two Taiwanese insurance sectors over a period of years.

The insurance data are hand-collected from annual financial statements of both life and non-life insurers. The period of observation is from 2001 through 2003. Using panel data and cross-sectional estimations, we investigate the participation and volume decisions on derivative contracts by Taiwanese insurance firms. A number of hypotheses are formulated and tested. The main results include:

(1) Exposure to foreign exchange risk is positively and significantly related to derivative use (in terms of both participation and extent decisions) for both the life and non-life sectors. This indicates that insurance companies engage in currency risk management with derivative instruments.

(2) The coefficient for the firm size variable is positive and significant in the participation decision model for the life sector. This finding supports the notion that informational economies and economies of scale are more important than the costs associated with financial distress.

(3) Life companies which are exposed to interest rate risk due to the duration of non-current liabilities being greater than the duration of non-current assets, tend to use derivatives to manage the risk. The larger the duration gap, the more likely it is that the life company will use derivatives.

(4) For non-life companies, there is a substitute relationship between reinsurance and derivative hedging. The greater the level of reinsurance, the lower the involvement in derivative activities.

We believe that our findings have important implications for practitioners, stakeholders and regulators interested in risk management. For example, the prominent effects of informational as well as scale economies mean that larger insurers are more likely to employ derivative instruments than smaller insurers. Since the misuse of derivatives could increase the likelihood of financial distress, regulators and shareholders should closely monitor derivative activities, especially within large corporations. Also, currency risk is an important factor determining firms' use of derivatives. Nevertheless, the range of derivatives that hedge currency risk is limited in the Taiwanese market.

With a view to providing firms with more alternatives, there is an urgent need for the development of further currency derivative products.

The interpretation of our findings should be tempered by two caveats. First, due to the regulatory requirements for derivative disclosure under current accounting standards, year-end notional value of derivatives positions are used as a measure of derivative usage throughout this paper rather than marked-to-market data that reflect the economic value of derivative contracts. Second, the results obtained from the panel data estimation may suffer from serial correlation of the error terms.

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