Review of Pacific Basin Financial Markets and Policies
Vol. 6, No. 4 (2003) 405–431

Determinants of Derivative Usage in the Life and General Insurance Industry: The Australian Evidence

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Core business and financial market risks are not easily reduced by standard operating procedures in insurance companies. Derivatives theoretically provide a cost effective vehicle to hedge these risks. This paper provides an empirical analysis of the determinants of derivative usage as well as the extent of derivative usage in the Australian insurance industry in both life and general insurance companies for the period 1997–1999.

Empirical results for the Australian life insurance industry in general confirm the findings of UK and US based research. However, the Australian general insurance industry does not appear to follow the conclusions of previous literature. Our results indicate that for life insurers, the determinants of derivative usage were size, leverage and reinsurance. For the general insurance industry the determinants were size and the extent of long tail lines of business written. As regards the determinants of the extent of derivative usage, these were size and asset-liability duration mismatches for life insurers. For the general insurance industry the determinants of the extent of derivative usage were size, the extent of long tail lines of business written, and the reporting year.

Keywords: Risk management; derivative usage; hedging; insurance companies.

1. Introduction

The usage of derivatives by non-financial corporate firms during the last decade has been widely documented around the globe (for example, research by Dolde (1993), Phillips (1995) and Bodnar *et al.* (1995, 1996) describes the situation in the US, Jalilvand and Tang (1996) in Canada, Grant and Marshal (1997) in the UK, De Ceuster *et al.* (2000) in Belgium, Alkeback and Hagelin (1999) in Sweden, Hakkarainen *et al.* (1997) in Finland, and Batten and Mellor (1993), and Batten, Mellor and Wan (1994) in Australia). Although size, leverage and asset/liability duration are generally consistent explanators, this research has also made it clear that hedging motives and determinants differ across countries. For example, US firms tend to hedge in order to reduce cash flow volatility, whereas Belgian and German firms, due to fiscal considerations, focus on earnings volatility [Bodnar and Gebhardt (1998) and De Ceuster *et al.* (2000)].

With respect to the use of derivatives in the financial industry, and in particular the insurance sector, the research literature is very limited. Only in the US [Colquitt and Hoyt (1997) and Cummins *et al.* (1997a, 2001)] and the UK [Hardwick and Adams (1999)] is evidence available that documents derivative hedging practices in the insurance industry. Given the importance of risk management for the banking and the insurance industry as a global concern it is important that this shortfall is addressed. Moreover, Cummins *et al.* (1997a) claim that the determinants of hedging behavior differ across different industry sub-sectors, for example, between general (called property/casualty insurers in the US) and life insurers.

This study is the first to offer insights into the motives and preconditions behind the use of derivatives in the Australian insurance industry. We further motivate our work by extending the research of Cummins *et al.* (1997a, 2001), Colquitt and Hoyt (1997), and Hardwick and Adams (1999) and examine the generality of their results in a contemporary small country situation. Third, previous studies with the exception of Gunther and Siems (1995) have concentrated on one specific year. Hardwick and Adams (1999) recognize that in studies with smaller sample sizes (such as those in Australia) sampling over a number of years may improve the robustness of the results. Hence, data is applied from the statutory reports of Australian insurers for 1997, 1998 and 1999. Fourth, following Cummins *et al.* (1997a, 2001), we focus on two large groups of insurers (life and general) and determine that there are differences in hedging motives and practices. Finally, the conclusions of this study will be of interest to regulatory bodies such as the Australian Prudential Regulation Authority (APRA), ratings agencies, investors, and potential suppliers of capital to the Australian insurance industry.

The remainder of this paper is organized as follows. Section 2 outlines the data sample and Sec. 3 describes the statistical models employed. The independent and dependent variables are defined and motivated by the literature in Sec. 4. The empirical results for life and general insurers are reported in Sec. 5 and a combined model for both life and general insurers is presented in Sec. 6. The paper is concluded in Sec. 7.

2. The Data Sample

Data were obtained from APRA for all life and general insurers. Life insurers are required to report under Section 252 of the Life Insurance Act 1995 (Prudential Rules 26, 31, 32, 35) and general insurers under Sections 44 and 45 of the Insurance Act 1973. Benefit fund friendly societies and health insurers were excluded from the sample, essentially because their operations are significantly different from life and general insurers. The final data set consisted of 481 firm years split into life and general insurers as set out in Table 1.

The most striking feature of Table 1 is the lower number of general insurers reporting in 1997. The current computerized reporting requirements of APRA came into place during 1997 for general insurers. Thus, firms with a June balance date for annual reports were not, at that time, required to submit their statutory reports in the current form. Hence, the data for 1997 only captures those general insurers with December reporting dates.

The original data set for general insurers consisted of 383 insurer reports over the three years. Two types of firms, however, were eliminated from the final data set. First, the data set was checked for insolvent insurers leading to the removal of one firm from 1999. Second, any firms that were deemed inactive, i.e., they did not write insurance policies throughout the year, were

Table 1. Sample of life and general insurers.

Reporting Year	Life Insurers	General Insurers
1997	45	66
1998	45	145
1999	41	139
Total	131	350

removed. This decreased the sample by a further 31 over the three years. One further firm was removed from the sample because of incomplete data, thus giving the final figure of 350 observations over three years.

The data for life insurers did not suffer the same problems as general insurers. There were no insolvent insurers or firms without premium revenue to remove. However, five insurers were deleted from the final data set due to incomplete information. Their statutory returns were not complete across all forms leaving some independent variables blank. Removal of these insurers brought the final data set to 131 observations over the three years.

3. Methodology

In order to study hedging behavior, two different models are estimated. The first, a decision model, is whether or not the insurers reported derivative activity in their regulatory reports. This is estimated using a Probit regression model since the dependent variable is of a binary nature (0 for non-users and 1 for users). The Probit model is defined as:

$$\Pr(y_i^* > 0) = \Phi(\lambda X)\,,$$

where

$\Pr(.)$ is the probability of an event occurring,
$\Phi(.)$ is the standard normal distribution function,
X is a $k \times 1$ vector of explanatory variables,
λ is a $k \times 1$ vector of variable coefficients.

Therefore, positive coefficients (λ_k's) are related to a higher probability of observing a derivative user ($y_i = 1$).

The second model estimates the determinants of the extent of derivative usage. To examine the participation decision a dependent variable is used which can be either 0, for non-users, or some measure of the total derivative positions held for users. Hence, the dependent variable is censored at zero. According to Greene (1997) "...conventional regression methods fail to account for the qualitative difference between *limit* (zero) observations and *non-limit* (continuous) observations" (Greene, 1997: 959). A solution to this problem is to use a Tobit regression model. This type of model accounts for the change in the distribution of the dependent variable when data is censored. However, following Colquitt and Hoyt (1997) and Hardwick and Adams (1999), there may be reasons to believe that the effects of the independent variables being examined may vary between the participation decision and the extent of usage decision. The Cragg (1971) generalization of the Tobit model separates the two decisions, participation and extent, into two different models.

Gunther and Siems (1995) used a Probit model to estimate the extent decision and then an Ordinary Least Squares (OLS) regression for the extent of usage only for those firms that were classified as users in the Probit model. This model raised concerns for Colquitt and Hoyt (1997), who state that using OLS for the second stage of the estimation may produce errors, which are heteroskedastic by construction. As such, they follow a suggestion by Greene (1997) who applied Heckman's (1979) two-step correction to OLS. This involves using the estimate of the inverse Mills ratio from the Probit regression as another independent variable in the OLS regression. If, however, the inverse Mills ratio is not significant, then it is reasonable to simply estimate the extent decision with the OLS regression. Therefore, we can write the extent equation following Hardwick and Adams (1999: 174) as:

$$Y_j^* = \beta_0 + \sum_{i=1}^{m} \beta_i X_{ij} + \beta_m M + u_j \,, \quad j = 1 \cdots n,\ i = 1 \cdots m \,,$$

where

m is the number of independent variables,
n is the number of observations,
Y_j^* is the extent of derivative use,
β_0 is the constant term,
$\beta_1 \cdots \beta_m$ are the coefficients of the independent variables,
X is a $k \times 1$ vector of explanatory variables,
M is the inverse Mills ratio, and
u_j is the error term associated with observation j.

4. Variables

4.1. *Dependent variables*

The usage of derivatives is measured by a binary variable, "USER", which simply expresses whether or not an insurer uses derivatives. For life insurers this is set to one for any activity in *Schedule 1 Form D* of the statutory reporting requirements and zero otherwise. For general insurers we are faced with two options for this dependent variable. The statutory reports ask a specific question as to whether the insurer uses derivatives [*Form 103*(*iii*), *Part A*, *Q1*]. However, not all of those insurers who answered "yes" recorded open derivative positions at the balance date. Therefore, the extent model outlined above would be inappropriate due to zero derivative positions for those classified as users. Hence, for model stability and consistency with life insurers, this dummy variable is set to one for only those insurers recording open positions in *Parts B or C* of *Form 103*(*iii*). In addition, a Probit regression is estimated using the answer to *Part A*, *Q1* as the independent variable, labeled "USERPAQ1", to see the effects of this decision and this is recorded alongside the main model.

The extent of usage is measured by a continuous variable, censored at zero (since derivative use cannot be negative). To achieve this we follow Colquitt and Hoyt (1997: 653) and Chorafas and Steinman (1994: 12), by examining the total notional value of contracts outstanding as an estimate of off-balance sheet (OBS) activity. In order to temper problems of skewed data we take the natural log of the total notional value of derivatives (i.e., variable "LNEXT" measures the extent of usage). For life insurers this is the total notional value from the three sections of *Schedule 1 Form D*: derivatives that increase asset exposure, derivatives that decrease asset exposure and other derivatives. The general insurance data, however, differs. APRA does not require general insurers to report the notional values of their derivative positions. Instead they are required to record the "fair value" of each derivative position, generally defined as the value of the derivative if the position were to be closed out today. In view of this, the fair value of derivative positions entered into was used as a proxy for the extent of usage. This decision follows the application of a similar variable by Berkman and Bradbury (1996: 8). The fair value of derivatives was measured as the total fair value[1] of positions held as recorded in *Parts B* and *C* of *Form 103(iii).*

4.2. *Independent variables*

The general independent variables suggested in the literature are firm size, leverage, asset and liability duration mismatches, the presence of foreign exposures, the level of reinsurance and the character of the business line. Other "classical" suggested determinants are organizational form, tax considerations and group status. In the Australian insurance context the organizational form variable is irrelevant since mutual insurers have disappeared from the insurance sector over recent years (Jenkins, 1998) leaving only stock

[1]The anonymous reviewer pointed out that the absolute value of the fair value of each transaction could also be employed for this purpose.

firms. The tax variable is most often included because firms in a convex portion of the taxation schedule can reduce expected taxes by reducing earnings volatility (Graham and Smith, 1997). Therefore, firms in the convex portion of the taxation schedule should be more likely to make use of derivatives in order to smooth their income stream. Since Australia's corporate tax is set at a flat rate, and firms are allowed to carry their losses forward for up to seven years, making income tax effectively negative in loss situations, there is no theoretical justification for the inclusion of such a variable. In view of this, taxation is not examined in this study. Finally, group status which was examined by Cummins, Phillips, and Smith (1997a, 2001), was not examined because reasons of confidentiality did not allow APRA to provide individual company names with the data set made available for this study.

4.2.1. *Size*

There are two main arguments surrounding the effects that firm size has on the propensity to use derivatives: economies of scale and costs of financial distress. Nance, Smith, and Smithson (1993: 269) argue that there are significant scale economies in setting up derivative trading areas; including staff expertise, research and infrastructure. As such, large firms are more likely to establish derivative trading groups. It is also noted that informational economies of scale exist with the use of derivatives. Also, Hoyt (1989) found the education of management rated highly as a factor determining the use of derivatives.

On the other hand, financial distress costs are proportionally higher for smaller firms (Warner, 1977). Hence, Colquitt and Hoyt (1997), among others, argue that smaller firms may be more likely to hedge than larger firms. Cummins, Phillips, and Smith (1997a: 29) also note that larger firms may have less need for derivatives since they may be more diversified than their smaller competitors.

Overwhelmingly, empirical results support the economies of scale and informational economies in determining the decision to participate in derivative markets [see Hardwick and Adams (1999) and Colquitt and Hoyt (1997) for life insurers, and Cummins, Phillips and Smith (1997a) for life and property/casualty insurers]. However, the extent of usage results vary. Colquitt and Hoyt (1997) did not find size to be a significant determinant of extent of usage, whilst Hardwick and Adams (1999) and Cummins, Phillips, and Smith (2001) found significant positive relationships. Following

Cummins, Phillips, and Smith (1997a and 2001) and Hardwick and Adams (1999) size is calculated as the natural log of total assets ("LNTA").

4.2.2. *Leverage*

Two hypotheses are proposed in the literature with regards to leverage. First, Colquitt and Hoyt (1997) argue that an increase in leverage increases the expected costs of financial distress as the probability of insolvency increases [see also Hardwick and Adams (1999) and Nance, Smith, and Smithson (1993)]. The second, and complementary hypothesis, is concerned with the under-investment problem discussed by Guy and Nam (1998), Froot, Scharfstein, and Stein (1993), and Warner (1977). Essentially, it is contended that the existence of large amounts of debt in the capital structure causes shareholders to forgo investment opportunities, even though they may have a positive net present value. This is because shareholders see all the benefits of these projects going directly to debt holders. In an environment where risk is reduced via derivatives hedging, shareholders are more likely to invest in risky projects.

Colquitt and Hoyt (1997) found support for the leverage hypothesis for the participation decision and extent of usage decisions in the US life insurance industry, as did Cummins, Phillips, and Smith (1997a, 2001) for both life and general insurers. Hardwick and Adams (1999) found only the participation decision to be significantly affected by leverage. We expect a positive relationship between leverage and derivative usage. The leverage variable, denoted "LEV", is calculated as total liabilities divided by net assets.

4.2.3. *Reinsurance*

Reinsurance may act as a substitute for off-balance sheet activity due to its similar effects on variance in taxable income and firm value activities [Cummins, Phillips, and Smith (1997a) and Colquitt and Hoyt (1997)]. In the same vein, Mayers and Smith (1990) conjecture that the use of reinsurance may simply show that an insurer is predisposed to hedge risk.

The empirical results regarding reinsurance, however, are mixed. Colquitt and Hoyt (1997) find reinsurance to be (weakly) positively related to the participation decision thus supporting the predisposition hypothesis. Hardwick and Adams (1999) find reinsurance to be significantly negatively related to derivative use. Finally, Cummins, Phillips, and Smith (1997a) found mixed results. Their data showed a weak negative relationship for property/casualty insurers. However, with life/health insurers they found a positive relationship.

The level of reinsurance, denoted "REINS", will be measured as the reinsurance expense scaled by total premiums.

4.2.4. *Foreign exposures*

We examine the impact of foreign exposures by attempting to proxy the foreign exchange risk faced by each insurer. Hardwick and Adams (1999) include an "international links" dummy variable in their model, which captures any international activity such as foreign ownership and overseas business written. This variable, denoted "FX", is the total level of assets denominated in foreign currencies scaled by total assets for general insurers. For life insurers it is the total level of reported currency exposures (minus AUD exposures) scaled by total assets. For general insurers, this is the figure for total assets outside Australia, scaled by total assets. Obviously firms can use natural hedges in regard to foreign currency exposure but one would expect this variable to be positively related with derivative usage.

4.2.5. *Mismatch of asset and liability duration* (*life insurers only*)

Asset-liability duration mismatches cause greater amounts of interest rate risk, and hence firms are more likely to hedge. Therefore, one would expect larger duration gaps to be associated with greater derivatives usage. Unfortunately, as in Cummins, Phillips, and Smith (1997a), the general level of accounting information available does not allow for the calculation of duration gaps. Instead the related interest rate risks are proxied. Colquitt and Hoyt (1997) break up asset and liability duration mismatches into asset side mismatches and liability side mismatches to see if one is managed more actively than the other.

Although Cummins, Phillips, and Smith (1997a) are unable to report any overall results for asset and liability duration mismatch, Colquitt and Hoyt (1997) are able to shed some light on the issue. For the participation regression the results seemed to indicate that insurers were more likely to hedge when long-term assets exceeded long-term liabilities. Colquitt and Hoyt (1997) proxy the mismatch between asset and liability duration by comparing the insurer's non-current assets and non-current liabilities. Unfortunately, the level of aggregation used in the reporting requirements for Australian general insurers does not allow for the separation of assets and liabilities into current and non-current components. Therefore, this variable can only be examined for life insurers. In the statutory returns for life insurers, investment assets are recorded separately to non-current assets and as such it was necessary to take this figure, minus identifiable short-term investments, and add that to the non-current assets figure to arrive at the correct level of non-current assets. Therefore, we examine the value of non-current assets (including longer-term investment assets) minus non-current liabilities, scaled by total assets. Following Colquitt and Hoyt (1997) this outcome is divided into two variables, "MASSET" and "MLIAB" depending on whether assets or liabilities dominate. MASSET is defined as the maximum of zero, or non-current assets minus non-current liabilities, scaled by total assets. MLIAB on the other hand is defined as the maximum of zero or non-current liabilities minus non-current assets, scaled by total assets.

4.2.6. *Business line* (*general insurers only*)

Cummins, Phillips, and Smith (1997a) note that some types of business written could act to shorten the duration gap. Jenkins (1998) describes the different kinds of business written by insurers as short and long tail business. Short tail business describes those policies written where the payout on claims is expected over the current year. Long tail business describes those policies where the payout on claims is expected to occur over a longer term. The latter type is mainly liability insurance where legal and medical proceedings tend to slow down the claim process.

Since the asset portfolio of general insurers tends to include a large proportion of bonds, the duration of assets is expected to exceed one year. Therefore, writing long tailed business would seem to be a natural hedge,[2] allowing a narrowing of the duration gap. Thus, one would expect the proportion of long tailed business written to be inversely related to derivative usage. On the other hand, short tailed business written would be positively related to derivative usage. We measure long tailed business, denoted by "BLINE", as the revenue generated from liability type policy premiums scaled by total premiums.

Limitations exist with the examination of this variable because reinsurers are not required to complete *Form 104*,[3] which specifies the nature of premiums written. This may be due to the more complicated nature of

[2]This assumption may not be appropriate because it ignores the interest rate sensitivity of loss reserves [e.g., see D'Arcy and Gorvett (2000)]. However, as pointed out by the anonymous reviewer, interest rate risk, while being one of the primary sources of risk for life insurers, is not so for general insurers.

[3]Form 104 is one of the forms completed by general insurers. It specifies the nature of premiums written, and items 3, 7, 8, 9 and 16 in column 1 of the form provide the necessary information to calculate the variable "BLINE".

the business, or a blurring of business lines. As a result, we are only able to examine the effects of this variable for a smaller sample of 280 annual reports that excludes those insurers who did not complete *Form 104*.

4.2.7. *Time trend*

Since there has been a general increase in the use of derivatives worldwide in recent decades, there is reason to believe that sampling over different years may show a general trend towards an increase. At the very least, the possible impacts on the regression analysis of sampling over the different years should be controlled. To this end, dummy variables were entered into the regression equations in order to denote the year of sampling, D1998 and D1999.

5. Empirical Results

5.1. *Descriptive statistics*

The descriptive statistics of the variables used are presented in Table 2 with the variables defined as follows:

LNEXT = Natural log of the notional value of derivative positions held at the balance date for life insurers, and natural log of the "fair value" for general insurers.

LNTA = Natural log of total assets.

LEV = Total liabilities divided by net assets.

MASSET = Max (0, Non-current assets minus non-current liabilities scaled by total assets).

MLIAB = Max (0, Non-current liabilities minus non-current assets scaled by total assets).

REINS = Reinsurance expense scaled by total premiums.

FX = Total current exposure minus AUD exposure scaled by total assets for life insurers, and total assets denominated in foreign currencies scaled by total assets for general insurers.

BLINE = Liability type premiums written divided by total premiums.

The most striking point is the large number of users among the life insurers in the sample. Around 58% of Australian life insurers held open derivative positions at the yearly balance dates. This is much higher than those reported for the US, 11.93% (Cummins, Phillips, and Smith, 1997a) or 13.13% (Colquitt and Hoyt, 1997) but closely follows the 57% of users found by Hardwick and Adams (1999) in the UK.

Table 2. Descriptive statistics.

	Mean	Median	SD	Min	Max
Life Insurers Derivative Users (USER = 1)					
$N = 76$ (58.0%)					
LNEXT	11.9	12.38	2.71	2.77	16.32
LNTA	14.8	15.12	1.41	11.26	17.77
LEV	21.4	11.56	27.73	1.16	132.84
MASSET	0.04	0.00	0.09	0.00	0.41
MLIAB	0.14	0.09	0.16	0.00	0.64
REINS	0.03	0.01	0.07	0.00	0.44
FX	0.11	0.09	0.07	0.00	0.29
Life Insurers Non-Derivative Users (USER = 0)					
$N = 55$ (42.0%)					
LNTA	12.03	11.63	1.44	9.69	15.40
LEV	2.93	1.86	3.09	0.04	18.93
MASSET	0.15	0.12	0.18	0.00	0.77
MLIAB	0.11	0.00	0.19	0.00	1.01
REINS	0.18	0.09	0.23	0.00	0.88
FX	0.04	0.00	0.05	0.00	0.17
General Insurers Derivative Users (USER = 1)					
$N = 46$ (13.14%)					
LNEXT	6.1	5.8	3.0	0.0	13.7
LNTA	13.2	13.9	1.5	8.9	15.7
LEV	5.4	3.3	9.5	0.5	61.3
REINS	0.19	0.11	0.22	0.00	1.00
FX	0.10	0.03	0.19	0.00	0.81
General Insurers Non-Derivative Users (USER = 0)					
$N = 304$ (86.86%)					
LNTA	11.02	11.04	1.71	6.05	15.80
LEV	10.99	1.95	47.79	0.07	503.03
REINS	0.32	0.20	0.31	0.00	1.00
FX	0.05	0.00	0.11	0.00	0.76

It can be observed that the general insurance industry differs significantly from the life insurance industry in terms of the number of active users of derivatives. Whereas 58% of life insurers report open derivative positions, only 13.14% of general insurers use derivatives. If we measure derivatives use with the USERPAQ1, the participation figure would be raised to 24.9%. Still, whilst the numbers of users within the general insurance industry are lower compared to Australian life insurers they are nonetheless high compared to previous US research. Cummins, Phillips, and Smith (1997a: 17) report that only 6.88% of their sample of 2063 American general insurers participated in derivative trading.

In comparison with general insurers, the average life insurer seems to be larger, more highly levered and less inclined to use reinsurance. All things being equal this would point to a group more likely to use derivatives. This could be due to the fact that different lines of business generate different risks. For life insurers, interest rate risk is one of the primary sources of risk, and this can be hedged with derivatives. For general insurers, the primary source of risk is catastrophe risk, which is not easily hedged with derivatives.

Table 2 offers some preliminary support for a number of the hypotheses posed. The size variable (LNTA) is larger for users than non-users, providing support for the economies of scale and informational economies hypotheses. The leverage (LEV) and derivative usage also appear to be positively related for life insurers. The extent of reinsurance entered into by general insurers would appear to follow the life insurance results in showing a substitution effect between reinsurance and derivative use. Finally, the foreign exposure variable appears to show the expected positive relationship, that is, higher foreign exposures would seem to be associated with higher levels of derivative usage.

5.2. *Participation decision*

Table 3 presents the Probit regression results. For general insurers, the results are for the sample with the BLINE variable. To check robustness, the table also includes the results for the USERPAQ1 variable for the general insurers. We will focus on the results for the USER variable, as the results for the USERPAQ1 variable are quite similar. Initially, the Probit regressions included dummy variables (D1998, D1999) to examine whether there was any significant change in derivative participation over time. However, they were insignificant and, hence, discarded from any further analysis.

The final regression for the life insurers (general insurers) produced a model with a log likelihood of −41.49 (−74.87) and an LR statistic, which tests the null hypothesis of all coefficients being equal to zero, of 95.24 (69.91). This has a Chi squared distribution and is significant at the 1% level and therefore the null hypothesis of all coefficients being zero is rejected. A McFadden R^2, analogous to the R^2 obtained from OLS regressions, was calculated as 0.53 (0.32).

A further test of the goodness of fit of the model is the classification table shown as Panel B of Table 3. This shows how well the model predicted

Table 3. Probit regression results.

Panel A

	Life Insurers		General Insurers			
Dependent Variable	USER		USER		USERPAQ1	
Independent Variables	Coefficient	Z-statistic	Coefficient	Z-statistic	Coefficient	Z-statistic
C	−5.59	−2.86***	−5.72	−5.86***	−5.43	−6.83***
LNTA	0.41	2.69***	0.39	5.02***	0.42	6.37***
LEV	0.08	1.8*	−0.00	−0.61	−0.01	−1.41
REINS	−3.12	−2.27**	−1.64	−2.29**	−0.31	−0.68
FX	−0.31	−0.1	−0.14	−0.13	−1.78	−1.76*
MASSET	−0.26	−0.17				
MLIAB	−0.44	−0.42				
BLINE			1.31	2.87***	0.26	0.71
Log likelihood	−41.49		−74.87		−116.90	
LR statistic (6 df)	95.24***		69.91***		72.00***	
McFadden R-squared	0.53		0.32		0.24	

Panel B: Classification Table (Prediction Success)

	Life Insurers			General Insurers					
	USER Actual			USER			USERPAQ1		
Dependent Variable	Dep = 0	Dep = 1	Total	Dep = 0	Dep = 1	Total	Dep = 0	Dep = 1	Total
Prediction									
Dep = 0	46	11	57	237	22	259	200	42	242
Dep = 1	9	65	74	6	15	21	14	24	38
Total	55	76	131	243	37	280	214	66	280
Correct	46	65	111	237	15	252	200	24	224
% Correct	83.64	85.53	84.73	97.53	40.54	90.00	93.46	36.36	80.00

*, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

the actual values of the dependent variable. The Probit model correctly predicted non-users among the life insurers (general insurers) in 83.64% (97.53%) of the cases and the users in 85.53% (40.54%) of the cases. The lack of accuracy in predicting users for general insurers can mainly be attributed to the small proportion of users in the sample for the regression to work with. As such these results are possibly less robust than those of the life insurance industry.

For the life insurers, size (LNTA), leverage (LEV) and reinsurance (REINS) were found to be significant determinants. Similar with the findings of previous derivative usage research, economies of scale in infrastructure and information search are also important in the Australian context. Leverage was also positively related to derivative participation. Hence, higher leverage and higher expected costs of financial distress are associated with increased derivative usage and it appears that derivatives are utilized in the insurance industry in order to hedge the probability of financial distress costs. The Probit regression shows a negative relationship between the extent of reinsurance and derivative participation at a significance level of 5%. This finding supports the research of Hardwick and Adams (1999) who found a substitution effect between two types of risk reduction methods — reinsurance and derivatives. Conversely, this result contradicts Colquitt and Hoyt (1997) and Cummins, Phillips, and Smith (1997a) who found that reinsurance indicated an insurer as being predisposed to using derivatives to hedge risk.

Further, there was no support for the findings of Hardwick and Adams (1999) regarding the effects of foreign exposure. The total foreign exposure measure may lack explanatory power because insurers with large foreign exposures may have the skills to "net off" exposures or set up natural hedges [see Daugaard and Valentine (1995: 12)].

Finally, the findings of Colquitt and Hoyt (1997) regarding the significance of the mismatch of asset and liability duration were not supported. This could mean one of two things. First, the variables used to proxy the mismatch may be inadequate as they oversimplify the measure of duration. Second, the motivations behind derivative use may not wholly follow a hedging motive. A capital enhancement motive instead may be driving some of the participation decision.

For the general insurers, the Probit regression confirmed the size effect and the importance of reinsurance. The role of foreign exchange positions marginally showed up. The coefficient of leverage was insignificant in both models. Thus, the empirical results for the Australian general insurance industry are somewhat different from those of Cummins, Phillips, and Smith (2001) and the evidence from the life insurance industry. This study also found the use of long tail lines of business to be significantly related to the decision to participate in derivative use at the 1% level.

5.3. *The extent of usage decision*

Table 4 presents the results of the second part of the Cragg (1971) generalization of the Tobit model. Originally, following Colquitt and Hoyt (1997) and Hardwick and Adams (1999), this was estimated using Heckman's (1979) two step correction to the OLS regression, which involved the inclusion of the inverse Mills ratio from the Probit regression as a further independent variable. This proved to be insignificant at conventional levels of significance and hence it was more appropriate to estimate the model using the OLS regression. For the life insurers, the dummy variables for time (D1998 and D1999) were shown to be insignificant and were dropped from the final model.

A further test, White's test for heteroscedasticity, was conducted, which revealed that the null hypothesis of homoscedasticity was rejected at 1% for the life insurers. Hence White's Heteroskedasticity-Consistent Standard Errors were used.

For life insurers, this model has a log likelihood value of −147.02 and an F-statistic of 18.23, which is significant at the 1% level. Therefore the null hypothesis that all coefficients are zero can be rejected at the 1% level. Furthermore, the regression explains a large portion of the variance in the dependent variable as shown by the adjusted R^2 value of 0.58. This regression contained significant coefficients for size (LNTA), and asset and liability duration mismatches (MASSET and MLIAB).

The size variable was significant once again and indicates a positive relationship between extent of derivative use and size. This corroborates the empirical results of Hardwick and Adams (1999) as well as Cummins, Phillips, and Smith (2001). However, it contradicts the results of Colquitt and Hoyt (1997). This is also inconsistent with the theory outlined in the literature, which would seem to indicate that after reaching a certain economies of scale hurdle derivative use becomes viable and the size relationship changes. This is where the proportional costs of bankruptcy discussed by Warner (1977) imply that the larger a firm becomes, the less its proportional costs of bankruptcy and, hence, demand for risk management products.

However, this assumes that insurers use derivatives only to hedge exposures. If derivatives are used for any of the other reasons mentioned by

Table 4. OLS regression (2nd part of Cragg estimation) dependent variable LNEXT.

Life Insurers				General Insurers			
Independent Variables	Coefficient	Std. Error	t-stat	Independent Variables	Coefficient	Std. Error	t-stat
C	-5.73^{**}	2.69	−2.13	C	−3.64	3.88	−0.94
LNTA	1.23^{***}	0.19	6.61	LNTA	0.62^{**}	0.29	2.12
LEV	0.01	0.01	1.04	LEV	−0.08	0.06	−1.28
REINS	2.93	3.25	0.90	REINS	1.34	2.74	0.49
FX	0.52	3.61	0.14	FX	3.54	2.26	1.56
MASSET	-6.64^{**}	2.52	−2.64	D1998	1.56	1.09	1.43
MLIAB	-4.22^{***}	1.44	−2.92	D1999	2.25^{*}	1.13	2.00
Log likelihood	−147.02			Log likelihood	−107.79		
F-statistic	18.2314^{***}			F-statistic	2.6248^{**}		
R-squared	0.61			R-squared	0.29		
Adjusted R-squared	0.58			Adjusted R-squared	0.18		

The inverse Mills ratio (λ_i) was not found to be significant in both industries. Hence the regression was estimated using OLS. White's corrected standard errors are reported for the life insurance industry.
*, ** and *** indicate statistical significance at 10%, 5% and 1% levels respectively.

Hodgson (1999), for example, capital enhancement, this argument breaks down. These results may, therefore, indicate that size allows derivative use to become not just viable but also profitable due to informational economies of scale and amassed expertise. A mitigating factor is that the proxy for derivative use does not control for insurer size. Thus a simpler explanation may be that larger insurers have larger exposures to hedge. Consequently, we reject the proposition that size is not related to the extent of derivative use.

Asset and liability duration mismatch was also found to be significant, but not with the expected sign. This finding contradicts the results of Colquitt and Hoyt (1997) as they found their asset and liability duration mismatch proxies to be positively related to the extent of derivative use. However, these results are similar to those of Cummins, Phillips, and Smith (2001) who found a negative relationship between extent of usage and their duration gap measure.

Once again these findings would appear to contradict the hedging related theories of derivative use. Logic would suggest that if a firm used derivatives only for hedging then balance sheet hedging (duration matching) would be a substitute for derivative use. However, these empirical results show the opposite. This would be consistent perhaps with insurers using derivatives for capital enhancement and even speculation. Since these activities are riskier than hedging one might expect firms to be more inclined to engage in these activities when other risks are minimal, such as when the asset-liability duration mismatch is negligible. Furthermore, less derivative activity would be seen as other risks emerge, that is, as the duration mismatch increases.

A supporting note to this argument is that Colquitt and Hoyt (1997) examined only derivatives that were used as part of a specific hedge. This may explain their differing results to this study and Cummins, Phillips, and Smith (2001). Hence, based on the regression results we can reject the null hypotheses that asset and liability duration mismatches are not related to the extent of derivative use, at significance levels of 5% and 1% respectively.

Leverage, reinsurance, foreign exposures and reporting year are not significantly related to the extent of usage of derivatives by Australian life insurers. Leverage may only be related to the participation decision because it is not hedged directly. Rather, a highly levered firm seeks to minimize the other risks it faces to reduce the expected costs of financial distress related to leverage. Hence the extent of usage may instead be related to the other risks faced by these insurers, not the level of leverage itself.

Reinsurance may also lack a direct relationship. Obviously reinsurance and derivatives are not perfect substitutes since they serve to reduce different types of risks faced by insurers. Their substitution value surrounds the possible reduction in overall risk they offer. Hence the substitution decision may have only directional and not proportional characteristics since the equivalence of units of reinsurance hedging and derivative hedging may be difficult to estimate. Finally, total foreign exposure measure may lack explanatory power due to a further unknown quantity discussed in the participation decision regression, i.e., insurer sophistication.

For general insurers, this regression has a log likelihood value of −107.79 and an F-statistic of 2.62, which is significant at 5%. Therefore, the null hypothesis that all coefficients are zero can be rejected at the 5% level. Furthermore, the regression explains a reasonable portion of the variance in the dependent variable as shown by the R^2 value of 0.29.

Obviously the independent variables in this model do not explain the extent of derivative use as well as the variables for life insurers. A possible explanation for this difference is the superior quality of the proxy for extent of usage in the life insurance model. As mentioned previously, the preferred measure of extent of usage, the natural log of notional values, was unavailable for the general insurance industry. Thus, given the available data, fair value of total derivative positions was used instead.

This regression contained significant coefficients for size (LNTA) and the time dummy for 1999 (D1999). The coefficient for the business line variable (BLINE) was also found to be significant at 10% level (with a magnitude of 4.72 and associated t-statistic of 1.73) when the regression was estimated for the smaller sample of 280 annual reports.

The size variable was significant once again and indicates a positive relationship between extent of derivative use and size. This corroborates the empirical results of Hardwick and Adams (1999) as well as Cummins, Phillips, and Smith (2001) and also follows the empirical results for life insurers. However, this is contradictory to the findings of Colquitt and Hoyt (1997). This is also inconsistent with the theory outlined in the literature, which would seem to indicate that after reaching a certain economies of scale hurdle derivative use becomes viable and the size relationship changes. This inconsistency can be explained as for the life insurers, and hence we can reject the null hypothesis that size is not related to the extent of derivative use, at a significance level of 5%.

For this regression, the coefficient of the 1999 dummy variable is significant at the 10% level. While this is not a very convincing level of significance, it nonetheless requires explanation. The significantly positive sign of the coefficient of D1999 implies that the extent of usage was greater in 1999 than in the previous two years. Coupled with the positive but insignificant coefficient for D1998, there is the possible suggestion of a faint trend to increase the extent of use of derivatives. However, due to the nature of the extent of use proxy this may simply indicate that 1999 saw a large currency movement, unexpected by derivative users, causing their contract fair values to increase around the balance date. Furthermore, even though inflation was weak through 1997 to 1999, it may be a confounding factor since this study does not attempt to control for inflationary effects over the period. Regardless of this, the null hypothesis that extent of derivative use is unrelated to the year of reporting can be rejected at a 10% level of significance.

The final variable found to be significant in the regression of the smaller sample is the business line (BLINE) variable. Hence, the null hypothesis that long tail lines of business are not related to derivative use can be rejected at a significance level of 10%. As with the participation regression the coefficient for BLINE had the opposite sign to that suggested by Cummins, Phillips, and Smith (1997a). This may be due to the fact that the various components of the BLINE variable are not correctly specified in terms of their duration. Alternatively, it is possible that the components of BLINE (such as liability for professional negligence) are highly risky. Consequently, instead of providing a natural hedge for long-term assets, BLINE, in fact, provides a further motive for the general insurers to make use of derivatives to hedge the highly risky long tailed business lines.

The extent of usage regression for general insurers revealed insignificant coefficients for four independent variables; viz. leverage, reinsurance, foreign exposures and the 1998 dummy variable. Therefore, null hypotheses corresponding to leverage, reinsurance and foreign exposures could not be rejected at conventional levels of significance. This closely follows the results for the Australian life insurance industry. Furthermore, this does reflect the general insurance results of Cummins, Phillips, and Smith (2001) except for the foreign exposure proxy and the life insurance results of Colquitt and Hoyt (1997) and Hardwick and Adams (1999) who found a general lack of significant variables in the extent of usage decisions. The explanations for lack of significance of these variables mirror those reasons given earlier for life insurers and are not repeated here.

6. A Combined Model for Life and General Insurers

The main element absent from the results of this study is a regression model covering both sectors. However, due to the different natures of reporting requirements for each sector, a comprehensive model cannot be constructed. Since this is still of interest, a simpler model was estimated for basic comparison of the two sectors. Because of the difference in dependent variable for the extent of usage decision, only the participation decision can be modelled. The results are presented in Table 5 for a Probit regression using the total sample of life and general insurers with dependent variable, participation, and independent variables, size (LNTA), leverage (LEV) and reinsurance (REINS). (LD is a dummy variable for the life insurers.)

This regression produced a model with a log likelihood of −153.22 and an LR statistic, which tests the null hypothesis of all coefficients being equal to zero, of 241.065. This is distributed as Chi squared and is significant at the 1% level. Hence the null hypothesis of all coefficients being

Table 5. Probit regression results — life and general insurers.

Dependent Variable: Participation Decision (USER)			
Independent Variables	Coefficient	Std. Error	Z-statistic
C	-7.4805^{***}	0.6934	−10.7881
LNTA	0.5374^{***}	0.0551	9.7532
LEV	−0.0005	0.0018	−0.2778
REINS	-0.5901^{***}	0.1988	−2.9683
LD	0.5065^{***}	0.17704	2.8609
Log likelihood	−153.22		
LR statistic (4 df)	241.065^{***}		
McFadden R-squared	0.4429		

*Statistically significant at 10% level.
**Statistically significant at 5% level.
***Statistically significant at 1% level.

Classification Table (Prediction Success)			
	Actual		
	Dep = 0	Dep = 1	Total
Prediction			
Dep = 0	334	40	374
Dep = 1	25	83	108
Total	359	123	482
Correct	334	83	417
% Correct	93.04	67.48	86.52

D1998 and D1999 were found to be insignificant and as such were removed from the final regression.

zero is rejected. Furthermore, a McFadden R-squared statistic of 0.4429 was calculated, which is analogous to the R^2 statistic of linear regressions.

A further test of the goodness of fit of the model is the classification table shown at the bottom of Table 5. This table shows how well the model predicted the actual values of the dependent variable. The Probit model correctly predicted non-users in 334 out of 359 cases (93.04%) and users in 83 out of 123 cases (67.48%) giving an overall correct prediction of derivative participation of 86.52%. Once again the main theories are supported at significance levels of 1% except for the relationship between leverage and derivative participation. This result may have been driven by the lack of significance of leverage in the general insurance Probit regression since general insurers make up the bulk of the sample.

The most important result from this regression is the significance of the life insurer dummy variable (LD), set to one for life insurers. In the previous section the difference between participation for general and life insurers was partially attributed to the fact that on average life insurers were larger, more highly levered, used less reinsurance and apparently faced greater foreign exposures. This regression included three of those factors and still the life insurer dummy variable proved to be positive and significant. This indicates that it is not these differences alone that cause the distinction in derivative participation as they are controlled for in this regression. Instead there is a fundamental difference between the activities of life and general insurers.

Jenkins' (1998) description of the two different sectors suggests that this difference stems mainly from the investment role of life insurers. The investment role of life insurers is of a long-term nature through life insurance policies, guaranteed investment contracts and other investment devices. General insurers on the other hand tend to invest over the shorter term as the majority of policies are short tail and hence funds will need to be available in the short term. It may also be worth examining the investment policies of life and general insurers both for fixed income versus equities, and short versus long-term bonds to determine whether this could provide further support for differing motives in derivative use than the standard desire to hedge.[4] Another difference, as mentioned earlier, is the relative availability of derivatives to hedge the primary risk faced by life and general insurers.

The larger use by life insurers could allow them to engage in capital enhancing derivative activities such as the writing of options. This would seem to be supported by the empirical results of Sec. 5 where duration mismatches

[4]We gratefully acknowledge this comment made by the anonymous reviewer.

were negatively related to derivative activities. Capital enhancement carries risk, whereas hedging reduces risk. Therefore, if a lower risk position appears to promote increased derivative use this may be seen as support for a capital enhancement motive. Consequently, this points toward the need for a rethink of the traditional determinants of derivative usage to include capital enhancement.

7. Conclusion

This paper has examined the determinants of derivative usage in the Australian insurance industry. Both the decision to participate in derivative use and the extent of usage decision for the Australian life and general insurance industries have been investigated.

The results both support and contradict the previous empirical evidence. Essentially, the Australian life insurance industry quite closely follows US and UK conclusions. The only exception to this was the results for asset-liability duration mismatches. However, the Australian general insurance industry does not appear to follow the previous literature. In summary, the results are as follows:

(1) For Australian life insurers, the determinants of derivative usage were size, leverage and reinsurance. For the general insurance industry they were shown to be size and the extent of long tailed lines of business written.
(2) For Australian life insurers, the determinants of the extent of derivative usage supported by the evidence were size and asset-liability duration mismatches. For the general insurance industry they were size, the extent of long tailed lines of business written, and the reporting year.
(3) The above results indicate that determinants do differ for life and general insurers in Australia. This is further supported by the significance of the life insurer dummy variable in a simple regression of both Australian life and general insurers, set out in Table 5.

In answering the research questions of this study, empirical results obtained suggested a shortcoming in the literature to date. Previous studies, as well as this one, have examined only three of the motives behind derivative use suggested by Hodgson (1999); risk management, income smoothing and to a lesser extent managerial welfare. However, evidence in this study appears to provide preliminary support for the capital enhancement motive. The capital enhancement motive remains largely untouched by the literature except in Cummins, Phillips, and Smith (1997a and 2001) where the information is present in their regressions but not completely examined.

The limitations of this study surround the proxies used to test the relationships hypothesized in previous literature. With the dependent variables, the study was limited somewhat by the dependent variable for the extent of usage in the general insurance industry. The generally accepted measure of notional contract values was unavailable. Consequently, the alternative used was the fair value of derivative positions held, which may distort the extent of usage somewhat. Further limitations applied to the general insurance data set as, due to the level of aggregation in reporting requirements, a proxy for asset and liability duration mismatch, such as for life insurers and one used in Colquitt and Hoyt (1997) was unable to be constructed.

The final limitation is perhaps the most important in light of the evidence of a possible capital enhancement motive behind derivative use, especially for life insurers. This study examined only the total value of notional and fair values for derivative positions held at the balance date. Had this study broken the regression models down into separate models for participation and extent of usage by individual derivative type, such as in Cummins, Phillips, and Smith (1997a and 2001), a fuller investigation of derivative use motivations could have been achieved. For example, the capital enhancement motivation could have been more clearly viewed by examining the regressions of options written against explanatory variables.

Acknowledgments

Authors are grateful to the Australian Prudential Regulation Authority (APRA) for providing the data set used in this study. Special thanks are due to the APRA staff members, Sandra Escobar, Craig Thorburn and Steve Davies, for their assistance during the data gathering process, and to Michael Kremmer for computational assistance. The views expressed in the paper are entirely those of the authors and do not necessarily reflect the views of the APRA, or any of the organizations they are affiliated with. Comments of participants of the 2002 Pacific Basin Finance, Economics and Accounting Conference in Singapore, staff members of School of Business, Stockholm University, and an anonymous reviewer are gratefully acknowledged.

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