# Hedging with Derivatives and Value Creation : an Empirical Examination in the Insurance Industry

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## Abstract

This paper aims to analyze the reasons why insurance companies make the decision to hedge their corporate risk through derivatives, and to identify the variables that determine hedging volume in the context of the agency theory and maximization of firm value. The empirical study is based on data provided by 28 Spanish life insurers. Apart from being a pioneering work in the Spanish insurance industry, this paper also includes several variables that have not been taken into account in previous studies. The results indicate that hedging decision and volume are positively related to the company's size, leverage and interest rate exposure. We also find that the type of product is important in the hedging decision. Finally, companies that use derivatives have a great return on assets that suggest a relationship between hedging decision and value creation.

*Key Words:* derivatives, risk management, value creation, life insurer, *logit, Tobit*.
*JEL Classification:* G32, G22

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## 1 - Introduction

Financial theory has traditionally considered that corporate risk management makes no sense in perfect financial markets. The irrelevance theorem of the capital structure of a firm can be applied to risk management issue. According to the MM (Modigliani and Miller) propositions, since shareholders can replicate the financial policies of the firm with transactions in the capital markets, the capital structure has no consequence on firm value. Similarly, corporate risk management does not increase shareholder value, because with portfolio diversification investors are able to perform risk management as well as the company's managers.

Nevertheless, currently there is wide theoretical support and substantial empirical evidence to justify this activity. Imperfections in markets, conflicts of interest and/or information asymmetries explain hedging as a mechanism that contributes to the maximization of firm value and to the mitigation of agency problems. Taking into account capital market imperfections, corporate risk management increases shareholder value because it reduces the volatility of corporate cash flows and, consequently, the costs related to these capital market imperfections. The fact that an important number of firms allocate resources to hedging shows the potential of corporate risk management for increasing shareholder value (Bartram, 2000).

Corporate risk management is of special interest in the insurance industry. With an important role in terms of assets transformation, insurers are subject to interest rate risk (Babbel and Santomero, 1997). Other risks are linked to the liquidity of their investments as well as to the characteristics of their liabilities, which include options such as surrender. In addition, the internationalisation process has increased the exposure of some insurance companies to exchange rate risk (Cummins et al., 1997). Also, non-life insurance companies experience high volatility in payments when events occur.

In this context, companies present different attitudes to risk, hence there are substantial differences in the frequency and intensity of their hedging. Derivatives constitute the main off-balance-sheet instruments used by companies to hedge the risks of their daily activity. This study aims to analyze the reasons why Spanish life insurance companies make the decision to hedge their corporate risk through derivatives, and to identify the variables that determine hedging volume in the context of the optimal hedging theory.

This study contributes to the existing literature by focusing explicitly on derivatives for managing corporate risk in life insurance companies. Moreover, this paper makes two important contributions. Firstly, our research focuses on the Spanish insurance market, and contributes important evidence on the practices of corporate hedging with derivatives. Thus, it provides a greater understanding of the European insurance markets for which, unlike the American market, there few studies are available (Hardwick and Adams, 1999). Secondly, we have worked with a wider set of independent variables than previous studies. This has meant the incorporation of several additional factors which had not been considered previously (type of products or asset portfolio).

The paper proceeds as follows. Section 2 describes previous research that has been done on derivative use in the insurance industry. Section 3 explains the theoretical background of our empirical model and the hypotheses. In section 4 the econometric models are explained and the empirical results are presented. In section 5, we conclude by summarizing the most important findings, introducing the potential limitations of the research and discussing areas for further research.

## 2 - Literature review

During the 1990s several studies were carried out to determine the variables that explain the use of derivatives by the companies in various industries and markets (Table 1). Of special interest in the insurance field are the studies by Colquitt and Hoyt (1997), Cummins et al. (1997a, 1997b), Hardwick and Adams (1999) and De Ceuster et al. (2003).

Colquitt and Hoyt (1997) found, for American life insurance companies, that the size of the insurer, leverage and reinsurance are positively related to the decision to hedge with futures and options. In fact, reinsurance seems to act as an indicator of the predisposition to hedge with such products, rather than as a substitute for hedging with derivatives. They also showed that highly leveraged insurance companies and those with a greater duration gap are likely to use derivatives to a greater extent.

A similar study involving non-life insurers as well as a greater number of variables was carried out by Cummins, Phillips and Smith (1997a, 1997b). These authors found that firm size and leverage were positively related to the decision to use derivatives as a hedging instrument and the extent of their use. The relationship of reinsurance with the use of derivatives

depended on the insurer's type of activity: a positive relationship for life companies and a weak negative relationship for non life. Finally, in contrast to Colquitt and Hoyt's results, they find a negative relationship between the duration gap and the level of hedging through derivatives.

In the United Kingdom, the study by Hardwick and Adams (1999) of life insurance companies stands out. Like the preceding studies they find that both the decision to use derivatives and the extent of their use are positively related to the size and the leverage of the firm. Nevertheless, unlike what occurs in the American market, these authors observe a negative relationship with respect to the use of reinsurance. The positive relationship with leverage and the negative one with reinsurance support the hypotheses that in the United Kingdom derivatives are used for purposes of hedging rather than for speculation. Also, mutual firms have a greater propensity than stocks to use derivatives. According to these authors, size and organizational form are the variables that mainly affect the use of derivatives in the United Kingdom.

In the Australian insurance market, De Ceuster et al. (2003) find that the decision to use derivatives and the extent of their use are positively related to firm size. As in Cummins et al. (1997b), they detect a negative relationship between asset-liability duration gap and the extent of derivative usage. With respect to life companies, they found evidence supporting the hypothesis of leverage in the use of derivatives, but not the reinsurance hypothesis.

**Table 1 - Empirical studies**

| | **NON – FINANCIAL FIRMS** | **FINANCIAL FIRMS** | |
|---|---|---|---|
| | | BANKS | INSURANCE COMPANIES |
| United States | Dolde (1993)<br>Phillips (1995)<br>Bodnar et al. (1995,1996) | Sinkey and Carter (1997)<br>Gunther and Siems (1995) | Colquitt and Hoyt (1997)<br>Cummins et al. (1997a, 1997b) |
| United Kingdom | Grant and Marshal (1997) | Naik and Yadav (2003) | Hardwich and Adams (1999) |
| Belgium | De Ceuster et al. (2000) | | |
| Finland | Hakkarainen et al. (1997) | | |
| Australia | Batten and Mellor (1993)<br>Batten, Mellor and Wan (1994)<br>Batten and Hettihewa (2003) | | De Ceuster et al. (2003) |

## 3 – Methodology

### 3.1 The data and sample

The data used for the analysis are from the *Survey of the Asset – Liability Management in Life Insurance Companies*, sponsored and conducted by the Insurers' Cooperative Research Association (Investigación Cooperativa entre Entidades Aseguradoras - ICEA). Data collection was carried out in 2002 using computer-assisted personal interviewing (CATI) and a structured questionnaire. The *Survey of the Asset – Liability Management in Life Insurance Companies* requires insurance firms to give details of their asset - liability portfolio as well as of the derivative instruments used and their particular classification (e.g., FRAs, swaps).

The empirical analysis is based on a sample of 28 life insurance companies operating in the Spanish market. In spite of the limited number of firms, it is a very representative sample, covering more than 50% of the Spanish market.

### 3.2 Variables

In order to study hedging behaviour, two different measures of the dependent variable are used. The first is a dummy variable equals to one for life insurance firms which use derivatives and zero otherwise (DHEDGE). The second is a continuous measure of the extent of hedging calculated as the ratio of the total notional value of derivatives to total assets of the firm (VHEDGE). Unlike other studies which only take into account futures and options, we have also considered OTC products. As in other markets, most operations are carried out in OTC markets (99.36%). Since most operations are long term, the resort to organized exchanges is not significant. Practically all trading is concentrated in interest rate swaps (94.12%) and in FRAs (5.17%).

We describe below the independent variables which, according to the literature, affect the decision to hedge, as well as the hypotheses regarding the relationship that should exist between these variables and the dependent variable (Table 2).

*a) Size*

There are contradictory hypotheses surrounding the effect of size on the hedging decision. According to Warner (1977) and Altman (1984), since

costs of an adverse financial situation are greater for small firms, these will hedge more frequently in order to avoid the probability of bankruptcy (Colquitt and Hoyt, 1997). If this hypothesis is satisfied, there will be a negative relationship between size and the use of derivatives. Besides, large firms tend to be more diversified through their different lines of business, resorting less to hedging than small firms (Cummins et al., 1997a).

However, other authors maintain that large firms are more willing to hedge with derivatives because they can better assume the high overheads associated with their use (Nance et al., 1993; Sinkey and Carter, 1994; Cummins et al., 1997b). In addition, large firms usually have the necessary financial and human resources to properly manage a portfolio of derivatives.

As in Colquitt and Hoyt (1997), size is calculated as the natural logarithm of the insurer's volume of premiums written (LOGPREM). We use a natural log transformation of this variable due to the skewed distribution of the volume of premiums of firms. As remarked above, the relationship between this variable and the use of derivative instruments may be either positive or negative depending on the underlying theoretical argument.

*b) Leverage*

Firms tend to hedge to avoid the costs of financial distress which are higher the greater the firm's level of debt. Many studies have tested the relationship between capital structure and risk management policy. In non-financial firms, Wall and Pringle (1989) showed that those with low ratings are more likely to use derivatives, in particular swaps. Dolde (1996) also found a direct relationship between leverage and derivative usage. However, other studies were unable to verify the existence of such a relationship (Nance et al., 1993; Mian, 1996; Geczy et al., 1997).

Similar results were found for financial firms. Sinkey and Carter (1997) found a weak relationship between capital structure and the use of derivatives for the case of U.S. banks, but Gunther and Siems (1995) reached contradictory results, finding a positive relationship between the banks' level of capitalization and their use of derivatives.

Regarding the insurance industry, Colquitt and Hoyt (1997), Cummins et al. (1997a, 1997b) and De Ceuster et al. (2001), show a positive relationship between the leverage of the companies and the use of derivatives, which is consistent with the hypothesis of costs mitigation of financial insolvency.

Following Colquitt and Hoyt (1997), leverage (LEVERAGE) is calculated as total liabilities divided by total equities. A positive relationship can be expected between this variable and the use of derivatives.

*c) Reinsurance*

Two contradictory hypotheses can be put forward. If the number of policies does not reach a minimum, reinsurance will be used by many companies to hedge the insurance risk and even interest rate risk. Cummins et al. (1997a) and Colquitt and Hoyt (1997) therefore indicate that reinsurance can act as a substitute for derivatives. In this sense, the greater the reinsurance activity of the companies the less should be the use of derivatives.

On the contrary, Mayers and Smith (1990) maintain that reinsurance is an indicator of a firm's predisposition to hedge, acting as a sign of greater derivatives usage.

The empirical results reflect both positions, but the evidence is not always strong. Cummins et al. (1997a) found a weak negative relationship between reinsurance and the use of derivatives for non-life insurers, and a positive relationship for life insurers. The study by Colquitt and Hoyt (1997) also sustains this positive relationship but with low significance. On the other hand, Hardwick and Adams (1999) and De Ceuster et al. (2001) observe a negative relationship between reinsurance and the use of derivatives.

As in Cummins et al. (1997a), Hardwich and Adams (1999) and De Ceuster et al. (2002), the level of reinsurance (REASSPRE) is measured by the ratio of ceded reinsurance premiums to the total premiums. The relationship of this variable to the use of derivative instruments may be either positive or negative.

*d) Mismatch of asset and liability duration*

An important element is the level of financial risk assumed by companies on their balance sheets. Staking and Babbel (1995) and Cummins and Weis (1991) indicate that insurers have a positive duration gap, so they are exposed to interest rate volatility. Therefore, companies with a larger duration gap will be more inclined to hedge with derivatives.

Colquitt and Hoyt (1997) found a positive relationship between the duration gap and the use of derivatives, indicating that those firms with greater duration gap hedge more. However, none of the previous studies on the insurance industry support these results.

The accounting information available did not make it possible to calculate duration gaps. Therefore, according to Cummins et al. (1997a) we opted to use the average maturity of asset portfolio (MATURITY) as a proxy

variable, since it is associated with the products in which the company assumes greatest interest risk. A positive relationship can be expected between the maturity of the asset and the use of derivatives.

*e) Fixed income portfolio*

Similarly to reinsurance, this variable is used to test whether the use of other risk management techniques is complementary to, or substitutes for, derivatives. In Spain it is quite common for firms to use cash flow matching techniques, known as on-balance-sheet hedging. It is to be expected that companies that resort more to these techniques present less use of derivatives.

On the contrary, on-balance-sheet hedging may also reflect the firm's propensity to hedge. In addition, these techniques occasionally incorporate derivatives into the design of the portfolio. Furthermore, the usage of segmentation techniques can favour the use of derivatives because they can adapt portfolio investments to the characteristics of each insurance product (Cox et al., 1996).

We use the percentage of asset portfolio invested in fixed income (BONDPORT), because this is related to the use of cash flow matching or immunization techniques (Otero, 2001). The relationship of this variable to the use of derivatives may be either positive or negative.

*f) Stocks and foreign currency portfolio*

Insurance companies invest in stocks and in foreign currencies, assuming financial and exchange rate risks. Since the profitability of shares is random, companies with higher proportion of stocks in their portfolios will assume a greater investment risk and be more willing to hedge with derivatives. The same argument could apply to investments in foreign currency.

To measure the market and exchange rate risk we use the percentage of the asset portfolio invested in stocks (STOCKPORT). The exchange rate risk is measured by the percentage of the asset portfolio invested in foreign currency (FOREINGPORT). A positive relationship can be expected between both variables and the use of derivatives.

*g) Type of product*

In some products, the insurance company guarantees a return either as a regular stream of income or as a lump sum payout at some future time. On the other hand, other products (like life insurance or with-profit policies) transfer the risk to the insured.

The higher the proportion of guaranteed return products in liability portfolio, the greater the use of derivatives. We use the percentage of income (INCOME) and lump sum products (LUMPSUM) in liability portfolio.

*h) Organizational form*

Since a mutual insurance company lacks effective mechanisms to control managers' behaviour, this organizational form is more likely to give priority to hedging strategies over maximization of value firm.

Additionally, maximization of firm value approach also supports the hypothesis that mutual insurers are more likely to use derivatives than stock companies. The main reason for this lies in their difficulties to obtain financing from stock markets, especially after a crisis. Under these circumstances, mutual insurers would have to reject profitable projects until enough retained earnings were accumulated. To avoid underinvestment problems they will hedge to a greater extent than stock companies.

An alternative hypothesis points out that mutual insurers are more efficient if they insure less complex risk activities (Mayers and Smith, 1988). Therefore, if they choose to focus on this type of activities, they will have less need to hedge and, thus, use fewer derivatives than stock companies.

As in Colquitt and Hoyt (1997), Cummins et al. (1997a) and Hardwich and Adams (1999), the organizational form (ORGFORM) is represented by a dummy variable, which is set equal to one for a stock company and zero for a mutual insurer.

**Table 2 - Variables and hypotheses**

| VARIABLE | MEASURE | HYPOTHESES |
|---|---|---|
| Size (LOGPREM) | Natural logarithm of the total volume of premiums | *H1a*: Small firms will hedge more frequently in order to avoid the probability of financial distress (-)<br>*H1b:* Hedging activities involve significant scale and information economies, therefore large firms are more likely to use them (+) |
| Leverage (LEVERAGE) | Total liabilities / Total equities | *H2*: Highly leveraged insurance companies have more interest rate risk and underinvestment problems, therefore they will be more inclined to hedge with derivatives (+) |
| Reinsurance (REINSPRE) | Volume of premiums ceded in reinsurance / Total premiums | *H3a:* Reinsurance can act as a substitute for derivatives (-)<br>*H3b:* Reinsurance may simply show that a firm is predisposed to hedge risk (+) |
| Maturity of the asset portfolio (MATURITY) | Average maturity of the asset portfolio | *H4*: Life insurance companies with a higher positive duration gap are more exposed to the volatility of interest rates, therefore they will be more inclined to hedge with derivatives (+) |
| Fixed income portfolio (BONDPORT) | Percentage of asset portfolio invested in fixed income | *H5a*: Cash flow matching techniques can act as a substitute for derivatives (-)<br>*H5b*: Cash flow matching techniques may simply show that a firm is predisposed to hedge risk. Besides, immunization techniques sometimes incorporate derivatives into the design of the portfolio (+) |
| Market risk (STOCKPORT) | Percentage of the asset portfolio invested in variable income | *H6*: Companies with a higher proportion of stocks in their portfolios will assume a greater investment risk and be more willing to hedge with derivatives (+) |
| Exchange rate risk (FOREINGPORT) | Percentage of the asset portfolio invested in foreign currency | *H7*: Companies with a higher proportion of foreign currency in their portfolios will assume a greater exchange rate risk and be more willing to hedge with derivatives (+) |
| Type of product (LUMPSUM) (INCOME) | Product's proportion of total liability | *H8:* Companies whose liability portfolio has a higher proportion of products that guarantee a return will be more willing to hedge with derivatives (+) |
| Organizational form (LEGALFORM) | Dummy variable equals to 1 for a stock company and 0 for a mutual insurer | *H9a*: Mutual companies will be more willing to hedge with derivatives owing to the lack of manager-control tools as well as their difficulties to get funding (+)<br>*H9b*: As mutual companies tend to focus on less complex risk activities, they will have less need of hedging (-) |

## 4 - Empirical results

In this section, we discuss the following issues: the relationship between asset-liability portfolio and hedging, the determinants of the hedging and volume decision, and if differences exist between hedgers and non-hedgers in terms of value creation indicators.

Table 3 shows the differences of means for the companies that do or do not hedge with derivatives. Significant differences were found in an important group of the variables selected in the theoretical framework. In particular, the users of derivatives tend to have greater *size* (LOGPREM) and present a higher level of *leverage* (LEVERAGE). They also show a greater *average maturity* (MATURITY) in their investment portfolios. The higher extent of *reinsurance* (REINSPRE) in non-users seems to indicate that this variable may act as a substitute for hedging. None of the mutual companies (ORGFORM) hedges with derivatives, although it is true that the sample is not very large.

Asset portfolios of non-users show a lower percentage of *fixed income* securities (BONDPORT) and a higher percentage of both *equity securities* (STOCKPORT) and *foreign currency* assets (FOREINGPORT). These variables do not behave as was expected *a priori*. However, in order to determine risk, asset portfolio should be analysed together with liabilities. Generally, if the company guarantees a return (INCOME and LUMPSUM products) higher financial risk is covered by investing in fixed income securities.

**Table 3 - Comparison of the variables between users and non-users of derivatives**

| | Using of derivatives | N | Mean | t-statistic |
|---|---|---|---|---|
| LOGPREM*** | 0 | 14 | 7.718 | -3.944 (0.0005) |
| | 1 | 14 | 8.640 | |
| LEVERAGE*** | 0 | 14 | 0.8471 | -2.802 (0.0095) |
| | 1 | 14 | 0.9492 | |
| REINSPREM | 0 | 14 | 0.057 | 1.402 (0.1726) |
| | 1 | 14 | 0.0147 | |
| LEGALFORM*** | 0 | 14 | 0.7714 | -3.122 (0.0044) |
| | 1 | 14 | 1 | |
| MATURITY | 0 | 14 | 7.051 | -0.538 (0.595) |
| | 1 | 14 | 7.838 | |
| GAPDUR | 0 | 6 | -3.5016 | -0.896 (0.390) |
| | 1 | 7 | -1.6465 | |
| BONDPORT | 0 | 14 | 0.5521 | -0.707 (0.486) |
| | 1 | 14 | 0.6203 | |
| STOCKPORT | 0 | 14 | 0.0593 | 0.992 (0.330) |
| | 1 | 14 | 0.0220 | |
| CURRENCYPORT | 0 | 14 | 0.053 | 0.4235 (0.6754) |
| | 1 | 14 | 0.0366 | |
| LUMPSUM | 0 | 14 | 0.3528 | 0.399 (0.692) |
| | 1 | 14 | 0.3042 | |
| INCOME | 0 | 14 | 0.2383 | -0.209 (0.836) |
| | 1 | 14 | 0.2616 | |

Table 3 shows the difference of means for the independent variables used in the empirical analysis between companies that hedge with derivatives (1) and those that do not (0). The *t statistic* is used to test the equality of means. In the selection, we have taken into consideration the Levene test for equality of variances (***,**;*) with a level of significance of 1% , 5% and 10%, respectively. P-value in parentheses.

### 4.1 Is there a relationship between asset-liability portfolio and hedging?

Cummins et al. (1997a) indicate that asset and liability portfolios may play a very important role in the hedging decision. As a consequence, the assets portfolio associated to each type of product is a valuable piece of information. Table 4 shows that if life insurance and "with-profits policies" are mostly offered and, consequently, the insurer assumes less investment risk by transferring it to the taker, the percentage of equity securities is higher (≥ 6%). On the contrary, if "policies with guaranteed returns" are mostly offered, equities portfolio (≤3%) is drastically reduced and conservative investments in fixed income products (≥ 60%) and deposits (≥ 10%) predominate.

**Table 4 - Asset - liability portfolio**

| | Life Insurance | With -Profits Policies | Guaranteed return (Lump sum payout) | Guaranteed return (Incomes) |
|---|---|---|---|---|
| CASH | 4.72% | 10.50% | 7.78% | 4.18% |
| FIXED INCOME | 22.86% | 70.86% | 60.99% | 64.64% |
| - Domestic | 16.43% | 60.03% | 40.57% | 49.70% |
| *Public* | 12.47% | 39.06% | 22.51% | 23.02% |
| *Private* | 3.96% | 20.97% | 18.06% | 26.68% |
| - Euro Area (excluding Spain) | 5.32% | 9.54% | 19.66% | 13.50% |
| *Public* | 0.43% | 1.42% | 0.23% | 1.28% |
| *Private* | 4.89% | 8.12% | 19.43% | 12.22% |
| - Foreign | 1.12% | 1.29% | 0.76% | 1.44% |
| BANK DEPOSITS | 4.23% | 3.58% | 10.45% | 25.13% |
| MORTGAGE LOANS | 0.00% | 2.84% | 2.24% | 5.07% |
| EQUITY SECURITIES | 11.26% | 6.66% | 2.53% | 0.11% |
| - Domestic | 9.69% | 6.47% | 2.49% | 0.10% |
| - Euro Area (excluding Spain) | 0.86% | 0.15% | 0.04% | 0.01% |
| - Foreign | 0.70% | 0.03% | 0.00% | 0.00% |
| SECURITIES INVESTMENT FUNDS | 36.33% | 4.25% | 14.30% | 0.12% |
| OTHER FINANCIAL INVESTEMENTS | 4.91% | 0.98% | 0.72% | 0.56% |
| REAL INVESTMENTS | 15.69% | 0.33% | 0.99% | 0.20% |
| TOTAL INVESTMENTS | 100.00% | 100.00% | 100.00% | 100.00% |

Matching techniques are reflected in asset - liability duration, allowing us to analyse the level of interest rate risk assumed. Since only 11 companies offered this information, the duration gap could not be used as a variable in the analysis, and we opted for the average maturity of asset portfolio (MATURITY). Nevertheless, Table 5 summarizes the data of the companies that did, in fact, facilitate such information. The greater interest rate risk (*mismatching*) corresponds to products with guaranteed returns which, as we shall see, concentrate most investment in derivative securities.

**Table 5 - Duration gaps**

| | Life Insurance | With-Profits Policies | Guaranteed return (Lump sum payout) | Guaranteed return (Incomes) | TOTAL |
|---|---|---|---|---|---|
| Asset duration | 4.9 | 8.0 | 5.6 | 8.4 | 7.2 |
| Liability duration | 5.0 | 8.3 | 7.0 | 7.1 | 8.4 |
| **Duration gap** | **-0.1** | **-0.4** | **-1.4** | **1.3** | **-1.2** |

Table 6 shows that the use of derivatives is closely linked to the products offered by the company and to the investment risk assumed. As we expected, a very substantial percentage of operations (90.79% of the notional value) are used to hedge products that guarantee future income, because these products have the longest maturity and the company assumes a substantial investment risk. On the other hand, since with-profits policies transfer part of the risk to the insured and life insurance policies are generally taken out for the short term with a lower investment component, these products are not hedged with derivatives.

**Table 6 - Derivatives and liability portfolio**

| | Life Insurance | With-Profits Policies | Guaranteed return (Lump sum payout) | Guaranteed return (Incomes) |
|---|---|---|---|---|
| OTC Markets | 0.00% | 99.66% | 100% | 100% |
| *FRAs* | 0.00% | 44.14% | 0.00% | 0.00% |
| *Swaps* | 0.00% | 52.48% | 99.49% | 100% |
| *Caps* | 0.00% | 0.00% | 0.51% | 0.00% |
| *Floors* | 0.00% | 3.04% | 0.00% | 0.00% |
| Organized Exchanges | 0.00% | 0.34% | 0.00% | 0.00% |
| *Financial futures* | 0.00% | 0.00% | 0.00% | 0.00% |
| *Options* | 0.00% | 0.34% | 0.00% | 0.00% |

| | | | | |
|---|---|---|---|---|
| Total Notional Value | 0.00% | 100% | 100% | 100% |
| % of Notional Value | 0.00% | 9.21% | 13.07% | 77.72% |

### 4.2 What are the determinants of hedging?

Multivariate analysis has been applied to test the determinants of derivatives decision by the Spanish life insurance industry (application Stata 9.0). In particular, two different models are estimated. Firstly, we use a logit regression model in order to estimate whether or not the insurers hedge. Secondly, we estimate the determinants of the hedging volume using a tobit regression model.

Specifically we have used a binomial logit model that relates the binary dependent variable ($Y$ = 1 or 0, depending on whether the company hedges or not) to the independent variables ($X_1, X_2, ....X_n$) which turned out to be statistically significant (Table 3), according to the following expression:

$$\Pr ob(y = 1) = \frac{1}{1 + e^{-z}} \tag{1}$$

Where:

$$Z = B_0 + B_1 X_1 + B_2 X_2 + ..... + B_n X_n \tag{2}$$

Two approaches have been applied: introducing the variables all together and introducing them step by step. In general, introducing the variables all together presented a good level of fit, but the results were not significant because of the multicollinearity between firm size and leverage. On the other hand, the step by step approach only included the variable firm size. These problems were dealt with by carrying out a factorial analysis with the variables firm size and leverage, in order to later apply another *logit* analysis of the factors. As can be seen in Table 7, from Barlett's sphericity test, the possibility of carrying out a factorial analysis has been verified on the basis of existing data.

**Table 7 - Factorial Analysis: Bartlett test**

| | | |
|---|---|---|
| Barlett's Sphericity Test | Chi-squared approximate | 15.490 |
| | Gl | 1 |
| | Sig. | 0.000 |

We used the main components method of data reduction obtaining a single factor, which explains 83.76% of the variance (the communities have satisfactory values 0,837). Using this factor as a new independent variable, a binomial logit analysis was once again applied (Table 8). The confusion matrix reflects the good predictive value of the model, classifying 85.71% of the cases correctly. As can be seen, the single factor, representing economies of scale linked to size, proves to be statistically significant and positively related to the hedging decision. This factor reflects the variables that individually turned out to be statistically significant in the first logit analysis. In addition, the MATURITY variable results significant and presents a positive relationship with the probability of hedging.

**Table 8 - Binomial logit estimations of the likelihood of using derivatives**

| Dependent variable (DHEDGE) : Using of derivates=1; Not using of derivatives=0 | |
|---|---|
| VARIABLE | COEFFICIENT |
| CONSTANT | -2.570***<br>(1.40) |
| COMPONENT 1 | 2.4877***<br>(0.89) |
| MATURITY | 0.333**<br>(0.174) |
| PseudoR$^2$ | 0.428 |
| LR-Test | 16.61*** |
| N | 28 |
| Y=0 | 14 |
| Y=1 | 14 |
| % correct estimations | 85.71% |

Logit regression estimates of the relationship between the likelihood that a firm uses derivatives to hedge and the listed variables. ***,**,* denotes significance at the 1%, 5% and 10% levels, respectively. Standard errors are in parentheses. In addition, we analyzed possible problems of heteroscedasticity, absence of normality and multicollinearity. Also, the high individual significance of the variables included in the models and the value of the correlation matrix determinant, indicates that the models do not present multicollinearity problems. Similarly, to check the normality of residuals we used the Jarque-Bera test and the normality of residuals hypothesis is accepted.

After hedging decision analysis, we evaluate hedging volume and decision together by applying a tobit model. As Haushalter (2000) and Allayannis et al. (2003), we use such a specification because not all firms use derivatives (i.e. we have a point mass at zero). This model expresses the observed response based on a latent variable $Y_j^*=X_j\beta+u_j$. Thus, the censored variable will be distributed as follows (Greene, 2001):

$$\begin{aligned} y_j &= 0 \quad if \quad y_j^* \le 0 \\ y &= y_i^* \quad if \quad y_j^* > 0 \end{aligned} \tag{3}$$

This distribution is a combination of a continuous and a discreet distribution where all the likelihood of the censored area is assigned to the censoring point at 0. Therefore, in a preliminary step, a probit model is used to determine the likelihood of the variable $Y_j^*$ having a value of 0 as opposed to having a positive value. In the second stage, the $Y_j$ variable will take on a real and positive value as long as a positive value has been assigned to the $Y_j^*$ variable. Thus, we can specify the following model for the subgroup whose dependent variable is non-null.

$$Y_j^* = X_j\beta + u_j \tag{4}$$

The estimations obtained with the tobit model directly represent the marginal effect of each variable on the average value $Y^*$. However, the interpretation of the coefficients is not as obvious if we wish to analyze the effect on the censored variable. In this case, the parameter estimations should be weighted by the likelihood that an observation is not censored:

$$\frac{\partial E(y_i / x_i)}{\partial x_i} = \beta\phi\left(\frac{\beta' x_i}{\sigma}\right) \tag{5}$$

The partial effects of $X_j$ on the expected value of $Y$ have the same sign as the coefficient, but the magnitude of the effects depends on the values of all the explanatory variables and parameters.

**Table 9 - Tobit regression estimations of hedging volume with derivatives**

| Dependent variable (VHEDGE) : Total notional value of derivatives / Total assets | |
|---|---|
| Variable | Coefficient |
| LOGPREM | 0.0000948***<br>(0.00003) |
| LEVERAGE | 0.0010145**<br>(0.0004642) |

| | |
|---|---|
| MATURITY | 0.0000252**<br>(0.0000124) |
| REINSPRE | -0.0008549<br>(0.0018826) |
| INCOME | -0.0004159**<br>(0.000183) |
| CONSTANT | -0.002984***<br>(0.0006135) |
| Left censores obs | 14 |
| Uncensored obs. | 14 |
| LR test | 25.44<br>(0.0001) |

Tobit regression estimates of the relationship between the percentage of hedging with derivatives and the listed variables. We model a firm's one-step hedging decision using a tobit method, because the continuous dependent variable that we use is censored at zero. ***,**,* denotes significance at the 1%, 5% and 10% levels, respectively. Standard errors are in parentheses.

As can be seen in Table 9, the determinants of hedging volume are very similar to those ones of the decision to hedge. Thus, there is a significant positive relationship with company size, leverage and interest rate exposure, measured by the maturity. In addition, a new variable, INCOME, shows to be significant and negatively related to hedging volume.

Like Hardwick and Adams (1997) for the British market, Cummins et al. (1997a, 1997b) for the U.S. market, and De Ceuster et al., (2001) for the Australian market, we also found a positive significant relationshipship between the size of the company (LOGPREM) and both hedging volume and decision. This outcome suggests a greater propensity of the larger life insurers to hedge with derivatives, which, in turn, supports the hypothesis that derivatives usage requires specialised technical and human resources that generate economies of scale (*Hypothesis 1b*).

Hedging decision and volume are also positively related to the insurer's leverage (LEVERAGE). Thus, the fact that highly leveraged companies are more likely to hedge with derivatives supports the hypothesis that firms wish to reduce their insolvency costs (*Hypothesis 2*). This result highlights the traditional hedging theory view that assumes companies closer to an insolvency situation will hedge more. Moreover, this finding is consistent with those of Colquitt and Hoyt (1997), Hardwick and Adams (1999) and De Ceuster et al. (2001) that found a positive relationship between the leverage of the companies and the use of derivatives. In addition, this

result is similar to that of Colquitt and Hoyt (1997) who showed a positive relationship between the insurer's leverage and the level of hedging.

The MATURITY variable has also a significant positive effect on both hedging volume and decision. This result shows as the companies with a larger duration gap will be more likely to hedge with derivatives in order to mitigate their interest rate risk (*Hypothesis 4)*. This finding is consistent with that of Colquitt and Hoyt (1997) who found a positive relationship between the duration gap and the use of derivatives.

Finally, the INCOME variable is found to be statistically related to the hedging volume but not in the expected direction. Contrary to what we expected in *Hypothesis 8*, the result shows that life insurers whose liability portfolio has a higher proportion of products that guarantee a return will be less likely to hedge with derivatives. Spanish companies mitigate their interest rate risk by guaranteeing a very low interest rate in their products and using derivatives only in particular cases. This fact could partially explain that if companies have a greater volume of products, they have a fewer percentage hedged.

### 4.3 Are there differences between hedgers and non-hedgers in terms of value creation indicators?

As we indicated, several studies support the hypothesis that hedging increases firm value. The present paper also aims to analyse whether firms that use derivatives as a hedging tool show better value creation indicators. We have found several limitations that make the analysis difficult. Basically, although value creation can be measured as an increase in stock prices, our sample of life insurers is not listed on the stock market. Therefore, we have to use classical measures such as ROA (return on assets), ROE (return on equity), and EVA (economic value added).

Stewart (1991) indicates that EVA takes into account the creation or destruction of firm value. He also maintains its superiority as a measure of profitability, compared to the traditional EPS (earnings per share), ROE or ROA, because it explains the variations in shareholder's wealth at least 50% better. In this sense, O´Byrne (1996) used a regression to demonstrate that EVA is better for explaining firm market value than other indicators (NOPAT, EPS or Income). Hall (1998) also tried to test the theoretical relationship between EVA and MVA (market value added) upheld by Stern & Stewart. He analysed the indicators of internal management (EVA, Standardised EVA,

ROA, ROE, EPS, and DPS) that had a higher correlation with MVA, in 135 industrial firms on the Johannesburg stock exchange over a 10-year period. He found that, of all these measures, the highest correlation coefficient was between MVA and EVA, coming to the conclusion that a relatively strong relationship exists between MVA and EVA.

Nevertheless, there are problems limiting the use of internal measures as true indicators of the value creation. Principally, shareholder's value creation is closely linked to variations in firm value, which, in turn, depends on future expectations of cash flow and changes in firm risk. However, internal measures can scarcely incorporate these expectations because they are based on yearly accounting results (Fernández, 2001; Biddle et al., 1997).

To test the hypothesis that hedging increases firm value, we decided to analyse whether there are significant differences between the companies that hedge with derivatives and those that do not. As indicators of the value creation we calculated ROE, ROA and EVA referring to the year 2002. We carried out a single-factor variance analysis, using the mentioned indicators as dependent variables and hedging as the factor.

Table 10 shows that the groups present differences in average returns with respect to all indicators. In general terms, the group of companies that hedge present better results, i.e. a higher return on assets and on capital, as well as higher average return. However, only return on capital is statistically significant. This can be interpreted to mean that large firms require less capital as a result of scale economies. The effect of leverage enables large firms to obtain better returns on capital, but exposes them to a higher degree of financial risk. This situation is made sustainable by pursuing hedging strategies that contribute to a more efficient asset-liability portfolio.

**Table 10- Analysis of variance between hedgers and non-hedgers**

| | t | gl | Sig. (bilateral) | DIFFERENCES |
|---|---|---|---|---|
| ROA | .613 | 26 | .546 | .0121929 |
| ROE | 1.795 | 26 | .084 | .11786 |
| EVA | .540 | 26 | .594 | .5007915 |

## 5 – Conclusion

This study aims to test optimal hedging to explain derivatives usage by life insurance companies. In particular, we analyze the variables that determine the hedging decision with derivatives as well as the hedging volume for a sample of 28 Spanish life insurance companies in 2002.

In the first section of the empirical research, we analyze whether the insurers' asset and liability portfolios have effects on their hedging decisions. The results highlight that the type of products offered by the insurer and the interest rate risk have an effect on derivatives usage. In fact, a very substantial percentage of the derivative instruments (90.79% of the notional value) are used to hedge products that guarantee future income. This is to be expected because these products have the longest maturity and the company assumes a substantial investment risk. Other financial risks, as equity and exchange rate risk, are not significant in the insurer's hedging. This result could be explained by the fact that this type of assets is linked to products where the insurer has already transferred the risk to the taker.

In the second section of the empirical research, we analyze the determinants of the hedging decision and volume. Thus, a first finding shows that the firm size positively influences hedging decision and volume, supporting the hypothesis that derivatives usage requires specialised technical and human resources that generate scale economies.

Our second finding relates to the impact of the insurer's leverage on the hedging decision and volume. Insurers with a higher leverage have a greater tendency to hedge with derivatives. This result highlights the traditional hedging theory view that assumes companies closer to an insolvency situation will hedge more in order to reduce their insolvency costs.

A third finding also provides evidence that the maturity of the insurer's asset portfolio positively influences his decision of hedging with derivatives as well as the hedging volume. This outcome shows as the companies with a larger duration gap will be more likely to hedge with derivatives in order to mitigate their interest rate risk.

A fourth finding shows that the insurer's liability portfolio is also statistically related to the hedging volume but not in the expected direction. The result shows that life insurers whose liability portfolio has a higher proportion of products that guarantee a return will be less likely to hedge with derivatives. Spanish companies mitigate their interest rate risk by guaranteeing a very low interest rate in their products. This fact could

partially explain that if companies have a greater volume of products, they have a fewer percentage hedged and use derivatives only in particular cases.

In the third and last section of the empirical research, we analyzed whether hedging increases firm value. We conclude that hedgers present better results in value creation indicators. Larger companies have a greater leverage leading to greater returns and increased financial risk. This financial risk is controlled using derivatives, suggesting a relationship between hedging and value creation.

The limitations of this paper are mainly associated to the availability of information. Although a considerable effort was made to obtain a larger sample of the Spanish life -insurance market, our results were limited by the availability of data from annual reports. Therefore, as a future line of research we propose developing panel data extending the study over several years.

We expect corporate hedging through derivatives to become increasingly important in the years to come, allowing us to have more comprehensive data. Finally, the relationship between indicators of value creations and corporate risk management will also provide numerous research opportunities for economists.

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