Costs and Benefits of the Use of Derivatives

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PhD Thesis

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A mi Maus y mi Paulo

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Introduction

Much has been written on the pricing of financial derivatives, but not that much has been done on the economic reasons, costs, benefits and impact of their use. This is quite surprising given the economic importance of these instruments: the world's aggregate position in derivatives has experienced a significant increase, and its growth does not seem to have stopped yet. It is therefore crucial to analyze and understand the use of derivatives in the economy. The three essays contained in this work intend to fill in this gap by analyzing diverse aspects of the use of derivatives by different economic agents.

The three chapters in this thesis try to answer some fundamental questions: overall, are derivatives playing a central role in the development of healthy financial markets, by allowing to reduce the risks and to share them across agents? Or are derivatives rather used for speculation and to increase financial risks? And, may derivatives be associated to agency costs? We try to give answers to these questions from different perspectives. In the first two chapters we analyze empirically the impact of the use of derivatives by mutual funds. In the third and last chapter we analyze the theoretical costs associated to the use of derivatives by non-financial firms. Thus, this thesis is organized in three chapters, each corresponding to a research paper, each of which may be read independently from the others.

In the first chapter, "The Use of Derivatives in the Spanish Mutual Fund Industry" (a joint paper with Jose M. Marín), we analyze the impact of the use of derivatives on the risk and performance of the Spanish mutual fund industry. The financial literature states that derivatives may be used for risk management purposes, reducing transaction costs, or managing better the information. However, the public perception is that derivatives are risky and speculative financial instruments that may portray dramatic losses. In order to contrast the stated beliefs and theories with empirical evidence, we analyze the case of the Spanish mutual fund industry. The findings indicate that funds do not use derivatives to hedge, we rather find evidence that certain fund types tend to increase their risks. Moreover, we find evidence that funds that use derivatives do not perform as well as funds that do not use derivatives.

The second chapter, "The Impact of a Regulatory Change on Mutual Fund Market Risk and Derivative Use", is an analysis about the reaction of Spanish mutual funds to the regulatory change of June 1997. In this reform, the Spanish Securities and Exchange Commission relaxed some restrictions on the use of derivatives by mutual funds. The effects of such a regulatory change had not been studied before. Thus, we analyze the impact of this regulatory change on derivative use in terms of risk and performance. The results indicate that the reform did not have any particular effects on risk, but it helped to improve performance. However, the improvement in performance was not as good as one would expect.

Finally, in the third chapter, "Moral Hazard and Adverse Selection in Corporate Financial Risk Management", we propose a theoretical model that states a possible explanation for the reduced use of derivatives by non-financial corporations. The recent financial literature offers a wide range of theories justifying corporate financial risk management. Although most of these theories give strong reasons for corporate hedging, empirical studies find that a great proportion of firms throughout the economy still do not manage their financial risks. Therefore, it seems natural to ask why there are firms reluctant to hedge despite all the potential benefits of corporate hedging. This paper proposes a rationale for this fact, by introducing moral hazard and adverse selection in an asymmetric information environment.

The three papers in this dissertation contribute to a better understanding of the use and impact of these financial instruments. Overall, the picture that emerges out of the three contributions is rather negative. First, the use of derivatives by Spanish mutual funds does not seem to be associated to hedging, moreover it seems to be associated with a lower performance. Second, a regulatory change on the use of derivatives aimed at improving the performance of mutual funds, seems not to have completely achieved its desired result. Finally, it seems that the use of derivatives by non-financial firms is associated with considerable agency costs. The negative picture that emerges from these studies should be put in relative terms, since even that the use of these instruments is associated with big costs, no strong evidence is found that derivatives are systematically used for speculation.

We think that the area of the economic costs and benefits of the use of derivatives is still open to further research. There are many open questions that future research could address to achieve a better understanding on the consequences of the use of these financial instruments. The three research studies analyze only a small subset of users of derivatives, thus it would be interesting to know how the situation looks for other users of derivatives.

Chapter 1

The Use of Derivatives in the Spanish Mutual Fund Industry

(Joint research with José M. Marín)

1.1 Introduction

Spanish mutual funds are heavy users of derivatives. Figure 1.1 provides some statistics on derivatives usage. The fraction of funds using derivatives has steadily increased during the last ten years. By 2005 some 60% of the Spanish mutual funds had some derivatives position in their portfolio. Even stronger is the increase in the *extent* of derivatives usage. The fraction of the total notional of derivatives positions to the net asset value of all funds increased from 2.7% to 15.8% during the same period. These figures sharply contrast with the figures obtained elsewhere. For instance, in their study of usage in the US market, Koski and Pontiff (1999) estimate that in 1993 only 21% of US mutual funds were users. In another study, Johnson and Yu (2004) estimate that the extent of usage in the Canadian market in 1998 ranges from 1.28% to 2.32%. Finally, Pinnuck (2004) reports a maximum extent of usage of 3.34%

in the Australian market during the period 1990 to 1997.[1] On the other hand, the Spanish mutual fund industry is quite large. In Figure 1.1 we also report the total net asset value under management by Spanish mutual funds relative to the total market capitalization of the Spanish market. Assets under management represented 100% of the Spanish market capitalization in the mid nineties. The figure has fallen to 60% by 2005. But this mostly reflects the large increase in the size of the Spanish market during the period. Assets under management amounted to 240 billion Euros at the beginning of 2005. An impressive figure. Given the order of magnitude of the Spanish fund industry and the extensive use of derivatives, it is quite surprising the lack of research analyzing the impact of derivatives usage on risk and performance, which is the main goal we pursue in this paper.

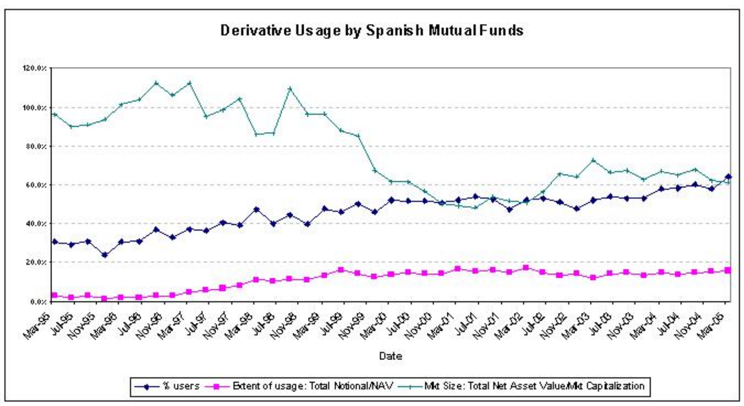

Figure 1.1: **Derivatives Usage by Spanish Mutual Funds.**

This table reports the percentage of users as the number of funds that reported some derivative position in a quarter divided by the total number of funds registered in the same quarter. Extent of derivative usage is measured as the total notional positions in derivatives of all funds per quarter divided by the total net asset value of all funds registered in the same quarter. The size of the mutual fund industry is measured as the total net asset value of all funds in the quarter divided by the Spanish market capitalization as of the end of the same quarter. The sample covers the period from March 1995 to March 2005. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. The market capitalization data is obtained from the Spanish Central Bank, Banco de España.

[1] These last two papers use a different measure of extent of usage than the one we use in this paper. Johnson and Yu (2004) measures extent of usage as total market value to the total asset position of all funds and Pinnuck (2004) as the total option delta position to net asset value of all funds.

Derivatives can be viewed as neutral or potentially performance-enhancing investment vehicles. Derivatives are neutral when, for instance, managers use them to synthesize cash positions. If managers were just doing this we should not expect significant differences in the return distributions of users versus non-users of derivatives. Furthermore, we should not observe significant differences in performance evaluation measures for users versus non-users of derivatives. But derivatives can also be used as an instrument for speculation, for risk management or to profit from market imperfections, such as transaction costs, or to better manage the fund's cash inflows and outflows. In these cases the return distributions and performance evaluation measures of users and non users can be quite different. In this paper we shed light on this issue by performing a comprehensive empirical analysis of derivatives usage in the Spanish mutual fund industry. To achieve this goal we focus on the differences in return distributions and performance of users versus non users of derivatives. We now turn to briefly relate these two variables to the alternative uses of derivatives.

Derivatives offer high leverage power and are often used as speculative instruments. Indeed this is the view of derivatives that has received the largest amount of attention in the media, with the extensive coverage of dramatic cases such as Enron, Daiwa Bank, or Sumitomo Corp (Tschoegl (2003), Johnson and Yu 2004)), which has contributed to the popular perception of derivatives as risky, even dangerous, instruments that may portray dramatic losses.[2] To understand the impact of speculative usage on return distributions and performance it is worthwhile thinking in users as market timers. It is well recognized that market timing per se adds volatility and that skillful timing adds skewness to the portfolio return. Furthermore, timing skills can be detected using several performance evaluation measures. On the other hand, some derivatives, such as options, are specially suitable for risk management and hedging. In particular, derivatives can be used to reduce the tails of the distribution of returns, that is, to decrease the effect of extreme market outcomes on portfolio

[2]For instance, see Koski and Pontiff (1999).

returns. Hence, we should expect the return distribution of users to exhibit smaller volatility, shortfall risk and kurtosis than the one of non-users, when derivatives are used for hedging purposes.

Derivatives can also be used to reduce transaction costs or to manage cashflows efficiently. Regarding costs, it is well know that, for instance, the typical roundtrip cost on index futures is well below the cost of trading the index constituents in the spot market. If managers were using derivatives for this purpose we should expect performance to improve. Regarding the latter issue, there is ample evidence that funds cash inflows and outflows are associated to past performance. Ippolito (1992) shows that funds receive cash inflows after periods of good performance, and suffer cash outflows after periods of bad performance. If fund managers are reluctant or unable to invest and divest securities in response to unexpected cash flows, then cash flows will influence the risk of the fund. Derivatives can be used to manage the impact of performance on risk by managing cash flows more efficiently. This is the cash flow management hypothesis proposed by Koski and Pontiff (1999). Very much related with this hypothesis is the incentive gaming hypothesis in fund management. Brown et al. (1996) , Chevalier and Ellison (1997) and Koski and Pontiff (1999) study the relation of past performance on changes in risk. They conclude before the evaluation period managers increase risk after periods of bad performance and decrease risk after periods of good performance for incentive reasons. Derivatives may be used to either dampen or increase the fund's risk. Hence derivatives can be used in a similar fashion for both cash flow management and incentive gaming.

To shed light on these issues we perform an extensive empirical study of derivatives usage in the Spanish mutual fund industry. Our study covers the period March 1995 to March 2005 and analyzes the universe of funds in the Spanish market.[3] It is indeed the first study that uses the whole set of funds in a country and for such an

[3]The only fund category excluded in our analysis is the case of Guarantee Funds. We do this for two reasons. First, because the fraction of non-users of derivatives is very small and, second, because of the special structure and objectives of these type of funds.

extended period. Studies for other countries either focus on the cross section of funds at some particular point in time or just use the time series of a subset of funds. This is important as our study does not suffer from sample selection biases. We classify the 18 official fund types into the following fund categories: Balanced Domestic, Balanced International, Domestic Equity, European Equity, Foreign Equity, Fixed Income, Money Market and Global funds. Within each category we separate users from non users of derivatives. In several parts of the paper we use two definitions of usage. We call *users* to those funds that have used derivatives at least once during their existence. Since many funds use derivatives very rarely, we also define *heavy users* as those funds that have taken positions in derivatives in more than 75% of the quarters of their life span and whose average notional positions are in the 75th percentile.

Our study focuses on four main issues. We first look at the main characteristics associated to derivatives usage. We look at two measures of derivatives usage: the decision to use derivatives and the extent of usage (defined as the fraction of the notional of derivatives positions to the net asset value of the fund). We find that users tend to be funds that: 1) belong to a large family of funds, 2) have other funds in the family using derivatives, 3) charge larger management fees, 4) charge no load fees, 5) are larger and 6) have a lower dividend yield. The first two variables highlight the important role of economies of scale in the decision and extent of usage. In contrast to the previous literature, in the Spanish case management fees play an important role in the decision to be user and in the extent of usage. The higher the management fees the higher the probability of using derivatives and the higher the extent of derivative use. In addition, we are able to distinguish within the set of variables that proxy for economies of scale the key variable: the existence of other funds in the family using derivatives, rather than the size of the family *per se*. The extent of usage is increasing with the number of funds in the family, the existence of more users in the family, larger management fees and being younger. These results contrast with those obtained by Johnson and Yu (2004) who find no characteristics associated to the extent of usage.

Second, we perform a comparative study of the risk and performance of users vs. non users of derivatives. We focus on typical mean-variance and market model related performance measures and we also test for selectivity and timing skills in the context of the Treynor-Mazuy (1966) model. The general picture that emerges from this study is quite negative. In only one category, fixed income funds, users exhibit superior performance than non-users and this only in the case of returns before fees. For the rest of categories either there are no significant differences or users perform worst than non users. The previous result remains true when we look at fund returns for heavy users of derivatives. The bad picture improves slightly for some fund categories if we consider before fees returns, but never to the point of making derivative users better performers, with the exception of fixed income funds in the case of returns before fees. This results sharply contrasts with those obtained in other markets where, in general, no significant differences in performance is appreciated. Regarding timing and selectivity skills users do not seem to exhibit either superior timing or selectivity skills, but rather the contrary. The only exceptions are the Balance Domestic and European Equity categories that exhibit timing skills and Fixed Income that exhibit selectivity skills.

Since risk has many dimensions beyond the standard deviation of returns and given that *ex ante* we expect derivatives usage to affect higher order moments of the distribution, we perform a comparative study of the return distributions of users versus non users of derivatives. This study focuses on the four central moments and the two 10% tails of the distributions of returns. The analysis of the moments of the distribution of returns does not support the view that mutual funds use derivatives for risk management purposes. On the contrary, stronger evidence is found that derivatives are used either for speculative purposes or to mimic the funds that do not use derivatives.

To complete our picture on derivatives usage we perform a final exercise testing the incentive gaming hypothesis versus the cashflow management hypothesis. The evidence on derivatives usage by Spanish mutual funds favors the cashflow management hypothesis. This result is consistent with the one obtained in Koski and Pontiff (1999) in their study of the US equity mutual funds. Our study also suggests that the management of cashflows is done by taking positions in market index derivatives.

The rest of this paper is organized as follows. In section 1.2 we briefly review the literature on the use of derivatives by mutual funds. In section 1.3 we describe the institutional setting of the Spanish mutual fund industry and the data used in the present study. Section 1.4 is dedicated to the study of the determinants of derivatives usage. The comparative study on risk and performance is executed in section 1.5, while section 1.6 is dedicated to the comparative study of the return distributions. In section 1.7 we test the incentive gaming versus the cashflow management hypothesis. The final section 1.8 is dedicated to some concluding remarks.

1.2 Related Literature

The existing literature on derivative use by mutual funds is not large and is naturally separated by countries. Koski and Pontiff (1999) analyze the use of derivatives by the US equity mutual funds during the year 1993. To determine if a fund uses derivatives they perform a survey. Johnson and Yu (2004) study the use of derivatives by the equity, fixed-income and foreign equity mutual funds in Canada in 1998. Finally, Pinnuck (2004) examines the use of exchange traded options for a sample of Australian equity mutual funds during the period 1990 to 1997. In this paper we extend the literature on derivative use in Spain by analyzing a richer data set than the previous studies. Our data set includes all fund categories, contains actual data on derivatives positions and covers the period March 1995 to March 2005.

About the incidence of derivative use among the mutual funds there are some differences in the findings. Koski and Pontiff (1999) and Johnson and Yu (2004) coincide that the use of derivatives is not very extended, they find that only about 21% of funds use derivatives. On the other hand, Pinnuck (2004) finds that 60% of funds in his sample use derivatives. In the present paper, we find that derivative usage is the Spanish case is more extended. Figure 1.1 shows that by 2005 some 64% of all funds in the industry use derivatives. Related to the extent of derivative use, only Johnson and Yu (2004) and Pinnuck (2004) report some figures. They use different measures but both conclude that the extent of derivative use is small. Johnson and Yu (2004) report ranges form 1.28% to 2.32%, while Pinnuck (2004) reports a maximum of 3.34%.[4] In the present paper we measure the extent of usage as the notional amount in derivatives divided by total net asset value. The values of this measure at the fund level range from zero to 100%, with an average value of 26%.

In relation to the fund characteristics associated to the decision and extent of derivative usage, Koski and Pontiff (1999) study the fund characteristics associated with the decision to use derivatives. They find that funds with greater trading activity, as measured by turnover, are more likely to use derivatives, and funds that are members of families are more likely to use derivatives. Johnson and Yu (2004) find that for fixed income funds and foreign equity funds the decision is related to fund age, younger funds being more likely to use derivatives. For domestic equity funds derivative usage is more likely for larger funds and with lower dividend yields and whether the fund is an Aggressive Growth fund. They do not find any relationship between the extent of derivative use and fund characteristics. Pinnuck (2004) finds only weak evidence that larger funds are more likely to use options. In this paper we analyze both the decision to use and the extent of usage of derivatives. We find that the decision to use derivatives is related to the number of fund in a family, and that the most important characteristic is the existence of another fund in the family

[4]Johnson and Yu's measure is total market value of derivatives divided by total asset value, while Pinnuck's measure is the total delta of the options positions divided by net asset value.

using derivatives. Larger and older funds increase the probability of using derivatives. No load funds and funds that have low dividend ratios are more likely to use derivatives. In addition, funds that charge larger management fees are also more likely to include derivatives among their positions. In contrast to the findings in Johnson and Yu (2004) we identify several characteristics associated to the extent of usage. In particular charging larger management fees and having lower dividend yield ratios is associated with a greater extent of derivative use.

Related to other risk-performance measures, Koski and Pontiff (1999) report no systematic differences among users and nonusers. Only Aggressive Growth funds have a lower beta than nonusers. They do not compute the Jensen's alpha, but they compute the alpha following the Ferson and Shadt (1996) and Shanken (1990) model of conditional betas. They do not find any differences between users and nonusers of derivatives. Johnson and Yu (2004) report a lower and negative alpha and a larger beta for users of derivatives of Domestic Equity funds, but once they control for warrants, the effect is lost and no differences prevail. Foreign Equity funds show no differences in their alpha and beta. They are not able to say anything about the Fixed Income funds, since their alphas and betas are given by the data source, and they do not provide these parameters. The results obtained in the present paper are quite different. We study both users and heavy users of derivatives and look at fund returns before and after fees. We find that in four fund categories users perform significantly worst than non users and that in there categories there are no significant differences. Only users, and specially heavy users, in the fixed income category exhibit superior performance. These funds exhibit larger sharpe ratios, larger alphas and larger appraisal ratios.

Regarding market timing, Koski and Pontiff (1999) report no differences between users and nonusers of derivatives. Johnson and Yu (2004) do not compute the market timing coefficient. Pinnuck (2004) does not mention anything related to market timing. In the Spanish market the evidence on market timing is mixed. For most of the fund categories the evidence points at worst timing and selectivity skills of users than non users. In two categories the evidence favors users and in the rest of the cases there no significant differences.

Regarding return distributions, Koski and Pontiff (1999) conclude that there are no systematic differences among users and nonusers of derivatives. Only Small Company funds have a smaller and more negative kurtosis and the Aggressive Growth funds have a larger and positive kurtosis. They do not compute the simple annual mean return. Johnson and Yu (2004) compute the annual mean return and the standard deviation but not the other higher moments. They find differences among fund types. Fixed Income funds have a larger mean return and a larger standard deviation. Foreign Equity funds have a lower mean return, and Domestic Equity funds have a lower mean return but a higher standard deviation. Pinnuck (2004) does not clearly state if he made this analysis. The evidence for the Spanish market is that derivatives do affect the four main central moments of the distribution of returns.

Finally, in relation to the inter-temporal effect of derivatives on the change in risk, only Koski and Pontiff (1999) do an analysis of this type. They conclude that derivative use reduces the change in risk. They interpret this result as being consistent with their stated hypothesis of derivative use for managing cash flows more efficiently. In Spain, restricting the sample to all but the fixed income funds, the results are very similar to those found in Koski and Pontiff (1999). The evidence supports the hypothesis that users of derivatives reduce their inter-temporal change in risk by relying on derivatives.

1.3 Institutional Setting and Database Description

1.3.1 Institutional Setting of the Spanish Mutual Fund Industry

Mutual funds in Spain are regulated and supervised by the Comisión Nacional del Mercado de Valores (CNMV), the Spanish equivalent to the US SEC. According to the regulation,[5] mutual funds are not allowed to have commitments in derivatives above the fund's net asset value, in addition the premium paid for non-linear derivatives cannot exceed 10% of the fund's net asset value, and Money Market funds are only allowed to use derivatives for hedging purposes. The first two restrictions are not compulsory if the fund pursues a specific return objective that has been guaranteed by a third party. In any case we expect to find evidence that Money Market funds do not use derivatives for speculation, but for hedging purposes. The evidence on Money Market funds partially supports this expectation. Money Market funds that use derivatives are indistinguishable from Money Market funds that do not use derivatives. The CNMV requires mutual funds to report the end of quarter portfolio of the fund including both on balance and off balance positions.

1.3.2 Database Description

The source of the data is the Spanish Security and Exchange Commission, CNMV[6] The database consists of the end of quarter open derivative positions for each open end mutual fund in Spain for the period March 1995 to March 2005. This database includes the whole population of mutual funds. At the end of March 1995 there were 695 funds, by the end of March 2005 there are a total of 2,623 funds registered. Thus, the number of funds in this ten year period has increased by a factor of almost 4.

[5] Orden Ministerial, de 6 de julio de 1992; Orden Ministerial, de 10 de junio de 1997; Circular 3/98, de 22 de septiembre.

[6] CNMV stands for "Comisión Nacional del Mercado de Valores" in Spanish.

In addition to the open positions in derivatives for each fund, the database includes information on the daily per share net asset value, the fund's family,[7] the total net asset value, the management fees,[8] and the fees charged for purchases and redemptions of the fund's shares and the deposit fee.[9] [10] We complement the database with information on the official fund types assigned by the same governmental agency and the fund's inception date. The fund categories are as of June, 2004, if a fund does not have a category assigned it is dropped out. Finally, we construct some additional variables, namely the number of funds in the family, if there are more than two funds in the family that report open positions in derivatives, and the dividend yield.[11] There is also information on the notional and market value of the derivative positions, which we aggregate per fund and quarter in order to analyze the extent of derivative use. For most of the positions there is also a brief name or description of the derivative position. Therefore, the database is an extensive and comprehensive set of information, which is ideal to analyze the use of derivatives by the mutual fund industry.

There are 18 official fund types which we aggregate into 9 fund categories for ease of analysis and exposition and to relate our study to those performed for other countries. In Appendix 1.9 we describe these official categories. The grouping of the official fund types into categories is based on the definitions of their their percentages invested in different asset classes.[12] The created new fund categories are Balanced Domestic, Balanced International, Domestic Equity, European Equity, Foreign Equity, Fixed Income, Money Market, and Specialty.

The database consists of a total of 41 quarters, with a total of 3,383 funds for the

[7] A fund family is defined as the management company that manages one or more mutual funds.

[8] The management fees are expressed as a percentage of either total net asset value or return, or a combination of both.

[9] In Spain funds pay a deposit fee which is based on the total assets under management and is represented as an annual percentage.

[10] management, deposit, redemption and subscription fees are revised on a quarterly basis.

[11] The dividend yield is computed using the fund's balance sheet.

[12] The official description of each fund type is in the table 1.19

whole time period. We drop out all those funds for which we could not assign an official type.[13] In addition, we only use funds with at least three years of observations and that are not Guarantee funds. The final sample size consists of 1,707 funds for the whole time period. Table 1.1 presents the aggregation of the official fund types into the new categories, including information on the sample size of each category.

Table 1.1: **Aggregation of Funds into Categories.**

CATEGORY	OFFICIAL CLASSIFICATION	NUMBER OF FUNDS
Balanced Domestic		**317**
	RVM	161
	RFM	156
Balanced International		**113**
	RFMI	54
	RVMI	59
Domestic Equity		**84**
	RVN	84
European Equity		**157**
	RVE	102
	RVIE	55
Foreign Equity		**261**
	RVIJ	23
	RVIO	159
	RVIU	37
	RVIM	42
Fixed Income		**382**
	RFCP	186
	RFLP	144
	RFI	52
Money Market		**211**
	FIAMM	211
Global		**182**
	FGL	182
Total		**1707**

This table reports the number of funds per official fund types and the aggregation into mutual fund categories for the analysis in this paper. The criteria used for the aggregation is the definition of each fund type, putting funds with similar definition into the same category (see appendix A). The sample covers the period from March 1995 to March 2005, and consists of those funds with at least three years of observations.Fund data is obtained from the Spanish Security and Exchange Commission, CNMV.

Based on the per share net asset value, the management fees, and the deposit fees the before- and after-fees-monthly returns are computed for each fund.[14] In the

[13]In Appendix 1.10 we discuss the treatment of some conflictive observations found in the database.

[14]For the computation of before fee returns after computing the monthly fund returns based on

study we use two definitions of funds using derivatives: *users* and *heavy users*. *Users* are funds that have taken positions in derivatives at least once during their existence. *Heavy users* as funds that have taken positions in derivatives in more than 75% of the quarters of their life span and whose average notional positions are in the 75th percentile of the whole population.

In the paper we use other non fund related data. In particular in the regression analysis we use index data to proxy for the relevant benchmark. The source of these indexes is Datastream and Spain's central bank, Banco de España. The indexes used are the FTSE World Index for the global funds, the IGBM for the domestic equity funds and the balanced funds, FTSE Euroblock Index for the European funds, the Nikkei 300 for the funds investing in Japan, the MSCI Emerging Index for Emerging funds, and the S&P500 for the US funds, the Spanish treasury bill (letras del tesoro) for the money market and short term fixed income funds, and the medium term and long term bond index for the long term fixed income funds. The risk-free rate is in general the one month Spanish treasury bill, except for the money market funds and the short term fixed income funds, for which the one week repo rate (compounded to be a monthly rate) is used.

1.3.3 Descriptive Statistics

Based on the derivative positions of each fund we construct Table 1.2 that provides the average numbers of the time series presented in Figure 1.1 for each fund category.

It is clear that derivative use is quite extended across fund categories. The average proportion of derivative users through time is about 40% within each fund category (see column 1 in table 1.2), with the exception of Money Market funds for which only an average of 19%is reported. Moreover, the amount of derivative positions is quite

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the monthly per share net asset values, we add back the management fees and the deposit fees. Since management and deposit fees are updated each quarter, we assume that during the months of the next quarter the fund does not change these fees. Moreover these fees are reported with an annually charge, thus we divide each fee by 12 in order to have the monthly estimates for the fees.

large. The average proportion of notional value to net asset value through categories is about 13%. Money Market funds are the less aggressive funds with only a 2% average position in derivatives to total net asset value, and Domestic Equity funds the most aggressive funds with an average proportion in derivatives of almost 26% of total net asset value (see column 2 in table 1.2). It is also important to notice that there is an important proportion of heavy derivative users within each fund category. The average proportion of these type of funds is about 13% across fund categories. Their aggressiveness in derivative positioning is quite clear. On average they have about 40% of net asset value invested in derivative positions as measured by their notional value. European equity funds having the most aggressive heavy users of derivatives with a 62% average position in derivatives, followed by Global funds with a 58%, and Domestic Equity funds with a 51%. Finally the least aggressive fund category are the Money Market funds with a 3.6% average position in derivatives.

Table 1.2: **Derivatives Usage by Type of Fund.**

	Users of Derivatives		**Heavy Users of Derivatives**	
Category	**Percentage**	**Extent**	**Percentage**	**Extent**
Balanced Domestic	46.6%	11.0%	13.6%	28.0%
Balanced International	44.1%	16.9%	13.6%	29.4%
Domestic Equity	65.4%	25.7%	15.1%	50.7%
Foreign Equity	38.7%	10.2%	14.8%	40.2%
Fixed Income	44.4%	10.6%	14.8%	30.5%
Money Market	18.5%	2.0%	9.1%	3.6%
Global	45.2%	14.9%	11.6%	57.8%
European Equity	50.2%	11.5%	14.4%	61.7%

This table collects for each fund category the average over the sample period of he percentage of derivative users and the extent of derivative use, as measured by the total notional positions in derivatives per quarter divided by the total net asset value. The extent for heavy users is the total notional position in derivatives of heavy users divided by the total net asset value of the heavy users of derivative. The sample covers the period from March 1995 to March 2005. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. The market capitalization data is obtained from the Spanish Central Bank, Banco de España.

The CNMV requires the funds to separate their end of quarter positions into two different files, one for the derivative positions and the other for non derivative positions. Using the name or brief description available for the derivatives we classify each derivative into derivative types.[15] The total number of derivatives instruments for the

[15]In order to do the classification we run a program that distinguishes some key words found in

sample period form March 1995 to March 2005 is 127,603.[16] Table 1.3 shows the preferences for the different type of derivatives in the Spanish mutual fund industry for the 1995-2005 period. We can observe that 32.8% of the positions correspond to option-type (non-linear) derivatives, while 48.4% are non-option type (linear) derivatives. We could not recognize 7% of the positions as any type of derivative and 10% were recognized as non derivative positions. According to the classification of the registered derivatives a greater proportion of derivatives are linear, while a smaller proportion of derivatives are non-linear. Based on the linear derivatives there is a preference for Futures, and based on the non-linear derivatives there is a preference for Calls and Floors. Warrants do not account for a great amount of derivative use. Among the non-recognized instruments most of them correspond to bond and currency related assets.

1.4 Determinants and Extent of Derivative Use

In this section we analyze the fund characteristics that are related to both the **decision** to use derivatives and the **extent** of usage. In the case of the decision to use derivatives we run a cross-section weighted least squares logit regression where the dependent variable is a variable that takes the value one if the fund is a user and zero otherwise.[17] In the case of the extent of usage we run a weighted least squares regression where the dependent variable is the ratio of the average notional in derivatives position over the sample period to the average fund net asset value over the sample period. The weights for both regressions are one over the square root of the number of periods used to compute the averages.

In both regressions, the explanatory variables are the average number of funds in

the derivative descriptions for some derivative types. The program classifies about a 98% of the derivatives, the rest is classified by hand.

[16] The same derivative instrument may be a position for one or more funds and for several months, but is counted as a single derivative instrument in this analysis.

[17] A logit model is a more adequate model if the frequency of ones is very high, which is the case for derivative users in the sample (Greene).

Table 1.3: **Use of Derivatives by Instrument Type.**

Instruments	**N**	**% of Sub totals**	**% of total**
Put	8,377	20%	7%
Call	14,751	35%	12%
Floor	13,745	33%	11%
Cap	1,219	3%	1%
Warrant	975	2%	1%
Unknown Non Linear	2,814	7%	2%
	41,881		
Forward	11,093	18%	9%
Future	42,405	69%	33%
Swap	6,696	11%	5%
Strips	123	0%	0%
Unknown Linear	1,416	2%	1%
	61,733		
Unknown Derivative	9,396	100%	7%
Bond	6,754	54%	5%
Currency	4,854	39%	4%
Unknown Non Derivative	947	8%	1%
	12,555		
Unknown Instrument	2,034	100%	2%
Total	127,599		

The table reports the distribution of the different derivative instruments used in the Spanish mutual fund industry. The classification is according to key words found in the description of the registered derivative instruments. A remaining small number of registered derivatives could not be classified. The sample covers the period March 1995 to March 2005. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV.

the family, a dummy indicating if in the family there are other funds using derivatives, the average size, the fund inception date, the average management fees, a dummy indicating if the fund charges front- or back-end load fees, the average of a measure for the dividend yield, and dummies that control for fund category. Averages are taken over the sample period.

Economies of scale may play an important role in the decision and extent of derivatives usage. High initial costs in equipment and regulatory requirements may prevent individual funds to use derivatives. Economies of scale considerations suggest that we should expect a greater use of derivatives when the fund belongs to a large family of funds, when there are more funds in the same family using derivatives and when the fund is large. Larger funds may also be more willing to use derivatives in order to manage their large positions more efficiently. The age of the fund may also play a role on the choice to use derivatives. On the one hand if young funds are associated with young managers, it could be that young managers are more willing to use sophisticated financial instruments. On the other hand, older funds may be managed by well experienced professionals who in turn are allowed to use derivatives.

Skillful managers may have a preference for derivatives. Since these managers are relatively better paid, larger fees are expected to be associated to larger derivatives usage. Load fees may be used to control for investor redemptions and deposits. The larger the load the smaller the cash inflows and outflows. If derivatives are used to manage cash flows then funds that charge no loads are more likely to use derivatives. Finally, the dividend yield may proxy the fund's investment style, associating higher dividend yield with value funds. Growth oriented funds may be more likely to use derivatives in order to capture the growth of stocks more efficiently.

1.4.1 Determinants of the decision to use derivatives

To analyze the decision to use derivatives we consider the following logit model:

$$\begin{aligned} der_i &= \alpha + \beta_1 numfunds_i + \beta_2 moreusers_i + \beta_3 lognav_i + \beta_4 assetfee_i \\ &\quad + \beta_5 inception_i + \beta_6 noload_i + \beta_7 divyield_i + \sum_j \beta_j dummy_{j,i} \end{aligned} \quad (1.1)$$

where der_i is a zero-one variable indicating derivative use by fund i, $numfunds_i$ is the number of funds in the family, $moreusers_i$ is the dummy indicating if there is another fund in the family using derivatives, $lognav_i$ is the log of the net asset value, $assetfee_i$ is the management fee, $inception_i$ is the year of inception, $noload_i$ is the dummy indicating if the fund charges no loads, $divyield_i$ is a measure for the dividend yield, and the rest of dummies control for fund category.

The first column in Table 1.4 reports the results obtained in the logit model equation 1.1. First notice that we find that the probability of using derivatives increases with the number of funds in the family, the existence of other users in the family and

Table 1.4: **Determinants of the Decision and Extent of Derivatives Usage.**

	Decision	**Extent**
Number of funds in family	0.0006	0.001
	(0)***	(0.000)***
More users of derivatives in family	0.1399	0.096
	(0.024)***	(0.057)*
Log of net asset value	0.0155	0.001
	(0.005)***	(0.007)
Management fee	0.0624	0.093
	(0.025)**	(0.039)**
Inception year	-0.0010	0.005
	(0.002)	(0.003)**
No load	0.0336	-0.013
	(0.012)***	(0.017)
Dividend yield	-0.2253	-0.193
	(0.1)**	(0.153)
Constant	1.7397	
Observations		1129
Degrees of freedom	14	
Log Likelihood	-299.51	
Pseudo r2	0.27	0.23

This table reports a weighted logit for the Determinants regression and a weighted least squares for the Extent regression. The weights are one divided by the square root of the number of observations used to compute the averages of the fund characteristics. The dependent variable, in the Determinants regression, is a zero-one variable indicating derivative use. In the Extent regression the dependent variable is the open Notional position in derivatives to total net asset value. Marginal effects of fund characteristics evaluated at average values are the coefficients in the Determinants regression and Extent of Derivative Use. The fund categories are the control variables. The sample covers the period from March 1995 to March 2005, and consists of those funds with at least three years of observations.Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

with the size of the fund. These three first results highlight the key role of economies of scales in the decision to use derivatives. The significance of size also supports the idea that larger funds are more willing to use derivatives to manage their positions. Larger management fees also have a positive effect on the probability of using derivatives, probably indicating that more skillful managers are better paid and are more likely to use derivatives. Higher skilled managers are more likely to use derivatives. Charging no loads increases by 2.5% the probability of using derivatives indicating the possibility of derivatives being used for cash flow management purposes. This hypothesis is corroborated in section 1.7 using a different methodology. The results also show that low dividend yields are related to derivative use, indicating the use of derivatives by growth oriented funds. The only variable that does not affect the decision to use derivatives is the fund's age.

To sum up, at the fund level, having more funds in the family, having other funds in the family using derivatives, having larger assets, charging larger fees on total assets, charging no loads and having a lower dividend yield increases the probability of using derivatives.

1.4.2 Extent of derivatives usage

In this case we run a weighted least squares regression of equation 1.1 defining der_i as the extent of usage rather than the binary variable for the decision to use derivatives. This variable is the average position in derivatives divided by the average fund net asset value for the 1995-2005 period. The results obtained in the estimation are reported in the second column of Table 1.4. Again, economies of scale play a significant role. The only variable related to economies of scales that loses significance is the fund's size. Management fees again are positively related to usage. Unlike in the case of the decision to use derivatives, the fund's age is significant. That is, younger funds are more aggressive in their position taking in derivatives.

Two main conclusions can be drawn from the exercise in this section. First, the main characteristics associated to the decision to use derivatives and the extent of its use are those related to economies of scale and fees. Users are more likely to be funds that belong to a large family of funds in which other funds also use derivatives. Furthermore, users are more likely to be expensive funds. This last result motivates our decision to consider fund returns both before and after fees in the empirical study that follows. The other main conclusion is that there is evidence of users being funds that do not penalize cash inflows and outflows. This already hints at users as funds that may be using derivatives to manage these cashflows. In section **??** we retake this issue and provide extra evidence in support of this conjecture.

1.5 Derivatives Usage and Performance

1.5.1 Fund Risk and Performance in the Context of the Market Model

In this section we study the performance of users vs. non users of derivatives, in each of the fund categories, using performance measures that arise in the basic mean variance/CAPM framework. In particular we compare how well the group of users versus non-users perform in term of Sharpe ratios, Jensen's alphas, appraisal ratios, and the Treynor index. The Sharpe ratio is the fund's excess return above the risk free rate divided by the standard deviation. It is the appropriate performance measure from the point of view of no well diversified investors or investors who are heavily invested in the fund. Sharpe ratios positive and above the Sharpe ratio of the market portfolio constitute evidence of superior performance. The Jensen's alpha corresponds to the alpha of the market model. It is the measure of performance of interest for well diversified investors. A positive alpha is evidence of superior performance. The appraisal ratio is defined as the Jensen's alpha divided by the root mean squared error of the market model. It is a measure of interest for well diversified investors. The larger the appraisal ratio, the better the performance. Finally, the Treynor index is similar to the Sharpe ratio, only that the adjustment is made according to the fund's exposure to the market (beta) rather than the total risk. It indicates if the fund outperforms the risk free rate and if the performance is achieved with lower market exposure. The appraisal ratio adjusts the alpha, i.e. the performance above the market exposure by the idiosyncratic risk, the additional risk faced by investing mainly in a single fund. This is also a measure of interest for an investor invested mainly in a single fund. It is a relevant measure for no well diversified investors. The larger the ratio, the more attractive the fund is.[18]

[18]For a deeper discussion on these performance measures and their application to the Spanish market, for instance see Marin and Rubio (2001).

The market model is given by:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i * (r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \tag{1.2}$$

where $r_{i,t}$ is the fund's return, $r_{f,t}$ is the risk free rate, and $r_{m,t}$ is the market's return. Observe that returns are computed on a monthly basis. The market portfolio is selected according to the official fund type. For the Balanced Domestic and Domestic Equity funds the Spanish market index, IGBM, is used. For the European Equity and Foreign Equity funds the corresponding market index is selected, ranging form the FTSE Euro Block Index, FTSE World index, the Medium Term and Large Term Index,[19] the Nikkei 300, the MSCI Emerging Index, and the S&P500. For the Money Market funds and Short Term Fixed Income Funds the return on the market are the Spanish treasury bills and the risk-free rate is the one week repo rate compounded to a corresponding monthly rate.[20] For all other funds the risk-free rate is the Spanish one month treasury bill. The sources of the information are Datastream and the Spanish Central bank.

We first estimate the market model for the whole universe of funds. Then we separate users from non users and group each one of them in their corresponding category. We test for differences in the means of the coefficients for users versus non users using the the t-statistic. To test for differences in the median we use the Wilcoxon test. Table 1.5 reports the results. The table also includes information of the betas and the idiosyncratic risk estimated using the market model. First, in sharp contrast to the results obtained in Koski and Pontiff (1999) for the US market, in the Spanish case there are only three fund categories for which fund users are not distinguished from non users: Balance Domestic, Global, and Money Market. Furthermore, in the case of Money Market funds the result is expected since by regulation Money Market funds are only allowed to use derivatives to reduce risk.

[19]This Medimu and Long Term Index is constructed by Spain's Central Bank, Banco de España.
[20]The treasury bills are known as "Letras del Tesoro" in Spanish.

More striking even is that we only find one category where there is some (very weak) evidence of a better performance by users: Fixed income. In particular, users exhibit a larger appraisal ratio, but also a smaller Sharpe ratio than non users. In the remaining four categories users perform worst than non-users, in the sense of exhibiting bad news in at least one performance evaluation measure, with the exception of Foreign funds for which no difference between users and non users is reported.

Table 1.5: **Risk and Performance of Users in a Market Model Context.**

Category	**measure**	**non-users**		**users**		**ttest**	**Wilcoxon**
		N	**mean**	**N**	**mean**	**t-stat**	**z-stat**
Balanced Domestic	Beta	35	0.3792	282	0.3197	1.65	1.6
	Idiosyncratic risk	35	0.0110	282	0.0104	0.53	0.78
	Jensen's alpha	35	-0.0018	282	-0.0018	0.03	-0.08
	Appraisal Ratio	35	-0.1715	282	-0.1855	0.47	-0.15
	Sharpe Ratio	35	-0.0458	282	-0.0191	-1.33	-1.29
	Treynor Index	35	-0.0021	282	-0.0037	0.33	-0.93
Balanced International	Beta	20	0.4106	93	0.3127	1.9*	2.17**
	Idiosyncratic risk	20	0.0099	93	0.0114	-0.82	-0.8
	Jensen's alpha	20	0.0003	93	-0.0007	2.64***	2.8***
	Appraisal Ratio	20	0.0193	93	-0.0905	3.08***	2.68***
	Sharpe Ratio	20	-0.0926	93	-0.0842	-0.3	-0.31
	Treynor Index	20	-0.0051	93	-0.0145	0.68	0.5
Domestic Equity	Beta	6	0.8155	78	0.8870	-0.78	-1.77*
	Idiosyncratic risk	6	0.0117	78	0.0140	-0.83	-1.09
	Jensen's alpha	6	0.0014	78	-0.0010	1.93*	2.29**
	Appraisal Ratio	6	0.1347	78	-0.0908	2.55**	2.33**
	Sharpe Ratio	6	0.1186	78	0.0820	1.21	0.61
	Treynor Index	6	0.0067	78	0.0055	0.57	0.45
European Equity	Beta	30	0.8620	127	0.9504	-1.82*	-2.33**
	Idiosyncratic risk	30	0.0251	127	0.0208	2.56**	2.76***
	Jensen's alpha	30	0.0023	127	-0.0003	3.64***	2.68***
	Appraisal Ratio	30	0.0679	127	-0.0349	3.06***	2.41**
	Sharpe Ratio	30	0.0122	127	-0.0267	1.88*	0.85
	Treynor Index	30	0.0020	127	-0.0006	1.38	0.81
Fixed Income	Beta	34	1.0967	348	0.6753	2.61***	2.19**
	Idiosyncratic risk	34	0.0031	348	0.0056	-2.35**	-4.09***
	Jensen's alpha	34	-0.0009	348	-0.0005	-1.45	-1.31
	Appraisal Ratio	34	-0.5831	348	-0.1645	-4.17***	-3.6***
	Sharpe Ratio	34	1.2114	348	0.5786	4.4***	3.86***
	Treynor Index	34	0.0023	348	0.0005	0.52	-0.15

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Table 1.5 – Continued from previous page

Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat
Foreign Equity	Beta	49	0.8943	211	0.8848	0.22	0.45
	Idiosyncratic risk	49	0.0236	211	0.0278	-2.1**	-1.75*
	Jensen's alpha	49	-0.0002	211	-0.0011	1.25	1.18
	Appraisal Ratio	49	-0.0315	211	-0.0504	0.72	0.85
	Sharpe Ratio	49	-0.0698	211	-0.0783	0.53	0.3
	Treynor Index	49	-0.0041	211	-0.0044	0.26	0.45
Money Market	Beta	51	0.9599	159	0.8932	0.88	-0.32
	Idiosyncratic risk	51	0.0011	159	0.0009	0.43	-1.4
	Jensen's alpha	51	-0.0006	159	-0.0003	-0.71	-0.27
	Appraisal Ratio	51	-1.1404	159	-0.9858	-1.21	-0.59
	Sharpe Ratio	51	1.6417	159	1.5402	1.33	1.45
	Treynor Index	51	0.0017	159	0.0026	-1.52	0.1
Global	Beta	17	0.3655	165	0.3357	0.4	0.14
	Idiosyncratic risk	17	0.0122	165	0.0172	-1.46	-1.57
	Jensen's alpha	17	0.0004	165	-0.0010	1.61	2.38**
	Appraisal Ratio	17	-0.0405	165	-0.0596	0.47	1.72*
	Sharpe Ratio	17	-0.1060	165	-0.0680	-1.06	-0.24
	Treynor Index	17	-0.0333	165	0.0030	-0.56	-0.22

This table presents the results for different risk and performance measures per fund category and group: users and nonusers of derivatives. A t-test and a Wilcoxon test are performed on the mean and median group values, respectively.The measures are the appraisal ratio, the beta of a market model, the Jensen's alpha form a market model, the idiosyncratic risk measured by the root mean squared error of the market model, the Sharpe ratio, and the Treynor index. Computations are based on monthly returns. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

It is possible that the very negative picture that arises from Table 1.5 is due to our definition of users. In particular, we may be including as users funds that have used derivatives very rarely and with bad luck in the past. For this reason we repeat the previous exercise but using the definition of heavy users. In this case we are looking at the performance of funds that not only use derivatives frequently but also take positions whose notional is relatively large. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile.

In Table 1.6 we report the results for heavy users. In general the results do not improve significantly. But there is some new evidence which is worthwhile addressing. First, Fixed Income remains as the only category in which there is some evidence of outperformance. The evidence is still very weak as only the appraisal ratio remains significantly larger. The second observation is that we now find some evidence of improved and worsening in performance in some of the other categories. In particular the performance of users in the Foreign Equity worsens (before there were no differences and now they exhibit worst performance) and the performance in European Equity funds improve (moving from underperformance to no significant differences). In the rest of categories the results are as negative or worst than before.

Table 1.6: **Risk and Performance of Heavy Users in a Market Model Context.**

Category	**measure**	**non-users**		**heavy users**		**ttest**	**Wilcoxon**
		N	**mean**	**N**	**mean**	**t-stat**	**z-stat**
Balanced Domestic	Beta	35	0.3792	50	0.3429	0.8	0.74
	Idiosyncratic Risk	35	0.0110	50	0.0105	0.39	0.6
	Jensen's alpha	35	-0.0018	50	-0.0018	0.07	0.14
	Appraisal Ratio	35	-0.1715	50	-0.1915	0.57	-0.03
	Sharpe Ratio	35	-0.0458	50	-0.0227	-0.84	-0.91
	Treynor Index	35	-0.0021	50	-0.0015	-0.3	-0.75
Balanced International	Beta	20	0.4106	17	0.3141	1.67	1.77*
	Idiosyncratic Risk	20	0.0099	17	0.0124	-0.88	-0.76
	Jensen's alpha	20	0.0003	17	-0.0009	2.8***	2.62***
	Appraisal Ratio	20	0.0193	17	-0.0976	2.71**	2.29**
	Sharpe Ratio	20	-0.0926	17	-0.0868	-0.2	0.03
	Treynor Index	20	-0.0051	17	-0.0051	0.04	0.49
Domestic Equity	Beta	6	0.8155	15	1.0250	-5.57***	-3.43***
	Idiosyncratic Risk	6	0.0117	15	0.0109	0.48	0.47
	Jensen's alpha	6	0.0014	15	-0.0013	2.57**	1.95*
	Appraisal Ratio	6	0.1347	15	-0.1253	2.67**	2.02**
	Sharpe Ratio	6	0.1186	15	0.0602	1.67	1.09
	Treynor Index	6	0.0067	15	0.0037	1.53	1.01
European Equity	Beta	30	0.8620	28	1.0137	-2.69***	-3.1***
	Idiosyncratic Risk	30	0.0251	28	0.0202	2.34**	2.35**
	Jensen's alpha	30	0.0023	28	0.0009	1.21	0.87
	Appraisal Ratio	30	0.0679	28	0.0326	0.73	0.36
	Sharpe Ratio	30	0.0122	28	-0.0380	1.56	1.03
	Treynor Index	30	0.0020	28	-0.0020	1.66	1.04
Fixed Income	Beta	34	1.0967	71	0.6421	1.91*	2.16**
	Idiosyncratic Risk	34	0.0031	71	0.0076	-3.49***	-5.07***
	Jensen's alpha	34	-0.0009	71	-0.0004	-1.1	-1.38
	Appraisal Ratio	34	-0.5831	71	-0.1059	-3.76***	-3.78***
	Sharpe Ratio	34	1.2114	71	0.3105	6.74***	4.43***
	Treynor Index	34	0.0023	71	0.0032	-0.31	1.19

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Table 1.6 – Continued from previous page

Category	measure	non-users N	non-users mean	heavy users N	heavy users mean	ttest t-stat	Wilcoxon z-stat
Foreign Equity	Beta	49	0.8943	49	0.8991	-0.11	0.47
	Idiosyncratic Risk	49	0.0236	49	0.0289	-1.97*	-1.35
	Jensen's alpha	49	-0.0002	49	-0.0009	0.83	0.41
	Appraisal Ratio	49	-0.0315	49	-0.0370	0.15	-0.07
	Sharpe Ratio	49	-0.0698	49	-0.1035	1.72*	1.74*
	Treynor Index	49	-0.0041	49	-0.0067	2.11**	2.03**
Money Market	Beta	51	0.9599	40	0.9568	0.06	-1.16
	Idiosyncratic Risk	51	0.0011	40	0.0008	0.89	-2.29**
	Jensen's alpha	51	-0.0006	40	-0.0006	0.08	-0.22
	Appraisal Ratio	51	-1.1404	40	-0.8582	-1.54	-1.03
	Sharpe Ratio	51	1.6417	40	1.5350	1.02	1.03
	Treynor Index	51	0.0017	40	0.0027	-0.91	-1.18
Global	Beta	17	0.3655	27	0.3395	0.25	-0.11
	Idiosyncratic Risk	17	0.0122	27	0.0188	-1.2	-1.1
	Jensen's alpha	17	0.0004	27	-0.0020	1.56	2.16**
	Appraisal Ratio	17	-0.0405	27	-0.0700	0.51	1.77*
	Sharpe Ratio	17	-0.1060	27	-0.0831	-0.42	0.3
	Treynor Index	17	-0.0333	27	-0.0516	0.48	0.4

The table presents the results for different risk and performance measures per fund category and group: heavy users and non users of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean and median group values, respectively.The measures are the appraisal ratio, the beta of a market model, the Jensen's alpha form a market model, the idiosyncratic risk measured by the root mean squared error of the market model, the Sharpe ratio, and the Treynor index. Computations are based on monthly returns and the management fee and the deposit fees are added back. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

In Section 1.4 we provided evidence of fund users being relatively expensive funds. It may be the case that the poor performance of users identified in the previous two exercises is due to the large expenses these funds must satisfy. To verify this we repeat our performance analysis but using the fund returns before fees rather that after fees as we did before. Results are reported in Tables 1.7 and 1.8. In general the results remain as before and at best improve slightly. In the case of *users* we find that in all categories, except the Money Market funds, performance yields mixed results before fees than after fees. In particular, the only category exhibiting some signs of superior performance after fees, Fixed Income, stops exhibiting superior performance in terms of the appraisal ratio, but now exhibits an improved Jensen's alpha. Notice that the Sharpe ratio continues to indicate some underperformance. Foreign equity funds that use derivatives exhibit now a larger Jensen's alpha than non users.

Table 1.7: **Risk and Performance Before Fees of Users in a Market Model Context.**

Category	measure	non-users		users		ttest	Wilcoxon
		N	mean	N	mean	t-stat	z-stat
Balanced Domestic	Beta	35	0.3785	282	0.3198	1.62	1.57
	Idiosyncratic Risk	35	-0.0006	282	-0.0004	-0.76	-0.8
	Jensen's alpha	35	0.0110	282	0.0104	0.52	0.75
	Appraisal Ratio	35	-0.0495	282	-0.0008	-1.67*	-1.56***
	Sharpe Ratio	35	0.0136	282	0.0717	-3.11***	-2.32
	Treynor Index	35	0.0024	282	0.0067	-1.61	-2.29
Balanced International	Beta	20	0.4108	93	0.3127	1.9*	2.18**
	Idiosyncratic Risk	20	0.0017	93	0.0006	2.98***	2.93***
	Jensen's alpha	20	0.0099	93	0.0114	-0.83	-0.85
	Appraisal Ratio	20	0.1987	93	0.0624	4.19***	3.43*
	Sharpe Ratio	20	-0.0218	93	0.0104	-1.28	-1.11
	Treynor Index	20	-0.0011	93	-0.0048	0.31	-0.8
Domestic Equity	Beta	6	0.8148	78	0.8871	-0.78	-1.77*
	Idiosyncratic Risk	6	0.0028	78	0.0006	1.83*	1.91*
	Jensen's alpha	6	0.0117	78	0.0140	-0.83	-1.11
	Appraisal Ratio	6	0.2668	78	0.0413	2.79***	2.36***
	Sharpe Ratio	6	0.1492	78	0.1137	1.14	0.57**
	Treynor Index	6	0.0085	78	0.0076	0.31	0.28
European Equity	Beta	30	0.8620	127	0.9506	-1.83*	-2.34**
	Idiosyncratic Risk	30	0.0038	127	0.0013	3.51***	2.53**
	Jensen's alpha	30	0.0251	127	0.0208	2.56**	2.76***
	Appraisal Ratio	30	0.1341	127	0.0532	2.62***	1.92***
	Sharpe Ratio	30	0.0413	127	0.0054	1.71*	0.7**
	Treynor Index	30	0.0038	127	0.0024	0.39	0.71
Fixed Income	Beta	34	-0.4950	348	-0.2567	-0.57	-1.15
	Idiosyncratic Risk	34	-0.0002	348	0.0007	-3.19***	-4.89***
	Jensen's alpha	34	0.0031	348	0.0056	-2.36**	-4.1***
	Appraisal Ratio	34	0.2882	348	0.2602	0.32	0.19
	Sharpe Ratio	34	1.7206	348	0.8769	5.01***	3.93**
	Treynor Index	34	0.0029	348	0.0052	-0.47	-2.06
Foreign Equity	Beta	49	0.8944	211	0.8849	0.22	0.45
	Idiosyncratic Risk	49	0.0014	211	0.0005	1.26	1.15
	Jensen's alpha	49	0.0236	211	0.0278	-2.1**	-1.74*
	Appraisal Ratio	49	0.0456	211	0.0189	1.09	1.23
	Sharpe Ratio	49	-0.0414	211	-0.0475	0.37	0.33
	Treynor Index	49	-0.0023	211	-0.0029	0.48	0.58
Money Market	Beta	51	-0.0320	159	0.0089	-0.26	1.37

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Table 1.7 – Continued from previous page

Category	measure	non-users		users		ttest	Wilcoxon
		N	mean	N	mean	t-stat	z-stat
	Idiosyncratic Risk	51	0.0002	159	0.0002	-0.09	-3.23***
	Jensen's alpha	51	0.0011	159	0.0009	0.4	-1.19
	Appraisal Ratio	51	0.5036	159	0.5305	-0.33	-1.26*
	Sharpe Ratio	51	2.2178	159	2.1264	0.97	0.88
	Treynor Index	51	-0.0090	159	0.0034	-1.76*	-0.53
Global	Beta	17	0.3656	165	0.3359	0.4	0.14
	Idiosyncratic Risk	17	0.0016	165	0.0002	1.74*	2.33**
	Jensen's alpha	17	0.0122	165	0.0172	-1.46	-1.56
	Appraisal Ratio	17	0.1578	165	0.0524	2.64***	2.53***
	Sharpe Ratio	17	0.0509	165	0.0163	0.92	0.23***
	Treynor Index	17	-0.0002	165	0.0719	-0.43	-0.72

The table presents the results for different risk and performance measures per fund category and group: users and nonusers of derivatives. A t-test and a Wilcoxon test are performed on the mean and median group values, respectively.The measures are the appraisal ratio, the beta of a market model, the Jensen's alpha form a market model, the idiosyncratic risk measured by the root mean squared error of the market model, the Sharpe ratio, and the Treynor index. Computations are based on monthly returns and the management fee and the deposit fees are added back. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

In the case of *heavy users* results are also mixed: Money Market funds remain unchanged and the rest of categories exhibit now significant worst performance.[21] All these results suggest that the larger fees that the users of derivatives in general charge are not justified at all in terms of performance. If any, their poor performance before fees would call for them to charge smaller fees than the other funds in the same category that do not use derivatives.

Table 1.8: **Risk and Performance Before Fees of Heavy Users in a Market Model Context.**

Category	measure	non-users		heavy users		ttest	Wilcoxon
		N	mean	N	mean	t-stat	z-stat
Balanced Domestic	Beta	35	0.3785	282	0.3198	1.62	1.57
	Idiosyncratic Risk	35	-0.0006	282	-0.0004	-0.76	-0.8
	Jensen's alpha	35	0.0110	282	0.0104	0.52	0.75
	Appraisal Ratio	35	-0.0495	282	-0.0008	-1.67*	-1.56***
	Sharpe Ratio	35	0.0136	282	0.0717	-3.11***	-2.32
	Treynor Index	35	0.0024	282	0.0067	-1.61	-2.29
Balanced International	Beta	20	0.4108	93	0.3127	1.9*	2.18**
	Idiosyncratic Risk	20	0.0017	93	0.0006	2.98***	2.93***
	Jensen's alpha	20	0.0099	93	0.0114	-0.83	-0.85

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[21]The exception is the Balance Domestic category in which there are no significant differences in performance in any of the four exercises we execute.

Table 1.8 – Continued from previous page

Category	measure	non-users N	non-users mean	heavy users N	heavy users mean	ttest t-stat	Wilcoxon z-stat
	Appraisal Ratio	20	0.1987	93	0.0624	4.19***	3.43*
	Sharpe Ratio	20	-0.0218	93	0.0104	-1.28	-1.11
	Treynor Index	20	-0.0011	93	-0.0048	0.31	-0.8
Domestic Equity	Beta	6	0.8148	78	0.8871	-0.78	-1.77*
	Idiosyncratic Risk	6	0.0028	78	0.0006	1.83*	1.91*
	Jensen's alpha	6	0.0117	78	0.0140	-0.83	-1.11
	Appraisal Ratio	6	0.2668	78	0.0413	2.79***	2.36***
	Sharpe Ratio	6	0.1492	78	0.1137	1.14	0.57**
	Treynor Index	6	0.0085	78	0.0076	0.31	0.28
European Equity	Beta	30	0.8620	127	0.9506	-1.83*	-2.34**
	Idiosyncratic Risk	30	0.0038	127	0.0013	3.51***	2.53**
	Jensen's alpha	30	0.0251	127	0.0208	2.56**	2.76***
	Appraisal Ratio	30	0.1341	127	0.0532	2.62***	1.92***
	Sharpe Ratio	30	0.0413	127	0.0054	1.71*	0.7**
	Treynor Index	30	0.0038	127	0.0024	0.39	0.71
Fixed Income	Beta	34	-0.4950	348	-0.2567	-0.57	-1.15
	Idiosyncratic Risk	34	-0.0002	348	0.0007	-3.19***	-4.89***
	Jensen's alpha	34	0.0031	348	0.0056	-2.36**	-4.1***
	Appraisal Ratio	34	0.2882	348	0.2602	0.32	0.19
	Sharpe Ratio	34	1.7206	348	0.8769	5.01***	3.93**
	Treynor Index	34	0.0029	348	0.0052	-0.47	-2.06
Foreign Equity	Beta	49	0.8944	211	0.8849	0.22	0.45
	Idiosyncratic Risk	49	0.0014	211	0.0005	1.26	1.15
	Jensen's alpha	49	0.0236	211	0.0278	-2.1**	-1.74*
	Appraisal Ratio	49	0.0456	211	0.0189	1.09	1.23
	Sharpe Ratio	49	-0.0414	211	-0.0475	0.37	0.33
	Treynor Index	49	-0.0023	211	-0.0029	0.48	0.58
Money Market	Beta	51	-0.0320	159	0.0089	-0.26	1.37
	Idiosyncratic Risk	51	0.0002	159	0.0002	-0.09	-3.23***
	Jensen's alpha	51	0.0011	159	0.0009	0.4	-1.19
	Appraisal Ratio	51	0.5036	159	0.5305	-0.33	-1.26*
	Sharpe Ratio	51	2.2178	159	2.1264	0.97	0.88
	Treynor Index	51	-0.0090	159	0.0034	-1.76*	-0.53
Global	Beta	17	0.3656	165	0.3359	0.4	0.14
	Idiosyncratic Risk	17	0.0016	165	0.0002	1.74*	2.33**
	Jensen's alpha	17	0.0122	165	0.0172	-1.46	-1.56
	Appraisal Ratio	17	0.1578	165	0.0524	2.64***	2.53***
	Sharpe Ratio	17	0.0509	165	0.0163	0.92	0.23***
	Treynor Index	17	-0.0002	165	0.0719	-0.43	-0.72

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Table 1.8 – Continued from previous page

Category	measure	non-users		heavy users		ttest	Wilcoxon
		N	mean	N	mean	t-stat	z-stat

The table presents the results for different risk and performance measures per fund category and group: heavy users and nonusers of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean and median group values, respectively.The measures are the appraisal ratio, the beta of a market model, the Jensen's alpha form a market model, the idiosyncratic risk measured by the root mean squared error of the market model, the Sharpe ratio, and the Treynor index. Computations are based on monthly returns and the management fee and the deposit fees are added back. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

In all our exercises so far we compare the mean and the median of some performance measures, irrespectively of whether or not each one of the measures is significant at the individual fund level. This makes us wonder if we are missing superior performance of users at the individual fund level which is not reflected in the aggregates. One way of looking into this issue is to compute the fraction of funds that exhibit significant positive or negative performance. As an illustration we look at the Jensen's alpha in the market model. In Table 1.9, panel A, we report the fraction of funds in each category that for which the parameter is significantly positive and negative based on after fee returns. The results are quite devastating for derivative user funds. As we can appreciate in almost all categories users exhibit a smaller fraction of significantly positive coefficients and a larger fraction of significantly negative coefficients compared to non users of derivatives. The results in panel B put the previous result into perspective. Once fees are added back, results are not any more that devastating for derivative users. In this case the proportion of positive significative coefficients outweighs the negative and significative coefficients. But the same is true for non-users of derivatives. Moreover, the proportion of positive significative alphas is larger for non users of derivatives for all funds except for the fixed income and money market funds. This table makes clear the important role of fees in determining a possibly positive performance measure, nevertheless non user of derivative funds seem to do it better.

1.5.2 Selectivity and Timing Skills

As stated in the introduction, funds may use derivatives to time the market. The previous analysis does explicitly test for timing skills. To complete our performance

Table 1.9: **Percentages of Significative Jensen's alpha Measures.**

Panel A						
After Fee Returns	**non-user**		**user**		**heavy user**	
Category	**positive**	**negative**	**positive**	**negative**	**positive**	**negative**
Balanced Domestic	5.7%	57.1%	1.4%	57.4%	0.0%	68%
Balanced International	0.0%	5.0%	0.0%	24.7%	0.0%	24%
Domestic Equity	33.3%	0.0%	3.8%	39.7%	0.0%	33%
European Equity	26.7%	10.0%	4.7%	18.1%	3.6%	7%
Fixed Income	2.9%	38.2%	3.4%	21.6%	2.8%	15%
Foreign Equity	6.1%	8.2%	5.7%	19.0%	6.1%	18%
Money Market	0.0%	70.6%	1.3%	78.0%	0.0%	78%
Global	5.9%	17.6%	4.2%	12.7%	3.7%	7%

Panel B						
Before-Fee Returns	**non-user**		**user**		**heavy user**	
Category	**positive**	**negative**	**positive**	**negative**	**positive**	**negative**
Balanced Domestic	17.1%	25.7%	13.1%	12.8%	14.0%	10%
Balanced International	35.0%	0.0%	14.0%	3.2%	11.8%	0%
Domestic Equity	50.0%	0.0%	5.1%	3.8%	6.7%	7%
European Equity	33.3%	0.0%	9.4%	2.4%	17.9%	0%
Fixed Income	20.6%	5.9%	21.6%	1.7%	18.3%	1%
Foreign Equity	10.2%	6.1%	10.0%	6.2%	10.2%	12%
Money Market	43.1%	0.0%	51.6%	0.0%	50.0%	0%
Global	29.4%	0.0%	17.6%	4.8%	7.4%	7%

The table presents the percentages of positive or negative and significant Jensen's alpha coefficients within each category and group. Groups of funds are non-users, users, and heavy users of derivatives. Heavy users are selected if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A coefficient is considered to be significant if it is significant at the 10% confidence level. Panel A reports after fee results, while panel B reports before fee results. The sample covers the period from March 1995 to March 2005. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

evaluation analysis we explicitly test for the existence of superior timing skill among users of derivatives. For this purpose we use the Treynor-Mazuy (1966) model which is the most widely used model. This model extends the market model by incorporating a factor that captures market increases. This factor is defined as the square of the market excess return. The model takes the form:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i * (r_{m,t} - r_{f,t}) + \beta_{timing,i} * (r_{m,t} - r_{f,t})^2 + \varepsilon_{i,t} \tag{1.3}$$

where $r_{i,t}$ is the fund's return, $r_{f,t}$ is the risk free rate, and $r_{m,t}$ is the market's return.

This model allows for the separation of timing and selectivity skills in fund management. The ability to select stocks is associated to a positive alpha while timing skills correspond to a positive market timing coefficient $\beta_{timing,i}$. The previous literature typically reports negative values for the β_{timing} coefficient (Ferson and Shadt (1996) Cumby and Glenn (1990), among others) and denotes the result as a "perverse" outcome. Regarding the alpha coefficient, it is well recognized by now that if there is market timing in a fund, then the alpha is biased downwards.

In Tables 1.10 to 1.13 we report the results of the estimation of the model. Table 1.10 and Table 1.11 correspond to the case of after fees returns for users and heavy users, respectively; Table 1.12 and Table 1.13 correspond to the case of before fees returns for users and heavy users, respectively.

The market timing coefficient is negative for almost all fund types independent of using or not derivatives. European equity funds are the only exception, they have a positive market timing ability. Balanced domestic and European equity that use derivatives show a larger market timing coefficient than the nonusers of derivatives. This result is robust to after and before fee returns, and when considering heavy users of derivatives. For all other fund types, there is no evidence that derivative use improves the market timing ability. It appears that balanced domestic, balanced international, global, and European equity funds that do not use derivatives have a better selectivity ability than their user of derivatives counterparts. It is robust for balanced domestic funds across after and before fees and when considering heavy users of derivatives. And no differences in selectivity and market timing are reported for domestic equity, foreign equity, and money market funds. For Income funds the reverse is true, that is, derivative users seem to have a better selectivity ability than nonusers when before fee returns are considered.

Regarding timing skills, in almost all the cases we find no significant differences between users and non users of derivatives. The exceptions are the Balance Domestic and the European Equity categories where the timing coefficient is significantly superior in all cases (before and after fees and for users and heavy users). Notice that the coefficient for the market timing of European Equity funds is even positive. Regarding the alpha or selectivity parameter, we only find superior selectivity skills in the Fixed Income category (in all cases). In the rest of categories the selectivity skills of users is worst or not significantly different to the one of non users.

Table 1.10: **Selectivity and Timing Skills Of Users.**

		non-users		**users**			
Category	**Measure**	**N**	**mean**	**N**	**mean**	**ttest t-stat**	**Wilcoxon z-stat**
Balanced Domestic	mkt timing	35	-0.5072	282	-0.1692	-4.44***	-3.39***
	selectivity	35	-0.0004	282	-0.0012	2.77***	2.63***
Balanced International	mkt timing	20	-0.2009	93	-0.1293	-0.47	-0.59
	selectivity	20	0.0008	93	-0.0003	2.63***	2.74***
Domestic Equity	mkt timing	6	-0.1698	78	-0.2877	0.54	0.26
	selectivity	6	0.0019	78	-0.0001	1.38	2.33**
European Equity	mkt timing	30	-0.4447	127	0.0070	-2**	-1.94*
	selectivity	30	0.0034	127	-0.0003	4.42***	3.15***
Fixed Income	mkt timing	34	-241.4907	348	-146.1361	-0.36	-1.19
	selectivity	34	-0.0012	348	-0.0006	-1.11	-2.3**
Foreign Equity	mkt timing	49	-0.5803	211	-0.4209	-0.75	-0.65
	selectivity	49	0.0016	211	0.0003	1.42	1.32
Money Market	mkt timing	51	-4.1428	159	-1.0561	-0.03	-0.47
	selectivity	51	-0.0005	159	-0.0002	-0.62	-0.41
Global	mkt timing	17	-0.4269	165	-0.3525	-0.27	-0.62
	selectivity	17	0.0014	165	0.0000	1.74*	1.66*

The table presents the results for the selectivity and the market timing coefficients, per fund category and group, in the context of the Treynor-Mazuy (1966) model. Groups are users and nonusers of derivatives. A t-test and a Wilcoxon test are performed on the mean group values respectively. Returns are computed on a monthly basis. The sample covers the period March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

To conclude, our performance evaluation study results in a very negative picture of derivatives usage in the Spanish Mutual fund industry. We only find a fund category, Fixed income, that exhibits some (weak) signs of superior performance.

1.6 Derivatives Usage and Return Distributions

The mean variance setting is restrictive as it summarizes risk in a single parameter, the volatility of the return. Investors may have a a clear preference for other moments of the distribution. For instance, other things equal, investors may have a preference

Table 1.11: **Selectivity and Timing Skills of Heavy Users.**

		non-users		heavy users			
Category	**Measure**	**N**	**mean**	**N**	**mean**	**ttest t-stat**	**Wilcoxon z-stat**
Balanced Domestic	mkt timing	35	-0.5072	50	-0.2358	-2.35**	-2.11**
	selectivity	35	-0.0004	50	-0.0011	1.59	2.02**
Balanced International	mkt timing	20	-0.2009	17	-0.2559	0.25	0.24
	selectivity	20	0.0008	17	-0.0003	1.86*	1.8*
Domestic Equity	mkt timing	6	-0.1698	15	-0.1286	-0.34	-0.16
	selectivity	6	0.0019	15	-0.0008	2.82**	2.41**
European Equity	mkt timing	30	-0.4447	28	0.1277	-2.17**	-1.85*
	selectivity	30	0.0034	28	0.0007	2.18**	1.52
Fixed Income	mkt timing	34	-241.4907	71	-133.9700	-0.39	-0.1
	selectivity	34	-0.0012	71	-0.0003	-1.5	-2.35**
Foreign Equity	mkt timing	49	-0.5803	49	-0.3716	-0.86	-0.44
	selectivity	49	0.0016	49	0.0003	1.08	0.52
Money Market	mkt timing	51	-4.1428	40	58.2579	-1.29	-0.1
	selectivity	51	-0.0005	40	0.0000	-0.98	-0.2
Global	mkt timing	17	-0.4269	27	-0.5620	0.34	-0.28
	selectivity	17	0.0014	27	-0.0005	1.79*	1.1

The table presents the results for the selectivity and the market timing coefficients, per fund category and group, in the context of the Treynor-Mazuy (1966) model. Groups are heavy users and non users of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean group values respectively. Returns are computed on a monthly basis. The sample covers the period March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

for small shortfall risk. For this reason it is interesting to look at other moments of the distribution to see if funds offer return characteristics of interests for investors. Analyzing the return distributions is also of interest as it may shed light on the reasons behind derivatives usage. As discussed in the introduction, we should expect some differences in return distributions when derivatives are used for speculation versus risk management/hedging.

In this section we analyze the impact of derivative use on the distribution of returns. We compute the four central moments and the 10% tails of the distribution of the monthly returns for each fund for the whole time period and compare the results for users versus non users of derivatives.[22] Before reporting the results it is

[22]It is important to remember that in order to have better estimates of the distribution of returns in the filtering of our data set we excluded all funds with less than three years of observations.

Table 1.12: **Selectivity and Timing Skills Before Fees Of Users.**

		non-users		users			
Category	**Measure**	**N**	**mean**	**N**	**mean**	**ttest t-stat**	**Wilcoxon z-stat**
Balanced Domestic	mkt timing	35	-0.4935	282	-0.1701	-4.26***	-3.29***
	selectivity	35	0.0007	282	0.0002	1.84*	1.41
Balanced International	mkt timing	20	-0.2043	93	-0.1286	-0.49	-0.67
	selectivity	20	0.0022	93	0.0010	2.85***	2.93***
Domestic Equity	mkt timing	6	-0.1686	78	-0.2882	0.55	0.28
	selectivity	6	0.0033	78	0.0015	1.26	2.08**
European Equity	mkt timing	30	-0.4441	127	0.0047	-1.99**	-1.93*
	selectivity	30	0.0049	127	0.0013	4.26***	3.05***
Fixed Income	mkt timing	34	-262.1762	348	-144.4942	-0.44	-1.34
	selectivity	34	-0.0005	348	0.0005	-1.85*	-3.15***
Foreign Equity	mkt timing	49	-0.5806	211	-0.4229	-0.74	-0.65
	selectivity	49	0.0032	211	0.0018	1.43	1.35
Money Market	mkt timing	51	3.5188	159	1.8403	0.02	-0.38
	selectivity	51	0.0004	159	0.0007	-0.65	-1.12
Global	mkt timing	17	-0.4326	165	-0.3559	-0.27	-0.61
	selectivity	17	0.0027	165	0.0011	1.84*	1.62

The table presents the results for the selectivity and the market timing coefficients, per fund category and group, in the context of the Treynor-Mazuy (1966) model. Groups are users and nonusers of derivatives. A t-test and a Wilcoxon test are performed on the mean group values respectively. Computations are based on monthly returns and the management fee and the deposit fees are added back. The sample covers the period March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

convenient to briefly discuss the results we should expect under particular hypothesis.

The ideal scenario of efficient use of derivatives would be one in which the return of users exhibit larger mean, lower volatility, larger skewness and a larger breakpoint for both the lower and upper 10% tail of the distribution. In our discussion below we will refer to *superperformers* to users in some category that exhibit robust evidence in at least three of the previous five conditions. On the other hand, if derivatives were successfully used for speculation we should expect the distribution of returns to exhibit either larger mean or larger skewness, and a larger breakpoint for the upper 10% tail. When one of the first two conditions are met and the latter condition too we will refer to this situation as a case of *successful speculation*. When the opposite conditions are met, that is if the distributions of returns exhibit a larger standard deviation, or a smaller breakpoint for the lower 10% tail and a larger breakpoint for

Table 1.13: **Selectivity and Timing Skills Before Fees Of Heavy Users.**

		non-users		heavy users			
Category	**Measure**	**N**	**mean**	**N**	**mean**	**ttest t-stat**	**Wilcoxon z-stat**
Balanced Domestic	mkt timing	35	-0.4935	50	-0.2369	-2.25**	-2.01**
	selectivity	35	0.0007	50	0.0004	0.84	0.86
Balanced International	mkt timing	20	-0.2043	17	-0.2589	0.25	0.24
	selectivity	20	0.0022	17	0.0009	2.31**	2.1**
Domestic Equity	mkt timing	6	-0.1686	15	-0.1277	-0.34	-0.16
	selectivity	6	0.0033	15	0.0006	2.78**	2.49**
European Equity	mkt timing	30	-0.4441	28	0.1265	-2.16**	-1.81*
	selectivity	30	0.0049	28	0.0021	2.2**	1.57
Fixed Income	mkt timing	34	-262.1762	71	-149.3526	-0.41	-0.16
	selectivity	34	-0.0005	71	0.0008	-2.1**	-3.02***
Foreign Equity	mkt timing	49	-0.5806	49	-0.3765	-0.84	-0.39
	selectivity	49	0.0032	49	0.0018	1.18	0.65
Money Market	mkt timing	51	3.5188	40	63.2440	-1.27	-0.62
	selectivity	51	0.0004	40	0.0009	-1.28	-1.61
Global	mkt timing	17	-0.4326	27	-0.5665	0.34	-0.25
	selectivity	17	0.0027	27	0.0006	1.8*	1.29

The table presents the results for the selectivity and the market timing coefficients, per fund category and group, in the context of the Treynor-Mazuy (1966) model. Groups are heavy users and nonusers of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean group values respectively. Computations are based on monthly returns and the management fee and the deposit fees are added back. The sample covers the period March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

the upper 10% tail, and no positive effect on mean or skewness is reported we will refer to this situation as a case of *unsuccessful speculation*. Finally, if derivatives were used for risk management/hedging purposes we should expect a lower volatility, lower kurtosis and a larger breakpoint for the lower 10% tail. When these three conditions are met in some fund category we will refer to this situation as a case of *hedging*.

As in the analysis in the previous section, funds are grouped in their respective categories. Within each category we separate funds that use derivatives using both the definition of users and heavy users. The analysis cover both the case of returns before and after fees. The mean of each measure is computed for each group and fund category. Finally, we compare the mean values for each group and measure and compute the t-statistic for the difference in group means and the Wilcoxon test on the group medians. The results are reported in tables 1.14, 1.16, 1.15, and 1.17.

Table 1.14: **Return Distributions of Users.**

Category	**measure**	**non-users**		**users**		**ttest**	**Wilcoxon**
		N	**mean**	**N**	**mean**	**t-stat**	**z-stat**
		11%		**89%**			
Balanced Domestic	mean	35	0.0020	282	0.0030	-2.16**	-2.32**
	sd	35	0.0238	282	0.0217	0.94	1.05
	skewness	35	-0.4585	282	-0.2328	-2.5**	-2.5**
	kurtosis	35	4.1995	282	4.3622	-0.45	-0.16
	10th centile	35	-0.0282	282	-0.0233	-1.75*	-1.83*
	90th centile	35	0.0304	282	0.0281	0.81	0.69
		18%		**82%**			
Balanced International	mean	20	0.0005	93	0.0015	-1.73*	-2.05**
	sd	20	0.0230	93	0.0202	0.97	1.41
	skewness	20	-0.6463	93	-0.2760	-2.08**	-2.63***
	kurtosis	20	3.5229	93	4.5076	-1.49	-2.22**
	10th centile	20	-0.0305	93	-0.0234	-1.76*	-2.17**
	90th centile	20	0.0267	93	0.0239	0.82	1.43
		7%		**93%**			
Domestic Equity	mean	6	0.0078	78	0.0073	0.37	0.28
	sd	6	0.0467	78	0.0546	-1.61	-2.52**
	skewness	6	-0.3791	78	-0.2664	-0.93	-0.76
	kurtosis	6	3.6254	78	3.5964	0.11	0.14
	10th centile	6	-0.0529	78	-0.0593	0.94	1.49
	90th centile	6	0.0651	78	0.0779	-1.65	-2.15**
		19%		**81%**			
European Equity	mean	30	0.0027	127	0.0011	1.55	0.77
	sd	30	0.0520	127	0.0536	-0.69	-0.95
	skewness	30	-0.5563	127	-0.5257	-0.41	-0.48
	kurtosis	30	3.8500	127	3.8238	0.12	1.15
	10th centile	30	-0.0668	127	-0.0701	0.75	0.52
	90th centile	30	0.0611	127	0.0631	-0.67	-1.07
		9%		**91%**			
Fixed Income	mean	34	0.0022	348	0.0031	-3.44***	-5.02***
	sd	34	0.0035	348	0.0061	-2.51**	-4.39***
	skewness	34	0.1273	348	0.2398	-0.63	0.83
	kurtosis	34	4.8619	348	4.9742	-0.12	-3.35***
	10th centile	34	-0.0018	348	-0.0041	1.69*	3.6***
	90th centile	34	0.0060	348	0.0100	-3.65***	-4.67***
		19%		**81%**			
Foreign Equity	mean	49	-0.0013	211	-0.0022	0.83	0.41
	sd	49	0.0559	211	0.0572	-0.51	-0.09
	skewness	49	-0.4410	211	-0.3842	-0.87	-0.61
	kurtosis	49	3.4423	211	3.5880	-0.97	0.18
	10th centile	49	-0.0745	211	-0.0780	0.8	0.71
	90th centile	49	0.0634	211	0.0643	-0.29	-0.11
		24%		**76%**			
Money Market	mean	51	0.0029	159	0.0028	0.76	0.58

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Table 1.14 – Continued from previous page

Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat
	sd	51	0.0021	159	0.0019	0.3	-0.26
	skewness	51	0.9277	159	0.7348	1.04	-0.16
	kurtosis	51	4.5274	159	4.8075	-0.24	-0.48
	10th centile	51	0.0011	159	0.0008	0.96	0.88
	90th centile	51	0.0053	159	0.0057	-0.82	-0.5
		9%		**91%**			
Global	mean	17	0.0010	165	0.0012	-0.16	-0.81
	sd	17	0.0232	165	0.0253	-0.46	-0.44
	skewness	17	-0.6062	165	-0.2614	-1.49	-1.48
	kurtosis	17	6.8704	165	5.5960	1.32	-0.1
	10th centile	17	-0.0304	165	-0.0297	-0.12	0.41
	90th centile	17	0.0266	165	0.0286	-0.41	-0.56

This table presents the four main central moments, the 10th and 90th percentiles of the funds' distribution of returns per category and group. Groups are nonusers and users of derivatives. A t-test and a Wilcoxon test are performed on the mean and median group values per category respectively. At the top of each fund category the percentages of users and non users of derivatives is shown. The central moments' measures are the returns' mean, the returns' standard deviation, the returns' skewness, and the returns' kurtosis. Returns are computed on a monthly basis. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

The first result is related to the incidence of derivative use (see top row of each fund category in table 1.14). In the Spanish mutual fund industry derivative use is very common. The percentages of derivative users vary from 76% for the money market funds to 93% for the domestic equity funds. On the aggregate derivative users represent an 86% of the sample. This result contrasts with previous evidence in which derivative users represented about 21% of the population in Canada and USA (Koski and Pontiff (1999), Johnson and Yu (2004)),and even with the 60% in Australia (Pinnuck (2004)).

Table 1.15: **Return Distributions of Heavy Users.**

Category	measure	non-users N	non-users mean	heavy users N	heavy users mean	ttest t-stat	Wilcoxon z-stat
Balanced Domestic	mean	35	0.0020	50	0.0028	-1.15	-1.51
	sd	35	0.0238	50	0.0225	0.49	0.63
	skewness	35	-0.4585	50	-0.2529	-2.06**	-2.14**
	kurtosis	35	4.1995	50	3.9530	0.75	1.47
	10th centile	35	-0.0282	50	-0.0244	-1.09	-1.22
	90th centile	35	0.0304	50	0.0296	0.2	0.09
Balanced International	mean	20	0.0005	17	0.0009	-0.63	-0.64
	sd	20	0.0230	17	0.0205	0.64	1.49
	skewness	20	-0.6463	17	-0.5661	-0.64	-0.15
	kurtosis	20	3.5229	17	4.1375	-2.22**	-1.83*
	10th centile	20	-0.0305	17	-0.0249	-1	-1.68*
	90th centile	20	0.0267	17	0.0246	0.47	1.25

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Table 1.15 – Continued from previous page

Category	measure	non-users N	non-users mean	heavy users N	heavy users mean	ttest t-stat	Wilcoxon z-stat
Domestic Equity	mean	6	0.0078	15	0.0065	0.75	0.7
	sd	6	0.0467	15	0.0613	-5.13***	-3.43***
	skewness	6	-0.3791	15	-0.2726	-1.09	-0.7
	kurtosis	6	3.6254	15	3.4088	1.42	0.7
	10th centile	6	-0.0529	15	-0.0688	2.81**	2.26**
	90th centile	6	0.0651	15	0.0882	-4.05***	-3.04***
European Equity	mean	30	0.0027	28	0.0006	1.34	0.98
	sd	30	0.0520	28	0.0563	-1.65	-2.18**
	skewness	30	-0.5563	28	-0.6527	0.99	0.78
	kurtosis	30	3.8500	28	3.8697	-0.07	0.75
	10th centile	30	-0.0668	28	-0.0760	1.72*	1.71*
	90th centile	30	0.0611	28	0.0665	-1.35	-1.74*
Fixed Income	mean	34	0.0022	71	0.0032	-2.77***	-4.66***
	sd	34	0.0035	71	0.0080	-3.58***	-5.13***
	skewness	34	0.1273	71	0.1782	-0.24	1.61
	kurtosis	34	4.8619	71	4.5212	0.3	-2.39**
	10th centile	34	-0.0018	71	-0.0064	2.76***	4.97***
	90th centile	34	0.0060	71	0.0122	-4.9***	-5.31***
Foreign Equity	mean	49	-0.0013	49	-0.0038	2.04**	2.11**
	sd	49	0.0559	49	0.0586	-0.86	-0.07
	skewness	49	-0.4410	49	-0.3363	-1.48	-1.28
	kurtosis	49	3.4423	49	3.1245	2.75***	2.82***
	10th centile	49	-0.0745	49	-0.0826	1.68*	1.65*
	90th centile	49	0.0634	49	0.0663	-0.74	-0.47
Money Market	mean	51	0.0029	40	0.0029	-0.06	-0.61
	sd	51	0.0021	40	0.0018	0.74	-1.08
	skewness	51	0.9277	40	0.9271	0	-0.62
	kurtosis	51	4.5274	40	4.1767	0.29	-0.04
	10th centile	51	0.0011	40	0.0010	0.79	0.2
	90th centile	51	0.0053	40	0.0056	-1.05	-1.58
Global	mean	17	0.0010	27	0.0002	0.46	-0.23
	sd	17	0.0232	27	0.0276	-0.64	-0.47
	skewness	17	-0.6062	27	-0.5532	-0.16	-0.47
	kurtosis	17	6.8704	27	5.3956	0.93	0.59
	10th centile	17	-0.0304	27	-0.0306	0.01	0.49
	90th centile	17	0.0266	27	0.0282	-0.27	-0.42

This table presents the four main central moments, the 10th and 90th percentiles of the funds' distribution of returns per category and group. Groups are non users and heavy users of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean and median group values per category respectively. The central moments' measures are the returns' mean, the returns' standard deviation, the returns' skewness, and the returns' kurtosis. Returns are computed on a monthly basis and the management fee and the deposit fees are added back.. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

The second result is that no fund category can be cataloged as using derivatives for *hedging*. That is, from the analysis of the distribution of returns no fund category reports evidence of using derivatives for hedging or risk management purposes. On the other hand, Balanced Domestic and Balanced International funds may be cataloged as *superperformers* considering after and before fees returns. Both fund categories report larger mean, larger skewness and a larger 10th centile, considering after and before fee returns. Heavy users of derivatives cannot be considered *superperformers* anymore. The only remaining characteristic is a larger skewness. Domestic Equity and European Equity funds may be cataloged as *unsuccessful speculators*. An increase in risk is reported, but no effect on skewness or performance is shown. Finally, Fixed Income funds can be cataloged as *successful speculators*, since they show a larger risk and a larger mean.

The third result is that the distribution of returns for Foreign Equity, Money Market, Global, and European Equity funds that use derivatives cannot be distinguished form the non users for the after and before fees return distributions. Only when heavy users are considered, some differences arises. European equity funds increase their risk in some form, and Foreign equity funds that heavily use derivatives reduce kurtosis, but also mean and the breakpoint of the 10% lower tail.

Table 1.16: **Before Fees Return Distributions of Users.**

Category	**measure**	**non-users**		**users**		**ttest**	**Wilcoxon**
		N	**mean**	**N**	**mean**	**t-stat**	**z-stat**
Balanced Domestic	mean	35	0.0031	282	0.0044	-2.63***	-2.76***
	sd	35	0.0238	282	0.0217	0.92	1.03
	skewness	35	-0.4485	282	-0.2314	-2.38**	-2.41**
	kurtosis	35	4.2059	282	4.3650	-0.43	-0.12
	10th centile	35	-0.0270	282	-0.0219	-1.83*	-1.95*
	90th centile	35	0.0315	282	0.0295	0.71	0.59
Balanced International	mean	20	0.0019	93	0.0028	-1.62	-1.85*
	sd	20	0.0230	93	0.0202	0.97	1.4
	skewness	20	-0.6490	93	-0.2774	-2.09**	-2.63***
	kurtosis	20	3.5270	93	4.5119	-1.48	-2.26**
	10th centile	20	-0.0292	93	-0.0221	-1.77*	-2.2**
	90th centile	20	0.0281	93	0.0252	0.82	1.46
Domestic Equity	mean	6	0.0092	78	0.0089	0.21	0.19
	sd	6	0.0467	78	0.0547	-1.62	-2.52**
	skewness	6	-0.3793	78	-0.2657	-0.92	-0.76
	kurtosis	6	3.6238	78	3.5981	0.09	0.14
	10th centile	6	-0.0514	78	-0.0577	0.92	1.48

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Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat
	90th centile	6	0.0664	78	0.0796	-1.69*	-2.21**
European Equity	mean	30	0.0041	127	0.0027	1.4	0.69
	sd	30	0.0520	127	0.0536	-0.7	-0.96
	skewness	30	-0.5571	127	-0.5254	-0.42	-0.49
	kurtosis	30	3.8517	127	3.8236	0.13	1.15
	10th centile	30	-0.0654	127	-0.0686	0.73	0.52
	90th centile	30	0.0626	127	0.0648	-0.73	-1.14
Fixed Income	mean	34	0.0030	348	0.0041	-4.38***	-5.39***
	sd	34	0.0035	348	0.0061	-2.5**	-4.36***
	skewness	34	0.1150	348	0.2447	-0.73	0.71
	kurtosis	34	4.8271	348	4.9765	-0.16	-3.51***
	10th centile	34	-0.0010	348	-0.0030	1.48	3.08***
	90th centile	34	0.0068	348	0.0111	-3.84***	-4.68***
Foreign Equity	mean	49	0.0002	211	-0.0006	0.83	0.5
	sd	49	0.0559	211	0.0573	-0.51	-0.09
	skewness	49	-0.4409	211	-0.3844	-0.86	-0.61
	kurtosis	49	3.4431	211	3.5884	-0.96	0.19
	10th centile	49	-0.0729	211	-0.0765	0.81	0.71
	90th centile	49	0.0650	211	0.0659	-0.28	-0.08
Money Market	mean	51	0.0038	159	0.0038	0.39	-0.66
	sd	51	0.0021	159	0.0020	0.29	-0.25
	skewness	51	0.9158	159	0.7330	1.02	-0.13
	kurtosis	51	4.3968	159	4.6830	-0.26	-0.53
	10th centile	51	0.0019	159	0.0017	0.87	-0.53
	90th centile	51	0.0063	159	0.0067	-0.87	-0.49
Global	mean	17	0.0022	165	0.0023	-0.06	-0.78
	sd	17	0.0232	165	0.0253	-0.45	-0.42
	skewness	17	-0.5982	165	-0.2578	-1.47	-1.51
	kurtosis	17	6.7723	165	5.5984	1.22	-0.14
	10th centile	17	-0.0292	165	-0.0286	-0.1	0.41
	90th centile	17	0.0279	165	0.0297	-0.37	-0.51

This table presents the four main central moments, the 10th and 90th percentiles of the funds' distribution of the before fee returns per category and group. Groups are non users and users of derivatives. A t-test and a Wilcoxon test are performed on the mean and median group values per category respectively. The central moments' measures are the returns' mean, the returns' standard deviation, the returns' skewness, and the returns' kurtosis. Returns are computed on a monthly basis and the management fee and the deposit fees are added back. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1.17: **Before Fees Return Distributions of Heavy Users.**

Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat
Balanced Domestic	mean	35	0.0031	50	0.0042	-1.47	-1.87*
	sd	35	0.0238	50	0.0225	0.47	0.62
	skewness	35	-0.4485	50	-0.2544	-1.94*	-2.04**
	kurtosis	35	4.2059	50	3.9521	0.77	1.53
	10th centile	35	-0.0270	50	-0.0230	-1.16	-1.32

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Table 1.17 – Continued from previous page

Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat
	90th centile	35	0.0315	50	0.0310	0.13	0.09
Balanced International	mean	20	0.0019	17	0.0021	-0.34	-0.24
	sd	20	0.0230	17	0.0205	0.64	1.49
	skewness	20	-0.6490	17	-0.5674	-0.65	-0.15
	kurtosis	20	3.5270	17	4.1352	-2.2**	-1.83*
	10th centile	20	-0.0292	17	-0.0238	-0.97	-1.65*
	90th centile	20	0.0281	17	0.0257	0.5	1.37
Domestic Equity	mean	6	0.0092	15	0.0080	0.71	0.7
	sd	6	0.0467	15	0.0613	-5.15***	-3.43***
	skewness	6	-0.3793	15	-0.2725	-1.09	-0.7
	kurtosis	6	3.6238	15	3.4088	1.41	0.7
	10th centile	6	-0.0514	15	-0.0674	2.82**	2.18**
	90th centile	6	0.0664	15	0.0896	-4.01***	-3.04***
European Equity	mean	30	0.0041	28	0.0020	1.35	1.09
	sd	30	0.0520	28	0.0563	-1.65	-2.19**
	skewness	30	-0.5571	28	-0.6526	0.98	0.78
	kurtosis	30	3.8517	28	3.8666	-0.05	0.75
	10th centile	30	-0.0654	28	-0.0746	1.73*	1.73*
	90th centile	30	0.0626	28	0.0680	-1.36	-1.76*
Fixed Income	mean	34	0.0030	71	0.0043	-3.52***	-5.03***
	sd	34	0.0035	71	0.0080	-3.56***	-5.15***
	skewness	34	0.1150	71	0.1840	-0.32	1.49
	kurtosis	34	4.8271	71	4.5116	0.28	-2.6***
	10th centile	34	-0.0010	71	-0.0053	2.58**	4.62***
	90th centile	34	0.0068	71	0.0133	-5.06***	-5.42***
Foreign Equity	mean	49	0.0002	49	-0.0024	2.13**	2.31**
	sd	49	0.0559	49	0.0586	-0.86	-0.07
	skewness	49	-0.4409	49	-0.3373	-1.46	-1.28
	kurtosis	49	3.4431	49	3.1253	2.75***	2.84***
	10th centile	49	-0.0729	49	-0.0812	1.7*	1.64*
	90th centile	49	0.0650	49	0.0677	-0.7	-0.35
Money Market	mean	51	0.0038	40	0.0039	-0.49	-1.7*
	sd	51	0.0021	40	0.0018	0.77	-0.91
	skewness	51	0.9158	40	0.9214	-0.03	-0.67
	kurtosis	51	4.3968	40	4.0074	0.36	-0.1
	10th centile	51	0.0019	40	0.0020	-0.28	-1.46
	90th centile	51	0.0063	40	0.0067	-1.1	-1.36
Global	mean	17	0.0022	27	0.0013	0.5	-0.33
	sd	17	0.0232	27	0.0276	-0.64	-0.47
	skewness	17	-0.5982	27	-0.5561	-0.13	-0.4
	kurtosis	17	6.7723	27	5.3952	0.89	0.54
	10th centile	17	-0.0292	27	-0.0294	0.03	0.47
	90th centile	17	0.0279	27	0.0294	-0.25	-0.35

Continued on next page

Table 1.17 – Continued from previous page

Category	measure	non-users N	non-users mean	users N	users mean	ttest t-stat	Wilcoxon z-stat

This table presents the four main central moments, the 10th and 90th percentiles of the funds' distribution of the before fee returns per category and group. Groups are non users and heavy users of derivatives. Funds are defined as heavy users if their frequency of derivative use is larger than the 75 percentile and their average ratio of notional value in derivatives to net asset value is larger than the 75 percentile. A t-test and a Wilcoxon test are performed on the mean and median group values per category respectively. The central moments' measures are the returns' mean, the returns' standard deviation, the returns' skewness, and the returns' kurtosis. Returns are computed on a monthly basis and the management fee and the deposit fees are added back. The sample covers the period from March 1995 to March 2005 and funds with more than three years of monthly observations. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

The study of the moments of the distribution of returns does not show strong evidence that mutual funds use derivatives for risk management purposes. The only exception are Balanced Domestic and Balanced International funds that use derivatives, which attain a larger mean and larger skewness at lower risk levels, with a larger breakpoint for the lower 10% tail (this is a rather weak measure for hedging). Moreover, the results show a stronger evidence that derivatives are used for speculation. In some cases the speculation seems to be successful (Fixed Income funds), in some others unsuccessful (Domestic Equity funds and European Equity funds that heavily use derivatives).

1.7 Cash Flow Management vs. Incentive Gaming Hypothesis

The incentive gaming theory in fund management states that if funds have bad (good) performance at the beginning of the evaluation period, they have an incentive to increase (decrease) the fund's risk as the final date of the evaluation period approaches. Hence the theory predicts that the changes in fund risk before the evaluation period are negatively correlated to the fund's previous performance. This theory has found empirical support in Brown et. al. (1996) and Koski and Pontiff (1999). In addition, in the fund literature, there is evidence that when funds perform well there is a tendency for the fund to receive new cash flows Ippolito (1992). These new cash flows, if large enough, can alter the risk profiles of the funds if the cash is not rapidly and efficiently spread out through the investment positions. Large cash inflows may have the effect of reducing the fund's risk, while large cash outflows may increase fund's risk. Since cash inflows tend to increase with the fund's good past performance and cash outflows with the fund's bad performance, we have a second channel that links the fund's risk with the fund's past performance. But, if funds are allowed to used derivatives, these in turn could be used to reduce, even eliminate, the effects of cash in- and outflows on the fund's risk profile. This is the cash flow management hypothesis of Koski and Pontiff (1999).

In order to analyze if the evidence favors the incentive gaming theory or the cash flow management hypothesis, Koski and Pontiff (1999) propose the following regression equation:

$$\Delta Risk_{i,t} = \alpha + \beta_1 D_i + \beta_2 Perf_{i,t-1} + \beta_3 D_i * Perf_{i,t-1} + \beta_4 * Risk_{i,t-1} + \Sigma_j \beta_j dummy_j \tag{1.4}$$

where $\Delta Risk_{i,t}$ is the change in risk form the second to the first semester of the year, D_i is a dummy variable which indicates the use of derivatives by fund i, $Perf_{i,t-1}$ is the difference of the fund's mean return and the average mean return in the first semester for all funds in the same investment category, and $Risk_{i,t-1}$ is the risk variable in the first semester. Finally, dummies are included for each time period, fund category, fund size, and the interaction of time-period and fund category. The analyzed risk measures are the six-month standard deviation, the six-month beta and the six-month idiosyncratic risk in the market model.[23] Koski and Pontiff (1999) do the simplifying assumption, as in the previous literature, that the fund's evaluation date is the natural calendar year end. We follow the same assumption. In order to capture this in the model only the change in risk from the first to the second semester of each calendar year is considered. A weighted least squares (WLS) regression is used, where the weight is one divided by the standard deviation of the fund error of

[23] We re-estimate the standard deviation, beta and idiosyncratic risk on a semestral basis. That is, for each six month period we estimate the parameters using the market model proposed in the previous sections.

a first pass OLS regression. The WLS regression controls for fund heteroscedasticity.

The coefficient β_2 of the $Perf$ variable relates performance and change in risk for funds that do not use derivatives.[24] In support to the cash flow management hypothesis and the incentive gaming hypothesis, it is expected to find a negative coefficient. The coefficient β_3 gives the marginal effect of the interaction of derivative use and past performance on the change in risk. It is expected to find a positive β_3 coefficient in support of the cash flow management hypothesis and a negative coefficient in support of the incentive gaming hypothesis. The reason for including the lagged risk variable $Risk_{i,t-1}$ in the regression specification is to control for measurement errors in the risk variables, therefore one would expect a reversion of the errors from one period to the next. The coefficient for this variable is expected to be negative.

Table 1.18 reports the results of the the OLS and the WLS regressions for three lagged risk measures (standard deviation, beta and idiosyncratic risk) controlling for size, dividend yield, fund categories, sub-period and the interaction of fund categories and sub-periods.[25] As expected in all cases the lagged risk variable $Risk_{i,t-1}$ has a negative and significant coefficient. The performance coefficient β_2 is negative for all risk measures and regressions, and significant for all lagged risk measures and regressions except for the OLS regression with the idiosyncratic risk as the lagged risk measure. The interaction of past performance and derivative use is positive and significant for the standard deviation and beta as lagged risk measures, and it is negative but not significant for the idiosyncratic risk as the lagged risk measure. That is, the effect of past performance on change in risk is reduced for derivative users if risk is measured as the standard deviation or as the market exposure, beta. Therefore, the evidence is more supportive of the cash flow management hypothesis

[24] A positive α indicates that the change in risk from the first to the second semester of the year has been increasing over time on average. A positive β_1 coefficient would indicate that the change in risk is larger on average for derivative users. We do not expect particularly any sign for these coefficients.

[25] The official fund types short term fixed income (RFCP), long term fixed income (RFLP) and money market (FIAMM) are excluded form the analysis since the estimation of the parameters beta and root mean squared for six-month periods presented several complications.

than the incentive gaming hypothesis. Observe also that the constant coefficient of the regression model is positive and significant for all lagged risk measures. We interpret this as evidence of a increase over time of the funds risk in the second semester relative to the first semester of the calendar year. Since the reduction in risk due to the use of derivatives is significant for the standard deviation and the beta as lagged risk measures, it seems that market index derivatives are the most likely instruments being used for cash flow management.

Table 1.18: **Cash Flow Management vs. Incentive Gaming.**

	STD ols	STD wls	IDIO ols	IDIO wls	BETA ols	BETA wls
Constant	0.015	0.202	0.057	0.474	0.202	0.090
	(0.029)	(0.049)***	(0.020)***	(0.040)***	(0.044)***	(0.078)
D	-0.003	-0.006	0.006	0.060	0.006	-0.026
	(0.006)	(0.012)	(0.004)	(0.010)***	(0.009)	(0.017)
Perf	-0.301	-0.590	-0.025	-0.151	-0.238	-0.535
	(0.046)***	(0.073)***	(0.034)	(0.069)**	(0.073)***	(0.109)***
D* Perf	0.321	0.867	-0.035	-0.014	0.142	0.228
	(0.049)***	(0.074)***	(0.036)	(0.072)	(0.078)*	(0.114)**
Risk:						
STD	-0.203	-0.461				
	(0.010)***	(0.012)***				
IDIO			-0.499	-0.627		
			(0.009)***	(0.013)***		
BETA					-0.342	-0.573
					(0.009)***	(0.013)***
Observations	7680	7680	7493	7493	7493	7493
R-squared	0.66	0.63	0.48	0.57	0.36	0.38

The table reports the results for the estimation of the Koski and Pontiff (1999) model where the change in risk is regressed on past performance (Perf), a dummy variable (D) indicating derivative use, the interaction of past performance and the dummy on derivative use (Dperf), and the lagged risk measure (Risk). The respective risk measures are the six month standard deviation (STD), the six month root mean squared error from a market model (IDIO), and the beta of the market model (BETA). The regressions control for log of assets, dividends, subperiods, for fund category and interactions of sub-period and fund category. Funds with outlying price patterns are eliminated. The fund types RFCP, RFLP and FIAMM are also eliminated, since their estimation parameter beta is too unstable for the six months estimation period. The dependent variable is the change in risk from the first semester of the calendar year to the second semester. The sample covers the period from March 1995 to March 2005. Fund data is obtained from the Spanish Security and Exchange Commission, CNMV. * significant at 10%; ** significant at 5%; *** significant at 1%.

1.8 Final Remarks

This study provides a comprehensive analysis of derivatives usage in the Spanish mutual fund industry. Mutual funds in Spain are heavy users of derivatives. By 2005 more than 60% of the funds were users and held positions in derivatives whose notional represented an average 10% of the funds value. These funds tend to be funds that belong to a large family where other funds also use derivatives, funds that charge large fees, non-load funds, large funds and funds with low dividend yields. In general, the use of derivatives does not improve the performance of the funds. In only one out of eight categories (Fixed Income funds) we find some (very weak and not robust) evidence of superior performance. In most of the cases users underperform non users. Users do not seem to exhibit either superior timing or selectivity skills, but rather the contrary. The only exceptions are the Balance Domestic and European Equity categories that exhibit timing skills and Fixed Income that exhibit selectivity skills. We find no strong evidence of derivative use for risk management purposes. The exceptions are Balanced Domestic and Balanced International funds which we cataloged as *superperformers* since they attain a larger skewness and a larger mean with a lower risk (larger breakpoint for the lower 10% tail). We find stronger evidence of derivatives being used either for speculative purposes or to mimic their non user of derivative counterparts. Finally, we find evidence of derivatives being used to manage the funds' cash inflows and outflows more efficiently.

The previous results, specially the ones on performance, configure a rather negative picture of derivatives usage in the Spanish mutual fund industry. One alternative explanation is is that the fees charged may be too high. In fact, we show that this is part of the problem, but that still when fees are added back to returns users do not outperform non users of derivatives. Another alternative is that our study misses some important aspect of usage. On the one hand, for brevity of exposition we have focused on some of the most widely used performance measures, but we are not providing evidence on some others of interest. In particular we do not address performance in the context of conditional asset pricing models nor in the context of factor models that control for the value, size and momentum effects. On the other hand our study compares the *average* performance of users and non users of derivatives, which is equivalent to compare equally weighted portfolios of those funds. Since skillful derivative traders are expensive, it may be the case that only the largest funds can afford them. If this were the case, our methodology is under-weighting the importance of these funds. This calls for an analysis of value weighted portfolios of funds. These two are some of the extensions we plan to address in future research.

1.9 Appendix A of Chapter 1

Name and description of the official fund categories. The official fund types are: FIAMM, Money Market funds; RFCP, Short Term Fixed Income funds; RFLP, Long Term Fixed Income funds; RFI, International Fixed Income funds; RFM, Balanced Fixed Income funds; RVM, Balanced Equity funds; RFMI, Balanced International Fixed Income funds; RVMI, Balanced International Equity funds; RVN, Domestic Equity funds; RVE, European Equity funds; RVIE, RVIJ, RVIU, RVIM, RVIO, for International Equity funds specializing in the geographical regions Europe, Japan, USA, Emerging Markets, and Other Markets respectively; GRV, GRF, Equity and Fixed Income Guaranteed funds; and FGL, Global funds.

Table 1.19: **Description of Official Fund Categories.**

Name	Description
FIAMM	Euro denominated fixed income assets, with a max 5% in non euro assets
RFCP	Duration less than two years, with a max 5% in non euro assets
RFLP	Duration larger than two years, with a max 5% in non euro assets
RFI	No equities allowed, with a max 5% in non euro assets
RFM	Less than 30% in equities, with a max 5% in non euro assets
RVM	Between 30% and 75% in equities, with a max 5% in non euro assets
RFMI	Less than 30% in equities, more than 5% in non euro assets
RVMI	Between 30% and 75% in equities, and more than 5% in non euro assets
RVN	More than 75% in equities traded in Spanish markets, with more than 90% in national assets
RVE	More than 75% in equites, and national assets less than 90%, a max of 30% in non euro assets
RVIE RVIJ RVIU RVIM RVIO	More than 75% in equities, at least 75% in assets issued by either European, Japan,
	USA, or Emerging markets, and Other issuers respectively , and more than 30% in non euro assets
FGL	Those funds that do not fit into any of the previous definitions

This table presents the official fund type definitions. Each fund in Spain is assigned to one of these fund types according to the fund's portfolio characteristics.

1.10 Appendix B of Chapter 1

In this section we briefly described some of the errors we have found in the fund data set and the criteria followed in trying to fix them.

- Reported values of notional and market value of derivatives positions. In most of the cases funds report the same figure for the notional and the market value of the position. In some cases they report one of them takes the value zero and the other a positive value. In a few cases negatives values were found. We decided to use the absolute value of the reported market value as the notional of the position.

- Typing errors for the notional amount and the market value for derivative positions. In some quarters we observed obvious typing errors. The information should be reported in thousands, but positions were introduced in units. Correction: The general procedure to fix this is to take the aggregate sum of the derivative positions and if they were greater than the total net asset value of the fund, the position was divided by 1000.

- Prices captured after death of funds: the share asset prices for some funds are reported after the official date of the fund's deregistration. Correction: A list of official date of deregistration was created for some funds, and any price falling after this date was eliminated.

- Problems in reporting prices for mergers or acquisitions:If a fund merged with others, in some cases prices continue to be reported for the merged fund or acquired fund after the merger date. Moreover, the price series typically show a clear discontinuity. For the series for which such a discontinuity was detected, the series is dropped out of the sample.

- Some funds where detected to have strange price patterns, one example is one fund whose price did not change through a long period of time. Such type of funds were eliminated.

Chapter 2

The Impact of a Regulatory Change on Mutual Fund Market Risk and Derivative Use

2.1 Introduction

In June 1997, the Spanish Security and Exchange Commission (CNMV)[1] introduced a reform that modified the code that regulates the use of derivatives by the mutual fund industry in Spain.[2] The stated aim of the new rule is to give mutual funds access to a wider set of instruments (principally OTC derivatives) for a better and more efficient management of their assets. In addition, the new regulation also changed the limit and the formula for the measure used to compare against the limit. For example, linear derivatives are not included in this measure anymore, therefore the reform eliminates the previous limits that existed on linear derivatives. Thus, the new limit is now exclusively for derivatives that imply the payment of a prime. At the same time, the limit was changed from a 16% of total assets to a 10% of net asset

[1]CNMV stands for "Comisión Nacional del Mercado de Valores".
[2]The reform refers to the Ministerial Order of June 10, 1997.

value. Therefore, on the one hand the new regulation enlarges the set of authorized derivatives and gives free hands in using linear derivatives, but on the other hand, it seems that it reduces the limit for trading in derivatives that imply the payment of a prime. It is not clear what the impact of the new regulation will have on the performance and the use of derivatives by the mutual funds. In particular, it is not clear what the impact on the aggregate mutual fund market risk is. Moreover, since the restrictions on the set of derivatives are loosened, it could have direct effects on the performance of funds. The present study addresses these issues, and in particular analyzes the effects on risk and performance of this new regulation.[3]

The following list represents the mayor changes introduced by the new regulation:

- It is now allowed to trade in OTC derivatives
- Repos are not considered derivatives any more
- The new measure for the derivative positions takes into account only the sum of the primes paid for the derivatives.
- The measure for derivative positions has to be smaller than 10% of fund net asset value.

Derivatives may be used for several purposes like hedging, speculating, timing the market, managing cash flows, reducing trading costs or exploiting information more efficiently (Koski and Pontiff (1999), Johnson and Yu (2004), and Marin and Rangel (2006)). Depending on the predominant use in the market we expect to find a stronger evidence for any of these uses after the regulatory change. If derivatives are used for several purposes and none is dominant, we expect to find no particular evidence in the aggregate.

For example, if derivatives are mainly used for reducing trading costs, exploiting information more efficiently, or timing the market we would expect an improved

[3]It has to be noted that neither in the previous regulation nor in the reformed regulation exists an explicit prohibition for any type of mutual fund to use derivatives in general.

performance without much impact on risk. While if derivatives are mainly used for hedging and managing cash flows, we would expect a reduction in risk, and a possible improvement in performance. Finally, if derivatives are mainly used for speculation, we would expect to find an increased risk, but also an increased performance.

We also expect to see an effect of the new regulation in one or both of two cases: either the funds that are defined as derivative users were constrained by the previous regulation, and thus after the new regulation we observe a change due to a change of the constraint; or, the funds that were non-users before the regulatory change are attracted to become users after the new regulatory environment. In any other case, we expect the regulatory change to have no significative effects.

This study analyzes the impact of the mentioned regulatory change in terms of the changes of behavior of mutual funds measured by their risk and performance before and after the introduction of the reform. In particular, since the reform is aimed at improving mutual funds' management of their assets, we expect as an effect of the reform an improved performance. Regarding risk, we want to know if the reform had any impact on it. Even that there is no explicit statement in the reform about risk, we understand under a better management of the funds' assets, if any, as a risk reduction. But, it could also be possible that funds understand under a better management of their assets as a risk increase, but in this case we would also expect an improved performance.

2.2 Background

Regulatory event studies have three specific features that make them particularly difficult to study (see MacKinlay (1997) and Binder (1985)). The first feature refers to the fact that what matters for any particular event is the knowledge of when the market changes its expectations. This is usually not easily known. Normally changes in regulation are publicly discussed and the final version of the regulation is known well in advance to the definitive release of the regulation. What really matters for purposes of an event study is thus to know the exact date in which investors' expectations change. The second feature refers to the unknown effect of the regulation. Regulations may affect some firms and help others. The mixed effects of the regulation may make it hard to find clear results. The third feature refers to the difficulty of distinguishing industry shocks from the regulatory effect. Often regulatory changes are aimed at some specific industry sector, therefore, making it difficult to separate industry shocks from the regulatory effect. It could be the case that in the same date of the change in expectations due to the regulatory change some other effect takes place. For example, it could be the case that on the date of the regulatory change also a generalized market fall occurs. In this situation the results would be biased by this additional effect.

In the current study the first feature, as to when market expectations change, is not a real problem. Even if the regulation is known, announced and expected since several months in advance to the official enforcement date, mutual funds cannot do any changes in their portfolio positions until the official enforcement date. What mutual funds can do is to start the administrative process in order to be allowed to use derivatives. In order to capture this effect, I consider in section 2.5.5 as a derivative user any fund that reports to use derivatives up to two and a half years after the introduction of the new rule. The second feature, the unknown effect of regulation, is not a problem either in this study. The direct effect of the new regulation is aimed at the current mutual funds that use derivatives and in a second order on the future or potential users of derivatives. Funds that do not use derivatives and did not use derivatives after the regulatory change are not directly affected by the change in regulation. The third and final feature, to distinguish the regulatory effect form industry specific shocks, seems to be an important aspect to take into account for this analysis. The regulatory change is specific to the mutual fund market and makes the analysis more troublesome. The goal is to be able to separate the fund market specific shocks from the effects of the new regulation. To handle this problem in our study a control group is used. In particular, a portfolio of mutual funds that do not use derivatives is followed and used as a control group.

Most regulatory event studies are based on changes in regulation for non-financial firms. To the best of our knowledge there are no studies analyzing the effect of a regulatory change within the mutual fund industry. This is the first study to do such an analysis.

In this analysis we are mainly concerned with the effects of the new regulation on the average mutual fund investor, irrespective of mutual fund style. That is, we want to address the question of whether an average investor in mutual funds in the Spanish market gained some benefit form the new regulation in the form of lower risk exposures or improved performance. Therefore, the main object under study is an equally weighted portfolio of Spanish mutual funds that are defined as users of derivatives.

Market risk is represented by the sensitivity of the mutual fund's portfolio to the market portfolio. For the average investor in Spain, we consider that the market risk is best represented by a Spanish market index, but we also relax this assumption by considering other alternative market indexes in section 2.5.4.

2.3 Data

As mentioned in the previous section, it is important to specify clearly the relevant date and the sample to be used. In addition, in order to disentangle the industry specific shocks form the effects of the new regulation a control group is constructed. A brief description of the relevant date, the sample, and the control group follows.

2.3.1 The relevant date

Mutual funds cannot change their position in terms of increasing the set of derivatives to be used beyond the legal limits until the enforcement of the new regulation. They also cannot use the new limits to compute the amount of derivatives to be used, until the same date. Thus, the relevant date for the analysis is the date at which the regulatory change is enforced, that is June 10, 1997. Notice that this event date has the direct implication that there is "clustering" of the observations. That is, "clustering" refers to the fact that the event date is the same for all mutual funds in the sample. Thus clustering refers to the existence of cross correlations that have to be considered for an event study like ours. There are several ways to deal with clustering, one of them is to construct a portfolio of the observations and perform the analysis with it.[4] In what follows we will use the portfolio perspective following Grout and Zalewska (2006) in line of our intuition of analyzing the effect of the reform on the average Spanish mutual fund shareholder.

2.3.2 The sample

The database consists of all funds in the Spanish mutual fund market for the time period January 1995 to October 1999. The data source is the Spanish Securities and Exchange Comision. The first date for which we count with information is January 1995. To construct the return series, we use monthly data. As a base case, we take the same time length before and after the introduction of the regulatory change, thus we select a 2 years and 4 months time span for each window (before and after the regulatory change).[5] In the event study terminology, the "estimation period" is from January 1995 to May 1997, and the "event window" from June 1997 to October 1999. The "estimation window" is intended to capture the situation before the event to be studied. In contrast the "event window" is intended to capture the effects of

[4] A second alternative is to use SURE models, see Binder (1998).

[5] We also consider other time intervals after the regulatory change. See section 2.5

the event. I eliminate all funds for which I have no information about their official fund type.[6] The official fund type is as of June 2004. In addition, we also eliminate all funds that have less than half a year of experience before the regulatory change. That is, all funds that report a net asset value for a period less than half a year before the regulatory change are eliminated. This guarantees that only funds with at least half a year of information before the regulatory change are included in the sample to be studied.[7] The unrestricted sample consists of $2,140$ funds and the final sample consists of 805 funds. The sample is to some extent representative of the mutual fund industry, since it represents about 60% of the market in terms of net asset value, number of shareholders, and 40% in terms of number of funds. Since the database includes information of the end of quarter positions for each mutual fund, we may distinguish funds that have reported a derivative position. Thus, the sample under study consists of those funds that report a derivative position before and after the regulatory change of June 1997. This sample consists of 417 funds. That is, a fund is considered to be a user of derivatives, if the fund reported a derivative position before the regulatory change and if the fund reported a derivative position after the regulatory change.

The figures in the diagonal of table 2.1 represent the number of funds that used derivatives before and after the regulatory change, as well as the respective figures for funds that did not use derivatives. Observe that the definition of derivative user is the most restrictive one, since it represents only the funds that did use derivatives before and after the regulatory change. From his table it is also clear that many

[6]In Spain there are 18 official fund types defined as: FIAMM, Money Market funds; RFCP, Short Term Fixed Income funds; RFLP, Long Term Fixed Income funds; RFI, International Fixed Income funds; RFM, Balanced Fixed Income funds; RVM, Balanced Equity funds; RFMI, Balanced International Fixed Income funds; RVMI, Balanced International Equity funds; RVN, Domestic Equity funds; RVE, European Equity funds; RVIE, RVIJ, RVIU, RVIM, RVIO, for International Equity funds specializing in the geographical regions Europe, Japan, USA, Emerging Markets, and Other Markets respectively; GRV, GRF, Equity and Fixed Income Guaranteed funds; and FGL, Global funds.

[7]It will become clear in the next section that this condition is needed for the event study to be properly defined.

Table 2.1: **Number of funds that use derivatives and funds that do not use derivatives before and after the regulatory change**

Regulatory Change		After		
		non-users	users	Total
Before	non-users	176	137	313
	users	75	417	492
	Total	251	554	805

This table presents the number of funds that used and did not use derivatives before and after the regulatory change from June 1997. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. The analyzed time period is January 1995 to October 1999. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

funds changed status from being a non-derivative user before the regulatory change to a derivative user. There is also a small amount of funds that changed status from being a derivative user before the introduction of the new regulation to not using derivatives any more. We think that this change is due to the fact that a new definition for derivatives is established after the new regulation. In particular, in the new regulation "repo" positions are not considered derivatives anymore. Thus, we think that the change of status of these funds was rather due to this change in definition. In section **??** we control for this effect.

In table 2.1 we can observe that apparently the change in regulation had one of the expected effects mentioned in the introduction: there seems to be a significative increase of users of derivatives after the regulatory change. Notice also that the selected definition for derivative users does not include all these "newly" defined funds as users of derivatives. In section 2.5.5 we control for this group of funds.

2.3.3 The control sample

To isolate the specific effects of the regulatory change from other changes that could affect the performance and risk of mutual funds a control sample is constructed. The aim of the control sample is to attempt to eliminate or "control" for any such alternative effects that may introduce some noise and thus a loss in significance or bias in the results.

A standard way to construct a control sample is to find funds within the same sector and with similar characteristics . In addition, there are some properties that are desirable in the construction of the control sample. It should attempt to be similar to the sample under study in terms of size, number of funds, and age. Of course there are limitations to find such a sample.

In our case, the defined control sample consists of all mutual funds that for the complete time period (the estimation window plus the event window) did not report any derivative positions. This sample consists of 176 funds. Notice in particular, that these funds are not directly affected by the new regulatory environment.

To compare some control group characteristics with the sample under study table 2.2 presents some average fund characteristics for the analyzed sample period, January 1995 to October 1999. Fund variables are measured on monthly basis. The analyzed fund characteristics are net asset value, number of shareholders, and management fees.

Table 2.2: **Characteristics of Funds that use Derivatives and Funds that do not use Derivatives**

Fund Characteristic		Derivative Use	
		0	1
Net Asset Value	mean	108	158
	sd	250	339
Shareholders	mean	4,217	5,770
	sd	10,134	12,476
Management fees	mean	1.22%	1.42%
	sd	0.47%	0.50%
Number of Funds		176	417

This table presents the mean and the standard deviation for the net asset value, the number of shareholders, and the management fees based on monthly observations. Net asset value is given in million Euros. Management fee is a percentage of net asset value charged for the management of the fund's assets. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The analyzed time period is January 1995 to October 1999. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

The average net asset value of funds that do not use derivatives is about 70% of the net asset value of funds that use derivatives. That is, the control group consists of typically smaller funds in terms of net asset value. The average fund net asset values are 108 million euros and 158 million euros, respectively for non-derivative-user and derivative-user funds. Basically the same can be said about the fund size as measured by the number of shareholders. The average number of shareholder in funds that do not use derivatives is $4,217$, while that for funds that use derivatives is $5,770$ shareholders. The same can be said about the management fees charged: non-derivative-user funds tend to charge a smaller management fee than derivative-user funds. Nevertheless that it would be desirable to have a control group of the same size of the analyzed group, we are limited to the available information, and thus this is one of our limitations to find the ideal control group.

2.4 The Effect On Risk and Performance

2.4.1 The model

The traditional approach (MacKinlay (1997), Binder (1985), Grout and Zalewska (2006)) to analyze event studies with the characteristics of the current analysis is to use a market model of the form

$$r_{it} = \alpha_i + \beta_i r_{mt} + \epsilon_{it} \tag{2.1}$$

Where r_{it} is the return for the portfolio i at time t, $r_m t$ is the return of the market portfolio at time t.

In order to perform the event study analysis a dummy variable d is included in the previous specification. In our particular case, d takes the value of one for the event period, June 1997 to October 1999, and zero otherwise. In addition to this dummy variable we also include the interaction of the dummy and the risk factor r_{mt}. The coefficient of this interaction would tell us the effect of the change in regulation on the market risk. Thus the typical analyzed model is of the form

$$r_{it} = \alpha_i + \beta_i r_{mt} + \gamma_i * d + \gamma_{int,i} r_{mt} * d + \epsilon_{it} \tag{2.2}$$

As before, i corresponds to the analyzed portfolio.

Instead of the above mentioned market model a CAPM like model is analyzed, because the CAPM model is the standard model for analyzing mutual funds. The advantage of the CAPM model over the market model is that the coefficient of the constant term of the specification is interpreted as the mutual fund performance, and the coefficient of the risk premium *beta* is interpreted as the market exposure of the mutual fund. The final specification including dummy variables is thus

$$r_{it} - r_{ft} = \alpha_i + \beta_i (r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i} (r_{mt} - r_{ft}) * d + \epsilon_{it} \tag{2.3}$$

where r_{ft} is the risk-free rate at time t, and i corresponds to the analyzed portfolio. The coefficients for the dummy variable (γ_i) and for the interaction term ($\gamma_{int,i}$) capture the effect of the new regulation on the performance of mutual funds and on their market risk exposure respectively. The interpretation of a positive α is that the mutual funds outperform the market, and a positive γ_i means that the effect of the regulation had a positive impact on the mutual fund performance. If derivatives are managed to use information better or to reduce transaction costs, the result should be an improvement in a risk adjusted performance measure like α. On the other hand, if derivatives are used to speculate or as an investment tool we can expect a positive $\gamma_{int,i}$ coefficient, that is an increased market exposure. While, if derivatives are used to hedge market wide risks we would expect a negative $\gamma_{int,i}$ coefficient.

In addition to analyzing the impact of the regulatory change on risk and performance, also the effect on market timing is considered. The model for the market timing specification is

$$r_{it}-r_{ft} = \alpha_i+\beta_i(r_{mt}-r_{ft})+\gamma_i*d+\gamma_{int,i}(r_{mt}-r_{ft})*d+\delta(r_{mt}-r_{ft})^2+\delta_{int,i}(r_{mt}-r_{ft})^2*d+\epsilon_{it} \quad (2.4)$$

Where δ captures the market timing ability of the fund, and δ_{int} the effect of the regulatory change on the market timing ability. If a mutual fund has some market timing ability, a positive δ coefficient is expected, while a negative one would be in line with the empirical evidence on market timing ability. This result is often called "the perverse" outcome.[8] Finally, if funds use derivatives more extensively to time the market, then a positive δ_{int} coefficient is expected.

The analyzed portfolios are an equally weighted portfolio of funds that use derivatives, an equally weighted portfolio of funds that do not use derivatives, and a portfolio consisting of the difference of the two previous portfolios. Return series are computed on a monthly basis and are annualized.

2.4.2 The effect on funds that use derivatives

An equally weighted portfolio of mutual funds that use derivatives is followed during the estimation and the event periods. We analyze three different models: a CAPM model, its extension including the effects of the reform, and a further extension with market timing as described in the previous section.

The CAPM model (see table 2.3 column 1) indicates a slightly negative performance for the average fund that used derivatives. We find an under-performance of 1.2% in annual terms, and the result is significant at the 5% level. The model also indicates that the average fund that used derivatives during this time period had a relatively low market exposure (a beta of 0.142) significant at the 1%. Thus, mutual funds that used derivatives report a low market exposure and a negative risk adjusted

[8] See Koski and Pontiff (1999) and Ferson and Shadt (1996) for some evidence on the perverse outcome result. In particular, the result is so common in the mutual fund literature that it seems it is already considered as an expected outcome.

Table 2.3: **Risk-Performance Analysis for Funds that Use Derivatives**

	(1) capm	(2) capm event	(3) capm mkt timing
α	-0.012	0.002	-0.002
	(0.006)**	(0.008)	(0.009)
β	0.142	0.116	0.109
	(0.007)***	(0.014)***	(0.017)***
γ		-0.023	-0.018
		(0.011)**	(0.013)
γ_{int}		0.032	0.040
		(0.016)*	(0.019)**
δ			0.017
			(0.019)
δ_{int}			-0.018
			(0.020)
Observations	56	56	56
R-squared	0.88	0.89	0.89

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (column 1), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (column 2), and $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (column 3) for i equal to an equally weighted portfolio of derivative-user funds. Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

performance for the period from January 1995 to October 1999.

Now we consider the extended model that takes into account the effect of the change in regulation (see table 2.3 column 2). The coefficient, γ, controlling for the effect of the change in the reform on the performance is negative, with a value of 2.3%, and is significant at the 5%. The coefficient controlling for the effect of the change in regulation on the market risk γ_{int} is positive taking a value of 0.032 and significant at the 1%. The market risk exposure beta captures the risk taking behavior of the average fund before the reform. Beta is 0.116 and significant at the 1% before the reform, while after the reform it raises by additional significant 0.032 points. These results seem to indicate a negative effect of the reform on the performance of the average mutual fund that used derivatives, and there is a clear increase of the market exposure after the reform. At this point in time, it would seem that the reform had rather negative effects on the mutual fund industry, since after the reform the average mutual fund that used derivatives reports a lower performance and an increased risk.

Finally, the extended CAPM model that considers market timing and the effect of the reform (table 2.3 column 3) shows no market timing evidence after the introduction of the reform. A positive but non significant coefficient , δ, for the market timing is reported; and a negative and non significant coefficient, δ_{int}, measuring the market timing ability after the reform is reported. Thus, we do not find any evidence of market timing ability before nor after the reform by the average mutual fund that used derivatives. We conclude that the reform did not incentive these type of funds to start timing the market.

Overall the models seem to describe relatively well the variance of the average mutual fund returns using derivatives since the R^2 of the regressions is close to 0.9.

2.4.3 The effect on funds that do not use derivatives

An equally weighted portfolio of mutual funds that do not use derivatives is followed during the analyzed time period: January 1995 to October 1999. Once again we study three models: a CAPM model, its extension considering the effect of the reform, and a further extension measuring market timing.

The CAPM model (Table 2.4 column 1) shows that non-derivative-user mutual funds experienced a negative risk adjusted return during January 1995 to October 1999, and the model also shows that these funds experienced a low market exposure. The α is -0.017 and the β is 0.056, both coefficients significant at the 1% level. This market exposure contrasts with the one of subsection 2.4.2 of 0.179. That is, the average mutual fund that uses derivatives in the analyzed time period experiences a much larger market exposure than the mutual funds that make no use of derivatives. The market exposure of the average mutual fund that does not use derivatives is less than a third of the average mutual fund that uses derivatives.

Table 2.4: **Risk-Performance Analysis for Funds that Do Not Use Derivatives**

	(1) capm	(2) capm event	(3) capm mkt timing
α	-0.017	-0.009	-0.009
	(0.004)***	(0.006)	(0.007)
β	0.056	0.047	0.047
	(0.005)***	(0.010)***	(0.012)***
γ		-0.012	-0.009
		(0.008)	(0.009)
γ_{int}		0.011	0.011
		(0.012)	(0.013)
δ			-0.000
			(0.014)
δ_{int}			-0.004
			(0.014)
Observations	56	56	56
R-squared	0.70	0.71	0.72

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (column 1), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (column 2), and $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (column 3) for i equal to an equally weighted portfolio of non-derivative-user funds. Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

As expected, the extensions of the CAPM model show that there is no effect of the regulation on the funds' risk and performance (the coefficients γ and γ_{int} are not significant). Also no evidence of a change in the behavior of market timing by mutual funds that do not use derivatives is found. These results are in line with our expectations. That is, the regulatory change should not affect the funds that do not use derivatives, and thus should have no effect on their risk and performance. Finally, no evidence is found relative to the market timing abilities of funds that do not use derivatives before and after the regulatory change (see table 2.4).

It seems that the proposed control group has the desired characteristics: it is a group within the same industry and is not affected by the regulatory change. Therefore, we can expect this control group to be useful for controlling for the industry specific effects.

Finally, it seems that the three models describe also relatively well the variation of the returns of the average mutual fund that does not use derivatives. The R^2 is around 0.7. It is to notice that the three models describe better the variation of returns of the average mutual fund that uses derivatives than that of the control group.

2.4.4 The net effect of the regulatory change

An important fact to be considered in the previous analysis is that the results related to the regulatory change could be driven by industry specific effects, as explained in section 2.2. That is, results could be driven by a common factor and different to the event under study, but that also affects the group under study contemporaneously to the event. In order to control for these industry specific effects we would like to have a portfolio net of these effects. For this purpose the portfolio of funds that do not use derivatives is used as a control portfolio. The portfolio net of industry effects is thus a portfolio of the difference of returns between the portfolio of derivative-user funds and the portfolio of non-derivative-user funds.

The CAPM model (see table 2.5 column 1) shows that funds that used derivatives from January 1995 to October 1999 under-performed the funds that did not make use of any derivatives. Moreover, we confirm the observation made in the previous subsection, that the average mutual fund that used derivatives experienced a larger market exposure than the average mutual fund that did not use any derivatives. The β coefficient is positive and significant at the 1% level, while the α coefficient is negative and also very significative.[9]

[9]We do not think a survivorship bias may be in play in these results due to the fact that in our sample we count with all funds that have an assigned fund category during the analyzed time period. On the one hand, while it is true that, a possible survivorship bias, where bad funds using derivatives fall out of the sample, would increase the under-performance result, on the other hand a survivorship bias were bad funds not using derivatives fall out of the sample would reduce the under-performance result. Thus, on the one hand, if we assume the reform affected the same way mutual funds using derivatives and mutual funds not using derivatives, then on average the result

Table 2.5: **Risk-Performance Analysis for a Portfolio consisting of the Difference between Users and Non Users of Derivatives**

	(1)	(2)	(3)
	capm	capm	capm
		event	mkt timing
α	-0.052	-0.068	-0.073
	(0.006)***	(0.009)***	(0.010)***
β	0.086	0.079	0.068
	(0.008)***	(0.015)***	(0.018)***
γ		0.032	0.036
		(0.012)**	(0.014)**
γ_{int}		0.010	0.021
		(0.018)	(0.020)
δ			0.024
			(0.020)
δ_{int}			-0.023
			(0.021)
Observations	56	56	56
R-squared	0.68	0.73	0.74

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (column 1), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (column 2), and $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (column 3) for i equal to a portfolio that consists of the difference of the equally weighted portfolio of derivative-user funds minus the equally weighted portfolio of non-derivative-user funds. Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

Analyzing the extended model that controls for the regulatory change (see table 2.5 column 2) we find that the under-performance of mutual funds using derivatives is reduced after the introduction of the regulatory change. We find a positive and significant γ coefficient. At the same time we find weak evidence that users of derivatives after the introduction of the regulatory change increased their market exposure. We find a positive but not statistically significant γ_{int} coefficient.

Notice that the under-performance of funds that use derivatives is not eliminated

should not be affected. On the other hand, if we think that the reform affected only mutual funds using derivatives, implying also the "death" of these type of funds, then a survivorship bias could be into play. Nevertheless, we do not think to be facing such a problem due to the fact that we count with a sample free of such a bias.

after the reform. That is, the hypothesis test of both coefficients being zero is rejected at the 10% level.[10]

Finally, no significant evidence is found on the market timing ability for funds that use derivatives (see table 2.5 column 3) before or after the regulatory change. Thus, we interpret these results as no evidence of an improved market timing ability by the average mutual fund that used derivatives during the analyzed time period.

We find that the effect of the reform had to some extent the desired result: after the regulatory change the mutual funds that used derivatives improved their performance. But the improvement was not sufficiently large to yield an equivalent performance as the average mutual fund that did not use derivatives. This result is net of any industry specific effects.

To sum up, based on the portfolio of funds that used derivatives there is no evidence that these funds outperform the market. Moreover it would seem that the reform had exactly the opposite effect: a decrease in performance and an increase of risk. Once the results are controlled for industry specific shocks an under-performance of the funds that use derivatives with respect to the funds that do not use derivatives is found. This under-performance is reduced after the introduction of the regulatory change, nevertheless the under-performance result remains unchanged after the regulatory change. Finally, there is very weak evidence that the reform had the effect of an increase of the market exposure by mutual funds using derivatives.

2.5 Robustness checks

In order to analyze the robustness of the results we study different situations that could eventually be driving the results. We will refer to the results presented until now as the base case situation. To have a better overview these results are restated in a single table (see table 2.6).

[10]This result are robust to different market portfolio proxies as can be seen in the subsection 2.5.4.

Table 2.6: **Risk-Performance Analysis in the Base Case**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.012	0.002	-0.002	-0.017	-0.009	-0.009	-0.052	-0.068	-0.073
	(0.006)**	(0.008)	(0.009)	(0.004)***	(0.006)	(0.007)	(0.006)***	(0.009)***	(0.010)***
β	0.142	0.116	0.109	0.056	0.047	0.047	0.086	0.079	0.068
	(0.007)***	(0.014)***	(0.017)***	(0.005)***	(0.010)***	(0.012)***	(0.008)***	(0.015)***	(0.018)***
γ		-0.023	-0.018		-0.012	-0.009		0.032	0.036
		(0.011)**	(0.013)		(0.008)	(0.009)		(0.012)**	(0.014)**
γ_{int}		0.032	0.040		0.011	0.011		0.010	0.021
		(0.016)*	(0.019)**		(0.012)	(0.013)		(0.018)	(0.020)
δ			0.017			-0.000			0.024
			(0.019)			(0.014)			(0.020)
δ_{int}			-0.018			-0.004			-0.023
			(0.020)			(0.014)			(0.021)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.88	0.89	0.89	0.70	0.71	0.72	0.68	0.73	0.74

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

Notice that for all analyzed portfolios the selected models perform relatively well. The R^2 is around or above 0.7.

2.5.1 The funds with few months of experience

It could be the case that the negative results of the under-performance of funds that use derivatives compared to the funds that do not use derivatives are due to the inexperience of new funds. Moreover, it could be argued the same for the risk taking behavior of the new funds, in the sense that these inexperienced funds would be taking unwillingly but systematically larger exposures.

In this section I intend to control for the effect of new funds. The sample of funds used in the base case are those funds that existed during January 1995 to October

1999, that had a fund category assigned, and that had at least half a year of experience. I analyze a different sub-sample: all funds with less than one year of monthly observations are eliminated. That is, the "new" or young funds are eliminated from the analysis.[11]

The same analysis as in the previous section is performed: an analysis of the CAPM model and its extensions controlling for the regulatory change and market timing ability are considered for a portfolio of funds using derivatives, for a portfolio of funds that do not use derivatives, and for the portfolio consisting of the difference of the two previous portfolios. The results are qualitatively the same as in the base case. That is, even after controlling for new funds, by eliminating them from the sample, the results of under-performance by funds that use derivatives remains. We also find the improvement result in performance after the regulatory change by the mutual funds using derivatives. Also in this case, the improvement does not compensate the overall under-performance, compared to the funds that do not use derivatives. We find no evidence in favor of market timing ability.

Table 2.7 shows the equivalent of table 2.1 taking into account the new restriction. Naturally the total amount of funds is smaller totalling 682 funds. Notice that the proportions remain very similar as before: 21% funds are non-derivative users, while 53% are derivative user funds (the rest of funds are those off the diagonal, and are those which changed status). The equivalent figures before were 22% and 52%, respectively.

Notice that now the change from non-users to users of derivatives is drastically reduced, nevertheless the change is still considerable. About the same amount of funds changed status to users of derivatives compared to the amount of funds that remained being non-derivative users. In table 2.8 the results for the elimination of funds with less than one year of observations are shown.

Notice that the selected models do not improve that well as in the base case

[11] We decided not to eliminate further funds due to sample size reasons. In table 2.7 we can appreciate the reduction of the number of analyzed funds.

Table 2.7: **Number of funds that use derivatives and funds that do not use derivatives before and after the regulatory change**

Regulatory Change		After		
		non-users	user	Total
Before	non-users	145	103	248
	users	73	361	434
	Total	218	464	682

This table presents the number of funds that used and did not use derivatives before and after the regulatory change from June 1997. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. The analyzed time period is January 1995 to October 1999. The fund sample consists of all funds in the time period that had at least one year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

situation, but still the R^2 is around or above 0.6. Apart from this, results are basically the same as before. We find no evidence that the inexperience of new funds could be driving the results.

2.5.2 Specific market event effects

It is interesting to analyze the generalized market movement during the 1995-1999 period. This period is basically characterized by a bull market, with a considerable market fall in August and September 1998. In order to address if the negative results could be driven by this market fall, we follow a further analysis.

Stock Market Description

For the time period January 1995 to October 1999 the Spanish stock market is mainly characterized by a rising market. The Spanish market index IGBM rose from 285 points to 870 points in this time period. But, in August and September 1998 the stock market fell sharply by 17.4% in the first month, and an additional 3.7% in the following month. Thus, the full period may be considered basically bullish, with the exception of the mentioned months.

To control for the effect of the market fall of August and September 1998 a dummy equal to one for these two months and zero otherwise is included in the base case

Table 2.8: **Risk-Performance Analysis Controlling for New Funds**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.013	0.002	-0.001	-0.019	-0.009	-0.010	-0.051	-0.068	-0.072
	(0.006)**	(0.008)	(0.010)	(0.005)***	(0.007)	(0.008)	(0.007)***	(0.010)***	(0.011)***
β	0.138	0.113	0.107	0.062	0.048	0.047	0.076	0.074	0.067
	(0.007)***	(0.015)***	(0.017)***	(0.006)***	(0.012)***	(0.014)***	(0.009)***	(0.017)***	(0.020)***
γ		-0.024	-0.021		-0.015	-0.010		0.033	0.036
		(0.011)**	(0.013)		(0.010)	(0.011)		(0.013)**	(0.015)**
γ_{int}		0.032	0.038		0.018	0.019		0.004	0.011
		(0.017)*	(0.019)*		(0.014)	(0.016)		(0.019)	(0.022)
δ			0.012			0.002			0.017
			(0.019)			(0.016)			(0.023)
δ_{int}			-0.013			-0.007			-0.016
			(0.020)			(0.017)			(0.023)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.87	0.88	0.88	0.66	0.68	0.69	0.59	0.64	0.65

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least one year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

models. The coefficient θ should capture any effect due to this market fall. The results are shown in table 2.9.

Once again, the results are qualitatively the same as in the base case. It is to notice that the coefficient θ, of the 1998 market fall, is relatively small, amounting to 1%-4% of losses or gains. This coefficient is only significant for non-users of derivatives (see column 2 in table 2.9) and negative. That is, mutual funds that do not use derivatives did suffer a statistically significant loss due to the market fall, but we do not find an equivalent result for the user of derivative funds. We find some positive coefficients for the other models but not statistically significant. Moreover, it would seem that users of derivatives had a slight advantage over the non-users of derivatives since the θ coefficient is positive (even if it not statistically significant). We may read this

Table 2.9: **Risk-Performance Analysis controlling for the 1998 Market Fall**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.011	0.002	-0.002	-0.015	-0.009	-0.009	-0.054	-0.068	-0.073
	(0.006)*	(0.008)	(0.010)	(0.004)***	(0.006)	(0.007)	(0.006)***	(0.009)***	(0.010)***
β	0.140	0.116	0.109	0.052	0.047	0.047	0.090	0.079	0.068
	(0.008)***	(0.015)***	(0.017)***	(0.005)***	(0.010)***	(0.012)***	(0.009)***	(0.015)***	(0.018)***
θ	-0.016	0.006	0.009	-0.040	-0.032	-0.027	0.042	0.030	0.033
	(0.032)	(0.032)	(0.035)	(0.022)*	(0.023)	(0.025)	(0.035)	(0.034)	(0.037)
γ		-0.023	-0.018		-0.009	-0.008		0.029	0.035
		(0.012)*	(0.013)		(0.008)	(0.009)		(0.012)**	(0.014)**
γ_{int}		0.033	0.041		0.007	0.008		0.014	0.025
		(0.017)*	(0.019)**		(0.012)	(0.014)		(0.018)	(0.020)
δ			0.017			-0.000			0.024
			(0.019)			(0.014)			(0.020)
δ_{int}			-0.018			-0.003			-0.025
			(0.020)			(0.014)			(0.021)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.88	0.89	0.89	0.72	0.72	0.72	0.69	0.74	0.75

$r_{it} - r_{ft} = \alpha_i + \theta * d_2 + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \theta * d_2 + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \theta * d_2 + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. d_2 is a dummy that takes the value of one if t is equal to August or September 1998 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

result as some very weak evidence that derivatives are used for hedging purposes, since given a sharp market fall users of derivatives did not suffer as much a loss as non-users of derivatives.

The results from the previous chapter are kept. From the analysis of the portfolio of the difference of returns, it is clear that the under-performance of funds using derivatives compared to funds not using derivatives is kept, even after controlling for the 1998 market fall. That is, we find the under-performance of mutual funds using derivatives after the introduction of the new regulation. We also still find an improvement of performance by the users of derivatives after the reform, but this improvement is still not good enough to compensate the general under-performance of users of derivatives.

Notice also that we find some evidence that funds using derivatives tend to increase their market exposure after the 1997 reform. This result is not kept anymore, once we control for the market specific effects.

If we think of the 1998 market fall as an industry specific effect, these results can also be viewed as evidence that the control group works as desired, that is, it controls for industry specific shocks.

Finally, notice that the model taking into account the 1998 market fall does not particularly improve the regression fit. The R^2 is similar as in the base case situation.

2.5.3 The event window effect

In this subsection we question for the fact of having selected an event window similar in size to the pre-event window size. In order to analyze the effect of the event window size on the results, we analyze different time frames. It could be that the selection of a large event window could be playing a key role in the results. Alternatively, we are interested in analyzing if the results hold for any time span after the regulatory change. That is, in the latter case we are interested in analyzing if the impact of the regulatory change is immediate, or if it takes some time to perceive the results. Hence, a one year and a half year event windows after the reform are analyzed.

The results of the different sizes of the event window are in general qualitatively very similar, and do not significantly change the base case conclusions. The results for the half year and one year long event windows are slightly different in that the improvement in performance after the reform is not found in the half year event window. Instead for the one year event window the relative improvement in performance after the regulatory change is also captured by the portfolio of differences in returns. For reasons of space, we only present the results for the half year long event window (see table 2.10).

Notice that the half year window in table 2.10 does not include the market fall

Table 2.10: **Risk-Performance Analysis in the case of a Half Year long Event Window**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.001	0.004	-0.001	-0.009	-0.009	-0.009	-0.065	-0.067	-0.073
	(0.006)	(0.007)	(0.008)	(0.002)***	(0.003)***	(0.003)***	(0.005)***	(0.006)***	(0.007)***
β	0.141	0.126	0.117	0.045	0.041	0.040	0.099	0.094	0.083
	(0.009)***	(0.013)***	(0.015)***	(0.003)***	(0.004)***	(0.005)***	(0.007)***	(0.011)***	(0.012)***
γ		-0.012	0.005		0.002	0.009		0.016	0.026
		(0.016)	(0.023)		(0.005)	(0.008)		(0.013)	(0.019)
γ_{int}		0.027	0.033		0.008	0.007		0.010	0.020
		(0.018)	(0.020)		(0.006)	(0.007)		(0.015)	(0.016)
δ			0.021			0.002			0.026
			(0.017)			(0.006)			(0.014)*
δ_{int}			-0.029			-0.007			-0.029
			(0.020)			(0.007)			(0.016)*
Observations	33	33	33	33	33	33	33	33	33
R-squared	0.89	0.90	0.91	0.88	0.89	0.90	0.85	0.86	0.88

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-November 1997. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and November 1998 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

described in section 2.5.2. Thus, this specification also controls for the effects of the 1998 market fall. The coefficients for the event dummy variable γ, that control for the effect of the reform on performance, are generally positive but not significant (see columns 2,3, 8 and 9 in table 2.10). The result changes already for the one year long event window.[12] Once again, the improvement in performance does not compensate the under-performance compared to funds that do not use derivatives. Thus, the one year long event window analysis yields the same results as in the base case.

We interpret these results as that mutual funds using derivatives needed a prolonged time frame to exploit the advantages of the reform in terms of improving their

[12]This table is available by request to the author.

performance. Before one years after the introduction of the reform mutual funds were not able to incorporate into the net present values of their funds the benefits of the reform.

Thus, we find find that funds that used derivatives improved their performance after the reform, but that the improvement in performance was only sensible until one year after the introduction of the reform. Nevertheless of the improvements in performance, mutual funds using derivatives under-perform mutual funds not using derivatives.

2.5.4 The market index effect

Since the analyzed portfolio consists of mutual funds with different investment objectives, it is of special interest to analyze the sensitivity of the result to different market index specifications. For this purpose we select the FTSE World Index and the FTSE Eurobloc Index,[13].

If the market index is the FTSE World Index the results are similar. An under-performance of derivative user funds over the non derivative user funds is reported. But, the improvement in the performance after the regulatory change is only weakly found. The coefficients for the performance are positive and only significant for the model that controls for market timing (see the γ in columns 8 and 9 of table 2.11).

If the index is the FTSE Eurobloc index, the results are qualitatively the same as before. In this case, the significant improvement in performance after the regulatory change is only present in the model that controls for the regulatory change event.

Thus, the result related to the under-performance of funds that use derivatives compared to funds that do not use derivatives is very robust. The result that funds that use derivatives typically have a larger market exposure than the funds that do not use derivatives is also very robust. But, the result of the increase of performance after the regulatory change is not very robust. If alternative proxies for the market

[13]These index data are from Datastream.

Table 2.11: **Risk-Performance Analysis if the Alternative Market Portfolio is a World Market Index**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.007	0.014	0.011	-0.014	-0.004	-0.005	-0.050	-0.059	-0.065
	(0.011)	(0.015)	(0.018)	(0.006)**	(0.008)	(0.010)	(0.007)***	(0.011)***	(0.013)***
β	0.162	0.120	0.116	0.058	0.047	0.046	0.108	0.081	0.075
	(0.019)***	(0.038)***	(0.039)***	(0.010)***	(0.021)**	(0.021)**	(0.013)***	(0.027)***	(0.028)**
γ		-0.038	-0.018		-0.018	-0.006		0.020	0.033
		(0.021)*	(0.025)		(0.011)	(0.013)		(0.015)	(0.018)*
γ_{int}		0.055	0.066		0.015	0.020		0.034	0.043
		(0.044)	(0.045)		(0.024)	(0.024)		(0.031)	(0.032)
δ			0.026			0.008			0.042
			(0.070)			(0.037)			(0.050)
δ_{int}			-0.064			-0.032			-0.059
			(0.074)			(0.040)			(0.053)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.57	0.60	0.62	0.38	0.41	0.45	0.54	0.58	0.59

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The FTSE World Index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV). The Index source is Datastream.

portfolio are used, we find only weak evidence of an improved performance after the reform. We also do not find robust evidence that the funds that use derivatives increased their market exposure after the regulatory change.

2.5.5 The effect of derivative definition

Non-users of derivatives that changed status to using derivatives

In this section, we aim to take into consideration the effect of the change of status from non-users of derivatives to users and viceversa. In table 2.1 of section 2.3.2, we observe that 137 funds changed status from being non-users of derivatives before the regulatory change to users of derivatives after the regulatory change, and 75

Table 2.12: **Risk-Performance Analysis if the Alternative Market Portfolio is a European Market Index**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.010	0.008	0.010	-0.015	-0.007	-0.006	-0.052	-0.064	-0.065
	(0.007)	(0.011)	(0.014)	(0.005)***	(0.007)	(0.009)	(0.006)***	(0.009)***	(0.011)***
β	0.194	0.157	0.160	0.072	0.064	0.067	0.124	0.106	0.101
	(0.014)***	(0.034)***	(0.040)***	(0.009)***	(0.022)***	(0.026)**	(0.012)***	(0.028)***	(0.033)***
γ		-0.031	-0.035		-0.015	-0.012		0.025	0.022
		(0.015)**	(0.019)*		(0.010)	(0.012)		(0.012)**	(0.015)
γ_{int}		0.045	0.042		0.009	0.005		0.022	0.028
		(0.037)	(0.043)		(0.024)	(0.028)		(0.030)	(0.035)
δ			-0.016			-0.014			0.020
			(0.092)			(0.060)			(0.075)
δ_{int}			0.020			0.005			-0.011
			(0.094)			(0.061)			(0.077)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.78	0.80	0.80	0.55	0.56	0.57	0.68	0.71	0.72

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The FTSE Eurobloc Index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV). The Index source is Datastream.

that stopped using derivatives. That is, in this sub-section we slightly change the sample under study and take the most general view on derivative use. We define as a derivative user fund a fund that reported any derivative before or after the reform. The time span under study continues to be January 1995 to October 1999, and as before we exclude those funds that started to report positions after June 1996.

In this section, users of derivatives are represented by the 629 funds of table 2.7 consisting of the off-diagonal elements and the previous users of derivative funds, and non-user of derivative funds by the 176 funds of the same table.

As can be seen from table 2.13 the results remain qualitatively the same as before. Thus, even under the most general view of the derivative user definition, it seems

Table 2.13: **Risk-Performance Analysis in the most general definition of derivative use**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	-0.013	-0.004	-0.007	-0.017	-0.009	-0.009	-0.053	-0.074	-0.078
	(0.003)***	(0.005)	(0.006)	(0.004)***	(0.006)	(0.007)	(0.005)***	(0.007)***	(0.008)***
β	0.085	0.068	0.062	0.056	0.047	0.047	0.029	0.030	0.022
	(0.004)***	(0.008)***	(0.010)***	(0.005)***	(0.010)***	(0.012)***	(0.007)***	(0.012)**	(0.014)
γ		-0.014	-0.011		-0.012	-0.009		0.040	0.043
		(0.007)**	(0.008)		(0.008)	(0.009)		(0.009)***	(0.011)***
γ_{int}		0.022	0.028		0.011	0.011		0.000	0.009
		(0.010)**	(0.011)**		(0.012)	(0.013)		(0.013)	(0.015)
δ			0.011			-0.000			0.019
			(0.011)			(0.014)			(0.015)
δ_{int}			-0.011			-0.004			-0.017
			(0.012)			(0.014)			(0.016)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.88	0.90	0.90	0.70	0.71	0.72	0.26	0.48	0.50

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before **or** after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before **and** after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

that funds that use derivatives under-perform funds that do not use derivatives, that they improve their performance after the regulatory change, but this improvement is not sufficient to over-perform non-users of derivatives, and user of derivative funds typically experience a larger market exposure than non derivative users.

2.5.6 The effect of fees

In this section we return to the base case study, that is, with the original defined sample and with the most restrictive definition for derivative users. In other studies, like in Gil-Bazo and Martinez (2004), it is shown that management fees play an important role in the performance evaluation of funds, particularly this may be important for funds using derivatives (see Marin and Rangel (2006)). In order to explore the relevance of fees on the results related to the under-performance result, fees are added back to the return series. That is, management and deposit fees are added back to the per share net asset value return series resulting in a return series net of fees. If fees applied by funds using derivatives are consistently larger than those charged by funds not using derivatives, we would expect either a reduction in the under-performance result of derivative user funds versus non derivative user funds. It could even be possible that we find a better performance of derivative user funds compared to non derivative user funds.

The performed analysis follows the lines of the base case study. The results are qualitatively the same as in the base case. The main differences are in relation to the performance evaluation measures. We only find weak evidence of a positive performance for funds that use derivatives: the α in columns 2 and 3 in table 2.14 are positive and statistically significant to the 5% and 10%. That is, even after taking fees into account, we do not find strong evidence that mutual funds outperform the market. If any, we can only say that funds that use derivatives do slightly better than the market, and this only net of fees. We also find an improvement in performance after the regulatory change, but the improvement in performance does not compensate the under-performance compared to funds that do not use derivatives (see the γ coefficient estimates in columns 8 and 9).

Even after controlling for fees charged by mutual funds, the main results are confirmed. Mutual funds that use derivatives improve their performance after the reform. Nevertheless, this improvement in performance does not compensate the under-performance compared to funds that do not use derivatives.

Table 2.14: **Risk-Performance Analysis For Net of Fee Returns**

	Users of Derivatives			Non Users of Derivatives			Users minus Non Users		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing	capm	capm event	capm mkt timing
α	0.005	0.020	0.016	-0.000	0.007	0.007	-0.052	-0.068	-0.073
	(0.006)	(0.008)**	(0.009)*	(0.004)	(0.006)	(0.007)	(0.006)***	(0.009)***	(0.010)***
β	0.142	0.116	0.108	0.056	0.047	0.047	0.086	0.079	0.068
	(0.007)***	(0.014)***	(0.017)***	(0.005)***	(0.010)***	(0.012)***	(0.008)***	(0.015)***	(0.018)***
γ		-0.024	-0.020		-0.013	-0.010		0.032	0.036
		(0.011)**	(0.013)		(0.008)	(0.009)		(0.012)**	(0.014)**
γ_{int}		0.033	0.040		0.011	0.012		0.010	0.021
		(0.016)*	(0.019)**		(0.012)	(0.014)		(0.018)	(0.020)
δ			0.017			-0.000			0.024
			(0.019)			(0.014)			(0.020)
δ_{int}			-0.017			-0.004			-0.023
			(0.020)			(0.014)			(0.021)
Observations	56	56	56	56	56	56	56	56	56
R-squared	0.88	0.89	0.89	0.69	0.71	0.72	0.68	0.73	0.74

This table presents the regression results for the models $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \epsilon_{it}$ (columns 1, 4, and 7), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \epsilon_{it}$ (columns 2, 5, and 8), $r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i * d + \gamma_{int,i}(r_{mt} - r_{ft}) * d + \delta(r_{mt} - r_{ft})^2 + \delta_{int,i}(r_{mt} - r_{ft})^2 * d + \epsilon_{it}$ (columns 3, 6, and 9) where i is either an equally weighted portfolio of funds that use derivatives (columns 1-3), or an equally weighted portfolio of funds that do not use derivatives (columns 4-6), or a portfolio consisting of the difference of the two previous portfolios (columns 7-9). Regressions are based on monthly observations for the period January 1995-October 1999. Returns are annualized. In this case the management and deposit fees are added back to the fund return series yielding net-of-fee returns. The IGBM index proxies for the market portfolio. The dummy d is equal one for t between June 1997 and October 1999 and zero otherwise. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. A fund is considered a derivative user if it reported a derivative position before and after the regulatory change. A fund is considered a non derivative user if it did not report a derivative position before and after the regulatory change. The fund sample consists of all funds in the time period that had at least half a year of experience before the regulatory change of June 1997. Data provided by the Spanish Securities and Exchange Commission (CNMV).

2.6 Conclusions

In June 1997 the Spanish Security and Exchange Commission, CNVM, introduced a reform that regulates the use of derivatives by mutual funds registered in Spain. The new regulation allows funds to trade with a greater set of derivatives than before. The regulation's stated aim is to allow mutual funds to manage better their portfolios and thus to improve performance. This study analyzes the impact on risk and performance of this regulatory change. The main conclusion is: mutual funds that use derivatives tend to under-perform funds that do not use derivatives. These results are robust under a series of alternative specifications: controlling for the effect of young (and possibly inexperienced) funds, controlling for the event window length, controlling for different market index proxies, controlling for different definitions of derivative use, and controlling for the impact of fees on fund returns.

As a second conclusion, we find some evidence that mutual funds that use derivatives improve their performance after the reform. This result is not robust to all alternative specifications. In particular, the improvement in performance is only sensible until 1 year after the reform. Moreover, the improvement in performance is not robust to changes in the proxies for the market portfolio. Thus, it seems that the main objective of the change in regulation, that is, to improve performance, is not strongly supported by the data.

Finally, we find very weak evidence of an increased market risk exposure after the regulatory change.

Overall we find evidence of an impact of the regulatory change on mutual fund behavior. On the one hand, many funds changed their status of non-users of derivatives to users of derivatives. On the other we find some improvement in performance.

Chapter 3

Moral Hazard and Adverse Selection in Corporate Financial Risk Management

3.1 Introduction

Financial theory has experienced a boom in the recent decades, which has driven an important development in the financial markets. Not only have financial firms participated in the expansion of these markets; non-financial corporations have also played an important role in this growth. This participation of non-financial firms has been partly due to the use of financial derivatives.[1] Yet, it was not until about a bit more than a decade ago that researchers began to question themselves theoretically about the motives to use derivative financial instruments by non-financial firms. These investigations have yielded quite a large body of literature on corporate hedging, which has already generated various theoretical arguments as to why firms use derivatives. Therefore, we can already talk of an existing 'Corporate Financial Risk Management

[1] See report in "The global OTC derivatives turnover by counterparty" Table pp.12 in the BIS Basel report (2001). The percentage of participation of non-financial firms in the mentioned market is 12.76%, 13.81% and 7,55% for years 1995, 1998 and 2001, respectively.

Theory'. Explanations given for the use of derivatives are varied and cover from investment decisions, tax incentives, costs of financial distress, liquidity management, external financing costs to managerial risk aversion, and managerial reputation concerns.[2] Hence, whether small or big, financially distressed or healthy, leveraged or not, there is an argument for every firm to take advantage of the potential benefits of hedging. That is, every firm falls in one or more of the theoretical cases as to why a firm should hedge. Nevertheless, there are still many non-financial corporations which do not consider financial risk management as part of their management strategies. Given all the different theories stressing the benefits of hedging, this fact is surprising.

The evidence of the proportion of firms that do not hedge is shown in different studies for several years. Based on Fortune 500's list as of year 1991, Geczy, Minton and Schrand(1997) classify a 40% of the firms as non-users of derivatives.[3] In their study, the selected firms were those with the highest reported sales in the USA for fiscal year 1990 and with an exposure to foreign exchange risk. On the other hand, based on the US gold mining industry, Tufano (1996) reported a 14,6% of non-user firms of financial risk management. Note that in this database, the non-users' firm value is around 653 million USD, and the users' firm value is between 721 and 1,144 million USD. In the same paper, based on the Wharton/Chase 1995 Survey,[4] Tufano reports that a 30% of US non-financial firms did not use derivatives. In another study, DaDalt, Nam and Gay (2001) reported an average of 40% of non-user US firms of financial derivatives, based on the 1997 "Database of Users of Derivatives" for fiscal years ending in 1992 to 1996. These non-user firms had an average mean asset value of 2,000 million USD, and the user firms of 5,000 million USD. Finally, in a more

[2]See Smith and Stulz (1985) for tax incentives, costs of financial distress and managerial risk aversion; Froot, Scharfstein and Stein (1993) for external financing costs and investment decision; Graham and Smith (2001) for tax incentives; Mayers and Smith (1982) for costs of financial distress; Holmstm and Tirole (2000) and Mello and Parsons (2000) for liquidity management, among others.

[3]The non-users refer to those firms not having bought any interest rate, commodity or foreign exchange rate derivatives for the considered period.

[4]The cited reference is "Survey of Derivative usage Among US Non-Financial Firms"

recent study Guay and Kothari (2002), based on Compustat's 1000 largest market valued stocks of non-financial firms as of 1995, report a 43% of non-user firms. In this case the non-user firms had an average market value of 2,400 million USD and the user firms an average market value of 8,600 million USD.

As showed, there are many big firms that decide not to buy derivatives.[5] Hence, it is not the firm size what matters when deciding whether to engage in financial risk management or not. That is, it is not a matter of the costs of setting up and maintaining a financial risk management team what makes firms discard the possibility of engaging in hedging; there have to be other reasons. A possible rationale to understand this phenomenon is that there are other implicit costs, such as moral hazard, related to the risk management activity. The literature has been concentrated in arguing why a firm buys derivatives, but there has not been any explicit analysis that explains why firms in fact do not buy derivatives. This paper addresses this issue.

I construct a model where the main assumption is that the manager of a firm has superior information about the exposures of the firm, compared to the shareholder. That is, given the informational asymmetry between the manager and the shareholder, I set up a principal-agent model to analyze the incentives necessary for the agent to follow the shareholder's objective.

The model's intuition is best followed by an example. Imagine that there is a single shareholder who is interested in investing in the specific risk represented by the firm, say a technology firm. Suppose that the technology firm sells a certain amount of its products to a foreign country. Therefore, its income depends on its productive activities as well as on external factors, such as the foreign exchange risk. If the shareholder is not interested in being exposed to this external risk, she will want the firm to hedge that risk with existing instruments in the financial markets. However, the shareholder does not manage the firm. Instead, she pays a manager, who has the ability to learn about the total exposure of the firm to the external risk. To get to

[5]Notice that the firm size is measured in terms of sales, firm value or asset value.

know the total exposure the manger will observe, at a cost, a signal on it. However, she is not going to reveal this information and the shareholder must give her the incentives to do what she desires. Thus, there is an asymmetry in the information between the manager and the shareholder related to the total exposure of the firm to the marketable risk. The friction that originates the moral hazard problem is the cost associated to the observation of the signal.

The problem described above involves two informational frictions, which are the following:

The adverse selection problem: Since the manager has superior information about the risks related to the production outcome, her decisions adversely affect the interests of the shareholder. That is, given that the manager faces some opportunities not seen by the shareholder, the shareholder does not know if the manager takes the best choice.

The moral hazard problem: Given that the principal gives the agent the power to hedge on her account based on the agent's superior information, there are in principle no guarantees that the manager will behave as expected. Therefore, some incentives are necessary.

3.2 Related Literature

One of the theories about why a firm should hedge is given by DeMarzo and Duffie (1991) . They present a model with asymmetric information between the firm manager and its shareholders. In this paper, they show that the shareholders will, under certain circumstances, unanimously agree on a full hedging strategy. Shareholders will also unanimously agree on a deviation of this (i.e. partial hedging) only if the deviation is (publicly) announced to the shareholders. One of the main assumptions they pose is that the financial strategy is exogenously given. Hence, they assume that the manager's interests are aligned with those of the shareholders. The present paper is inspired in theirs; however in this paper the financing decision is endogenous and moral hazard is introduced. Other differences are that I assume one instead of multiple shareholders, and I also assume that a disclosure from a deviation of the full hedging strategy is not going to happen.[6] Both stories coincide in that risk averse shareholders are assumed and that the manager has superior information on the firm's financial risks.

Other papers introducing asymmetric information to justify corporate hedging have been written by Breeden and Viswanathan (1998) and DeMarzo and Duffie (1995) . Both papers follow a similar argument, namely that the manager's reputation concerns will drive them to hedge. DeMarzo and Duffie (1995) explore the information effect of hedging under different disclosure policies. They assume that managers and shareholders are equally informed about managerial ability, but managers are better informed about the source and size of the risks the firm faces. Breeden and Viswanathan (1998) explore managerial responses to asymmetric information. In contrast to DeMarzo and Duffie (1995), their assumptions are that managers are better informed about their abilities and about the source and size of the risks faced by the firm. The principal assumption of both papers is that managers are mainly concerned about their managerial reputation. The present paper differs in that neither the ability of the manager nor her reputation play a role in the decision process. However, it coincides with both models in the type of asymmetry of information assumed related to the firm's marketable exposure. In their models there is no need for the shareholders to control for moral hazard problems, since these problems do not arise. In DeMarzo and Duffie(1995), the only conflict between shareholders and managers arises when deciding the disclosure policy. But, since the disclosure policy is decided by the shareholder, no real conflict exists. In Breeden and Viswanathan(1998), there is no modelling of any type of conflict between the interests of shareholders and managers. Managers will care on firm value to the extent of owning an amount of shares

[6] I am assuming a hermetic manager.

of the firm.[7]

The present problem is related to delegated portfolio management, since the shareholder is hiring a manager for her superior ability to observe the total exposure of the firm and hedge it. My developed model is, therefore, closely related to the models of portfolio management presented by Bhattacharya and Pfleiderer (1985) and Stoughton (1993) , but it differs in an important aspect. I let the signal the manager observes to be on the total exposure and not on the risk factor. This implies that the manager has a different type of ability. Additionally, the decision of the manager in my model is on the amount of hedging instruments to buy, whereas in their models the decision is on the fraction of the risky asset to be invested.

3.3 The Model

In order to introduce moral hazard, I consider a one period principal-agent model. I assume that the agent has superior information about the production process of the firm, that this information is not available to the principal, and that it is infinitely costly to transmit this information to the principal. Both the agent-manager and the principal-shareholder are assumed to be risk averse. Their preferences are represented by a negative exponential utility function with a constant absolute risk aversion of a and b, respectively. The manager receives a fixed wage ϕ and a bonus $\psi(Y)$, which is a function of the firm's income, Y. This bonus could be either a stock option or a certain fraction of the income of the firm. For the moment, I assume only linear bonuses, therefore $\psi(Y) = \alpha Y$, where α stands for the proportion of shares of the firm owned by the manager. Hence, the manager's wealth will be given by

$$w_a = \phi + \alpha Y,$$

[7] Breeden and Viswanathan (1998) take into account in their model the implicit cost of hedging related to the loss in value of the option value of shares.

whereas the principal's wealth, represented by the residual income of the firm, is

$$w_p = (1-\alpha)Y - \phi.$$

The firm: The firm's dividend Y is equal to the operating income of the production Y_o plus a financial strategy F.[8] For example, if a firm "ABC" decides not to employ any financial strategy, but rather to concentrate its efforts on the production and selling of its products, then ABC's income will only be equal to the operating income $Y = Y_o$. I will assume that the firm's operating income Y_o can be decomposed as

$$Y_o = G + qZ,$$

where G is the firm-specific risk and Z is a marketable risk.[9] Continuing with the example, if firm ABC is, say, a technology firm, we may think of G as the risk represented by the firm's technology measured in monetary terms. ABC has to sell its products after the production. If we imagine that these products are sold in a foreign country, then Z stands for the foreign exchange rate.[10] If ABC sells q units of product at the foreign unitary price to the foreign country client, then q denotes the total exposure of the firm to the foreign exchange risk. I assume G, q and Z are independent and jointly normally distributed random variables. That is,

$$\begin{pmatrix} G \\ q \\ Z \end{pmatrix} \sim N\left(\begin{pmatrix} \overline{g} \\ \overline{q} \\ \overline{z} \end{pmatrix}, \begin{pmatrix} V_g & 0 & 0 \\ 0 & V_q & 0 \\ 0 & 0 & V_z \end{pmatrix} \right),$$

where $\overline{g}$, $\overline{q}$ and $\overline{z}$, V_g, V_q, V_z are known by everybody.

[8] The terms financial strategy, financing decision and hedging will be used interchangeably, since I am abstracting from any other type of financial decision.

[9] I refer to marketable risk as the one for which there exists a financial instrument in the market. On the other hand, a firm-specific risk is the one related exclusively to the firm.

[10] Note that Z is observed by everybody.

The financial strategy If we assume that the firm employs a financial strategy, then it must be fully funded by a bond b. The size of the bond is determined by the purchase of φ financial contracts on the risk Z at price p. For instance, the firm ABC may buy φ futures contracts on the exchange rate Z with a future price of p. In order to do this, ABC will need the funds b to support the strategy. I will assume the interest rate to be equal to zero. The first period constraint for the hedging strategy is therefore

$$\varphi p + b = 0.$$

In the second period, the payout of the financial strategy is $F = \varphi Z + b$. ABC's futures contracts on the exchange rate are mature, and payoffs on the futures contract and of the bond are realized. These two equations imply a single financing constraint

$$F = \varphi(Z - p).$$

Therefore, the dividend stream of the firm that also manages a financial department is $Y = Y_o + F$, that is,

$$Y = G + qZ + \varphi(Z - p).$$

The decision variable φ is the one that determines the final financing strategy. If the financing strategy is to fully hedge the marketable risk, then $\varphi = -q$, whereas if the strategy is not to hedge at all, then $\varphi = 0$. This means that partial hedging is represented by $\varphi \epsilon (-q, 0)$, and any other φ represents an increase in the marketable risk.[11] In what follows, I assume that the firm has a financial department and the manager is free to decide the financing strategy.

To model the conflict of interests between the manager and the shareholder, I introduce a cost function related to the agent's effort. That is, the agent has to exert effort to get to know the exposure level of the firm at a cost. Given this situation there are no guarantees that the manager will act in the interest of the shareholder.

[11] The latter can be thought of as speculation.

The cost of effort: In order to obtain the superior information the manager has to exert some effort $e \geq 0$ at a cost $c(e)$, which is assumed to be measurable in monetary terms.[12] This function will be assumed in the usual terms: $c'(e) > 0$, $c''(e) \geq 0$, $c(0) = 0$ and $c'(0) = 0$. In particular, we may think of it as $c(e) = \frac{1}{\kappa}e^2$, where $\kappa > 0$ will be a free parameter.[13] The utility functions of the agent and the principal are then

$$U_a(w_a) = -e^{-a(w_a - c(e))}$$

$$U_p(w_p) = -e^{-bw_p},$$

respectively. If the manager exerts effort she will observe a signal S on the realization of the total exposure q of the firm to the marketable risk Z.

The signal: The manager has the ability to receive a signal S on the total exposure q, and for this ability the shareholder will hire him. Thus, I assume the signal to be

$$S = q + \varepsilon,$$

where the random variables q and ε are jointly normally distributed and uncorrelated with each other. Let $E[\varepsilon] = 0$, $Var[\varepsilon] = V_\varepsilon$, $E[q] = \overline{q}$ and $Var[q] = V_q$. I will additionally assume that the signal S and the variance V_ε are private information to the manager. That is, once the manager knows the signal on q she is not going to disclose her information to the shareholder. We may think of this situation as if it is too costly to disseminate the acquired information, or as if the manager is eager not to share it.

Lets state the expectation of the risk q conditional on S,

$$E[q|S] = K * S + (1 - K) * \overline{q} \equiv M$$

[12] The cost may be visualized as a disutility form exerting effort.
[13] Observe that κ equal to infinity, is equivalent as having no cost function.

with $K = \frac{V_q}{V_q + V_\varepsilon}$ which is interpreted as the weight or importance given to the signal S.[14] The conditional variance is

$$V[q|S] = \frac{V_q V_\varepsilon}{V_q + V_\varepsilon} \equiv H^{-1}.$$

Where, H is the precision of the signal S, and M the conditional expectation given S.[15] That is, the higher the precision, the better the signal and the more weight is given to the signal.

The effort: The effort level is related to the precision of the signal as follows $V_\varepsilon = \frac{V_q}{e}$. That is, there is a direct relationship between effort and precision of the signal. The manager has to exert great effort e to get a more precise signal, which means having a "small" error variance V_ε. The intuition behind this, is that ABC's manager will have to sit down, at her work, and exert effort to get to know the marketable risks to which the firm is exposed. She will also need to know all the production and selling process, so as to asses the possible total exposure to the marketable risks of the firm. That is, ABC's manager has to get to know the business before being able to hedge. The relation between the effort level and the error variance of the signal means that the precision H depends linearly on e, namely

$$H(e) = \frac{1+e}{V_q}$$

and also K depends on the effort level,

$$K(e) = \frac{e}{1+e}.$$

[14] Observe that, as V_ε converges to zero, K converges to one, therefore assigning a greater value to the signal S. That is, the better the signal the more the manager takes it into account.

[15] These two results are based on the statistical result, that if X and Y are jointly normally distributed then $E[X|Y] = E[X] + \frac{Cov[X,Y]}{Var[Y]}(Y - E[Y])$ and $Var[X|Y] = Var[X] - \frac{(Cov[X,Y])^2}{Var[Y]}$.

Substituting $K(e)$ in the conditional mean results in

$$M = \overline{q} + K(e)(S - \overline{q}).$$

It is worth noting that as $e \to \infty$ then $V_\varepsilon \to 0$ and $K \to 1$. The greater the effort, the better the precision and the more the manager gives a weight to the signal S she observes.

The decision time line:

————|————————|————————|————————|————

Contract Signing *Effort decision* *Signal observed* *Policy decision*

The effort decision is taken by the agent before receiving any signal, but after signing the contract with the shareholder, who will pre-commit on the fixed wage and the promised bonus schedule. Then, the manager observes a signal on the exposure of the firm, to decide with this information the firm's hedging policy.

Hence, I have a principal-agent problem, in which the principal has to care about giving the agent the proper incentives to be aligned with her objective. The principal has not the superior information that the manager has, and therefore the principal is hiring the manager. Moreover, it is costly for the manager to get to know the superior information. Hence, the adverse selection and the moral hazard problems arise, and the principal's problem to solve is the following:

$$\begin{aligned} \max_{\alpha,\phi} \quad & E[U_p(w_p)] \\ s.t. \quad & w_a = \phi + \alpha Y && (3.1) \\ & w_p = (1-\alpha)Y - \phi && (3.2) \\ & Y = G + qZ + \varphi(Z-p) && (3.3) \\ & E[U(w_a)] \geq -1 && (3.4) \\ & e \ \epsilon \ \text{argmax} E[U_a(w_a)] && (3.5) \\ & \varphi \ \epsilon \ \text{argmax} E[U_a(w_a)|S] && (3.6) \end{aligned}$$

Equation 3.4 refers to the reservation utility that the principal has to guarantee to the agent, otherwise the agent is not going to work for the principal. I assume that this level is the inactivity level, that is, $w_a = 0$. The problem is to be solved backwards in the decision time line. Starting from equation 3.6, when the agent has already seen the signal, she decides the optimal hedging strategy. Then, taking the calculated hedging strategy, going one step back, the agent optimizes her effort level, represented by equation 3.5. The manager takes the decision unconditionally, since at this stage she has not seen the signal. In both stages, the agent takes the fixed wage as given, as well as the bonus share. Given the optimal hedging strategy and the optimal effort level, the principal sets the fixed wage so that equation 3.4 is binding. Doing so is optimal for her. Finally, the principal optimizes her expected utility in terms of the optimal share assigned to the manager. In this way an optimal contract can be signed between the manager and the principal.

3.4 Solution of the model

3.4.1 First Best Solution

The (super) first best solution: the principal's financing decision: Following with the example of firm ABC. Assume there is a shareholder interested in investing in the technology firm ABC, since she appreciates that risk. What will the shareholder do if a financing strategy is available to the firm and she runs the firm? Let's assume that the principal knows the realization of q and therefore does not hire a manager. Since q is known to the principal, Y is normally distributed and $w_p = Y$. Thus, the shareholder wants to maximize her expected utility $E\left[U_p(w_p)\right] = E\left[-e^{-bY}\right]$, which is equivalent to the problem

$$\max_{\varphi} E[Y] - \frac{1}{2} bVar(Y).$$

Here $Y = G + qZ + \varphi(Z - p)$.[16] The result of this problem is given by the optimal financial policy

$$\varphi^*_{FB} = \frac{E[Z] - p}{bV_Z} - q.$$

Since we have that $E[Y] = E[G] + qE[Z] + \varphi(E[Z] - p)$ and $Var[Y] = Var[G] + (q + \varphi)^2 Var[Z]$, then the first order necessary condition with respect to φ yields the result. If I assume that there are risk neutral investors in the market for the financial contract on Z, this would imply that $E[Z] = p$, and then the optimal financing strategy for the principal-shareholder is to set

$$\varphi^*_{FB} = -q.$$

Hence, the shareholder is interested in fully hedging the marketable risk. DeMarzo and Duffie(1991) arrive at a similar result, as mentioned before. In their model,

[16] See the result 3.6.1 in the appendix.

a partial hedging strategy may also be supported under the assumption that the deviating strategy is publicly announced. The intuition for their result is that, by revealing the deviating strategy, the shareholders will be in a better position to take an optimal decision, which depends on personal preferences on all the risks available in the market. In contrast to DeMarzo and Duffie's (1991) model, the present paper does not model that optimal decision of the shareholder, but it models the internal decision process of the firm, once having decided that hedging is optimal.

Since the shareholder is not going to run the firm, she hires a manager and gives her the power to take financial decisions on the shareholder's account. The difference between the manager and the shareholder is that the manager has superior information related to the total exposure q, whereas the shareholder does not know that exposure.

3.4.2 General Solution

The financial policy decision

The principal's problem is solved backwards in the decision line. Hence, the first step is to solve for the manager's problem described by (3.6), that is

$$\begin{aligned} \max_{\varphi} \quad & -E\left[e^{-a(\phi+\alpha Y-c(e))}|S\right] \\ s.t. \quad & Y = G + (q+\varphi)Z - \varphi p \end{aligned}$$

Assumption 1 $a^2\alpha^2 V_q V_z < 1$

Notice, that assumption 1, economically, means that the risk aversion coefficient of the manager cannot be too big. In other words, there is a maximum risk tolerance for the manager about the inherent risks, V_q and V_z, related to the company. If these risks are to high, the manager will not be willing to work at that firm.

From here on, I suppose assumption 1 holds.

Proposition 1 *The manager's optimal policy, given that she observes the signal S, is given by*

$$\varphi^* = -M.$$

See proof in the appendix.

Notice that M, the conditional expectation, is a random variable that depends on the signal S and the effort level e. In particular, as e converges infinity, M converges to q, which is the shareholder's first best (optimal decision).

The first part of the problem is solved, namely the manager hedges the marketable risk depending on how good her signal is on the exposure of the firm. The manager is aligned with the shareholder's interest to the extent that she gets the right compensation to make a great effort. If I assume for a moment that the manager does not face a cost on effort, or equivalently that κ is equal to infinity, then she does exactly what the principal expects from her. That is, she completely hedges the marketable risk, since this does not represent a cost to her.

The effort level decision

Now I will solve the problem of the effort level for the manager, represented by equation (3.5). At this stage the manager will take the financial policy $\varphi = -M$ as given. Remember that $M = (1-K)\overline{q} + KS = (1-K)\overline{q} + K(q+\varepsilon)$, and that $K = \frac{e}{1+e}$. Therefore,

$$\varphi = -\tfrac{\overline{q}+eq+e\varepsilon}{1+e}. \tag{3.7}$$

The problem of the agent is

$$\begin{aligned} \max\nolimits_e \quad & E[U_a(w_a)] = E[-e^{-a(w_a-c(e))}] \\ s.t \quad & w_a = \phi + \alpha(G + (q+\varphi)Z - \varphi p) \\ & \varphi = -\frac{\overline{q}+eq+e\varepsilon}{1+e} \end{aligned}$$

The solution of the problem is stated in the following theorem.

Proposition 2 *An optimal effort level e^* exists and is unique. The optimal effort decision of the manager is characterized by the equation*

$$c'(e^*) = \frac{1}{2}\frac{r}{aV_z}\frac{p^2}{(1+e^*-r)^2} - \frac{1}{2}\frac{r}{aV_z}\frac{p^2}{(1+e^*)^2} + \frac{1}{2}\frac{r}{a(1+e^*)(1+e^*-r)}. \tag{3.8}$$

See proof in the appendix.

Once having characterized the optimal effort level, it is useful to state some comparative statics.

Proposition 3 *The optimal effort level is increasing in*

- *the manager's firm stake α,*
- *the variance of the external risk V_z,*
- *the variance of the total exposure V_q,*
- *the risk aversion coefficient of the manager a,*
- *the price of the hedge instrument p, and*
- *the parameter κ of the cost function.*

See proof in the appendix.

The intuition for the comparative statics is as follows; the increase in the risks of the firm, V_q and V_z, have the effect to increase the effort level of the manager, since the manager is risk averse. Therefore, for a more risky firm, the manager will exert greater effort to reduce the variability of her income (See figures 3.1 and 3.2, for an intuition of how the optimal effort changes with the external risk and the total exposure).[17]

[17] All the presented graphics are based on the following parameter values: $\kappa = 9$; $a = 2$; $\alpha = .1$; $Vq = .2$; $Vz = .9$ and $p = 1$.

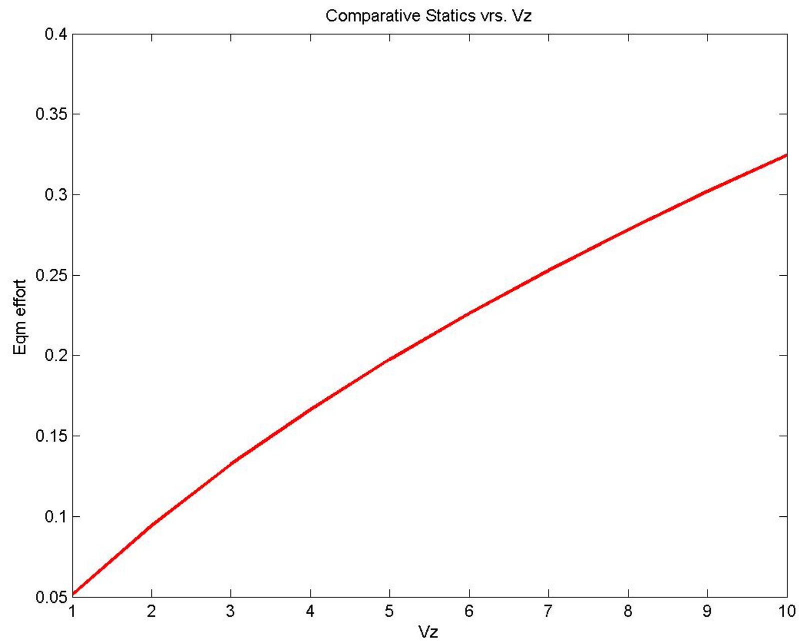

Figure 3.1: **Firm's External Risk.**

For the other parameters, if the manager is more risk averse, naturally, she is going to exert greater effort to reduce the variability of her income (See figure 3.3).

If the cost associated to the effort is lower, κ bigger, the manager will be more willing to exert more effort, at increasing rates (See figure 3.4).

If the hedge instrument's price is higher, the manager will exert greater effort, since the hedge is affecting her utility through the hedging's cost represented by p (See figure 3.5).

Lastly, if the manager gets a higher bonus through α, she has more incentives to exert greater effort (See figure 3.6).

It is interesting to notice the difference in the concavity of the numerical examples presented in the graphs. These graphs seem to indicate a convexity of the optimal effort to the manager's risk aversion, the manager's stake, and the financial instrument's price. That is, for low levels of these parameter, the optimal effort is not very sensitive to changes; but for higher levels of these parameters, the optimal effort

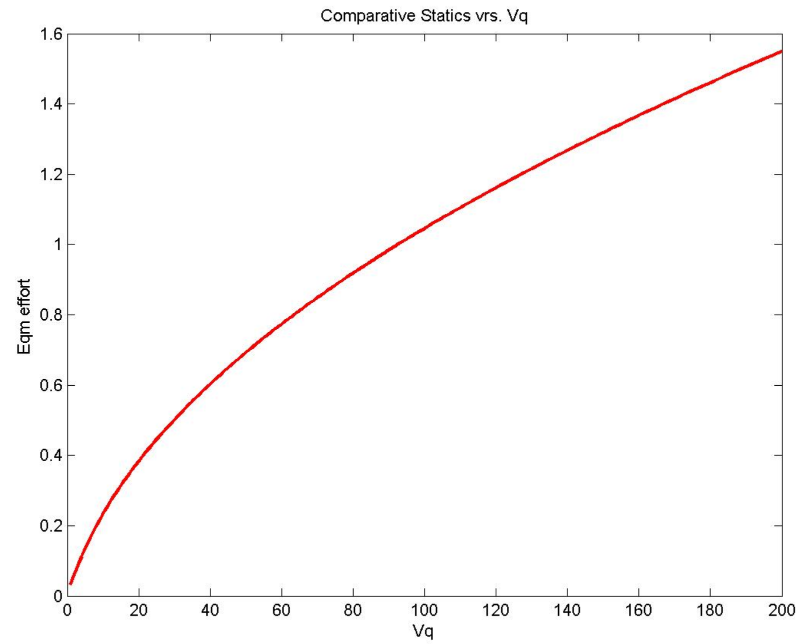

Figure 3.2: **Firm's External Exposure.**

level seems more sensitive. On the other hand the graphs suggest a concavity for the external risk, the total exposure and the cost of effort parameter κ. That is, for higher levels of riskiness of the firm, or low levels of the cost of effort, the optimal effort level will be less sensitive to changes in the parameter values.

Observe that the main difference between α and the other parameters, is that α can only take values up to one. That is, the optimal effort level e^*, will increase up to a maximal level $\overline{e^*} < \infty$.

This last observation is of great importance, since it means that a linear incentive schedule will not suffice so that the manager exerts the effort the shareholder desires. That is, if the maximal effort level is below the shareholder's desired effort level, linear incentive contracts are not good for the desired objective of the shareholder.

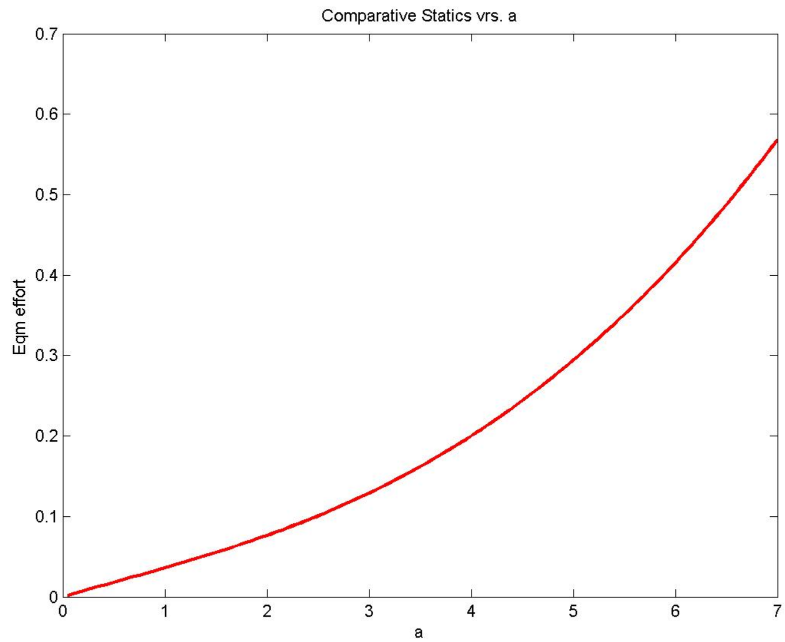

Figure 3.3: **Manager's Risk Aversion.**

The binding condition

Since the principal is an optimizing agent, she sets the inequality represented in 3.4 such that it binds using the fixed wage. Setting any other fixed wage is not optimal for the agent. She could reduce the fixed wage, still keeping the manager to work with her, and therefore achieving a higher utility. Consequently, the principal sets the fixed wage ϕ so that

$$E[U_a(w_a)] = -1,$$

given the optimal decision strategies e^* and φ^* of the manager calculated in the previous steps.

Proposition 4 *The fixed wage is given by*

$$\phi = \frac{1}{a} ln(F^*),$$

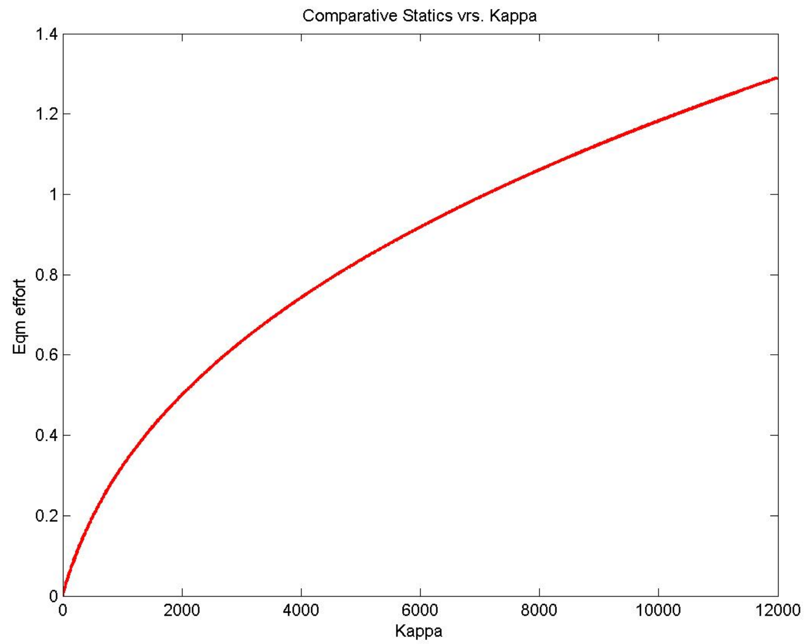

Figure 3.4: **Cost of Effort.**

where

$$F^* = [\frac{1+e^*}{1+e^*-t^2V_zV_q}]^{\frac{1}{2}} e^{a(e^*)-a\alpha\bar{g}+\frac{1}{2}a^2\alpha^2V_g+pt\bar{q}+\frac{1}{2}\frac{p^2t^2V_qe^*}{1+e^*}+\frac{1}{2}\frac{p^2t^2V_q}{1+e^*-t^2V_zV_q}}.$$

The Principal's Problem

The Principal's problem is stated as follows:

$$\begin{aligned} \max_\alpha \quad & E[U_p(w_p)] \\ s.t. \quad & w_p = (1-\alpha)Y - \phi \\ & \phi = \frac{1}{a} ln(F^*) \\ & Y = G + qZ + \varphi^*(Z-p) \end{aligned}$$

That is, the principal's problem reduces to find the optimal α that maximizes her expected utility. For doing so, the principal has to take into account that the optimal

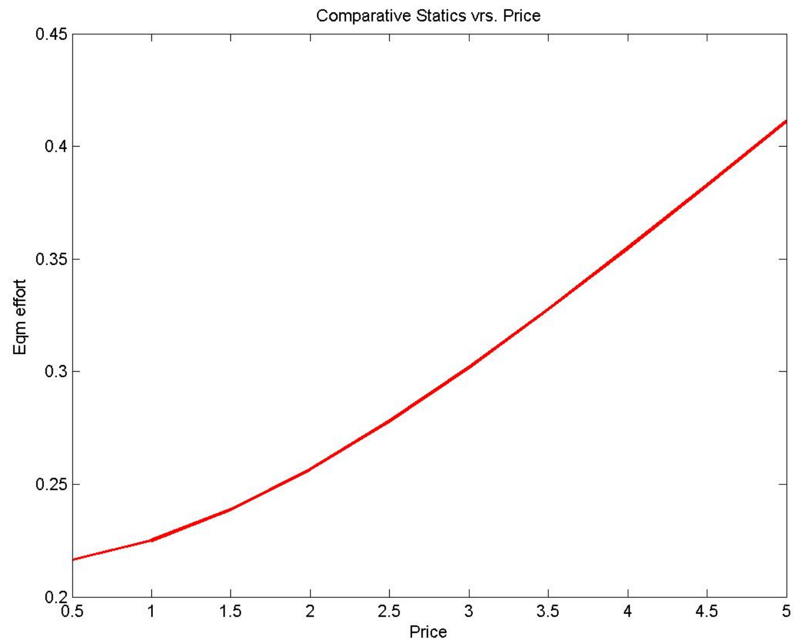

Figure 3.5: **Financial Instrument's Price.**

effort level e^* is affected by her decision on α, and correspondingly φ^* changes as well.

For the moment I do not solve this problem, since the analysis if the objective of the shareholder can be achieved can be previously made. That is, at the stage of the optimal effort-level decision and the comparative statics that result form it, one can determine if the first best objectives may be achieved.

3.4.3 Second best solution of the model

Since the first best solution is not fair in the sense that the shareholder may observe the signal on the total exposure of the firm without any cost, in this part I develop another situation. For this case I assume that for the shareholder to observe the signal, she will have to exert effort at the same cost as the manager. Since she will have no need of any manager, we are in a situation of an owner-manager firm. So that the utility function for the owner-manager will be $U_p(w_p) = -e^{-b(w_p - \frac{e^2}{\kappa})}$, where $w_p = Y = G + qZ + \varphi(Z - p)$. So that the question that naturally arises is How much

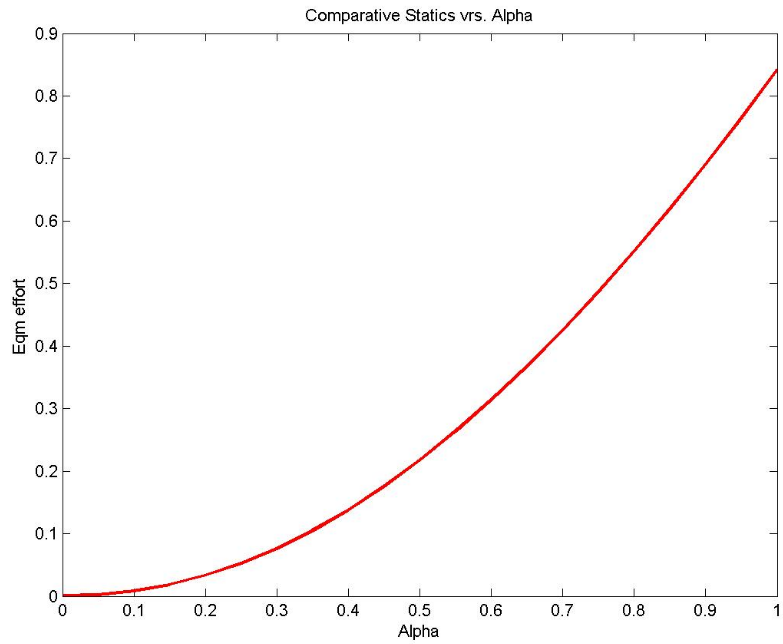

Figure 3.6: **Manager's Stake.**

effort will the shareholder exert to hedge the financial risks inherent to the firm?. The decision time line will be as before. First, effort has to be exerted to observe a signal on the total exposure of the firm to the financial risk, and finally a financial policy is chosen.

The financial policy decision

The model is solved backwards in the time line. That is, the shareholder will solve

$$\varphi \ \epsilon \ \text{argmax} E[U_p(w_p)|S]$$
$$\Leftrightarrow \max_{\varphi} E[-e^{G+qZ+\varphi(Z-p)-\frac{e^2}{\kappa}}]$$

Proposition 5 *The optimal financial strategy for an owner-manager, who wishes to* *hedge the marketable risk is*

$$\varphi^*_{SB} = -M. \tag{3.9}$$

See proof in the appendix.

Conclusion for the second best solution, first step:

Since $\varphi^*_{SB} = -M$ the owner-manager will only hedge a weighted average between the signal and the mean exposure of the firm, as the contracted manager does in the general solution.

The effort level decision:

Knowing that the owner-manager will take $-M$ as the financial policy to hedge the financial risk of the firm, how much effort will she exert?

The problem to solve now is

$$\max_e E[u_p(w_p)]$$

Proposition 6 *The objective function of the owner-manager when deciding the optimal effort level is*

$$O = -e^{b\frac{e^2}{\kappa} - b\bar{q}p} e^{-\bar{G} + \frac{b^2}{2}V_G} \left(\frac{1+e}{1+e-b^2V_qV_Z}\right)^{\frac{1}{2}} e^{b^2p^2V_q\left[\frac{1}{1+e-b^2V_qV_Z} + \frac{e}{1+e}\right]}$$

See proof in the appendix.

This objective function is now comparable to the one obtained in the first best and the general solutions.

3.5 Conclusions

A principal-agent model with asymmetric information and moral hazard is developed to give a possible reason why firms do not hedge. The model shows that with linear contracts the first best of the principal, namely, that the manager exerts infinite effort, cannot be achieved. That is, with a linear incentive schedule the moral hazard problem outweighs any possible incentive. This model predicts that there would be no hedging at all in corporations. But, since there are actually other types of incentives for the managers, rather than only linear ones, there is some scope to explain the differences observed in data.

3.6 Appendix of Chapter 3

Proof. of Proposition1 The Problem is

$$\max_{\varphi} -E\left[e^{-a(\phi+\alpha[G+qZ+\varphi(Z-p)]-c(e))}|S\right].$$

Observe that the objective function is equal to

$$\begin{aligned}
&-E\left[e^{-a(\phi+\alpha G)}e^{-a(qZ\alpha+\alpha\varphi(Z-p))}e^{ac(e)}|S\right] \\
&= -E\left[e^{-a(\phi+\alpha G)}|S\right]e^{ac(e)}E\left[e^{-a(qZ\alpha+\alpha\varphi(Z-p))}|S\right] \\
&= -E\left[e^{-a(\phi+\alpha G)}\right]e^{ac(e)}e^{a\alpha\varphi p}E\left[e^{-a\alpha Z(q+\varphi)}|S\right]
\end{aligned}$$

I have used the fact that G is independent of the other random variables q, Z and S. I have also used the fact that φ, α, ϕ and a are non stochastic. Now, observe that $E\left[e^{-a(\phi+\alpha G)}\right]e^{ac(e)}$ is a positive constant and does not depend on the decision variable φ, therefore I rewrite the original problem as

$$\max_{\varphi} -e^{a\alpha\varphi p}E\left[e^{-a\alpha Z(q+\varphi)}|S\right].$$

If I assume that $a^2\alpha^2 V_{q|S} V_z < 1$ holds, then I can use result 3.6.4 in the appendix for the second factor of the objective function, where I set $t_3 = -a\alpha$, $X = (q + \varphi)$, $M = E[q|S]$ and $V_{x|S} = V_{q|S} = H^{-1}$. I get that the problem is equivalent to solving

$$\max_{\varphi} -e^{a\alpha\varphi p} \left(\frac{\frac{H}{V_z}}{\frac{H}{V_z} - a^2\alpha^2} \right)^{\frac{1}{2}} e^{\frac{-a\alpha}{2}\left[-aV_z\alpha(M+\varphi)^2 + 2\overline{z}(M+\varphi) - H^{-1}\overline{z}^2 a\alpha\right]}.$$

Observe that $\left(\frac{\frac{H}{V_z}}{\frac{H}{V_z} - a^2\alpha^2} \right)^{\frac{1}{2}}$ is a constant and does not depend on the decision variable φ as well as $e^{\frac{-a\alpha}{2}\left[2M\overline{z} - H^{-1}\overline{z}^2 a\alpha\right]}$. The maximization problem is equivalent to

$$\max_{\varphi} -e^{a\alpha\varphi p} e^{\frac{-a\alpha}{2}\left[-aV_z\alpha(M+\varphi)^2 + 2\overline{z}(M+\varphi)\right]},$$

which is equivalent to

$$\max_{\varphi} -a^2\alpha^2 \frac{1}{2}(M + \varphi)^2 + 2a\alpha(\overline{z} - p)\varphi$$

The first order condition is

$$-a^2\alpha^2 V_z(M + \varphi^*) = a\alpha(p - \overline{z})$$

which is equivalent to

$$\varphi^* = -M.$$

Remember that $\overline{z} = E[Z] = p$, because I assumed a risk neutral market on the financial derivative. ■

Proof. of Proposition2

I prove the theorem in two steps, first I show that the optimal effort is characterized by equation (3.8) given in the proposition, then I prove the existence and uniqueness of the optimum.

step1: (The optimality condition) Let $t = -a\alpha$, then the problem is equivalent to

$$\max_e \quad -e^{-a(\phi - c(e))}E[e^{-a\alpha G}]E[e^{t(q+\varphi)Z - t\varphi p}].$$

First I calculate the last expectation of this expression. Substituting the value for φ given in (3.7), taking into account that the only random variables are q, ε and Z, I get the following result

$$E[e^{t(q+\varphi)Z - t\varphi p}] = e^{\frac{p\overline{q}t}{1+e}}E[e^{\frac{t}{1+e}(Zq - \overline{q}Z - eZ\varepsilon + peq + pe\varepsilon)}].$$

Lets set $R = \frac{t}{1+e}$. I will concentrate now in calculating the value for the previous expectation term of the last equation. First I will integrate with respect to ε, therefore

$$\int\int_{\Re^2} \frac{1}{2\pi\sigma_q\sigma_z} e^{RZq - R\overline{q}Z + Rpeq} e^{-\frac{1}{2}\left[\frac{(q-\overline{q})^2}{V_q} + \frac{(z-\overline{z})^2}{V_z}\right]} \int_{\Re} \frac{1}{\sqrt{2\pi}\sigma_\varepsilon} e^{-Re(z-p)\varepsilon} e^{-\frac{1}{2}\left[\frac{(\varepsilon)^2}{V_\varepsilon}\right]} d\varepsilon \; dqdz.$$

If I use result 3.6.1 in the appendix for the last integral, with $\overline{x} = 0$ and $t_1 = -Re(z-p)$, I obtain that it is equal to $e^{\frac{1}{2}R^2e^2(z-p)^2}V_\varepsilon$ and if I use the fact that $V_\varepsilon = \frac{V_q}{e}$ then, the mentioned integral is equal to $e^{\frac{1}{2}R^2eV_q(z-p)^2}$. Substituting this expression for the integral in the multiple integral expression, and rearranging the terms so as to integrate now with respect to q I get

$$\int_{\Re} \frac{1}{\sqrt{2\pi}\sigma_z} e^{-R\overline{q}Z + \frac{1}{2}R^2eV_q(z-p)^2} e^{-\frac{1}{2}\left[\frac{(z-\overline{z})^2}{V_z}\right]} \int_{\Re} \frac{1}{\sqrt{2\pi}\sigma_q} e^{R(z+pe)q} e^{-\frac{1}{2}\left[\frac{(q-\overline{q})^2}{V_q}\right]} dqdz.$$

Again, using the result 3.6.1, now with $t_1 = R(z+pe)$ and $\overline{x} = \overline{q}$, the last integral is equal to $e^{R(z+pe)\overline{q} + \frac{1}{2}R^2(z+pe)^2V_q}$. Substituting this last expression instead of the last integral, I get a single integral in z. I will concentrate now only on the exponent terms, without those terms corresponding to the density.

$$
\begin{aligned}
& -R\overline{q}z + \frac{1}{2}R^2 eV_q(z^2 - 2zp + p^2) + Rz\overline{q} + Rpe\overline{q} + \frac{1}{2}R^2(z^2 + 2zpe + p^2e^2)V_q \\
= & -R\overline{q}z + \frac{1}{2}R^2eV_qz^2 - R^2eV_q\ zp + \frac{1}{2}R^2eV_qp^2 + Rz\overline{q} \\
& +Rpe\overline{q} + \frac{1}{2}R^2z^2V_q + R^2zpeV_q + \frac{1}{2}R^2p^2e^2V_q \\
= & \frac{1}{2}R^2[1+e]V_qz^2 + [0]z + \frac{1}{2}R^2V_qep^2(1+e) + Rpe\overline{q}.
\end{aligned}
$$

That is, the term for z vanishes. Observe that the factor related to z^2, namely $\frac{1}{2}R^2[1+e]V_q$, may be simplified as follows $\frac{t^2}{2(1+e)}V_q$, since $R = \frac{t}{1+e}$. I can use now the result 3.6.2 of the appendix, with $t = \frac{a^2\alpha^2}{2(1+e)}V_q$, to obtain

$$
\begin{aligned}
E[e^{\frac{t^2}{2(1+e)}V_qZ^2}] &= [C(t)]^{\frac{1}{2}} e^{\frac{1}{2}\frac{t^2V_q}{1+e-a^2\alpha^2V_zV_q}\overline{z}^2} \\
C &= \frac{1+e}{1+e-a^2\alpha^2V_zV_q}
\end{aligned}
$$

The previous expression is true if the condition $1 > \frac{a^2\alpha^2}{(1+e)}V_qV_z$ holds, otherwise the expectation term would not exist. And this is guaranteed by assumption 1. All these previous calculations imply that the value of the expected utility of the manager is equal to

$$
\begin{aligned}
& -\left[\frac{1+e}{1+e-a^2\alpha^2V_zV_q}\right]^{\frac{1}{2}} e^{ac(e)+\frac{p\overline{q}t}{1+e}+\frac{1}{2}\frac{ept}{1+e}(tV_qp+2\overline{q})+\frac{1}{2}\frac{t^2V_q}{1+e-t^2V_zV_q}\overline{z}^2} \\
= & -\left[\frac{1+e}{1+e-a^2\alpha^2V_zV_q}\right]^{\frac{1}{2}} e^{\frac{1}{2}a^2\alpha^2p^2V_q\left[\frac{(1+e)^2-a^2\alpha^2V_qV_ze}{(1+e)(1+e-a^2\alpha^2V_qV_z)}\right]-a\alpha p\overline{q}}
\end{aligned}
$$

That is, the maximization problem of the manager is of the form

$$
\max_e -\frac{1}{2}\ln h(e) - ac(e) - f(e),
$$

where the functions $h(e)$ and $f(e)$ are

$$h(e) = \frac{1+e}{1+e-a^2\alpha^2 V_z V_q} \tag{3.10}$$

$$f(e) = \frac{1}{2}\frac{p^2 a^2\alpha^2 V_q e}{1+e} + \frac{1}{2}\frac{p^2 a^2 \alpha^2 V_q}{1+e-a^2\alpha^2 V_z V_q} + pt\overline{q} \tag{3.11}$$

This maximization arises from the fact that I have multiplied by -1 the objective function before taking the log, and then multiplying again the obtained expression by -1. The first order condition of this problem is

$$ac'(e) = -\frac{1}{2}\frac{h'(e)}{h(e)} - f'(e).$$

The derivatives for h and f are

$$h'(e) = \frac{-a^2\alpha^2 V_z V_q}{(1+e-a^2\alpha^2 V_z V_q)^2}$$

$$f'(e) = \frac{1}{2}\frac{p^2 a^2 \alpha^2 V_q}{(1+e)^2} - \frac{1}{2}\frac{p^2 a^2\alpha^2 V_q}{(1+e-a^2\alpha^2 V_z V_q)^2}$$

Let $r = a^2\alpha^2 V_q V_z$. The first order condition may be rewritten as

$$\begin{aligned} c'(e) &= \frac{1}{2}\frac{r}{aV_z}\frac{p^2}{(1+e-r)^2} - \frac{1}{2}\frac{r}{aV_z}\frac{p^2}{(1+e)^2} + \frac{1}{2}\frac{r}{a(1+e)(1+e-r)} \\ &= \frac{1}{2}\frac{r}{aV_z}\left[\frac{p^2(1+e)^2 - p^2(1+e-r)^2 + V_z(1+e)(1+e-r)}{(1+e)^2(1+e-r)^2}\right] \\ &= \frac{1}{2}\frac{r}{a}\frac{1}{(1+e)^2(1+e-r)^2}\left[[e+1+\frac{r}{2V_z}(2p^2-V_z)]^2 - \frac{r^2p^4}{V_z^2} - \frac{r^2}{4}\right] \end{aligned}$$

where I have used the fact that $\overline{z} = p$, that is the competitive market assumption on the financial contract. The last equation obtains after completing the square of the resulting quadratic term in the numerator. This implies that the roots of the quadratic term are

$$e_{1,2} = \frac{rp^2}{V_z} - \frac{r}{2} \pm \frac{r}{2V_z}\sqrt{V_z^2 + 4p^4} - 1$$

step2: (Existence and uniqueness) Given that equation 3.8 characterizes the optimal effort level, I need to show that there exists an e^* that satisfies 3.8 and that this e^* is unique. For this, I show that the right hand side (RHS) of the equation is decreasing, while the left hand side (LHS) is increasing, and the existence of the solution follows. Since these monotonicity properties are strict the uniqueness of the solution follows. Observe first that the RHS is positive for all nonnegative e, since it can be rewritten as

$$\tfrac{1}{2}a^2\alpha^2 V_q p^2\{\tfrac{1}{(1+e^*-r)^2} - \tfrac{1}{(1+e^*)^2}\} + \tfrac{1}{2}a\alpha^2 V_q V_z \tfrac{1}{(1+e^*)(1+e^*-r)}. \tag{3.12}$$

First, remember that $r = a^2\alpha^2 V_q V_z$. The last summand is clearly positive for non-negative e, since we have that $0 < r < 1$, where the last inequality comes from the conditional maximization problem of the manager.[18] These constraints on r imply that $r - 1 < 0$, but since e is positive, therefore $(1 + e)$ and $(1 + e - r)$ are positive. Observe also that $(1 + e - r) < (1 + e)$, that is $\frac{1}{1+e-r} > \frac{1}{1+e}$, both positive. Therefore, $\frac{1}{(1+e-r)^2} > \frac{1}{(1+e)^2}$, which implies that the first summand of (3.12) is also positive. Now, taking the first derivative of the RHS with respect to the effort I get that it is equal to

$$\frac{1}{2}a^2\alpha^2 V_q p^2\{-\frac{2}{(1+e^*-r)^3} + \frac{2}{(1+e^*)^3}\} - \frac{1}{2}a\alpha^2 V_q V_z \frac{2+2e-r}{(1+e^*)^2(1+e^*-r)^2}.$$

By the same reasons, the second summand of this expression is negative. Since $\frac{1}{1+e-r} > \frac{1}{1+e}$ it follows that $\frac{1}{(1+e-r)^3} > \frac{1}{(1+e)^3}$, therefore the first summand is also negative. Hence $RHS(e)$ is strictly decreasing, for all nonnegative e.

---

[18]See assumption1.

For the left hand side, $LHS(e) = c'(e)$. It is clearly strictly increasing, since by assumption $c''(e) > 0$. Now, observe that $LHS(0) = 0$, while $RHS(0) > 0$. Since the $RHS(e)$ is strictly decreasing, and the $LHS(e)$ is strictly increasing, the existence and the uniqueness of the optimal effort level e^* follows. ■

Proof. of Proposition 3

Departing form equation 3.8, and using the implicit function theorem I get the desired result. The derivation with respect to α yields

$$c''(e^*)\frac{\partial e^*}{\partial \alpha} = a\alpha V_q p^2 \{\frac{1}{(1+e^*-r)^2} - \frac{1}{(1+e^*)^2}\} + a\alpha V_q V_z \frac{1}{(1+e^*)(1+e^*-r)}$$

$$+\frac{1}{2}a^2\alpha^2 V_q p^2 \{\frac{1}{(1+e^*-r)^2} - \frac{1}{(1+e^*)^2}\}\frac{\partial e^*}{\partial \alpha}$$

$$-\frac{1}{2}a\alpha^2 V_q V_z \frac{2+2e^*-r}{(1+e^*)(1+e^*-r)}\frac{\partial e^*}{\partial \alpha}.$$

Putting all the terms that involve the derivative of e^* with respect to α in one side, I obtain

$$\left[c''(e^*) + \frac{1}{2}a^2\alpha^2 V_q p^2 \{\frac{1}{(1+e^*-r)^2} - \frac{1}{(1+e^*)^2}\} - \frac{1}{2}a\alpha^2 V_q V_z \frac{2+2e^*-r}{(1+e^*)(1+e^*-r)}\right]\frac{\partial e^*}{\partial \alpha}$$

$$= a\alpha V_q p^2 \{\frac{1}{(1+e^*-r)^2} - \frac{1}{(1+e^*)^2}\} + a\alpha V_q V_z \frac{1}{(1+e^*)(1+e^*-r)}$$

That is, I have an equation of the form $A\frac{\partial e^*}{\partial \alpha} = B$. Observe that, following the same arguments as in the previous theorem, I obtain that $A > 0$ and that $B > 0$. Therefore the proposition for α follows. Note that the other parameters, a, p, V_q and V_z affect the implicit derivative the same way as α does, therefore, the proofs follow the same steps as described for α. Therefore, they have the same sign. ■

Proof. of Proposition 4

Now I will state the value of the fixed wage, given that the optimal decisions of the manager, e^* and φ^* are taken as given. Notice first, that the unconditional expectation of the manager was calculated in the first step of the proof of theorem 2, namely

$$E[U_a(w_a)] = -e^{-a\phi}[\frac{1+e}{1+e-t^2V_zV_q}]^{\frac{1}{2}}e^{a(e)-a\alpha\overline{g}+\frac{1}{2}a^2\alpha^2V_g+pt\overline{q}+\frac{1}{2}\frac{p^2t^2V_qe}{1+e}+\frac{1}{2}\frac{p^2t^2V_q}{1+e-t^2V_zV_q}}.$$

If I call F the second and third factors of the right hand side of the equation, then the binding condition may be restated as follows

$$\begin{aligned} E[U_a(w_a)] &= -1 \\ -E[U_a(w_a)] &= 1 \\ e^{a\phi} &= F \\ a\phi &= ln(F) \\ \phi &= \frac{1}{a}ln(F) \end{aligned}$$

Since at the time of setting the terms of the contract the principal takes the optimal functions of the manager as given, she will evaluate F at these optima; therefore set F^* instead of F and e^* instead of e in the above equations. ■

Proof. of Proposition 5

The objective function is

$$\begin{aligned} & E[-e^{G+(q+\varphi)Z-\varphi p)-\frac{e^2}{\kappa}}] = -e^{b\varphi p+b\frac{e^2}{\kappa}}E[e^{-bG}|S]E[e^{-b(q+\varphi)Z}|S] \\ & = -e^{b\varphi p+b\frac{e^2}{\kappa}}E[e^{-bG}]E[e^{-bQZ}|S] \\ & = -e^{b\varphi p+b\frac{e^2}{\kappa}}e^{-b\bar{G}+\frac{b^2}{2}V_G}e^{-\frac{b}{2}[-bV_{Q|S}\bar{Z}^2+2\bar{Z}E_{Q|S}-bV_ZE^2_{Q|S}]}c(b)^{\frac{1}{2}} \end{aligned}$$

To obtain the first equation I used the fact that φ is a function of S, therefore I put it outside the expectation. For the second equation I used the independence of G from q and Z. And, for the next equation I used the fact that G is independent of S.

Finally I substituted $Q = q + \varphi$ and used the result A.4. Where

$$c(b) = \frac{\frac{V_Z + V_{Q|S}}{V_Z^2 V_{Q|S}}}{\frac{V_Z + V_{Q|S}}{V_Z^2 V_{Q|S}} - b^2}$$
$$b^2 < \frac{1}{V_Z V_{Q|S}}$$

But, which is the value for $E_{Q|S}$ and $V_{Q|S}$?

$$\begin{aligned}
&E_{Q|S} = E[Q|S] = E[q+\varphi|S] = E[q+\varphi] + \frac{\text{Cov}(q+\varphi, S)}{\text{Var}(S)}(S - E[S]) \\
&= \bar{q} + \varphi + \frac{\text{Cov}(q+\varphi, q+\epsilon)}{\text{Var}(q+\epsilon)}(S - E[q+\epsilon]) \\
&= \bar{q} + \varphi + \frac{V_q}{Vq + V_\epsilon}(S - \bar{q}) \\
&= \varphi + KS + (1-K)\bar{q} = \varphi + M
\end{aligned}$$

Where $K = \frac{V_q}{V_q + V_\epsilon}$ is the weight or importance given to the signal.

$$\begin{aligned}
&V_{Q|S} = Var(Q|S) = Var(q+\varphi|S) = Var(q+\varphi) - \frac{\text{Cov}^2(q+\varphi, q+\epsilon)}{\text{Var}(q+\epsilon)} \\
&= V_q - \frac{V_q^2}{V_q + V_\epsilon} = \frac{V_q^2 + V_q V_\epsilon - V_q^2}{V_q + V_\epsilon} = \frac{V_q V_\epsilon}{V_q + V_\epsilon} = H^{-1}
\end{aligned}$$

Observe that $E_{Q|S}$ depends on φ and M. And M depends on S, which usually is stochastic. But since S is assumed to be known, therefore M is non-stochastic. On the other hand $V_{Q|S} = H^{-1}$ does not depend on φ. We interpret H as the precision of the signal.

I want to optimize the objective function with respect to φ, therefore I will eliminate all the constant terms. The objective function becomes

$$\begin{aligned}
&-e^{bp\varphi} e^{-\frac{b}{2}[-bH^{-1}\bar{Z}^2 + 2\bar{Z}(\varphi+M) - bV_Z(\varphi+M)^2]} \\
&= e^{bp\varphi + \frac{b^2}{2}H^{-1}\bar{Z}^2 - b\bar{Z}(\varphi+M) + \frac{b^2}{2}V_Z(\varphi+M)^2} = -e^{f(e)}
\end{aligned}$$

Since I want the max $-e^{f(e)} \equiv \min e^{f(e)} \equiv \min f(e) \equiv max - f(e)$, the objective function becomes

$$-bp\varphi - \frac{b^2\bar{Z}^2}{2H} + b\bar{Z}(\varphi + M) - \frac{b^2}{2}V_Z(\varphi + M)^2,$$

and the first order condition is

$$-bp + b\bar{Z} - b^2V_Z(\varphi + M) = 0,$$

therefore

$$\varphi_{SB} = \frac{p + b\bar{Z} - b^2V_ZM}{b^2V_Z},$$

which can be rewritten as

$$\varphi_{SB} = \frac{-bp + b\bar{Z}}{b^2V_Z} - M = \frac{\bar{Z} - p}{bV_Z} - M.$$

But, since I am assuming that $E_Z = \bar{Z} = p$ then

$$\varphi_{SB} = -M.$$

■

Proof. of Proposition 6

The objective function is

$$E[-e^{-b[G+qZ+\varphi_{SB}(Z-p)-\frac{e^2}{\kappa}]}] = -e^{b\frac{e^2}{\kappa}}E[e^{-bG}]E[e^{-b(q+\varphi_{SB})Z+bp\varphi_{SB}}].$$

Observe that φ_{SB} depends on the effort level e, since $V_\epsilon = \frac{V_q}{e}$.[19] On the other hand φ_{SB} depends on q and ϵ, in fact $\varphi_{SB} = -(1-K)\bar{q} - K(q+\epsilon) = -(1-K)\bar{q} - Kq - K\epsilon$.

[19]The noise is inversely related to the effort, i.e. the greater the effort exerted, the smaller the noise of the signal.

Analyzing only the stochastic exponential term I have that

$$
\begin{aligned}
&-b(q+\varphi_{SB})Z + bp\varphi_{SB}\\
&= -b(q-(1-K)\bar{q}-Kq-K\epsilon)Z + bp(-(1-K)\bar{q}-Kq-K\epsilon)\\
&= -bqZ + b(1-K)\bar{q}Z + bK(q+\epsilon)Z - bp(1-K)\bar{q} - bpK(q+\epsilon)\\
&= -bqZ + b(1-K)\bar{q}Z + bKqZ + bK\epsilon Z - b(1-K)\bar{q}p - bpKq - bpK\epsilon\\
&= bq(K(Z-p)-Z) + b\epsilon K(Z-p) + b(1-K)\bar{q}Z - b(1-K)\bar{q}p
\end{aligned}
$$

Idea: integrate first w.r.t. ϵ, then w.r.t. q and finally w.r.t Z. Why? ϵ is multiplied only by Z, therefore Z may be considered like a constant for the integration. On the other hand q is only multiplied by Z, and therefore to integrate w.r.t. q is easy as before. Finally integrating w.r.t. Z, I will consider a linear term and a quadratic one. The objective function is therefore

$$
O = -e^{b\frac{e^2}{\kappa}-b(1-K)\bar{q}p}e^{-b\bar{G}+\frac{b^2}{2}V_G}E[e^{bq(K(Z-p)-Z)+b\epsilon K(Z-p)+b(1-K)\bar{q}Z}]
$$

Working out only the las term of the objective function O, and calling this part O_1, I have

$$
\begin{aligned}
O_1 &= E_Z[e^{b(1-K)\bar{q}Z}E_q[e^{bq[K(Z-p)-Z]}]E_\epsilon[e^{b\epsilon K(Z-p)}]]\\
&= E_Z[e^{b(1-K)\bar{q}Z}e^{b[(K-1)Z-Kp]\bar{q}+\frac{b^2[(K-1)Z-Kp]^2}{2}V_q}e^{\frac{1}{2}b^2V_qZ^2}]
\end{aligned}
$$

Working out only the exponent

$$b(1-K)\bar{q}Z + b\bar{q}(K-1)Z - b\bar{q}Kp + \frac{1}{2}b^2K^2((K-1)^2Z^2 - 2K(K-1)Zp$$
$$+K^2p^2)V_q + \frac{1}{2}b^2K^2(Z^2 - 2Zp - p^2)V_\epsilon$$
$$= -b\bar{q}Kp + \frac{1}{2}b^2V_q(K-1)^2Z^2 - b^2V_qKp(K-1)Z + \frac{1}{2}b^2V_qK^2p$$
$$+\frac{1}{2}b^2V_\epsilon K^2Z^2 - b^2V_\epsilon K^2Zp + \frac{1}{2}b^2V_\epsilon K^2p^2$$
$$= \frac{1}{2}b^2[(K-1)^2V_q + K^2V_\epsilon]Z^2 - b^2Kp[V_q(K-1) + KV_\epsilon]Z$$
$$+\frac{1}{2}b^2p^2K^2(V_q + V_\epsilon) - b\bar{q}Kp$$

Since $K = \frac{e}{1+e}$, $1 - K = -\frac{1}{1+e}$ and $V_\epsilon = \frac{V_q}{e}$, therefore

$$(K-1)^2V_q + K^2V_\epsilon = [\frac{1}{(1+e)^2} + \frac{e}{(1+e)^2}]V_q = \frac{1}{1+e}V_q$$

and

$$(K-1)V_q + KV_\epsilon = -\frac{1}{1+e}V_q + \frac{e}{1+e}\frac{V_q}{e} = 0$$

finally

$$K^2(V_q + V_\epsilon) = \frac{e^2}{(1+e)^2}V_q(1 + \frac{1}{e}) = V_q\frac{e}{1+e}.$$

That is, the linear term of Z vanishes. The exponent is therefore

$$+\frac{1}{2}b^2\frac{1}{1+e}V_qZ^2 + \frac{1}{2}b^2p^2\frac{e}{1+e}V_q - b\bar{q}Kp.$$

Integrating now w.r.t. Z, I get

$$c(t)^{\frac{1}{2}}e^{tc(t)\bar{Z}^2}$$

with

$$c(t) = \frac{1}{1 - 2V_Z \frac{1}{2} b^2 \frac{V_q}{1+e}} = \frac{1+e}{1+e-b^2 V_q V_Z}$$

Therefore

$$(\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 \frac{V_q}{1+e-b^2 V_q V_Z} \bar{Z}^2}$$

I have that

$$O_1 = (\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 \frac{V_q}{1+e-b^2 V_q V_Z} \bar{Z}^2 + \frac{1}{2} b^2 p^2 V_q \frac{e}{1+e} - b\bar{q}Kp}$$

$$O_1 = (\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 V_q [\frac{\bar{Z}^2}{1+e-b^2 V_q V_Z} + \frac{p^2 e}{1+e}] - b\bar{q}Kp}$$

And the objective function becomes

$$O = -e^{b\frac{e^2}{\kappa} - b\bar{q}p + bK\bar{q}p} e^{-\bar{G} + \frac{b^2}{2} V_G} (\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 V_q [\frac{\bar{Z}^2}{1+e-b^2 V_q V_Z} + \frac{p^2 e}{1+e}] - b\bar{q}Kp}$$

$$O = -e^{b\frac{e^2}{\kappa} - b\bar{q}p} e^{-\bar{G} + \frac{b^2}{2} V_G} (\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 V_q [\frac{\bar{Z}^2}{1+e-b^2 V_q V_Z} + \frac{p^2 e}{1+e}]}$$

As before, by setting $\bar{Z} = p$ the objective function is

$$O = -e^{b\frac{e^2}{\kappa} - b\bar{q}p} e^{-\bar{G} + \frac{b^2}{2} V_G} (\frac{1+e}{1+e-b^2 V_q V_Z})^{\frac{1}{2}} e^{b^2 p^2 V_q [\frac{1}{1+e-b^2 V_q V_Z} + \frac{e}{1+e}]}$$

■

The following results are stated, but not proved, since these are standard results in statistics, and their proofs require only completing squares.

Result 3.6.1 *Let $X \sim N(\mu, \sigma^2)$ that is, X is a normal random variable, then*

$$E\left[e^{tX}\right] = e^{t\mu + \frac{1}{2} t^2 \sigma^2}$$

Result 3.6.2 *Let* $X \sim N(\mu, \sigma^2)$ *and let* $C(t) = \frac{\frac{1}{2\sigma^2}}{\frac{1}{2\sigma^2} - t}$, *if* $\frac{1}{2\sigma^2} > t$ *then*

$$E\left[e^{tX^2}\right] = [C(t)]^{\frac{1}{2}} \, e^{tC(t)\mu^2}$$

Result 3.6.3 *Let* $X \sim N(\mu, \sigma^2)$ *and let* $C(t_2) = \frac{\frac{1}{2\sigma^2}}{\frac{1}{2\sigma^2} - t_2}$, *if* $\frac{1}{2\sigma^2} > t_2$ *then*

$$E\left[e^{t_1X + t_2X^2}\right] = [C(t_2)]^{\frac{1}{2}} \, e^{\frac{1}{2}C(t_2)\left[t_1^2\sigma^2 + 2\mu(t_2\mu + t_1)\right]}$$

It is easy to check that by setting $t_2 = 0$ result 3.6.1 obtains. And that by setting $t_1 = 0$ result 3.6.2 obtains.

Result 3.6.4 *Assume* $Y = XZ$ *and* $V_z V_{x|S} t_3^2 < 1$ *then*

$$E\left[e^{tY}|S\right] = \left(\frac{\frac{H}{V_z}}{\frac{H}{V_z} - t^2}\right)^{\frac{1}{2}} e^{\frac{t}{2}\left[V_z t \mu_{x|S}^2 + 2\mu_z \mu_{x|S} + V_{x|S}\mu_z^2 t\right]}$$

where (Z, X) *are independent, jointly normally distributed and* Z *independent of* S. *The conditional mean of* (Z, X) *is given by* $(\mu_z, \mu_{x|S})$ *and the conditional variances by* V_z *and* $V_{x|S} = Var[X|S]$, *respectively. Observe that* $\mu_{x|S} = E[X|S]$ *and* $H = \frac{V_z + V_{x|S}}{V_z V_{x|S}}$, *since* Z *is independent of* S *but* X *is not.*

Proof.

$$E\left[e^{t_3Y}|S\right] = \int\int_{R^2} e^{t_3XZ} f_{X,Z}(X, Z|S) dX dZ$$

Since X and Z are jointly normally distributed we have that

$$f_{X,Z}(x, z|S) = \frac{1}{2\pi\sigma_z\sigma_x} e^{-\frac{1}{2}\left[\frac{(x-\mu_{x|S})^2}{V_{x|S}} + \frac{(z-\bar{z})^2}{V_z}\right]}$$

Therefore, what we have to do is to complete squares. Integrating first with respect to X and then with respect to Z we get the following: After completing the first square what remains is

$$e^{t_3 Z\left(\mu_{x|S}+\frac{1}{2}\sigma^2 t_3 Z\right)},$$

due to result 3.6.1, and taking $t_1 = t_3 Z$. After completing the square with respect to Z and applying result 3.6.3 this time with $t_1 = t_3\mu_{x|S}$ and $t_2 = \frac{1}{2}V_{x|S}t_3^2$ we obtain the desired result. ■

Result 3.6.5 *Let $X \sim N(\mu, \sigma^2)$ then*

$$E\left[e^{t\max(X-K,0)}\right] = \Phi\left(\frac{K-\mu}{\sigma}\right) + \left[1 - \Phi\left(\frac{K-(\mu+t\sigma^2)}{\sigma}\right)\right]e^{t(\mu-K)+\frac{t^2\sigma^2}{2}}$$

where, Φ is the standard normal cumulative distribution function.

Proof.

$$\begin{aligned}
E\left[e^{t\max(X-K,0)}\right] &= \int_{-\infty}^{\infty} e^{t\max(X-K,0)}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{(x-\mu)^2}{2\sigma^2}}dx \\
&= \int_{-\infty}^{K}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{(x-\mu)^2}{2\sigma^2}}dx + \int_{K}^{\infty} e^{t(X-K)}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{(x-\mu)^2}{2\sigma^2}}dx \\
&= \Phi\left(\frac{K-\mu}{\sigma}\right) + \int_{K}^{\infty}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{1}{2\sigma^2}\left[x^2-2\mu x+\mu^2-2\sigma t x+2\sigma^2 tK+(\mu+\sigma^2 t)^2-(\mu+\sigma^2 t)^2\right]}dx \\
&= \Phi\left(\frac{K-\mu}{\sigma}\right) + \int_{K}^{\infty}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{1}{2\sigma^2}\left[(x-(\mu+\sigma^2 t))^2+\mu^2+2\sigma^2 tK-\mu^2-(\sigma^2)^2t^2-2\mu\sigma^2 t\right]}dx \\
&= \Phi\left(\frac{K-\mu}{\sigma}\right) + \int_{K}^{\infty}\frac{1}{\sqrt{2\pi\sigma^2}}e^{-\frac{(x-(\mu+\sigma^2 t))^2}{2\sigma^2}}dx\, e^{\left[-tK+\frac{\sigma^2 t^2}{2}+\mu t\right]} \\
&= \Phi\left(\frac{K-\mu}{\sigma}\right) + \left[1-\Phi\left(\frac{K-(\mu+t\sigma^2)}{\sigma}\right)\right]e^{\left[t(\mu-K)+\frac{t^2\sigma^2}{2}\right]}
\end{aligned}$$

■

Result 3.6.6 *Let $X \sim N(\mu, \sigma^2)$ then*

$$E\left[e^{t\max(K-X,0)}\right] = \Phi\left(\frac{K-(\mu-t\sigma^2)}{\sigma}\right)e^{t(K-\mu)+\frac{t^2\sigma^2}{2}} + \left[1-\Phi\left(\frac{K-\mu}{\sigma}\right)\right]$$

where, Φ is the standard normal cumulative distribution function.

Proof.

$$E\left[e^{t\max(K-X,0)}\right] = \int_{-\infty}^{\infty} e^{t\max(K-X,0)} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx$$

$$= \int_{-\infty}^{K} e^{t(K-X)} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx + \int_{K}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx$$

Since,

$$-\frac{1}{2\sigma^2}\left[x^2 - 2\mu x + \mu^2 + 2t\sigma x - 2\sigma^2 tK\right]$$

$$= -\frac{1}{2\sigma^2}\left[x^2 - 2\mu x + \mu^2 + 2t\sigma x - 2\sigma^2 tK + (\mu - t\sigma^2)^2 - (\mu - t\sigma^2)^2\right]$$

$$= -\frac{1}{2\sigma^2}\left[(x - (\mu - t\sigma^2))^2\right] + t(K-\mu) + \frac{t^2\sigma^2}{2}$$

then the result equals to

$$= \Phi\left(\frac{K - (\mu - t\sigma^2)}{\sigma}\right) e^{t(K-\mu) + \frac{t^2\sigma^2}{2}} + \left[1 - \Phi\left(\frac{K-\mu)}{\sigma}\right)\right]$$

■

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