Do Ownership Structures Affect the Risk Incentive Provided by Managerial Portfolio Holdings? An Empirical Analysis of UK Alternative Investment Market Companies

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Abstract

This paper analyzes the wealth and risk incentive effects of managerial options and shareholdings on the hedging probability of UK listed Alternative Investment Market (AIM) companies. We find that the wealth incentive effect provided by managerial option holdings increases the hedging likelihood. On the contrary, the wealth incentive effect provided by managerial shareholdings decreases the hedging likelihood. Further tests show that the incentive effect provided by managerial shareholdings is significantly different if managers are not substantial shareholders of the company. Managers with substantial ownership are significantly less risk averse. Thus, the size and ownership structure characteristics of AIM companies seem to result in similarities between managers' and owners' behavior.

JEL classification: G32; G34.

1. Introduction

Since the arguments of Smith and Stulz (1985) on managerial risk aversion and corporate hedging, several empirical studies have analyzed the relation between managerial options and shareholdings and risk management practices (see e.g., Haushalter, 2000; Knopf, Nam, and Thornton, 2002; Rogers, 2002). Typically, as a measure of managerial risk aversion, some of the studies use the percentage of shareholdings. Other studies use variables based on the number or value of shares and options, or the wealth and risk incentive provided by those options and shares. In this paper, we argue that in small and closely held companies, both the scale of the incentives (amount of the incentives) and the level of ownership (percentage of shareholdings) should be considered when testing the effect of managerial portfolio holdings on corporate risk management practices. Our contribution to the literature is twofold. First, we estimate managers' wealth (delta) and risk (vega) incentives provided by option holdings, taking into consideration important option characteristics that can impact managers' attitudes toward risk. Second, we do not concentrate on large, widely held companies but on small closely held companies listed on the UK Alternative Investment Market (AIM). This sample choice is due to their particular ownership and governance structures that have implications on financial decision making and agency cost relations in these companies.

Our first contribution arises from the fact that, contrary to previous literature, (e.g., Knopf, Nam, and Thornton, 2002; Rogers, 2002) we do not use the Black and Scholes equation (BSE) to estimate the managerial wealth and risk incentives provided by option holdings. We argue that the BSE does not allow for the consideration of important characteristics of managerial options, for instance the

vesting period or the likelihood that a manager could be fired or could leave before the option vests. Also, of potentially greater importance for our paper, faced with an incomplete market, managers often exercise their options long before maturity (Hudart and Lang, 1996; Carpenter, 1998). In this paper, we estimate the vega and delta of managerial option holdings using the model proposed by Cvitanic, Wiener, and Zapatero (2008). We suggest that the model of Cvitanic, Wiener, and Zapatero (2008) allows us to better consider the characteristics of the options held by the managers of companies in our sample.

Our second contribution is based on our sample selection of companies listed in the AIM market. We argue that this sample provides advantages in studying managerial risk aversion and corporate hedging. The AIM market is dominated by small market capitalization companies, has less demanding rules for shareholders' approval and corporate governance requirements, and has no minimum free float requirement. These features mean that these companies are distinctive in terms of ownership structure and are considerably different from the companies that are normally considered in the risk management literature. Consequently, the risk effect of managerial portfolio holdings suggested by Smith and Stulz (1985) is not necessarily observed in these companies.[1] Thus, we investigate if the incentive provided by managerial portfolio holdings in small and closely held companies has a different effect on the hedging likelihood than the incentive provided in larger and in more widely owned companies.

Our results show that if the incentives provided by managerial share and option holdings are treated as exogenous variables, then the variables do have an impact on the manager's decision to hedge. The delta of options has a significant

[1] Some of the literature has failed to find a relation between managerial portfolio holdings and risk management practices in large widely held companies.

positive effect on the hedging probability, and the vega of the option holdings has a negative (though not statistically significant) effect on the hedging probability. We find that the wealth effect provided by shareholdings is significant but negatively related to the hedging probability. This result could be explained by the fact that the large majority of the companies traded on the AIM are small or because they are closely held. We test if the incentives provided by managerial shares and option holdings of the smaller companies in the AIM market are significantly different from the incentives provided by the larger companies in this market.[2] We find that the managerial incentives do not differently affect the hedging likelihood according to the size of the company (in our sample).

Furthermore, we test if the scale of the separation of the roles of manager/shareholder affects the impact of the incentive provided by managerial holdings on the hedging likelihood. Our results show that the scale of the separation of the roles of manager/shareholder does affect the wealth incentive provided by shareholdings but not the wealth and risk incentive provided by option holdings. In companies where managers do not hold a significant proportion of the company shares, the wealth incentive provided by managers' shareholding significantly increases the hedging likelihood. This finding is consistent with treating managerial incentive holdings as endogenous variables and with re-defining our hedging decision variable as a "derivatives usage" variable. Therefore, the size and ownership structure characteristics of AIM companies seem to result in managers' actions that are similar to owners' actions. This finding could be explained by the fact that since they are

[2] The majority of the larger companies in our sample would still be classified as small in other studies. The largest company in our sample in 2006 (the year of our analysis) has a market capitalization of £853 million, and the smallest has £100 thousand. Such a large size difference could have an effect on the incentive provided by managerial shares and option holdings. Therefore, we believe that it is important to test if the incentive provided by managerial shares and option holdings of very small companies can be different from the incentive provided by managerial shares and option holdings of larger (less small) companies.

significant owners, these managers perceive company value as their own wealth, or because managers that are substantial shareholders are more confident in their capabilities and in the future prospects of the company, they are more willing to accept risk. Thus, risk-aversion agency conflicts due to the separation of the roles of manager/shareholder do not seem to be extensive in closely held AIM companies. Consequently, managers of AIM companies seem to act considerably differently from the managers of the widely owned companies normally considered in the risk management literature.

The remainder of this paper is organized as follows. Section 2 discusses the relevant literature on the effect of managerial incentives on risk management practices and hedging in small companies. It also explains our intuition for using a model other than the BSE to calculate the incentives provided by managerial option holdings. The characteristics of the AIM market and the attractions of this market for our study are presented in section 3. In section 4, we present our variables and develop our hypotheses. Section 5 presents details of our sample and our results, and section 6 concludes.

2. Literature review

2.1. Previous studies of managerial incentives as determinants of corporate hedging

Concentrating on large, widely held companies, Smith and Stulz (1985) show that through the design of adequate compensation contracts, companies can induce managers to follow an optimal hedging policy (due to managerial risk aversion, under their model framework, an optimal hedging policy would be achieved if the manager

hedges less). Since managerial holdings of shares and options, particularly, result from current and previous years' compensation contracts,[3] the shares held by the manager provide an incentive to hedge more and the options held by the manager can provide an incentive to hedge less. The argument that options can induce the manager to take more risk is challenged by Amihud and Lev (1981) and Lambert, Larcker, and Verrecchia (1991). They suggest that undiversified risk-averse managers can become even more risk averse as their portfolio of options increases. Guay (1999) argues that executive options can provide both an incentive to increase (through vega) and decrease (through delta) company risk. Since options link the managers' wealth to the companies' value, they will increase the risk of the portfolio of the manager. Therefore, options can provide a risk-aversion incentive. On the other hand, since the options' value increases with volatility, they could provide the manager with an incentive to increase risk. Ross (2004) argues that managerial shareholdings can induce risk-taking behavior and, conversely, managerial option holdings can induce risk aversion.

Early empirical studies on the effect of managers' portfolio holdings on risk management policies have produced mixed results (see Tufano, 1996; Geczy, Minton, and Schrand, 1997; Gay and Nam, 1998; Haushalter, 2000). Spano (2007) is, to our knowledge, the most recent test of the relation between managerial ownership and corporate hedging considering the same country as this study (larger UK companies from the Main Market of the London Stock Exchange). His overall results suggest that in the UK, managerial share ownership does not affect the decision to hedge. Moreover, for some model specifications, Spano (2007) finds that the relation between managerial ownership and the decision to hedge is negative (though not

[3] This is mainly true for managerial options' holdings since managers can trade on their share holdings, but the same is not true for options granted under compensation schemes.

statistically significant). The mixed results in these US and UK studies could be due to the managerial risk incentive proxies used (normally the number or value of shares and options held by the executive director or the percentage of shareholdings) since those proxies fail to adequately capture the risk incentive effect provided by managers' portfolio holdings.

Knopf, Nam, and Thornton (2002) and Rogers (2002)[4] measure the sensitivity of CEO equity (-like) portfolio holdings to both company value and company risk (delta and vega) and use those measures as proxies for the manager's wealth and risk incentives. Both studies conclude that hedging activity is positively related to the shares and options' sensitivity to share prices (delta) and is negatively related to the options' sensitivity to risk (vega). The latter result is not statistically significant in Knopf, Nam, and Thornton (2002). Contrary to Knopf, Nam, and Thornton (2002), Rogers (2002) models the CEO risk incentives and hedging policy as endogenous variables that could explain the difference in the results of both studies.[5] The proxy used in these two studies, the manager's portfolio sensitivity to both changes in company value and risk (delta and vega), is a better proxy for the manager's wealth and risk incentives. However, the measure of managerial incentives provided by options can still have some problems due to the specific characteristics of options granted on company equity.

2.2. Characteristics of managerial wealth and risk incentives

[4] Rajgopal and Shevlin (2002) also analyze the relation between companies hedging and managerial risk incentives using vega as a proxy for managerial risk incentive. Consistent with Smith and Stulz (1985), the authors find a negative relation between hedging and managerial risk incentives.

[5] Rogers (2002) shows a significant negative relation between the managerial risk incentive (measured as the ratio of vega to delta) and hedging.

The majority of options granted to managers are American, i.e., they can be exercised at any time. Knopf, Nam, and Thornton (2002) and Rogers (2002) treat the options as European, i.e., the manager is assumed to only be able to exercise the options at maturity. An American option on a non-dividend paying share will never be exercised before maturity since (before maturity) a non-dividend paying option is always worth more than its payoff. Therefore, its value is the same as a European option. If holders do not wish to continue holding the option, they would be better off selling it than exercising it. However, (some) companies do pay dividends and, more importantly, managers cannot sell their options and are constrained on hedging them (the manager faces an incomplete market). As a consequence, it could be (sub)optimal for managers to exercise their options before maturity and, thus, the treatment of an American option as if it were European possibly leads to a bias in the results. Intuitively, we would expect the American feature to affect the value of the managers' options portfolio and the wealth and risk incentives provided by that portfolio of options. More precisely, if managers are able to sell their options, we would expect the value of the options to be understated in the literature due to the inappropriate treatment of the American feature. On the other hand, since managers are not allowed to sell their options and are constrained on hedging them, they could decide to exercise those options, perhaps due to liquidity issues or if they leave the company, before it would have been optimal from the perspective of an unconstrained holder. The treatment of the American feature as if it were European can overstate the value of the options and their wealth and risk incentives. Thus, it is possible that some of the results found in the existing literature are biased due to an imprecise treatment of the options exercise policy.

Another characteristic of these studies that can potentially bias the results is the approximation method used to determine the wealth and risk incentive provided by the managers' option holdings. The approximation method suggested by Core and Guay (2002) can bias the results, particularly in situations where the manager's portfolio contains a considerable amount of out-of-the-money options. The authors argue that the bias resulting from implementing their approximation method (if the manager's portfolio of options has out-of-the-money options) is likely to be important in studies where the managerial incentives are measured as the sum of the incentives provided by options and shares, i.e., when researchers measure managerial incentives as the sum of, for example, the delta of shares and option holdings (this variable is used in Knopf, Nam, and Thornton, 2002 and Rogers, 2002).

Other characteristics of the options, that have not been considered in previous studies and could affect their wealth and risk incentives, are the vesting period and the likelihood that the manager could leave or be fired before the options mature. The majority of options granted to managers in both the US and the UK have a vesting period of three years.[6] During this vesting period, managers cannot exercise their options. Brisley (2006) suggests that calendar vesting schedules are unlikely to offer correct incentives for risk taking. If an option is deeply in the money and has already vested, the risk-averse manager will rationally exercise it.[7] If an option is deeply in the money and has not vested, it could lead the manager to seek to reduce risk, i.e., to hedge more. The intuition is that risk-averse managers holding non-vested, deeply in–the-money options, will want to avoid the risk of their options falling out-of-the-

[6] The UK Combined Code suggests that options should have a vesting period of at least three years. The Combined Code on Corporate Governance sets out standards of good practice for UK companies listed on the Main Market of the London Stock Exchange in relation to issues such as board composition and development, remuneration, accountability and audit, and relations with shareholders.
[7] Huddart and Lang (1996) and Carpenter (1998) show that managers tend to exercise their options long before maturity.

money. Therefore, vesting periods can affect the options' wealth and risk incentives. Moreover, the likelihood that managers will leave the company before their options mature could also affect the options' value and the incentives provided by those options. If managers leave the company and hold unvested options, they will forfeit the options. On the other hand, if they leave the company and hold vested options, they will have a short period of time to exercise the options.[8]

In this paper we calculate the managers' wealth and risk incentives using the model developed in Cvitanic, Wiener, and Zapatero (2008). The model allows the consideration of some of the important characteristics of options granted to managers, for instance the vesting period, the possibility that the manager could leave or be fired before maturity, and the fact that managers could decide to exercise their options before maturity.

2.3. Hedging determinants in small companies

The literature on the determinants of corporate hedging concentrates on large companies and often excludes small companies.[9] However, there are a few exceptions. For example, Pennings and Garcia (2004) analyze the determinants of corporate hedging of small- and medium-sized companies in the Dutch pork marketing channels. Using a generalised mixture regression model, the authors group the companies into segments of managers who behave similarly. Then they study the

[8] In the US, managers have up to three months to exercise their options after they leave the company (Cvitanic, Wiener, and Zapatero, 2008).

[9] As an example, Purnanandam (2008) analyzes the relation between financial distress and corporate risk management, excluding from his sample the first quartile of the size distribution. This literature argues that company size is a corporate hedging determinant although often arguing that the direction of the effect is ambiguous. Moreover, it is not clear how to interpret some of the results since the literature uses proxies for size, which depend on the size range of the selected sample. In other words, the same company can be considered small or large depending on which sample it is included. This could explain the ambiguous results concerning the effect of size on corporate hedging.

determinants of derivative usage for each segment. They conclude that the determinants vary by segment and that the differences can be partially explained by factors like ownership structure. Vickery (2008) analyzes the choice of fixed-rate loans (compared to floating-rate loans) by small companies as a risk management tool. The results support the hypothesis that financially constrained small companies that are more exposed to interest rate movements match significantly more than nonfinancially constrained small companies. The author finds that managerial ownership is not a significant determinant of company risk management.

3. The AIM (Alternative Investment Market)

The AIM was launched in the UK in 1995 with the objective of attracting small, high-growth British companies. The AIM has developed significantly and now attracts not only British companies but also companies from several overseas countries, closed-end property, and investment funds (Arcot, Black, and Owen, 2007). The market is still dominated (in terms of number of companies) by small market capitalization companies. The large majority of the companies listed in the AIM (82%) have a market capitalization less than £50 million, with 69% of the companies having a market capitalization below £25 million.[10]

In terms of the number of companies being traded, the AIM is larger than the Main Market of the London Stock Exchange. In May 2009, there were 1,438 companies listed on the AIM (the Main Market had 1,054 companies). Since there is no requirement for companies to be traded before admission, the AIM is considered

[10] In the UK Main Market, the large majority (59%) has a market capitalization larger than £50 million, with only 25% having a market capitalization less than £25 million (LSE statistics, May 2009).

mainly as a feeder of the Main Market, but this feature of the market is no longer the case for all companies. Some companies that are traded on the Main Market choose to move to the AIM to achieve visibility amongst their peer companies (Arcot, Black, and Owen, 2007), and some larger companies choose to remain in the AIM despite fulfilling the requirements of the Main Market. The latter group could choose to remain in the AIM because the requirements in corporate governance and shareholder approval are less stringent than in the Main Market. The less demanding rules for shareholder approval and corporate governance requirements are certainly attractive, particularly for less-structured, small, high-growth companies, but it could result in lower protection of shareholder rights. In other words, it could lead to potential agency conflict between managers and shareholders.

The other two aspects of the AIM that are attractive for smaller companies are the lack of a minimum requirement of capital being raised[11] and no minimum free-float requirement. The lack of a float requirement makes these companies unique in terms of ownership structure. In 2007, institutional investors owned 60% of the shares being traded on the AIM, but this investment was made mainly in relatively high market capitalization companies. About half of the remaining 40% of shares were owned by directors, employees, and members of the founding family (Arcot, Black, and Owen, 2007). Thus, the ownership structure of these companies is considerably different from the large, widely owned companies, which are normally considered in the risk management literature in the UK and US.

The large majority of the shares traded on the AIM are owned by a small group of institutional investors. Therefore, those companies are more likely to be adequately monitored and are less likely to be exposed to manager/shareholder

[11] The market enables companies to raise relatively small amounts of capital, normally from £10 million upwards. In the UK Main Market, the majority of the companies raising money from January to May 2009 raised £100 million or more.

agency conflicts. Also, in a large proportion of the remaining companies, the owner is also a manager with a large portfolio of shares in their company (in some cases in our sample, around 90% of the shares). Since agency conflicts between manager and shareholder arise due to the separation of the two roles, under the agency model framework it is likely that in those companies there would be a lower level of agency disputes. Moreover, in terms of the focus of this study, closely held, smaller companies are likely to have smaller management teams that would be easier to monitor both internally and externally. Conversely, it can be argued that small management structures can result in agency conflicts since risk management policies, and also the management of the different corporate functions, can depend on the opinion of a single individual or a very small team of individuals. The less demanding rules for shareholder approval and corporate governance requirements can also result in exacerbated agency costs; however, the one that dominates financial decision making is an empirical question.

4. Variables and hypotheses development

The majority of the studies on hedging determinants use derivative holdings as a proxy for corporate hedging. However, by concentrating on derivative holdings, the studies fail to consider that companies commonly use internal/operating hedging techniques like duration hedging and cash flow matching. Moreover, given our analysis on AIM-quoted companies that could lack financial sophistication, we should expect that if they decide to hedge their FX and interest rate exposures, they would initially consider the use of internal/operating hedging techniques. Thus, if we use the hedging proxies commonly utilised in the literature, we could classify as non-hedger

companies that actively hedge their FX and interest rate exposures. Therefore, to define if a company hedges or not, we look in the annual report for the details of the company's risk management policy. If the company uses derivatives to hedge its exposure and/or if it uses other internal risk management techniques like duration or cash flow matching, we classify the company as a hedger. The hedging variable is a binary variable that takes the value of one if the company hedges and zero if the company does not hedge. In section 5 we present full details of our data source and sample.

4.1 Managerial ownership incentives as determinants of corporate hedging

Following Knopf, Nam, and Thornton (2002) and Rogers (2002), we recognize that managers' portfolios of shares and options can provide two distinct incentives to avoid or increase the company's risk. Since shares and options link managers' wealth to company value and since managers are constrained on diversifying their portfolio, shares and options can give the manager an incentive to hedge more than would be optimal from the perspective of an unconstrained shareholder. Using a similar approach to Knopf, Nam, and Thornton (2002), we measure this wealth incentive as the natural log of the sum of the delta of the managers' shares and options, i.e., the natural log of the pound change in managers' wealth as the share price changes by 1%. The log specification of the variables reflects the fact that as the share-based wealth of managers' increases, the incentive to alter share price increases but at a diminishing rate. Thus, this specification supports a concave utility function. We argue that due to liquidity issues, shares and options could provide different levels of risk aversion and we disentangle our measure of

wealth incentive into two distinct variables: the log of the delta of the shares and the log of the delta of the options. Options can also provide an incentive to increase risk since an option increases in value with volatility. As in Knopf, Nam, and Thornton (2002), we measure this incentive to increase risk as the natural log of the pound change in the managers' portfolio of options as volatility changes by 1%, i.e., vega. The large majority of the studies that analyze managerial compensation or managerial shares and option holdings concentrate on the CEO. We recognize that financial decisions could be made by other board members so instead of concentrating only on the CEO portfolio holdings, we consider the shares and option holdings of the team of executive directors. To our knowledge, only Main, Bruce, and Buck (1996), Aggarwal and Samwick (2003), and Coles, Daniel, and Naveen (2006) examine team incentives.

Knopf, Nam, and Thornton (2002) and Rogers (2002) measure vega and option deltas using the BSE. We argue that the BSE does not take into account the options' vesting period, the likelihood that the manager will leave and forfeit the options, and the managers' exercise policy. These omissions are likely to bias the proxies and the inference taken from using those proxies. We estimate our proxies for vegas and deltas of the current option holdings using the model proposed by Cvitanic, Wiener, and Zapatero (2008). This model allows us to consider the vesting period of the options, the likelihood that the manager could leave and forfeit the options, and the possibility that the manager could exercise the options before maturity. The delta of the shares is calculated using the methods in Knopf, Nam, and Thornton (2002) and Rogers (2002), i.e., the delta is the product of 1% of the share price at the annual report year-end and the number of shares held by the manager.

Since managers are constrained on hedging the part of their wealth that is connected to company value, the literature suggests that as managers' wealth becomes

more linked to company value, managers will become more risk averse. Thus, we expect the log of the delta of shares and the log of the delta of options to be positively related with the companies hedging decision. Conversely, since vega measures the willingness to take risk, we expect to find a negative relation between vega and the hedging decision.

4.2. Other hedging determinants - control variables

In a setting where shareholders hold diversified portfolios, risk management can be affected by the structure of the corporate tax code, financial distress costs, underinvestment costs, and the managers' wealth and risk incentives (Smith and Stulz, 1985).[12] Since hedging could increase company value in the presence of financial distress costs, we expect to find a positive relation between leverage and the likelihood that the company hedges. As a proxy for financial distress, we use leverage. In the presence of underinvestment costs, hedging can be value enhancing. Underinvestment costs are likely to be more pronounced in companies with high growth opportunities. As a proxy for growth opportunities, we use the market-to-book value ratio. We expect to find a positive relation between our proxy for growth opportunities and the likelihood that the company will hedge.

The effect of size as a hedging determinant is not clear in the theoretical or empirical literature.[13] Authors like Nance, Smith, and Smithson (1993), Geczy,

[12] We do not include tax as a determinant of corporate hedging. Many UK companies face a linear effective tax function, which implies that for UK firms the tax-based motive for hedging is possibly weak (Spano, 2007). Other UK studies on the determinants of corporate hedging that do include a tax variable consider a dummy variable based on tax-loss carry-forwards. However, this is more likely a measure of financial distress.

[13] This literature argues that company size is a corporate hedging determinant although often arguing that the direction of the effect is ambiguous. Moreover, it is not clear how to interpret some of the results since the literature uses proxies for size, which depend on the size range of the selected sample.

Minton, and Schrand, (1997), and Rogers (2002) argue that due to economies of scale, larger companies are more likely to hedge. Other authors argue that since smaller companies are more likely to have information asymmetries and more costly external financing, smaller companies are more likely to benefit from hedging (Tufano, 1996). It could be argued that the larger companies in our sample would correspond to small companies in the samples of the hedging determinants of the literature, and in our sample the size hypothesis is difficult to verify. Nevertheless, we believe that the size spread in our sample does allow us to test the size hypothesis due to different levels of economies of scale and information asymmetry. We measure company size as the natural log of total assets, but we do not make a prediction on the relation between firm size and hedging likelihood. As hedging alternatives, companies can use conservative financial policies. Companies that distribute more of their earnings as dividends are more likely to be cash constrained. We use the dividend yield and the quick ratio as proxies for hedging alternatives. We expect to find a positive relation between dividend yield and the hedging likelihood and a negative relation between the quick ratio and the hedging likelihood.

Vickery (2008) argues that industries in which output or cash flow co-vary positively with interest rates are less exposed to interest rate risk since this positive co-variance constitutes a natural hedge. The author finds that coal mining, petroleum refining, and oil and gas extraction industries show the highest correlation between interest rates and output or cash flow changes. To control for natural hedges, we include in our model a dummy variable, which takes the value of one if the company belongs to those industries. We expect to find a negative relation between our dummy variable and the hedging likelihood.

In other words, the same company can be considered small or large depending on which sample it is included. This could explain the ambiguous results concerning the effect of size on corporate hedging.

AIM companies could lack financial sophistication and adequate corporate governance structures. We hypothesise that non-executive directors will monitor managers' actions and that companies with better corporate governance structures will be more likely to adopt adequate risk management policies.[14] AIM companies are not required to follow the Combined Code on Corporate Governance (required by UK companies listed in the Main Market). However, there is a set of guidelines published by the Quoted Companies Alliance (QCA), which is aimed at AIM companies. According to the QCA guidelines, a company should have at least two independent non-executive directors on its board of directors. We include in our model a dummy variable that takes the value of one if the board has less than two non-executive directors. We hypothesise that in companies in which the board has less than two non-executives, managers are internally less monitored. Companies that are less monitored could be financially less astute and thus be less likely to use hedging techniques. This argument would result in a negative relation between our variable and the hedging likelihood. Conversely, companies that are less monitored could be more likely to adopt more conservative risk management decisions since they will be more exposed to managerial agency problems and thus hedge more. The latter would result in a positive relation between our variable and the hedging likelihood. Therefore, we do not make a prediction on the relation between our dummy variable and the hedging likelihood.

The data for the control variables are obtained from Datastream or the annual reports of the sample companies.

[14] There are mixed findings on the impact of outside (non-executive) directors on the use of derivatives. Marsden and Prevost (2005) suggest only a passive role for outside directors on the use of derivatives, but Borokhovich, Brunarski, Crutchley, and Simkins (2004) find that outside directors have an influence in the decision of the companies to use of interest rate derivatives.

4.3. Determinants of managerial wealth and risk incentives

Some of our control variables in the hedging likelihood model can affect managerial incentives. For example, we would expect managers of companies with higher leverage ratios to be monitored by their debtholders, (primarily in the case of AIM companies the major debtholders would be their banks). Thus, the more leveraged companies could be less likely to grant equity-like compensation to their managers. Companies are expected to optimally design compensation contracts to mitigate agency problems, thus managerial incentives are endogenous variables and treating these variables as exogenous can lead to spurious inference.

Guay (1999) and Core and Guay (1999) study the determinants of the managers' portfolio deltas and vegas. We use some of their determinants, as well as some suggested by other studies. We also add some corporate governance variables to define our model of managerial wealth and risk incentives for our sample of AIM companies due to their specific governance structure. Larger companies are likely to pay more to their executives, and we expect to find a positive relation between delta and vega and firm size. Core and Guay (1999) argue that managers of riskier companies are likely to demand higher compensation levels. However, Aggarwal and Samwick (1999) show that managers' pay performance sensitivity can decrease with risk. Therefore, based on this mixed evidence, we make no prediction on the relation between companies' risk and delta and vega. Our proxy for risk is the natural log of the annualised standard deviation of daily share price returns of up to one year prior to the date of the hedging analysis.

Companies with more growth opportunities are less easy to monitor so we expect that in those companies the compensation of managers will be more tied to the

companies' performance. We expect to find a positive relation between delta and vega and growth opportunities. Our proxy for growth opportunities is the market-to-book ratio.

Cash compensation can be used as an indicator of managers' outside wealth and thus it can be a measure of risk aversion. Under this interpretation, a manager that is paid more cash is less risk averse and needs to be less monitored. Therefore, we expect a negative relation between cash and vega and delta. On the other hand, higher levels of cash compensation can reflect higher pay packages. As a result, the relation between cash compensation and vega and delta could be positive. As a proxy for cash compensation, we use the natural log of the salary, benefits, and bonus paid to managers.

John and John (1993) show that as leverage increases, pay performance sensitivity decreases. Thus, more leveraged companies are less likely to use options and shares to pay to its executives. We expect to find a negative relation between gearing and delta and vega.

Following Guay (1999) and Rajgopal and Shevlin (2002), we recognize that managers' wealth convexity and concavity (vega and delta) are related. Since vega measures managers' incentive to increase risk, it can be argued that such an incentive has to be constrained to value-enhancing projects (a manager could increase risk by investing in negative NPV projects). This incentive is provided by delta. Thus, delta should be a determinant of vega. On the other hand, since the incentive to take value-enhancing projects (delta) could lead the manager to consider altering the company's risk and since the incentive to alter the company's risk is measured by vega, vega should be a determinant of delta (for example, Coles, Daniel, and Naveen, 2006 use

vega as a determinant of delta). As the same underlying variables drive the values of both vega and delta, we expect to find a positive coefficient between vega and delta.

Yermack (1995) suggests that companies can grant shares and options to reward management for good performance. As a proxy for past performance, we use the average monthly share price return over the two years prior to the annual report end date.

Utility, banking, and insurance industries are more regulated and thus more monitored. In these industries it can be less necessary to link managers' wealth to performance. We use a dummy indicator that takes the value of one if the company belongs to one of these industries, and we expect to find a negative relation between our variable and delta and vega.

The quality of governance can also have an impact on compensation policies and on managerial shares and option holdings. Moreover, we would expect that managers of companies with poorer governance structures extract greater compensation (Core and Guay, 1999; Hanlon, Rajgopal, and Shevlin, 2003). We use two proxies for good corporate governance: the percentage of non-executive directors on the board and a dummy variable that takes the value of one if there are less than two non-executive directors on the board. Since poor governance can lead to rent extraction, we expect to find a positive relation between our dummy variable and vega and delta, and a negative relation between the percentage of non-executive directors and both vega and delta. The QCA guidelines for corporate governance for AIM companies advise that companies should have a separate remuneration board and that only non-executive directors should be on this board. We hypothesise that companies with separate remuneration boards are more likely to design compensation contracts that better align the interests of managers and shareholders. We create a dummy

variable that takes the value of one if the company does not have a remuneration committee (or if it does not disclose in its annual report the existence of such a committee) or if executive directors sit on the remuneration committee. We expect to find a negative relation between our dummy variable and vega and delta. Lastly, since companies can have different numbers of executive directors and we are measuring managerial incentives as the total of the managerial incentives of the executive team, we include in our regression the number of executive directors as an independent variable.

The data for the managerial wealth and risk incentives variables are obtained from Datastream or the annual reports of the sample companies.

5. Data description and results

5.1. Data description

We randomly select 446 companies listed on the AIM market and collect their 2006 annual report.[15] We search in the annual report for information related to each company's exposure to currency, interest rate risk, and its hedging practices. If the company stated in the annual report that it is exposed to currency or interest rate movement, or if the company has debt/investments or exports/imports in a foreign currency, we consider that it is exposed to interest rate or currency risk. Otherwise, we exclude the company from the sample. Earlier studies are criticized for not having

[15] We chose 2006 as the year of our analysis since new accounting rules governing the accounting and disclosure of risk management were introduced in the UK for listed companies for the year-end 2006. The new accounting rules aimed to align the text of UK accounting standards with that of International Financial Reporting Standards (IFRS). The previous accounting standard FRS 13 was withdrawn following the implementation of FRS 25 (IAS 32) 'Financial Instruments: Disclosure and Presentation' and FRS 26 (IAS 39) 'Financial Instruments: Measurement'.

these selection criteria because companies that had little or no currency or interest rate risk were classified as non-hedgers. Graham and Rogers (2002) and Rogers (2002) are exceptions to this criticism. Additionally, we exclude a company from the sample if the company does not clearly disclose the information concerning executive directors' ownership of shares and options, the options' details, or if the company's share price data are not available. This selection criterion results in a final sample of 317 companies (of which 250 indicate they are exposed to currency risk and all companies in our sample have interest rate risk).

Table 1 presents a comparison of the means of hedgers and non-hedgers. It shows that hedgers are the larger of the AIM companies and have a higher probability of financial distress. Executive directors of companies that hedge own a significantly smaller share of the company, and the incentive to alter share price provided by the shareholdings of the executive team is significantly higher for non-hedgers. This result is also true for the wealth incentive provided by share options. Nevertheless, the difference between the two groups is not statistically significant. Vega is larger in the hedger group although again the difference is not statistically significant. This effect is not driven by the number of options held by the executive team since executive teams of the non-hedger companies hold significantly more options than executive teams of companies which hedge (these results are not reported in Table 1). A possible explanation is that the options held by executive teams of the non-hedger group are well in the money, but the options held by the executive team of the hedger group are in the "at the money" region. Thus, although the executive team of the hedger group holds fewer options, those options provide a larger incentive to increase the company's risk.

Insert Table 1

In 94% of the companies in our sample the executive team holds shares of the company, and in 81% of the companies the executive team holds options (showing the importance of considering options when defining proxies for managerial incentives). To value the executive options using the model suggested by Cvitanic, Wiener, and Zapatero (2008), we need the following information concerning the options: the exercise price, the vesting period, the time to maturity, the share price at the date of the annual report, the risk-free rate, volatility,[16] the executive options' exercise policy, and the executive exit rate. The exit rate represents the likelihood that the director will leave the company before the option matures and thus possibly either forfeit the unvested options or immediately exercise the vested options. As a measure for the exit rate, we use 7.71%, the rate of UK CEO turnover post publication of the Cadbury report (reported in Dahya, McConnell, and Travlos, 2002). In Cvitanic, Wiener, and Zapatero (2008), the executive director exercises the options if the share price hits a certain multiple of the exercise price or at maturity.[17] We use the exercise multiple reported in Carpenter (1998) and assume that when the share price is 2.75 times higher than the exercise price, the executive will exercise their options.[18] The exercise price, vesting period, and time to maturity are from the annual report. Daily share prices and dividend yields are from Datastream. As a proxy for the risk-free rate, we

[16] Our proxy for volatility is the standard deviation of share price returns of up to one year prior to the annual report end date.

[17] The intuition for this result is that when options are deeply in the money, the executive will exercise them to avoid the risk of it falling out of the money. Also, this feature of the model allows for the fact that most executives tend to exercise their options long before maturity (Hudart and Lang, 1996; Carpenter, 2002).

[18] Ideally, we should calculate this exercise multiple for each company with historic data on the options' exercise policies of the executives. Unfortunately, for this and related papers this data is not available.

use the yield to maturity of UK treasury STRIPS with the same (or approximately the same) time to maturity as the options being valued.

In Table 2, we present some descriptive statistics of the ownership and cash compensation variables for the executive directors in our sample.[19] It shows that on average the executive board holds 17.57% of the shares of the company although there is, nevertheless, a large spread between the first and last quartiles. The average wealth incentive (provided by shares) to increase the share price by 1% (delta of shares) is £81,461. The incentive provided by options to increase the share price by 1% (options' delta) is much smaller, with an average value of £10,583. For their sample of US companies, Coles, Daniel, and Naveen (2006) report values of the sum of deltas of shares and options of teams of executives of $1,387,000, which is substantially larger than the values in the table (based on average 2006 exchange rate).[20] The average incentive to increase volatility by 1% is £2,149, which again is considerably smaller than the figure reported by Coles, Daniel, and Naveen (2006) of $202,000. For comparison purposes, in Table 2 we also report the value of the call options held by the executive team, the delta and the vega calculated using the BSE (respectively BSE, DeltaBSE, and VegaBSE). The average figures, obtained using the BSE model, are larger than the figures obtained using the Cvitanic, Wiener, and Zapatero (2008) model. This result seems to indicate that by using the BSE model to calculate the proxies for risk and wealth incentives, the literature could have been

[19] Some of the companies only disclose the total cash compensation paid to the board. Since we are only interested in the pay to executive directors, in those cases we adjust the total to the executives by dividing the total paid to directors by the number of directors in the board and then multiplying the figure by the number of executive directors. We are aware that we could be understating the cash compensation paid to the executives since non-executive directors are likely to be paid less.

[20] In Coles, Daniel, and Naveen (2006), the figure of the delta of team compensation is the sum of the delta of the top four executives and the CEO. Since our figure includes all the executive directors (which can result in a team larger or smaller than four), the comparison of two figures has to be treated with caution. We would like to investigate if the large difference in the figures is driven by the delta of shares, the delta of options, or both. Unfortunately, such a comparison cannot be established since Coles, Daniel, and Naveen (2006) only report the sum of the deltas of shares and options.

overstating the values of those proxies. Lastly, in 2006, the average sum of salary, benefits, and bonus of the executive teams was £368,211. Coles, Daniel, and Naveen (2006) report a figure of $3,678,000, which again shows a large discrepancy between both samples. The large difference between our figures for both managerial equity wealth and cash compensation and the results reported in Coles, Daniel, and Naveen (2006), for example, can be explained by the size of the companies in our sample. We would expect that larger companies, like those analyzed in Coles, Daniel, and Naveen (2006), would have larger compensation packages. Although this disparity is expected, the differences in value between US and UK compensation packages are not new to the literature (see Conyon and Murphy, 2000).

Insert Table 2

5.2. Regression results: Incentive variables as exogenous variables

The relation between hedging and managerial wealth and risk incentives was tested using a logit regression. The independent variables are a set of control variables and the managerial wealth and risk incentives. The managerial incentives are defined as the sum of the managerial incentives of the executives' team.[21] In the second column of Table 3 (Model 1), we present our results using in this model specification the log of the sum of the deltas of shares and options.

[21] This approach assumes that the number of executives is constant across the different companies. As a robustness test, we repeat all the calculations, adjusting the risk incentive variables to the number of executives on the board. The qualitative results do not change when we do this adjustment, and we only report the results obtained using the executive team incentives measures.

Insert Table 3

Our results support the hypothesis that larger companies are more likely to hedge. This finding could be due to the economies of scale hypothesis, as suggested by previous literature, or due to the fact that the smaller companies in the AIM market could be financially less sophisticated and less likely to hedge. Also, the results support the hypothesis that companies which are more cash constrained are more likely to hedge. The results for managerial incentives are opposite to what we should expect. The log of the sum of the delta of shares and options is negative, and the log of the vega of options is positive; both variables are statistically significant. As a robustness test, we estimate Model 1 and Model 2 specifications with the unlogged version of the incentive variables, and the results are qualitatively the same. This result could occur since under Model 1 specification, the coefficient of the log of the vega variable can be giving us information about the overall incentive provided by options and not necessarily the risk incentive provided by options. This finding can be a result of the log specification of the incentive variables, meaning that as the share-based wealth of the executives increases, the incentive variables will also increase but at a diminishing rate. Since the executives' share-based wealth is dominated by shareholdings, the wealth effect incentive provided by options is potentially not being captured by our proxy. Moreover, options and shares can provide different incentives since an option reflects the right to ownership, but not ownership. Although this result is partially reflected in the delta (the delta of a share is one and an option will (commonly) have a delta smaller than one), an option always has the probability of finishing out of the money. Thus, it is likely that the incentives provided by shares and options are viewed differently by managers. Also, contrary to

shareholdings, executive options cannot be traded and, therefore, shares are more liquid from the executive's point of view. To capture, the (possible) different incentives provided by options and shares, we separate our variable (log of the sum of the deltas of shares and options) into two variables: the log of the delta of shares and the log of the delta of options (Model 2).

The results in Table 3 (Model 2) show that shares and options provide different incentives. We can see that, as suggested in Guay (1999), options provide two incentives: they induce risk aversion (as measured by the option's delta which is significant) and they also induce risk taking (as measured by options' vega, which is not significant). As a robustness test, we estimate Model 1 and Model 2 using the BSE to calculate the delta and vega of options. The results are qualitatively the same for all variables, but the wealth incentive provided by options (the options' delta coefficient) is positive but not significant if we use the BSE. This result shows the importance of using an options pricing model that adequately considers the specificities of executive options. It could be argued that our result is conditional on our assumption of the exercise multiple. Estimating the options' wealth and risk incentives using the BSE indirectly provides a (weak) robustness test of our results on the assumption that the executive will exercise the options when the share price is 2.75 times the exercise price (or alternatively at maturity or if the executive leaves holding vested options, if the option is in the money). In the case that the exercise multiple is very large (infinity in the limit), the executive will only exercise the option at maturity and we can use the classic BSE.[22] As a further robustness test, we run Models 1 and 2 but with the wealth and risk incentives provided by options estimated using a low exercise multiple. Since executives can exercise their options as soon as

[22] To be precise, this is only true for the exercise policy since the vesting period and the likelihood that the executive will leave or be fired before the options mature is still considered in the Cvitanic, Wiener, and Zapatero (2008) model (and not in the BSE model).

they vest, we calculate the wealth and risk incentives if executives exercise their options as soon as they are in the money.[23] Our results are again qualitatively the same. Further, to test the robustness of our results to our assumption of the rate of executive turnover, we re-estimate vega and delta using 4.3%, which is the forced UK CEO turnover rate post publication of the Cadbury report (reported in Dahya, McConnell, and Travlos, 2002), and we re-run our regression models. Our results remain unchanged (these results are available from the authors).

We find that the delta of shares has a (significant) negative coefficient. This result indicates that companies in which the executive directors' wealth, as measured by the delta of shares, is more linked to companies' value are less likely to hedge. This finding contradicts the predictions of Smith and Stulz (1985). A possible explanation for our result is that management teams of smaller companies can have different risk attitudes and perceptions than larger firms. This attitude to risk could influence their choices in hedging (Pennings and Smidts, 2000). Also, corporate decisions in smaller companies are not made in separate functions but by managers who are responsible for multiple functions (Pennings and Garcia, 2004). Thus, smaller companies might have more autonomous management teams in which executives have to fully understand the different aspects of the business and the consequences of their corporate actions. Another possible explanation is that smaller companies could have better internal monitoring mechanisms or can be easier to monitor. Both explanations, if true, would result in mitigated agency conflicts due to managerial risk aversion. Moreover, since in smaller companies managers are often significant owners who founded the company and have entrepreneurial characteristics (and can be less risk averse), we would expect that the wealth incentives of management teams of

[23] We assume here that the executives exercise vested options when the share price hits the exercise price plus 0.0001pence.

smaller companies result in stronger risk-taking incentives than the wealth and risk incentives of larger companies.

Some of the larger companies in the AIM could be similar to some of the smaller companies examined in prior research in the UK and US. We decide to further explore our sample and test if there is a significant difference between the effect of managerial incentives in the smaller and larger companies in the AIM market. For this test, we consider two additional specifications of our model. In Model 3, we interact the managerial incentives with a dummy variable that takes the value of one if the company has a turnover smaller than £5.6 million. In Model 4, we interact our incentive measures with a dummy variable that has the value of one if the company has a market capitalization less than £50 million.[24] Our hypothesis is that in smaller companies, the incentives provided to the executives team, by shares and options, is significantly different from the incentives provided in larger companies in the AIM market. Table 4 shows that in the smaller companies there is a stronger negative relation between the incentive provided by shares and options and the hedging likelihood. Nevertheless, the interaction coefficients are not significant. Thus, we cannot conclude that the effect on the hedging likelihood of the incentives provided by shares and options of the executive teams of the smaller companies is significantly different from the effect of the incentive provided to the executive teams of the larger companies in the AIM market. Our result for the incentive provided by options is nevertheless sensitive to our definition of dummy variables. As a robustness test of the results of Model 3, we re-estimate the model using a more stringent definition of the size dummy variable (D_small). A company is defined as small, according to section 382 of the UK companies' Act 2006, if it satisfies two of the three following

[24] The £50 million cut-off point is chosen since the large majority of companies traded in the Main Market have a larger market capitalization. See footnote 9 for details.

requirements: turnover of no more than £5.6million, total assets of no more than £2.8million, and not more than fifty employees. Therefore, we redefine the dummy variable of Model 3 (D_small). The dummy (D_small) now takes the value of one if the company had a turnover less than £5.6 million and its total assets are less than £2.8million. As in Model 3, the interaction coefficient shows that the wealth effect, provided by shareholdings, of small companies is not statistically different from the wealth effect provided to managers of larger companies (these results are available from the authors). The interaction coefficients of wealth and risk incentives, provided by options, are now statistically significant (the coefficient of the interaction variable with the options' wealth incentive is negative, and the interaction effect of the risk incentive positive). As a robustness test of Model 4, we redefine our small capitalization dummy variable (D_SmallCap). In 2006, the majority of the companies traded on the AIM had a market capitalization less than £25million. Thus, we redefine our dummy variable (D_SmallCap) as taking the value of one if the company has a market capitalization inferior to £25million. Qualitatively our results do not change.

Insert Table 4

5.3. Do executive teams that hold large proportions of shares behave more like owners?

The managerial compensation literature suggests that since options increase with volatility, option holdings can provide an incentive to increase risk.[25] On the other hand, since both options and shareholdings link managers' wealth to company

[25] Using a certainty-equivalence framework, Lambert, Larcker, and Verrecchia (1991) and Hall and Murphy (2002) show that in the money options can increase managerial risk aversion.

value and increase managers' sensitivity to changes in share prices (delta), options and shares could provide an incentive to decrease company risk. In other words, since options link the manager's wealth to company value, the manager could become more risk averse. Less developed in the managerial compensation literature is the idea that since delta increases with share value, the value of the managerial portfolio of options and shares increases if the manager's actions are value enhancing, i.e., delta can also provide an incentive to hedge less, if hedging is value enhancing (exceptions include Ross, 2004; Low, 2009). Ross (2004) shows that the effect of compensation contracts on managerial risk attitudes is not only dependent on the shape of the payoff function of the compensation contract (concave or convex). A convex (concave) payoff function will not necessarily result in a convex (concave) effect on the manager's utility function. The effect of the payoff function depends on its functional shape but also on the level of wealth of the manager, the manager's risk aversion coefficient, and whether the manager has an increasing or decreasing risk aversion utility function. Managerial ownership of shares can result in risk-taking behavior, and conversely, managerial ownership of options can result in risk aversion behavior. Ultimately, the incentive provided by delta will depend on which of the two effects (risk aversion or value enhancing incentive) dominates. We would expect that in companies where the separation between ownership and control is less pronounced, the value enhancing incentive would dominate. Thus, managers who own a large proportion of the shares of the company can be less risk averse and hedge less. As stated in section 3, many AIM companies are closely held, with managers often being a majority shareholder. It is possible that agency conflicts arising from the separation of the role of manager/shareholder are less likely to occur in some of these companies. If this hypothesis is correct, then in companies where managers are large

shareholders, we should not find evidence of agency conflicts due to managerial risk aversion. It is also possible that managers who own a large proportion of the company are overconfident or more risk tolerant since they could feel more responsible for the company and have more confidence in the future prospects (Malmendier and Tate, 2005 and Lewellen, 2006 present evidence of manager overconfidence).

We test the alternative hypothesis that executive teams that hold 5% or less of the shares of the company[26] are more risk averse, and the hedging likelihood of such teams is larger than the hedging likelihood of executive teams that hold larger proportions of company shares.[27] To test this hypothesis, we interact a dummy variable that takes the value of one if the directors hold 5% or less of the shares outstanding (D_5) with our managerial incentive variables. We expect to find a positive relation between our interaction variable and the likelihood that the company will hedge.

Table 5 shows that the wealth incentives provided by shares have a different effect in the hedging likelihood if the executive team holds a small proportion of the shares of the company. Moreover, the results show that in companies where the executive team holds less than 5% of the shares outstanding, managers are more risk averse. This wealth incentive can happen due to overconfidence of managers that hold a large proportion of the shares of the company or because in those companies the separation of the roles manager/shareholder is less pronounced. There is no significant difference in the effect on the hedging likelihood of the incentives provided by options.

[26] Morck, et al. (1988) use a cutoff point of 5% ownership. As a robustness test, we repeat our calculation for a cutoff point of 10%, which is slightly higher than the median of our sample (9.89%). The results remain qualitatively the same.

[27] Although we should expect that as the percentage of share ownership of the executive increases so does the delta of their shares, delta is not a function of the number of shares outstanding. For example, the executive team of company A can have a larger percentage of the company, when compared to company B, and a smaller delta.

Insert Table 5

5.4. Regression results: Incentive variables as endogenous variables

We recognize that some of our control variables could affect the directors' incentives, and therefore, managerial holdings incentives are endogenous variables. To control for endogeneity, we first estimate three tobit regression models (since some of the executive teams do not hold options or shares) for the managerial incentives variables. We use the predicted value from these models as explanatory variables of the risk management model in a two-stage least squares framework (our method is similar to Rogers, 2002). The results of the tobit models are presented in Table 6. Our results do not support the hypothesis that options held by executive teams of larger companies provide larger incentives to alter company risk or share value. Moreover, shares held by executive teams of smaller companies provide larger incentives to alter share price. Shares held by executive teams of companies with higher growth opportunities provide larger incentives to alter share value.[28] We find a significant positive relation between cash compensation and the managerial incentive provided by shares, which according to our hypothesis would indicate that managers whose wealth is more linked to company value are paid more. Since the large majority of the companies in our sample do not grant shares, this result is not necessarily an indication of larger pay packages. This finding could indicate that managers who have more wealth connected to company value actively decide on their

[28] The coefficient of the market-to-book value variable is significant only at weak levels.

pay. For companies in which the board has less than two non-executive directors, managers have smaller incentives to alter share price. Therefore, we find no evidence of the rent extraction hypothesis due to poorer governance structures. In those companies, managers have a higher incentive to alter the company's risk. The previous two-year share price returns have a positive coefficient for deltas and a negative coefficient for vega. The positive coefficient could indicate that, as suggested by Yermack (1995), shares and options can be granted to reward past performance. However, the large majority of the companies in our sample do not grant shares, thus, although the Yermack (1995) hypothesis can be valid for options, it is less likely to apply to shares. Nevertheless, some of the shares held by managers can result from the exercise of options. It is also possible that the coefficients explain the mechanical relation between share prices and deltas and vegas (Rogers, 2002). As share prices increase, deltas will increase and vega will decrease (since the share price is moving away from the exercise price). This relation can explain the negative coefficient in Model 8. Lastly, as expected, vega and delta of options are positively related.

Insert Table 6

Assuming that companies optimally design compensation contracts to mitigate agency problems and that the coefficients of the three tobit models in Table 6 represent the permanent effect on vega and delta, we use those coefficients to estimate the predicted values of vega and delta. We then use those predicted values as instruments of the logit regression model. In Table 7, Model 9 shows that treating the incentive variables as endogenous produces a significant difference in the results. The

wealth and risk incentives held by the executive teams do not seem to affect the hedging likelihood. In Model 10, we interact our D_5 dummy variable with the managerial incentives and find that in companies where the executive teams hold a large proportion of the companies' shares, managerial effects do not impact the hedging likelihood. Conversely, executive teams that hold a smaller proportion of the companies' shares are significantly more risk averse and more likely to hedge.

Insert Table 7

5.5. Robustness test

Overwhelmingly, the risk management literature identifies hedgers as users of derivatives. As a robustness test, we redefine our dependent variable as it is commonly used in the literature (derivative users), and we re-estimate Models 4, 5, and 10 in Models 11, 12, and 13 with the new dependent variable. Table 8 shows that 70 companies hedge with derivatives compared to 95 in the previous tests. The results for size and hedging alternatives are qualitatively the same. The coefficient of the wealth incentive provided by shares is not significant in the Model 11 specification. This result could indicate that due to this misclassification, the prior empirical literature could have misinterpreted the effect of managerial incentives on the hedging likelihood. Nevertheless, as the literature normally concentrates on large and widely held companies, we would expect that larger companies would use more derivatives,[29] and the difference in the definition of the hedgers' classification should be less important in the previous studies. Lastly, Models 12 and 13 confirm our previous

[29] On the other hand, many of the earlier studies considered periods when hedging was less prevalent, especially using derivatives.

results (at the 10% significance level), which indicate that the wealth incentive provided by the shares held by executive teams that hold a small proportion of the company has a significantly different effect on the hedging likelihood.

Insert Table 8

6. Conclusion

In this paper, we estimate managerial incentives and the hedging decision of UK AIM companies. In the model of managerial incentives, we consider a variety of important characteristics of executive options, including the vesting period, the probability that the executive leaves the company before the options mature or vest, and the possibility that the options are exercised before maturity. Our results show that the model used does impact the observed effect of managerial incentives on the hedging likelihood. This result is an indication that the BSE model may not be an adequate model to approximate the value of the incentives provided by executive options. Also, contrary to previous literature, we do not concentrate on large and widely held companies since we study the effect on the hedging likelihood of managerial wealth and risk incentives of small and closely held companies. Small, closely held companies where managers hold a large proportion of the company are more likely to be close to the zero agency-cost case of Jensen and Meckling (1976). Therefore, in these companies, managerial portfolio holdings could provide considerably different incentives than those previously observed in the literature.

We propose that in small, closely held companies where managers own a large proportion of the company, not only the scale of managers' incentives is important but

also the level of ownership (percentage of ownership). Managers that are majority shareholders are likely to be more committed and devote more effort to the company even if the incentive amount resulting from their holdings is smaller. They are also more likely to have entrepreneurial characteristics and be less risk averse. Both the scale of managers' incentives and their level of ownership should be considered when analysing the effect of the managers' portfolio holdings on managers' risk-taking financial decisions. Our results support our hypothesis. In companies where managers own a large proportion of the shares of the company, the wealth effect of managerial shareholdings results in a risk-taking effect and this result is consistent throughout several robustness tests. We find that managers who hold a smaller proportion of the company (although they can hold significant amounts of equity) are significantly more risk averse. Thus, the size and ownership structure characteristics of AIM companies seem to result in similarities between managers' and owners' actions. Future research should analyze if our results are characteristic to our sample, and if in samples where managers exercise their options much closer to maturity (e.g., the share price hits the "desired" level defined by the executive much later) the same result is observed.

Table 1
Comparison of means between hedgers and non-hedgers of 317 companies listed on the UK AIM market.

This table provides a comparison of the means of financial variables between hedgers and non-hedgers of 317 companies listed on the UK AIM market. Information is year-end data from Datastream and the companies' annual reports.

Definition of Variables:
Percentage distributed dividends is the percentage of companies that distributed dividends in 2006. Percentage of foreign companies is the percentage of foreign companies within the group. Market-to-book value is the ratio of market value of equity to book value of equity at year-end. Total sales is the year-end total sales. Market value is the market capitalization of the company at the year-end 2006. Gearing is the ratio of book value of debt to market value of equity. Share ownership is the percentage of share ownership of executive directors. The total assets measure is the total assets reported. Quick ratio is the average ratio of current assets to current liabilities. Delta of shares is the average of the change in the executive directors' portfolio of shares as the share value changes by 1%. Delta of options is the average of the change in the value of the executive directors' portfolio of options as the share price changes by 1%. Vega is the average of the change in the value of the executive directors' portfolio as volatility changes by 1%.

Percentage distributed dividends, percentage of foreign companies, and total sales appear in the table to provide information on the sample, but they are not used in the regression models.

	Non-Hedger	*Hedger*	*Probability*
Number of companies	222	95	
Percentage distributed dividends	18.02%	36.84%	
Percentage of foreign companies	5.41%	8.42%	
Market-to-book value	1	3	0.21
Total sales (thousands of pounds)	37,088	46,315	0.34
Market value (thousands of pounds)	38,906	77,842	0.13
Gearing	19.90%	56.26%	**0.00**
Share ownership	20.37%	11.02%	**0.00**
Total assets (thousands of pounds)	37,288	65,359	**0.01**
Quick ratio	10	7	0.20
Delta shares (thousands of pounds)	97	45	**0.05**
Delta options (thousands of pounds)	11	8	0.15
Vega (thousands of pounds)	2.0	2.4	0.25

Table 2
Descriptive statistics of compensation, ownership variables, and directors' board composition.

This table provides control and managerial wealth and risk incentive variables in 317 AIM companies from 2006 Annual Reports. Information is year-end data from Datastream or the companies' annual reports.

Definition of Variables: Share ownership is the percentage of share ownership of executive directors. Delta shares (£) is the change in the executive directors' portfolio of shares as the share value changes by 1%. Call (£) is the value of the options held by executive directors. Delta options (£) is the change in the value of the executive directors' portfolio of options as the share price changes by 1%. Vega (£) is the change in the value of the executive directors' portfolio of options as volatility changes by 1%. BSE (£) is the value of the Black and Scholes options pricing formula. DeltaBSE (£) is the change in the value of the executive directors' portfolio of options as the share price changes by one percent, calculated using the Black and Scholes model. VegaBSE (£) is the change in the value of the executive directors' portfolio of options as volatility changes by one percent, calculated using the BSE. No. of executives is the number of executive directors on the board. No. of non-executives is the number of non-executive directors on the board. Executive cash (£) is the sum of salary, benefits, and bonus paid to the executive directors during the year.

	Mean	*Q1*	*Median*	*Q3*	*Max*	*Standard deviation*
Share ownership	17.57%	1.36%	9.89%	28.06%	94.53%	20.39%
Delta shares (£)	81,461	2,097	13,974	59,231	6,358,554	380,266
Call (£)	822,918	6,647	118,363	540,114	39,266,322	2,938,293
Delta options(£)	10,583	112	1,983	7,854	400,797	31,577
Vega (£)	2,149	0	587	2,094	28,057	4,372
BSE (£)	936,447	10,361	141,701	610,054	46,361,555	3,330,682
DeltaBSE (£)	11,711	151	2,304	9,102	469,882	35,139
VegaBSE (£)	3,389	47	1,137	3,274	41,205	6,180
No. of executives	3	2	3	4	7	1
No. of non-executives	3	2	3	3	7	1
Executive cash (£)	368,211	137,911	279,682	470,955	3,883,739	389,107

Table 3
Effect of managerial incentives on hedging likelihood.

This table reports the results of the logit regression on the relation between hedging and managerial wealth and risk incentives. The dependent variable is an indicator variable, which takes the value of one if the firm hedges. Information is year-end data from Datastream or the companies' annual reports.

In Model 1, the managerial incentives are measured as the log of vega and the log of the sum of the delta of shares and options held by the executive team. In Model 2, we disentangle the log of the delta of shares and delta of options into two separate variables: the log of the shares and the log of the options held by the executive team.

Definition of Variables: Log (total assets) is the natural log of total assets. Market-to-book value is the ratio of market value of equity to book value of equity. Gearing is the ratio of book value of debt to market value of equity. Dummy-industry is a dummy variable which takes the value of one if the company belongs to one of the following industries: coal mining, petroleum refining, oil and gas extraction. Dividend yield is the companies' year-end dividend yield. Quick ratio is ratio of current assets to current liabilities. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Log (delta share+delta options) is the natural log of the change in the executive directors' portfolio of both shares and options as the share value changes by 1%. Log(delta shares) is the natural log of the change in the value of the executive directors' portfolio of shares as the share price changes by 1%. Log(delta options) is the natural log of change in the value of the executive directors' portfolio of options as the share price changes by 1%. Log(vega) is the natural log of the change in the value of the executive directors' portfolio of options as volatility changes by 1%.

	Model 1		*Model 2*	
Variable	Coefficient	*p*-value	Coefficient	*p*-value
Intercept	-7.533	0.0000	-6.919	0.0001
Log (total assets)	0.417	**0.0001**	0.352	**0.0004**
Market-to-book value	0.009	0.3937	0.01	0.3782
Gearing	0.4745	0.1936	0.593	0.1353
Dummy-industry	0.365	0.5633	0.278	0.6375
Dividend yield	0.275	**0.0054**	0.336	**0.0014**
Quick ratio	-0.002	0.8066	0.0005	0.9254
Dummy if less than 2 non-executives	0.038	0.9225	0.131	0.7335
Log (delta shares + delta options)	-0.189	**0.0125**		
Log (delta shares)			-0.166	**0.0018**
Log (delta options)			0.142	**0.0232**
Log (vega)	0.094	**0.0273**	-0.017	0.7499
Total observations	317		317	
Hedgers	95		95	
Non-hedgers	222		222	
McFadden R-square	14.3%		15.8%	

Table 4
Models of differences in the effects of managerial incentives in small and large AIM companies.

This table reports the results of the logit regression on the relation between hedging and managerial wealth and risk incentives including a proxy for small and large AIM companies. The dependent variable is an indicator variable that takes the value of one if the firm hedges. In Model 3, we interact the incentive variables with a dummy variable, which takes the value of one if the company's 2006 turnover is less than £5.6 million. In Model 4, we interact the incentive variables with a dummy variable, which takes the value of one if the company's market capitalization is less than £50 million.

Definition of Variables: Log (total assets) is the natural log of total assets. Market-to-book value is the ratio of market value of equity to book value of equity. Gearing is the ratio of book value of debt to market value of equity. Dummy industry is a dummy variable, which takes the value of one if the company belongs to one of the following industries: coal mining, petroleum refining, oil and gas extraction. Dividend yield is the companies' year-end dividend yield. Quick ratio is ratio of current assets to current liabilities. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Log(delta shares) is the natural log of change in the value of the executive directors' portfolio of shares as the share price changes by 1%. Log(delta options) is the natural log of change in the value of the executive directors' portfolio of options as the share price changes by 1%. Log(vega) is the natural log of the change in the value of the executive directors' portfolio of options as volatility changes by 1%. D_small is a dummy variable, which takes the value of one if the company had in 2006 a turnover inferior to £5.6 million. D_small_cap is a dummy variable, which takes the value of one if at the annual report year-end the market capitalization of the company is inferior to £25 million.

	Model 3		*Model 4*	
Variable	Coefficient	*p*-value	Coefficient	*p*-value
Intercept	-6.485	0.0003	-6.338	0.0006
Log (total assets)	0.326	**0.0016**	0.319	**0.0030**
Market-to-book value	0.009	0.3946	0.009	0.3760
Gearing	0.605	0.1317	0.592	0.1309
Dummy-industry	0.497	0.414	0.235	0.7028
Dividend yield	0.315	**0.0032**	0.336	**0.0012**
Quick ratio	0.001	0.8630	0.0004	0.9451
Dummy if less than 2 non-executives	0.141	0.7204	0.095	0.8074
Log (delta shares)	-0.144	**0.0302**	-0.158	**0.0495**
Log (delta options)	0.154	**0.0396**	0.227	**0.0523**
Log (vega)	-0.025	0.6902	-0.097	0.3431
D_small*Log (delta shares)	-0.052	0.5312		
D_small*Log (delta options)	-0.064	0.6591		
D_small*Log(vega)	0.141	0.7086		
D_small_cap*Log(delta shares)			-0.008	0.9263
D_small_cap*Log(delta options)			-0.137	0.3997
D_small_cap*Log(vega)			0.128	0.3287
Total observations	317		317	
Hedgers	95		95	
Non-hedgers	222		222	
McFadden R-square	16.0%		16.1%	

Table 5
Model of differences in the effects of managerial incentives in companies where managers hold smaller proportions of shares.

This table reports the results of the logit regression on the relation between hedging and managerial wealth and risk incentives including a proxy for managerial share ownership. The dependent variable is an indicator variable, which takes the value of one if the firm hedges. In Model 5, we interact a dummy variable, which takes the value of one if the directors hold 5% or less of the shares outstanding with our managerial incentive variables.

Definition of Variables: Log (total assets) is the natural log of total assets. Market-to-book value is the ratio of market value of equity to book value of equity. Gearing is the ratio of book value of debt to market value of equity. Dummy industry is a dummy variable, which takes the value of one if the company belongs to one of the following industries: coal mining, petroleum refining, oil and gas extraction. Dividend yield is the companies' year-end dividend yield. Quick ratio is ratio of current assets to current liabilities. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Log(delta shares) is the natural log of change in the value of the executive directors' portfolio of shares as the share price changes by 1%. Log(delta options) is the natural log of change in the value of the executive directors' portfolio of options as the share price changes by 1%. Log(vega) is the natural log of the change in the value of the executive directors' portfolio of options as volatility changes by 1%. D_5 is a dummy variable which takes the value of one if the executive directors hold less than 5% of the companies' shares outstanding.

Model 5		
Variable	Coefficient	*p*-value
Intercept	-6.958	0.0000
Log (total assets)	0.369	**0.0002**
Market value to book value	0.011	0.3539
Gearing	0.480	0.1502
Dummy-industry	0.193	0.7543
Dividend yield	0.325	**0.0039**
Quick ratio	-0.001	0.8874
Dummy if less than 2 non-executives	0.214	0.5769
Log (delta shares)	-0.274	**0.0007**
Log (delta options)	0.172	**0.0541**
Log (vega)	0.0002	0.9969
D_5*Log (delta shares)	0.204	**0.0425**
D_5*Log (delta options)	-0.038	0.7760
D_5*Log(vega)	-0.089	0.4359
Total observations	317	
Hedgers	95	
Non-hedgers	222	
McFadden R-square	17.2%	

Table 6

Models of determinants of managerial wealth and risk incentives.

This table estimates three tobit regression models (since some of the executive teams do not hold options or shares) for the managerial incentives variables. We use the predicted value from these models as explanatory variables of the risk management model in a two-stage least squares framework. In Model 6, the dependent variable is the log of the delta of options. In Model 7, the dependent variable is the log of the delta of shares. In Model 8, the dependent variable is the log of vega.

Definition of Variables: Log (total assets) is the natural log of total assets. Log(Volatility) is the natural log of the annualised standard deviation of daily share price returns of up to one year prior to the year-end. Market-to-book value is the ratio of market value of equity to book value of equity. Past return is the average monthly share price return over the two years prior to the year-end. Log (cash) is the natural log of the sum of salary, benefits, and bonus. Gearing is the ratio of book value of debt to market value of equity. Dummy-ind2 is a dummy variable, which takes the value of one if the company belongs to one of the following industries: utility, banking, insurance. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Dummy if no remuneration committee is a dummy variable, which takes the value of one if the company does not have a remuneration committee or if it does not disclose the existence of such committee. Number of executives is the number of executive directors on the board. Percentage of non-exec is the percentage of non-executive directors on the board. Log(vega) is the natural log of the change in the value of the executive directors' portfolio of options as volatility changes by 1%. Log(delta shares) is the natural log of change in the value of the executive directors' portfolio of shares as the share price changes by 1%. Log(delta options) is the natural log of change in the value of the executive directors' portfolio of options as the share price changes by 1%.

Model 6			*Model 7*		*Model 8*	
Variable	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
Intercept	-0.597	0.7481	6.305	0.0258	-2.773	0.2440
Log (total assets)	0.085	0.5004	-0.358	**0.0221**	-0.109	0.3880
Log (Volatility)	0.357	0.2860	-0.401	0.1994	-0.001	0.9971
Market value to book value	0.002	0.1254	0.005	0.0586	-0.001	0.7582
Past return	7.271	**0.0267**	5.507	**0.0528**	-11.785	**0.0036**
Log (cash)	0.145	0.4173	0.634	**0.0007**	0.360	0.2659
Gearing	-0.276	0.0779	0.142	0.3867	0.192	0.1857
Dummy-ind2	-0.748	0.0804	0.356	0.2784	-0.176	0.7048
Dummy if less than 2 non-executives	-1.083	**0.0203**	-1.581	**0.0035**	1.092	**0.0262**
Dummy if no remuneration committee	-0.217	0.5081	0.062	0.8138	-0.604	0.1175
Number of executives	0.129	0.494	0.225	0.0983	0.040	0.8542
Percentage of non-exec.	-0.750	0.6195	-2.469	0.1028	1.100	0.522
Log (vega)	0.868	**0.0000**	0.030	0.4704		
Log (delta shares)					-0.097	0.0832
Log (delta options)					1.300	**0.000**
Total observations	317		317		317	
Censored observations	61		22		82	
Adjusted R-square	64.6%		19.9%		64.0%	

Table 7
Two-stage models of hedging likelihood.

This table uses the predicted values of the coefficients of the three tobit models in Table 6 as instruments of the logit regression model. In Model 9, we treat the incentive variables as endogenous variables, which produces a significant difference in the results. In Model 10, we interact our D_5 dummy variable with the managerial incentives.

Definition of Variables: Log (Total assets) is the natural log of total assets, at year-end. Market-to-book value is the ratio of market value of equity to book value of equity. Gearing is the ratio of book value of debt to market value of equity. Dummy industry is a dummy variable, which takes the value of one if the company belongs to one of the following industries: coal mining, petroleum refining, oil and gas extraction. Dividend yield is the companies' year-end dividend yield. Quick ratio is ratio of current assets to current liabilities. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Pred_Log(delta shares) is the estimated value of natural log of the delta of shares using Model 7 of Table 6. Pred_Log(delta options) is the estimated value of natural log of the delta of options using Model 6 of Table 6. Pred_Log(vega) is the estimated value of the natural log of the vega of options using Model 8 of Table 6. D_5 is a dummy variable, which takes the value of one if the executive directors hold less than 5% of the companies' shares outstanding.

	Model 9		*Model 10*	
Variable	Coefficient	*p*-value	Coefficient	*p*-value
Intercept	-7.571	0.0001	-7.685	0.0001
Log (total assets)	0.383	**0.0004**	0.386	**0.0003**
Market value to book value	0.01	0.4162	0.010	0.3778
Gearing	0.583	0.1575	0.447	0.2045
Dummy-industry	0.216	0.7103	0.153	0.8064
Dividend yield	0.296	**0.0041**	0.308	**0.0063**
Quick ratio	0.001	0.7991	0.001	0.8158
Dummy if less than 2 non-executives	0.129	0.7280	0.174	0.6423
Pred_Log (delta shares)	-0.073	0.4863	-0.164	0.1924
Pred_Log (delta options)	0.015	0.8251	0.100	0.3413
Pred_Log (vega)	0.105	0.1413	0.065	0.5036
D_5*Pred_Log(delta shares)			0.348	**0.0009**
D_5*Pred_Log(delta options)			-0.298	0.0745
D_5*Pred_Log(vega)			0.145	0.3926
Total observations	317		317	
Hedgers	95		95	
Non-hedgers	222		222	
McFadden R-square	13.6%		16.5%	

Table 8
Robustness tests.

This table reports the results when we redefined our dependent variable as it is commonly defined in the literature (derivative users) and we re-estimate Models 4, 5, and 10 as Models 11, 12, and 13. Definition of Variables: Log (total assets) is the natural log of total assets, at year-end. Market-to-book value is the ratio of market value of equity to book value of equity. Gearing is the ratio of book value of debt to market value of equity. Dummy industry is a dummy variable, which takes the value of one if the company belongs to one of the following industries: coal mining, petroleum refining, oil and gas extraction. Dividend yield is the companies' year-end dividend yield. Quick ratio is ratio of current assets to current liabilities. Dummy if less than 2 non-executives is a dummy variable, which takes the value of one if the company has less than two non-executive directors in the board. Log(delta shares) is the natural log of change in the value of the executive directors' portfolio of shares as the share price changes by 1%. Log(delta options) is the natural log of change in the value of the executive directors' portfolio of options as the share price changes by 1%. Log(vega) is the natural log of the change in the value of the executive directors' portfolio of options as volatility changes by 1%. D_5 is a dummy variable, which takes the value of one if the executive directors hold less than 5% of the companies' shares outstanding. Pred_Log(delta shares) is the estimated value of natural log of the delta of shares using Model 7 of Table 6. Pred_Log(delta options) is the estimated value of natural log of the delta of options using Model 6 of Table 6. Pred_Log(vega) is the estimated value of the natural log of the vega of options using Model 8 of Table 6.

Model 11			*Model 12*		*Model 13*	
Variable	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
Intercept	-7.277	0.0001	-7.494	0.0000	-8.263	0.0001
Log (total assets)	0.343	**0.0011**	0.376	**0.0004**	**0.369**	**0.0010**
Market value to book value	0.007	0.4751	0.007	0.4735	0.004	0.5681
Gearing	0.525	0.1437	0.439	0.1148	0.462	0.1387
Dummy-industry	0.673	0.2914	0.598	0.3562	0.639	0.3310
Dividend yield	0.325	**0.0007**	0.292	**0.0030**	**0.273**	**0.0037**
Quick ratio	-0.013	0.1005	-0.014	0.0652	-0.013	0.1475
Dummy if less than 2 non-executives	-0.097	0.8163	-0.075	0.8596	0.026	0.9510
Log (delta shares)	-0.072	0.1614	-0.199	**0.0246**		
Log (delta options)	0.063	0.3583	0.170	0.0733		
Log (vega)	-0.003	0.9793	-0.023	0.7585		
D_5*Log(delta shares)			0.204	0.0614		
D_5*Log(delta options)			-0.276	0.0760		
D_5*Log(vega)			0.079	0.5570		
Pred_Log (delta shares)					0.045	0.7490
Pred_Log (delta options)					0.050	0.6301
Pred_Log (vega)					0.092	0.3681
D_5*Pred_Log(delta shares)					0.199	0.0712
D_5*Pred_Log(delta options)					-0.044	0.7811
D_5*Pred_Log(vega)					-0.159	0.3440
Total observations	317		317		317	
Hedgers	70		70		70	
Non-hedgers	247		247		247	
McFadden R-square	15.0%		16.5%		16.1%	

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