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# The Effect of CEO Risk Appetite on Firm Volatility: An Empirical Analysis of Financial Firms

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*Abstract*

*This paper examines the effect of CEO risk appetite on the return volatility of a sample of large, listed financial firms over the period 2000-2008. After controlling for firm specific characteristics, the results give strong evidence that the CEO risk appetite has an important effect on firm volatility. The biographical measures for CEO risk appetite are significant explanatory variables of all measures of firm volatility employed in this study. The effect of CEO age is significant and positive for all four volatility measures, while CEO education and current job tenure are negative and significant for all four measures. Executive experience with other firm boards has a negative and significant effect on total and idiosyncratic volatility. Interestingly, CEO wealth is complementary to the other biographical variables with a positive effect all but in the default volatility measure. Our results carry implications for shareholders, financial regulators, governments and managers.*

***JEL Classification*:** F30; G32; G33.

***Key words*:** Executive compensation, stock options, risk appetite, firm risk, financial institutions.

## 1. Introduction

The subprime mortgage crisis is only the most recent reminder of the primary importance of risk management for financial institutions. On the one hand, as Carey and Stulz (2005) have emphasized, there cannot be a franchise value without taking on risk. On the other hand, Merton (1993) has cautioned that although taking on risk may enable a financial firm to make profits, it can also damage its franchise value with customers. In its most extreme manifestation, damaged franchise value can cause the demise of the financial firm as credit, counterparties and clients dry up and disappear with resulting losses for all concerned. The nationalization of Northern Rock and the bankruptcy of Lehman Brothers in the wake of the financial crisis of 2007 are recent, vivid examples of how excessive managerial risk-taking can damage a financial firm's franchise value and the interests of a wide range of stakeholders, including shareholders, creditors, counterparties and clients. Indeed, the sheer level of economic damage and social repercussions caused by the crisis has attracted the attention and involvement of politicians, governments and regulators. Thus, it is of considerable academic and practical interest to understand what factors, if any, affect managerial risk-taking by financial institutions. Indeed, in a survey of emerging themes in the banking sector, Wilson et al. (2010) underline the importance of risk-taking incentives and the implications for systemic stability. In this paper we look at the factors that could affect managerial appetite for risk-taking and examine their effect on the level of firm volatility for a set of large, UK financial institutions over the period 2000 to 2008.

Although firm performance has often been the focus of studies on managerial decision making,[1] the relationship between managerial decision making and firm risk has also been considered. Many of these studies look at the effect of managerial equity based compensation on firm risk in the context of the agency conflict that opposes managers and shareholders. In the non-financial sector, for example, Agarwal and Mandelker (1987), DeFusco et al. (1990) and Chok and Sun (2007) find a positive relationship between firm risk and option-based compensation. In the financial sector, Saunders *et al.* (1990) find that banks with high managerial equity ownership exhibit greater risk than those with low managerial equity ownership, while Chen *et al.* (1998), employing a similar methodology over a different time period, find the contrary. However, Chen *et al.* (2006), focusing on option-based compensation, find that both option based compensation and option based wealth increase firm risk in the banking industry. Other studies look at the effect of corporate governance mechanisms on firm risk. Pathan (2009), for example, assesses the relationship between firm risk and board structure and finds that strong bank boards that reflect shareholder interests positively affect bank firm risk while the CEO's ability to control board decisions negatively affects it. Similarly, Akhigbe and Martin (2008) investigate the influence of governance and disclosure on risk in the US financial services sector and provide some evidence that stronger disclosure and governance reduce firm risk. None of the risk-based studies consider managerial risk appetite and the effect it could have on risk-taking.

[1] For studies in the non-financial sector see, for example: Coughlan and Schmidt (1985), Lewellen et al. (1987), Jensen and Murphy (1990a,b), Agrawal et al. (1991), Mehran (1995),), Goldberg and Idson (1995), Aggarwal and Samwick (1999), and Core et al. (1999). For the financial sector see: Barro and Barro (1990), Crawford et al. (1995), Hubbard and Palia (1995), Collins et al. (1995), Houston and James (1995), Fields and Fraser (1999), and John et al. (2000).

Risk appetite, however, figures prominently in modern financial theory. Risk aversion, defined as the extent to which an agent dislikes risk and is willing to avoid it, is the most common representation of risk appetite. Markowitz's (1952) mean-variance efficiency analysis and Sharpe (1964) and Lintner's (1965) Capital Asset Pricing Model are derived within the Von Neumann and Morgenstern (1953) Expected Utility Theory, which is based on the assumption of risk aversion. These two models are the pillars of modern portfolio theory and the inspiration for hundreds, if not thousands, of academic studies.[2] Risk appetite is not limited to the concept of risk aversion. Friedman and Savage (1948), Swalm (1966), Levy (1969) and Kahneman and Tversky (1979), show that typical preferences must include risk seeking as well as risk averse segments.[3] The stochastic dominance literature developed by Hadar and Russell (1969) and Hanoch and Levy (1969), which includes the concepts of conditional stochastic dominance (Clark and Jokung, 1999) and marginal conditional stochastic dominance (Shalit and Yitshaki, 1994) extends this insight and provides decision rules for both risk seekers and risk averters. Besides risk aversion and risk seeking, risk neutrality also figures as an important representation of risk appetite in modern financial theory and practice. Since Cox and Ross (1976), many, if not most, asset pricing models are based on the concept of risk neutrality. Therefore, given the importance of risk appetite in financial decision-making, the issue of risk-taking in the financial sector warrants further inquiry.

[2] Expected utility theory has been extended beyond the concept of risk aversion. For example, using the same methodology as the Pratt (1964) analysis of risk aversion, Kimball (1990) developed the concept of prudence for analyzing problems where the uncertainty affects marginal utility rather than utility.

[3] There is circumstantial evidence of widespread risk-seeking behavior in the US mortgage sector leading up to the crisis, although those that sought the risk are not necessarily those who ended up bearing the risk..

Our study is a first step in this direction. Along with firm specific characteristics such as size and leverage, it explicitly considers the CEO risk appetite as a determinant of the volatility of financial firms' returns. The period itself is interesting because it includes the dot.com crisis at the beginning of the century, the run-up to the subprime mortgage crisis of 2007 and the crisis itself. The case of the UK is also interesting because it differs in one significant aspect from that of the US, the object of most research on the determinants of firm volatility. Although similar to the US with respect to shareholder rights,[4] the UK bankruptcy code provides creditors with much stronger legal protection than that offered by the US code. On the La Porta *et al.* (1998) scale, for example, the UK is awarded a creditor rights score of 4 (strong creditor rights) whereas the US score is 1, making the US one of the most anti-creditor English law countries. Stronger creditor rights faced by UK firms have the potential to influence CEO risk-taking. First of all, UK creditors have more leeway to restrict managerial decisions that could adversely affect the value of their loans. Secondly, CEO jobs are more precarious due to the enhanced power of creditors to force liquidation and the absence of a UK equivalent of the US Chapter 11, which protects a bankrupt firm from creditors while it restructures and often leaves management in place to effect the restructuring. Thus, UK CEOs have more of an incentive than US CEOs to rein in their risk taking to protect their jobs[5]. The strict application of the absolute priority rule is also a deterrent to risk-taking. Bebchuk (2002),

[4] For shareholder rights LaPorta et al. report the following scores: Rule of law (RL): UK Score = 8.57, US = 10; rating of accounting disclosure standards (ASR): UK Score = 78, US = 71; anti-director rights (ADR): UK Score = 5, US = 5.

[5] Amihud and Lev (1981), Holmstrom and Ricart ICosta (1986) and Hirshleifer and Thakor (1992) have provided evidence that managers avoid taking risks, including those that enhance firm value, due to career concerns. According to this view, managers may even spend corporate resources to diversify their companies' operational risks to protect their career.

for example, has shown that violations of the absolute priority rule, as witnessed under debtor-friendly codes, can lead to greater risk-taking.

The main contribution of this paper is that the empirical results indicate that CEO risk appetite does, in fact, play an important role in the determination of the volatility of firms in the financial sector. The portion of CEO risk appetite captured by the CEO's demographic characteristics is statistically significant. CEO age has a positive effect on firm volatility, while CEO education, job tenure and experience on other boards affect it negatively. Finally, CEO wealth is marginally significant, suggesting that an increase in wealth leads to more risk-taking.

The remainder of this paper is organized as follows. The next section describes the data used in the study, provides our expectation about the effect of the variables on firm risk, and describes the method adopted for the analysis. Section 3 presents the empirical results, section 4 the robustness tests and section 5 concludes.

## 2. Data and methodology

### *2.1 Data selection*

We hand collected data from Boardex and company annual reports on CEO risk appetite starting from a sample of 65 financial firms listed on the FTSE 250 as of January 2000[6]. CEO risk appetite is captured by wealth and biographical characteristics. CEO wealth includes the value of all stock ownership, unexpired stock options and long term incentive plans (LTIPs) accumulated and held by the CEO to date. CEO biographical

[6] Relevant Boardex data is only available from 2000.

characteristics include age, education, time in role, and time on other boards. The data for generating firm volatility measures and control variables is obtained from Datastream (for full definition see Table 1). After excluding firms without the requisite CEO risk appetite information, this yields a sample of 45 financial firms for the period 2000 to 2008, which includes 24 banks and saving institutions, 10 insurance companies, and 11 securities firms.

The dependent variable is firm volatility. We use three measures of firm volatility: the standard deviation of stock returns and two measures estimated from a two-factor model. The annual daily standard deviation of stock returns *(TV)* is defined as the total firm volatility. Following Pathan (2009), Chen et al. (2006) and Anderson and Fraser (2000), we employ a two-factor model to decompose total firm volatility into two separate market-based volatility measures.

$$r_j = \alpha_j + \beta_{mj} r_m + \beta_{Ij} I + e_j \qquad (1)$$

where $r_j$ is the daily return on firm j, $r_m$ is the daily return on the market (proxied here by the FTSE AllShare index), $I$ is the daily 90-day Treasury bill, and $e_j$ is a random error term. Estimation of equation (1) produces the following volatility measures for each firm-

year: $\beta_{mj}$, which is a measure of systematic volatility *(SYSV)*, and $\sigma_{ej}$, the standard deviation of the residuals, which is a proxy for firm idiosyncratic volatility (*IDIOV*).

*2.2 Data description*

One route to estimating measures of risk appetite requires the specification of a utility function.[7] Given the wide range of potential functions and the difficulty of verifying that any given function is the right one, this looks like a dead end street. An alternative to specifying a particular utility function is to use the primitive determinants of risk appetite that have been consistently documented in the recent empirical literature: wealth, age, education, and experience.[8] Hall (1998) argues that risk appetite can be proxied by demographic and executive biographical characteristics and many studies suggest that this is, in fact, the case. Grimm and Smith (1991) and Gottesman and Morey (2006) show a significant relationship between CEO characteristics and organizational outcomes. Other studies, such as Hamao *et al.*, (2003) for managerial investment decisions, Johnson and Marietta-Westberg, (2003) for disclosure decisions, and Campbell *et al.*, (2001) for more focused business strategies, show a relationship between managerial characteristics and firm volatility. Chok and Sun (2007) show that age in particular is a significant determinant of volatility in the bio-tech sector. In this study, the CEO risk appetite variables of interest are wealth (*CEO* wealth), age (*CEO age*), education (*CEO education*), and experience (*CEO time in other boards* and *CEO time in role)*. The definition of these variables and their expected effect on firm volatility is

[7] Another route involves developing general market measures of risk aversion. See, for example, Coudert and Gex (2008).
[8] Abdel-Khalik (2007) takes a similar approach in his study of earnings smoothing.

discussed below. For convenience, empirical definitions of all variables are presented in Table 1.

Our measure of *CEO wealth* includes all equity-based holdings, including vested and non-vested options. Unlike previous studies, our measure for option-based wealth is more comprehensive, and consists of the value of all unexpired stock and LTIP (long-term incentive plans) options accumulated and held by the CEO to date.[9] There is a strong argument that equity based wealth (*CEO wealth*) should have a positive effect on firm volatility, because option values are positively related to the stock variance.[10] According to Hirshleifer and Suh (1992), incorporating stock options into executive compensation would predispose CEOs to take riskier decisions than they would otherwise. More recently, Coles et al. (2006) also provide evidence of a strong relation between executive compensation in the form of options and the financial policies of the firm. Similarly, Chen et al. (2006) find a positive relationship between option-based executive compensation and firm risk. On the other hand, Smith and Stultz (1985) argue that since the value of option-based compensation is sensitive to changes in the underlying stock price - as the stock price increases (decreases), value of the options increases (decreases) - CEOs holding in or at-the money options in an undiversified portfolio would be exposed to firm-specific risk and hence may be inclined to reduce this

[9] The value of the accumulated option is estimated by Boardex using the Black and Scholes (1973) formula adjusted for continuously paid dividends. A possible error arises from omitting other assets as well as from using Black-Scholes values for stock options. For example, Huddart (1994) and Hall and Murphy (2002) highlight the problem with the overstatement of the values of executive stock options to the executive in comparison to the value of a comparable traded option. This is due to restrictions on trade as well as to risk aversion.

[10] Baranchukand and Chib (2008) provide evidence that firms increase option awards to their CEOs when agency problems become more pronounced.

risk in order to preserve the stock price. Thus, the foregoing discussion suggests that the *CEO wealth* can affect firm risk either positively or negatively.

Although it is generally agreed that age, education and experience are likely to affect firm volatility, there is no definitive argument on the direction it will take. Vroom and Pahl (1971) and Hitt and Tyler (1991) document a negative relation between executives' age and risk taking and argue that older CEOs are more cautious and conservative and therefore less likely to take risks. Golden and Zajac (2001), however, find that strategic change is positively related to age, and argued that it requires a degree of confidence and experience to introduce strategic change and that this is mainly present in senior and older managers. More recently, Chok and Sun (2007) find that the age of managers positively affects idiosyncratic volatility, concluding that only experienced leaders dare to take big risks. Where education is concerned, there is some evidence in the medical journals of a negative relationship between education and risk aversion (see Rosen *et al.*, 2003) attributed to the argument that the educated individual should have a more thorough understanding and knowledge of the nature and consequences of a specific decision, thereby overcoming a "fear" of risk. The counterargument is that lack of education may impair the executive's ability to fully understand the decision at hand, and can lead to a risky choice because of an incomplete grasp of the consequences. This study uses the number of professional and academic degrees to proxy for education. Where CEO experience is concerned, it can be argued that a degree of experience is required to recognize the potential benefits of risk taking, such that the more experienced CEO may have a greater appetite for risk. The counter-argument is that experience leads

the CEO to recognize the pitfalls of risk-taking and reduces his appetite for risk. Finkelstein and Hambrick (1990) report that CEO experience is negatively related to risk appetite. Similarly, CEO experience has also been positively related to maintaining the status quo by Hambrick, Geletkanycz and Fredrickson (1993) and negatively related to strategic change by Grimm and Smith (1991) and Thomas and Ramaswamy (1996). Thus, the extant literature suggests that we can have no strong priors on the signs of the CEO biographical characteristics of age, education and experience. We use two variables to proxy for experience, CEO time in role and CEO time on other boards.

Three control variables are included to capture various manifestations of firm heterogeneity in the sample. All empirical studies examine the relationship between firm size (*Total assets*) and firm volatility. There are, however, competing arguments for either a positive or negative relation between the two. The negative relationship arises from the diversification possibilities related to size. For example, Anderson and Fraser (2000) find a negative relation between bank size and total risk while Saunders, Strock and Travlos (1990) show a negative relation between systematic risk and bank size. [11] The positive relationship is related to the ability of larger financial institutions to operate with lower capital ratios (Liang and Rhoades, 1991) and pursue riskier activities (Demsetz and Strahan, 1997). Size is measured as the log of total assets. Following Chen at al. (2006), we also control for off-balance sheet activity (*Non-regular income*) and expect a positive relationship with firm volatility[12]. Finally, following Akhigbe and Martin's (2008) study of US financial service sector, we control for the impact of

[11] We thank an anonymous referee for this insight.
[12] For banks and other financial firms, off-balance sheet activity is measured as non-interest income divided by total income; for insurance companies, it is non-premium income over total income.

leverage (*Leverage*) on firm volatility. Normally, higher leverage is associated with higher stock price volatility. However, as argued in the introduction, the strong creditor rights faced by UK firms have the potential to reduce CEO risk-taking. Thus, the effect of leverage on firm volatility can be positive or negative. A negative effect suggests that the UK bankruptcy code plays an important role in CEO decision-making.

**[Insert table 1]**

Table 2 presents the descriptive statistics for the variables discussed above. The average *CEO wealth* is £1,552,387 and is significantly lower than the $8,700,130 reported by Chen et al. (2006) on a sample of US banks. This finding is consistent with Conyon and Murphy (2000), who found that US CEOs are granted more options than their UK CEO counterparts, indicating that US CEO compensation is tightly linked to firm performance. CEOs, on average, are 50 years old, have a university degree, have been 4.01 years in the current job, and have a total time experience at board level with other companies of 1.85 years. The Pearson's pair-wise correlation matrix in table 3 shows that education is correlated with age, time in role and time in other boards.[13]

*2.3 Methodology:*

This section presents the empirical specification of the determinants of firm volatility. Let $V_{it}$ be the computed volatility for the returns of firm $i$ at $t$, where $V_{it} \in \{TV_{it}, SYSV_{it}, IDIOV_{it}\}$. Let $CWT_{it}$ be the estimated CEO wealth, $X_{it}$ be the vector of CEO

[13] In variance inflation tests of these variables none was greater than 2, which indicates there is no problem with colinearity.

biographical characteristics, and $C_{it}$ the vector of firm specific characteristics (control variables). Consider the following specification for:

$$V_{it} = \alpha CWT_{it} + X'_{it}\gamma + C'_{it}\delta + \lambda_i + \xi_{it} \qquad (2)$$

where $\alpha$ is a scalar, $\gamma$ and $\delta$ are k-dimensional vectors of coefficients, $\lambda_i$ are unobserved firm fixed effects, and $\zeta_{it}$ is a disturbance term assumed to be normally and independently distributed, with mean zero and variance $\sigma_{\xi}^2$.

One salient problem with the estimation of equation (2) is that $CWT_{it}$ (*CEO wealth*) is likely to be endogenous. If this is the case, the results from fixed-effects estimation may not be reliable. We address this issue in two ways. First, we use single equation instrumental variable (IV) estimation and a Hausman test to investigate whether $CWT_{it}$ is affected by endogeneity bias. The previous period *CEO wealth* ($CWT_{i,t-1}$) is used as an instrument. The economic rationale is that CEO decisions are persistent, and business conditions tend to be autocorrelated, leading to autocorrelation in the *CEO wealth* which depends directly on these factors. Given the strong persistence in equity-based compensation, we expect $CWT_{i,t-1}$ to be a powerful predictor of $CWT_{it}$. At the same time, the lagged *CEO wealth* cannot depend on current firm volatility measures and hence is uncorrelated with the current period disturbance term (i.e., exogenous). To check for under identification (whether instruments are correlated with endogenous variables), the Anderson-Canon LM statistic is reported. We also perform the Stock and Yogo (2005) weak identification test to control for biased estimators due to weak instruments.

In a second step, we model the relation between firm volatility and wealth in a simultaneous-equation to capture the potential feedback effect. We estimate this relationship in a framework of a system of equations where the equation for firm volatility is as specified in equation (2) and the wealth specification follows Chen et al. (2006):

$$CWT_{it} = \eta V_{it} + \tau Log(TA_{it}) + \varsigma SP_{it} + \lambda_i + \varepsilon_{it} \qquad (3)$$

where $\eta$, $\tau$ and $\varsigma$ are scalars. $V_{it} \in \{TV_{it}, SYSV_{it}, IDIOV_{it}\}$ is the computed firm volatility, $Log\ (TA_{it})$ is the natural logarithm of *total assets*; $SP_{it}$ stands for the fiscal year-end stock price, $\lambda_i$ are unobserved firm fixed effects, and $\varepsilon_{it}$ is a disturbance term assumed to be normally and independently distributed, with mean zero and variance $\sigma_\varepsilon^2$. We estimate equations (2) and (3) simultaneously using three-stage least squares (3SLS), where the disturbance terms are assumed to be contemporaneously correlated.

## 3. Results

We first test whether the estimated *CEO wealth* is endogenous. The Hausman test provides significant evidence of an endogeneity bias at the 5% level between all firm volatility measures and *CEO wealth*, suggesting the latter requires instrumentation (see Table 4). The Anderson-Canon test is significant and indicates that equation (2) is identified. The Cragg-Donald *F*-statistic is greater than the critical value provided by Stock and Yogo (2005), indicating that the null hypothesis of weak instruments can be rejected. Hence, based on the argument in the preceding section, we instrument the *CEO*

*wealth* at *t* using the *t-1*-dated *CEO wealth* together with firm-fixed effects and year dummies. The results of the unreported instrument equation show that the coefficient of lagged *CEO wealth* is significant at the 1% level, with a coefficient 0.430, suggesting positive wealth persistence, as expected. The $R^2$ and *F* statistics for the instrumented *CEO wealth* equation are 42% and 1.75 respectively, confirming the quality of these instruments.

**[Insert Table 4]**

Table 4, presents the results of the factors that affect firm volatility using three different measures: total volatility, idiosyncratic volatility and systematic volatility. For each measure of volatility, we run two models: a model that controls for the unobserved firm heterogeneity and a model that controls for the unobserved sector heterogeneity. As expected, our measures of CEO biographical risk appetite are key explanatory variables of firm volatility. The effect of *CEO age* is significant and positive for all three measures of risk, which suggests that managerial risk appetite increases with age. This finding is consistent with Golden and Zajac (2001) and Chok and Sun (2007) and the argument that older CEOs are more confident in taking challenging and risky decisions. *CEO Education* is significant for all three measures of risk but affects firm volatility negatively, suggesting that educated CEOs tend to adopt a more cautious approach to risk-taking. With respect to executive experience, tenure in the current job (*CEO time in role*) is significant and negative for all three measures of volatility, while *CEO time in other boards* also has a negative significant effect on total and idiosyncratic volatilities. This

result provides evidence for the argument that experience leads the CEO to recognize the pitfalls of risk-taking and reduces his appetite for risk.

The coefficient of the instrumented *CEO wealth* is not significant for any of the specifications and the sign varies. This weak relationship warrants further robustness analysis.[14]

With respect to the control variables, size (*total assets*) has a positive and significant effect on firm volatility. This is consistent with the argument that larger financial institutions have the ability to operate with low capital ratios and pursue riskier activities. *Leverage* has a positive and significant impact on firm volatility, which confirms the conventional relationship between leverage and volatility. Contrary to expectations, *non-regular income* has a positive and significant effect on the total and idiosyncratic volatilities.

Overall, these results suggest that firm volatility is sensitive to the risk appetite of the CEO reflected in the demographic variables as well as to the other control variables. On the other hand, there is no significant relationship between firm volatility and CEO wealth.

[14] Preliminary robustness checks suggest that wealth and biographical characteristics are complementary. When we run the regressions without wealth, the significance of the biographical variables is diminished. This suggests that wealth and the biographical variables are complementary and that both are required for the correct model specification.

Table 5 shows the results based on the three stage least squares (3SLS). 3SLS is a combination of multivariate regression (SUR estimation) and two stage least squares (2SLS) that generates instrumental variable estimates, taking into account the covariances across equation disturbances (Green, 2003). The results of the 3SLS are generally consistent with the results reported in Table 4 with respect to the CEO biographical and control variables. The main difference is that *Non-regular income* is only significant for idiosyncratic volatility.

Results are different for the *CEO wealth*, which is positive but becomes significant in most specifications. This is evidence in support of the risk-taking hypothesis, implying that the CEO's risk appetite increases as his stock of equity-based wealth increases, inciting him to pursue strategies that increase the volatility of the firm.

**[Insert table 5]**

## 4. Further robustness checks

In this section we conduct further robustness checks to ensure the validity of the foregoing results. First, as an additional measure of firm volatility, we calculate a Z-score to account for insolvency (distance to default). Following Boyd et al. (1993) and Pathan (2009), a Z-score is computed for each fiscal year. The Z-score for each fiscal period is computed as Z = {[Average(Returns) + Average(Equity/Total assets)]/ SD(Equity/Total Assets)}. Calculated this way, the Z-score has an inverse form, i.e. 1/Z, in order to make the interpretation of the signs of coefficients comparable. Thus, a high Z-score means more default risk.

Results are reported in table 6. The results with respect to CEO characteristics are qualitatively similar to those in tables 4 and 5. The CEO accumulated option, however, is not significant in any specification. One plausible explanation is that while option values are enhanced by increased volatility, these values would be destroyed in the case of default. Interestingly, and contrary to the results in tables 4 and 5, we find that firm size is negative and significant with respect to insolvency, reflecting perhaps the "too big to fail" factor.

Second, we employ the Generalised Method of Moments (GMM) system estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). The GMM estimator combines a set of first differenced equations with equations in levels, where instrument variables are generated within the system. The consistency of the GMM estimates is subject to the absence of higher-order serial correlation in the regression error term and to an optimal choice of instruments. The results are reported in Table 7. Tests for serial correlation are, denoted as AR(1) and AR(2), are both statistically insignificant, suggesting the absence of first-order and second-order serial correlation. The Sargan test of over-identifying restrictions is not significant, indicating that the instruments used in the GMM estimation are not correlated with the error term.

The results of the GMM estimations confirm the results in Tables 4, 5 and 6. The interpretation of the coefficients on the proxies for CEO risk appetite (*CEO age*, *CEO education*, *CEO time in role*, *CEO time in other boards*) remains qualitatively the same. For example, the statistically significant negative coefficients on CEO education across

all the measures of risk suggest that educated CEOs are associated with lower risk. Similarly, the statistically significant positive coefficients on CEO age across all measures of firm risk except systematic volatility (*SYSV*) suggest that CEO age relates positively to firm volatility. Overall, the GMM estimates in Table 7 provide further empirical evidence that CEO risk appetite measures are the key determinants of firm volatility.

## 5. Conclusion

This paper examines the effect of CEO risk appetite on firm volatility for a sample of large, listed financial firms over the period 2000-2008. We use four measures of firm volatility, five proxies for risk appetite, three control variables for firm characteristics and three estimation methodologies to test this relation.

The results give strong evidence that the CEO risk appetite has an important effect on firm volatility. The biographical measures for CEO risk appetite are significant explanatory variables of all measures of firm volatility employed in this study. The effect of *CEO age* is significant and positive while *CEO Education*, executive experience with other firm boards (*CEO time in other boards*) and CEO tenure in the current job (*CEO time in role*) have a negative and significant effect on total and idiosyncratic risk. These results highlight the importance of CEO risk appetite in the determination of firm volatility and suggest that age, education and job experience should be considered when determining CEO compensation packages.

Where shareholders, financial regulators, governments and managers are concerned, the implication is that when trying to understand the level of firm volatility with a view to regulatory decisions, the pertinent CEO biographical characteristics should be considered. We have identified a number of these characteristics but, clearly, this is a topic where further research is needed to strengthen and deepen our knowledge. This simple but versatile approach provides a basis for generating further hypotheses about other variables, which may affect the risk appetite of CEOs, that we have not studied in this article, but which might be incorporated in future work.

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**Table 1: Definitions of variables**

| ***Variables*** | ***Definition*** |
|---|---|
| *CEO wealth* | The value of all equity holdings, unexpired stock and LTIPs options accumulated and held by the CEO to date (£, thousands). |
| *CEO age* | In years |
| *CEO education* | # of professional and academic qualifications |
| *CEO time in role* | In years, the length of time that the CEO has been in the current role |
| *CEO time in other boards* | In years, the total length of time spent by the CEO at board level within quoted companies other than that being viewed, divided by the number of those companies |
| *Log (Total assets)* | Total assets of the company |
| *Non regular income* | The percentage of income derived from non-regular sources (non-premium income in the case of insurance companies, and non-interest income for banks and other financials) |
| *Leverage* | The ratio of long-term total debt to total assets. |
| *Stock price* | Fiscal year-end stock price (pence) |
| *Total volatility (TV)* | The annual standard deviation of firm share returns |
| *Idiosyncratic volatility (IDIOV)* | Estimated from a two-factor model (see equation 1) |
| *Systematic volatility (SYSV)* | Firm market beta (see equation 1) |
| *Insolvency volatility (Z-score)* | Z= 1/{[Average (Returns) + Average (Equity/Total Assets)]/SD(Equity/Total Assets)}. |

**Table 2: Descriptive Statistics**

| Variable | Min | Mean | Max | SD |
|---|---|---|---|---|
| *CEO wealth* | 0 | 1552.38 | 24146 | 2635.3 |
| *CEO age* | 32 | 50.07 | 69 | 6.62 |
| *CEO education* | 0 | 1.43 | 6 | 1.15 |
| *CEO time in role* | 0 | 4.10 | 25.2 | 4.10 |
| *CEO time in other boards* | 0 | 1.86 | 14 | 2.61 |
| *Total assets (£ M)* | 0.0016 | 86.5 | 2390 | 271 |
| *Non regular income* | 0 | 37.79 | 100 | 41.47 |
| *Leverage* | 0 | 0.22 | 0.96 | 0.26 |
| TV | 0 | 0.02 | 0.09 | 0.01 |
| IDIOV | 0 | 0.02 | 0.09 | 0.01 |
| SYSV | -0.57 | 0.70 | 2.65 | 0.57 |
| Z-score | 25.66 | 18.60 | 12.58 | 2.97 |

**Table 3 Pearson correlation coefficients**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1.CEO accumulated option | 1 | | | | | | | |
| 2. Log (CEO age) | -0.1 | 1 | | | | | | |
| 3. CEO Education | **0.22** | -0.09 | 1 | | | | | |
| 4. CEO time in role | 0.04 | 0.1 | 0.26 | 1 | | | | |
| 5. CEO time in other boards | **0.19** | 0.39 | **0.21** | **0.23** | 1 | | | |
| 6. Log (total asset) | 0.01 | -0.01 | **0.36** | -0.04 | 0.1 | 1 | | |
| 7. Total debt ratio | -0.03 | 0.002 | **0.16** | 0.09 | **-0.15** | **0.27** | 1 | |
| 8. Non-regular income | 0.2 | 0.14 | -0.1 | -0.05 | **0.23** | **-0.44** | -0.16 | 1 |
| 9. TV | -0.12 | 0.05 | -0.07 | **0.13** | 0.06 | 0.02 | 0.08 | 0.02 |
| 10. IDIOV | **-0.17** | 0.01 | **-0.14** | 0.12 | -0.03 | **-0.15** | 0.07 | 0.09 |
| 11. SYSV | **0.23** | 0.06 | **0.27** | 0.12 | **0.28** | **0.6** | **0.13** | **-0.21** |
| 12. Z-score | -0.03 | 0.01 | **-0.36** | 0.06 | -0.09 | **-0.99** | **-0.26** | **0.43** |

Bold texts indicate statistically significant at 1% level or better.

Table 4: The determinants of firm volatility

| | TV | | IDIOV | | SYSV | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| CEO accumulated option | 0.03 | -0.15 | -0.02 | -0.17 | 0.31 | 0.50 |
| | (0.36) | (-1.42) | (-0.23) | (-1.18) | (0.84) | (1.49) |
| Log (CEO age) | 3.93** | 5.34** | 3.13** | 4.26** | 12.48** | 12.16** |
| | (4.02) | (4.09) | (3.51) | (3.79) | (3.20) | (2.93) |
| CEO Education | -0.27** | -0.35** | -0.20** | -0.26** | -1.04** | -1.01** |
| | (-2.78) | (-2.72) | (-2.19) | (-2.30) | (-2.65) | (-2.43) |
| CEO time in role | -0.09** | -0.09** | -0.08** | -0.07** | -0.22** | -0.25** |
| | (-3.44) | (-2.57) | (-3.09) | (-2.42) | (-1.97) | (-2.17) |
| CEO time in other boards | -0.07** | -0.05 | -0.08** | -0.07* | -0.20 | -0.08 |
| | (-2.06) | (-1.22) | (-2.45) | (-1.71) | (-0.15) | (-0.53) |
| Log (total asset) | 0.38** | 0.20 | 0.25** | 0.11 | 2.23** | 2.75** |
| | (2.95) | (1.28) | (2.15) | (0.82) | (4.34) | (5.61) |
| Total debt ratio | 3.36** | 2.91** | 3.47** | 3.07** | 8.42** | 10.78** |
| | (4.84) | (3.25) | (5.47) | (3.98) | (3.03) | (3.78) |
| Non-regular income | 0.01** | -0.001 | 0.01** | -0.001 | 0.004 | -0.01* |
| | (2.10) | (-1.05) | (2.44) | (-0.07) | (0.41) | (-1.68) |
| Constant | -17.57** | -20.35** | -13.09** | -15.35** | -76.03** | -83.11** |
| | (-4.00) | (-3.47) | (-3.26) | (-3.03) | (-4.32) | (-4.45) |
| Firm-fixed effects | Yes | | Yes | | Yes | |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector Dummies | | Yes | | Yes | | Yes |
| *N* | 268 | 268 | 268 | 268 | 268 | 268 |
| $R^2$ | 0.59 | 0.43 | 0.55 | 0.41 | 0.39 | 0.30 |
| *Hausman-test* $\chi^2(1)$ | 31.05** | 29.43** | 13.68** | 15.91** | 14.13** | 15.04** |
| *Anderson-Canon LM test* | 68.02** | 69.74** | 136.19** | 71.83** | 136.19** | 71.83** |
| *Cragg-Donald F-test* | 282.09** | 281.13** | 282.09** | 283.04** | 282.09** | 283.04** |

Note: TV (Total Volatility), IDIOV (Idiosyncratic Volatility) are multiplied by 100, SYSV (Systematic Volatility) is multiplied by 10. The estimator is instrumental variables (IV), with an instrumented CEO wealth. Instrument is one period lagged CEO accumulated option. The coefficients' standard errors are adjusted for the effects of non-independence by clustering on each firm. Hausman test is a test for endogeneity bias. The null hypothesis of the Anderson-Canon test is underidentification. The Cragg-Donald F-test tests for weak identification (10% critical value of Stock-Yogo weak ID test is 19.93). For full definition of variables see Table 1. *t* statistics in parentheses (* $p < 0.10$, ** $p < 0.05$).

Table 5: Firm volatility determinants - 3SLS

| | TV | | IDIOV | | SYSV | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| CEO accumulated option | 0.66** | 0.87* | 0.49* | 0.68 | 6.74** | 7.72** |
| | (2.00) | (1.74) | (1.77) | (1.62) | (2.76) | (2.62) |
| Log (CEO age) | 5.62** | 8.80** | 4.47** | 7.42** | 25.98* | 26.42 |
| | (2.96) | (2.86) | (2.85) | (2.87) | (1.95) | (1.52) |
| CEO Education | -0.60** | -1.03** | -0.46** | -0.83** | -3.44** | -3.54* |
| | (-3.05) | (-3.09) | (-2.82) | (-2.98) | (-2.46) | (-1.88) |
| CEO time in role | -0.11* | -0.17* | -0.08* | -0.14* | -0.72* | -0.82 |
| | (-1.84) | (-1.87) | (-1.70) | (-1.82) | (-1.74) | (-1.59) |
| CEO time in other boards | -0.17** | -0.21** | -0.16** | -0.21** | -3.59 | -0.40 |
| | (-2.70) | (-2.24) | (-3.05) | (-2.62) | (-0.82) | (-0.79) |
| Log (total asset) | 0.81** | 0.55* | 0.57** | 0.40 | 5.74** | 5.70** |
| | (3.25) | (1.83) | (2.80) | (1.58) | (3.17) | (3.28) |
| Total debt ratio | 5.41** | 4.62** | 4.65** | 4.14** | 30.98** | 36.00** |
| | (3.45) | (2.24) | (3.59) | (2.38) | (2.74) | (2.97) |
| Non-regular income | 0.001 | -0.001 | 0.001 | -0.001 | -0.04* | -0.06** |
| | (0.24) | (-1.03) | (1.48) | (-0.24) | (-1.82) | (-2.40) |
| Constant | -28.05** | -40.26** | -20.88** | -32.81** | -181.12** | -189.08** |
| | (-2.76) | (-2.52) | (-2.49) | (-2.44) | (-2.46) | (-2.04) |
| Firm-fixed effect | Yes | | Yes | | Yes | |
| Year dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector dummies | | Yes | | Yes | | Yes |
| N | 315 | 315 | 315 | 315 | 315 | 315 |

Note TV (Total Volatility), IDIOV (Idiosyncratic Volatility) are multiplied by 100, SYSV (Systematic Volatility) is multiplied by 10.. The estimator is three-stage least-squares. For full definition of variables see Table 1. *t* statistics in parentheses (* $p < 0.10$, ** $p < 0.05$).

Table 6 Determinant of Insolvency Risk (Z-score)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| CEO accumulated option | -0.00 | -0.07 | 0.15 | 0.23 |
| | (-0.04) | (-1.66) | (1.58) | (1.49) |
| Log (CEO age) | 1.11** | 1.69** | 1.38** | 2.74** |
| | (2.99) | (3.19) | (2.62) | (2.87) |
| CEO Education | -0.08** | -0.12** | -0.14** | -0.32** |
| | (-2.07) | (-2.17) | (-2.61) | (-3.05) |
| CEO time in role | -0.03** | -0.03* | -0.02 | -0.06* |
| | (-2.59) | (-1.94) | (-1.40) | (-1.92) |
| CEO time in other boards | -0.01 | -0.01 | -0.04** | -0.06** |
| | (-1.10) | (-0.39) | (-2.07) | (-2.00) |
| Log (total asset) | -0.88** | -0.96** | -0.76** | -0.86** |
| | (-17.84) | (-15.33) | (-11.03) | (-9.19) |
| Total debt ratio | 0.65** | 0.50 | 0.92** | 0.99 |
| | (2.44) | (1.38) | (2.13) | (1.52) |
| Non-regular income | 0.001* | -0.001* | 0.001 | -0.001* |
| | (1.78) | (-1.74) | (0.09) | (-1.77) |
| Constant | -9.56** | -10.46** | -11.19** | -16.28** |
| | (-5.69) | (-4.37) | (-3.95) | (-3.29) |
| Firm-fixed effect | Yes | | Yes | |
| Year dummies | Yes | Yes | Yes | Yes |
| Sector dummies | | Yes | | Yes |
| *N* | 268 | 268 | 315 | 315 |

Note: The dependent variable is Z-score (Distance to default). The estimator in columns (1) and (2) is instrumental variables (IV), with an instrumented CEO wealth. Instrument is one period lagged CEO accumulated option. The estimator for columns (3) and (4) three-stage least-squares. For full definition of variables see Table 1. *t* statistics in parentheses (* $p < 0.10$, ** $p < 0.05$).

Table 7 GMM results

| | TV | IDIOV | SYSV | Z-score |
|---|---|---|---|---|
| CEO accumulated option | -0.04 | -0.01 | 0.09 | -0.01 |
| | (-0.77) | (-0.27) | (0.39) | (-0.29) |
| Log (CEO age) | 2.57** | 2.49** | 2.31 | 0.77** |
| | (2.79) | (2.91) | (0.57) | (2.14) |
| CEO Education | -0.40** | -0.36** | -1.45** | -0.11** |
| | (-4.39) | (-4.27) | (-3.62) | (-3.23) |
| CEO time in role | -0.07** | -0.08** | -0.08 | -0.02* |
| | (-2.55) | (-2.92) | (-0.62) | (-1.91) |
| CEO time in other boards | -0.06* | -0.07** | 0.16 | -0.02 |
| | (-1.84) | (-2.23) | (1.10) | (-1.24) |
| Log (total asset) | 0.78** | 0.56** | 3.41** | -0.69** |
| | (6.48) | (4.95) | (6.39) | (-14.73) |
| Total debt ratio | 1.56** | 1.84** | -0.73 | 0.40 |
| | (2.21) | (2.82) | (-0.23) | (1.44) |
| Non-regular income | -0.01* | -0.00 | -0.01 | -0.00 |
| | (-1.94) | (-1.23) | (-1.06) | (-1.46) |
| N | 262 | 262 | 262 | 262 |
| *F- test* | 31.65** | 26.49** | 11.47** | 81.24** |
| *Sargan test* | 29.43 | 18.12 | 17.04 | 30.29 |
| *AR(1)* | -1.19 | -1.45 | -1.84* | -1.41 |
| *AR(2)* | -1.37 | -1.31 | -1.46 | -1.60 |

TV (Total Volatility), IDIOV (Idiosyncratic Volatility) are multiplied by 100, SYSV (Systematic Volatility) is multiplied by 10, Z-score (Distance to default). The models are estimated using Arellano-Bond system GMM estimator and include year dummies. Second lag period and earlier are used as instruments. F-test is a test of the joint significance of reported coefficient estimates under null hypothesis. Sargan test is a test of overidentifying restrictions under the null of instrument validity. AR(1) and AR(2) are tests for first and second order serial correlation in residuals. For full definition of variables see Table 1. *t* statistics in parentheses (* $p < 0.10$, ** $p < 0.05$).