What Fuels Oil Company Risk? ♣

Abstract

This article has a simple research question: what determines the risks of oil producing companies listed in Australia and the United States, and are there any differences between their risk attitudes? A literature review is used to develop an integrated theory of firm risk that is validated using a hand-collected database covering active oil and gas production companies in Australia and the United States. Australian firms had less risk management, greater propensity for operational and financial risk, and higher risk on multiple market and accounting measures. After controlling for country of listing, risk in both countries responded as predicted to firm risk propensity and risk management, which each had a small number of deep-seated drivers spread across firm structure, governance, and performance. These common risk-related features between firms in geographically remote countries point to the complexity of achieving portfolio diversification. Validating and quantifying the theory of risk proposed here provides a strong framework that can be tested further in different settings.

The purpose of this paper is to examine the nature, drivers and strategic consequences of variations in risk between listed oil companies in Australia and the United States. Analysis develops a descriptive theory of firm risk, and tests the proposition that firm risk differs according to geography.

The study uses an industry - oil exploration and production - that is characterised by varying risk attitudes; and covers six years from 1999 to 2004, which is a recent full cycle in the equities market and eliminates biases from trends in markets that have been shown to significantly distort results (e.g. Bennett and Sias, 2006). To overcome the small pool of candidate firms and provide depth to the analysis, two samples were obtained: all companies listed in Australia that produce oil or gas (N=14), and a similar sample of US-listed companies matched by market capitalisation.

A single industry sector was chosen for several reasons. The most important is to eliminate the typical difficulty in evaluating cross-country attitudes which is to separate differences arising from variations between industries. The oil industry is truly global in terms of strategic opportunities, technology and markets; so industry environments should be similar between countries, and differences between firms can be attributed to national-specific factors such as legal frameworks and local managers' characteristics. Conducting the study in two countries also provides an out-of-sample robustness check and comparison of national risk propensity.

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This article contributes substantially to the literature because the oil industry's financial aspects have only been superficially studied (despite the availability of good data), with the principal focus on hedging and capital structure. For introductions to this literature see Haushalter (2000) and Jin and Jorion (2006). Conversely oil exploration has long been seen as a good laboratory to study risk taking (e.g. Grayson, 1960) because firms have clear choices between business strategies with different risks, especially the balance between high risk oil exploration and lower risk acquisition of reserves; the level of commodity hedging; and mix of funding.

A second contribution is to adopt an integrated approach which relates multiple measures of risk to firm structure and strategies. This broad perspective extends our understanding of firm risk by developing the full relationship between firm characteristics and risks, which contrasts with previous studies into the nature of financial and business risk that have focused on a single measure of risk or a single risk strategy.

Risk in this article follows its dictionary definition as a hazard or exposure to mischance (*Concise Oxford Dictionary*), and matches the way that risk is viewed by managers (March and Shapira, 1987) and investors (Olsen and Troughton, 2000). Thus risk is a probability measure, and is quantified *ex post* from actual loss experience. Risk propensity is a complementary *ex ante* measure of a firm's willingness to accept the possibility of loss. Risk management is an action or strategy that deliberately changes either the probability of a risk or the quantum of resulting loss.

The study has a simple research objective: identify and quantify traits of oil production companies that determine risk to shareholder value. The first step is to develop a model through comprehensive review of the literature. This hypothesises that firm risk is a function of risk propensity and risk management, and these in turn are driven by identifiable firm traits. The model is validated using data from Australian and US oil companies to analyse correlations, followed by regression to build a parsimonious explanatory model for firm risk.

At this stage it may be helpful to summarise key results. In brief, the first important finding was statistically significant links between four different measures of firm risk derived from market and accounting returns. Correlations were significant ($p<0.07$) for each of the six paired combinations, which suggests that `firm risk' or uncertainty in shareholder value – no matter how it is measured – arises from some aspect of a common set of latent risk parameters. This last point was amplified in the second important conclusion that variation between firms' risk is largely explained by differences in risk propensity (particularly capital structure and bias towards exploration expenditure), risk management (oil hedging) and independent firm parameters.

By comparison to their US counterparts, Australian firms had less risk management and greater propensity for operational and financial risk; not surprisingly, Australian firms had higher risk on each of the market and accounting measures. After controlling for country of listing, risk in both countries responded as predicted to firm risk propensity and risk management, which each had a small number of deep-seated drivers spread across firm structure, governance, and performance. These common risk-related features between firms in geographically remote countries point to the complexity of achieving portfolio diversification. Results also extend the theory of the firm by finding support for the importance of governance to risk. Overall the study's findings have considerable implications for investors and managers.

The balance of the paper proceeds as follows. The first section identifies the principal theoretical influences on firm risk with supporting evidence from published studies, describes measures of risk and risk propensity, and states the research question. This is followed by an outline of the analytical methodology and description of data. After reporting and discussing results, I close with a brief conclusion.

I. Theoretical Influences on Oil Company Risk

Three linked factors explain the probability and quantum of loss in value of oil companies: risk, risk propensity, and risk management. Risk is a measure of loss or uncertainty in value (in terms of both type of loss and its quantum) and is expressed as the frequency of occurrence and size of a particular loss, generally using *ex post* actual experience such as operational incidents or falls in share price. Risk propensity is an *ex ante* measure of expected risk, or a firm's willingness to accept the possibility of a particular type or quantum of loss. This is a function of deliberate firm choice, and can only be quantified by proxies such as investment mix and strategic decisions such as gearing. Risk management is an action or strategy that changes (up or down) either the probability of a risk or the quantum of resulting loss. Although firm risk is an observable feature, risk propensity and risk management are endogenously determined and can only be measured by proxies.

Over and above the risk propensity and risk management programs of a firm, a variety of firm-specific variables affect its risk. These can be external such as macroeconomic conditions (growth, interest rates), industry environment (regulation, competition, profitability) and the nature of the firm's shareholders. They can also be internal to the firm and related to its inanimate features (size, gearing) and managerial traits and decision biases.

The interaction of these factors can be expressed as follows:

$$\text{Risk}_{i,t} = \frac{\sum_{t-n}^{t} \text{Risk Propensity}_i}{\sum_{t-n}^{t} \text{Risk Management}_i} Z_{i,t} \qquad \ldots \qquad (1)$$

In words, the frequency and quantum of value loss by firm i at time t is a positive function of structure and strategies put in place over time that raise or lower the probability of such losses (i.e. firm risk propensity); an inverse function of risk management processes over time that mitigate value loss from a risk's occurrence; and is related to $Z_{i,t}$ which is a vector of firm-specific variables that capture the firm's inherent risk parameters.

A. Risk Propensity

The risk propensity of oil companies is a function of three sets of traits or strategies that can be distinguished by their nature or source. The first relates to conscious decisions (including inactions) about company structure such as size and gearing. The second source of risk propensity is more tactical and is sourced in strategic decisions such as manager selection,

exploration strategy and investments. The third source of risk propensity is actions by the firm that impact its cash flows. Consider these theoretical influences on risk propensity.

The first source of risk propensity fits within the concept of *behavioural corporate finance* (Shefrin, 2001), which explains decisions in terms of the firm's endogenous traits and exogenous drivers. The most important of these traits and drivers are a firm's structural features, which – when taking a resource based view of the firm (Hart, 1995) - will influence risk propensity by placing a limit on maximum sustainable loss; and will influence risk management through determining its capacity to identify and execute well-judged risks.

Size is a particularly important risk-related feature. Larger firms tend to have a diversified portfolio of assets that – through the co-insurance effect (Hyland and Diltz, 2002) - makes them more resilient to any given loss. This is enhanced by their generally higher level of slack or surplus resources such as greater capacity to raise capital to replace any loss; and by economies of scale that enable larger firms to execute activities with high transaction costs such as raising debt. Thus larger firms can better tolerate and manage risks. The intuition that large firms have higher risk propensity is consistent with the positive link between leverage (which is a proxy for risk propensity) and firm size (Panno, 2003). And the expectation that large firms should have lower observed (i.e. *ex post*) risk levels was confirmed in an analysis by Reuer and Leiblein (2000) which concluded that downside risk (probability of below target performance) is lower for larger firms.

Another effect of firm size on risk propensity is to constrain decision processes through organisational complexity (age, number of business segments and capital intensity), internal and external dependencies and constraints from historical decisions, and uncertainty avoidance that comes from more formal and less flexible processes. This was confirmed in a study of oil explorers by Walls and Dyer (1996) who defined risk propensity as a preference to explore for new reserves rather than acquire them; and for foreign rather than domestic exploration. They found that large companies tended to be more risk averse.

Another pointer to structural risk propensity is the finding of Claessens, Djankov and Nenova (2000) that firms' attitudes towards risk differ between countries. They ascribed this to institutional factors such as legal protections for shareholders, directors and creditors; civil or common law systems; and nature of the financial system. Further exploring this issue is one of the research objectives of this article.

The second source of corporate risk propensity is the company's strategic decisions such as manager selection, exploration strategy and investments. It is tactical in nature, reflects transient results and opportunities, and is largely within the company's control.

An intuitively obvious influence on firm risk propensity is the behaviour of its managers, which starts at the Board. The number of directors influences decisions, although the effect may not be linear with an optimum typically seen as around eight (Jensen, 1993). Board composition influences risk propensity, because reaching consensus is a function of common thinking within the Board (promoted by more insider directors and less diversity of directors, including range of ages and proportion of women directors) and relevant expertise (that may come from broad-based experience of outside directors) (Gummer, 1998). Another – although less intuitively obvious –

impact on risk propensity is the proportion of outside directors as they can be expected to act in the interests of all shareholders (not just managers).

Below the Board level, senior executives make most of the important day-to-day decisions, and they can have a substantial portion of their human capital tied up in the firm, as well as their wealth given the tendency to include significant stock and options in compensation packages. Thus executives can be over-invested in their employer relative to diversified shareholders. Studies of executive psychology conclude that risk-prone managers tend to be younger, better educated, male and adopt multiple risky behaviours such as smoking and adventure sports (Grable, 2000). The wide variation observed in manager traits explains the variation in their risk propensity (see, for example: Levy and Levy (2002); MacCrimmon and Wehrung (1984); and Williams and Narendran (1999)). Thus concentration risk can become an important source of bias in managers' decisions and hence in firm risk propensity.

An important driver of managerial risk propensity is compensation. The simplest is where an executive is paid a fixed salary, which provides an incentive to avoid risks that may jeopardise job security. In theory, linking wealth of executives to stock prices promotes alignment of their interests with those of shareholders and should solve the principal-agent problem. However, there are differences in the incentives provided by shares and options. Shares have a linear pay-off so that wealth rises and falls directly with the share price. This introduces the possibility of loss for managers and – perhaps perversely - can increase their risk aversion (the under-investment problem). Options, however, have only a zero or positive pay-off: this tends to make managers more risk prone, particularly when their options are out of the money (that is, when the price at which the options can be exercised is above the current share price). If executives are risk-averse, at-risk compensation will lead them to reduce variation in firm value by adopting low risk strategies and extending risk management; or else they will require higher compensation to offset their lower risk-adjusted income. Thus the mix of employee compensation interacts with managers' risk attitudes to influence their decisions and firm risk propensity (Coles, Daniel and Naveen, 2006).

The impact of compensation on firm decisions was confirmed by Rajgopal and Shevlin (2002) who examined the risk propensity of US oil and gas firms as measured by exploration and hedging strategies. They found that managers with options adopted variance-increasing strategies and more risky investments: exploration risk (variance in operating cash flows) was positively related to the sensitivity of CEO stock options to volatility of stock returns. Independent of this link, the hedge ratio (hedged volume as a proportion of reserves) was negatively related to the sensitivity of CEO stock options to volatility of stock returns. Thus firms whose CEOs have more options will pursue more risky investment strategies and avoid risk management strategies such as hedging. A study of gold mining companies by Tufano (1996) found that hedging rises with compensation of managers using stock, so firms whose managers are compensated with shares take less risk than firms where managers are compensated through options. Thus where executive shares promote risk aversion, options encourage uncertainty-increasing strategies.

Further influences on risk propensity can arise from ownership structure which is known to influence firm decisions, given that a substantial shareholder has more incentive to pressure management (Shleifer and Vishny, 1997). Support for this comes from empirical evidence which shows that hedging increases with a narrow shareholder base (Mayers and Smith, 1990), which

indicates that shareholders with concentrated exposure to the firm will pressure it to more actively manage financial risks.

A final tactical influence on risk is recent performance because firms with results below a reference level tend to take more risk. This has been formally specified in Prospect Theory which proposes domain-sensitive risk propensity so that decision makers are risk averse above an endowment reference point and risk embracing below (Kahneman and Tversky, 1979). In an analysis of American firms' propensity to take business risks as proxied by innovation, debt, R&D and high risk-high return investments, Singh (1986: 582) concluded: "poor performance triggers risk taking … Most firms, when faced with poor performance, would undertake decisions that would only further their decline." Change in risk attitude around a reference level was confirmed in the study of oil explorers by Walls and Dyer (1996) which found a concave relationship between risk propensity and return on assets.

The third source of oil company risk propensity comprises actions by the firm that change the level or uncertainty of cash flows, which is the principal risk to shareholders. Following the conventional assumption that the market value of a firm is equal to the present value of its expected cash flows discounted at a risk adjusted rate, risks to shareholder value arise in the quantum and frequency of [negative] changes to expected cash flows and to the discount rate. An oil company's expected cash flows are a function of its production, cost structure and oil prices; whilst the discount rate is a function of firm-specific risk and overall market risk.

Just as a rising tide lifts all boats, oil companies have little influence over oil prices and overall market risk. They do, however, have considerable influence over expected cash flows, firm-specific risk and the frequency of information releases relating to changes in these parameters. This makes governance processes important to firm risk, for their ability (or not) to continuously improve expected cash flows and operational reliability, and control disclosure of price-sensitive information. For instance, less frequent releases of larger quanta of price-sensitive data should bring greater volatility to prices and hurt shareholder value. Financial features of firms also influence information flows. For instance, the processes around securing and retaining debt (such as obtaining a rating and communicating to lenders) promote reduction in information asymmetry between the firm and stakeholders.

Firm size will also impact disclosure because economies of scale give larger firms better communications resources; and transaction costs make it easier to gather private information on large firms, so they are subject to better analyst and media coverage (Hong, Lim and Stein, 2000). Similarly larger firms are held to higher standards, which lifts reputational risks from tardy exposure. There is also likely to be a positive link between disclosure standards and institutional ownership because the latter is increased by lower risk of adverse selection that accompanies better information flow (Merton, 1987). Debt, too has a positive link to governance quality because the rights of creditors are better defined and protected than those of shareholders (Shleifer and Vishny, 1997).

Again these intuitions are confirmed by empirical analyses. Durnev and Kim (2005) found that the quality of firms' disclosure practices is directly related to size; investment opportunities as measured by growth in sales over the prior two years; and external financing needs. Other studies

found that disclosure standards are positively related to firm performance, size and security issuance (Lang and Lundholm, 1993) and institutional ownership (Core, 2001).

Risk can also be affected by external factors, especially the firm's environment because rapid change or tough competition can be a partial substitute for governance (Börsch-Supan and Köke, 2002). Firm environment can be evaluated directly through the rate of change in assets and sales, the proportion of the CEO's compensation at risk (which tends to rise when the environment is uncertain and turbulent: Prendergast, 2002), and variance in firm return.

In combination, the risk precursors described above lead firms to develop their own unique risk profiles specific to recent performance, manager attributes, the firm's traits, and a range of exogenous factors.

B. Risk Management

The principal motivation for firms to manage risk is to benefit some or all shareholders. Management of pure risks (that is those that only have a negative value, such as industrial or natural disasters) should benefit all shareholders and it is intuitively obvious why this objective consumes a considerable portion of management time.

By contrast, management of speculative risks (which have an upside as well as a downside, such as investment) provides varying benefit to shareholders according to sensitivity of their wealth to firm performance (see: Froot, Scharfstein and Stein (1993); and Smith and Stulz (1985). Management of pure risk has numerous rationales. The first is to directly reduce costs and thus increase expected cash flows. The most obvious examples arise with volatile cash flows. For instance, some jurisdictions including the United States have asymmetrical tax treatment of losses and gains so that large losses can increase tax paid through a cycle. Volatile cash flows can also increase transaction costs, such as by increasing the probability of financial distress and so raising the cost of external finance. A second rationale is to reduce uncertainty in cash flows, and thus optimise other firm strategies such as gearing and investment to avoid the underinvestment problem (Froot, Scharfstein and Stein, 1993) in which risk-averse managers forego value-enhancing projects that increase leverage or otherwise increase firm risk. A third rationale for risk management – which becomes an agency cost - is to benefit managers by reducing external scrutiny, risks to their wealth, or the burden on them of financial distress.

In managing risk, firms first set a `risk budget' or indicative level of overall risk, sometimes as a specific utility function (Meulbroek, 2002), but more often in qualitative terms. Either way, firms with high levels of operational risk – such as mineral exploration companies and R&D-intensive firms – tend to minimise risks that they can control in other areas. They then select from many available risk management tools, including insurance to protect against operational losses, hedging to smooth cash flows, roll out of comprehensive enterprise risk management programs (DeLoach, 2000), and minimising the possibility of bankruptcy. The last motivation suggests that firms with higher gearing will use hedging to minimise uncertainty in cash flows. Another risk management technique is to hold slack or surplus resources; these include overheads that can be

quickly freed up to manage loss, or untapped borrowing capacity that can replace a loss, which is a form of self-insurance.

Size is expected to be an important influence on risk management as economies of scale enable larger firms to execute activities with high transaction costs such as hedging and specialist functions such as enterprise risk management.

These hypotheses are confirmed by empirical studies. Haushalter (2000) examined 100 US oil and gas companies and found that hedging activity (the proportion of future production protected against price risk) is related to firm size and gearing. Evidence in relation to industry influences on risk management is mixed. In a study of US non-financial firms, Mian (1996) found that about a third of mining companies hedge interest-rate, currency-price or commodity-price risk, which is somewhat higher than the figure for all firms of about a quarter. By contrast, Tufano (1996) found that about 85 percent of gold producers manage gold price risk, with the level of hedging moving inversely with commodity prices.

C. Measures of Risk

As noted above, firm risk in this article is the probability and quantum of loss in value and is calculated *ex post* from actual loss experience. Previous studies of the determinants and consequences of firm risk have used a broad range of risk measures that can be conveniently classified as calibrating either operational or financial risks. Although these measures are typically observable, it is important to note that a firm has little direct control over them.

Operational risk measures typically address a single source of firm loss. Thus a study of profitability of US nuclear power stations by Osborn and Jackson (1988) used plant reliability (ratio of actual hours of operation to available hours) and frequency of operational violations as risk measures. Other studies have used operational risk measures as diverse as fraud charges by the Securities and Exchange Commission (Abbott, Park and Parker, 2000); product recalls (Rubin, Murphy and Jarrell, 1988); and fines by the Environment Protection Agency (Bartel and Thomas, 1987).

A difficulty with many risk measures is that they are generally not available in a standardised format for all firms, which promotes use of measures calculated from share prices and accounting data.

Stockmarket measures of firm risk rely on the normative assumption that the value of a firm is equal to the present value of its expected future earnings, discounted at a risk-adjusted rate. When a firm experiences a risk event (whether accident, strategic blunder or competitive threat), the onset is unexpected and hence not already built into the share price. Expected future earnings for the firm will be revised downwards in light of the potential consequences; moreover the risk-adjusted discount rate will be revised upwards with emergence of unexpected risk. As a result, the firm's share price falls by an amount proportional to the magnitude of the new risk. Risk-driven fluctuations in share prices suggest a convenient measure of firm risk is the uncertainty of its return, which is quantified in the standard deviation of price changes.

Stockmarket data provide three risk measures that will be used in this study. Two can be derived from a multifactor market model (Jorion, 1990):

$$R_{i,t} = \alpha_i + \beta_{i,oil} R_{oil,t} + \beta_{i,m} R_{m,t} + \varepsilon_{i,t} \quad \ldots \quad (2)$$

where $R_{i,t}$ is the market return on oil stock i from time t-1 to time t; α_i is a constant; $R_{oil,t}$ and $R_{m,t}$ are, respectively, the returns on oil prices and the market index; $\beta_{i,oil}$ reflects the sensitivity of the price of stock i to movements in the price of oil; and $\varepsilon_{i,t}$ is an error term ($\beta_{i,m}$, of course, reflects the sensitivity of the price of stock i to movements in the broad market, $R_{m,t}$, and is systematic risk which is not the subject of this article).

The first measure of investor risk is *oil beta*, which is represented by $\beta_{i,oil}$ in equation (2) and is the sensitivity of the stock's price to movements in the price of oil. The second measure is *idiosyncratic risk*, which is the standard deviation of the error term, $\varepsilon_{i,t}$ in equation (2) and measures uncertainty in returns arising from firm-specific factors.

A third measure of non-systematic risk to investors is termed *downside risk* and represents the possibility of underperformance relative to the market (Ang, Chen and Xing, 2006). It is calculated as the standard deviation of returns below the market, and equals the value of Standard Deviation(0, if $R_{i,t}>R_{m,t}$; else $R_{m,t} - R_{i,t}$). This idea of below-benchmark returns is close to the concept of risk reported from surveys of investors (Olsen and Troughton, 2000) and managers (March and Shapira, 1987).

Accounting data provide a variety of measures of firm risk, again following the intuition that risk contributes to volatility in returns, and hence uncertainty in accounting returns becomes a measure of risk. Typical examples include the standard deviation of Return on Assets (ROA) which is equal to EBIT as a percent of total assets; and the standard deviation of EBITDA divided by the mean EBITDA.

Although the many possible measures of risk appear to be reporting qualitatively different aspects of firm performance, a number of studies have found statistically significant linkages between the quite different operational and financial measures of risk. Noronha and Singal (2004), for instance, found that airlines with higher bond ratings and hence lower expected financial risk also had better operational safety records. Coleman (2007) also identified significant links between operational and financial measures of risk. Miller and Bromiley (1990), Miller and Reuer (1996), and Palmer and Wiseman (1999) have each found strong correlations between very different measures of risk.

Intuitively these links should not be a surprise. Share prices are the present value of expected future cash flows discounted at a risk-adjusted rate. Because operational risks impact on expected cash flows and the risk to those cash flows, uncertainty in share prices – as measured by idiosyncratic risk – becomes a proxy for the full range of a firm's business risks.

D. Research Question

The working hypothesis of this article is that firm risk propensity arises from latent variables established by exogenous factors (such as ownership), core firm traits (structure, products and

processes), governance (Board composition, and employee compensation), and recent performance. Along with characteristics of the firm's managers, these determine risk propensity which is quantified using proxies based on outcomes of risk-decisions such as corporate structure and business strategy, or external assessment such as credit rating. Risk as measured by uncertainty in returns, operational incidents, and shocks to reputation is determined by risk propensity and exogenous factors from the macro-economy and the firm's industrial environment, including price and competition. Overlaying thus, formal risk management programs (including hedging, slack resources, insurance and enterprise risk management) increase or decrease firm risk established by its traits and risk propensity. Actual risk experience will feedback to future risk propensity.

This produces a theoretical model of firm risk as set out in figure 1, which provides a simple research objective: identify traits of oil production companies that drive risk propensity and risk management and so determine firm risk.

[Insert Figure 1 Here]

An important feature of this model is the clearly implied endogeneity between risk propensity and risk management. Size, for instance, independently increases risk propensity and risk management and results in lower risk. A typical outcome discussed above is that gearing, which is a measure of risk propensity, is correlated with hedging, which is a proxy for risk management. Many other measures of risk propensity and risk management are similarly correlated and complicate evaluation of these two effects.

II. Data and Analytical Methodology

The study uses twinned samples of listed companies that produced oil or gas at the end of 2004. The first sample includes all listed Australian oil and gas producers (N=14), whilst the second is a similar number of US-listed firms (N=17) roughly matched to the Australian sample by market capitalisation. In the middle of the sample period, the average market capitalisation of the samples was $1.2 billion and $1.1 billion, respectively. The tickers and names of the firms are shown in table 1.

[Insert table 2 here]

The period covered is the six years from 1999 to 2004, which is the most recent full cycle in the US equities market. Most Australian companies have a June 30 reporting date; and US companies have a December 31 reporting date. Annual Reports or Forms 10-K for each firm were used to hand collect annual values of 31 firm-specific variables.

Three measures of risk that are used were described earlier: idiosyncratic risk, downside risk and oil beta. In addition, the standard deviation of return on assets (EBIT/Total assets) is used as a risk measure in a robustness test of the analysis. Each was calculated using CRSP share price data.

Three measures of risk propensity comprise: annual oil and gas exploration expenditure as a proportion of shareholders funds, which is a measure of the preference for building oil reserves through the higher risk strategy of exploration; annual oil and gas acquisition expenditure as a proportion of acquisition expenditure plus exploration expenditure, which is a measure of a preference for the low risk strategy of acquiring, rather than exploring for, new reserves; and Altman Z, which is an indication of credit quality with a high value proxying for low risk of default.

Risk management is measured as the volume of oil and gas hedged, expressed as years at current production.

An Australian dummy has the value of 1 for firms listed in Australia and zero for US firms. The other firm variables encompass standard measures of scale (market capitalisation, oil and gas reserves and production, reserves lifetime), financial strategy (debt, current ratio, debt-to-equity ratio), structure (substantial shareholders, number of board members, CEO tenure, employee options as a proportion of issued shares), financial performance (cash per barrel of oil produced), market factors (price-to-book ratio) and prior period performance (which equals previous two year's share price change minus that of the Index).

The Appendix provides definitions of all variables. Calculated data were winsorised at the one percent level; that is any values that were more than three standard deviations from the mean were set to equal three standard deviations from the mean.

Once the data had been collected, analysis flowed sequentially through three steps. The first evaluated covariances between risk and risk propensity measures. The second step calculated univariate correlations to establish significant influences between variables. The final step was panel regression to identify parsimonious explanations for the risk measures.

III. Results

A. Covariances between Risk and Risk Propensity Measures

This section evaluates correlations within and between measures of risk (each of which has been quantified from financial returns: idiosyncratic risk, downside risk, oil beta), risk management (hedging level) and risk propensity (level of exploration expenditure, balance between acquisition of new reserves and exploration, and credit default risk). The top section of table 2 reports significant ($p<0.1$) correlations between these measures.

[Insert table 2 here]

Each of the three risk measures is correlated with the others. In particular, idiosyncratic risk and downside risk are strongly ($p<0.001$) correlated between themselves, and each is also negatively correlated ($p<0.05$) with oil beta. The close relation between idiosyncratic risk and

downside risk (R=0.93) resolves the occasional criticism that idiosyncratic risk is not a useful measure of the way that managers view risk because it includes gains as well as losses.

In terms of oil beta, I suspected a possible systemic basis and tested the link between daily returns of oil prices and market indexes over the survey period, but it did not prove significant ($p>0.4$). The negative link between oil beta and firm-specific measures of financial risk suggests that uncertainty in firm returns arising from uncertainty in oil's price (i.e. oil beta) is a substitute for non-systemic, or firm-specific, uncertainty in returns.

Turning to risk propensity, there is a strong ($p<0.01$) positive relationship between preference for low risk acquisition over high risk exploration to build reserves and Altman Z. This is to be expected as high values of each measure are indicative of risk averse strategy. Again, though, it is interesting to see such a close relation (R=0.27) between qualitatively different measures.

Significant correlations between quite different measures of risk imply they are driven by a common set of underlying firm traits. This extends studies discussed earlier that demonstrate equivalence between very different measures of risk, and conclude they can be used interchangeably. Similarly there are strong relationships between measures of risk propensity. This provides my first thematic conclusion which is the strong link between qualitatively different measures of firm risks and risk propensity that is indicative of shared underlying drivers.

B. Univariate Correlations

The second analytical step was to examine univariate relationships between oil company risk, risk propensity, risk management and firm characteristics.

Oil producing firms with high idiosyncratic and downside risks have high expenditure on exploration (i.e. greater operational risk propensity), but lower credit risk (i.e. lower financial risk propensity) and less hedging (i.e. less risk management); they are also smaller in scale, have longer serving CEOs and smaller Boards, and longer reserves lifetimes and higher cash flow per barrel of production. Risk is higher for Australian firms, and following years of lower oil prices.

These results confirm the validity of equation (1) and key aspects of the hypothesised model of firm risk. In particular risk is positively related to risk propensity and negatively related to risk management; and higher risk firms are smaller, strong financial performers, with smaller Boards.

Firms with a high oil beta have high credit risk (i.e. greater financial risk propensity), but lower expenditure on exploration (i.e. lower operational risk propensity) and more hedging (i.e. more risk management); they are also smaller in scale, with substantial shareholders, and have longer serving CEOs and larger boards, shorter reserves lives, and larger employee option holdings. Oil beta is lower for Australian firms and is higher following a period of stock price underperformance.

Firms that have larger hedging programs and so manage risk more actively are smaller, with substantial shareholders and larger Boards, and smaller employee option holdings. Australian firms have less hedging.

Oil producing firms with high propensity for financial risk as indicated by low Altman Z are smaller, with substantial shareholders, younger and shorter serving CEOs, larger boards, larger employee option holdings, shorter reserves lives and have experienced recent stock price underperformance. Firms with propensity for high operational risk as indicated by preference for exploration over acquisition to build reserves tend to be larger, with younger and shorter serving CEOs, smaller Boards, longer reserves lives, strong cash flows from production, and recent stock price outperformance. Australian firms have lower financial risk and higher operational risk.

In summary, firms with high levels of risk tend to be risk prone as evidenced by a bias towards exploration expenditure and have limited risk management as evidenced by a low level of hedging. They tend to be smaller in scale and have small boards. These results are generally consistent with the hypothesised model. The negative link between financial risk (as proxied by Altman Z) and operational risk (as proxied bythe balance between exploration and acquisition) is consistent with the concept of firms adopting a risk budget: firms with high operational risks will limit risk in other areas to stay within an overall risk target; and *vice versa*. In keeping with Prospect Theory, high propensity for financial risk follows poor historical performance, although there is a lower propensity for operational risk. In addition compensation through options promotes risk propensity, which is also higher in firms that are smaller and have small boards.

This suggests a second thematic conclusion that firm risk responds to a small number of drivers.

C. Panel Regression

The third analytical step used multiple linear regression of panel data (N=186) comprising annual values of firm variables, including lagged oil prices. These seek parsimonious explanations for firm risk and risk propensity, and the results that are reported in table 3 prove to be consistent with the hypothesized model and earlier conclusions.

[Insert table 3 here]

Three measures of firm risk are analysed. The first is idiosyncratic risk, which is significantly positively related to Australian dummy, debt:equity ratio, and employee options holdings; whilst it is significantly negatively related to size. Downside risk has the same relationships. The third risk measure is oil beta, and it is significantly positively related to firm size, CEO tenure, price:book ratio, employee options holdings and acquisition expenditure as a proportion of spending on exploration and acquisition; and is negatively related to the Australian dummy, substantial shareholdings and Altman Z.

The measure of risk management as proxied by the level of oil and gas hedging is positively related to size, director numbers and prior two year's share price performance versus the index; and is significantly negatively related to the prior year's oil price, Australian dummy, substantial shareholdings, price:book ratio and employee options holdings.

The analysis also reports regressions with three measures of firm attitudes towards risk as the dependent variables, and so indicates traits that make a firm risk prone or risk averse. The first measure is one of risk propensity in the level of exploration expenditure as a percentage of shareholder equity, which is significantly positively related to Australian dummy and employee options holdings; and is negatively related to CEO tenure and reserves lifetime. The second measure is one of risk aversion and equals acquisition expenditure as a proportion of acquisition plus exploration expenditure, which is positively related to CEO tenure, debt:equity ratio, reserves lifetime and cash flow per barrel of production. The third measure is also one of risk aversion in Altman Z, which is positively related to CEO age, CEO tenure, and price:book ratio; and is significantly negatively related to substantial shareholdings and debt:equity ratio.

These biases in oil companies' strategy can be explained in terms of five well-known influences: firm size; stakeholder influences; moral hazard; firm performance; and managerial biases.

Firm size is important because of the effect of transaction costs and co-insurance. Transaction cost theory relies on the intuition of Coase (1937) that firms exist because they are cost-effective intermediaries between suppliers of production inputs and customers for end products. Thus success is linked to their ability to lower transaction costs, which comes from economies of scale that are related to turnover, and economies of scope through cost-effectively combining two separate processes. Each facilitates high-cost specialist activities such as a corporate treasury which explains why large firms have more active hedging programs; size also provides resources that can be used to offset losses that occur. Co-insurance is complementary to economies of scope and reduces risk associated with a portfolio of assets as it becomes more diversified by geography or type (Lewellen, 1971), and allows firms to increase their risk-taking without increasing overall risk (Hyland and Diltz, 2002). It explains why larger firms are less risky with lower idiosyncratic and downside risks.

Stakeholder influences are seen where corporate decisions explicitly take into account the interests of different clienteles, including classes of shareholders, analysts and other stakeholders (Holmstrom, 1979). The most obvious source of stakeholder influence is the role of substantial shareholders who have greater opportunity and motivation to pressure firms to adopt their preferred strategies. Thus firms with substantial shareholders are more risk prone with less active risk management (lower hedge life) programs and higher credit default risk (lower Altman Z). It seems that large shareholders in oil companies seek greater risk, which contradicts previous studies (e.g. Mayers and Smith, 1990).

Moral hazard arises from the action of an outside party that changes the risk-return relationship which is expected from a resource or strategy of the firm. It has similarities with stakeholder influences, but the impacts are less targeted and specific.

The most obvious source of moral hazard is the differences between firms listed in Australia and the United States, which are evidenced by significant regression co-efficients for the Australian dummy. Idiosyncratic and downside risks are higher for Australian firms, whilst oil beta is lower. Australian firms are more risk prone, as evidenced by less active risk management (lower hedging levels) and higher operational risk propensity (bias towards exploration over

acquisition). In short, shareholders in Australian oil companies face higher risk because the companies take greater operational risk and do not manage their oil price exposures.

Moral hazard also comes from the state of the world. For instance, hedging is lower following a year of higher oil prices, which matches previous studies (e.g. Tufano, 1996), and suggests that oil company managers expect oil price trends to continue.

The previous financial performance of firms has an effect that is comparable to moral hazard because it impacts cash flow and so can constrain strategies relating to capital structure and expenditure. Thus firms with a high debt:equity ratio exhibit higher idiosyncratic and downside risks, which leads to risk-averse preference for acquisition and a higher probability of credit default (lower Altman Z).

Another bias from previous financial performance is seen with firms whose share price has underperformed the Index in the prior two years as they become more risk prone with less active risk management (hedging) programs. By contrast, firms with a long reserves lifetime and strong cash flows per barrel of production are more likely to adopt a risk averse strategy of building reserves by acquisition. Expressed differently, firms with a history of share price underperformance and which lack a secure, profitable reserves base tend to be risk prone. These biases in firm strategy conform to loss averse behavior inherent in Prospect Theory (Kahneman and Tversky, 1979).

Managerial biases arise from decisions that are influenced by managers' interests, characteristics or incentives, and – when they result in sub-optimal decisions for shareholders – represent agency problems.

Firms whose Boards have more directors tend to be risk averse with more active risk management (hedging) programs. This is consistent with longstanding evidence that group risk propensity is different to that of individuals (Park and Hinsz, 2006), and supports largely anecdotal evidence that large groups tend to be more risk averse.

Firms whose CEOs have longer tenure tend to be more risk averse with lower levels of exploration spending, a bias towards acquisitions to build reserves and higher value of Altman Z (lower credit default risk). This matches other evidence that CEO entrenchment leads to greater risk aversion.

Managerial compensation also proves important to strategy as firms whose employees have larger holdings of options have higher idiosyncratic and downside risks. This is not surprising given the less active risk management (lower hedge life) and greater exposure to higher risk exploration. Thus options promote greater risk in firms.

In summary, firm-specific risk can largely be explained ($R^2 \sim 0.5$) by business strategies reflecting risk management (hedging), risk propensity (credit quality, exploration intensity), nationality, a small number of fundamental firm traits (especially size and gearing), and organizational arrangements (CEO tenure, employee compensation through options). Risk management strategies and risk propensity can also be explained ($R^2 > 0.2$) by prior year's oil

price and stock price performance relative to the Index; nationality; firm traits (size, substantial shareholding, gearing and reserves lifetime) and organizational arrangements (CEO tenure, Board size, and employee compensation through options). Evidence that risk, risk management and risk propensity arise in core firm traits leads to the third thematic conclusion which is that risk measures are correlated because they each reflect a common set of deep-seated or latent risk-related traits of firms.

D. Robustness Test

To test the robustness of the findings, a parallel analysis constructs a risk measure from annual values of accounting data, which is standard deviation of return on assets (here ROA=EBIT/Total Assets). This proved strongly correlated ($R>0.55$) to both idiosyncratic risk and downside risk, and table 4 reports results of cross-sectional regression of the standard deviation of return on assets and idiosyncratic risk against independent variables used in table 3. This shows that firm risk as proxied by the standard deviation of ROA has a significant positive relationship to the Australian dummy, director numbers, employee option compensation and Altman Z; and is negatively related to size. These results are the same as those for idiosyncratic risk using the cross-sectional data, and are consistent with findings using the panel data. This robustness test is an important validation of the earlier analysis and conclusions.

[Insert table 4 here]

IV. Conclusion

Drawing together the results above confirms the validity of the model of firm risk shown in figure 1. Firm risk propensity is established by innate firm features (such as scale), corporate structure, operational and financial strategy, governance, and recent performance. Similarly risk management (i.e. hedging) responds to firm traits such as size and governance. These traits drive executive decisions and strategies that show up in measures of firm risk. In effect, latent risk variables flow through managers' decisions to determine risk propensity and risk management and thus the level of risks to shareholder value as measured by variability in market and accounting returns.

These conclusions reinforce the significance to firm risk of core drivers: size, corporate structure, historical strategies, governance, performance, and firm traits. They have significant implications for managers and investors.

The first is that firm risk has deep-seated sources. No matter how risk is defined, it proves strongly related to core firm traits with over a quarter of risk propensity determined by relatively stable factors such as inherent structural traits. This suggests the relevance of Chaos Theory, in which systems do not approach equilibrium nor decay to instability but remain within a region that is defined by an attractor: although the system moves unpredictably within the region, it respects its boundaries and thus the performance of chaotic systems is confined to a particular space (Dolan and Garcia, 2002). It is easy to envisage firms as chaotic systems, with core features

that act as attractors for various performance measures, including risk. These pre-dispose a firm to low or higher risk; similarly each firm's unique culture socialises its decision makers to further determine risk outcomes. Firm traits and culture are sticky, which makes risk hard to change and renders some firms as chronically risk prone and plagued by crises for years, whilst others operate without incident even in the most hazardous and complex industries. Reformist boards will heed the evidence that risk sources lie in company fundamentals and conclude that turning around a poor risk record requires sweeping change: simply sacking the CEO or tinkering with the organisation can never be enough to transform a chronically high or low risk firm.

Governance proves to have a number of influences on firm risk. For instance a smaller Board is associated with lower management of financial risk (i.e. less hedging) and more operational risk, which flow through to greater variability in return on assets and higher investor risk. In addition, the analysis offers strong evidence that concentrated ownership (as evidenced by percentage of shares held by substantial shareholders) also lifts the risk propensity of a firm and reduces risk management. Results provide support for agency theory, which describes the lack of co-ordination between the objectives of a firm's principals (i.e. its shareholders) and their agents (i.e. managers) that arises because of information asymmetry and conflicting rewards (Eisenhardt, 1989). For example, compensating employees with options increases firm risk, whilst it is reduced by a longer serving CEO.

There is also an important driver in historical strategies as shown in the relationship between higher risk propensity and poor recent financial performance. This confirms Prospect Theory and analyses in other areas that show poor performance can bring higher risk.

A final striking feature of this analysis is the influence of nationality. Australian firms have higher operational risk propensity and less risk management than their American equivalents, and so are significantly more risky on financial and accounting measures. After controlling for nationality, though, there is strong similarity between Australian and American firms in the drivers and nature of their risks. Certainly the two samples are from the same industry, and comparable in terms of firm size. In addition, Australia and the United States share a number of institutional features such as language, a related currency, and similar financial, legal and political systems. It is, however, intuitively surprising that the magnitude of the risks to investors in the two countries are similar, and that the determinants of these risks are largely common. Superficially this provides a serendipitous out-of-sample robustness check that adds weight to the findings. Beyond that, though, it cautions that investors in oil production companies do not necessarily achieve diversification of firm-specific risks by spreading holdings between countries.

Looking ahead the analysis has confirmed much of the hypothesised risk model developed in the first section. It confirms the validity of equation (1) in which risk is positively related to risk propensity and negatively related to risk management. It also quantifies firm variables that drive risk. On balance the framework advanced here provides a strong theoretical and empirical framework for a theory of risk that can be tested further against different datasets.

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Figure 1 - Model of Firm Risk

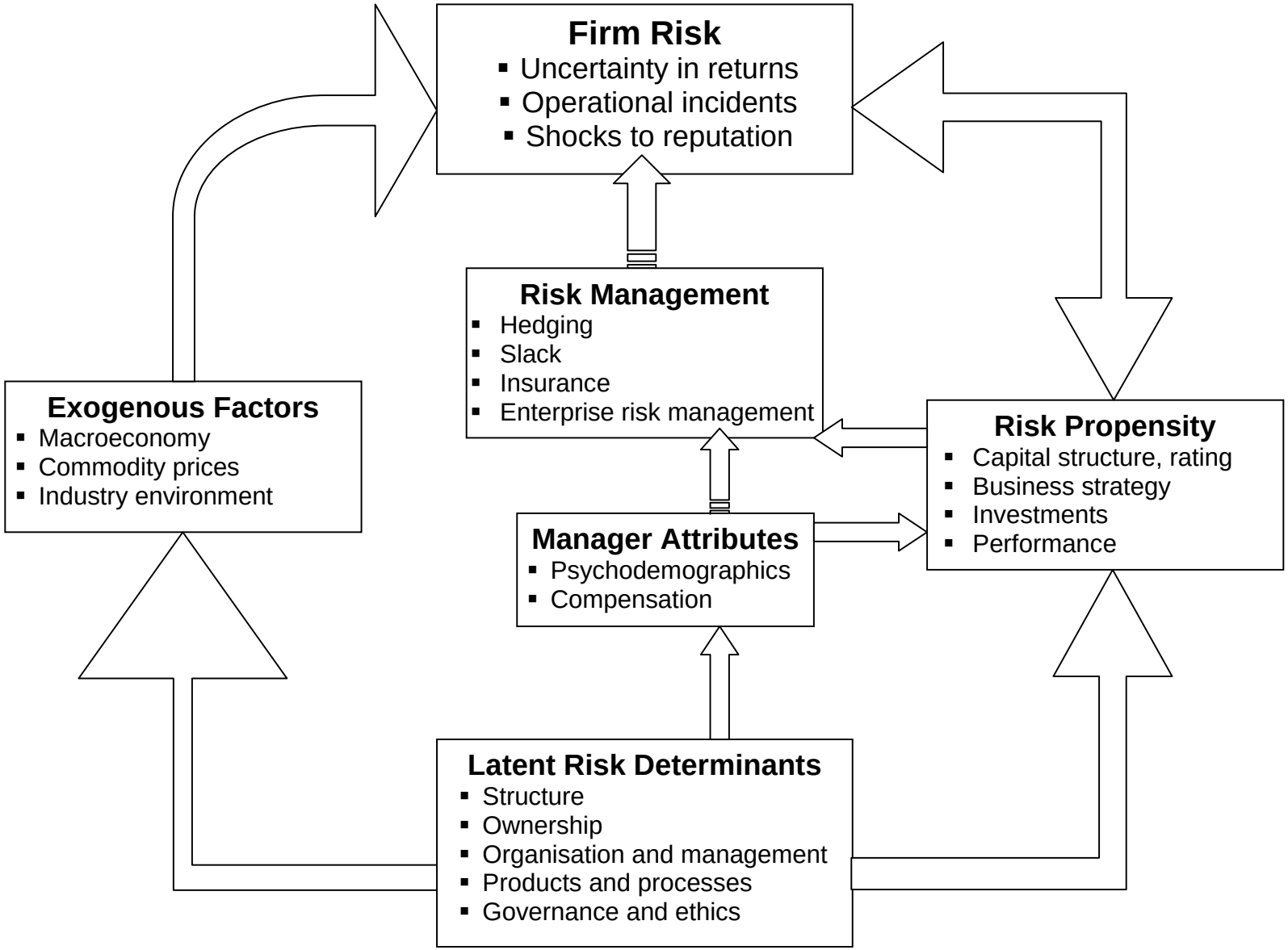

Table 1: Sample Firms: Tickers and Names

Australian Listed	
AMU	Amadeus Energy Limited
AZZ	Antares Energy Limited
ARQ	Arc Energy Limited
AWE	Australian Worldwide Exploration Ltd
BPT	Beach Petroleum Limited
CUE	Cue Energy Resources Limited
HDR	Hardman Resources Limited
MOS	Mosaic Oil NL
OSH	Oil Search Limited
PSA	Petsec Energy Limited
ROC	Roc Oil Company Limited
STO	Santos Limited
TAP	TAP Oil Limited
WPL	Woodside Petroleum Limited

US Listed	
APA	Apache Corporation
BRY	Berry Petroleum Co
COG	Cabot Oil & Gas Corp
CRK	Comstock Resources Inc
DNR	Denbury Resources Inc
EPL	Energy Partners Ltd
FST	Forest Oil Corp
GDP	Goodrich Petroleum Corp
HNT	Harvest Natural Resources
THX	Houston Exploration Co
TMR	Meridian Resource Corp
PXD	Pioneer Natural Resources Co
PXP	Plains Exploration & Production Co
PPP	Pogo Producing Co
SM	St. Mary Land & Exploration Co
SGY	Stone Energy Corp
SFY	Swift Energy Co
WGR	Western Gas Resources Inc

Table 2: Correlations of Explanatory Variables

Significant ($p<0.1$) correlations shown measures of risk and risk propensity and of firm variables that prove significant in the analyses. Significances at the five and one percent levels are denoted by * and **, respectively.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	IdioRisk	1																			
2	Downside risk	.925**	1																		
3	Oil Beta	-.169*	-.146*	1																	
4	Oil&Gas hedges	-.360**	-.300**	.345**	1																
5	ExplEx:ShEq	.316**	.219**	-.159*	-.141	1															
6	Acq:Acq+Exp	-.104				-.432**	1														
7	Altman Z	.166*		-.210**	-.192*		.265**	1													
8	PriorOilPrice	-.325**	-.303**						1												
9	Aussie Dummy	.292**	.192**	-.575**	-.412**	.275**	-.104	.361**		1											
10	Ln Marcap	-.110	-.187*	-.381**	-.145*	.137		.302**		.846**	1										
11	Subs Share			.212**	.088	-.049		-.255**	-.138	-.374**	-.368**	1									
12	CEO Age						.129	.138				-.248**	1								
13	CEO Service	.137	.166	.256**		-.298**	.385**	.238*		-.210*	-.154		.441**	1							
14	Director #	-.527**	-.426**	.356**	.524**	-.247**	.236**	-.257**		-.492**	-.140	.209**	.212**	.189	1						
15	Debt:Equity	.288**	.290**	.128				-.282**	-.205*	-.215**	-.281**	.169*				1					
16	Price:Book		-.138				.119	.408**			.108				.109	.147	1				
17	Res:Prod	.447**	.353**	-.384**	-.228**	.219**		.136		.419**	.158*	-.201*		-.127	-.425**		-.254**	1			
18	Cash:Prodn	.254**	.131	-.166*	-.145	.359**	.156	-.062		.245**	.138	-.144			-.165*		-.039	.492**	1		
19	EmpOpt:IssSh			.501**	.156*	-.103	-.171	-.394**		-.740**	-.719**	.318**			.180*	.380**		-.308**	-.214**	1	
20	PriorPerfVsIndx			-.265**		.204**		.155*	.341**	.235**	.182*	-.176*			-.192*	-.208*		.100	.235**	-.202**	1

Table 3: Panel Regression of Risk, Risk Management and Risk Propensity

Reports results from regression of risk measures against risk management and risk propensity measures, and of risk management and risk propensity measures against firm variables. Data is a panel from 1999 to 2004 (N=186), with years ending in June in Australia and December in the United States. Analysis only includes variables with at least a weakly significant relationship to firm risk, risk management or risk propensity. Significances at the ten, five and one percent levels are denoted by *, ** and ***, respectively.

	Firm Risk			Risk Management	Risk Propensity		
	Idiosyncratic Risk: Percent	Downside Risk: Percent	Oil Beta	Oil & Gas Hedge life	Exploration Exp as % Shareholder Equity	Acquisition Exp:Acq+ Expl Exp	Altman Z
Constant	3.90**	1.75**	0.033	4.521	-0.044	-0.327	-0.527
Prior Year Oil Price	-0.030	-0.0174	-0.004	-0.140**	-0.00017	0.002	0.008
Aussie Dummy (=1 for ASX listing)	3.02***	1.31**	-0.245*	-7.363***	0.189**	-0.190	0.866
Ln Market Capitalization	-0.393***	-0.154**	0.041**	0.802***	-0.003	-0.016	-0.106
Substantial Shareholders %	-0.081	0.078	-0.202*	-3.317*	0.030	-0.477	-1.79***
CEO Age (years)	2.393E-4	0.0041	-0.003	-0.067	0.003	0.001	0.034**
CEO Service (years)	0.023	0.0096	0.005**	-0.009	-0.005***	0.015***	0.042***
Director number	0.00045	0.0040	0.004	0.357**	0.007	0.011	0.067
Debt:Equity Ratio	0.0052*	0.295***	0.036	0.720	0.024	0.111*	-0.495***
Price:Book Ratio	0.00142	-0.0100	0.047*	-0.645*	-0.015	0.023	0.671***
Reserves:Production	0.0034	-0.0075	-0.004	-0.047	-0.005**	0.016*	0.001
Cash ($ thou):Production (BOE)	-20.5	0.57	-0. 97	0.94	1.03	12.0***	6.34
Employee Options:Issued Shares	0.0071*	0.0042**	0.001*	-0.014*	0.001*	0.001	0.001
Prior Two Years Perf vs Index (%)	-0.0607	0.138	-0.048	1.351*	0.050	-0.028	-0.031
Oil & Gas hedges (years)	-0.0253	-0.0065	0.001				
Exploration Expend:Shareholder Equity	1.648	0.378	0.201				
Acquisition Exp:Acq+ Expl Exp	1.597	0.136	0.103*				
Altman Z	0.154	0.034	-0.037*				
R-squared	0.545	0.502	0.340	0.280	0.294	0.239	0.683
F	5.791	5.032	3.058	3.567	3.752	2.664	15.078

Table 4: Regression of Annual Measures of Risk, Risk Management and Risk Propensity

Reports results from cross-sectional regression of risk measures against risk management and risk propensity measures, and of risk management and risk propensity measures against firm variables. Data are averages for 1999 to 2004 (N=31). Significances at the ten, five and one percent levels are denoted by *, ** and ***, respectively.

	Idiosyncratic Risk: Percent	Std Dev ROA
Constant	3.04	-0.0041
Aussie Dummy (=1 for ASX listing)	0.582	0.0519*
Ln Market Capitalization	-0.400**	-0.0180*
Substantial Shareholders %	0.428	0.0023
CEO Age (years)	0.0037	0.0001
Director number	0.179	0.0182**
Debt:Equity Ratio	0.776	0.0116
Price:Book Ratio	-0.265	0.0064
Reserves:Production	0.00453**	0.0001
Cash ($ thou):Production (BOE)	0.0653**	0.0000
Employee Options:Issued Shares	8.11	0.6940**
Prior Two Years UnderPerf vs Index (%)	590.8***	15.60
Oil & Gas hedges (years)	0.0151	-0.0039
Exploration Expend:Shareholder Equity	1.178	0.0952
Altman Z	0.276**	0.0171***
R-squared	0.757	0.586
F	7.024	3.728

Appendix: Description of Analytical Variables Included in Analysis

Name	Description of Variable
Risk Measures	
Idiosyncratic Risk	Standard deviation of the error term, ε, in equation 2. Calculated daily
Downside risk	Standard deviation of the lesser of zero and return below the Index (All Ordinaries in Australia, S&P 500 in US). Calculated daily
StdDevROA	Standard deviation of annual values of EBIT divided by Assets.
Oil Beta	Value of $\beta_{i,oil}$ in equation 2. Calculated daily
Risk Propensity Measures	
Altman Z	Altman's Z-score. Value of 5 corresponds to an S&P A rating
Exploration Expenditure as % Shareholders Equity	Exploration expenditure divided by shareholders equity.
Acquisition Expenditure as % Exploration Expenditure plus Acquisition Expenditure	Acquisition expenditure divided by the sum of exploration expenditure and acquisition expenditure.
Prior two years' relative performance %	Derived from value of average daily return of the firm minus the Index over the previous two years. For underperformance, equals the value if negative (i.e. underperformance), otherwise zero.
Risk Management Measure	
Oil & Gas Hedge Life	Volume of oil and gas futures and options divided by production.
Environment Measure	
Oil Price	Monthly average for WTI in the year
Firm Variables	
Aussie dummy	Equals 1 for firms listed in Australia; 0 for US listing
Ln Market Capitalization	Natural logarithm of market capitalization
Substantial Shareholders %	Percentage of issued capital held by Substantial Shareholders
CEO Age (years)	Age of CEO in years.
CEO Service (years)	CEO tenure in years
Director numbers	Number of directors on the Board.
Debt:Equity Ratio	Interest bearing debt divided by shareholders equity.
PriceToBook	Ratio of Market capitalisation to Shareholders equity
Reserves:Production	Oil & gas reserves (bbl OE) divided by Oil & gas production.
Cash Flow: Production $/BBL OE	Operating cash flow divided by current year's oil and gas production.
EmpOptShares	Outstanding employee share options as percentage of issued shares