Reinsurance and the Cost of Equity in the United Kingdom's Non-Life Insurance Market

Abstract

The effect of risk management on the cost of equity of insurers is investigated. Using panel data drawn from firms operating in the UK's non-life insurance sector, we show that reinsurance (risk management) can decrease the cost of equity of insurance companies, but the relation is non-monotonic in nature. We find that reinsurance purchase is associated with reduction in the cost of equity but the rate of reduction declines as the level of premiums ceded relative to total gross premiums written increase. We also find that cost of equity is positively associated with the probability of bankruptcy and that reinsurance can reduce the cost of equity by reducing the probability of bankruptcy.

Key words: Risk management; Cost of Equity; Reinsurance; Insurance; Bankruptcy; United Kingdom.

I. Introduction

There is a growing body of literature which investigates how risk management affects firm risk and cost of external finance. For example, Bartram, Brown and Conrad (2011) find that use of financial derivatives reduces both total risk and systematic risk for non-financial firms. Campello, Lin, Ma and Zou (2011) show that hedgers have lower cost of borrowing and investment restrictions enabling them to undertake value enhancing projects. Chen and King (2014) also find that corporate hedging results in lower cost of debt. There is, however, lack of substantial evidence on the effect of risk management on the cost of equity of hedgers. The evidence is even scarcer in the case of financial intermediaries as most of the empirical studies exclude financial firms from their investigation.

This study provides empirical evidence on the impact of financial risk management on the cost of equity of insurers. Financial risk management studies propose number of rationales for corporate hedging. According to Smith and Stulz (1985) reduced tax liability, lower costs of financial distress and reduced probability of underinvestment are the key benefits of corporate hedging in imperfect capital markets. Similarly Leland (1998) argues that the value of the debt tax shield can be increased by increasing debt capacity through hedging. Empirical evidence on the effect of hedging on firm value is however mixed (Aretz and Bartram, 2010). Moreover, most of this evidence pertains to use of financial derivatives by non-financial firms. Number of studies on financing and risk management policies of firms assume that if financial markets are imperfect then external financing is costlier than internally generated funds (e.g. see Froot, Scharfstein and Stein, 1993). Froot (2007, p. 273) states that "…most financial policy decisions, whether they concern capital structure, dividends, capital allocation, capital budgeting, or investment and hedging policies, revolve around the benefits and costs of a corporation holding risk". Similarly, Smith and Stulz (1985) show that risk management (hedging) is an element of overall corporate financing policy. Therefore, risk management and financing decisions are intertwined. Though risk-return trade-off is the basis of every business decision, the impact of risk management on firm risk and value is still a contested issue. The situation is more complex in the case of financial institutions because their business risks and financial risks are interdependent.

Prior research (e.g., Doherty, 2000; Doherty, 2005; Doherty and Tinic, 1981; O'Brien, 2006; Scotti, 2005) suggests that corporate financing and (re)insurance[1] decisions are inextricably bound and that investigating this issue empirically could yield interesting insights into the determinants of firm value in insurance markets. For example, Doherty and Tinic (1981) show that reinsurance can reduce the probability of ruin for direct insurance writers and allow them to charge higher premiums than would otherwise be the case, thereby increasing expected returns for shareholders. Launie (1971) notes that knowledge of the cost of capital can help insurance managers to make more informed portfolio and capital structure decisions and better manage financial risks. The cost of equity being an integral element of the overall cost of capital of a firm, its relationship with reinsurance is also important from the perspective of maximising the traded value of an insurer. Sharfman and Fernando (2008) suggest that in the context of a firm's standing in the capital markets, the link between risk management and the cost of equity is a fundamental strategic issue. Similarly, Stulz (1996, p. 24) argues that by reducing the downside financial distress/bankruptcy risks, risk management (reinsurance) can reduce the cost of equity along with increasing corporate debt capacity. Doherty and Lamm-Tennant (2009) also suggest that reinsurance, being a leverage neutral post-loss financing mechanism, can enable primary insurers to mitigate the adverse effects of rising losses such as the increased risks of financial distress and/or bankruptcy.

Bartram, Brown and Conrad (2011) provide empirical evidence that hedging has positive effect on firm value. Some studies have examined the direct impact of (re)insurance on the

[1] (Risk) reinsurance involves a primary insurer ceding a share of its annual premiums on a block of underwritten business to a reinsurance company in return for the reinsurer assuming an agreed proportion of losses that may arise (Berger, Cummins and Tennyson, 1992). In contrast, financial reinsurance invariably involves reinsurance companies providing primary insurers with an upfront capital sum representing the net present value (NPV) of liabilities with the level of premiums linked to future claims and profit emergence (Adiel, 1996).

value of firms using economic measures such as Tobin's q (e.g., see Zou, 2010)[2] or market capitalization (e.g., see Scordis and Steinorth, 2012), but none has examined the relation between the cost of equity capital and reinsurance. Therefore, this study could potentially contribute important insights on the interplay between the cost of capital and reinsurance that might be useful for insurance suppliers, brokers, managers, industry regulators, and investors. For example, the study could help determine the optimal level of reinsurance necessary for a particular insurance firm to reduce its cost of equity and maximize its value for its shareholders.

This study contributes to the existing insurance and finance literature, and generate regulatory/practical implications in at least the following three important regards. First, the mutual interdependence of investment and risk management decisions becomes critical in the case of insurers, which are systemically important regulated financial intermediaries. This is because insurers are mandated by law to maintain a certain minimum amount of capital in order to bear assumed risks and continue operating as a going concern. Such a requirement results in the deadweight cost of capital being imposed on insurers (Froot, 2007). The contingent capital attributes of reinsurance in this case can reduce the level of retained equity and so maximize the traded value of an insurer (Doherty and Lamm-Tennant, 2009). On the other hand, Borch (1961, p. 35) points out that reinsurance is expensive for insurers because "…when an insurance company reinsures a part of its portfolio, it buys security and pays for it". In other words, reinsurance is a costly instrument. These conflicting views indicate that the purchase of reinsurance can be viewed as cost-benefit trade-off. The dynamics of the cost of equity – reinsurance relation implied by the aforementioned trade-off has hitherto remained insufficiently explored in the insurance-economics literature. We maintain that this is an issue that is closely related to the problems of capital structure optimization and value added by risk management for which a consensus solution has not yet been found. Being the first study to focus on the interplay between the cost of equity capital and risk management (reinsurance) in the non-life insurance industry, this study contributes new and important insights that can lead to determination of optimal level of reinsurance for an insurer. This is an issue that carries some commercial and regulatory importance.

Most of the previous studies have focused on financial derivatives while attempting to explain the impact of risk management on firm value (e.g., see Allayannis and Weston, 2001;

[2] Tobin (1969, p. 21) defines q as ". . . the value of capital relative to its replacement cost." Scordis and Barrese (2006) view Tobin's q as a measure of a firm's investment opportunities which might proxy for other factors other than firm value such as a firm's market power.

Gay, Lin and Smith, 2011; Géczy, Minton and Schrand, 1997; Haushalter, Klasa and Maxwell, 2007). The current study diverges from this tradition by focusing on reinsurance which is a pure indemnity contract. This is in contrast with financial derivatives which can be used for speculative as well as hedging purposes (Harrington and Niehaus, 2003). Moreover, Haushalter (2000) suggests that unlike (re)insurance indemnity contracts, the use of financial derivatives for hedging may not completely eliminate basis risk exposures. Aunon-Nerin and Ehling (2008) also note that derivatives data are often 'noisy' and so difficult to interpret. These characteristics make it difficult to extract relevant information from derivatives data, which is usually scarce in view of the fact that industrial firms are seldom statutorily required to disclose such information. However, these limitations concerning the amount and quality of public information are overcome in this study as regulations mandate insurers to disclose reinsurance transactions in their regulatory returns. Therefore, it follows that the 'pure-hedge' nature of reinsurance and a sufficiently large panel dataset of reinsurance transactions allow for 'cleaner' tests of the research questions posed in this study.

Since investment financing and risk management decisions go hand in hand, it is important to control for potential endogeneity induced by such a relation. This study therefore tests the cost of equity – reinsurance relations using a battery of tests to ensure the validity of the results. Moreover, an instrumental variable technique is employed to ensure the robustness of the results. Further, a novel technique combining the full information beta method of Kaplan and Peterson (1998) and the non-parametric method of equity beta estimation (Wen, Martin, Lai and O'Brien, 2008) is devised for this study. This study is the first to employ such a procedure for examining the cost of equity - reinsurance relations in the non-life insurance sector, both in the UK and overseas.

The remainder of our paper is organized as follows. Section 2 provides institutional background information on the UK's property-casualty insurance market and justifies the UK as a domain within which to focus the study. Section 3 reviews the related literature and develops the research hypotheses. Section 4 describes the research design employed, including a description of the data, description of the model, and definition of the variables. Section 5 discusses the empirical results, while section 6 concludes the paper.

II. Institutional Background

The UK's non-life insurance market is the fourth largest in the world (after the US, Japan and Germany) accounting for around 16 percent of the annual premiums written in the continental European non-life market and 5.3 percent of the world non-life insurance market (Seiler, Staib and Puttaiah, 2013). The UK insurance industry currently controls financial assets valued approximately at £2.7 trillion, and contributes to the UK economy by directly investing nearly 54% of this amount in the UK economy in the form of various financial investments (Office for National Statistics, 2013). The UK insurance industry is additionally a major exporter for the UK economy with premium income valued at £41 billion coming from overseas, of which nearly £14 billion are attributed to general insurance business (Association of British Insurers, 2012c)[3]. The non-life insurance market in the UK can be divided into two major constituencies, namely the domestic insurance market and the London market. The domestic insurance market caters to the insurance needs of households and businesses in the UK, whereas the London market is largely international with a significant proportion of business attributable to reinsurance. The London market includes Lloyd's and the company market. The purpose of the company market is to allow brokers to place risks through a number of corporate insurers. On the other hand, prospective policyholders cannot approach a Lloyd's syndicate directly, and the business must be placed only through authorised Lloyd's brokers. This apparent segregation of these markets however does not prevent some overlap between the respective markets. For example, a large or unique risk may simultaneously be placed with corporate insurers in the company market and Lloyd's syndicates (General Insurance Manual, 2008). Given such a vibrant insurance market, there are currently about 700 insurance operatives authorised to conduct business in the UK's non-life insurance market (Association of British Insurers, 2012c).

During the period covered by our study the UK's insurance industry has witnessed some regulatory changes. The relevant regulations have evolved to become more comprehensive with the implementation of a risk-principles based approach to solvency over the period of this study. However, regulation in the UK has remained a 'lighter touch' compared with the risk-based capital solvency requirements prevailing in the US. Therefore, the evolution of the UK's regulatory regime has not resulted in regulatory requirements intervening with the industry's capability to innovate and introduce new products in the market. The effect of this difference in regulatory approach could be interesting in terms of comparing the results of this study and US-focused research of a similar nature. Moreover, the UK insurance market operates under a unitary (homogenous) regulatory regime. This is in contrast to the US insurance market where regulation is the responsibility of the State-based regulators. Standards issued by the National Association of Insurance Commissioners (NAIC) are used

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[3] Figures do not include premiums written by insurance companies that are not members of Association of British Insurers, and premiums written in Lloyd's market.

in the US to coordinate regulation activity between the States. However, as these standards are not mandatory, there are some regulatory differences between the States. Moreover, the US-based insurers are subject to premium rate regulation, which is not the case in the UK (Nelson, 2000). Thus, the premiums charged by the insurers in the UK's non-life insurance market are governed mainly by market forces (e.g., competition). These attributes of the UK's non-life insurance market facilitate potentially 'cleaner' tests of research questions put forward in this study.

An important aspect of the institutional background of the UK's non-life insurance sector is the accounting practices prevalent in this sector. Non-life insurers in the UK are required to produce their annual accounts in accordance with the UK GAAP or IFRS 4 (since 2005), which intend to present a 'true and fair' view of the financial condition of the company. These set of accounts are also used for calculating the tax liability of the insurers. The 'fair value accounting' followed under the UK GAAP/IFRS 4 tries to value assets and liabilities at, or close to, their true market values; therefore it can induce volatility in the claim reserve, tax liability and capital adequacy calculations. The amount recoverable under a reinsurance treaty however, is independent of common valuation parameters (such as interest rates); hence, purchase of reinsurance can be instrumental in reducing the volatility induced by mark-to-market accounting. Moreover, the supply of reinsurance in the UK insurance market is not distorted by discrimination against foreign reinsurers as is the case in the US (Cole and McCullough, 2006). Browne and Ju (2009) report that the foreign reinsurers in the US are required to fully fund the claims arising in the current period and the reserves for future claims from US-cedants in the form of funds on deposit/trust accounts or a letter of credit. These requirements can distort the supply of reinsurance in the US insurance market, whereas the UK non-life insurance market is free of any such supply-side distortions. Furthermore, the extent of the reinsurance cover purchased is a free managerial decision in the UK non-life insurance sector, in contrast with some other jurisdictions, such as China, where the purchasing of reinsurance is mandatory. These regulatory features potentially make the results obtained in this study free of regulation induced biases.

Given the large number of players in the general insurance market competing for the same set of investors and customers, reinsurance can be a useful tool for signalling the financial health of an insurer, capacity building, and strategic capital and risk management. Given the size of the market; homogeneity of the regulations; and independence of managers to purchase reinsurance from statutory requirements, the UK is considered to be ideal environment in which to conduct this study. Thus, reinsurance as a capital and risk management tool and its interaction with the cost of capital become important considerations for commercial as well as regulatory applications in the UK insurance market.

III. Related Literature and Hypotheses Development

In finance theory, the optimal use of (re)insurance can manifest itself by reducing the corporate cost of capital and so increase the shareholders' wealth by generating economic value in excess of the cost of capital (e.g., see Shimpi, 2002). Not only this, the management of underwriting risks is vital for insurers to outperform competition in the product-markets they operate in (Upreti and Adams, 2015). As Froot (2007) suggests, insurers and reinsurers are not only subjected to the investment risk, but also to the product market imperfections arising from the inability of policyholder-customers to efficiently diversify insurable risks. Survey evidence provided by Wakker, Thaler and Tversky (1997) and Merton (1993) suggests that customers deeply (and disproportionately) discount the premium for an insurance contract for any increase in the probability of default on the part of the insurer. Hence, reinsurance can enable the insurer to command higher market premiums by reducing the probability of a default. On the other hand, reinsurance can be expensive. For example, Froot (2001) finds that due to market frictions (e.g., information asymmetries and agency costs) the price of catastrophe reinsurance coverage in the US property-liability insurance market often exceeds the actuarial value of expected losses. Schrand and Unal (1998) also opine that because of the transaction costs involved, the hedging (reinsurance) of core risks can have a deleterious effect on firm value. Therefore, rather than reduce the cost of capital (increase firm value) reinsurance could increase the cost of capital (reduce firm value). It is therefore imperative to reconcile these conflicting arguments to comprehend the effect of reinsurance on the cost of the equity of the insurers.

During the past three decades, the increasing frequency and severity of environmental perils, such as hurricanes, earthquakes, and floods have resulted in wide-scale losses around the globe. For instance, the cost of insured losses resulting from super-storm Sandy in 2012, the Japanese earthquake and tsunami in 2011, and hurricane Katrina in 2005 are estimated to be USD 28 billion (Mortimer, 2013), USD 35 billion (Bevere, Enz, Mehlhorn and Tamura, 2012) and USD 41 billion (Knabb, Rhome and Brown, 2005) respectively. Man-made disasters too have proven costly for the insurance industry. In fact, one of the largest property-liability claims in history was caused by the September 11 terrorist attacks in the US in 2001 with insured losses estimated at approximately USD 40 billion (Makinen, 2002). Moreover, the magnitude and frequency of losses caused by both natural and manmade disasters is likely to increase over time due to the increased severity and frequency of natural disasters resulting from climate change, and the emergence of new man-made perils such as cyber-terrorism (Froot, 1999; Lewis and Murdock, 1996). Indeed, Bevere et al. (2012) report that combined economic losses on the global scale due to all the disasters in 2011 were estimated at over USD 370 billion. This figure is the largest ever recorded in history, with an increase of approximately 64% over USD 226 billion of losses recorded in 2010.

This trend of rising losses from catastrophes has serious implications for the insurance industry, as it can undermine the capital adequacy of insurers to service the claims of existing customers and to underwrite new business. Moreover, for other stakeholders, such as policyholders and investors, this possibility can potentially threaten their contractual benefits as it implies an increase in insurance companies' insolvency risk and a decrease in their profitability. According to Jean-Baptiste and Santomero (2000) these concerns have resulted in an increased interest amongst managers, reinsurers, regulators, and others in better understanding the risk management and pricing techniques within the insurance industry. For property-liability (non-life) insurers, an improved understanding of risk-bearing and risk-financing is particularly important due to the potential geographical and product-market concentration of risks.

Risk Management and Value Creation

In their influential work on the modern theory of corporate risk management, Mayers and Smith (1982) argue that risk management can add value to a firm if it allows them to mitigate some of the frictional costs arising in imperfect markets. As mentioned previously, a firm facing increased frictional costs, such as the costs of financial distress, is more likely to incur agency problems leading to sub-optimal investment decisions. Therefore, it follows that prudent risk management can mitigate these problems by reducing the cost of external finance, and the potential for agency incentive conflicts thus promoting investments in value enhancing projects. In the same vein, Doherty (2000, p. 9) adds that "…hedging complements other sources of financing, internal and external, to replace destroyed assets and new investments". Such reasoning has given rise to a sizable body of literature that links corporate financing decisions to risk management (e.g., see DeMarzo and Duffie, 1995; Froot, 2007; Froot, Scharfstein and Stein, 1993). However, business risks can vary between different firms and across industrial sectors. Therefore, to explain the value added by risk management at the firm level, it is imperative that the value creation process of concerned industry is well understood. To facilitate this exposition, the value creation process in the insurance industry is now discussed below.

The mechanism by which insurers create value is well explained in Hancock, Huber and Koch (2001, p. 8), which has been reproduced succinctly here. They suggest that an insurance company can be likened to a leveraged investment fund that generates funds for investing through insurance markets (instead of capital markets) by selling insurance policies and invests them in financial assets in accordance with statutory and regulatory requirements. This structure spells competitive advantages as well as disadvantages for the insurance industry. In comparison to other investment funds, non-life insurers are potentially at a disadvantage on the investment front because of limitations imposed by the regulators on investment portfolio allocation decisions. In contrast, the scenario is invariably different on the fund generation side and thus a potential source of value added by the insurance industry. Doherty and Tinic (1981) observe that insured parties by definition are risk-averse and unable to diversify away the risk they are endowed with at the market rates in the capital markets. As a result, insurers are able to charge premiums above their actuarially fair values, i.e., at a price higher than their economic/production costs and one that includes loadings for insurers' profits and reserve margins. Policyholder customers are willing to pay this price as long as it is below the utility they attribute to insurable assets. It thus follows that insurers are able to 'borrow' loss contingent capital from insurance markets at favourable rates in comparison to raising finance on the capital markets (Froot, 2008). This mitigates the disadvantages faced by insurers on the investment front. Therefore, efficiently managing and pricing the risk inherent in the contingent claims sold in the insurance markets forms the core function of the insurance business. This reasoning further implies that, prudent risk management is the 'bed-rock' on which insurance industry is built. Therefore this feature of the insurance markets is bound to impact on the cost of the equity capital employed in the insurance companies.

Reinsurance and the Cost of Equity

Based on above arguments, it can be concluded that reinsurance can add value only if it enables insurance companies to optimise on the frictional costs arising due to market imperfections. However, this view understates the utility of reinsurance as it is intrinsically different from other financial hedges (e.g. derivative instruments) in at least four key regards. First difference can be characterized using the definition of a financial hedge. Nance, Smith and Smithson (1993, p. 267) define corporate hedging as, "…the use of off-balance-sheet instruments – forwards, futures, swaps, and options – to reduce the volatility of firm value". Reinsurance on the other hand is well accounted for in the financial statements submitted to the regulator by an insurer, with the claims recoverable from the reinsurers being counted as one of the admissible assets used in calculating the capital adequacy requirements of insurers[4]. Therefore, reinsurance is a hedge instrument that is well-integrated with the capital structure of an insurer. The second reason that makes reinsurance different from the financial risk hedging is the fact that reinsurance involves the transfer of ‘pure downside risks’ making it a pure hedge (indemnity) instrument which cannot be used for speculative purposes (Aunon-Nerin and Ehling, 2008). Moreover, Campello, Lin, Ma and Zou (2011) note that some firms may opt out of their hedging positions once they have secured sufficient capital from lenders; however, this option is not possible with reinsurance. This gives rise to the third difference between reinsurance and other financial hedges as once agreed, the reinsurance contract is legally binding both on the primary insurer (the cedant) and the reinsurer. Fourth, reinsurance treaties often provide ancillary advisory services, such as the pricing of emerging or unusual risks, and/or claims handling. These ‘real services’ can provide added-value for the shareholders and policyholders of insurance firms. Given these differences, reinsurance can be valuable to insurance companies, not only by reducing the cost of external finance, but also in other respects.

Harrington and Niehaus (2003, p. 125) define underwriting risk as “…the risk that prices and reported claim liabilities will be inadequate as compared to realized claim costs”. In other words, the underwriting risk is effectively the result of the interplay between estimated claim costs and the uncertainty in their estimation. Since policyholder-customers of an insurance company are also its major capital providers (creditors), the management of underwriting risk is also important from a strategic product-market perspective. By the same token, Froot (2007) suggests that insurers and reinsurers are not only subject to the investment risk, but also to the product market imperfections arising due to the inability of policyholder-customers to efficiently diversify insurable risk. This reasoning implies that exposure to financial distress will subject an insurer to reduced new business growth and hence loss of profitability, as well as increase in the market cost of capital. Doherty and Tinic (1981) further argue that the cost of capital of insurance firms can be reduced by purchasing reinsurance and their traded value is increased because policyholders are willing to pay higher premiums for enhanced financial strength. This proposition is consistent with empirical results from the US property-liability insurance industry reported in Sommer (1996). Froot (2008) also notes that reinsurance is important because compared with investors the policyholder-customers of insurance companies are less efficient at diversifying risk, and that reinsurance provides such fixed financial claimants with the certainty of indemnification in the event of an insured loss. Reducing the probability of ruin through reinsurance could also enable direct insurers to create value for their shareholders by increasing their underwriting capacity (Adams, 1996;

[4] Not all assets held by an insurer can be used for calculating the capital adequacy requirements. Only the statutorily allowed ‘admissible assets’ may be used.

Blazenko, 1986), and reducing current and expected taxes (Abdul-Kader et al., 2010; Adams et al., 2008; Garven and Loubergé, 1996). In this sense, determining the decision to reinsure can also be viewed as a financing (capital structure) choice decision (Garven and Lamm-Tennant, 2003; Hoerger et al., 1990). The foregoing analysis therefore implies that:

H_a1: Other things being equal, insurers using reinsurance have a lower cost of equity than non-users.

Sung (1997) reports that the mispricing of assumed risks by primary insurance writers can result in a sub-optimally diversified risk pool as well as engender increased agency costs and other market failure problems (e.g., increased risks associated with moral hazard and bankruptcy). Likewise, Doherty and Lamm-Tennant (2009, p. 57) contend that "…it makes sense for primary insurers to retain the primary or "working" layers of the risks they underwrite, while passing the "tail risks" or excessive geographical or product concentrations to reinsurers." Hence reinsurance can be an important risk management mechanism for improving the risk bearing capacity of primary insurers (Mayers and Smith, 1990; Adams, 1996). Recent advances in finance theory explicitly recognise that frictional costs and other market imperfections (e.g., taxes) are important factors motivating the purchase of reinsurance (Mayers and Smith, 1990).

Froot et al. (1993) provide a framework for analysing risk management decisions in terms of market frictions and the impact of financing policy on firms' investment decisions. They argue that cash flow volatility can be costly for shareholders and that by stabilising cash flows following unexpected shock events, risk management techniques (reinsurance) enhances the value of (insurance) firms by enabling managers to realise positive NPV projects in their firms' investment opportunity sets. Plantin (2006) also argues that because of reinsurance companies' close contractual relationships with direct insurers and their regular monitoring of insurers' underwriting and claims settlement systems, reinsurance can serve as an important signalling device to investors as to insurers' future financial condition. Shimpi (2002) further contends that the contingent capital properties of (re)insurance can help lower annual combined loss ratios (i.e., claims plus expenses including commissions as a proportion of net premiums written) as well as reduce the required level of retained equity capital. This attribute can help signal surety to investors thus reducing the cost of capital and increasing risk-adjusted returns for shareholders. The implied market signalling benefits of reinsurance can help direct insurance writers to reduce their equity cost of capital. Froot (2008) points out that holding too much equity in insurance firms is not only expensive for investors but also increases the risk of resource misuse and excessive perquisite consumption by managers (see also Tufano, 1998). In other words, the frictional cost of capital in insurance firms can arise from agency incentive conflicts between management and owners (Laux and Muermann, 2010). Laux and Muermann (2010) further argue that as stock insurance firms invariably raise equity prior to selling policies, competition in insurance markets limits the amount of equity capital that can be raised at a cost that maximises their expected return on investment. However, as a contingent capital mechanism, reinsurance can relax equity limits and help optimise the allocation of capital in insurance firms in a way that financially benefits shareholders (Froot, 2007). Moreover, reinsurance can become economically advantageous to a direct insurance writer in the face of information asymmetries and agency problems such as the underinvestment and asset substitution incentives (Doherty and Smetters, 2005; Jean-Baptiste and Santomero, 2000; Jensen and Meckling, 1976; Mayers and Smith, 1990). In other words, primary insurers are likely to reinsure when frictional costs exceed loadings for reinsurers' profits and expenses (Garven and MacMinn, 1993).

On the other hand, reinsurance can be expensive. For example, Froot (2001) finds that due to market frictions (e.g., information asymmetries and agency costs) the price of catastrophe reinsurance coverage in the US property-liability insurance market often exceeds the actuarial value of expected losses. Schrand and Unal (1998) also opine that because of the transaction costs involved, the hedging (reinsurance) of core risks can have a deleterious effect on firm value. Therefore, rather than reduce the cost of capital (increase firm value) reinsurance could increase the cost of capital (reduce firm value). Reinsurance, if purchased in excess of the optimal level required by the insurer, can result in 'deadweight costs' because of the transaction costs and reinsurer's profit loadings (Froot, 2008). As long as the benefits of risk hedging via reinsurance outweigh the costs, then purchasing more reinsurance should lead to a reduction in the cost of equity, and but the relation is likely to be non-monotonous. This analysis thus suggests that the relation between hedging and the cost of capital is likely to be non-linear. In a similar vein, Purnanandam (2008) argues that the propensity to use hedging increases with leverage, but this relationship reverses for extremely high levels of leverage. Indeed, Zou (2010) finds empirical evidence of a concave (inverted U-shape) relation between the purchase of property insurance and firm value (as measured by Tobin's q) in Chinese publicly listed companies (PLCs). Since firm value is inversely related to the equity cost of capital, one would expect the relationship between the cost of equity and extent of reinsurance to be non-linear as well. It is therefore imperative to reconcile these conflicting arguments to comprehend the effect of reinsurance on the cost of the equity of the insurers. Therefore the second test hypothesis is:

H_a2: Cost of equity of an insurer decreases with an increase in the level of reinsurance but the relation is non-linear in reinsurance (ceteris paribus).

Reinsurance and the Probability of Default

Mayers and Smith (1990) contend that the decision of direct insurers to procure reinsurance is analogous to the purchasing of insurance by non-financial firms. Several reasons have been reported in the literature to explain the corporate purchasing of reinsurance[5]. These include: the need to increase the underwriting capacity and facilitate the spreading of assumed risks (Adams, 1996), to reduce the bankruptcy risk and avoid regulatory intervention in the event of a severe loss (Hoerger, Sloan and Hassan, 1990); to improve reported earnings (Adiel, 1996); to reduce expected taxes (Adams, Hardwick and Zou, 2008); to mitigate agency problems such as the underinvestment incentive (Garven and MacMinn, 1993); the provision of real advisory services (Cole and McCullough, 2006); and to signal the surety of the economic condition to the financial markets (Plantin, 2006). Not only this, the management of underwriting risks is vital for insurers to outperform competition in the product-markets they operate in (Upreti and Adams, 2015). As Froot (2007) suggests, insurers and reinsurers are not only subjected to the investment risk, but also to the product market imperfections arising from the inability of policyholder-customers to efficiently diversify insurable risks.

Survey evidence provided by Wakker, Thaler and Tversky (1997) and Merton (1993) suggests that customers deeply (and disproportionately) discount the premium for an insurance contract for any increase in the probability of default on the part of the insurer. Like non-financial firms, property-liability insurers are mainly financed by shareholders who expect to earn a 'fair' market return on their invested capital.[6] Krvavych and Sherris (2006) add that in the presence of frictional costs (e.g. taxes and transaction costs) shareholder value is more likely to be enhanced by managing underwriting risks than by creating value from managing investment portfolios. It is so because underwriting risk is the core risk for the insurance industry, hence their competitive advantage stems from managing this risk. In finance theory, the optimal use of (re)insurance can manifest itself by reducing the corporate cost of capital and so increase the shareholders' wealth by generating economic value in

[5] Powell and Sommer (2007) report that in the United States (US) property-liability insurance market approximately 80 per cent of annual reinsurance business is conducted within conglomerate groups rather than externally in the reinsurance market. Adams and Diacon (2006) estimate a similar percentage (approximately 75%) for reinsurance conducted in the United Kingdom's (UK) property-liability insurance market.

[6] For example, Adams and Diacon (2006) report that approximately 95 percent of annual net premiums in the UK's property-liability insurance market are written by stock companies. A 'fair' market return in this context is defined as a return in excess of the market cost of equity (e.g., see Shimpi, 2002).

excess of the cost of capital (e.g., see Shimpi, 2002). Hence, by reducing the probability of a default, reinsurance can not only enable insurers to increase market share but also to reduce their cost of equity. In other words, reinsurance reduces the cost of equity by reducing the probability of bankruptcy. To test this proposition we formulate the following hypothesis:

H_a3: Reinsurance reduces probability of default of an insurer (ceteris paribus).

Having formulated our three principle hypotheses, we present the methodology we employ to test the proposed hypotheses in the following section.

IV. Research Design

Data

Data used in this study are derived from two sources. The first data sources are the regulatory returns filed by the licensed general insurance companies operating in the UK to the insurance industry regulator – the FSA. SynThesys Non-Life Insurance Database provided by Standard & Poor's (2011) compiled the regulatory returns filed by 469 insurance companies operating in the UK non-life insurance market between 1985 and 2010. However, the SynThesys database does not provide consolidated returns of group companies as regulations require independently operating and reporting insurers to file their returns individually, rather than on the basis of their group membership. Additionally, not all firm-year cases included in the database are usable (e.g., as a result of the negative values of accounting items (e.g., the negative values of gross annual premiums written) and missing observations). Therefore, as in Petroni (1992), and Gaver and Paterson (1999) amongst others, certain restrictions were imposed on the complete set of observations to derive a sample with plausible values of certain key parameters. Only firm-year observations for which total assets, total gross premiums written, primary and direct gross premiums written, total capital resources, cash, capital reserve requirements, claims incurred, policyholders' surplus, paid-in capital and premiums ceded were reported to be positive, are included in the estimation sample. Further, this sample's 'filtering procedure' also required that the return on assets be greater than -1 for the firm-year to be included in the sample. To 'force' the data to be longitudinal (panel) in nature, the firms that do not have at least two years of observations are excluded from the estimation sample. This results in a sample of 397 firms with 5,427 observations. In conjunction with this dataset, our study also used Datastream (2012) database provided by Thomson Reuters. Datastream was used to collect the data required for calculating the cost of equity. Specifically, data on the Financial Times Stock Exchange (FTSE) Non-Life Insurance Index were used to calculate returns for the UK non-life insurance sector[7], whereas the FTSE All Share Index was used for calculating the market return[8].

Cost of Equity Estimation

There are various techniques for calculating the cost of the equity of a firm, but their application is often constrained by the availability of the requisite data. It has been reported in the academic literature that market-based accounting methods provide the most accurate estimates of the cost of equity as these estimates tend to correspond well with the usual risk proxies (e.g., see Botosan and Plumlee, 2005). Since these techniques are by definition market based, these techniques are useful only for publicly quoted firms. This is so because the long time series of earnings and/or dividend forecast data required for estimating the equity cost of capital using these techniques are available only for widely held listed firms. Insurance (composite and pure non-life insurers) firms listed on the London Stock Exchange (LSE) however, represent only a small proportion (27 out of 701 licensed firms in 2010) of the total population of UK-licensed general insurers[9]. Results obtained using a sample of only 27 firms would not be generalisable; hence in the interest of maintaining a representative sample of a decent size, the idea of applying estimation techniques using market-based accounting was discarded. Following this, two techniques based on asset pricing theory were selected for the cost of equity estimation.

The R-L model attributed to Rubinstein (1976) and Leland (1999) is the primary technique for cost of equity estimation used in this study. The R-L model assumes the log-normality of market returns, but does not make any distributional assumptions regarding the returns of a particular stock. Wen et al. (2008) operationalise the R-L model for US property-liability insurance companies, and report that the R-L model, being distribution-free, provides better estimates (in terms of proximity to realised returns) of portfolio return for insurers with highly

[7] As the name suggests, the FTSE 350 Nonlife Insurance Index is a market-capitalisation weighted index of all the companies in the non-life insurance sector of the FTSE 350 Index. The index was developed with a base value of 1,000 as of December 31, 1985 (Datastream, 2012).

[8] The FTSE All-Share is a market-capitalisation weighted index representing the performance of all eligible companies listed on the London Stock Exchange's main market, that pass screening for size and liquidity. The FTSE All-Share Index covers approximately 98% of the UK's total market capitalisation (Datastream, 2012).

[9] Some of the firms included in the sample (e.g. Allianz) are quoted in the stock exchanges based in the country of their respective parents.

skewed returns, and/or a relatively small size. Even though the R-L model is a market-data based techniques, it can be used for non-listed firms if used in conjunction with the 'full information beta' (hereafter FIB) technology described in Kaplan and Peterson (1998). Indeed, Cummins and Phillips (2005) successfully apply the CAPM using FIB technique in the case of US-based non-listed property-liability insurers. They further assert that such methodology can be used for calculating the cost of capital of mutual companies as well. Consequently, this technique do not impose severe limitations on the data in terms of organisational form or the listing status of the insurance firm, which is desirable in the context of this study. Next we briefly explain the implementation of the FIB method in the case of this study.

Cummins and Phillips (2005, p. 447) state that the "…FIB methodology produces cost of capital estimates that reflect the line of business composition of the firm". Following their study, we estimated the industry level betas for each line of business as the first step of the FIB procedure. They further explain that in arbitrage free markets the value of a firm can be considered as the sum of the values of individual assets (lines of business) owned by the firm. Therefore, it follows that a firm's beta can also be represented as the sum of beta coefficients of individual lines weighted by their corresponding weights representing their proportional contribution to the firm's market value. Since individual lines are not traded in the market, the market value of individual business lines is not known. Therefore, following Kaplan and Peterson (1998), revenues for six lines of business at the industry and firm level are used in this study to proxy for the relative weight of each line at the industry-level and firm-level respectively[10]. So as the initial step for estimating the cost of equity, we calculated industry level beta corresponding to each of the available monthly observations using the following equation:

$$\beta = \frac{Cov[R_i, -(1+R_m)^{-b}]}{Cov[R_m, -(1+R_m)^{-b}]}$$

$$\text{where, } b = \frac{1}{2} + \frac{E[\ln(1+R_m)] - \ln(1+R_f)}{Var[\ln(1+R_m)]} \quad (1)$$

As is evident from the equation (1) above, the three key inputs required for estimation are R_i - the return on a portfolio of non-life insurance companies; R_f – the return on the risk-free

[10] Owing to the availability of coherent data six major groups of insurance business are classified as different lines in this study. These are: personal accident; motor insurance; property insurance; liability insurance; marine, aviation & transport insurance; and miscellaneous and financial loss.

asset and Rm – the return on the market portfolio. The proxies used for all these variables were obtained using data from Datastream (2012). The FTSE 350 Non-life Insurance Index was used to proxy R_i, the monthly return on the industrial sector. Data on this index are available from December 1985 onwards. Since the monthly return on the UK government Treasury Bill of one month maturity precisely matches the duration of returns on the insurance industry index and the market index, it was used as a proxy for the risk-free rate R_f. Similarly, the return on the FTSE All-Share Price Index was used to approximate the monthly market return. It is important to note here that there is a mismatch of the duration of data available on the FTSE 350 Non-Life Insurance Index, which is based on data from December 1985 and the data available from SynThesys Non-Life, which provides data from 1985 onwards. Therefore to avoid losing one year's data in the estimation, the bootstrap method utilising the full sample of available returns was employed to estimate the yearly industry beta for each year from 1985 to 2010. However, industry beta can also be calculated using the CAPM with the same set of variables used for estimating betas using the R-L model and employing the following equation:

$$R_i = R_f + \beta(R_m - R_f) \quad (2)$$

The long-run average of risk premium is used as short term estimates of risk premium could be confounded by period specific environmental (e.g., macroeconomic) events (Koller, Goedhart and Wessels, 2010). Therefore, to incorporate the long period estimates of risk premiums in this research project, the risk premium of 5.23% as reported in Table I of Kyriacou, Madsen and Mase (2006, p. 347) is used. Kyriacou et al. (2006) calculate the historical risk premium using UK-specific data from the year 1900 to 2002. As suggested in the academic literature, the arithmetic mean is employed in their study to arrive at this estimate (e.g. see Koller et al., 2010, p. 239). The yearly risk premia so calculated for each firm in the estimation sample serve as the dependent variable in testing each of the two hypotheses proposed.

Variables

Since the cost of equity is a reflection of investor risk perception, it can be impacted by various factors that have an effect on their risk perception. Prior research identifies many variables that can influence the riskiness of a firm. For example, reinsurance can be major factor in defining the riskiness of an insurer. Since this research study primarily aims to explain the effect of reinsurance on the cost of the equity of the insurers, the principal explanatory variables (decision to reinsure and the extent of reinsurance) used in this research are derived from the premiums ceded to the reinsurers. To test the 'reinsurance participation' hypothesis, an indicator variable, named REINID, which takes value 1 if a firm cedes any premiums to a reinsurer and 0 otherwise, is used. In the current study, 376 sample firms (nearly 95% of all the firms in the sample) use reinsurance with approximately 93% of the firm-year observations (5,063 out of 5,427) indicating the use of reinsurance. To gauge the extent of reinsurance used by insurers relative to the gross premiums written at the total business level, the ratio of premiums ceded to gross premiums written (hereafter reinsurance ratio) is employed. The variable label REINS denotes the reinsurance ratio given in Table 1 below.

In numerous studies leverage is considered to be an important factor in determining the cost of equity, and that the cost of equity increases with an increase in leverage (e.g. see Modigliani and Miller, 1958, 1963). Jensen and Meckling (1976), and Jensen (1986) contend that agency costs are also associated with debt, and as such, indirectly affect the cost of equity. Prior research studying the link between the cost of equity and firm risk characteristics (e.g. see Botosan and Plumlee, 2005) also uses leverage as one of the determinants of the cost of equity. Following these studies, leverage is used here as one of the explanatory variables for observed risk premium. In the context of this study's leverage, LEV, is defined as the net provisions scaled by reported capital resources.

Fama and French (1995) demonstrate that firm-size is a significant factor in determining the risk premium demanded by investors. In Fama and French's (1997) FF3F model, firm size is inversely related to the cost of equity. Such a relationship between firm size and the cost of equity arises because larger firms have greater access to capital markets than smaller firms, plus, they are more diversified in terms of both geographical and product-markets. Berk (1995) also suggests that the market value and firm risk are inherently inversely related. In the same vein, Botosan, Plumlee and Wen (2011) define firm size as the natural logarithm of the market value of the firm. However, this measure is not possible in this study as most of the firms in our sample are not publicly traded. Therefore, the natural logarithm of the total assets reported in the statutory annual returns filed by the insurers has been used to proxy for the size of the firm. It is considered that this is a reasonable proxy for two main reasons. Firstly, insurers are required by regulation to regularly (at least annually) mark their assets to market values for statutory solvency monitoring purposes, and second, a large proportion of insurers' assets are marketable securities which in any case are reported at, or close to their true market values.

Insurers being financial intermediaries face significant liquidity risks on their balance sheets (Borde, Chambliss and Madura, 1994). BarNiv and Hershbarger (1990) also suggest that liquidity risk is an important component of the potential financial distress costs of an insurer. The liquidity risks arise due to the possibility that insurers' investments (usually in marketable securities which are exposed to interest rate risk, market risk, and credit risk) will not be able to meet an increased demand for liquidity in the aftermath of a major catastrophe event. Borde et al. (1994) also report that liquidity has a positive and statistically significant relation with an insurer's risk. This view supports the argument that an insurer's liquidity level can lead to a more risky investment strategy. To account for this possibility, a variable representing the liquidity level of an insurer is also included in the estimation. The ratio of reported liquid assets (cash and cash equivalents) to total assets, denoted LIQ, is thus used to measure liquidity risk. As in Borde et al. (1994) the relation between liquidity risk and the cost of equity is predicted to be positive, but LIQ being an inverse measure of liquidity risk, we expect this coefficient to be negative.

One of the important considerations in determining firm-level risk is the level of product-market diversification of the firm. For example, Cole and McCullough (2006, p. 176) assert that, "…differences in the lines of business sold affect a firm's investment opportunities, earnings volatility, and overall level of risk". Indeed, in their study Drew, Naughton and Veeraraghavan (2004) find that idiosyncratic volatility is priced in the stock market. Since a diversified insurance firm is likely to have lower volatility returns, a Herfindahl index (HINDX) is used in this study to measure product diversification in accordance with the prior research (e.g., see Mayers and Smith, 1990). This variable (HINDX) is defined as the sum of squares of the premiums generated by individual lines of business as a proportion of the total premiums written at the total business level. In other words, for a firm 'i' operating in 'N' different lines of insurance in a given year 't', the Herfindahl index can be calculated as:

$$HINDX_{it} = \sum_{j=1}^{N} \left(\frac{GPW_{ijt}}{GPW_{it}} \right)^2 \quad (3)$$

where j represents the number of lines.

A small HINDX (significantly less than 1) represents a highly diversified company, whereas for a 'pure-play' company this index is equal to one. Since a diversified company is expected to be less risky, the cost of equity is expected be an increasing function of HINDX.

Insert Table 1 here.

Models

To test the first hypothesis, which relates the cost of equity to the managerial decision to reinsure, the following model is specified:

$$COE_{it} = \beta REINID_{it} + \gamma LEV_{it} + \phi SIZE_{it} + \rho LIQ_{it} + \theta HINDX_{it} + \varepsilon_{it} \quad (4)$$

Equation above is similar (but not identical) to the models used by Botosan and Plumlee (2005), and Botosan et al. (2011) to compare the relative accuracy of the cost of equity estimates obtained using different techniques. The model in the equation (4) above is based on the idea that the risk undertaken by investors must be priced in the cost of equity, hence the factors that can affect this risk must be accounted for in the model. All the variables appearing in the equation (4) above are described in Table 1, while the last term ε_{it}, in the equation (4) represents an error term that accounts for unobserved firm specific effects (e.g., variations in managerial quality) α_i, time specific shocks (e.g., macroeconomic changes) v_t and a random (white noise) error term η_{it}. That is:

$$\varepsilon_{it} = \alpha_i + v_t + \eta_{it} \quad (5)$$

In the presence of firm specific effects, the ordinary least squares estimator (OLS) is biased and inconsistent (Greene, 2003). For instance, firm-effects introduce a downward bias in estimates of standard errors. This downward bias in standard errors results in an upward bias in the magnitude of estimated t-statistics, which in turn leads to a statistical significance being assigned to variables that may not be significant (Greene, 2003). There is potential for the firm effects to be present in our dataset, so we use fixed effects estimator to alleviate this concern. Moreover, we use standard errors corrected for clustering within firms which is likely to control for the downward bias in standard errors (Wooldridge, 2002). This approach is consistent with recommendations of Gormley and Matsa (2014) who argue that fixed effects estimator is more consistent than other common methods (e.g. demeaning the dependent variable) used for controlling unobserved heterogeneity. Moreover, year-dummies are used in our regressions to control for time specific effects.

According to the second hypothesis put forward in section III, the relation between the cost of equity of insurance firms and the extent of reinsurance is expected to be non-linear. The extent of reinsurance for the purpose of testing the second hypothesis is defined as the reinsurance ratio (see Table 1). To capture the element of non-linearity, we include a slope dummy in our equation. For implementing this, we first create an indicator variable based on median value of reinsurance ratio. This dummy variable takes value 1 if reinsurance ratio is higher than the median and 0 otherwise. Next we interact this dummy variable with the reinsurance ratio variable to construct a variable *REININT* which captures the non-linearity of slope between the observations above and below the median value of reinsurance ratio.

Thus, to test the extent of the reinsurance hypothesis the following baseline model is specified:

$$COE_{it} = \beta_1 REINS_{it} + \beta_2 REINSINT_{it} + \gamma LEV_{it} + \phi SIZE_{it} + \rho LIQ_{it} + \theta HINDX_{it} + \varepsilon_{it} \qquad (6)$$

However, reinsurance is a key element of the capital structure of insurance companies, so there is potential for endogeneity in the specified model (Cole and McCullough, 2006). For example, a higher degree of corporate leverage can lead to a higher demand for reinsurance, which in turn can increase the underwriting capacity of the insurer leading to a further increase in leverage. Eventually this is likely to result in a higher cost of capital. To alleviate concerns about prospective endogeneity, an instrumental variable approach is also used in this study. An instrumental variable possesses the property that it is a good predictor of the endogenous variable, but is uncorrelated to the main dependent variable (Greene, 2003).

Instrumental Variable

An insurer that under-reserves is more likely to be financially distressed and so is subject to a greater risk of bankruptcy. As reinsurance is a form of contingent capital, other things being equal, a financially troubled insurer is thus more likely to use reinsurance than insurers who are in a sound financial condition. Indeed, Petroni (1992) provides evidence that there is a higher probability of under-reserving by financially distressed insurers in the US property-liability insurance industry. Cole and McCullough (2006, p. 174) also assert that, "…if an insurer has positive loss development, or has been under-reserving, then the insurer is likely to demand more reinsurance in an effort to mitigate potential financial constraint". Accordingly, it follows that reserving errors can, at least in part, explain the use of reinsurance, and therefore, a reserving error variable is a potential instrument for the extent of reinsurance. Moreover, the academic literature provides no evidence that a reserving error is directly related to the cost of equity, and so it has all the properties of a 'good instrument'. In this study, reserving errors are estimated using the Weiss method developed in Weiss (1985), scaled by reported capital resources are used as the measure for reserving errors. Further, the Weiss method of estimating reserving errors is one of the most common methods of estimating reserving errors (Grace and Leverty, 2012). According to the Weiss method, for an insurance firm 'i' reserving errors corresponding to the estimated losses in year 't', can be calculated 'n' years after year 't', using the following equation:

$$\text{Reserve Error}_{i,t} = \text{Incurred Losses}_{i,t} - \text{Developed Losses Paid}_{i,t+n} \qquad (7)$$

Reserving errors calculated using the equation (7) above show the difference between the expected losses in a given year and the actual payments made corresponding to those losses in a future year. A negative error would then be evidence of under-reserving.

Accordingly, the reserve error variable is expected to be negatively related to the demand for reinsurance. In this study, the errors are calculated one year in the future (i.e., n = 1). Hence, the inclusion of this variable results in the loss of one year of data (i.e., the latest year for which data are available for a particular firm), as the figures for future values of developed losses corresponding to the latest year were not available at the time of analysis. Therefore, without the loss of generality, the ratio of reserving error to reported capital resources, denoted $RESERR_{it}$, is used as an instrument for the reinsurance ratio.

Using this instrumental variable, along with other variables from the structural equation (6), the reinsurance can now be predicted using following equation:

$$REINS_{it} = \delta_1 RESERR_{it} + \delta_4 LEV_{it} + \delta_5 SIZE_{it} + \delta_7 LIQ_{it} + \delta_8 HINDX_{it} + u_{it} \quad (8)$$

The last term u_{it} of the reduced form equation (8) denotes the error term of the first-stage IV estimator. The Tobit estimation procedure is employed in the first-stage regressions to account for censored nature of the dependent variable. However, other estimators are also used to check the robustness of results. The instrumental variable (IV) approach followed here utilises a two stage least squares (2SLS) estimator. As the name suggests, the 2SLS estimator involves two stages of estimation. In the context of the current study, the value of the endogenous variable, $REINS_{it}$, was predicted using the reduced form equation. The predicted values so obtained were then inserted in the structural equation (6) to estimate the effect of the extent of reinsurance purchased on the cost of equity of an insurer. The interaction term also is redefined to reflect the predicted values of reinsurance ratio in this equation. The estimation procedure controls for time specific effects by including year-dummies in the regression analysis.

Reinsurance and the Probability of Bankruptcy

As mentioned in section III, we propose that reinsurance can potentially reduce the cost of equity by reducing the probability of default; so we first establish that probability of bankruptcy indeed is a determinant of cost of equity. For this we employ the following regression model:

$$COE_{it} = \alpha_i + \lambda BROPB_{it} + \beta_1 REINS_{it} + \beta_2 REINSINT_{it} + \phi SIZE_{it} + \rho LIQ_{it} + \theta HINDX_{it} + \varepsilon_{it} \quad (9)$$

To estimate the probability of bankruptcy we use a logit model proposed by Shumway (2001). Chava and Jarrow (2004) show that this model has superior forecasting performance compared with Altman’s (1968) z-score model. This model uses a dummy variable as the dependent variable, which takes value 1 to indicate a bankrupt firm in a given year and 0 to indicate a solvent firm. We follow ‘private firm model’ of Chava and

Jarrow (2004), which uses net income to total assets ratio (*NITA*) and total liability to total assets ratio (*TLTA*) as explanatory variables. We winsorize these variables at 1st and 99th percentiles at left and right tails respectively. Post regression we predict the probability of bankruptcy, *BPROB*, for each firm using the logistic function. This predicted value is then used in equation (9) above to test for relation between probability of bankruptcy and the cost of equity. We expect to find a positive relation between the two, as predicted by the trade-off theory of capital structure. Since *TLTA*, a measure of leverage, is used as an explanatory variable for predicting probability of bankruptcy, we do not include the variable *LEV* in equation (9) to avoid endogeneity.

Then we test the relation between reinsurance ratio and *BPROB* using the following equation:

$$BROPB_{it} = \alpha_i + \beta REINS_{it} + \gamma LEV_{it} + \phi SIZE_{it} + \rho LIQ_{it} + \theta HINDX_{it} + \varepsilon_{it} \quad (10)$$

We test the robustness of this relation using the IV estimates of *REINS* obtained from reduced form equation (8). We predict the relation between reinsurance ratio and the probability of bankruptcy to be negative, i.e. it is predicted that reinsurance reduces the probability of default. Next we present the results obtained from the analysis of our sample.

V. Empirical Results

Descriptive Statistics

According to the sample selection criteria detailed in section IV, the estimation sample used in this study contains 397 firms observed over 25 years (1986 to 2010) resulting in 5,427 firm-years of observations. The univariate statistics pertaining to continuous variables in this sample are presented in Table 2. This table reports the mean, median, standard deviation, minimum and maximum values of each variable. Moreover, the number of available observations (N), number of individual firms to which these data belong (n), and the average time period for which each of the firms was observed (T) are also reported.

The first variable listed in Table 2 is the equity risk premium, *RP*, estimated using the R-L model. For each firm, this variable denotes the excess return over the risk-free rate demanded by investors to invest in the firm. The equity risk premium for the firms in the estimation sample ranges from a minimum of 4.63% to a maximum of 6.91% and a mean value of 5.65%. This variable is homogenously distributed over the entire sample as the median value of 5.67% and is very close to the overall mean indicating a low level of skewness. A modest value of the overall standard deviation (0.52%) relative to the mean suggests that the variable shows a low variability around the mean. The low variability could be reflecting similar business risks within the UK's non-life insurance industry. The second variable listed in Table 2 is the reinsurance ratio, *REINS*, which ranges from a minimum of 0 to maximum of 1. A smaller value of this ratio indicates a lesser volume of premiums ceded relative to gross premiums written at the total business level. A very high value of the ratio is equivalent to a very high cession rate, indicative of an insurer either in run-off or in financial distress. Given the sampling technique employed, most of the firms in the estimation sample are expected to be going concerns, resulting in moderate values of reinsurance ratio, Nonetheless, there are a few insurers left in the estimation sample that have large values of reinsurance ratio in comparison to the mean and median values of 0.32 and 0.26 respectively. Unlike the equity risk premium, the reinsurance ratio shows a higher variation relative to its mean with standard deviation being 0.28.

Leverage, denoted by *LEV*, is the next variable reported in Table 2. In the estimation sample, leverage ranges from 0 to 1671.5. This suggests the presence of both the new entrants, and very highly leveraged insurance firms in the estimation sample. The overall standard deviation at 22.78 is several times the mean of 2.62 indicating substantial variation in leverage within the estimation sample. A higher mean (2.62) than the median (1.40) shows that the distribution of this variable is positively skewed. We winsorize this variable at 1^{st} and 99^{th} percentile levels at lower as well as upper tails to avoid the confounding effect of extreme values (outliers) of this variable in our regressions. Post-winsorization, leverage (*WLEV*) has a mean of 2.12, which is closer to the median with substantial changes in the minimum and maximum values.

The variable *SIZE* in Table 2 is calculated as the natural logarithm of total assets reported by an insurer in a year. Such a transformation serves two purposes. First, since the total assets of a firm in an industry are log-normally distributed, the logarithmic transformation results in a 'near' normally distributed variable. Second, the scaling of total assets is achieved by this transform, which makes the results from econometric analysis easier to interpret. The size of the firms in the estimation sample, measured using the log of monetary value of total assets, ranges from 5.70 (approximately £0.3 million) to 16.62 (£16.5 billion). Interestingly, the between and within-standard deviations in size are of similar magnitude at 6.54 and 6.27, indicating that the variation in firm size across firms in a given year is likely to be of the same scale as the variation in the size of a firm over the study period. The well behaved distribution of this variable is reflected in similar mean and median values at 11.02 and 10.9 respectively. The overall standard deviation of this variable at 1.96 suggests that this variable has very little variation relative to its mean.

Liquidity, denoted by *LIQ* in Table 2*,* is another important variable used in this study. This variable reflects the level of liquid assets in the asset mix of an insurer in a year. This variable should be bounded between 0 and 1 as it is not possible to have negative values of liquid assets or to have liquid assets greater in value than total assets in a given year. Therefore, to eliminate the implausible values, *LIQ* is also winsorized at the at 1^{st} and 99^{th} percentile levels at left and right tails respectively. Post winsorization all the values of this variable are within the aforementioned plausible range. Product diversification is denoted in Table 2 as *HINDX* which corresponds to the annual value of the Herfindahl index calculated for each firm. About 54% (213 out of 397) of the firms in the estimation sample conducted their business as mono-line companies (Herfindahl index of 1), for at least one year during the study period. Similar, but relatively large magnitudes of mean (0.66) and median (0.64) indicate that less diversified insurers are more prevalent in the estimation sample. In other words, insurers operating in the UK non-life insurance market tend to specialise in a few niche lines of business rather than diversifying their business across all the product-markets at their disposal. However, there are a few well diversified insurers in the estimation sample with the minimum value of *HINDX* being 0.16.

As mentioned in the previous section, reserving errors have been used in this study as an instrument for use of reinsurance. Unlike other variables, observations for this variable are available only until the year 2009 (as explained in section III). There is substantial variation in the values of reserving errors with minimum and maximum values being -73.41 and 29.92 respectively. A reserving error of 9.07 means that the difference between the reserves for the estimated losses and actual losses was 9.07 times the capital resources reported by the insurer. These are extreme values when compared to the mean and median values of 0.08 and 0.03 respectively. Given these observations, it is unsurprising that the standard deviation is large at 1.44 as compared to the reported measures of central tendency. Therefore to alleviate the confounding effects of extreme values of this variable in the first stage of IV regressions, the values of reserving error are winsorized at the 1st percentile on both the tails. After winsorization, the reserving errors range from a minimum of -0.73 to a maximum of 1.58.

Having discussed the univariate statistics in some detail, to further discuss the simultaneous interactions between the variables entering the regression analysis, it is important to consider the correlations between these variables. Therefore, the following section presents pairwise correlations between the key variables used in this study.

Multivariate Results

The hypothesis regarding the decision to reinsure or not is tested by conducting a regression analysis based on the equation (4) above. Panel A of Table 3 reports the relevant coefficient estimates and diagnostics. The diagnostic tests confirm the presence of both autocorrelation and heteroskedasticity in our dataset. To counter the bias induced in standard errors due to these factors, we use method of Driscoll and Kraay's (1998) standard error estimation which controls for both arbitrary spatial and temporal dependence in panel data. As mentioned in previous section, we use fixed effects estimator advocated by Gormley and Matsa (2014) to control for unobserved heterogeneity that may be present. Year dummies are used in the regression to control for the time specific effects. The coefficient estimate on the variable *REINSID*, which indicates the decision to reinsure, is negative and statistically significant ($p \leq 0.01$, one-tailed). This result provides evidence in favour of the first hypothesis that insurers utilising reinsurance for risk management generally have smaller risk premiums (cost of equity) in comparison to insurers who do not purchase reinsurance. As mentioned in section III above, reinsurance (risk management) can add value to a firm by enabling it to optimise its capital structure, and thus minimise its equity cost of capital.

As expected, the winsorized value of leverage, *WLEV*, is positively and significantly associated with the cost of equity. Specifically, *WLEV* has an estimated coefficient of 0.006 with one-tailed p-value less than 0.05. This finding conforms to traditional theories of capital structure which suggest that the cost of equity is an increasing function of leverage. A high leverage leads to increased frictional costs, such as costs associated with financial distress, resulting in a higher equity risk premium. In accordance with what was hypothesized, Table 3 also shows that holding a relatively higher proportion of cash and cash equivalents in the asset mix reduces the equity risk premium of insurers. This result shows that though insurance is a solvency based business, but liquidity risk is also an important consideration for insurers. Table 3 however shows that firm size and degree of product diversification do not have a statistically significant effect on the equity risk premium, but the signs of these coefficients is as predicted.

Insert Table 3 here.

The results of regression analysis for testing the 'reinsurance volume decision' hypothesis are presented in Panel B of Table 3. Diagnostic tests again confirm the presence of heteroskedasticity and autocorrelation in our data, so we again use the fixed effects estimator and control for biased errors by using Driscoll-Kraay method. Similarly, year dummies have been used to control for time specific effects. The coefficient for *REINS* is negative and statistically significant, which shows that purchase of reinsurance is associated with lower risk premium. For insurers purchasing higher than median level of reinsurance (approximately 24% of gross premiums written) however the association is weaker as compared with insurers that cede a lower proportion of premium underwritten. As per the results, one percent increase in premiums ceded is associated with nearly a 29 basis point drop in the equity risk premium, but the drop tapers off to 5 basis points for insurers ceding more than 24% of their gross premiums written. This suggests that the relation between equity risk premium and the reinsurance ratio is negative but non-linear. It is well established that reinsurance can increase the underwriting capacity, and an increase in underwriting can result in a higher leverage. Moreover, reinsurance does carry some cost, so as hypothesised in section III, at relatively higher levels of cession rates reinsurance is less effective in reducing the cost of equity capital. Nevertheless, it can be concluded that risk management can reduce the equity risk premium for an insurer. This result is in accord with recent findings of Bartram, Brown and Conrad (2011) who show that hedging can reduce both total risk and systematic risk for a non-financial firm.

There can be many channels through which such a relation can be manifested. One such channel is reduction in costs related to financial distress and bankruptcy achieved by use of financial risk management. Results reported in Table 4 present evidence that such a channel does indeed exist. Panel A of Table 4 presents results of a logit regression run using Chava and Jarrow's (2004) 'private firm model'. We predict each insurer's probability of bankruptcy using the logistic transformation and use the values so obtained to run a fixed effects estimator using the model specified in equation (9). The results so obtained are reported in Panel B of Table 4, which shows that predicted probability of bankruptcy is positively related to the equity risk premium. This result is in accordance with the view presented in trade-off theory of capital structure which suggests that bankruptcy risk is priced in the financial markets. Although it can be argued that idiosyncratic risks, such as the risk of financial distress, can be diversified away by investors; there is an increasing body of evidence that finds that risk of default at firm level is priced in the financial markets. Bartram, Brown and Stulz (2012, p. 1330) also state that "…idiosyncratic risk is important for the large numbers of investors who are imperfectly diversified". In the same vein, we conclude that reinsurance can reduce the cost of equity capital.

Insert Table 4 here.

Other coefficients reported in Panel B of the Table 4 are very similar to the results reported in Table 3. Regression results reported in Panel C of Table 4 establish that reinsurance is associated with reduced probability of default. Therefore, by reducing the probability of bankruptcy reinsurance can reduce the equity risk premium. Panel C also reports that probability of bankruptcy increases with leverage, whereas it decreases with product diversification. As with the equity risk premium, size of the insurer doesn't seem to have any statistically significant effect on the probability of bankruptcy.

Robustness Tests

To establish the consistency and reliability of empirical results reported above, we adopt an instrumental variable (IV) approach. We use reserve estimation error obtained using Weiss method as the instrument for our key instrument variable. Panel A of Table 5 reports the results of the first stage regression (as per equation (8)) obtained using a Tobit regression on a smaller sample of 3397 observations corresponding to 270 insurers for which requisite data were available. The robustness of this estimation was tested using the random effects and the fixed effects estimators which have also been reported along with Tobit results. We find that our instrumental variable is positively and statistically significantly related to the reinsurance ratio. Except for leverage, all other variables appearing in the reduced form equation also have statistically significant effects on reinsurance ratio. We predict the value of reinsurance ratio, named *PREINS*, using this regression, and use the predicted values in the second stage regressions. The second stage regression results reported in Panel B of Table 5 show that the predicted reinsurance ratio is associated with a lower risk premium. More importantly, the results still suggest a difference in coefficient for insurers with cession rates lower and higher than the median of reinsurance ratio. Thus reinsurance is less effective at reducing the cost of equity at higher levels of cession rates. The difference between insurers with lower and higher cession rates now is less pronounced because of two reasons. First, the predicted values of reinsurance ratio have a smaller range than the original sample, and second, the estimation sample itself is smaller.

Insert Table 5 here.

Finally, Panel C of Table 5 reports the effect of predicted reinsurance ratio on the probability of bankruptcy, which, as proposed, is found to be negative and statistically significant. As expected, leverage is again positively associated with the probability of default, whereas size and liquidity are negatively related to it. Product diversification, proxied by the Herfindahl index still has a negative relation with probability of default as was the case in Panel C of Table 4. Having discussed all the empirical results obtained in this study, we now present conclusions in the final part of this paper.

VI. Conclusions

The linkage between risk management and the capital structure of a firm has been examined in several academic studies (e.g., see Froot et al., 1993; Froot and Stein, 1998; Leland, 1998; Stulz, 1996). These studies argue that risk management enables companies to optimise their capital structure by stabilising future cash flows and/or minimising frictional costs. The current study examines the role played by reinsurance in determining the cost of equity finance in the UK non-life insurance sector. Following is a discussion of the main conclusions drawn from the empirical analysis conducted in this study.

The first main conclusion drawn from the analysis carried out is that the use of reinsurance seems to be well explained by optimal capital structure theory-based arguments. The empirical results obtained in this study support the proposed hypothesis that users of reinsurance in the UK non-life insurance markets have a comparatively lower cost of equity than their counterparts without any reinsurance cover. This could reflect that investors in the UK's non-life (property-liability) insurance market incorporate the risk reduction achieved by diversification through reinsurance in their return expectations. As predicted by the 'reinsurance volume decision' hypothesis (Ha2), the study finds that there is a non-linear relation between the extent of reinsurance use and the UK-based non-life insurers' cost of equity. This result accords with the theoretical predictions made in Froot (2007) and Froot and Stein (1998) which suggest that risk management remains a value-added activity unless the associated costs exceed the cost of the risk of loss being mitigated. This result is also in line with the empirical findings of Purnanandam (2008) which hint at the existence of optimal capital structure, and that of Zou (2010) which show that the relation between the extent of property insurance use and the firm value is graphically concave. This finding also indicates that reinsurance is an important instrument at an insurer's disposal to achieve an optimal capital structure in inefficient financial markets.

Empirical results obtained for the control variables used in this study are mixed in regards to consistency with prior empirical research and finance theory. As predicted, leverage is found to be positively related to the cost of equity across a majority of the estimations conducted in this study. It is well documented in the academic finance literature that leverage increases the riskiness of a firm and leads to an increase in the cost of equity. In line with expectations, insurers having more liquid assets relative to their stated total assets tend to have a lower cost of equity, as higher liquity levels improve investors' confidence that the insurance firm is relatively immune to loss from investment in financial instruments. A greater level of product market diversification and larger firm size doesn't seem to have a statistically significant and consistent effect on equity risk premia of insurers. We also observe that equity risk premium has a positive association with the probability of bankruptcy, and that reinsurance can reduce the equity risk premium by reducing the probability of bankruptcy.

This study is believed to be the first to provide empirical evidence on the impact of reinsurance purchase on the cost of the equity of an insurer. The findings of this research provide useful insights for assessing a firm's future profitability, riskiness and market value. The empirical evidence provided by this study suggests that investors take account of reinsurance purchased in assessing risks associated with an insurer's business, and thus in pricing its securities. Managers can also use this information to optimise the capital structure of their respective employers resulting in the minimisation of the prospective cost of equity, and other frictional costs arising due to market imperfections. Moreover, an optimal reinsurance (risk management) policy can reduce the level of retained share capital resulting in the maximisation of reported returns on equity. This insight could help policyholders and shareholders to make better informed choice decisions and potentially assist regulators to design and develop capital maintenance rules.

Most previous studies have focussed on financial derivatives while attempting to explain the impact of risk management on firm value (e.g., see Allayannis and Weston, 2001; Gay et al., 2011; Géczy et al., 1997; Haushalter et al., 2007). Moreover, derivatives' data are not only 'noisy' and difficult to interpret, but may not be able to completely eliminate the risk exposure (Haushalter, 2000). In contrast the current study focuses on reinsurance which not only is a pure indemnity contract, but provides a prospectively rich and publicly available (in the case of the UK) dataset to use in this research project. Therefore, this study provides cleaner evidence for the cost of equity – risk management relation within the UK non-life insurance market because of the 'pure-hedge' nature of reinsurance and the sufficiently large dataset employed to test the hypotheses. In this regard, the study provides a 'solid' basis for further academic research on the role of corporate hedging and its impact on the market value of firms. This could be of interest to investors, financial analysts, and credit rating agencies amongst others.

It is also believed that this study is the first to combine the full information beta method of Kaplan and Peterson (1998) with the non-parametric method of equity beta estimation described in Wen et al. (2008) to arrive at a firm-level equity risk premia. This is a novel technique for the cost of equity estimation that encompasses all organisational forms and accounts for all the 'moments' of the return distribution. This allows the cost of equity estimates to incorporate all the risk factors priced by investors while maximising the sample size. Therefore, this method is considered to be superior to other common asset pricing models such as the CAPM. As a result, it is considered that the present study makes a prospectively useful methodological contribution to the literature.

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Table 1

UK Property-Liability Insurers, 1986-2010: Definition of Variables

This table presents the labels of the key variables used in the study together with their full description.

Variable	Represents	Description
$RP_{i,t}$	Equity Risk Premium	*Annual equity risk premium for an insurer.*
$REINS_{i,t}$	Level of reinsurance ceded	Amount of reinsurance premiums ceded in year t divided by the gross insurance premiums written in year t.
$LEV_{i,t}$	Leverage	Net provisions scaled by reported capital resources in year t
$LIQ_{i,t}$	Level of cash holdings	Ratio of cash (& cash equivalents) to total assets in year t.
$SIZE_{i,t}$	Firm size	Natural log of total assets in year t.
HHI	Line of business Herfindahl-Hirschman Index	Sum of square of share of each line in a firm's annual premiums written.
$TLTA_{i,t}$	A measure of leverage	Ratio of annual total liability to annual total assets.
$NITA_{i,t}$	A measure of profitability	Ratio of annual net income to annual total assets.
$BPROB_{i,t}$	Probability of bankruptcy	Probability of bankruptcy of an insurer obtained using 'private firm model' of Chava and Jarrow (2004).
$RESERR_{i,t}$	Reserving Errors	Reserving errors calculated using Weiss (1985) method scaled by capital resources in year t

Table 2

UK Property-Liability Insurers, 1986-2010: Descriptive Statistics

This table reports the overall descriptive statistics of all variables defined in Table 1 for the entire period of analysis. Variables with prefix 'W' (e.g. WLEV) have been winsorized at the 1^{st} and 99^{th} percentiles at left and right tails respectively.

Variable	MEAN	SD	MEDIAN	MIN	MAX	OBS	FIRMS	AVG. TIME
RP	5.655	0.520	5.665	4.629	6.915	5427	397	13.67
REINS	0.312	0.277	0.242	0.000	1.000	5427	397	13.67
REINSINT	0.264	0.311	0.000	0.000	1.000	5427	397	13.67
LEV	2.624	22.798	1.400	0.000	1617.500	5427	397	13.67
WLEV	2.122	2.966	1.400	0.007	24.670	5427	397	13.67
LIQ	0.757	0.186	0.795	0.002	1.625	5427	397	13.67
WLIQ	0.757	0.184	0.795	0.052	1.000	5427	397	13.67
SIZE	11.018	1.965	10.900	5.242	17.566	5427	397	13.67
HINDX	0.666	0.277	0.636	0.158	1.000	5427	397	13.67
RESERR	0.079	1.437	0.034	-73.410	29.918	3405	278	12.25
WRESERR	0.094	0.262	0.034	-0.731	1.583	3405	278	12.25
BPROB	0.023	0.064	0.008	0.000	0.771	6821	455	14.99
TLTA	0.449	0.221	0.474	0.000	0.953	5427	397	13.67
WTLTA	0.449	0.221	0.474	0.004	0.953	5427	397	13.67
NITA	0.028	0.145	0.024	-2.857	3.929	5418	397	13.65
WNITA	0.026	0.100	0.024	-0.490	0.482	5418	397	13.65

Table 3

UK Property-Liability Insurers, 1986-2010: Fixed Effects Estimates

This table presents the results of the fixed effects estimation that tests the effects of the reinsurance ratio on the annual risk premium of non-life insurers operating in the UK's non-life insurance market. Panel A reports the results of reinsurance participation decision and Panel B presents the results of the reinsurance volume decision. Also reported are the results of diagnostic tests to detect presence of heteroskedasticity and autocorrelation in panel data. All variables are as defined in Table 1. Both two-tailed and one-tailed test statistics for each explanatory variable have been reported in the table.

Panel A

Variable	Coeff.	Robust Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
REINSID	-0.065	0.031	-2.05	0.04	4.22	0.02
WLEV	0.006	0.002	3.70	0.00	13.67	0.00
WLIQ	-0.066	0.038	-1.74	0.08	3.01	0.04
SIZE	-0.006	0.008	-0.74	0.46	0.55	0.23
HINDX	0.052	0.042	1.24	0.21	1.54	0.11
Year Dummies	Yes					
Observations	5427					
Firms	397					
Diagnostics						
1	Wooldridge test for first order autocorrelation in panel data					
	F(1, 373)	208.389	p-value	0		
2	Modified Wald test for group-wise heteroskedasticity					
	χ2 (397)	3.9E+34	p-value	0		

Panel B

Variable	Coeff.	Robust Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
REINS	-0.287	0.077	-3.74	0.00	13.98	0.00
REINSINT	0.236	0.065	3.64	0.00	13.28	0.00
WLEV	0.006	0.002	3.64	0.00	13.21	0.00
WLIQ	-0.069	0.040	-1.74	0.08	3.03	0.04
SIZE	-0.009	0.008	-1.11	0.27	1.22	0.13
HINDX	0.052	0.042	1.25	0.21	1.56	0.11
Year Dummies	Yes					
Observations	5427					
Firms	397					
Diagnostics						
1	Wooldridge test for first order autocorrelation in panel data					
	F(1, 373)	207.733	p-value	0		
2	Modified Wald test for group-wise heteroskedasticity					
	χ2 (397)	1.2E+34	p-value	0		

Table 4

UK Property-Liability Insurers, 1986-2010: Probability of Bankruptcy and Equity Risk Premium

Panel A presents the results of logit model of Chava and Jarrow (2004) used for predicting probability of bankruptcy. Panel B reports the fixed effects estimates of probability of bankruptcy on the equity risk premium. Panel C reports the results of fixed effects estimation of effect of reinsurance on probability of bankruptcy. Standard errors used in Panels B and C were obtained using Driscoll-Kraay (1998) method. All variables are as defined in Table 1. Both two-tailed and one-tailed test statistics for each explanatory variable have been reported in the table.

Panel A

Variable	Coeff.	Std. Error	Z	p-value
WTLTA	5.543	0.607	9.13	0.00
WNITA	-5.814	0.801	-7.26	0.00
CONSTANT	-7.327	0.460	-15.94	0.00
Observations		5529		
Firms		409		

Panel B

Variable	Coeff.	Robust Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
BPROB	0.243	0.107	2.27	0.02	5.16	0.01
REINS	-0.289	0.077	-3.75	0.00	14.06	0.00
REINSINT	0.238	0.065	3.67	0.00	13.50	0.00
WLIQ	-0.074	0.040	-1.85	0.07	3.41	0.03
SIZE	-0.007	0.008	-0.89	0.38	0.78	0.19
HINDX	0.053	0.042	1.25	0.21	1.56	0.11
Year Dummies			Yes			
Observations			5418			
Firms			397			

Panel C

Variable	Coeff.	Robust Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
REINS	-0.011	0.002	-4.96	0.00	24.64	0.00
WLEV	0.007	0.001	12.00	0.00	143.91	0.00
WLIQ	0.003	0.004	0.74	0.46	0.55	0.77
SIZE	0.000	0.001	0.12	0.91	0.01	0.55
HINDX	-0.009	0.003	-3.43	0.00	11.74	1.00
Year Dummies			Yes			
Observations			5418			
Firms			397			

Table 5

UK Property-Liability Insurers, 1986-2010: IV Estimates

Panel A presents the results first stage IV estimates used for predicting reinsurance ratio. Superscripts *; ** and *** denote statistical significance at 10%, 5% and 1% level respectively (two-tail). Panel B reports the fixed effects regression estimates of effect of predicted reinsurance ratio on the equity risk premium. Panel C reports the results of fixed effects estimation of effect of predicted reinsurance ratio on the probability of bankruptcy. All variables are as defined in Table 1.

Panel A

Variable	Tobit		Random Effects		Fixed Effects	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
WRESERR	0.039***	0.011	0.038**	0.016	0.041**	0.016
WLEV	-0.002	0.001	-0.002	0.002	-0.002	0.002
WLIQ	-0.206***	0.023	-0.208***	0.048	-0.200***	0.051
SIZE	-0.037***	0.004	-0.037***	0.009	-0.044***	0.012
HINDX	-0.113***	0.018	-0.116**	0.047	-0.093*	0.051
CONSTANT	0.862***	0.112	0.862***	0.112	0.904***	0.137
Year Dummies	Yes		Yes		Yes	
Observations	3397		3397		3397	
Firms	270		270		270	

Panel B

Variable	Coeff.	Robust Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
PREINS	-0.876	0.444	-1.97	0.05	3.89	0.02
PREINSINT	0.122	0.061	2.01	0.05	4.04	0.02
WLEV	0.002	0.002	0.98	0.33	0.96	0.16
WLIQ	-0.163	0.115	-1.42	0.16	2.00	0.08
SIZE	-0.042	0.019	-2.19	0.03	4.79	0.01
HINDX	-0.168	0.081	-2.08	0.04	4.32	0.98
Year Dummies	Yes					
Observations	3397					
Firms	270					

Panel C

Variable	Coeff.	Std. Error	Two-tailed Test		One-tailed Test	
			Z	p-value	χ2	p-value
PREINS	-0.169	0.039	-4.36	0.00	19.00	0.00
WLEV	0.007	0.000	36.63	0.00	1341.66	0.00
WLIQ	-0.030	0.008	-3.59	0.00	12.88	0.00
SIZE	-0.007	0.002	-4.39	0.00	19.25	0.00
HINDX	-0.028	0.005	-5.29	0.00	28.00	1.00
Year Dummies	Yes					
Observations	3395					
Firms	269					