SOLVENCY OF STOCK VERSUS MUTUAL INSURERS: Evidence from Dutch panel data

Leo de Haan & Jan Kakes*

This version: February 2007

Abstract

We investigate the capital structure of 350 Dutch insurers during the period 1995-2005. Our main findings are: (1) a small company size, a mutual organisation, high profitability, large equity investments, or being a fire insurer, all contribute to higher solvency margins; (2) minimum solvency requirements from the supervisor are less easy to explain by firm characteristics and do not correlate positively with risk; (3) neither do insurers follow solvency requirements closely; (4) most insurers have surplus capital which, together with a large company size and high profitability, reduces the risk of insolvency.

JEL codes: G22, G32
Keywords: Insurance companies, Ownership structure, Capital structure, Solvency requirements

---

* De Nederlandsche Bank, P.O. Box 98, 1000 Amsterdam. Corresponding and presenting author L. de Haan, De Nederlandsche Bank, P.O. Box 98, 1000 AB Amsterdam, e-mail l.de.haan@dnb.nl.
The authors wish to thank Jack Bekooij, Marcel Eggenkamp and Ton Kok for the provision of supervisory data and Harry Teeuwen, Ruud Pijpers, and Evert Haaksma for elucidating them. All errors are the sole responsibility of the authors. The views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

1 INTRODUCTION

Recently, a number of Dutch mutual insurance companies changed their corporate structure and got listed on the stock market, a trend earlier observed in the United States (e.g. Viswanathan and Cummins, 2003). Presumably, a main reason for a stock listing is to get broader access to funding, in order to finance growth. The capital structure generally differs quite a lot between mutual and stock insurance companies (Harrington and Niehaus, 2002). This partly reflects their different risk characteristics (Lamm-Tennant and Starks, 1993).

We investigate the capital structure of mutual versus stock insurance companies, using a data set of about 350 Dutch insurers from all lines of business[1] during the period 1995-2005. The dataset is quite unique, because it not only contains data on actual capital but also on minimum capital requirements prescribed by the supervisor. This offers an opportunity to extend the analysis of determinants of actual capital structures to the explanation of solvency requirements, the modelling of the probability of undercapitalization, and an analysis of the extent to which insurers take such prudential requirements into account when setting their solvency targets. We estimate models explaining (1) the actual solvency margin, (2) the solvency margin required by the supervisor, (3) the difference between the two, and (4) the probability of undercapitalization defined by a solvency margin below 150% of the required solvency margin.

Our objective is to provide more insight into differences in capitalization between types of insurance companies, with different corporate structures and in various lines of business. In particular, it is useful to explore to what extent solvency requirements play a relevant role in insurers' financial decisions. This may also be relevant in the context of changes in the supervisory framework foreseen for the next years.

Our study is structured as follows. The next section discusses the main characteristics of the Dutch insurance sector and recent developments in solvency indicators. Section 3 formulates a number of hypotheses based on theories of capital structure, which are tested in subsequent sections. Section 4 explains our dataset and methodology. The results are presented in Section 5. Section 6 concludes.

[1] Health, property-liability and life insurance.

2 THE DUTCH INSURANCE SECTOR

Table 1 shows how the number of mutual and stock insurance companies evolved since 1995. Both groups represent a significant proportion, although stock insurers are clearly the majority. Over time, the number of institutions gradually declines, reflecting consolidation within the financial sector.

[Insert Table 1 about here]

Insurers' financial soundness is often measured by solvency indicators. The Dutch prudential supervisor formulates minimum solvency requirements for each individual insurer, which are largely based on insurers' activities and performance in the past few years. More specifically, both the volume of contributions and insurance claims are – after adjustment for reinsurance – translated into minimum financial buffer requirements. The higher of the two determines the regulatory solvency requirement. Insurers' actual solvency margins are usually presented in terms of the required solvency margin – this is called the solvency ratio. [2]

Figure 1 shows the median solvency ratio for Dutch insurers, split into stock companies and mutual companies. The availability of supervision data on the required solvency margin of individual insurers makes our dataset unique. It allows identification of insolvent, under- or overcapitalized insurers. The actual solvency margin does not give enough information on the funding position of insurers as it does not take account of the risk profiles of their insurance obligations. For example, if a high-risk company and a low-risk company have identical solvency margins, the former may be undercapitalized while the latter is overcapitalized. It appears that mutual companies have higher solvency ratios than stock companies. The median solvency margin is 4 to 6 times higher than required for mutual companies, while it is 2 to 3 times higher for stock companies.

[Insert Figure 1 about here]

Figure 2 shows the solvency ratio by line of business. Interestingly, fire insurers have much higher solvency margins than required during the whole sample period; their solvency

[2] Appendix A gives the definitions for the alternative solvency indicators and shows trends for comparison purposes.

margins are on average 8 times the required level. On the other hand of the spectrum is life insurance, with a solvency ratio of about 2 to 3 times the minimum requirement. The solvency ratios in the other lines of business move within a range of 250% to 400%.

[Insert Figure 2 about here]

Strictly speaking, any insurance company should have a solvency ratio of at least 100%. In practice, however, the ratio is substantially higher. Figure 3 shows the 1^{st}, 5^{th}, 10^{th}, 25^{th}, 50^{th} and 75^{th} percentiles of the distribution of the solvency ratio for each year; it also shows the minimum solvency ratio observed. The 1^{st} percentile line moves neatly along the 100% line, indicating that roughly 99% of the insurers are fulfilling the capital requirement. Hence, only 1% of the sample, i.e. about 3 or 4 firms, is below the 100% limit. Taking a solvency ratio of 150% as a warning threshold for 'near undercapitalization', around 10% of the insurers appear to have fallen into this 'danger zone' during the sample period.

[Insert Figure 3 about here]

3 THEORY OF CAPITAL STRUCTURE

Since Modigliani and Miller (1958) we know that the choice of the optimal capital structure is a trade-off between costs and benefits of holding capital. This is the case for any company, and thus also for an insurance company. The main benefit of holding a capital buffer is that it helps to avoid financial distress when there are high losses on the insurance portfolio or the investment portfolio. For an insurance company, the probability of insolvency can be further reduced by risk diversification. This can be achieved by combining different lines of business and by holding a diversified investment portfolio. An insurer can also reinsure part of the insurance risks elsewhere.

Capital structure theory tells that insurers will not hold substantial amounts of capital to eliminate the probability of bankruptcy. This is because holding capital is costly. Among the costs of holding capital, agency costs are quite important (Jensen and Meckling, 1976). Agency costs of insurance companies are associated with owner-manager conflicts and owner-policyholder conflicts. The former arise because managers do not fully share in the residual claim held by owners. This gives managers incentives to try to expropriate a fraction of the surplus. Conflicts between owners and policyholders arise because policyholders' claims to assets have legal priority over owners' claims. Agency theory predicts that the optimal capital structure is determined by trading off the benefits from low capitalization (mitigating the owner-manager conflict) with the benefits from more capitalization (mitigating the owner-policyholder conflict). Depending on the dominant type of conflict within a company, the firm may be under- or overcapitalized.

Mutual and stock companies differ in the way they are prone to agency cost (e.g. Mayers and Smith, 1981; Laux and Muermann, 2006). A mutual is an organization in which the customers or policy holders are also the owners of the company. By contrast, stock organizations are characterized by a strict separation between owners and customers. While mutual insurers control the owner-policyholder conflict by merging these two entities into one, the owner-manager conflict is arguably more severe than for stock companies, because the mechanisms available for owners to control managers are more limited than in the stock ownership form. One would expect the benefits from removing the owner-policyholder conflict to exceed the costs of unresolved owner-manager conflicts in mutual insurance firms. Consequently, the elimination of the owner-policyholder conflict is likely to result in a reduced marginal benefit from holding capital in mutuals, suggesting that mutual insurers may be less capitalized than stock insurers, other things equal (Cummins and Nini, 2002). Hence, the agency theoretic prediction is that mutual insurers have lower capitalization than stock insurers.

As mutual insurers' main source of capital is their policyholders, it would be very difficult to raise additional funding in a limited period of time. Stock insurers, on the other hand, especially if they are large and have a good track record, have easier access to the public capital market. Because of this comparative disadvantage in raising external capital, mutual insurers may, for precautionary reasons, have higher optimal capital ratios (Froot and Stein, 1998; Harrington and Niehaus, 2002). This higher valuation of 'slack' capital by mutuals would be consistent with the pecking order hypothesis of Myers and Majluf (1984).

Asymmetric information between suppliers and applicants of capital makes it harder, especially for smaller, less well-known insurers, to obtain additional capital from the market if the need arises. Therefore such firms may prefer to retain and hold on to profits as a buffer of internal funding instead of depending on the capital market. This preference for internal over external financing is known as the pecking order hypothesis (Myers and Majluf, 1984). If this hypothesis holds, more profitable insurers will have higher capitalization than less profitable insurers.

We will use these theoretical insights when specifying our empirical models in the empirical section of this study.

4 METHODOLOGY AND DATA

We use data from supervision, which are published in aggregated form in DNB's *Statistical Bulletin*. The unbalanced panel consists of 300 to 350 insurance companies, of which 37% are mutual insurers (Table 1). In our regression analysis, we try to explain several dependent variables that are related to insurers' solvency. These are (1) the actual solvency margin, (2) the required solvency margin, (3) the difference between these two, the so-called 'solvency surplus', and (4) the probability of undercapitalization. Appendix A gives the definitions for the solvency indicators and shows their trends. In choosing the first dependent variable, the actual solvency margin, we follow other US studies that use similar measures of capitalization. The research question is: what determines the level of capitalization actually maintained by insurers. The second independent variable investigated, the required minimum solvency margin set by the supervisory authority – the availability of which makes our dataset rather unique – allows us to deepen the analysis. This type of data offers an opportunity to extend the analysis of capital structure to the explanation of solvency requirements, the modelling of the probability of undercapitalization, and an assessment of the extent to which insurers incorporate these prudential requirements when targeting their capital structures. The third dependent variable is comparable to the solvency *ratio* (i.e. the ratio of actual over required solvency margins) that is normally used as an important solvency indicator by the supervisory authority; we prefer the difference form over the ratio form because the former allows easier interpretation of the regression coefficients. The trends in both measures are comparable, as shown in Appendix A.

The explanatory variables are based on the theoretical insights discussed in the previous section:

(1) *Mutual*. This is a dummy variable taking a value of one for mutual and zero for stock companies. A priori, this variable's impact on a firm's solvency is ambiguous, as

indicated in Section 3. While agency theory predicts lower capitalization for mutual insurers because of the elimination of the owner-policyholder conflict, the pecking order hypothesis expects that mutual insurers have a greater tendency than stock insurers to hoard capital because of their limited ability to access capital markets.

(2) *Company size*. Presumably, as large insurers have more scope for diversification than small insurers, their total losses are more predictable. Hence, large firms probably need a relatively lower capitalization to achieve a particular level of insolvency risk. The size of the company is measured by the natural logarithm of total assets.

(3) *Shares*. The proportion of shares in the investment portfolio is a standard measure for the risk profile of the insurer's asset portfolio. The more volatile assets are held by the firm, for a given solvency ratio, the more vulnerable it is for asset price fluctuations that could lead to undercapitalization. Hence, we expect a higher proportion of shares in the portfolio to require a higher level of capitalization.

(4) *Profitability*. A profitable firm has more internal funds at its disposal that can be hoarded as a buffer, so higher profitability will lead to higher solvency margins when insurers' financial behaviour is consistent with the pecking order hypothesis. Profitability is measured by return on assets. As profits are influenced by all operational and financial decisions of the insurer, some interaction between profitability and the other variables is to be expected. We will come back to this later on.

(5) *Reinsurance*. If a company reinsures the bulk of its risks elsewhere, it should require lower capitalization to achieve a given level of insolvency risk. Hence, we expect a negative relationship between the use of reinsurance and capital. The use of reinsurance is measured by the proportion of reinsurance premiums paid in total premiums earned.

(6) *Long-tailed business*. The ratio of loss reserves over incurred losses is a proxy for the time lag between policy issuance and the payment of the claims, with higher ratios indicating longer tailed business. As this ratio increases, the managers are in control of the policyholders' funds for a longer time, which offers the managers the opportunity for engaging in activities that provide private benefits, possibly at the detriment of the company and policyholders. This will raise the agency cost of capital and urge insurers to choose lower capital levels (Cummings and Nini, 2002). Moreover, long-tail lines of insurance tend to generate less income from underwriting than shorter-tail lines, putting long-tailed insurers at a disadvantage in raising internal capital. Hence, we expect a negative effect of long-tailed business on capital utilization.

(7) *Risk*. Higher risk requires more capitalization. Risk is measured by the standard deviation of the loss ratio per firm (e.g. Meyers, 1989; Guo and Winter, 1997; Lamm-Tennant and Starks, 1993). The loss ratio is the ratio of losses incurred to premiums earned and is a frequently used proxy for profitability in the insurance literature. This measure of risk captures the risk on the insurance portfolio, while the earlier mentioned variable Shares measures the risk on the investment portfolio.

(8) *Herfindahl.* This index measures the degree to which an insurer is diversified across lines of business. Insurers with more diversified underwriting portfolios are expected to run less insolvency risk and therefore require less capitalization (e.g. Klein et al., 2002; Cummins and Nini, 2002). Lower Herfindahl indices imply higher diversification and, consequently, we expect a positive effect on the use of capital.

(9) *Line of business*. A dummy variable for each line of business taking the value of one if the company in that year is predominantly in that line of business and zero if it is not. This dummy variable should capture any remaining unobservable, time-invariant effects related to the line of business an insurer is active in.

(10) *Year.* A year dummy for each sample year. This dummy variable captures the effects of macro-economic trends or structural breaks, which are common to all insurers. To our knowledge, there have been no significant structural breaks in the supervisory framework during the sample period.

Table 2 summarizes the above-mentioned theoretical predictions for the explanatory variables (Appendix A summarizes their definitions). The predictions fall in three categories: agency cost theory, risk theory, and pecking order theory. In the second column we also give the theoretical prediction for the required solvency margin prescribed by the supervisory authority. As prudential supervisors are primarily focused on the prevention of insolvency risks, we assume that minimum solvency requirements will be set in line with risk theoretical predictions regarding the risk profiles of insurers. We doubt, however, that either the agency theory or the pecking order theory yield usable predictions for the prudential behavior of the supervisor. It is not realistic to assume, for example, that minimum solvency requirements will be set higher for companies that are for some reason more prone to manager-owner conflicts, nor is it to be expected that requirements are higher for companies that can retain moreprofits because they are more profitable. Therefore, the cells for the agency and pecking order theories in this column are left open.

[Insert Table 2 about here]

Table 3 below shows summary statistics for the (non-dummy) variables. Consistent with Figure 1, the table shows that mutual insurers have higher solvency margins than stock insurers. This is in accordance with the findings for US insurers (Harrington and Niehaus, 2002). Mutual insurers are also required to have higher solvency margins, but the difference is much smaller than for actual solvency margins. Mutual insurers are smaller sized, invest more in shares, are more profitable, use more reinsurance, and have shorter tailed business. In the US mutual insurers are also smaller and invest more in shares than stock insurers, but are less instead of more profitable (Harrington and Niehaus, 2002).[3] When looking at medians, mutual insurers are in less risky business, which is consistent with the findings for US insurers by Lamm-Tennant and Starks (1993). Finally, stock companies are more diversified across different lines of business than mutual insurers according to the differences in their mean Herfindahl indexes.

[Insert Table 3 about here]

Table 4 gives the summary statistics for the same set of variables by line of business. Life insurers have and are required to have the lowest solvency margins. Fire insurers have much more capital than required, as already noted when discussing Figure 2; the median fire insurer has a surplus solvency margin of 50.6 percentage point. Life insurers' solvency margins are closest to required margins (the surplus is only 5.5 percentage point). The largest insurers are to be found among life insurers, followed by car and health insurers. Fire insurers are among the smallest. Surprisingly, life insurers invest relatively little in shares, while their liabilities are typically long-term and in the long run the highest investment returns are to be expected from shares. Profitability is lowest for life insurers. The same holds for transport insurers, who also invest relatively little in shares. Fire, transport and other non-life insurers are heavy users of reinsurance. Life insurance is typically long-tailed, around 8 times longer than non-life insurance. Risk is relatively low for car insurers. Generally, due to the skewness of the distribution for higher risks, mean risk is higher than median risk, especially for transport and other non-life insurance. Car insurers stand out as being more diversified overdifferent lines of business; their median Herfindahl index is 0.533.

[Insert Table 4 about here]

Table 4 also gives the numbers of mutual and stock companies by line of business. Typically, life insurers are mostly stock companies, while fire insurers are mostly mutual insurers. Many mutual insurers are also to be found among health insurers.

Table 5 presents the correlation coeffic ients for the (non-dummy) variables. These give insight into the relationships between the dependent and independent variables. First, we note that the correlation between the actual solvency margin and the required solvency margin is relatively low (0.383). This suggests that insurers determine their solvency margins quite independently from the minimum levels prescribed by the supervisor. Consequently, the solvency margin and the solvency surplus are correlated strongly (0.958).[4] The correlations are most ly consistent with the priors from risk theory: size is correlated negatively with capitalization, share ownership positively, long-tailed business negatively, and risk positively. Only the positive correlation with reinsurance is unexpected. The negative correlation between company size and reinsurance indicates that smaller firms, having higher capitalizations, use more reinsurance. Possibly, size effects confuse reinsurance effects on capitalization. Finally, correlations with the Herfindahl index are ge nerally low. Profitability is positively correlated with capitalization, consistent with the pecking order hypothesis. As partial correlations such as the ones discussed here do not take the possibility into account that two variables may correlate just be cause they are both related to a third variable, we will perform a multivariate analyses in Section 5.

[Insert Table 5 about here]

We use the following econometric estimators. First, we apply the Feasible Generalized Least Squares (GLS) for the cross-section time-series analysis of the solvency measures. This estimator allows for the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels.[5] Second, we perform a probit estimation for the probability of undercapitalization. Inspired by Figure 3, the dependent variable in the probit model is a dummy variable, 'undercapitalization', with the following values:

[3] They give descriptives for 1991, 1995 and 1998.
[4] We investigate this issue further in Section 5.
[5] We tried OLS as well, yielding qualitatively similar results to GLS.

undercapitalization = 0 if cover ratio > 150%

undercapitalization = 1 if cover ratio $\leq$ 150%

The frequency distribution of undercapitalization by year is given in Table 6. Around 12% of the sample is undercapitalized according to this criterion.

[Insert Table 6 about here]

The probit approach is taken from the literature on corporate bankruptcy, being employed by e.g. Bunn and Redwood (2003). The probit model is to be preferred to the traditional discriminant analysis according to comparative work by e.g. Lennox (1999), who shows that the former can identify failing companies more accurately than the latter. We note that other work on company failures has recently employed the Merton (1974) model, which imposes assumptions about the value of firms' underlying assets and capital structure. Whether the firm defaults is determined by the market value of its assets in conjunction with the liability structure. However, the Merton model requires a share price to assess volatility and information on default probabilities which lack for our sample of mutual and non-listed stock companies.[6]

Third, we use the within estimator for the analysis of the adjustment of actual to required solvency margins over time. In this estimator the focus is on the explanation of solvency margins over time, taking the time-invariant differences in solvency levels between individual insurers as given. The research question is whether insurers rebalance their capital structures to meet supervisory capitalization requirements.

[6] Application of this methodology for the few listed stock insurers in our sample lies beyond the scope of this study that focuses on mutual versus stock insurers. For an application of the Merton approach to the Netherlands, see e.g. Van den End and Tabbae (2005).

5 RESULTS

In this section we present the results of the multivariate analysis of the determinants of solvency margins (Section 5.1) and the probability of undercapitalization (Section 5.2), after which (in Section 5.3) we investigate the adjustment of actual to required solvency margins.

5.1 Determinants of actual, required and surplus solvency margins

We regress three solvency measures – actual solvency margin, required solvency margin and solvency surplus – on the set of explanatory variables introduced above. All independent variables have been lagged once, to avoid simultaneity bias. The results of the GLS estimations are presented in Table 7.

The model fit for the actual solvency margin is reasonably good; it explains 70% of the variation of the actual solvency margins of 252 insurers during 1995-2005. The explanatory variables company size, mutual, profitability, reinsurance and shares are statistically significant. The signs of the coefficients of company size and shares are consistent with risk theoretical predictions. However, reinsurance has a positive sign, suggesting that insurers that reinsure more risk have higher solvency margins. The negative coefficient for profitability and the positive coefficient for mutual are consistent with the pecking order hypothesis. All else equal, solvency margins between mutual and stock insurers differ by 7.2 percentage points. Variables long-tailed business, risk and Herfindahl are not statistically significant. The line of business dummy variables indicate that fire insurers have, apart from their other characteristics such as company size etc., an independent, time-invariant, upward effect on actual solvency margins. This effect is 27.3 percent of total assets vis-à-vis solvency margins kept by life insurers, which function as reference point for the line of business dummy variables.[7] Finally, the year dummies indicate that insurers' solvency margins hit a low in 2002 after which there was a strong recovery, reflecting macro-economic developments on the stock markets. Figure 4 shows the contributions of the continuous explanatory variables to the variation in actual solvency margins; the bars give the partial effects of a one-standard-deviation increase in a single explanatory variable on the mean predicted solvency margin. The figure makes clear that company size is economically most important among these

[7] The dummy variable for life insurance has been omitted from the regression to prevent singularity. Thus, coefficients of line of business dummy variables are relative to life insurance companies.

variables, followed by the use of reinsurance and investments in shares. Hence, being small sized, having a mutual organisation, running high profits, investing heavily in shares, or being a fire insurer, all contribute to higher solvency margins.

[Insert Table 7 and Figure 4 about here]

We re-estimated the equation for the actual solvency margin adding the (lagged) required solvency margin to the set of regressors (model 2). This way we check the hypothesis that insurers set their solvency targets in line with supervisory requirements. The coefficient found for the required solvency margin is 0.127 and is statistically significant at conventional levels, but economically is not substantial. This confirms our first observation when discussing the low correlation between the actual and required solvency margin in Table 5. Of course, it could be the case that, while the cross-sectional distribution of actual and required solvency margins do not strongly match, still insurers aim to move their solvency margins gradually towards required levels. This issue is taken up further in Section 5.3 where we specially investigate the adjustment process.

The fit for the required solvency margin (model 3) is less strong, with a pseudo-R^2 of 0.406. Company size is still significant and negative, but its effect is halved compared to that on the actual solvency margin. Mutual now has a negative, though small, coefficient. Note that this multivariate analysis contradicts the univariate analysis of Table 3, where mutual insurers were found to have higher solvency requirements. Hence, allowing for other factors, such as company size, makes a difference. Profitability is no longer significant, which is not unexpectedly, as there is no a priori reason why supervisory authorities should take account of pecking order behaviour, i.e. hoarding of surplus capital from internal funds. Neither reinsurance nor shares appear to affect solvency requirements, though these are risk measures. Risk and Herfindahl are now statistically significant, but have negative, though small, coefficients. It should be noted that these theoretically disappointing findings for the risk proxies are not totally unexpected, when one realises that the figures for the legal capital requirements compiled during the sample period were not risk-based.[8] As for the other estimation results, the coefficients for the lines of business dummies suggest that transport and health insurers are required to have higher solvency margins, by 6 percentage points (vis-

[8] This does not imply that the supervisor did not have a complete picture of the insurers' risk profiles. A complete risk assessment was realised through dialogue between supervisor and insurer.

à-vis life insurers). Fire insurers do not require extra capitalization, which makes it even more puzzling why insurers in this line of business actually have so much capital. All in all, the required solvency margin is not easy to explain by the firm characteristics and do not correlate positively with risk.

The results for the solvency surplus (column 4), being the difference between the actual and the required solvency margin, consequently is a weighted average of the results for the former and the latter, with signs identical to the signs found in the equation of the dominant actual solvency margin. We note that all explanatory variables are now significant. Hence, being small sized, having a mutual organisation, running high profits, investing heavily in shares, having a long-tailed business, being in risky business, have low diversification over different lines of business, or being a fire insurer, all contribute to the explanation of higher than required solvency margins.

5.2 Determinants of probability of undercapitalization

The probit estimates are presented in Table 8. We have added the lagged solvency surplus to the previously used set of variables. The reason is that we expect the probability of undercapitalization to be lower the higher the surplus solvency the year before. Indeed, the marginal effect for this variable is significant and negative. In the second regression we leave out the statistically insignificant variables one by one in order of significance. We are left with seven significant variables. Dropping insignificant variables with missing values for many company-years increases the sample size substantially in this second regression.

[Insert Table 8 about here]

The marginal effect of mutual is −0.012, indicating that a mutual insurer's probability of undercapitalization is 1.2 percentage point lower than a stock insurer's. The effects of line of business are in the same order of magnitude (+2 percentage points for health insurers, -0.7 for mixed non-life insurers). The economic interpretation of the marginal effects for the continuous variables is less straightforward, as these represent the effects for an infinitesimal change in the explanatory variables. For ease of interpretation, Figure 5 therefore plots the probability effects for the continuous explanatory variables; the bars give the partial effects on the probability of undercapitalization of a one-standard-deviation increase for each explanatory variable. The solvency surplus in the previous year is the most important probability reducer, followed by company size, profitability, and long-tailed business. Company size reduces insolvency risk because, as was mentioned earlier, losses of large insurers are more predictable than those of small firms. The insolvency risk reducing effect of long-tailed business is understandable when one realises that this variable was defined by the ratio of loss reserves to incurred losses.

[Insert Figure 5 about here]

One may want to use probit model (2) to predict undercapitalization one year ahead, for it is possible to calculate the probability of undercapitalization. To do that, one has to choose a cut-off value for the probability of undercapitalization, above which value one classifies an insurer as 'insolvent'. This is an arbitrary decision that will affect the relative frequencies of errors of the first and second type that will be made. A type-I error is classifying a financially sound insurer as insolvent. A type-II error is classifying a financially distressed insurer as solvent. For a supervisor a type-II error is presumably worse than a type-I error, because it is less detrimental to financial stability to be too prudential than to be too lenient. Therefore, it is in the supervisor's interest to choose a low cut-off value. Table 9 illustrates this. By choosing a cut-off value of 0.25 one can reduce the probability of a type-II error to 37.9% (= 92/243 $\times$100%). At a conventional cut-off value of 0.5, this probability is 68.3%, and with a cut-off value of 0.8 it is even 90.95%. Hence, if the model is to be used to track insolvent insurers, it would be wise to choose a cut-off value of 0.25.

[Insert Table 9 about here]

5.3 How closely do insurers follow solvency requirements?

When discussing Table 5 and 7, we observed that the correlation between actual and required solvency margins is low. Of course, it could be the case that, while the cross-sectional distribution of actual and required solvency margins do not match, still insurers aim to move their solvency margins gradually towards the required levels over time. In this subsection we therefore explore the adjustment behaviour.

Let us assume that insurer i has a target solvency margin, S_i^*, which is determined by a factor d times the required solvency margin, S_i^R, plus a company specific intercept, a_i, taking account of any other unobservable, time-invariant, idiosyncratic factors that determine actual solvency margins of individual insurers:

$$S_{it}^* = d\, S_{it}^R + a_i, \qquad 0 \le d < \infty \tag{1}$$

where t is the time operant. Factor d can be interpreted as the target solvency ratio, irrespective of other insurer-specific factors; Figure 1 suggests a value around 4. However, it should be noted beforehand that is not a priori clear whether this observed value of 4 reflects a combination of $d \approx 4, a_i = 0$ or, alternatively, $d < 4, a_i > 0$. This is what we want to investigate here.

Next, we are interested in the adjustment process. We assume partial adjustment, because of the time and costs involved when adjusting capital structures. Specifically, we assume that an insurer adjusts his actual solvency margin gradually in case of a deviation between his actual and target solvency margin:

$$\Delta S_{it} = l\,(S_{it}^* - S_{i,t-1}), \qquad 0 \le l \le 1 \tag{2}$$

where l is the partial adjustment parameter. Substitution of (1) into (2) yields:

$$\Delta S_{it} = l\, d\, S_{it}^R - l\, S_{i,t-1} + l\, a_i \tag{3}$$

We estimate equation (3) for the whole sample using the within estimator that incorporates the fixed company effects a_i. The resulting equation reads (not reporting the 486 company specific intercepts for reasons of space):[9]

[9] Robust t-values are given within parentheses. ** denotes statistical significance of the coefficients at the 1% level. The set of fixed effects is significant at the 1% level according to the appropriate F-test.

$$\Delta S_t = 0.044 S_t^R - 0.545 S_{t-1}$$

(4.51)** (-37.19)**

$R^2 = 0.319$
#obs. = 3479
#insurers = 486

The R^2 for the within estimation (i.e. not counting the influence of a_i) denotes a reasonable fit considering that the dependent variable is expressed in first differences. The estimated coefficients are all statistically significant at the 1% significance level and have the expected signs. Their respective values imply that $d \approx 0.08$ suggesting that insurers take remarkably little notice of solvency requirements when setting their targets.[10] The coefficient $l \approx 0.545$ moreover implies a rather low adjustment speed.

Hence, this auxiliary estimation result confirms our earlier impressions that insurers do not follow solvency requirements closely.

6 CONCLUSION

We investigated the capital structure of mutual versus stock insurance companies empirically, using a data set of about 350 Dutch insurers during the period 1995-2005. We estimated models (1) explaining actual and required solvency margins, (2) predicting probabilities of undercapitalization, and (3) describing insurers' adjustment behaviour to solvency requirements.

Our main findings are:

1. Being small sized, having a mutual organisation, running high profits, investing heavily in shares, or being a fire insurer, all contribute to higher solvency margins. These results are mostly consistent with the theoretical predictions that risk, agency costs and asymmetric information play an important role in the capital structure decisions of insurers.
2. Minimum solvency margins, set by the supervisory authority, are less easy to explain by firm characteristics and do not correlate positively with some risk indicators.
3. Neither do insurers follow solvency requirements closely.

[10] We obtain similar parameter values when estimating equation (1) directly.

4. Most insurers have surplus capital which, together with a large company size and high profitability, reduces the risk of insolvency.

Finally, we make one observation on the policy implications of our findings. The data reveal that insurers as a group hardly take capital requirements into consideration when setting capital structure targets. Half the population of insurers has thrice the amount of capital that is required, and one quarter five times or even more. It is clear that under such circumstances capital regulation is hardly binding. The data also reveal that solvency requirements do not correlate positively with risk measures while actual solvency margins do. The figures for the legal capital requirements compiled during the sample period were not risk-based. Hence, one explanation for insurers to hold more capital than the required solvency margin is that the latter underestimates the real capital need. It is foreseen that in the near future, effectively around 2010, solvency regulation will be modernised with the introduction of the new European supervisory framework (Solvency II). This will bring the introduction of a risk-sensitive solvency regime, contributing to both adequate risk management by insurers and more effective solvency regulation.

REFERENCES

Bunn, P., and V. Redwood (2003), Company accounts based modelling of business failures and the implications for financial stability, Bank of England Working Paper No. 210.

Cummins, J.D., and G.P. Nini (2002), Optimal capital utilization by financial firms: evidence from the property-liability insurance industry, *Journal of Financial Services Research* 21(1/2), 15-53.

End, J.W. van den, and M. Tabbae (2005), Measuring financial stability: applying the MfRisk model to the Netherlands, DNB Working paper no. 30.

Guo, D., and R.A. Winter (1997), The capital structure of insurers: theory and evidence, mimeo.

Froot, K., and J. Stein (1998), Risk management, capital budgeting, and capital structure policy for financial institutions: an integrated approach, *Journal of Financial Economics* 47, 55-82.

Harrington, S.E., and G. Niehaus (2002), Capital structure decisions in the insurance industry: stocks versus mutuals, *Journal of Financial Services Research* 21(1/2), 145-163.

Jensen, M.C., and W.H. Meckling (1976), Theory of the firm: managerial behavior, agency costs, and ownership structure, *Journal of Financial Economics* 3(4), 305-360.

Klein, R.W., R.D. Phillips, and W. Shiu (2002), The capital structure of firms subject to price regulation: evidence from the insurance industry, *Journal of Financial Services Research* 21(1/2), 79-100.

Lamm-Tennant, J., and L.T. Starks (1993), Stock versus mutual ownership structures: the risk implications, *Journal of Business* 66(1), 29-46.

Laux, C., and A. Muermann (2006), Mutual versus stock insurers: fair premium, capital, and solvency, CFS Working Paper no. 2006/26.

Lennox, C. (1999), Identifying failing companies, a re-evaluation of the logit, probit and DA approaches, *Journal of Economics and Business* 51, 347-364.

Mayers, D, and C.W. Smith (1981), Contractual provisions, organizational structure, and conflict control in insurance markets, *Journal of Business* 54, 407-434.

Meyers, G.G. (1989), Analysis of the capital structure of an insurance company, *Proceedings of the Casualty Actuarial Society* 76, 147-171.

Myers, S.C. and N. Majluf (1984), Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics* 13, 187-221.

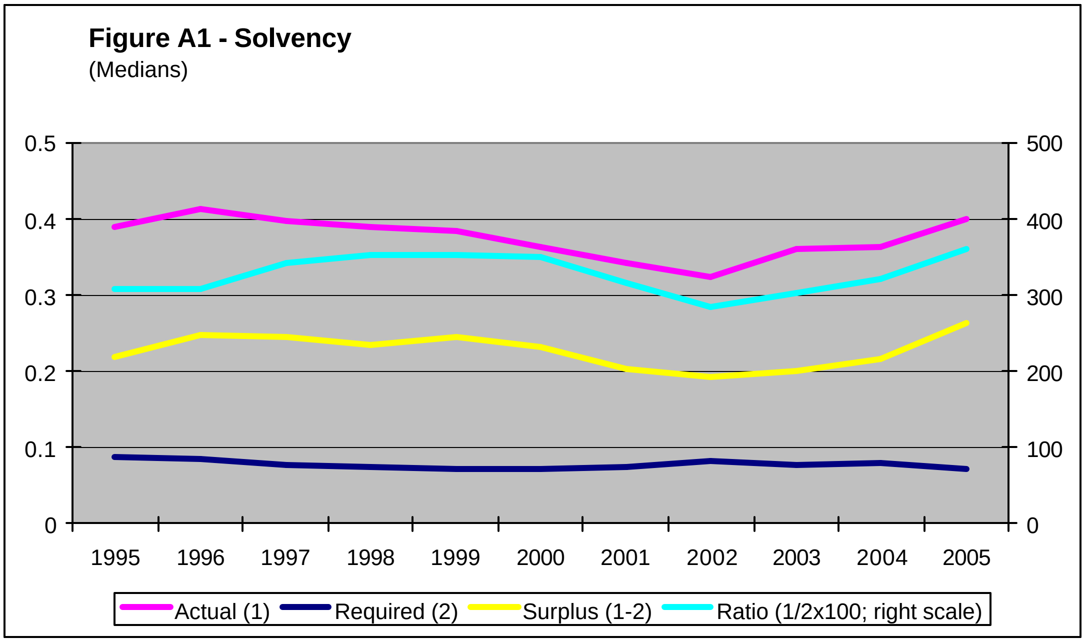
Merton, R.C. (1974), On the pricing of corporate debt: the risk structure of interest rates, *Journal of Finance* 29, 449-470.

Modigliani, F., and M. Miller (1958) , The cost of capital, corporate finance, and the theory of investment, *American Economic Review* 48, 655-669.

Viswanathan, K.S., and J.D. Cummins (2003), Ownership structure changes in the insurance industry: an analysis of demutilization, *The Journal of Risk and Insurance* 70(3), 401-437.

APPENDIX A – DEFINITIONS OF VARIABLES AND SOLVENCY TRENDS

Actual solvency margin:	(Capital + Reserves + Undistributed profits + Subordinated debt + Members' accounts – Intangible assets) / Total assets.
Required solvency margin:	(Provisions for life assurance + Savings deposits + Insured capital on risk basis + Supplementary insurance premiums) / Total assets.
Solvency surplus:	Actual solvency margin – Required solvency margin
Solvency ratio:	(Actual solvency margin / Required solvency margin) $\times$ 100%
Mutual:	Dummy variable Mutual = 1 in case of a mutual company and 0 in case of a stock company.
Company size:	log (Total assets).
Shares:	Shares / Investment portfolio.
Profitability:	Result / Total assets.
Reinsurance:	Reinsurance premiums paid / Total premiums earned
Long-tailed business:	Loss reserves / Incurred losses.
Risk:	standard deviation of Loss ratio = (Incurred losses / Premiums earned net of reinsurance)
Line of business:	Dummy variable = 1 if the company in that year is predominantly (i.e. more than 50% of its written premiums) in that particular line of business and 0 if it is not. Considered lines of business are Health, Car, Transport, Fire, Other non-life, Mixed non-life, Life. (Mixed non-life = 1 for company-years without a premium share higher than 50% in any of the considered lines of business.)
Year:	Dummy variable for each sample year.
Undercapitalization:	Dummy variable = 1 if solvency ratio $\leq$ 150% and 0 if solvency ratio > 150%.
Herfindahl:	The sum of squares of the proportions of premiums written by line of business. Considered lines of business are Health, Car, Transport, Fire, Other non-life, Life.



For comparison sake, Figure A1 plots the median trends for the four solvency measures defined above.

TABLES

Table 1– Frequency distribution of mutual and stock companies, by year

	Mutual	Stock	Total
1995	130	221	351
1996	138	230	368
1997	133	235	368
1998	136	243	379
1999	134	241	375
2000	123	221	344
2001	117	213	330
2002	115	206	321
2003	115	200	315
2004	113	194	307
2005	106	182	288
Total	1360	2386	3746

Table 2– Explanatory variables and theoretical predictions

	Actual solvency margin	Required solvency margin
Agency cost theory		
Mutual	–	.
Long-tailed business	–	.
Risk theory		
Company size	–	–
Shares	+	+
Reinsurance	–	–
Risk	+	+
Herfindahl	+	+
Pecking order theory		
Mutual	+	.
Profitability	+	.
Long-tailed business	–	.

Explanatory note: + / – indicates positive / negative expected correlation of the explanatory variable with the solvency margin. A dot indicates that the particular theory yields no prediction.

Table 3 - Summary statistics 1995-2005, mutual versus stocks

	Mutual company		Stock company	
	Median	Mean	Median	Mean
Actual solvency margin	0.566**	0.549**	0.258	0.325
Required solvency margin	0.093**	0.135*	0.071	0.117
Solvency surplus	0.448**	0.414**	0.146	0.208
Company size	8.669**	9.048**	11.448	11.309
Profitability	0.034**	0.037**	0.015	0.021
Reinsurance	0.304**	0.314**	0.053	0.195
Shares	0.163**	0.209**	0.109	0.169
Long-tailed business	2.238**	5.698**	4.447	10.190
Risk	0.091**	0.742	0.129	1.044
Herfindahl	1	0.978**	1	0.830

Explanatory note: Variable definitions are given in Appendix A. **, * indicates that the differences between mutual and stock companies are statistically significant at the 99% and 95% confidence level, respectively.

Table 4– Summary statistics 1995-2005, by line of business

	Health	Car	Transport	Fire	Other non-life	Life
	Means and medians, respectively [a]					
Actual solvency margin	0.454 0.475	0,306 0,371	0.412 0.469	0.601 0.599	0.449 0.521	0.092 0.159
Required solvency margin	0.158 0.176	0,084 0,122	0.123 0.135	0.075 0.120	0.114 0.173	0.035 0.064
Solvency surplus	0.239 0.299	0.212 0.249	0.280 0.334	0.506 0.478	0.280 0.348	0.055 0.094
Company size	10.566 10.467	11.616 10.831	9.203 9.063	8.310 8.581	9.101 9.421	12.855 12.367
Shares	0.222 0.281	0.191 0.206	0.104 0.171	0.153 0.213	0.157 0.184	0.071 0.111
Profitability	0.025 0.031	0.028 0.027	0.009 0.022	0.049 0.048	0.029 0.026	0.007 0.008
Reinsurance	0.016 0.130	0.080 0.223	0.272 0.359	0.375 0.398	0.299 0.391	0.014 0.073
Long-tailed business	0.487 2.347	2.124 2.349	1.086 2.620	2.531 3.634	2.049 4.593	17.481 20.626
Risk	0.101 0.882	0.059 0.089	0.150 3.985	0.116 0.300	0.138 2.172	0.172 0.511
Herfindahl	1 0.969	0.533 0.591	1 0.920	1 0.949	1 0.940	1 1
	Number of insurers					
Mutual	45	5	8	96	9	12
Stock	67	32	14	32	36	107

Explanatory note: Variable definitions are given in Appendix A. Non-life insurers have been assigned to a particular line of business if more than 50% of its premiums in a particular year is written in that particular line of insurance.
a) Medians and means in the first and second rows, respectively.

Table 5– Correlation coefficients

	Actual solvency margin	Required solvency margin	Solvency surplus	Company size	Shares	Profitability	Reinsurance	Long-tailed business	Risk
Actual solvency margin	1.000								
Required solvency margin	0.383	1.000							
Solvency surplus	0.958	0.101	1.000						
Company size	-0.700	-0.435	-0.613	1.000					
Shares	0.366	0.163	0.343	-0.215	1.000				
Profitability	0.477	0.002	0.491	-0.279	0.149	1.000			
Reinsurance	0.503	0.281	0.454	-0.531	0.160	0.193	1.000		
Long-tailed business	-0.392	-0.276	-0.336	0.251	-0.153	-0.205	-0.202	1.000	
Risk	0.381	0.425	0.278	-0.386	0.344	0.090	0.294	-0.248	1.000
Herfindahl	0.028	-0.172	0.084	-0.116	-0.087	-0.009	-0.077	0.336	-0.072

Number of observations: 1,986. Variable definitions are given in Appendix A.

Table 6– Frequency distribution of undercapitalization, by year

	Undercapitalization = 0	Undercapitalization = 1	Total
1995	326	53	379
1996	345	47	392
1997	340	55	395
1998	357	49	406
1999	354	47	401
2000	324	43	367
2001	305	48	353
2002	289	52	341
2003	292	42	334
2004	283	34	317
2005	278	21	299
Total	3493	491	3984

Table 7– GLS estimates, 1995-2005

	(1) Actual solvency margin	(2) Actual solvency margin	(3) Required solvency margin	(4) Solvency surplus
		Marginal effects		
Required solvency margin $_{t-1}$	-	0.127*	-	-
Company size$_{t-1}$	-0.018**	-0.017**	-0.009**	-0.006**
Profitability $_{t-1}$	0.371**	0.343**	-0.019	0.382**
Reinsurance $_{t-1}$	0.127**	0.125**	0.006	0.095**
Shares$_{t-1}$	0.157**	0.144**	-0.004	0.153**
Long-tailed business$_{t-1}$	0.0004**	0.0004**	-0.000	0.001**
Risk	0.004	0.004	-0.003**	0.008**
Herfindahl	0.022	0.019	-0.026**	0.084**
		Fixed effects		
Mutual	0.072**	0.076**	-0.019**	0.079**
Health insurance	0.202**	0.193**	0.062**	0.129**
Car insurance	0.160**	0.157**	0.026**	0.159**
Transport insurance	0.120**	0.118**	0.060**	0.065**
Fire insurance	0.273**	0.275**	-0.004	0.307**
Other non-life insurance	0.164**	0.170**	0.007	0.174**
Mixed non-life insurance	0.155**	0.150**	0.019**	0.162**
1997	0.006**	0.006**	-0.001*	0.008**
1998	0.004*	0.005*	-0.003**	0.008**
1999	0.013**	0.013**	-0.002*	0.015**
2000	0.013**	0.013**	-0.002	0.012**
2001	0.003	0.005	0.001	0.001
2002	-0.004	-0.003	0.004**	-0.008*
2003	0.017**	0.016**	0.003*	0.012**
2004	0.019**	0.019**	0.002	0.013**
2005	0.025**	0.025**	-0.001	0.023**
Intercept	0.274**	0.247**	0.180**	0.009
Pseudo R^2	0.701	0.714	0.406	0.675
Number of obs.	1670	1670	1670	1670
Number of insurers	252	252	252	252

Explanatory note: Variable definitions are given in Appendix A. The reported marginal effects are changes in the dependent variable per unit change in each independent, continuous variable. The reported fixed effects are changes in the dependent variable for a discrete change in each independent dummy variable from 0 to 1. The feasible generalized least squares estimator used allows for the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels. Suffixes * and ** indicate statistical significance of the effects at 95 and 99% confidence levels, respectively.

Table 8– Probit estimates, 1995-2005

Dependent variable is Undercapitalization

	(1)	(2)
	Marginal effects	
Solvency surplus $_{t-1}$	-0.112**	-0.177**
Company size $_{t-1}$	-0.004**	-0.007**
Profitability $_{t-1}$	-0.134**	-0.130*
Reinsurance $_{t-1}$	-0.002	
Shares $_{t-1}$	0.002	
Long-tailed business $_{t-1}$	-0.0002	-0.0004**
Risk	0.0004	
Herfindahl	0.0007	
Mutual	-0.006	-0.012**
	Fixed effects	
Health insurance	0.008	0.020**
Car insurance	0.006	
Transport insurance	-0.005	
Fire insurance	-0.002	
Mixed non-life insurance	-0.004	-0.007*
Pseudo R^2	0.374	0.390
Number of obs.	1649	2476
Number of insurers	287	401

Explanatory note: Variable definitions are given in Appendix A. The reported marginal effects are changes in the probability that undercapitalization = 1 for an infinitesimal change in each independent, continuous variable. The reported fixed effects are changes in the probability that undercapitalization = 1 for a discrete change in each independent dummy variable from 0 to 1. Standard errors (not reported) are calculated using the Huber/White/sandwich estimator and allowing for correlation of observations for the same company. Suffixes * and ** indicate statistical significance of the effects at 95 and 99% confidence levels, respectively.

Table 9– Classification predictions of probit model (2) for different cut-off values

Cut-off = 0.25			
	True		
Classified	Undercapitalized	Not undercapitalized	Total
Insolvent	151	138	289
Solvent	92	2095	2187
Total	243	2233	2476

Cut-off = 0.5			
	True		
Classified	Undercapitalized	Not undercapitalized	Total
Insolvent	77	31	108
Solvent	166	2202	2368
Total	243	2233	2476

Cut-off = 0.8			
	True		
Classified	Undercapitalized	Not undercapitalized	Total
Insolvent	22	5	27
Solvent	221	2228	2449
Total	243	2233	2476

FIGURES

Figure 1 - Solvency ratio: stocks versus mutuals

(Medians, %)

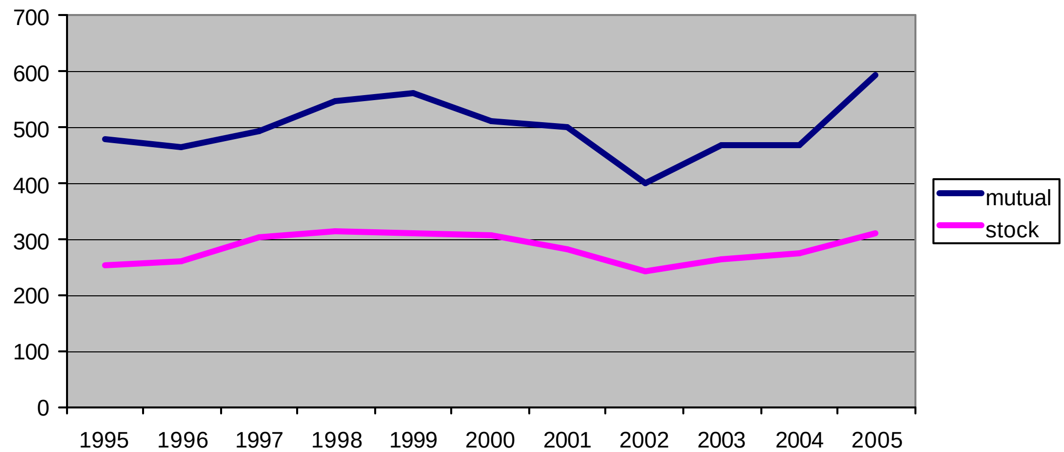
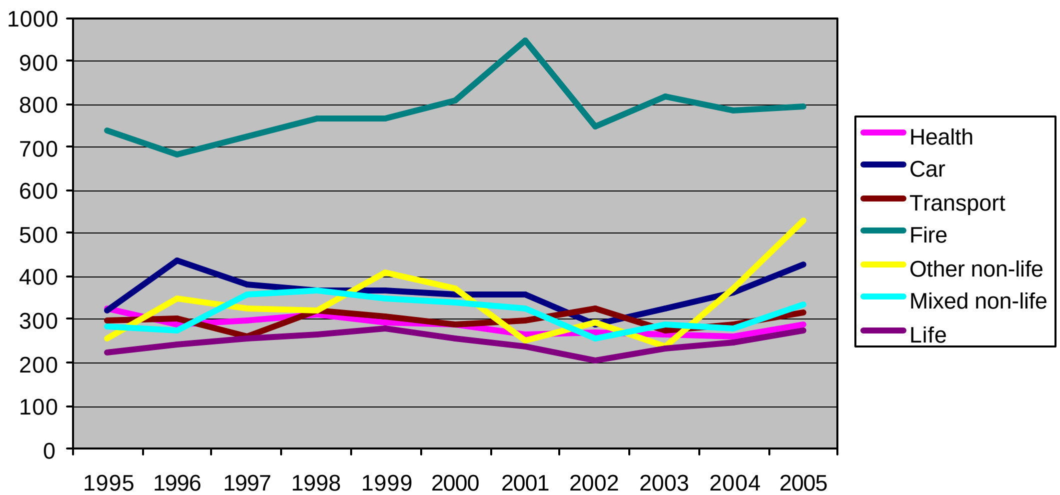


Figure 2 - Solvency ratio, by line of business

(medians, %)



Explanatory note: Non-life insurance companies have been assigned to a particular line of business if more than 50% of its premiums in a particular year is written in that particular line of insurance. "Mixed non-life" is the residual group of non-life companies without a premium share above 50%.

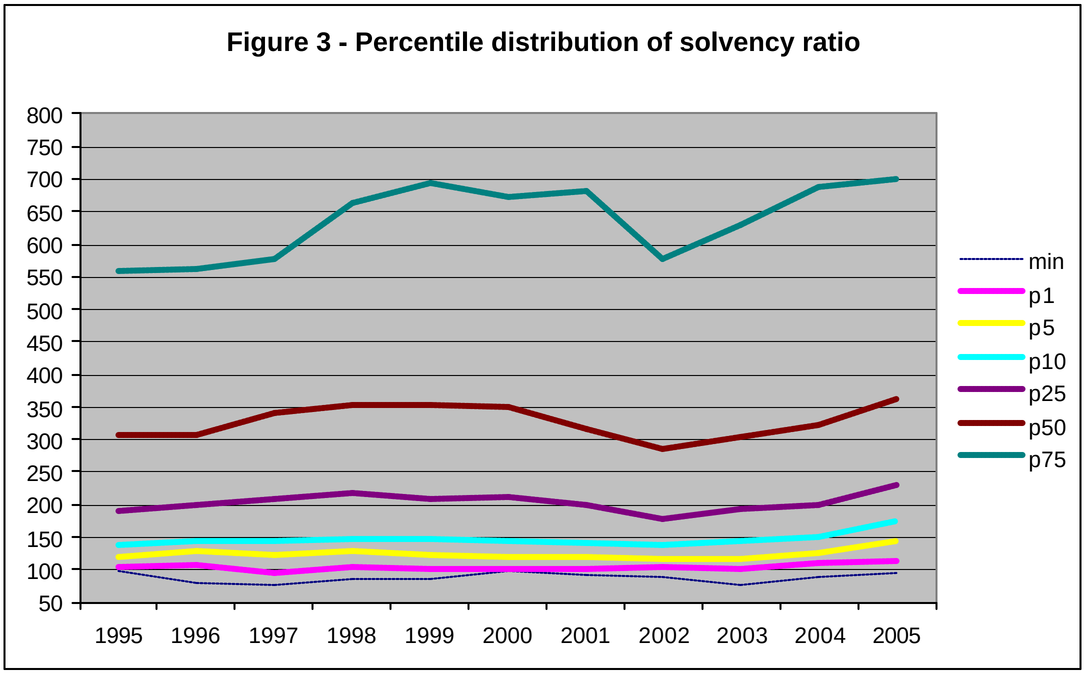


Figure 3 - Percentile distribution of solvency ratio
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
min
p1
p5
p10
p25
p50
p75

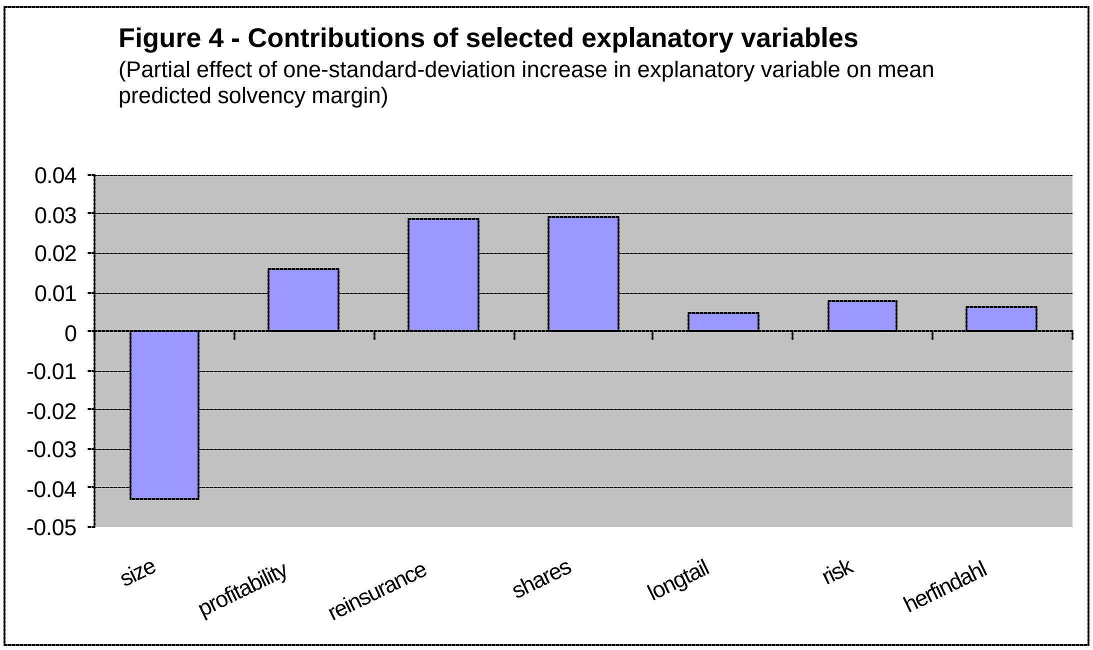


Figure 4 - Contributions of selected explanatory variables
(Partial effect of one-standard-deviation increase in explanatory variable on mean predicted solvency margin)
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
size
profitability
reinsurance
shares
longtail
risk
herfindahl

Figure 5 - Probability effects of selected explanatory variables
(Partial effect of one-standard-deviation increase in explanatory variable on probability that undercapitalization = 1)