Asian Economic and Financial Review, 2013, 3(2):160-177

Asian Economic and Financial Review

journal homepage: http://aessweb.com/journal-detail.php?id=5002

LOSS RESERVE ADJUSTMENT AND ITS DETERMINANTS: EMPIRICAL EVIDENCE FROM THE UNITED KINGDOM GENERAL INSURANCE INDUSTRY

Chi-Feng Wang
Department of Business Administration, National Yunlin University of Science and Technology, Taiwan
Yung-Ming Shiu
Department of Risk Management and Insurance, College of Commerce, National Chengchi University, Taiwan
Andrew Adams
School of Management and Languages, Heriot-Watt University, Edinburgh, UK
Kuei-Ling Ou
Department of Finance, Tunghai University, Taiwan

ABSTRACT

The purpose of this paper is to assess whether loss reserving adjustment exists in the UK general insurance industry and, if so, what motivates managers to modify reserves. Our research shows that: insurers bias loss reserve accrual to smooth income or to avoid triggering regulatory intervention; insurers underestimate loss reserves to avoid reporting small losses; insurers' current and expected future performance affect their loss reserve estimation; insurers focused on commercial lines of business underestimate loss reserves more than insurers focused on personal lines; and certain economic and firm-specific factors influence the accuracy of loss reserves. The findings contribute to our growing understanding of earnings manipulation in the non-life insurance industry and should be of interest to regulators, investors and creditors.

Keywords: Loss reserve errors, Earnings distribution, General insurance.

INTRODUCTION

The loss reserve held for unpaid claims is generally the largest liability on a general insurer's balance sheet and is determined with significant managerial judgment. In some cases, the originally reported loss reserve can be quite different from the ultimately developed loss reserve. The loss reserve adjustment may have nothing to do with manipulation but may simply reflect estimation problems. On the other hand, the loss reserve adjustment may occur due to an insurer's

management manipulating reserves to make the insurer appear financially healthy, to smooth income or to reduce tax payments. In this paper, we investigate the existence and determinants of loss reserve errors in the United Kingdom (UK) general insurance industry using statutory returns over the period 1990 to 2002. The UK general insurance industry provides a potentially interesting setting within which to conduct this investigation for two reasons. First, unlike its United States (US) counterpart, the UK insurance sector is relatively less regulated (Wang, 2002) and so our study offers a potentially cleaner empirical investigation of the existence and determinants of loss reserve errors. Second, the examination of loss reserve errors is worthwhile to conduct in the UK general insurance sector because it is an important insurance market that generated annual premiums of £51.31 billion (US$ 77.03 billion) in 2002, ranking first in the Europe and third in the world (Swiss Reinsurance Company., 2003). Moreover, since the changes in legislations in the UK during the analysis period do not have significant effects on how insurers operate, the associated confounding legal effects are accordingly minimized.

But what are the underlying determinants of loss reserve manipulation? A wealth of research has investigated the underwriting cycle and suggests that underwriting cycles are influenced by certain economic variables. As loss reserve accrual is closely linked to underwriting activity, we might also expect loss reserve manipulation to be influenced by economic variables. We find this to be the case, with changes in real GDP, changes in the inflation rate and the short-term interest rate all significant factors. We also find that net premiums written scaled by total assets is a significant explanatory variable. The remainder of the paper is organized as follows. Section 2 reviews previous studies relating to reserve manipulation and economic variables affecting insurers' reported earnings. Section 3 outlines the research questions and hypotheses. Section 4 provides details of the methodology and data employed. Section 5 summarizes the empirical results and Section 6 is the conclusion.

LITERATURE REVIEW

The relevant literature may be categorized as: reserve adjustment by non-life insurance companies; economic variables and the underwriting cycle; and evidence on earnings management by non-insurance firms.

Reserve Adjustment by Non-Life Insurance Companies

Most studies of reserve adjustment by non-life insurance companies focus on the US property-casualty (P&C) insurance industry. Early research on the influence of economic factors on the smoothing of reported earnings through loss reserve management can be traced back to Weiss (1985). Using a pooled cross-section, time-series approach she finds a negative relation between

interest rates/unexpected inflation and loss reserving manipulation. When interest rates and unanticipated inflation increase, insurers tend to underestimate loss reserves in reported financial statements. However, her work focuses entirely on automobile liability insurance.

Petroni (1992) uses weighted least squares regression to establish a direct link between the income smoothing behavior of insurance managers and their firm's financial condition. Over 1,000 US P&C insurance firms are studied from 1979 to 1983. IRIS ratios are used to measure an insurer's financial condition. Petroni (1992) reports that the incentive to understate insurance reserves is a decreasing function of the actual financial condition of the insurer. Thus, managers of financially weak insurers tend to underestimate their claim loss reserves relative to financially strong insurers. Unfortunately, the research does not consider whether the bias is designed intentionally to meet a particular financial reporting goal.

(Beaver *et al*., 2003) partially address this research gap. They employ a distributional approach to consider further the influence of earnings on reserve bias. Their results show that P&C insurers with small positive earnings understate loss reserves to avoid reporting losses relative to insurers with small negative earnings. They also find that public and mutual insurers are more likely to engage in earnings management than private insurers with the effect insignificant in the case of private insurers. Researchers have investigated whether earnings manipulation is associated with masking insolvency problems in the P&C insurance industry. Gaver and Paterson (2004) contend that managers have an incentive to bias loss reserves in order to avoid violating certain regulatory ratios. Mayers and Smith (2004) investigate whether mutual P&C insurers have an incentive to manage the accounting information in their reported statements when they are converting to common stock ownership. Their evidence suggests that such mutual insurers are more likely to engage in surplus management because policyholders' embedded equity claims are important in the conversion process.

Economic Variables and the Underwriting Cycle

The underwriting cycle is comprised of periodic hard and soft markets. Soft markets are characterized by loose underwriting standards, low premiums, and unprofitable underwriting. Hard markets are characterized by tight underwriting standards, high premiums and profitable underwriting. There are various explanations for the underwriting cycle. One school of thought is based on the irrational behavior of insurance markets, such as competitor-driven pricing, native rate-making processes, and capacity constraints. Another is called the rational expectations/institutional intervention hypothesis. This suggests that the underwriting cycle is caused by external factors and market features, not irrational behavior. There is now considerable

evidence to show that economic factors have a significant effect on the P&C insurers' earnings performance and pricing strategies.

Lamm, Tennant and Weiss (1997) use a generalized least squares model to analyze whether changes in insurance premium levels are influenced by the factors of the rational expectations/institutional intervention hypothesis. Insurance markets in twelve developed countries over the period 1965 to 1987 are considered, and the results suggest that both changes in the relevant stock market index and real gross domestic product (GDP) are significantly related to premium changes in most countries. Grace and Hotchkiss (1995) document a link between insurance industry performance and long-run general economic conditions using a cointegration technique. They also show that real GDP is negatively related to premium changes.

A number of studies have investigated the influence of interest rates on underwriting profits. Fields and Venezian (1989) use joint generalized least squares to study the effect of economic variables on profits in all lines of the P&C insurance industry. The results suggest not only that different lines have individual cycles but also that interest rates have a significant influence on the profitability of insurers. There is positive correlation between interest rates and insurance operating margins, and those lines of business for which investment income is important are more sensitive to unanticipated changes in interest rates. The paper also shows that disaggregated models with interest rate terms perform better than simple autoregressive models in explaining the behavior of profits.

Doherty and Garven (1992) apply a capacity constraint model to show that changes in interest rates simultaneously influence the insurers' capacity structure and equilibrium underwriting profit. Their study reveals that changes in interest rates result in changes in the level of underwriting profit. Thus, changes in interest rates may influence the insurer's operating performance and underwriting pricing decisions. Fung *et al.* (1998) study the factors that influence insurance cycles in different lines of business using a vector autoregressive model. Their empirical results show that interest rates provide significant explanatory power for the premiums of home multiple perils, other liability, auto liability and workers' compensation.

Leng and Meier (2006) use time series analysis to investigate whether underwriting cycles are an international phenomenon or whether each country has its own distinct pattern. They conclude that the factors causing underwriting cycles are country-specific rather than global. Furthermore, they find that the loss ratio series is not co-integrated with the interest rate series, which is inconsistent with established theory.

Evidence on Earnings Management by Non-Insurance Firms

There has been considerable research interest in the relationship between non-financial firms' reported earnings and the accounting discretion of managers. Hayn (1995) documents a discontinuity in the earnings distribution of companies using the Compustat database: too few firms report small losses and too many firms report small profits. Burgstahler and Dichev (1997) extend this work and discover that the earnings kink is due to earnings management. Dechow *et al.* (2003) also show that, for non-financial firms selected from the Compustat annual database, the number of firms reporting small profits is much greater than the number of firms reporting small losses. There have been numerous studies concerned with the determinants of loan loss provisions (LLP) in the banking industry. LLP is generally the largest accrual for most banks and is under management control should it wish to bias reported earnings. Kanagaretnam *et al.* (2003)examine the hypothesis that managers in the banking industry who are concerned about job security, bias their reported earnings. The empirical evidence shows that if a bank has poor current earnings but good expected future earnings, managers will tend to understate LLP to smooth pre-managed income. They show that the LLP adjustment in the banking industry correlates closely with financial position.

Rivard *et al.* (2003) also report that managers in the banking industry use LLP as a tool for income smoothing, and that managers are more likely to engage in income smoothing after the Basel Accord risk-based capital requirements were introduced in 1988. (Pain, 2003) investigates the influence of macroeconomic variables and bank-specific factors on LLP in the UK. The results show that real GDP has a significant effect on major UK banks' provisions, with most banks increasing their provisions in lean years.

Bikker and Metzemakers (2005) examine how bank provisioning behavior is related to the business cycle, using 8000 bank-year observations from 29 OECD countries. They contend that provisioning is substantially higher when GDP growth is lower, consistent with the notion of counter cyclicality (i.e. banks decrease provisions during an economic expansion and increase them during an economic recession). So the evidence suggests that LLPs are negatively correlated with the business cycle and are also influenced by firm-specific factors. It seems reasonable to expect that the same will apply to the non-life insurance industry.

RESEARCH QUESTIONS AND HYPOTHESES

Research Questions

We consider two main research questions. First, does reserve management exist in the UK insurance industry? Second, what are the main influences on loss reserve management? We adopt

the approaches used in prior literature to establish the existence of reserve adjustment. Our investigation then looks more deeply into the factors influencing reserve estimation manipulation.

Hypotheses

We will address six major hypotheses in null form. The first hypothesis concerns the first of our main research questions.

H1: *Managers in the UK non-life insurance industry do not manipulate their loss reserves.*

Given previous evidence from the insurance, banking and non-financial sectors, we can expect that earnings manipulation is more likely to occur when an insurer has small pre-managed losses. We therefore test the following hypothesis.

H2: *Managers in the UK non-life insurance industry do not adjust the loss reserves to avoid small losses.*

The nature of loss reserve accrual in the insurance industry is similar to LLP in the banking industry. Following the work of Kanagaretnam *et al.* (2003), we therefore test the following hypothesis.

H3: *Current and future performance have little to do with loss reserve manipulation.*

A number of research papers have studied the underwriting cycle for different lines of business. However, few have looked at loss reserve adjustment for different lines of business. We test whether firms writing mainly commercial lines of business are more likely to bias their claims loss reserve than firms writing mainly personal lines of business. Our fifth hypothesis is:

H4: *Managers of commercial lines of business do not manage the loss reserve accrual to avoid losses.*

Assuming loss reserve manipulation exists, we now consider the determinants of loss reserve management. These include economic factors and firm-specific factors.

H5: *Economic variables and firm-specific factors do not bias the accuracy of loss reserve estimation.*

METHODOLOGY AND SAMPLE

We adopt a two-phase approach. In the first phase, we use descriptive statistics to assess whether loss reserve errors exist, and examine the relation between loss reserve errors and reported earnings. The second phase investigates the determinants of loss reserve errors. Our initial sample consists of all UK non-life insurance firms in the SynThesys Non-Life database from 1990 through 2002. The insurers must have loss reserves subject to managerial discretion. Insurers that cede all premiums to other insurers are excluded since they do not have reserves. We also exclude observations with an original loss reserve estimate that differs from the revised estimate by more than 50 percent in absolute value. Firms are first categorized into net income class (Dechow *et al.*,

2003) to show the distribution of earnings scaled by total assets across the industry. We expect to find a significant discontinuity in the earnings distribution of reported net income scaled by total assets. We then calculate descriptive statistics for loss reserve adjustment across the industry. If the mean and median adjustments are negative, this suggests manipulation of loss reserves to avoid losses. We then examine the relationship between loss reserve adjustment and the distribution of reported earnings in the insurance industry, employing the following model used by Beaver *et al.* (2003):

$$ADJUST_{t+j,t} = \alpha_t + \beta_1 NEGATIVE_t + \beta_2 BELOW_t + \beta_3 ABOVE_t + \beta_4 POSITIVE_t + \beta_5 \mathrm{AUTO}_t + \beta_6 \mathrm{LIA}_t + \varepsilon_t \quad (1)$$

Although several studies in corporate finance have taken the magnitude of the discontinuity in the earnings distribution at zero as a measure of earnings manipulation, Beaver et al. (2003) develop the idea further for the insurance industry. To test whether the discontinuity in the earnings distribution is caused by reserve manipulation, they divide the earnings distribution into five parts: ZERO, NEGATIVE, BELOW, ABOVE and POSITIVE, defined in Table 1. In this model, the coefficients β1, β4 provide estimates of the difference in the loss reserve for small (big) loss firms compared to small (big) profit firms. The reserve adjustment of zero earnings firms is given by α. Additionally, they control for certain types of business, namely automobile (AUTO) and liability (LIA), each measured as net premiums earned for that type of business as a percentage of total net premiums earned.

Table-1. Specification of the Loss Reserve Adjustment Equation

$$ADJUST_{t+j,t} = \alpha_t + \beta_1 NEGATIVE_t + \beta_2 BELOW_t + \beta_3 ABOVE_t + \beta_4 POSITIVE_t + \beta_5 \mathrm{AUTO}_t + \beta_6 \mathrm{LIA}_t + \varepsilon_t \quad (1)$$

Variable	Variable Definition
ADJUST	The difference between the developed loss reserves in year t+5 and originally reported loss reserves in year t, divided by the developed loss reserve in year t+5.
BELOW	The first earnings group below zero.
NEGATIVE	The other earnings groups below zero
ABOVE	The first earnings group above zero.
POSITIVE	The other earnings groups above zero.
LIA	Net premiums earned for the liability business as a percentage of total net premiums earned.

AUTO	Net premiums earned for the private and commercial automobile business as a percentage of total net premiums earned.

We employ this model in our study of the UK non-life insurance industry and go further to assess:
a) the effect of current and expected future performance on reserve manipulation;
b) whether insurers writing commercial business are more likely to manipulate reserves than insurers writing personal business. Although much research has been carried out to show the existence of loss reserve manipulation, there has been relatively little research assessing the determinants of reserves error. To ascertain the effect of firm-specific and economic variables on the accuracy of loss reserve estimation, we apply an OLS model and panel model to investigate the determinants of loss reserve manipulation in the UK non-life insurance market. The explanatory variables considered in this research are defined in Table 2.

Table-2. Specification of the Determinants Equation

$$ADJUST_{i,t} = \alpha_t + \beta_1 PRETA_{i,t} + \beta_2 CAPTA_{i,t} + \beta_3 INT_t + \beta_4 \Delta GDP_t + \beta_5 \Delta \mathrm{INF}_t + \beta_6 CB_{i,t} + \beta_7 \Delta STOCK_t + \varepsilon_{\mathrm{i,t}} \quad (2)$$

Variable	**Variable Definition**
$ADJUST_{i,t}$	The difference between the developed loss reserves in year $t+5$ and the originally reported loss reserves in year t, divided by the developed loss reserves in year $t+5$
$PRETA_{i,t}$	Net premiums written scaled by total assets for insurer i in year t
$CAPTA_{i,t}$	Capital divided by total assets for insurer i in year t
INT_t	Rate of return on three month Treasury bills
ΔGDP_t	ln(Real gross domestic product)$_t$ - ln(Real gross domestic product)$_{t-1}$
$\Delta INFLATION_t$	ln(Inflation Rate)$_t$ - ln(Inflation Rate)$_{t-1}$
$CB_{i,t,}$	Overall combined ratio for insurer i in year t
$\Delta STOCK_t$	ln(Stock index)$_t$ - ln(Stock index)$_{t-1.}$
$\varepsilon_{i,t}$	Error term

Following prior studies (Petroni, 1992; Gaver and Paterson, 2004), we use a five-year development window because most claims are paid within five years since the loss was incurred. The combined ratio is the sum of the ratio of expenses before taxes to premiums written and the ratio of losses and loss adjustment expenses to premiums earned. Other firm-specific factors are net premiums written and capital both scaled by total assets. UK macroeconomic data for changes in real GDP, the short-term interest rate, changes in inflation rate and changes in stock index are obtained from Datastream. We use the FTSE 100 stock index, the main index of the United Kingdom stock market, for changes in the stock index.

EMPIRICAL RESULTS

Figure 1 shows that the distribution of earnings scaled by total assets is discontinuous. Like Beaver *et al.* (2003), we document a significant kink in this distribution near zero. The number of insurers reporting small profits is much greater than the number of insurers reporting small losses. This finding lends support to the notion that insurers may report small profits through manipulating loss reserves.

Figure-1. The distribution of reported net income scaled by total assets.

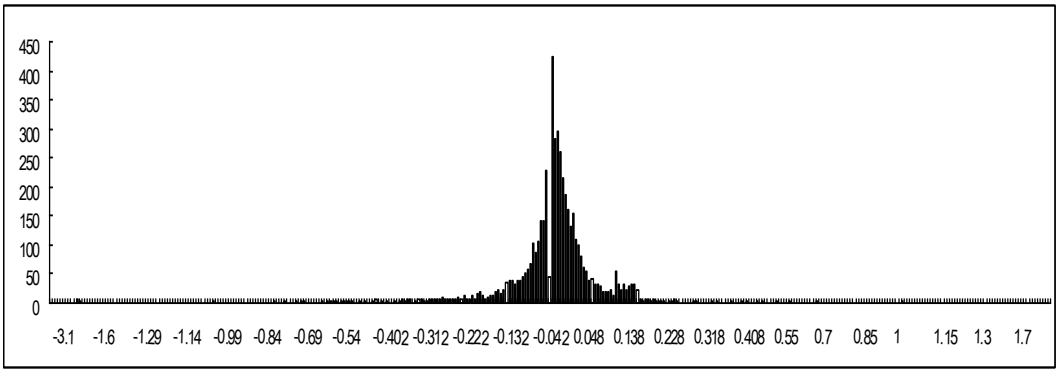


Table 3 provides descriptive statistics for loss reserve adjustment, measured as the difference between the developed loss reserve and the originally reported loss reserve, scaled by the developed loss reserve. The results show that loss reserves are significantly overstated at the 25th percentile, but unadjusted at the 75th percentile. Table 3 also suggests that both the mean and the median adjustment are overestimated. The results reject the hypothesis (H1) that managers in the UK non-life insurance industry do not manipulate their loss reserves.

Table-3. Descriptive statistics for the loss reserve adjustment

Year	N	Mean	Std. Dev.	First quartile	Median	Third quartile	p-value, mean
1990	130	-0.069	0.161	-0.160	- 0.023	0.011	0.000

1991	129	-0.063	0.127	-0.032	0.000	0.000	0.000
1992	130	-0.075	0.144	-0.039	0.000	0.000	0.000
1993	133	-0.076	0.144	-0.066	0.000	0.000	0.000
1994	130	-0.079	0.138	-0.088	0.000	0.000	0.000
1995	128	-0.081	0.128	-0.148	0.000	0.000	0.000
1996	126	-0.08	0.129	-0.114	0.000	0.000	0.000
1997	126	-0.068	0.118	-0.097	0.000	0.000	0.000
1998	131	-0.060	0.107	-0.080	0.000	0.000	0.000
1999	130	-0.074	0.128	-0.122	0.000	0.000	0.000
2000	131	-0.073	0.130	-0.116	0.000	0.000	0.000
2001	137	-0.076	0.128	-0.114	0.000	0.000	0.000
2002	146	-0.081	0.135	-0.125	0.000	0.000	0.000
Total	1712	-0.073	0.132	-0.100	- 0.002	0.001	0.000

We now look more carefully at the relationship between management of the loss reserve accrual and the distribution of earnings. We employ Equation (1) and examine the sensitivity of the results in the OLS model, fixed effects model and random effect model. If the Lagrange Multiple (LM) test statistic is too high to reject the hypothesis, we replace the homogeneous pooled ordinary least squares estimate with the heterogeneous panel data model. The Hausman test is used to determine which kind of panel data model is fitted. Table 4 (Panel A) shows that the fixed effects model is the most appropriate model to examine H2: Managers in the UK non-life insurance industry do not adjust the loss reserves to avoid small losses. In Table 4 (Panel A) the results for the fixed effects model show that the magnitude of reserve development is similar across all regions of the earnings distribution.

However, in Panel B of Table 4, we compare the coefficient of ABOVE and BELOW, and the coefficient of POSITIVE and NEGATIVE. We reject both the null hypothesis that ABOVE=BELOW and the null hypothesis that NEGATIVE=POSITIVE at the 1% level. Even if we control for the automobile and liability lines of business (right hand side of the table), the results for the earnings distribution indicators are substantially the same. We conclude that the reserve development of small profit insurers is significantly higher than that of small loss insurers, and the reserve development of big loss firms is significantly higher than that of big profit firms. We further conclude that the managers of large loss firms are more incentivised to smooth income than those of large profit firms. The results above are all consistent with Beaver *et al.* (2003) .

Table-4. Regression of loss reserve adjustment on earnings groups

$$ADJUST_{t+j,t} = \alpha_t + \beta_1 NEGATIVE_t + \beta_2 BELOW_t + \beta_3 ABOVE_t + \beta_4 POSITIVE_t + \beta_5 \mathrm{AUTO}_t + \beta_6 \mathrm{LIA}_t + \varepsilon_t \quad (1)$$

Panel-A. Regression summary statistics

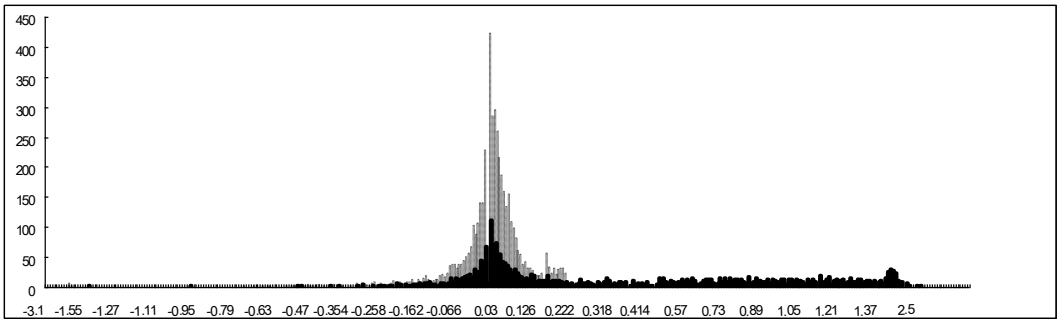
	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSITIVE	0.070	2.470	0.036	1.061	0.034	1.584	0.078	2.866	0.036	1.076	0.036	1.689
NEGATIVE	0.115	4.014	0.040	1.200	0.043	1.968	0.116	4.377	0.040	1.196	0.044	2.053
ABOVE	0.122	4.072	0.052	1.500	0.053	2.397	0.123	4.276	0.052	1.507	0.053	2.464
BELOW	0.100	3.217	0.036	1.056	0.037	1.650	0.103	3.447	0.034	1.018	0.037	1.681
AUTO							- 0.015	- 4.511	-0.000	-5.609	-0.000	
LIABILITY							-0.000	-10.456	-0.000	-2.053	-0.000	
Adjusted R^2	0.032		0.694				0.106		0.705			
N	1711		1711		1711		1711		1711		1711	
LM test					1974.06							1771.58
Hausman test					33.76							62.13

Panel-B. Tests of coefficient restrictions

regression	F- statistic	p-value	F- statistic	p-value	F-statistic	p-value	F-statistic	p-value
All equal	14.93	0.000	18.93	0.000	34.65	0.000	19.73	0.000
β1=β4	0.97	0.328	19.02	0.000	0.73	0.392	19.83	0.000
β2=β3	2.48	0.116	18.99	0.000	3.10	0.079	19.78	0.000

We use the White test to check whether heteroskedasticity exists in the models employed in our research. When the test statistic exceeds the critical Chi-square value, we use White's heteroskedasticity corrected covariance matrix to derive heteroskedasticity-consistent estimates to estimate the fix-effects models. An alternative research design for identifying the impact of earnings management on the earnings distribution is to test the pre-managed earnings distribution. If the discontinuity in the earnings distribution is induced by loss reserve adjustment, we would expect the distribution of pre-managed earnings to be more dispersed than reported earnings, especially around zero. Gaver and Paterson (2004) define loss reserve manipulation as the cumulative net adjustment in the reserve account five years after the initial loss year. The loss reserve manipulation is then subtracted from reported earnings. Figure 2 shows that the distribution of pre-managed earnings is smoother and more stable than the reported earnings distribution. This suggests that insurers modify loss reserves to avoid reporting losses. As anticipated, there is no discontinuity around zero in the pre-managed earnings.

Figure-2. The distribution of reported earnings (broken line) and pre-managed earnings (shaded), scaled by total asset.



Job Security and the Distribution of Reported Earnings

Kanagaretnam *et al.* (2003) consider whether managers in the banking industry who smooth earnings through the manipulation of LLP are influenced by their job security. They conclude that managers of banks with poor current performance but expected good future performance (the 'poor-good' group) have greater incentive to modify LLP than managers of banks with good current performance but expected poor future performance (the 'good-poor' group). To examine whether reserve adjustment in the UK non-life insurance industry is influenced by managers' job security, we follow the approach of DeFond and Park (1997), which relates to non-insurance organizations, to separate insurers into four groups. Poor (or good) performance is defined as earnings below (or above) the industry median earnings and next year's earnings is taken as a reasonable proxy for anticipated future performance. We combine the job security approach and distributional approach to divide our sample of firms. Table 5 shows whether reserve adjustment is influenced by job security in the four groups. The results of the LM and Hausman tests in panel A suggest that the most appropriate model is the fixed-effects model for equation (1) with four variables and the random-effects model is the most appropriate model for equation (1) with six variables. Table 5 (panel A) shows that managerial discretion applies in the case of poor-poor firms. The coefficients on all earnings group variables are positive and statistically significant, suggesting that when managers face current poor performance and anticipate that the performance will remain poor in the future, they underestimate loss reserve accrual. The LM and Hausman test statistics in panel B favor the random-effects model in the four factor equation and the fixed-effect model in the six factor equation. Panel B reports results for those insurers with good current performance and expected good future performance. There is no insurer in the left tail (NEGATIVE) of the earnings distribution. The coefficients of POSITIVE and ABOVE are negative and significant at the 1% level, and the coefficient of BELOW is negative but not significant at the 10% level. We conclude that good-good firms have an incentive to overvalue loss reserves to save income for the future.

The LM and Hausman test statistics in panel C favor the random-effects model in the four factor equation and the fixed-effects model in the six factor equation. The results in panel C suggest that insurers in the poor-good group understate their loss reserve estimates but the results are not statistically significant. However, we reject the null hypothesis that ABOVE=BELOW and POSITIVE=NEGATIVE at less than the 1% level, so we believe that there is a difference in reserve development between small profit and small loss insurers for the poor-good group. It may be that because managers expect good future performance they recognize inadequate loss reserves to avoid triggering regulatory intervention. In panel D, insurers with good current but expected poor future performance are concentrated on the right of the earnings distribution. The results

suggest that managers smooth income by overstating loss reserve estimates but the results are not statistically significant.

Table-5. Regression of loss reserve adjustment on earning portfolios for job security

$$ADJUST_{t+j,t} = \alpha_t + \beta_1 NEGATIVE_t + \beta_2 BELOW_t + \beta_3 ABOVE_t + \beta_4 POSITIVE_t + \beta_5 \text{AUTO}_t + \beta_6 \text{LIA}_t + \varepsilon_t \quad (1)$$

Panel-A. Regression summary statistics of poor-poor firms

	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSTIVE	0.168	5.209	0.228	6.196	0.194	6.076	0.175	6.305	0.228	6.504	0.191	6.532
NEGATIVE	0.158	5.221	0.222	6.113	0.188	6.031	0.170	6.561	0.222	6.419	0.185	6.468
ABOVE	0.181	5.309	0.237	6.654	0.206	6.615	0.183	6.26	0.237	6.993	0.203	7.059
BELOW	0.159	4.755	0.215	5.743	0.183	5.630	0.163	5.685	0.213	5.96	0.177	5.924
AUTO							-0.000	-9.019	-0.000	-6.017	-0.000	-7.187
LIABILITY							-0.000	-5.155	-0.000	-2.050	-0.000	-5.405
Adjusted R^2	0.047		0.747				0.298		0.771			
N	540		540		540		540		540		540	
LM test					322.65						230.18	
Hausman test					4.14						19.32	

Panel-B. Regression summary statistics of good-good firms

	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSTIVE	-2.021	-0.243	-0.28	-5.023	-0.245	-4.728	-0.010	-0.118	-0.28	-5.009	-0.243	-4.682
ABOVE	0.024	0.272	-0.268	-4.680	-0.230	-4.311	0.029	0.332	-0.269	-4.675	-0.226	-4.232
BELOW	0.039	0.319	-0.159	-1.485	-0.149	-1.651	0.034	0.329	-0.158	-1.476	-0.15	-1.669
AUTO							-0.000	-2.154	0.000	0.231	-0.000	-1.927
LIABILITY							-0.000	-3.994	0.000	0.420	-0.000	-0.828
Adjusted R^2	0.003		0.815				0.057		0.814			
N	445		445		445		445		445		445	
LM test					485.22						474.88	
Hausman test					3.88						13.94	

Panel-C. Regression summary statistics of poor-good firms

	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSTIVE	0.026	0.348	0.032	0.706	0.021	0.497	0.027	0.398	0.032	0.720	0.020	0.473
NEGATIVE	0.078	1.098	0.022	0.509	0.038	0.912	0.089	1.354	0.022	0.506	0.042	1.044
ABOVE	0.082	1.076	0.010	0.211	0.026	0.589	0.081	1.164	0.010	0.209	0.028	0.655
BELOW	0.040	0.554	0.013	0.299	0.021	0.509	0.054	0.801	0.016	0.312	0.025	0.608
AUTO							-0.000	-3.103	-0.000	-2.304	-0.000	-3.785
LIABILITY							-0.000	-6.378	-0.000	-2.058	0.000	-4.123
Adjusted R^2	0.016		0.818				0.166		0.823			
N	275		275		275		275		275		275	
LM test					48.53						30.72	
Hausman test					9.79						20.00	
Regression	F-statistic	p-value	F-statistic	p-value			F-statistic	p-value	F-statistic	p-value		
All equal	2.14	0.076	9.19	0.000			10.07	0.000	9.39	0.000		
β1=β4	0.26	0.618	9.31	0.000			0.29	0.591	9.50	0.000		
β2=β3	0.03	0.868	9.32	0.000			0.04	0.841	9.52	0.000		

Panel-D. Regression summary statistics of good-poor firms

	OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSTIVE	-0.031	-0.425	-0.110	-1.208	-0.076	-1.228
ABOVE	-0.003	-0.047	-0.109	-1.181	-0.066	-1.045
AUTO	-0.000	-4.009	-0.000	-0.000	-0.000	-3.788
LIABILITY	-0.000	-2.598	-0.000	-0.000	-0.000	-2.761
Adjusted R^2	0.152		0.773			
N	303		303		303	
LM test					38.58	
Hausman test					3.02	

Line of Business and the Distribution of Reported Earnings

The A. M. Best Company classifies homeowner and farm owner multiple peril, automobile liability and physical damage lines as personal lines. All other lines are classified as commercial. Division of our sample into personal and commercial firms is then inevitably subjective. We regard an insurer as commercial if 70 per cent of premium revenue comes from commercial lines of business and an insurer as personal if 70 per cent or more of premium revenue comes from personal lines of business. We anticipate that firms writing commercial lines are more likely to bias reserve estimation than firms writing personal lines.

Table 6 (panel A) shows that the loss reserves of firms focused on commercial lines of business are understated in all sections of the earnings distribution and panel C shows that for commercial firms, the loss reserves of small profit firms are more biased than those of small loss firms.

Table-6. Regression of loss reserve adjustment on earning portfolios for commercial and personal line of business

$$ADJUST_{t+j,t} = \alpha_t + \beta_1 NEGATIVE_t + \beta_2 BELOW_t + \beta_3 ABOVE_t + \beta_4 POSITIVE_t + \beta_5 \mathrm{AUTO}_t + \beta_6 \mathrm{LIA}_t + \varepsilon_t \quad (1)$$

Panel-A. Regression summary statistics of commercial firms

	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSTIVE	0.089	2.986	0.125	2.804	0.116	4.878	0.094	3.200	0.125	2.806	0.116	4.902
NEGATIVE	0.133	4.469	0.129	2.891	0.124	5.211	0.133	4.535	0.129	2.890	0.123	5.226
ABOVE	0.128	4.129	0.140	3.119	0.134	5.674	0.128	4.213	0.140	3.131	0.135	5.717
BELOW	0.126	3.908	0.129	2.767	0.117	4.828	0.128	4.052	0.123	2.762	0.117	4.842
AUTO							-0.000	-0.127	-0.000	-1.336	-0.000	-2.136
LIABILITY							-0.000	-5.123	-0.000	-1.429	-0.000	-3.607
Adjusted R^2	0.048		0.704				0.081		0.706			
N	1047		1047		1047		1047		1047		1047	
LM test					490.14						510.29	
Hausman test					30.74						36.02	

Panel-B. Regression summary statistics of personal firms

	OLS Model		Fixed Effects Model		Random Effects Model		OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
POSITIVE	0.049	0.962	-0.033	-0.714	-0.024	-0.622	0.06	1.227	-0.033	-0.622	-0.022	-0.564
NEGATIVE	0.073	1.415	-0.032	-0.679	-0.018	-0.463	0.086	1.737	-0.032	-0.600	-0.016	-0.325
ABOVE	0.092	1.671	-0.023	-0.463	-0.013	-0.303	0.095	1.790	-0.024	-0.426	-0.013	-0.318
BELOW	0.055	0.975	-0.021	-0.421	-0.013	-0.305	0.059	1.090	-0.026	-0.454	-0.014	-0.325
AUTO							-0.000	-3.409	-0.000	-2.408	-0.000	-3.253
LIABILITY							-0.000	-0.496	-0.000	-1.146	-0.000	-3.790
Adjusted R^2	0.004		0.667				0.084		0.676			
N	664		664		664		664		664		664	
LM test					633.53						571.11	
Hausman test					4.22						12.34	

Panel-C. Tests of Coefficient Restrictions of Commercial Firms

Regression	F- statistic	p-value	F- statistic	p-value	F-statistic	p-value	F-statistic	p-value
All equal	14.07	0.000	17.66	0.000	16.37	0.000	17.60	0.000
β1=β4	0.68	0.411	17.78	0.000	0.64	0.426	17.72	0.000
β2=β3	2.87	0.091	17.72	0.000	3.16	0.076	17.65	0.000

Unlike the results reported in panel a, none of the coefficients in panel B are statistically significant, so there is little evidence to suggest that managers of firms focused on personal lines of business underestimate loss reserves. This is consistent with the notion that managers of such firms have limited opportunities to bias accounting numbers, as reported in the literature.

Determinants of Loss Reserve Management

What factors influence managers to engage in reserve management? We investigate this issue using economic variables which have significant power in explaining the underwriting cycle together with economic factors and firm-specific factors which affect the LLP manipulation in the banking industry as reported by Bikker and Metzemakers (2005). However, preliminary investigations showed a strong correlation between earnings scaled by total assets and capital scaled by total assets. The earnings factor is therefore eliminated from the analysis. The regression results in Table 7 show that premium revenue (scaled by total assets) is negatively associated with reserve adjustment, suggesting that premium revenue increases at a time when insurers overvalue loss reserves to avoid insolvency. Other firm-specific factors are not significant.

Table-7. Regression summary statistics of relation between economic variables and reserve adjustment

$$ADJUST_{i,t} = \alpha_t + \beta_1 PRETA_{i,t} + \beta_2 CAPTA_{i,t} + \beta_3 INT_t + \beta_4 \Delta GDP_t + \beta_5 \Delta \mathrm{INF}_t + + \beta_6 CB_{i,t} + \beta_7 \Delta STOCK_t + \varepsilon_{i,t} \quad (2)$$

	OLS Model		Fixed Effects Model		Random Effects Model	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
PRETA	-1.584	-45.354	-1.030	-21.274	-1.149	-26.956
CAPTA	-0.000	- 0.674	-0.000	- 0.869	-0.000	- 0.917
INT	1.518	2.546	1.694	4.177	1.630	4.046
ΔGDP	1.484	2.703	1.599	4.374	1.530	4.198
ΔINF	-0.039	- 1.352	-0.043	- 2.229	-0.043	- 2.227
CB	-0.000	- 0.270	0.000	0.170	0.000	0.126
ΔSTOCK	-0.010	- 0.069	0.048	0.479	0.035	0.344
Adjusted R^2	0.431		0.753			
N	2732		2732		2732	
LM test					2277.26	
Hausman test					70.58	

The coefficient for interest rate is positive and significant, which is consistent with Weiss (1985). The result suggests that a rise in interest rates, which directly influences insurers' investment returns, leads to a soft insurance market and loose underwriting standards. According to underwriting cycle theory, we would expect to see low premiums and unprofitable underwriting in soft markets leading to managers underestimating loss reserves to offset future unfavorable underwriting results. The coefficient of change in GDP is positive and significant. So managers use their discretion to understate reserve estimation in economic expansion conditions. The results also suggest that change in inflation rate is negatively related to reserve manipulation. The implication here is that when inflation increases, real investment income decreases and managers overvalue loss reserves to maintain solvency. To test for robustness, we calculate the correlations between short term interest rate, changes in inflation and GDP growth rate and conclude that the correlations are low. The coefficient of the change in stock index is not significant. Thus, there is no evidence that performance of the stock market influences loss reserve adjustment.

CONCLUSIONS

Loss reserves represent the largest liability estimated at managers' discretion on non-life insurer balance sheets, so it is the primary means of exercising discretion in the management of earnings. In this paper, we have tested a number of hypotheses concerning loss reserve manipulation in the UK non-life insurance industry. Our empirical results reveal several interesting findings:

1. Reserving manipulation exists in the UK non-life insurance industry, a finding consistent with the literature on US property-casualty insurers (Petroni, 1992; Beaver *et al.*, 2003; Gaver and Paterson, 2004).

2. Managers of UK non-life insurers adjust loss reserves to avoid small losses, as reported in prior research for the US property-casualty industry (Beaver *et al.*, 2003; Dechow *et al.*, 2003). The number of insurers reporting a small profit is greater than the number reporting small losses. The earnings distribution is discontinuous around zero but becomes smooth after subtracting the discretionary loss reserve accrual. Results also show that insurers with big losses manipulate their loss reserve accrual to avoid triggering regulatory intervention.

3. Small profit insurers in both poor-poor and poor-good groups are more likely to underestimate reserves compared to small loss insurers. However, we believe that the underlying reasons are different for the two groups. Managers of small profit firms in the poor-poor group adjust loss reserves to avoid triggering a regulatory investigation but managers of small profit firms in the poor-good group adjust loss reserves to smooth earnings. This is the first study to investigate whether managers' manipulation of loss reserve manipulation is influenced by their job concerns.

4. Firms writing mainly commercial lines of business are more likely to bias their claims loss reserve than firms writing mainly personal lines of business. This is consistent with the view of Petroni (1992) that managers of personal lines of business have less opportunity to influence reported reserves. We find no evidence of reserve adjustment for firms concentrating on personal lines of business.

5. Both economic factors and firm-specific factors are associated with accuracy of reserve modification. The explanatory power of changes in real GDP, changes in the inflation rate and the short term interest rate is high in each case. Moreover, our results suggest that net premiums written scaled by total assets helps to explain loss reserve manipulation. Inadequate loss reserves may imply potential insolvency problems, hence the need to investigate reserve manipulation and its determinants in the UK non-life insurance industry. If regulators do not detect earnings manipulation in time, they are likely to face more serious problems at a later stage. Our research provides the authorities concerned with suggestions for monitoring non-life insurers more effectively.

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