Surplus Sensitivity and Immunization of Property and Liability Insurers

Jin Park, B. Paul Choi, Dohan Song, and Sukho Lee

Abstract

The P/L insurers were exposed to a great amount of risk from changes in interest or inflation rates because the over 83 percent of insurers assets are invested in bonds and stocks, of which values are inflation or interest rate sensitive. In addition, the insurer's liability is not free from interest rate risk, too. This study is designed to examine IRR exposures of P/L insurers and to identity how surplus immunization strategy should be designed given the IRR exposures. Using insurers predominantly underwriting private passenger auto lines of business, this study finds that sample insurers were not actively practice surplus immunization management. For P/L insurers investigated in this study, surplus immunization was not only sub-optimal, but also infeasible.

I. Introduction

For property and liability (P/L) insurers as financial institutions, the investment income is an important factor in insurance pricing along with other underwriting and cost factors, especially during the economic downturn. In 2010, the P/L insurance industry as a whole reported net underwriting losses of $10.4 billion, but it earned net investment income of $47.2 billion, not including realized capital gains of $5.7 billion, resulting net after-tax income of $34.7 billion (Insurance Information Institute, 2011). The reported investment income was primarily resulted from the industry's investment in bonds and stocks, for the amounts of $873.7 billion and $226.1 billion, respectively. As these two investment categories accounted for about 83.6 percent of the industry's aggregate total assets, the P/L insurers were exposed to a great amount of risk from changes in interest or inflation rates.

The P/L insurers' liabilities are exposed to interest rate risk (IRR). The P/L insurers allot loss reserves to pay for future payments related to currently open claims and claims that are incurred but not yet reported (IBNR). Loss reserves are subject to claim inflation (Hodes & Feldblum, 1996 and Gorvett & D'Arcy, 2000), which is highly positively correlated with interest rate. That is, the nominal value of future loss payments increases as unexpected inflation occurs, causing an increase in insurer's liabilities under the common assumption that inflation increases with interest rates. As the result, the market value of the P/L insurers' liabilities changes as interest rate changes. Therefore, if the market value of assets decreases more than that of liabilities when interest rate changes, the insurer's economic (market) value of surplus decreases by the difference. However, this high correlation between interest and inflation does not hold during stagflation.

The most commonly used IRR measures in the empirical and analytical literature are maturity gaps and duration measures. A duration measure is sensitive to a number of assumptions, including (1) parallel shifts of the term structures of interest rates, (2) small changes in interest rates, and (3) invariant future cash flows. Gorvett and D'Arcy (2000) cite that a parallel shift of the term structure of interest rates explains 80 percent of historical interest

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rate movement. In addition, the duration measures may not be meaningful when interest rate volatility is high (Fabbozi, 1995). If one or more of these assumptions are violated, these duration measures become less accurate measures of IRR. The assumption of invariant future cash flows presents the most problems in applying them to a P/L insurer's liabilities, because a P/L insurer's liabilities are subject to claim inflation. That is, the expected future claim payments vary with a change in inflation, specifically claim inflation (Gorvett & D'Arcy, 2000). In addition, insurers may exercise call or put options depending on circumstances, which violates the assumption of invariant future cash flow. In such a case, effective duration, which takes into account of variable future cash flows as interest rates change, is appropriate. Only a handful of studies measure effective duration of P/L lines of business (i.e., Gorvett and D'Arcy, 2000). Convexity, the change in duration with respect to an interest rate change, is also an important supplemental measure for IRR, especially when interest rate changes are large.

This study is designed to examine IRR exposures of P/L insurers and to identity how surplus immunization strategy should be designed given the IRR exposures. In doing so, this study is different from extant studies in two aspects. First, this study operationalizes measurement of total IRR of P/L insurers using duration and convexity. Exploring IRR of both assets and liabilities, or surplus as a whole, can lead to an increased awareness of risk and management of IRR. Most extant studies demonstrate how IRR may adversely affect the insurer's surplus using a hypothetical insurer (e.g., CAS Financial Analysis Committee, 1989 and Tzeng, Wang, & Soo, 2000). Most studies using empirical data for real insurers exclude IRR of insurers' assets. In many other cases, extant studies do not include all liability components in the IRR measures. The focus mostly lies on loss reserves, loss adjustment expenses reserves, and unearned premiums reserves. Second, the measurement of IRR will take into account of differences in individual insurers (rather than the industry's aggregate figures) by analyzing an insurer's own loss development factors (LDFs) of line of business for all lines of business to project loss payments. Extant studies investigating IRR include a few selected lines of business, instead of all lines of business. For example, Feldblum (1989) analyzed IRR of general liability only, while Gorvett & D'Arcy (2000) focused on IRR of private passenger auto liability and general liability. Thus, so for, private passenger auto liability, general liability, and workers compensation are the most studied lines of business.

II. Measurement of Duration and Convexity

Modified duration is a useful measure of the sensitivity of a bond's price to interest rate changes, and it is calculated as the Macaulay duration divided by one plus the current yield. A convexity measure of a security, the change in duration with respect to changes in interest rates, is the approximate change in the price of the security that is not explained by duration (Fabozzi, 1995).[3]

A. Interest rate sensitivity of liabilities

An estimation of future cash flows is a key to measuring the duration and convexity. Thus, to measure duration and convexity of P/L insurers' liabilities, we first need to estimate

[3] Formulas to fin the modified duration and convexity of a security are presented in many finance textbooks.

payout patterns adjusted for inflation for each line of business. A "loss-development triangle method" with data from Schedule P in the statutory NAIC Annual Statement is used to estimate claim payout patterns. After the payout patterns are estimated and the duration and convexity of liabilities are measured for various liability components, interest rate risk of an insurer's liability, IRR_L, is calculated as follows:

$$IRR_L = w_{LR}(-MD_{LR}(\Delta i) + \frac{1}{2}MC_{LR}(\Delta i)^2) + w_{UP}(-MD_{UP}(\Delta i) + \frac{1}{2}MC_{UP}(\Delta i)^2) + w_{OL}(-0.5(\Delta i)) \quad (1)$$

where *MD* and *MC* are duration and convexity, respectively, and the subscripts *LR*, *UP*, and *OL* denote loss and loss adjustment expense reserves, unearned premiums, and other liabilities of an insurer, respectively. The w_i's are weights for the corresponding liabilities, and other liabilities are assumed to have a duration of 0.5, which means the cash flow happens in the middle of a year.

B. Interest rate sensitivity of assets

Schedule D in the NAIC Annual Statement provides comprehensive bond and stock portfolio information. P/L insurers are required to report the composition of their bond portfolio by types of bonds and by quality and maturity of bonds. Duration and convexity of the bond portfolio are calculated under the assumption that cash flows occur in the middle of the year.

The price sensitivity of stock price due to changes in both the real rate of interest and the rate of inflation is calculated followed by Leibowitz, et al. (1989). The inflation and interest rate flow-through parameters that are necessary to calculate the total interest rate sensitivity of stock portfolio are estimated using Maximum likelihood estimates of ARCH(2) models, which are obtained using quarterly dividend growth rates from the 1st quarter of 1980 to the 4th quarter of 1999. To ensure the conditional variance of the error term is positive and finite, the intercept term in an ARCH model should be positive, while all other coefficients of the ARCH model should be nonnegative. In addition, the sum of all coefficients of the ARCH model, except the intercept, should be equal to or greater than zero, but less than one, $0 \leq \sum_{i=1}^{q} \alpha_i < 1$ (Greene, 2000). These constraints are all satisfied with the models specified, and the Jarque-Bera normality test fails to reject the null hypothesis that errors of an ARCH(2) model is normally distributed. With these estimates, the interest rate sensitivity of stock price is estimated as 8.3, which means when the inflation rate increases by 100 basis points (or one percent), the value of the P/L insurer's stock portfolio decreases by 8.3 percent. The traditional duration measure was estimated to be over 11 percent. (Results are available upon request).

In this study, the price sensitivity of stock is dichotomized into its sensitivity to the real rate of interest and its sensitivity to the inflation rate, and the equation can be easily extended to measure the total price sensitivity of stock portfolio to interest rates by simply replacing the price of a stock with the value of entire stock portfolio. Therefore, once duration and convexity of stock and bond portfolios are measured, IRR of assets of an insurer, IRR_A, is measured as follows:

$$IRR_A = w_B(-MD_B(\Delta i) + \frac{1}{2}MC_B(\Delta i)^2) + w_S(\frac{dP_S}{P_S}) + w_{OA}(-0.5(\Delta i)) \quad (2)$$

where the subscripts *B* and *S* denote the Bond portfolio and Stock portfolio of an insurer, respectively. The w_i's are weights for the corresponding portfolios. For example, w_{OA} is the weight for other assets excluding cash and the duration for other assets, like other liabilities, is assumed to be 0.5.

C. Interest rate sensitivity of surplus

The measurement of interest rate risk of a P/C insurer's surplus is meaningful only when all related balance sheet items are aggregated and the net positions are identified. Given the IRR_A and IRR_L, total interest rate sensitivity of surplus (IRR_S) is calculated as follows:

$$IRR_S = IRR_A\left(\frac{\text{Assets}}{\text{Surplus}}\right) - IRR_L\left(\frac{\text{Liabilities}}{\text{Surplus}}\right) \quad (3)$$

III. Sample and Data

The sample of P/L insurers used in this study consists of P/L insurers that predominantly wrote private passenger auto lines of insurance. The sample consists of insurers whose net premiums written (NPW) for the combination of private passenger auto liability and physical damage insurance were more than 70 percent of total NPW as reported in the NAIC Annual Statement. Due to the data availability to the authors at the time of the analysis, the data used in this paper is limited to Year 1999, which limits the generalizability of this study's findings. However, using a single year of data does not weaken the validity and rationale of this study.

The number of insurers meeting selection criterion described above was 386. Of these, 159 insurers were eliminated due to a lack of loss payout data from Schedule P in the NAIC Annual Statement. An additional 16 insurers were eliminated because they reported negative loss reserves, cash or other assets. The number of sample insurers for analyzing IRR of insurers becomes 211 insurers.

Equations (1) through (3) shown in the previous section are estimated using various parts in the NAIC Annual Statement. IRR_A is measured using data primarily from Schedule D in the NAIC Annual Statement, and IRR_L is mainly based on LDFs estimated using data from Schedule P – Part 2 in the Annual Statement. IRR_S is measured as a value weighted average, IRR_A and IRR_L. All interest rate sensitivity measures are based on a parallel shift in the yield curve by 100 basis points (one percent), and insurers are assumed to maintain their stock portfolio and hold bonds until their maturity.

IV. Estimation results

A. Interest rate sensitivity of liabilities

Table 1 in the next page presents the duration and convexity of loss reserves for selected lines of the sample insurers. Duration of loss reserves ranges from 0.56 for short-tail lines of business as a whole to 5.38 for Product liability (Occurrence) insurance. In general, personal lines of business have lower durations than commercial lines of business, which is expected. Duration of unearned premium reserves for all lines of business is 0.9. Measured as a value weighted average of liabilities, duration of total liabilities including other liabilities is 1.19, meaning when interest rate changes by one hundred basis points (one percent), the present value of liabilities changes by 1.19 percent.

Table 1. Modified Duration and Convexity of P/L Insurer's Liabilities

		Modified Duration		Modified Convexity	
Loss and LAE Reserves	N	Mean	S.D.	Mean	S.D.
Homeowners/Farmowners	121	1.43	0.81	3.36	3.82
Private Passenger Auto Liability	211	1.48	0.50	3.29	2.09
Commercial Auto Liability	114	1.85	0.83	4.72	4.09
Workers Compensation	66	4.05	2.88	19.59	17.10
Commercial Multiperil	54	3.10	2.14	14.84	18.24
Medical Malpractice - Occurrence	10	4.67	0.88	22.97	5.59
Medical Malpractice - Claims Made	1	0.79	NA	1.09	NA
Special Liability	21	3.48	3.58	17.25	27.66
Other Liability - Occurrence	109	3.24	2.95	17.23	15.94
Other Liability - Claims Made	29	3.47	2.67	18.45	22.00
International	1	5.26	NA	31.22	NA
Reinsurance – NP Assumed Property[a]	16	3.09	1.45	14.10	8.73
Reinsurance – NP Assumed Liability[a]	33	5.14	1.47	27.69	11.10
Reinsurance – NP Assumed Fin. Lines[a]	2	3.03	0.27	13.67	1.34
Product Liability – Occurrence	23	5.38	2.76	33.12	27.58
Product Liability - Claims Made	5	2.28	0.18	5.82	2.07
Short-Tail Lines of Business (Aggregated)	211	0.56	0.13	0.48	0.19
Loss and LAE Reserves – Total	211	1.56	0.59	4.00	3.00
Unearned Premium Reserves – Total	211	0.92	0.42	2.04	1.78
Reserves – Total	211	1.32	0.56	3.30	2.71
Total Liabilities[b]	211	1.19	0.48	2.78	2.23

Note: [a] NP – Non-Proportional
[b] Other liabilities other than reserves are assumed to have modified duration and convexity of 0.5 and zero respectively.

The measures of convexity range from 3.29 for PPAL to 33.12 for Product liability (Occurrence); that is, if the interest rate instantaneously changes by one percent in any direction, the present values of loss reserves for PPAL and Product liability (Occurrence) increase by 0.0329 and 0.3312 percent, respectively. Therefore, if duration and convexity are considered together, the present value of PPAL loss reserves would decrease by 1.4471 percent (-1.48 + 0.0329) as the interest rate increases by one percent, and the present value would increase by

1.5129 percent (1.48 + 0.0329) as the interest rate decreases by one percent. By the same token, an increase in the interest rate of one percent decreases the present value of total liabilities by 1.1622 percent (-1.19 + 0.0278), while a decrease in the interest rate of one percent increases it by 1.2178 percent (1.19 + 0.0278). The differences in the percentage value changes between increase and decrease in the interest rate are the direct result of the convex shape of the general price-yield relationship for a financial security (Saunders & Cornett, 2006). For a given change in the interest rate, the percentage value increase is greater than the percentage value decrease (Fabozzi, 1999).

B. Interest rate sensitivity of assets

Comparisons of duration and convexity for insurers' bond portfolios are shown in Tables 2 and 3, by four types of issuer and two types of investment class. A yield curve for Treasury securities with different term-to-maturities was used to discount investment grade Government Bonds, while arithmetic average yield rates of AAA to BBB-rated bond yields were used to discount other investment grade bonds. For non-investment grade bonds, a term structure of average yield rates of BB+ to C-rated bonds was employed, while a constant default risk premium of 0.42 percent was added to the yield curve of Treasury securities to discount non-investment grade Government Bonds.

Table 2. Comparison of Modified Durations of P/L Insurers' Bond Portfolio

	Sample Insurers			Industry Excluding Other Auto Insurers			
Government Bonds	N	Mean	Std. Dev.	N	Mean	N	Mean
Investment Grade	195	4.99	2.72	711	5.03	1,326	4.61**
Non-Investment Grade	3	6.82	1.25	41	6.23	16	5.33
All Government Bonds	195	4.98	2.72	711	5.05	1,327	4.61**
Tax-Exempt Bonds							
Investment Grade	189	7.13	2.38	656	7.71***	1,093	6.96
Non-Investment Grade	20	6.29	3.30	68	5.54	43	5.17*
All Tax-Exempt Bonds	189	7.13	2.38	658	7.69***	1,094	6.95†
Public Utility Bonds							
Investment Grade	115	4.60	2.51	449	4.82	491	4.68
Non-Investment Grade	10	4.98	2.45	70	4.58	51	4.56
All Public Utility Bonds	115	4.59	2.46	453	4.81***	499	4.68†
Industrial Bonds							
Investment Grade	173	5.04	1.73	642	5.28*	914	5.05†
Non-Investment Grade	75	4.10	1.59	286	4.51†**	253	4.42†**
All Industrial Bonds	175	4.99	1.67	643	5.26	926	5.01
Total Bonds	211	5.82	2.13	747	5.87	1,542	4.97†***

Note: Investment grade bonds include the NAIC bond classes 1 and 2. The NAIC bond classes from 3 to 6 and undefined classes are categorized as non-investment grade bonds.

† A variance ratio test (F-test) rejects the null hypothesis that sample variances between groups are equal.

***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Table 2 displays durations for all bond portfolios, and Tax-Exempt Bonds have the largest durations for all groups of insurers, while Public Utility Bonds generally have the smallest durations. In addition, between the sample insurers and the other auto insurers, the sample insurers on average have statistically significantly smaller durations for investment grade Tax-Exempt Bonds (7.13 versus 7.71), all Public Utility Bonds (4.59 versus 4.81), and non-investment grade Industrial Bonds (4.10 versus 4.51). The duration for total bond portfolios of the sample insurers is not statistically different from that of the other auto insurers (5.82 versus 5.87), but it is statistically significantly different from the duration of the industry (5.82 versus 4.97).

Table 3. Comparison of Modified Convexities of P/L Insurers' Bond Portfolio

	Sample Insurers			Industry Excluding Other Auto Insurers			
Government Bonds	N	Mean	Std. Dev.	N	Mean	N	Mean
Investment Grade	195	29.24	29.28	711	30.11†	1,326	26.45*
Non-Investment Grade	3	39.35	15.88	41	38.36	16	29.45
All Government Bonds	195	29.18	29.18	711	30.31	1,327	26.42
Tax-Exempt Bonds							
Investment Grade	189	45.16	25.11	656	51.63†***	1,093	44.23†
Non-Investment Grade	20	37.84	35.84	68	32.19	43	25.82*
All Tax-Exempt Bonds	189	45.14	25.11	658	51.46†***	1,094	44.19†
Public Utility Bonds							
Investment Grade	115	22.49	24.72	449	23.86†	491	23.49
Non-Investment Grade	10	24.10	16.75	70	18.80	51	18.85
All Public Utility Bonds	115	22.20	24.02	453	23.67†**	499	23.19†
Industrial Bonds							
Investment Grade	173	25.91	16.79	642	28.56†**	914	26.63†
Non-Investment Grade	75	15.56	12.45	286	19.84†**	253	19.63†**
All Industrial Bonds	175	25.24	16.26	643	28.30	926	26.23
Total Bonds	211	34.00	20.39	747	34.99	1,542	28.74†***

Note: Investment grade bonds include the NAIC bond classes 1 and 2. The NAIC bond classes from 3 to 6 and undefined classes are categorized as non-investment grade bonds.

† A variance ratio test (F-test) rejects the null hypothesis that sample variances between groups are equal.
***, **, and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

For convexity as shown in Table 3, the statistical results are similar to duration. In addition, none of the bond portfolios for any group of insurers on average has negative convexity. When the interest rates decrease, the positive convexity will further increase the value of the bond portfolios. In contrary, when the interest rates increase, the positive convexity will mitigate the decrease in the value of the bond portfolios. For example, the value of the sample insurers' total bond portfolios decreases by 5.48 percent (-5.82 + 0.34), when the interest rates increase by one hundred basis points, whereas the value increases by 6.16 percent (5.82 + 0.34) for the same one hundred basis points decrease.

The investigation of duration suggests that P/L insurers in general did not employ a surplus immunization strategy. As discussed earlier, the duration for total reserves including unearned premium reserves is 1.32 for the sample insurers, and the duration for total bond portfolios is 5.82. Albeit not weighted by their values, a simple comparison of these durations suggests that the sample insurers were substantially exposed to interest rate risk, especially for an increase in interest rates.

C. Interest rate sensitivity of surplus

The measurement of interest rate risk of a P/L insurer's surplus is meaningful only when all related balance sheet items are aggregated and the net positions are identified. Table 4 reports on the increase (decrease) of major balance sheet items with respect to an interest rate decrease (increase) of one percent. An increase in the interest rates of one percent results in an average 4.72 percent decrease in the insurer's asset value, while the value of an insurer's liabilities decreases by 1.18 percent at the same time. That is, on average P/L insurers specializing in private passenger automobile insurance will experience a decrease in their surplus of 9.73 percent when the interest rate increases by one percent.

Table 4. Total Interest Rate Sensitivity and Dollar Sensitivity

	When Δi = -1 percent		When Δi = 1 percent	
	Mean	Std. Dev.	Mean	Std. Dev.
Total Interest Rate Sensitivity of				
Assets	4.93	1.98	-4.72	1.87
Bonds[a]	6.03	2.24	-5.69	2.04
Stocks	8.30	0.00	-8.30	0.00
Other Assets[b]	0.50	0.00	-0.50	0.00
Liabilities	1.20	0.49	-1.18	0.47
Loss & LAE Reserves	1.58	0.60	-1.54	0.57
Unearned Premiums Reserves	0.93	0.43	-0.91	0.41
Other Liabilities	0.50	0.00	-0.50	0.00
Surplus	10.23	5.21	-9.73	4.85
Dollar Sensitivity of Total Assets	6,615.3	42,935.5	-6,392.8	41,886.2
Dollar Sensitivity of Total Liabilities	611.6	3,337.6	-598.1	3,266.0
Dollar Sensitivity of Surplus	6,003.7	39,838.6	-5,794.7	38,868.4

Note: Dollar sensitivity is a measure of a change in dollar value (in thousands) with respect to changes in the interest rate.

[a] Mortgage backed securities and other option embedded bonds are not differentiated from non-option embedded bonds.

[b] Other assets do not include cash on hand.

On the other hand, when the interest rates decrease by the same amount, changes in the absolute values of assets, liabilities and surplus are greater than when the interest rate increases because of the convex relationship between yield and price of a financial security. The one percent decrease in the interest rate increases the values of assets and liabilities by 4.93 percent and 1.20 percent, resulting in a net increase in surplus of 10.23 percent. Therefore, it is clear from the Table 4 that the P/L insurers studied on average "borrow short and lend long" as other financial institutions such as banks and life insurers. Therefore, insurers' downside risk is interest rate increases because the increases in the interest rates decrease insurers' asset value more than their liability value, resulting in a net decrease in surplus value, which is a typical IRR position taken by most financial institutions (Zaglauer and Bauer, 2008).

Dollar sensitivity, a product of total interest rate sensitivity and value of a balance sheet item, shows a change in the value of a balance sheet item with respect to a change in the interest rate. For example, a one percent increase in the interest rate decreases the value of assets by $6.4 million, while the value of liabilities also decreases by a mere $0.6 million, resulting in a net decrease of $5.8 million in surplus. When interest rate decreases by one percent, the gain from the change is about $6.0 million in surplus.

One of many implications from this sort of line of study is to find a strategy to immunize surplus (or equity) from interest (or inflation) rate changes. Surplus immunization is achieved if the value of surplus is unaffected when interest or inflation rates change. Thus, to immunize an insurer's surplus against the change, the insurer has to maintain their asset and liability sensitivity such that a change in the dollar value of assets is equal to a change in the dollar value of liabilities when interest or inflation rates change.

Let $\overline{IRR}_A$ be the total sensitivity of assets required to immunize surplus given total sensitivity of liabilities (IRR_L), and $\overline{IRR}_L$ be the total sensitivity of liabilities required to immunize surplus given total sensitivity of assets (IRR_A). Table 5 shows that the sample insurers' $\overline{IRR}_A$ and $\overline{IRR}_L$ are on average 0.65 and 10.15. That is, in order to achieve surplus immunization given liability sensitivity of 1.15, insurers have to restructure their investment portfolio so the sensitivity of the portfolio becomes 0.65. In contrast, if asset sensitivity of 4.69 is given, insurers have to adjust their liability, so their liability sensitivity becomes 10.15. However, surplus immunization by adjusting liability sensitivity seems to be infeasible, because insurers cannot liberally adjust their liabilities, which are mainly reserves.

Table 5. Insurer's Asset and Liability Sensitivity – Surplus Immunization

	Mean	Std Dev
Measured Total Sensitivity of Assets (IRR_A)	4.69	1.86
Measured Total Sensitivity of Liabilities (IRR_L)	1.15	0.42
Total Sensitivity of Assets Required to Immunize Surplus ($\overline{IRR}_A$)	0.65	0.34
Total Sensitivity of Liabilities Required to Immunize Surplus ($\overline{IRR}_L$)	10.15	10.83

Note: IRR_A and IRR_L measures do not consider the existence of option embedded bonds.

Surplus immunization management seems to be sub-optimal to taking IRR for the sample insurers. Given liability sensitivity, achieving asset sensitivity of 0.65 implies greater weight in the insurer's investment portfolio for cash and short-term investment, which will substantially reduce investment income. The reduction in investment income increases the insurance price, which may not be an easy task in rate regulated states, especially in a timely manner. Even without rate regulation, the high insurance price will eventually jeopardize insurers' survivability in this competitive industry.

However, insurers longing for surplus immunization should consider using financial derivatives, because financial derivatives can transform the duration of balance sheet items without significant additional capital (Simons, 1995). Cowley and Cummins (2005) discuss the importance of securitization and argue that securitization allows insurers to achieve liquidity goal and provides an alternative source of financing by spreading risk more broadly. The findings of Lee and Stock (2000) also suggest that use of option embedded securities, not necessarily derivatives, reduces surplus sensitivity, when interest rate changes are large. Additionally, Tzeng, Wang and Soo (2000) suggest that a linear programming can be utilized to derive an optimal asset allocation subject to zero surplus duration.

V. Conclusion

This study is mainly motivated by the fact that there is a lack of research on interest rate risk of the property/liability (P/L) insurance industry. Unexpected changes in interest (or inflation) rates may severely jeopardize insurers' survivability and surplus position. Unless they properly manage their assets and liabilities, the potential impact of changes in interest rates on P/L insurer's investment revenue, profitability, and surplus may be so large that insurers may become insolvent. The proper management of assets and liabilities is not possible without properly understanding the IRR that the insurers are exposed to (Santomero & Babbel, 1997 and Brewer et al., 2007).

The result of the investigation of the sample insurers' surplus sensitivity shows that the sample insurers in general did not actively practice surplus immunization management. Given the asset and liability sensitivities, the sample insurers might not be able to practice surplus immunization management. To have their surplus immunized, the insurers had to adjust their asset portfolios, so total sensitivity of assets had to be 0.65 on average. In other words, the insurers must forgo most of their investment income, forcing them to increase their insurance prices. The increase in the prices would probably result in a loss of business to their competitors who did not immunize their surplus. Another means to achieve surplus immunization was to have liability sensitivity of 10.15, which was a more difficult task because an apparent means to achieve the target liability sensitivity was through adjusting their payout pattern. Therefore, at least for P/L insurers investigated in this study, surplus immunization was not only sub-optimal, but also infeasible.

The implication of this study is that regulators should be concerned with interest rate sensitivities of insurer's assets, liabilities, and surplus as a whole. On average, a one percent change in interest rates decreases the value of surplus by 9.73 percent, or $5.8 million for insurers specializing in private passenger auto insurance. However, caution is warranted in generalizing the findings of this study because (1) the data used in the study is limited to a single year and (2) the sample insurers are predominantly in private passenger auto insurance lines of business. In addition, the sample period used in the study did not have the same economic conditions as recent years. Therefore, analyzing insurer's IRR exposures over time including the recent financial crisis will test the findings of this study and improves generalizability of empirical findings.

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