An Examination of Reinsurance Effect on the Risk Management of General Insurance Companies*

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* This is preliminary result. Comments are welcomed.

Contents

I. Research Background

General(property & liability) insurance companies assume various risks but insurance products covering the risks differ significantly depending on each market's economic conditions and government regulations. For example, Korean general insurance companies deal with four property and liability risks: fire, marine, special(liability), and automobile risk.

- Korean general insurers have considerable long-term insurance business, it is not usually considered the typical non-life insurance product.
- Four risks (fire, marine, liability, automobile) are known to be independent each other.
- General insurance companies can be specialized in one or two risks, but most of the general insurance companies in Korea currently handle all four risks.

As general insurance companies loss experiences(ratios) tend to volatile, the insurers try to reduce the loss ratio volatility (= insurance risk) by reinsurance.

- Since reinsurance tends to reduce required capital for the primary insurer, it helps to improve the financial soundness ratio of the primary insurer.
- Each independent risk is being managed through reinsurance.
- Reinsurance strategy is an essential risk management tool in case of fire, marine, and special(liability) risks in Korea because of small number of cases and high severity but reinsurance strategy appears less important for automobile insurance satisfying the law of large number.

I. Research Background

Reinsurance is not free lunch for primary insurers. Risk transfer through reinsurance incurs reinsurance costs.

Since the volatility of loss ratios for lines(risks) are different from each other, the effect of reinsurance must be different from each line too.

- For the same reinsurance ceding, the effect of reducing the loss ratio volatility differs for each type of line(risk).

Therefore insurance companies are seeking to control as much risk as possible with a limited capital by minimizing risk variability through an efficient reinsurance strategy.

I. Research Background

The purpose of this study is to find out whether insurers minimize the volatility of the total risk by using reinsurance.

- In particular, we want to examine whether insurers adapt an optimal reinsurance strategy while operating mutually independent insurance lines.

We excluded automobiles, long term, and special(liability) risks because:

- special risk has not enough data,
- automobiles and long term insurance have different risk characteristics and their reinsurance strategies are different.
- (For example auto insurance has much lower volatility of the loss ratio)

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I. Research Background

In the case of general insurance, the amount of ceding to reinsurance or the retain ratio are determined based on past experience data.

- Estimate the probability of an accident in the next year based on past experiences.
- At this time, there are differences according to risk types, but it is generally known to be based on experience data of more than 5 years.

On the other hand, the primary insurance companies do not cede 100% to reinsurance company.

- The reinsurance company also demands that the primary insurer retains more than a certain percentage as to control moral hazard of the primary insurer.

Reinsurance is utilized subject to a given reinsurance cost set by the company.

- Therefore, the insurance company should minimize the total risk by appropriately using an efficient reinsurance strategy.

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II. Literature Review

◆ kalusszka(2001) theoretically derived the optimal reinsurance by using mean and variance of the reinsurer's hare of the total claim amount.

◆Gajek & Zagrodny (2005) theoretically considered the problem of finding an optimal insurer's strategy of purchasing reinsurance under the standard deviation calcuation principles.

◆Cai et al (2008) showed optimal reinsurance depending on confidence level, satefy loading in the forms of stop loss.

◆ Matsukoka (2008) attempts to determine the optimum combination of reinsurance and retention in the Japanese property insurance business by using integrated risk management approches. He employs Monte Carlo simulation to determine reinsurance and retention level.

◆Kim & Kim (2015) examines whether the Korean property and liability insurers as a whole retain or cede more or less than the optimal level within a given risk-based capital framwork. The paper finds some evidence that the Korean insurers retain less than the optimum level.

III. Research Methodology

Theoretical Model

[Theorem]
Given two variables about loss ratios of business lines after reinsurance

$X_1' \sim (\mu_1', \sigma_1')$, $X_2' \sim (\mu_2', \sigma_2')$.

In order to minimize variability of $Y' = A'X_1' + B'X_2'$

the ratio of the two standard deviations should have a reciprocal relationship with the ratio of the retained premium A' and B' after reinsurance.

[Proof]

From basic statistics knowledge we have

$$V(Y') = A'^2 \sigma_1' + B'^2 \sigma_2' \quad \text{----------} \quad (1)$$

Because of reinsurance cost and reinsurers' refuse taking 100% risk, we can have a condition on standard variations as following;

$$\sigma_1' + \sigma_2' = k > 0 \quad \text{----------} \quad (2)$$

The sum of volatility of loss ratios by business lines can not be zero. There is a limit to volatility because there is a limit ceding to reinsurance.

Q.E.D.

III. Research Methodology

Under condition (2), the equation (1) can be minimized with following values of σ_i

$$\sigma_1 = \frac{B'^2}{A'^2 + B'^2}, \sigma_2 = \frac{A'^2}{A'^2 + B'^2} \quad \text{----------} \quad (3)$$

From (3) we can derive a relation between standard deviations and retained premiums of two risks.

$$\frac{\sigma_1}{\sigma_2} = \frac{B'^2}{A'^2} \quad \text{----------} \quad (4)$$

Volatility of loss ratios by business line and premiums after reinsurance change annually.

Based on past experience, insurance companies establish a loss ratio prediction and set reinsuranc e strategy.

- If risks are managed at the enterprise level and the reinsurance strategy is established accordin gly, the volatility of each business line should be expressed as Equation (3). The relationship bet ween these equations is shown in Equation (4).

- We could find out if an insurer uses reinsurance strategy efficiently at the enterprise level by checking whether the each insurer's data satisfies Equation (3).

Insurance company loss ratios, however, are not known exactly and are only predicted based on p ast experience with range σ_i .

III. Research Methodology

Empirical Examination

Therefore, the following examination three procedure is used empirically purpose.

1. Find the trend line of the annual loss ratio and find the residuals of the actual values and the e stimated values.

2. Find the standard deviation of the residuals in 5-year increments.

Example: Standard deviation of residuals from 1997 to 2001 σ_{2001}
Standard deviation of residuals from 1998 to 2002 σ_{2002}

3. We could verify that the equation (3) is true by using standard deviations σ_i from the stage 2 and retained premiums after reinsurance ceding.

Therefore in this paper we try to verify that

$$y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2} \qquad \text{----------} \qquad (5)$$

converges to zero. This means that the ratio of standard deviation of two lines converges equal to the reciprocal of retained premium ratios of two lines. However, predicted loss ratios and actual loss ratios are usually different, the equation (5) may not converges to zero.

III. Research Methodology

- Since the Y value of equation (5) may not converges to zero, we evaluate the insurer's reinsurance practice by following two methods
- First, whether the Y value moves within a certain range. We could check if the company manges to retain total risk within a centain boundary.
- Second, whether the Y value move back to zero once the Y value moves away from zero ($|Y|$ gets bigger) We could check if the company tries to contain the total risk once the total risk becomes bigger.

III. Research Methodology – data

In this paper, we used data from 1997 ~ 2014 on fire and marine insurance's premium and loss ratio in insurance statistical annual report published by Korea Insurance Development Institute.

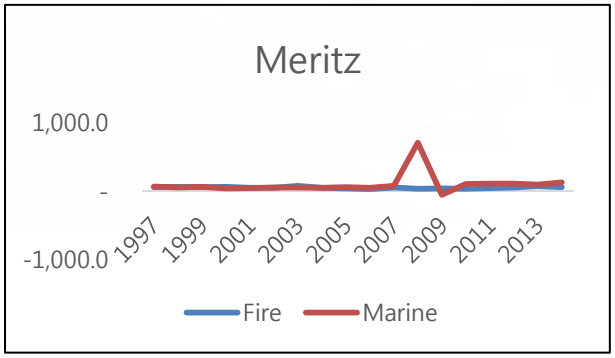
We used data from six major P/L insurance companies which account for almost 85% of P/L insurance market in Korea. The insurers are Samsung F&M, Hyundai Marine Insurance, Dongbu Fire Insurance, KB F&M Insurance, Meritz Fire, and Lotte F&M Insurance.

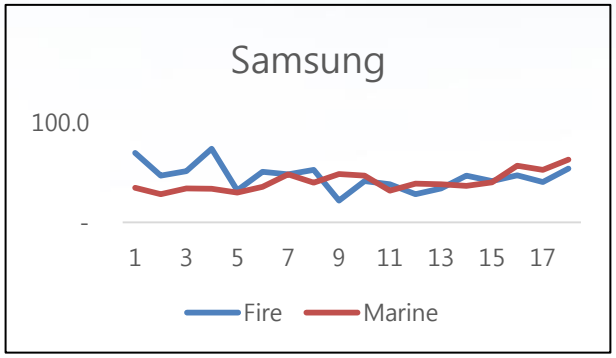
Small P/L insurance companies are excluded because they would have a limitation in systematically establishing reinsurance strategies on enterprise level.

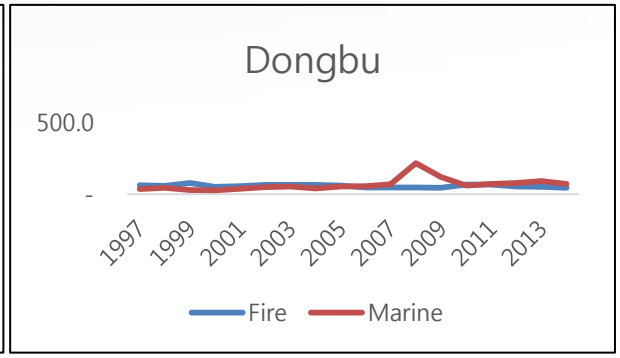
IV. Research Results – Loss Ratios

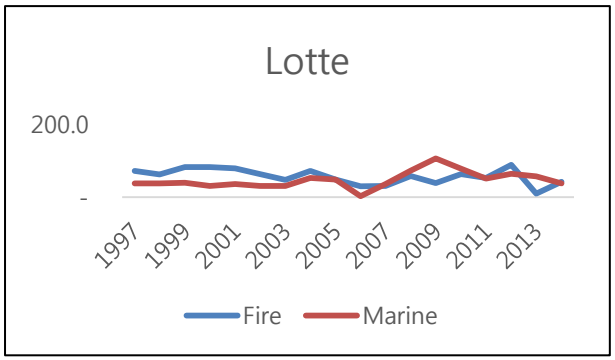
With a glance at graphs of loss ratios of fire and marine business, Samsung F&M seems to be trying to make two loss ratios equal.

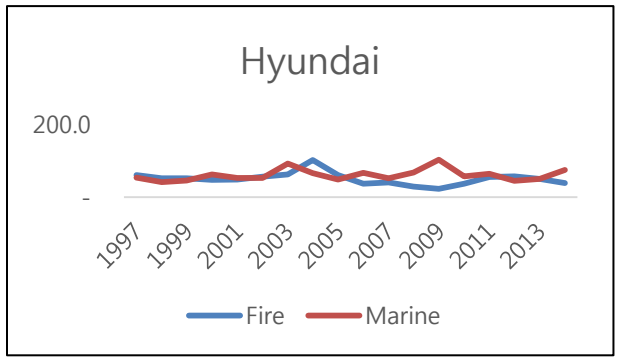
Others had huge losses at marine business at 2008 and the high peak can be found in the graphs.

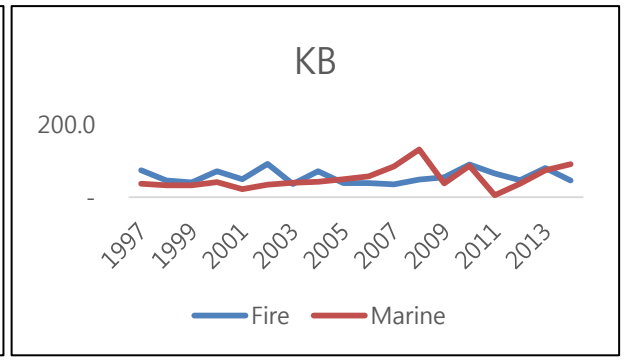












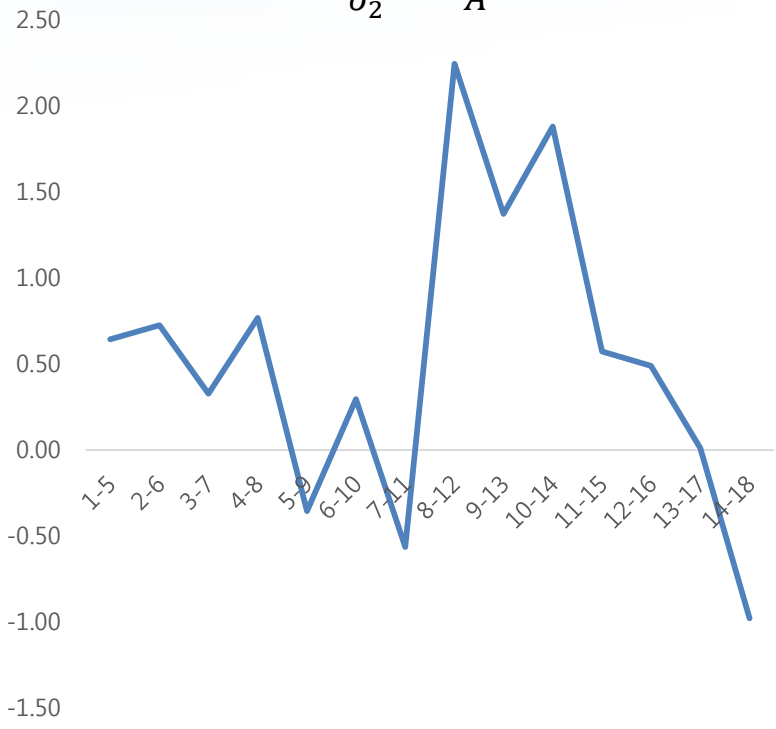
IV. Research Results – insurers

- For each company we calculated the value of *Y (= a – b)* by the equation (5)
- Meritz Fire had a huge loss with Marine line in 2008 and 2009, which results in the sharp increase in loss ratio variation during the time period 8~12. After that period it is understood that Maritz tried to reduce the loss variation.

Meritz Fire

Time Period	Retained Premium		(mm2/mf2)^2	Loss Ratio variation		mf2/mm2	Y = a-b
	mf2	mm2		mf2	mm2		
	Fire	Marine	a	Fire	Marine	b	
1-5	15,438	14,619	0.90	5.26	20.77	0.25	0.64
2-6	17,727	18,815	1.13	5.93	14.76	0.40	0.72
3-7	17,638	18,994	1.16	11.16	13.41	0.83	0.33
4-8	15,253	22,472	2.17	11.54	8.22	1.40	0.77
5-9	17,361	18,877	1.18	13.51	8.78	1.54	-0.36
6-10	16,210	20,742	1.64	15.87	11.83	1.34	0.30
7-11	20,294	21,899	1.16	16.05	9.29	1.73	-0.56
8-12	19,172	28,925	2.28	9.24	284.30	0.03	2.24
9-13	18,563	21,957	1.40	8.22	304.91	0.03	1.37
10-14	17,918	24,740	1.91	8.20	303.79	0.03	1.88
11-15	18,998	14,677	0.60	7.30	301.13	0.02	0.57
12-16	18,941	13,630	0.52	8.94	301.08	0.03	0.49
13-17	18,329	9,294	0.26	16.14	65.57	0.25	0.01
14-18	26,167	13,766	0.28	14.95	11.91	1.26	-0.98

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$



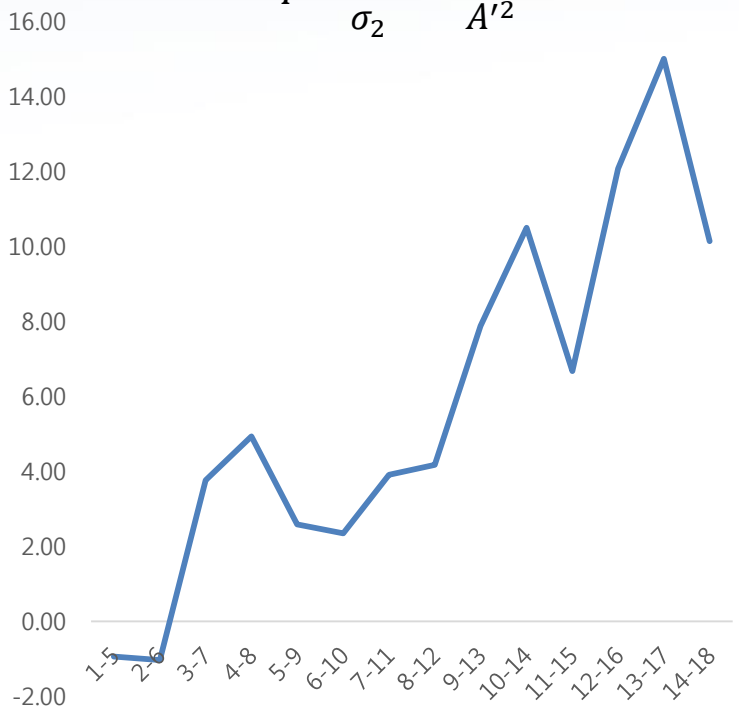
IV. Research Results – Insurers

Samsung F&M has increasing *Y (= a- b)* calculated from equation (5), which indicates the total risk of Samsung F&M increases after reinsurance over the years. Samsung may not pay good attention to total risk management strategy using reinsurance.

Samsung F&M

Time Period	Retained Premium		(sm2/sf2)^2	Loss Ratio variation		sf2/sm2	Y = a-b
	sf2	sm2		sf2	sm2		
	Fire	Marine	a	Fire	Marine	b	
1-5	21,320	39,360	3.41	16.54	3.80	4.35	-0.94
2-6	23,437	51,479	4.82	14.87	2.54	5.86	-1.03
3-7	21,720	54,502	6.30	14.52	5.73	2.53	3.76
4-8	21,570	58,990	7.48	14.59	5.73	2.55	4.93
5-9	25,009	53,881	4.64	13.27	6.45	2.06	2.59
6-10	24,987	55,034	4.85	11.78	4.71	2.50	2.35
7-11	24,190	55,437	5.25	11.32	8.42	1.34	3.91
8-12	24,960	59,293	5.64	11.36	7.74	1.47	4.18
9-13	23,371	69,616	8.87	8.22	8.25	1.00	7.88
10-14	22,164	75,578	11.63	7.35	6.54	1.12	10.50
11-15	23,018	72,999	10.06	7.91	2.34	3.38	6.68
12-16	22,505	82,448	13.42	9.46	7.06	1.34	12.08
13-17	15,620	62,085	15.80	6.11	7.68	0.80	15.00
14-18	25,303	83,150	10.80	6.14	9.37	0.65	10.14

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$



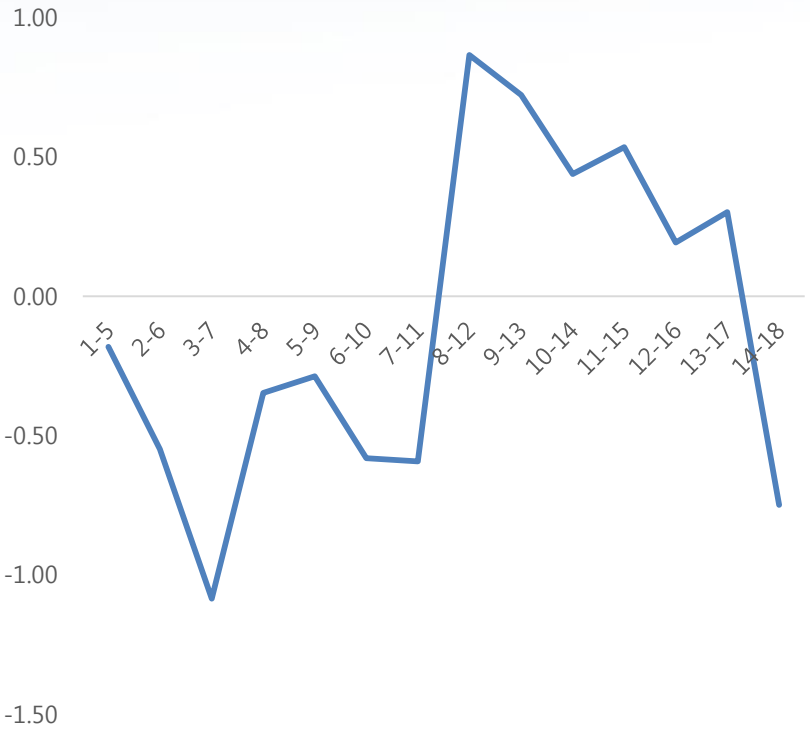
IV. Research Results – Insurers

Dongbu Fire over the research period seems to have a certain in the loss variation because *Y(= a-b)* it is moving within small range.

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$

Dongbu Fire Insurance

Time Period	Retained Premium		(dm2/df2)^2	Loss Ratio variation		df2/dm2	Y = a-b
	df2	dm2		df2	dm2		
	Fire	Marine	a	Fire	Marine	b	
1-5	17,985	14,623	0.66	9.61	11.41	0.84	-0.18
2-6	21,871	14,615	0.45	10.06	10.11	1.00	-0.55
3-7	20,518	15,371	0.56	9.87	5.99	1.65	-1.09
4-8	21,692	17,128	0.62	7.62	7.86	0.97	-0.35
5-9	26,649	17,763	0.44	5.01	6.86	0.73	-0.29
6-10	30,710	20,629	0.45	7.17	6.95	1.03	-0.58
7-11	33,338	26,586	0.64	8.33	6.77	1.23	-0.59
8-12	33,673	33,370	0.98	7.82	67.80	0.12	0.87
9-13	35,378	31,768	0.81	5.38	64.49	0.08	0.72
10-14	36,281	27,678	0.58	9.57	67.18	0.14	0.44
11-15	38,059	32,041	0.71	11.81	67.95	0.17	0.53
12-16	37,453	21,599	0.33	10.63	75.99	0.14	0.19
13-17	24,708	18,698	0.57	9.49	35.06	0.27	0.30
14-18	32,889	25,056	0.58	8.52	6.41	1.33	-0.75



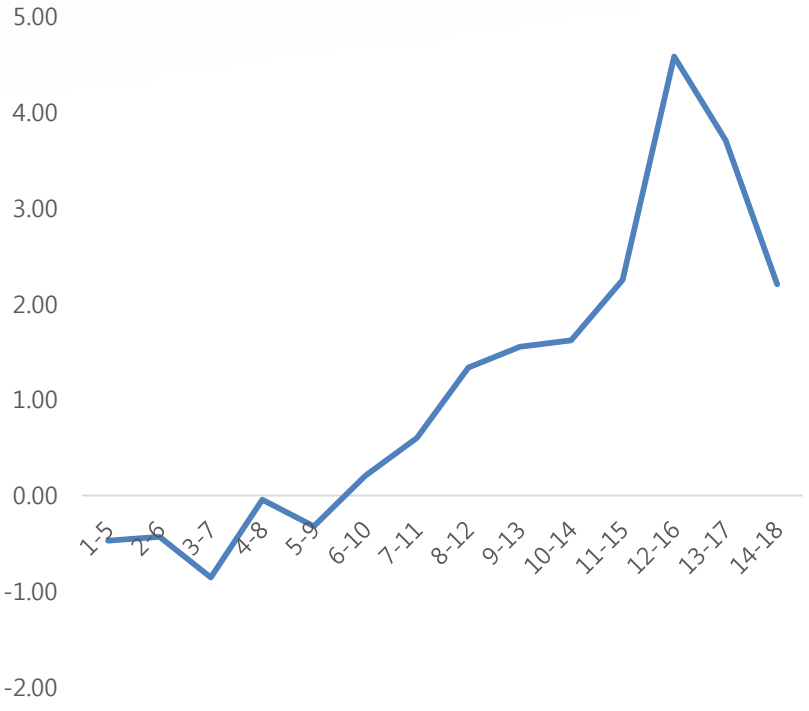
IV. Research Results – Insurers

Lotte F&M's *Y (= a- b)* tend to increase over the years but *Y(= a – b)* deceases from the period 12-16.

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$

Lotte F&M Insurance

Time Period	Retained Premium		(lm2/lf2)^2	Loss Ratio variation		lf2/lm2	Y = a-b
	lf2	lm2		lf2	lm2		
	Fire	Marine	a	Fire	Marine	b	
1-5	5,581	6,628	1.41	10.84	5.76	1.88	-0.47
2-6	5,089	5,521	1.18	10.52	6.54	1.61	-0.43
3-7	4,916	5,026	1.05	12.38	6.52	1.90	-0.85
4-8	4,135	5,101	1.52	12.39	7.92	1.56	-0.04
5-9	4,767	5,192	1.19	12.47	8.27	1.51	-0.32
6-10	4,693	4,454	0.90	14.44	20.81	0.69	0.21
7-11	4,354	5,021	1.33	15.17	20.82	0.73	0.60
8-12	4,337	6,136	2.00	16.98	25.54	0.66	1.34
9-13	4,252	5,862	1.90	12.62	36.56	0.35	1.56
10-14	4,172	6,043	2.10	17.95	37.55	0.48	1.62
11-15	3,938	6,633	2.84	15.45	26.36	0.59	2.25
12-16	3,103	7,281	5.51	20.57	22.35	0.92	4.59
13-17	2,559	5,664	4.90	29.07	24.44	1.19	3.71
14-18	3,735	7,270	3.79	27.87	17.60	1.58	2.21



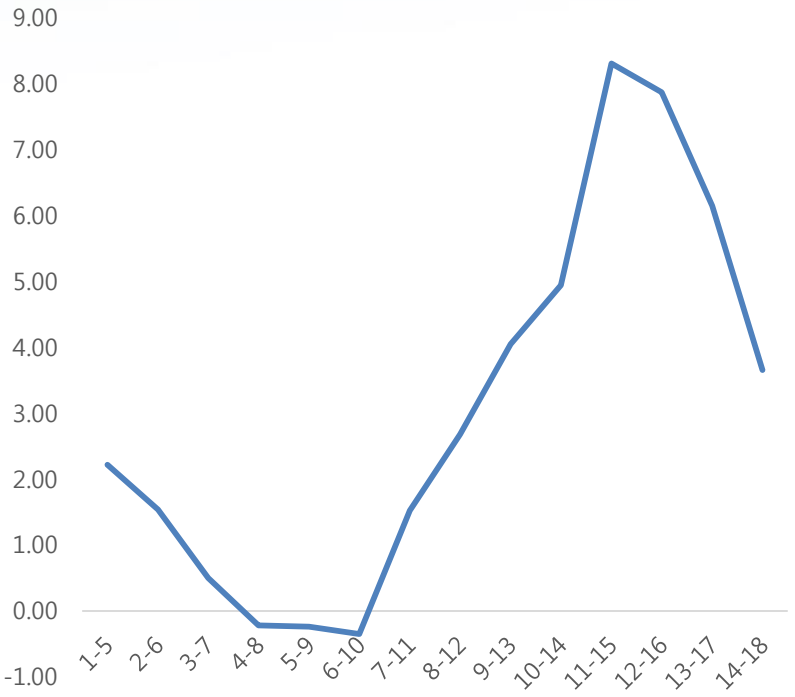
IV. Research Results – Insurers

Hyundai Marine seems to demonstarate a interest in efficient reinsurance strategy in later years because Y(=a-b) decreases from the period 12~16.

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$

Hyundai Insurance

Time Period	Retained Premium		(hm2/hf2)^2	Loss Ratio variation		hf2/hm2	Y = a-b
	hf2	hm2		hf2	hm2		
	Fire	Marine	a	Fire	Marine	b	
1-5	15,165	25,044	2.73	3.87	7.60	0.51	2.22
2-6	15,733	22,745	2.09	4.04	7.31	0.55	1.54
3-7	16,742	16,045	0.92	7.37	17.48	0.42	0.50
4-8	14,544	16,555	1.30	23.72	15.66	1.51	-0.22
5-9	16,707	16,516	0.98	21.63	17.79	1.22	-0.24
6-10	16,907	16,911	1.00	23.20	17.18	1.35	-0.35
7-11	16,506	28,061	2.89	24.74	18.07	1.37	1.52
8-12	14,245	34,192	5.76	27.76	9.00	3.08	2.68
9-13	12,884	27,844	4.67	12.81	20.48	0.63	4.04
10-14	13,206	30,322	5.27	6.49	19.54	0.33	4.94
11-15	14,273	42,727	8.96	13.09	19.79	0.66	8.30
12-16	15,744	46,220	8.62	16.82	22.27	0.76	7.86
13-17	12,510	32,629	6.80	15.75	23.90	0.66	6.14
14-18	19,005	40,309	4.50	9.68	11.43	0.85	3.65



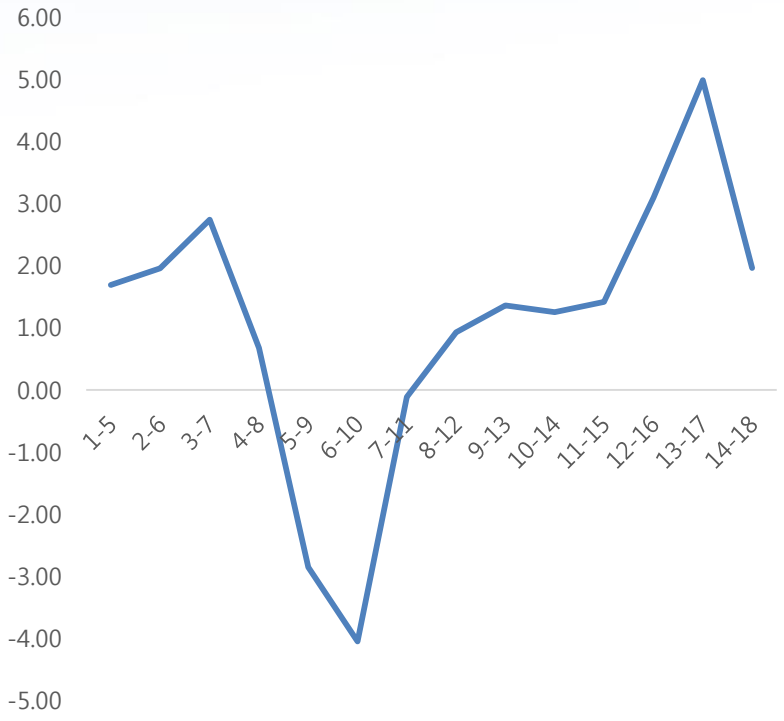
IV. Research Results – Insurers

KB F&M also had huge loss at Marine business in 2008~ 2009, which results in sharp decrease of the loss ratio variation time period 8~12.

$$Y = \frac{\sigma_1}{\sigma_2} - \frac{B'^2}{A'^2}$$

KB Insurance

Time Period	Retained Premium		(km2/kf2)^2	Loss Ratio variation		kf2/km2	Y = a-b
	kf2	km2		kf2	km2		
	Fire	Marine	a	Fire	Marine	b	
1-5	12,350	22,413	3.29	15.29	9.53	1.60	1.69
2-6	11,684	24,819	4.51	21.05	8.25	2.55	1.96
3-7	11,594	27,660	5.69	23.11	7.83	2.95	2.74
4-8	19,285	36,002	3.49	21.44	7.62	2.81	0.67
5-9	33,512	30,227	0.81	23.42	6.38	3.67	-2.86
6-10	30,782	31,047	1.02	24.88	4.90	5.07	-4.06
7-11	25,476	24,335	0.91	15.12	14.70	1.03	-0.12
8-12	20,415	23,922	1.37	14.58	32.56	0.45	0.93
9-13	17,507	21,984	1.58	7.95	36.46	0.22	1.36
10-14	17,162	23,475	1.87	21.69	35.11	0.62	1.25
11-15	18,419	24,838	1.82	20.37	51.03	0.40	1.42
12-16	16,050	29,760	3.44	17.55	51.91	0.34	3.10
13-17	8,470	19,940	5.54	17.67	32.11	0.55	4.99
14-18	11,091	17,603	2.52	19.55	35.24	0.55	1.96



IV. Research Results

As previous analysis results shows that moving patterns of Y (equation 5) for insurers differ and that the values Y does not converge to zero.

Therefore we try to answer following two questions in order to examine if the insurer's reinsurance practice reduce total risks of the company.

Question 1: Whether $Y\ (= a\text{-}b)$ moves within a certain range?

Question 2 : Do Insurers try to get Y closer to zero once the value y moves away from from zero?

IV. Research Results – Question 1

Question 1: Whether *Y (= a-b)* moves within a certain range?

Answer : We find the answer by calculating RSS (Residual Sum of Squares) of *Y*.

	Meritz	Samsung	Dongbu	Lotte	Hyundai	KB
RSS(SSR)	10.2	295.7	4.7	35.0	110.2	67.8
rank_RSS	2	6	1	3	5	4

The RSS result indicates that Dongbu Fire is the smallest (considered the most stable) and Meritz Fire is the second. Samsung F & M seems to be the most volatile. This fact may indicate Dongbu pays more attention total risk of the company with respect to reinsurance strategy or practice. However we need more concrete evidence to support this.

* The RSS is the sum of the squares of residuals. It is a measure of the difference between the data and an estimation. A small RSS indicates a tight fit of the model to the data. Hence a small RSS in our research shows company's effort to make *Y (=a-b)* zero.

IV. Research Results – Question 2

Question 2 : Do Insurers try to get Y closer to zero once the value y moves away from from zero?

Answer :
Sometimes loss ratios increase because of unexpected events. It is useful to check the number of years in which the Y value of an year falling below the Y value of the previous year.

From this point of view, we have a following result;

	Meritz	Samsung	Dongbu	Lotte	Hyundai	KB
Number of falling	8	5	6	6	7	5

Meritz Fire has 8 times of fallings, the highest number.

Samsung F&M and KB Insurance have 5 times of fallings, the lowest number.

These numbers show that Meritz tried to reduce the Y value through a reinsurance strategy if the Y value is high while Samsung and KB did not try that much to reduce the Y value.

V. Discussion

We have following findings.

Samsung F&M appears doing well in risk management with reinsurance because the loss ratios of fire and marine converges to each other (page 13).

- But the *Y* value of equation (5) shows a different story. That is, The calculation of relation between standard variations and retained premiums shows a reverse result. Furthermore RSS shows that Samsung F&M seems uninterested in total risk management with reinsurance.

On the other hand, Dongbu and Meritz are doing well in risk management with reinsurance although they had a huge loss at marine business.

- They seemed to try to maintain the value *Y* within the small range.

Limitation and Further Research

This paper only provide a limited explanation for total risk management strategy with reinsurance. In this regard further investigation are warranted. We have to find out total risk management strategy and reinsurance practices of the insurers. We may need to more data and inputs from industry practitioners.

<end>

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Thank you

Dziękuję