Analysis of Multi-National Underwriting Cycles in Property-Liability Insurance

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Abstract

We use the loss ratio series of Switzerland, Germany, USA, and Japan, and test for possible structural changes. The results show that all four countries have breaks in different years. This result leads to the hypothesis that the factors affecting underwriting cycles are country-specific factors, such as economic environment and regulations, instead of global/international effects. Although financial theory and insurance pricing theory suggest that the loss ratio series should be cointegrated with the interest rate series, the empirical results do not support the theories at all time.

Keywords: Underwriting cycles, property-liability insurance, structural changes

JEL codes: C5, D4, G2, L1

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Introduction

Insurance industry is drawing attention again. The terrorist attacks of September 11 last year showed once more, how difficult it must be for insurers to calculate expected loss payments to determine the premiums needed not to incur company losses. Following the attacks, premiums have gone up 20 to 30 percent for the fourth quarter of 2001 (Insurance Information Institute, 2001, Council of Insurance Agents and Brokers, 2001). This event pushed the insurance market further into the "hard market" after many years in the "soft market". In a hard market, premiums for insurance go up, insurers limit their policy renewals, new policies are difficult to get, and available policies have higher deductible and lower policy limit. In other words, the affordability and availability of insurance become an issue for consumers. The soft market is the opposite of the hard market. Consumers may benefit from the soft market, but insolvency of insurance companies creates externalities, which becomes a society problem. Like business cycles, underwriting cycles have been studied by regulators, consumers, and insurers in order to predict future underwriting results and decrease fluctuations of underwriting results.

A wide range of studies about underwriting cycles is based on several different theories. Venezian (1985) shows that underwriting results followed an AR(2) process due to the rate-making procedures adopted by insurers. Cummins and Outreville (C&O, 1987) show that data reporting, accounting, and regulatory lags (delay) cause the second order of autoregression even under the assumption that the insurers are rational. They conclude that underwriting cycles exist internationally with cycle lengths of six to eight years. Two later studies, Lamm-Tennant and Weiss (1997), and Chen, Wong, and Lee (1999), followed C&O's method and confirmed the results. Doherty and Kang (1988) use demand and supply to explain underwriting cycles. Gron (1994) and Winter (1988) use the theory of capacity constraints. Niehaus and Terry (1993) were

the first to use VAR analysis for underwriting cycles. Fung, Lai, Patterson, and Witt (1998) test all the existing theories for underwriting cycles by VAR and found that no single theory can explain underwriting cycles completely. Leng (2000) used longer data period and more recent data and found that combined ratio of P/L insurance industry for the United States has a break in 1981. Before the break, combined ratio was stationary and followed an AR(2) process. After the break, combined ratio is not stationary but behaves as the financial theory predicted for a competitive market. International data have not previously been analyzed in this way. Meier (2001) also suggests there is a break in 1981 in the US data. By using more recent data, she showed that underwriting cycles for four countries have either longer cycle lengths than those from C&O, 1987, or no cycles at all anymore.

Underwriting results from four countries, Switzerland, Germany, USA, and Japan, are studied in this paper. C&O, 1987 brought underwriting cycles to an international level. However, some questions that arose from studies using more recent data, such as the changes of the coefficients and explaining power of the AR(2) process, and the cycle lengths, need to be answered. If all of these four countries have underwriting cycles as C&O 1987 indicated, is there any change in the cycles after C&O's study? Does each country have its own distinct pattern? Or, are the phase and oscillation of the underwriting cycle for one country similar to those of other countries? Meier (2001) shows that AR(2) processes do not have the same explaining power as C&O had since the adjusted R^2s are lower, the coefficients of the second lag are not significant in four countries, and the cycle lengths are much longer. The possible causes of these changes should be studied further. Therefore, additional tests are imposed to check for possible breaks. A break implies the potential for changes in the nature of "the cycle". We

should explore whether international data have breaks, and if there are breaks, how the fluctuations of underwriting profit behave before and after the breaks.

The remainder of the paper is arranged as follows. In the next section, some background information about these four countries' property-liability insurance industry is given. Following that is the data section with data sources, characteristics of the loss ratio series for each country, and a comparison of the loss ratio series among the four countries. Then follows a hypotheses section for the testing procedures for each hypothesis. The results section shows test results for our hypotheses. In the discussion section, we mention the possible explanations for the results. In the further analysis section, results from extended tests for issues addressed in discussion section are reported. The paper closes with the conclusions.

Background Information

1. Switzerland:

1.1 Organizational Form/Ownership Structure

Most insurance companies in Switzerland are stock companies.

1.2 Distribution System

In Switzerland, insurance is usually sold directly by the insurance companies. However, there also exist independent agents who handle their customers' insurance portfolios. In recent years, some collaboration between insurance companies and banks emerged. There is a growing market for independent agents and there are several independent evaluators of insurance policies.

1.3 Entry-Exit Barriers and Competitiveness in the Industry

The Swiss insurance market is quite regulated. The profit margin is limited and there are also strict rules on solvency requirements. In recent years, there were several take-overs and the

market got more concentrated.

2. Germany:

The German insurance market is organized very similar to the Swiss one. However, the German market also follows regulations imposed by the European Union.

2.1 Organizational Form/Ownership Structure

The main ownership structure of German insurance companies is stock ownership.

2.2 Distribution System

The distribution system is similar as in Switzerland: most insurance policies are sold directly by the insurance companies. However, there also exist agents who sell insurance policies for different companies, especially if the single companies do not offer all lines of business that a customer needs.

2.3 Entry-Exit Barriers and Competitiveness in the Industry

Due to the regulation on the profit margin, it is quite hard for new companies to enter the market. Also, the market is getting more and more concentrated.

3. *United States*

3.1 Organizational Form/Ownership Structure

There are four kinds of ownership structures for insurance companies in the United States. They are stocks, mutuals, reciprocals, and Lloyds. The two most common ownership forms are: one is stocks, which is the standard form, and the other is mutuals, which are like cooperatives. Mayers and Smith (1988) have performed a detailed analysis to show that even though stock insurers face the separation of managerial, ownership/risk bearing, and customer/policyholder functions, they specialize in each function and lower costs. This result can be seen from the wide range of lines and low geographical concentration in stock insurers'

business. On the other hand, mutual insurers combined three functions to eliminate the agency problem. But, they have to compensate the cost of management by writing standard business, which requires less management discretion.

In recent years, some major mutual life insurers demutualized. In property-liability insurance, this tendency is not seen.

3.2 Distribution System

There are three distribution channels: brokerage, independent/American agency system, and direct writing system.[1] Among these systems, the independent agency and the direct writing system are dominant in the market. The independent agency system allows the agents sell insurance policies from different insurers and the agency owns the client lists. The direct writing system only allows the agents sell insurance from a single insurance company. Historically, the independent agency system and brokers were the dominant sales systems. After World War II, direct writers started gaining market shares by selling policies with lower rates, especially in personal lines of business. Since the independent agency system is more costly, it has been seen as less efficient (Joskow, 1973, Cummins and VanDerhei, 1979). But the fact that the independent agency system continues to exist shows that effects other than a low price, such as service and quality, are important to consumers as well.

3.3 Entry-Exit Barriers and Competitiveness in the Industry

The insurance market has long been seen as a competitive one with a large number of companies and low concentration. Since the capital requirement is moderate, entry barriers have been considered as not very high. However, the distribution system may play a role as an entry barrier. The entry barrier is low when a new entrant chooses the distribution system through the

[1] Sometimes, the direct writing system is listed separately as exclusive agency and direct sale system.

American Agency System. If a new insurer wants to get into the insurance market through the direct writing system, it has to pay a large amount of advertisement in order to make consumers aware of its existence, which becomes an entry barrier.

4. Japan

4.1 Organizational Form/Ownership Structure

There are four kinds of insurance companies in Japan. They are the horizontal (financial) keiretsu system, the vertical keiretsu system, independent companies, and foreign companies. Financial keiretsu and vertical keiretsu systems dominate this industry. A financial keiretsu has a commercial bank, a trust bank, a life insurance company, and a non-life insurance company. A vertical keiretsu is usually related to a large industrial company, e.g. Toyota or Hitachi. The relationship is a long-term one between contractor and subcontractors. Usually, a keiretsu insurer insures its own keiretsu members.

4.2 Distribution System

The Japanese non-life insurance distribution systems are direct sale and the independent agency system. The brokerage system just started when the New Insurance Business Law was effectuated in 1996. In Japan, selling insurance is labor intensive because insurers hire many part time sales people to sell their products. The independent agents represent almost all insurers but, unlike the independent agents in the United States, the agents do not own their client list. Generally speaking, the commission is comparably higher in Japan than in the U.S. Combining high commissions with labor-intensive selling technique, Japanese non-life insurers operate with high underwriting expenses. In order to account for their high expense ratio, as we point out later, Japanese insurers operate with the lowest loss ratio among the four countries in our study.

4.3 Entry-Exit Barriers and Competitiveness in the Industry

The total number of non-life insurance companies in Japan was only 54 in 1995. The top four companies, which are all financial keiretsu, have about half of the market share. Therefore, the Japanese non-life insurance market can be classified as an oligopoly. Due to regulations, all insurers follow a price schedule and sell standard policies, which are highly controlled by the government. There was no price competition until the New Insurance Business Law in 1996. This cartel price system puts insurers in a very stable underwriting operation environment.[2] Due to the lack of product differentiation and price competition, Japanese insurers compete by recruiting and maintaining more sales people and by offering more service, which increases underwriting expenses.

Data

For insurance data we use direct premiums written, incurred losses, and internal capital[3] from the Bundesamt für Privatversicherungen for Switzerland and from Swiss Re for the other countries. As macroeconomic data, we use GDP, CPI, and interest rate from the International Financial Statistics Yearbook, OECD, and from the Bank of International Settlement. GDP is local currency without inflation adjusted. The base year of CPI is 1995. Interest rate is Government bond Yield, which is a long-term interest rate for either 10 or 20 years. The data period for premium written and incurred losses for Switzerland and the US is from 1955 to 1997, for Germany from 1955 to 1991[4], and for Japan from 1968 to 1997. For internal capital, the data

[2] This explains why only one insurance company went insolvent since World War II. The company gone bankrupt is Nissan Life in 1997.

[3] Internal capital = paid-in internal capital + reserve allocation + balance carried forward to the next financial year.

[4] Due to the German reunification in 1989, data for former West Germany is available up to 1991 only.

period are 1974 to 1997, 1975 to 1987, 1967 to 1997, and 1974 to 1989 for Switzerland, Germany, the US, and Japan, respectively.

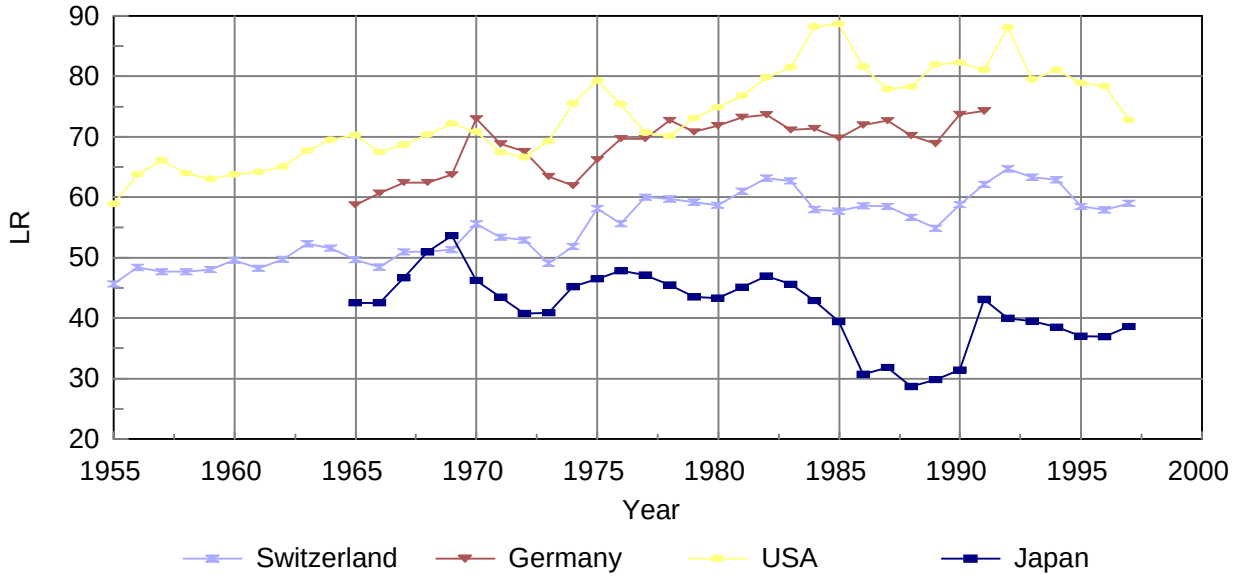
Figure 1 shows the loss ratios[5] of the four countries. We can see the cyclical patterns and the level of the loss ratio series from this figure: Switzerland and Germany exhibit very similar cyclical patterns. However, the loss ratio of Germany is about 8 to 10 percentage points higher than that of Switzerland. The patterns for the loss ratio series of USA and Japan are very different from each other, as well as from those of the two European countries. Table 1 shows the correlation coefficients of the loss ratios among the four countries. Germany and Switzerland are highly correlated and both of them are correlated with US. Japan, however, is negatively correlated with the other three countries. This implies that the underwriting results for Japanese insurers move into other directions than the ones for the other three countries. This result confirms that international operation has a diversification effect to lower the fluctuation of the underwriting results.

Table 1. Correlation Coefficients of Loss Ratios among Four Countries

	CHLR	DLR	JPLR	USLR
CHLR	1	0.8905	-0.1934	0.6391
DLR		1	-0.3150	0.5646
JPLR			1	-0.4059
USLR				1

[5] Some ratios often used in the insurance literature need to be mentioned. (1) Pure loss ratio is the ratio of incurred losses to premiums earned. (2) Loss ratio (LR) is the ratio of incurred losses plus loss adjustment expenses to premiums earned. (3) Combined ratio (CR) is loss ratio plus expense ratio (ER). Expense ratio is the ratio of underwriting expenses to premiums written. Combined ratio is often used to show insurers' underwriting results. If CR > 100%, insurers suffer underwriting losses and vice versa. Due to the data limitation, the variable we use in this paper is the ratio of incurred losses to premium written. We call it loss ratio throughout the paper.

Figure 1. The Comparison of Loss Ratios from Four Countries



Two situations may cause high correlation of loss ratio series among different countries. The first situation is that the insurance markets in these countries are closely tied. The second situation is that their economies are closely tied. The first situation can be seen after the September 11th attack. US insurers suffer huge losses, but a large portion of the losses is covered by reinsurance. Most reinsurers are European companies. Therefore, we expect to see that the loss ratio series between European countries and the U.S. are highly correlated.[6] An example for the second situation is an economic tie between Switzerland and Germany. When one decides to change economic policies, such as increasing interest rate, the other is likely to follow. This dynamic movement between the two countries can be seen from the correlation of macroeconomic variables, such as interest rate, GDP, and CPI.

Table 2 shows the correlation coefficients of interest rates among the four countries. Germany and Switzerland again have the highest correlation coefficient, and Switzerland and the

[6] However, the other side of argument can be made as well. For example, there was a liability crisis in the US in 1984 to 1985, but the loss ratios of Germany and Switzerland did not have a peak.

U.S. have the lowest one. This shows that economies of European countries have closer ties with each other than with either that of the US or Japan.

Table 2. Correlation Coefficients of Interest Rates among Four Countries

	CHI	DI	JPI	USI
CHI	1	0.7877	0.5555	0.1174
DI		1	0.7485	0.4855
JPI			1	0.4828
USI				1

Further analysis is needed to find out whether insurance market tie or economy tie cause highly correlated underwriting results between two countries.

What concerns the level of the loss ratio, the U.S. has the highest loss ratio and Japan has the lowest one. However, this doesn't imply that insurers in the U.S. have the lowest operating profit since we don't have the data for underwriting expenses and investment income, which are very different among the countries due to regulatory and economic environments.[7]

Hypotheses

Hypothesis One: The loss ratio follows an AR(2) process

Venezian (1985) and C&O (1987) show that underwriting losses/profits follow a second order autoregressive model.[8] We would like to see whether this is still true by using more recent data. If this hypothesis is true, that is, if the AR(2) process for the loss ratio has significant

[7] In 1995, combined ratios for Switzerland, Germany, United States, and Japan are 1.07, 0.99, 1.07, 0.96, respectively. In the same year, expense ratios for these countries are 0.34, 0.27, 0.30, and 0.46. As we mentioned earlier, the Japanese distribution system causes higher underwriting expenses.

[8] C&O, 1987, include a time trend in AR(2) process to adjust the downward trend of underwriting expenses.

coefficients and high a R^2, then we find cycle lengths and compare them with previous studies. If this hypothesis is not true, we go on to the next hypothesis.

Hypothesis Two: The loss ratio series are stationary.

The autocorrelation function (ACF), partial autocorrelation function (PACF), and Augmented Dickey-Fuller (ADF) test are used to check whether the loss ratio series are stationary. If this hypothesis is true, we should use vector autoregressive (VAR) process and impulse-response function to determine the relationship between the loss ratio and macroeconomic variables. If the loss ratio series are not stationary, we should check whether these series have breaks because a break in a series may cause rejection of stationarity.

Hypothesis Three: The loss ratio series do not have breaks.

Chow test and switching regression are used to test for breaks. If this hypothesis is true, we use the first difference of loss ratio series to run AR(2).[9] If the loss ratio has a break, we look for the year of the break for each country.

Hypothesis Four: Loss ratio and interest rate are cointegrated before and after the break.

From Capital Asset Pricing Model (CAPM, Fairley, 1979, Hill and Modigliani, 1981), insurance policy is treated such as that an insurer borrows a lump sum from its policyholder and returns a certain amount of payment if the insured event happens during the insured time period. In other words, an insurance policy is a debt-like contract. Underwriting return (r_u) should be:

$$r_u = -r_f + \beta_u \left(r_m - r_f \right) \qquad (1)$$

where r_f is the risk free rate, and $\left(r_m - r_f \right)$ is the market risk premium.

[9] We should take the first difference of LR when it is a difference-stationary (DS) process. LR series is not a trend-stationary (TS) process because LR cannot go up or down unlimited. Nelson and Plosser (1982), and Stock and Watson (1988) discuss these two processes in detail.

The assumptions for Equation (1) are that the tax rate is zero and insurers invest the entire premiums earned for a year.[10] The relationship between underwriting return and loss ratio is:

$$r_u = \frac{1}{P}(P - L - E) = 1 - LR - ER \Rightarrow LR = r_f + 1 - \beta_u (r_m - r_f) - ER$$

where P is premium, L is losses, E is expenses, LR is loss ratio, and ER is expense ratio.

If $\beta_u (r_m - r_f)$ and ER are constant, Equation (1) is:

$$LR = r_f + c \Rightarrow LR - r_f - c = 0 \qquad (2)$$

where *c* is a constant. Equation (2) shows that the loss ratio and the risk free interest rate are cointegrated and positive correlated with cointegrating coefficient –1.

From insurance pricing theory (Doherty and Kang, 1988, Haley, 1993), the price of insurance should reflect the investment income by discounting expected losses because insurers invest premium from the time the premium is received to the time the loss is paid. Taking *i* as the rate of return on investment, we get the following:

$$P_t = \frac{E(L_t)}{(1+i)} \Rightarrow \frac{E(L_t)}{P_t} = LR = (1+i) \Rightarrow LR - i - 1 = 0$$

The result from the insurance pricing theory is consistent with the one from CAPM. Therefore, from a theoretical point of view, the loss ratio series should be cointegrated with the interest rate. If a break in the loss ratio series is caused by a break in the interest rate series, two series should be cointegrated regardless of the timing of the break. Otherwise, financial theory and insurance pricing theory cannot explain the fluctuation of the underwriting results.

[10] The assumptions are set due to the data limitations. Usually, taxes on premium and underwriting profit are not zero. Also, insurers do not invest all their premium for liquidity purpose and insurers do not invest their premium for one year. Especially, insurers for long tail lines would invest longer than a year. Biger and Kahane, 1978, developed a fund-generating coefficient to measure the proportion of premium invested and how long insurers invest the fund. Kahane, 1978, and Leng, 2001 show that it is not equal to 1.

Results

1. AR(2) Process with and without a Time Trend

Tables 3 and 4 are the results of AR(2) processes for the loss ratio series with and without a time trend. The coefficients of the second lag for AR(2) are not significant at the 5 percent level with or without time trend for all countries.

Table 3. Loss Ratio Following an AR(2) Process Without Time Trend

	C		AR(1)		AR(2)		Adj. R^2	F
	Coef	t	Coef	t	Coef	t		
Switzerland	57.4168	17.4238	0.8819	5.4372	-0.0050	-0.0322	0.7861	74.4986
Germany	70.5213	45.1453	0.7581	4.0438	-0.0716	-0.4210	0.5436	18.8645
USA	75.1603	19.7725	0.9780	5.9147	-0.1180	-0.7461	0.7825	72.9573
Japan	41.3424	14.5318	1.0443	5.7243	-0.2686	-1.4580	0.6784	32.6405

** is for 1 percent significant level, and * for 5 percent significant level.

Table 4. Loss Ratio Following an AR(2) Process With Time Trend

	C		AR(1)		AR(2)		T		Adj. R^2
	Coef	t	Coef	t	Coef	t	Coef	t	
Switzerland	47.6111	29.8029	0.7463	4.6598	-0.2177	-1.2993	0.3588	5.6851	0.8138
Germany	65.9844	29.7951	0.6948	3.6755	-0.2016	-1.0642	0.2351	2.0732	0.5607
USA	63.8226	24.8090	0.8598	5.0761	-0.2912	-1.6693	0.4574	4.3960	0.7989
Japan	49.5896	15.9702	0.9181	5.0706	-0.3457	-1.9558	-0.4592	-2.9314	0.7159

** is for 1 percent significant level , and * for 5 percent significant level .

2. Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF)

Figure 2 shows the ACF and PACF for Switzerland.[11] The figure suggests that this series is not stationary since the ACF decays slowly and the PACF is significant at one lag only.

3. Augmented Dickey-Fuller (ADF) Test

[11] The ACF and PACF for the other three countries are similar as the ones for Switzerland. They are available on request from the authors.

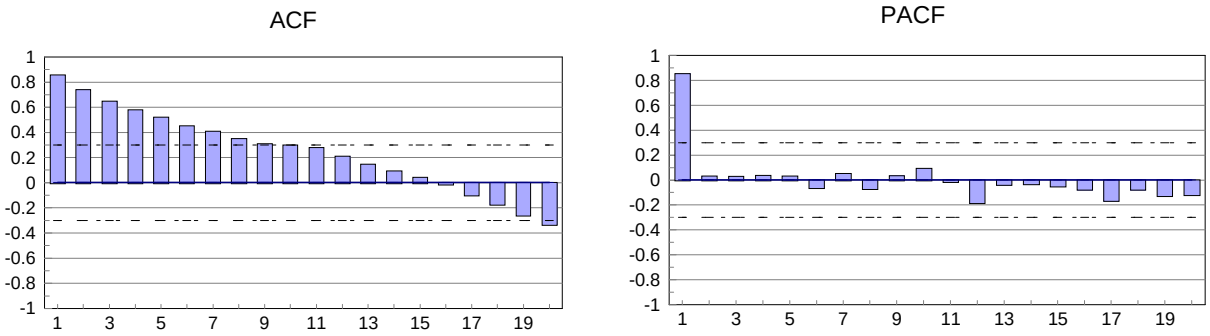
We check whether the loss ratio series have unit roots by applying the ADF test.[12] From Table 5, we conclude to accept the null hypothesis that this series has a unit root. The results of the ADF test are confirmed by the ones from the ACF and PACF.

Table 5. ADF Test for Loss Ratio

	Switzerland	Germany	US	Japan
LR(-1)	-0.1231	-0.3135	-0.1399	-0.2244
t-Statistic	-1.6936	-2.7178	-1.9303	-2.0509

MacKinnon critical value is –2.9339 for 5 percent level.

Figure 2. ACF and PACF of the Loss Ratio for Switzerland



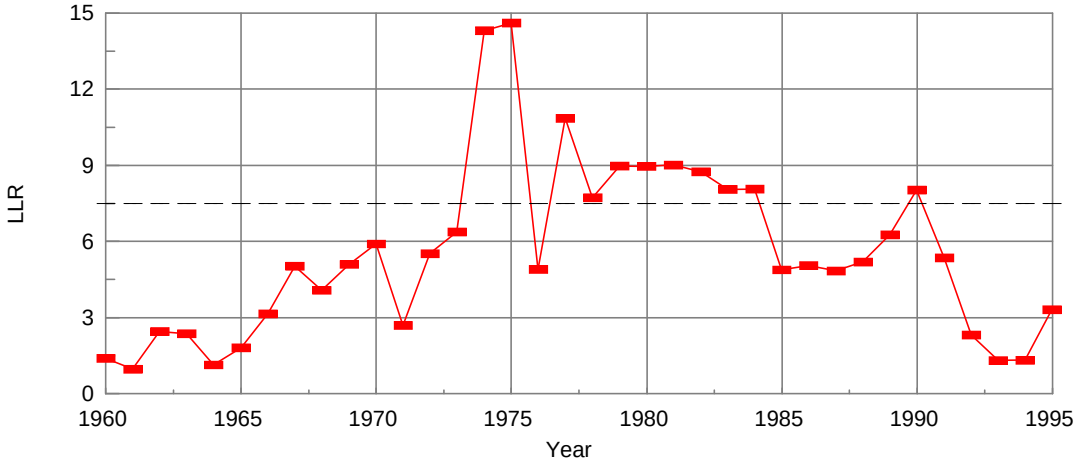
The dashed lines are plus and minus 2 standard deviations.

4. Chow Test and Switching Regression[13]

The methods we use to check for structural changes are the Chow test and Switching Regression. Appendix A shows the steps for the Switching regression. The results are reported as the F-statistic for the Chow Test and the Log Likelihood Ratio (LLR) for the switching regression in Table 6. Figure 3 is the plot of the LLR for Switzerland. It shows that the structural change happened gradually and reached the highest LLR in 1975.

[12] The number of lags for the lagged difference term in the test is determined by the Akaike Information Criterion (AIC) and the Schwarz Bayesian Information Criterion (BIC). In our case, one lag is included.
[13] Judge, Griffiths, Hill, Lütkepohl, and Lee (1985) describe the method of switching regression, which seeks to identify the switching point or year of structural change. Brown, Durbin, and Evans (1975) call this method Quandt's log-likelihood ratio technique because it was originally developed by Quandt (1958).

Figure 3. Log Likelihood Ratios from Switching Regressions for Switzerland



The dashed line is the 5% significant level.

We found that Germany also has a break in 1975, US has a break in 1986, and Japan has a break in 1985. From Figure 1, the loss ratio of Switzerland was consistently lower than 55 percent before 1975 but higher than 55 percent after 1975. For Germany, its loss ratio is volatile in the first sub-period and lower than 70 percent, but it is above 70 percent in the second sub-period. The Japanese loss ratio is above 40 percent in the first period but lower than that in the second period. Using combined ratio, Leng(2000) found a break for the US in 1981. Obviously, the years of breaks are different for the combined ratio and for the loss ratio in the US because the expense ratio is not constant. However, combined ratio is more suitable for studying structural change rather than the loss ratio to reflect the fluctuation of the underwriting results. Unfortunately, underwriting expenses are only available for the US data. Different variables with different years of break in the US helps us to be aware of the possible bias from the use of the loss ratio as a variable in the analysis for the other countries.

Table 6. The Results from Chow Test and Switching Regression

	Switzerland		Germany		US-LR		Japan	
	F-statistic	LLR	F-statistic	LLR	F-statistic	LLR	F-statistic	LLR
1960	0.4038	1.3951			0.6231	2.1332		
1961	0.2821	0.9796			0.6797	2.3217		
1962	0.7216	2.4607			0.8090	2.7489		
1963	0.6949	2.3721			0.8558	2.9024		
1964	0.3303	1.1445			0.5422	1.8624		
1965	0.5285	1.8164			0.4229	1.4598		
1966	0.9325	3.1527			0.4441	1.5319		
1967	1.5233	5.0315			0.9203	3.1130		
1968	1.2206	4.0797			0.7644	2.6020		
1969	1.5448	5.0983			0.6883	2.3502		
1970	1.8103	5.9140	0.8980	3.1725	0.6129	2.0994	1.8854	6.3226
1971	0.7954	2.7042	0.3413	1.2444	0.8648	2.9318	2.2699	7.4677
1972	1.6835	5.5266	1.5674	5.3427	1.6044	5.2829	1.8319	6.1601
1973	1.9637	6.3781	0.9241	3.2602	2.2334	7.1813	1.2670	4.3877
1974	4.8762**	14.3180**	1.6857	5.7110	2.0809	6.7292	1.0753	3.7624
1975	4.9980**	14.6187**	2.4210	7.9064**	1.1673	3.9096	1.7553	5.9255
1976	1.4836	4.9079	2.1613	7.1487	1.1934	3.9931	1.6773	5.6851
1977	3.5371*	10.8570*	1.6392	5.5667	1.3329	4.4353	1.9714	6.5826
1978	2.4211	7.7315	1.8212	6.1272	2.5279	8.0411*	2.0570	6.8389
1979	2.8543	8.9730*	0.7425	2.6460	3.0213*	9.4421*	2.0816	6.9123
1980	2.8495	8.9595*	1.0871	3.8011	2.6457	8.3798*	2.0425	6.7957
1981	2.8717	9.0223*	0.8162	2.8967	2.8616	8.9937*	2.1531	7.1243
1982	2.7764	8.7526*	0.5442	1.9612	2.8646	9.0022*	2.7120	8.7341*
1983	2.5352	8.0622*	0.4497	1.6292	2.4170	7.7195	3.7040*	11.4002**
1984	2.5388	8.0724*	0.5006	1.8084	2.3232	7.4455	4.0146*	12.1900**
1985	1.4785	4.8921	0.4943	1.7863	2.6860	8.4953*	4.1556*	12.5420**
1986	1.5292	5.0500	0.6721	2.4045	4.0817*	12.3001**	3.6948*	11.3766**
1987	1.4654	4.8511	0.5330	1.9220	2.5980	8.2430*	1.9464	6.5073
1988	1.5789	5.2040	0.4573	1.6560	3.0800*	9.6055*	1.9169	6.4183
1989	1.9268	6.2669			2.8740*	9.0287*	1.2504	4.3339
1990	2.5233	8.0277*			2.7712	8.7379*	2.0069	6.6891
1991	1.6298	5.3614			3.4398*	10.5939*	4.5257*	13.4473**
1992	0.6806	2.3248			3.4562*	10.6385*	1.8046	6.0766
1993	0.3811	1.3178			4.1916*	12.5851**	0.0717	0.2657
1994	0.3852	1.3317			0.8429	2.8601	0.1478	0.5451
1995	0.9841	3.3203			0.5116	1.7595	0.1109	0.4099

Discussion

The break in the loss ratio for Switzerland and Germany is in 1975, which coincides with a serious recession in these two countries. The pattern of the loss ratio series seems to support the hypothesis that this recession may have caused the structural change. If the recession did cause the break in the insurance industry, the loss ratios should be cointegrated with GDP or/and CPI for the whole period regardless of the time of the break. If the cause of the break is due to the change of regulations or competitiveness in the property-liability insurance industry, the relationship between loss ratio and interest rate should change after the break. This may be the explanation for the break for the US since regulations changed from bureau rating to competitive pricing and competition in the property-liability insurance market forced insurers to reflect investment income into the rate-making process during the end of the 70s to the beginning of the 80s.[14] It is also possible that the liability crisis from 1984 to 1985 effected underwriting standards for insurers. If this is the case, the break should only affect the liability part of business. However, most lines of business include both property and liability parts and they are difficult to separate. Based on the available data, the loss ratio should be cointegrated with the ratio of premium to surplus, which is used to measure the insurers' risk taking behavior. [15]

In Japan, the loss ratio does not behave as the other three countries' loss ratios: its loss ratio goes down after the break. Therefore, the cause of the break in Japan must be different from the ones for the other countries. In 1980, savings-type insurance policies started to become popular in the Japanese non-life insurance market. From 1985 to 1994, it reached a share of

[14] Self-insurance and captives are the alternatives for insurance. Insurers use price competition and reflect investment income into premium to decrease consumers switching to alternative methods. However, self-insurance and captives gain their popularity when the insurance market becomes a hard market.

[15] The premium to surplus ratio is one of the tests used in the Insurance Regulatory Information System (IRIS) to predict insurers' financial strength to prevent insolvency. If an insurer has a premium to surplus ratio of more than 3, which is considered that the insurer is engaged in a high risk underwriting practice, the insurer fails this test.

about 30 to 45 percent of the non-life insurance premium. The premium for savings-type insurance contains risk premium and savings, which accounts for more than 90 percent of the premium. If no covered incident occurred during the policy period, insurers refund the savings portion of the premium and guarantee the payment of interest to the policyholder after the policy matures. If a covered incident occurred, the claims are determined by the policy agreement. Since internal capital includes a savings portion of the premium, internal capital should increase more than the loss ratio when the savings type insurance became popular. Therefore, if the popularity of the savings-type insurance caused the break in Japan, the relationship between loss ratio and internal capital should change. Another thing worth mentioning is that, due to the regulatory requirements, the US insurers invest the majority of assets in bonds which makes the interest rate important to their underwriting results. On the other hand, Japanese insurers invest much more of their assets in stocks, loans, and real estate. Therefore, economy condition should have more effect on insurers' income than the interest rate does.[16]

Further Analysis

In this section, we test for the possible reasons for the cause of the break for each country. For Switzerland, the loss ratio series is not stationary before the break, but stationary after the break. Also, the loss ratio after the break follows an AR(2) process.[17] Interestingly, the interest rate also has a break in 1975. Cointegration analysis shows that loss ratio and interest rate after the break are cointegrated. This implies that the break is most likely caused by regulation changes. The loss ratio is also cointegrated with GDP, but this relationship changed

[16] In 1995, US insurers invested 60.7% of their assets in bonds. Japanese insurers, on the other hand, invest only 18% of their assets in bonds.

[17] $LR = 59.91 + 0.78 * LR(t-1) - 0.43 * LR(t-2)$ with 0.4 R^2, and cycle length is 4.8. All the coefficients are significant and in the theoretical range proposed by C&O, 1987.

with the break. It seems that the condition of the economic recession did have an impact on the insurance industry.

For Germany, the loss ratio is cointegrated with the interest rate only after the break with cointegrating coefficient close to –1, which is what insurance pricing theory suggests.

For the US, the loss ratio is neither cointegrated with interest rate nor with the premium to surplus ratio. This may be caused by the small sample in the second period. However, the loss ratio is cointegrated with internal capital, what supports the capacity theory. Looking at the relationship between premium written and internal capital, we find that internal capital for the second period is twice as high as the one for the first period for the same amount of premium. This seems to be the result of regulatory requirements.

For Japan, the cointegrating relationship between the loss ratio and GDP changed due to the break[18] and the one between loss ratio and interest rate only exists before the break. This is possibly the joint effect of the economic situation and regulations.

Conclusions

Previous studies for underwriting cycles in property-liability insurance show that underwriting profit follows an AR(2) process. Leng (2000) shows that the combined ratio for the United States has a break in 1981. Meier (2001) also suggested a break in 1981 in the US data.

In our paper, we look into the special characteristics of property-liability insurance markets for the four countries, Switzerland, USA, Germany and Japan, and their loss ratio series. We find that the insurance markets of Switzerland and Germany are closely tied, but they are not tied to the US and Japan. Also, Japanese loss ratio series is negatively correlated with the series

[18] Before the break, loss ratio and GDP move into opposite directions, but after the break, two variables move into the same direction.

of the other three countries. This shows that the underwriting cycle in Japan has a different phase than the cycles in the other countries. Therefore, international operation has a diversification effect which can be used to reduce the fluctuation of underwriting results.

The loss ratio series from the four countries are neither stationary nor stable. Testing for possible structural changes, we find that all four countries have breaks, but in different years. For Switzerland and Germany, the break is in 1975. For Japan and the US, the breaks are in 1985 and 1986, respectively. This shows that even though underwriting cycles are an international phenomenon, they are not caused by the same international/global effect. More likely, the structural changes in these countries are caused by the economic environment and regulation in each country.

From financial theory and insurance pricing theory, the loss ratio and the interest rate series should be cointegrated. However, empirically the two series are not cointegrated at the 5 percent level. This is interesting for future research on possible explanations for the contradiction between theory and empirical results.

Appendix A. Switching Regression

The null hypothesis is that there is no structural change at t_0. T_1 is the number of observations before the break, t_0 is the year of a possible structural change, T_2 is the number of observations after the break. $T = T_1 + T_2$. The log-likelihood ratio is given by:

$$\lambda = \frac{1}{2} T_1 \log \sigma_1^2 + \frac{1}{2} T_2 \log \sigma_2^2 - \frac{1}{2} T \log \sigma^2,$$

-28 follows a χ^2 distribution with *k* degrees of freedom, where *k* is the number of parameters. To estimate t_0, we maximize the likelihood function, what can be accomplished by running regressions recursively for every year. The behavior of the series can be seen by plotting the graph of the LLR against successive years. This graph not only shows the stability of the regression, but also whether structural changes have occurred gradually or abruptly.

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