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UNDERWRITING CYCLES IN EUROPEAN NON-LIFE INSURANCE COMPANIES

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I declare that I have compiled the paper independently
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ABSTRACT

Due to lack of consensus on the topic, this study the second-order autoregressive process in non-life insurance sector loss ratios. In addition, underwriting cycle lengths and correlation relationships are investigated. The aim of this research is to investigate out whether the loss ratio time series follow the second-order autoregressive process in European countries' insurance companies, as well as to examine the lengths of the underwriting cycles. In addition, the objective is to examine how European loss ratios are correlated with each other as well as with non-European countries' loss ratios.

The results show that in general the loss ratios do not follow the second-order autoregressive process. However, in some countries the ratios follow the process and the cycle length calculated is approximately similar to what previous studies have suggested.

Correlation coefficient analysis suggests that European countries' loss ratios are positively correlated with each other. In addition, they are in general also positively correlated with the ones of Australia, Japan, and the United States.

Keywords: Underwriting cycle, loss ratio, non-life insurance, autoregression, correlation coefficient

INTRODUCTION

Premiums written in non-life insurance market have historically followed a cyclical trend. The traditional explanation for this has been that after a few years of higher premiums and lower loss ratios, premiums have started to fall and insurance companies to record higher loss ratios. After gaining reserves with collecting higher premiums, companies start to push on for higher market share with lowering their insurance policy prices and thus loosening their underwriting standards and adapting more risky and aggressive market strategy. This type of insurance market is call a "soft market". Later, having reported increasing loss ratios and falling premiums they tighten their underwriting standards and premiums begin to rise. The market is said to have been entered to a "hard market" phase. In addition to increasing premiums, during hard market phase insurers reduce their policy renewals, new policies are hard to obtain, and offered policies have higher deductibles and lower policy limits. This trend, underwriting cycle, has been studied by regulators, scholars, and insurers to be able to forecast future underwriting results and to reduce instabilities in underwriting outcomes.

Like in any economic and financial market cycle, the length of underwriting cycles is not constant. However, many researchers have recorded a cycle with a period of around six years in the profits of the property-liability insurance sector (Berger, 1988), (Cummins & Outreville, 1987), (Simmons & Cross, 1986), (Venezian E. C., 1985). However, more recent studies suggest that the cycle length is longer (Meier, Underwriting Cycles in Property-Liability Insurance: Do they (still) exist?, 2001), (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003), (Meier & Outreville, (Why) is there an Insurance Cycle in the USA?, 2004). Although underwriting cycles do not usually follow any general financial market cycle, insurance companies, and thus underwriting cycles, are affected by financial market situation as well as micro and macroeconomic determinants.

Numerous hypotheses have been presented to explain the underwriting cycle. Theories suggest that variations in underwriting results arise from reporting, accounting, and regulatory lags (Cummins & Outreville, 1987), fluctuations in demand in supply (Doherty & Kang, 1988), (Berger, 1988), pricing

methods implemented by insurance companies (Venezian E. C., 1985), interest rates (Wilson, 1981), (Doherty & Kang, 1988), (Fields & Venezian, 1989) and capacity constraints (Gron, 1994), (Winter, 1988).

Nevertheless, there appears not to be consensus on formation of underwriting cycles. A study done by Venezian showed that the loss ratios followed a second-order autoregressive process in the United States (Venezian E. C., 1985). Later, Cummins and Outreville confirmed this result on international scale (Cummins & Outreville, 1987). They argued that the regulatory and institutional factors cause delays in insurers' decision-making, thus making it impossible to apply the best information available to the ratemaking process. Their results were later confirmed by other studies (Lamm-Tennant & Weiss, 1997), (Chen;Wong;& Lee, 1999). However, some of the more recent studies have showed that the second-order autoregressive process is not significant in loss ratio time series (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003), (Leng & Meier, 2006). Yet, this has not been studied exclusively in Europe with European Union's common regulative practices. As there has also been evidence that the cycle length is extending, but the evidence is relatively scare and not in consensus, research on this matter with more recent data could bring additional evidence on the existence of underwriting cycles.

Furthermore, the correlation relationships of European countries loss ratios could as well provide new information on the connection between these countries economies. The author argues that as the economies of most European countries are in relatively close economic relationship it is expected that also the insurance sectors and thus loss ratios are linked together at some level. In addition, correlation between European countries and major non-European countries should also be reviewed. Some of the previous research has suggested that there is negative correlation in loss ratios between countries that have a very close economic relationship, which does not support previously mentioned argument (Leng & Meier, 2006).

Hence, the aim of this research is to investigate out whether the loss ratio time series follow the second-order autoregressive process in European countries' insurance companies, as well as to examine the lengths of the underwriting cycles. In addition, the objective is to examine how European loss ratios are correlated with each other as well as with non-European countries' loss ratios.

In order to fulfill the aim of the study, following hypotheses are tested in this research:

Hypothesis 1) Loss ratio time series follow second-order autoregressive process in European countries.

Hypothesis 2) If first hypothesis is true, underwriting cycle lengths are relatively close to each other in Europe.

Hypothesis 3) Loss ratio time series are correlated between Europe and the United States.

The structure of this paper is following: In the first part previous research on the topic is reviewed and discussed. The second part explains the research design and data used in this study. In the third consists of the results of the research as well as discussion and comparison of them in relation to other studies on the topic. Lastly, the final part summarizes the paper and its findings and suggests some future research topics.

1. THEORETICAL PART

1.1. Literature review

1.1.1. Surplus and underwriting cycles

Berger created a model of underwriting cycle in the property-liability insurance industry depending on the assumption that the cycle is related to profitability (Berger, 1988). The general description for the existence for the underwriting cycle is that profits increase surplus (capacity), leading to aggressive marketing (and more risky underwriting standards) and declining profitability, which in turn results in decline in surplus followed by increased profitability. The main element of this theory is that increasing profits support surplus, causing a balancing shift in supply as a result of a change in the required risk premium.

Even though various hypotheses had been presented to explain the reasons behind underwriting cycle, this study aimed to give an explanation for it based on the fact that underwriting cycles have a long history, and thus they should be studied as a part of very basic economic fundamentals of the insurance industry. Hence, the model developed excluded any possible significances of expenses, taxes, investment income, interaction with the capital market, or ratemaking methodology. Instead, the hypothesis of the study was that the changing aspects of the underwriting cycle originate from the fact that profits feed back into surplus with a delay. In the model, companies were assumed to set its underwriting policy for the following year based of end-of-year surplus. The more financially secure the firm is, the more willing it will be to underwrite what would otherwise be considered marginal risks. The profit and loss results of the company's underwriting policy were presumed to go by with a one-year lag.

The model assumed that market supply is a function of previous period surplus, since at any given price companies will be more willing to underwrite marginal risks when surplus is high. A function showing a relationship between market price and quantity, and previous period surplus was created:

$$(P_t, Q_t) = f(S_t - 1) \quad (1)$$

where

P_t – market price,

Q_t – quantity,

S_t – surplus.

It was also assumed that profitability is a function of price and quantity in the previous period:

$$\pi_t = g(P_t - 1, Q_t - 1) = g(f(S_t - 2)) = h(S_t - 2) \quad (2)$$

where

π_t – profits in period t.

After this, Berger presented a maximizing function for firms:

$$\text{Max } J(\pi, \rho) = PQ - C(Q) - \rho(Q, S) \quad (3)$$

where

$\rho(Q,S)$ – increasing function of the probability of ruin.

The function $\rho(Q,S)$ represents the tradeoff which the company faces between the expected profits which may result from increased volume, versus the increased profitability of ruin which may also occur. It is not the probability of ruin, but rather the "dollar equivalent" of it.

This model was created based on the assumption that increased profitability results in surplus, leading to balancing shifts in supply. However, it does not take in consideration expected future profits or losses. It assumes only that insurers will make their supply decisions based on current surplus situation, although future expected profits or losses have impact on future surplus which in turn affect probability of ruin in the future. Nevertheless, Berger argues that taking into consideration the generally conservative nature of insurance company management, and the exceptionally complex and

changeable environment in which they operate, the effect of these expected profits or losses would be minimal at best.

1.1.2. Delays in decision-making processes

Most of the research on underwriting cycles was made on the United States market, and thus Cummins and Outreville tested out the results of previous studies on international scale (Cummins & Outreville, 1987). They argued that if the insurance market equilibrium prices are decided in competitive market and indicate rational expectations, then also the expected future profits and losses and other relevant variables reflected in the market prices should be equivalent to the unbiased expectations, dependent on information available at the time when the prices are determined. Thus, rational expectations would suggest that any type of profit cycle would exist. Rather, institutional and regulatory factors intervening in insurance market create an "apparent" cycle, they argued. These intervening factors include data collection lags, regulatory lags, policy renewal lags, and statuary accounting rules.

Data collection lags are on some level common to every industry. In insurance sector, ratemaking, or determining the prices, is generally based on annual data. Naturally, the delays in reporting and settling claims and delays in organizing and analyzing the data results in ratemaking process not relying on the best or latest information available at the date of ratemaking. Projections about future rates are made based on the last period and mid-point of the period and do not reflect perfect information.

Regulatory lags result from government authorities' rate approving process which is in practice in many countries. Insurance rates must have a regulatory authority's approval before they can be applied. This regulation process usually creates additional delays between the experience period and the effective date of the revised rates. In addition, in competitive system rates may be revised more often.

An insurance policy's term is generally six months or one year, meaning that its rates can be revised only twice or once a year. Unlike commodities' or stock shares' prices, insurance policy rates cannot be changed instantly to reflect new information on market. Hence, for example, if policy terms are annual, rates are revised every year, and new rates go into effect on January 1, the price for the average policy will change about July 1 and the new rates will not be in effect for all policies until December 31.

Financial reporting also plays a major role in creation of underwriting cycles, Cummins and Outreville argue. Most of the data used to demonstrate the existence of underwriting cycles are calendar year data. These data reflect loss estimates on an incurred basis, meaning that losses are matched to issued coverage during the calendar year. In a rational expectations world, loss estimates for any given year would reflect all information available at the end of the year, at the time when the statutory statements are submitted. The premium rates for the years are also established on accrual accounting. The reported premiums are those what were collected by the companies for providing coverage during that year. However, as previously discussed, the ratemaking process already is exposed to delays, and thus these premiums reflect only information available at the time when these policies were issued. Hence, it is very likely that there is a mismatch between the information content of reported premiums and the information content of reported losses.

Thus, Cummins and Outreville argued that the underwriting cycles result from interfering regulatory and institutional factors, and created a simple model of insurance market, built on simplifying assumptions about ratemaking lags and reporting practices:

$$\pi_t = a_0 + a_1\pi_{t-1} + a_2\pi_{t-2} + \omega_t \quad (4)$$

where

π_t – underwriting profit,

ω_t – a random error term.

This model's equation was estimated using data from several industrialized nations from years 1957-1979. The dependent variable in most of the regressions was the ratio of premiums to losses. Profit ratios were not used as exact data was not available for all the countries examined. However, profit ratios are highly correlated with premiums to losses ratios in countries where both data are available, Cummins and Outreville argue. Hence, using premiums to losses ratio as a dependent variable to estimate underwriting cycles was not considered as a severe inadequacy.

The equation was estimated using ordinary least squares method. Estimation showed statistically significant relationships of coefficient of at least one of the lagged profit terms in 12 of 13 countries. The second order lagged profits term was statistically significant and negative in eight countries and was close to significance for one additional country. Hence, the estimation resulted in evidence of cycles existing in majority of countries tested. The cycle length was between six and eight years in six of the countries tested and slightly over eight years for a seventh country.

In this research, Cummins and Outreville applied a hypothesis about insurance prices being determined in competitive market where rational expectations apply, rather than prices being formed due to supply factors as major part of prior studies had suggested at that time. Part of the hypothesis was that regulatory and institutional factors resulted in lags in insurance market making their decision-making processes more inaccurate and thus created underwriting cycles, even though insurers would have rational expectations about the future profits and losses.

1.1.3. Breaks in underwriting cycles

Leng and Meier argued determinants of underwriting cycles being country-specific, rather than internationally common ones (Leng & Meier, 2006). They pointed out that even though some of the research made after Cummins' and Outreville's study (Cummins & Outreville, 1987) had confirmed the results, some of the studies done with more recent data had suggested that underwriting cycles had longer cycle lengths than those of Cummins' and Outreville's study's, or no cycles at all. Meier had also showed in her previous study that the second order auto-regressive process didn't have the same explaining power than it had had in Cummins' Outreville's study, since the adjusted R2 s were lower. In addition, breaks in the nature of cycle were found in the US data. Thus, using data of underwriting results from four countries, USA, Germany, Switzerland, and Japan, the changes of coefficients and explaining power of the second order auto-regressive process, and the cycle lengths and possible breaks in cycles in these countries were studied with more recent data.

The second order autoregressive model was applied for data of sample countries to find out if the coefficients for lags are significant. The dependent variable used was loss ratio. Furthermore, the loss ratio should be cointegrated with the interest rates. According to insurance pricing theory, the prices of insurance should reflect the investment income by discounting expected losses because insurers invest premiums from the time the premium is received to the time the loss is paid, Leng and Meier argued. Hence, the breaks in loss series and breaks in interest rates series were compared. If the timings of these two breaks had not been linked, the insurance pricing theory would not have been explanation for instabilities in underwriting results.

The results of the second order auto-regression for the loss ratio series were that the coefficients of the second lag were not statistically significant for all countries. The breaks in the loss series for Switzerland and Germany coincided with a major recession in these two countries. The pattern of the

loss ratio series supported the hypothesis that the recession may have resulted in some structural changes in the industry, Leng and Meier argued. The insurance markets of Switzerland and Germany were closely tied, but they were not tied to US and Japan markets. In addition, Japan's loss ratio series were negatively correlated with the loss ratio series of the other three countries. Hence, the underwriting cycle in Japan has a different phase than the cycles in the other countries, state Leng and Meier.

All of the countries tested had breaks in the cycles, but the timing was not same. This illustrates that even though underwriting cycles appeared internationally, they were not caused by the same global effect. It can be expected that the structural changes in each of the countries were rather caused by the economic environment and regulation in each country, Leng and Meier conclude.

1.1.4. Underwriting cycle relationship with reinsurance prices

As reinsurance prices had been reported to variate during past ten years, Meier and Outreville examined again loss ratio time series in three European countries, France, Germany, and Switzerland (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003), and in the United States (Meier & Outreville, (Why) is there an Insurance Cycle in the USA?, 2004) and aimed to find out whether underwriting cycles and these fluctuations had a relationship to be found. Reinsurance makes it possible to primary insurer to increase its premium volume more than it would be possible without reinsurance. With prices of reinsurance decreasing, it makes them more affordable and increases companies' capacity, price competition and in the end reflects to loss ratio, they argued.

In both studies, they first reviewed previous studies and the explanations for underwriting cycles. They concluded that factors as unbalance between supply and demand, capacity constraints, naïve rate-making process, interest rates, regulatory and accounting delays, catastrophic losses, and general business cycles and practices have been suggested to have a relationship with formation of underwriting cycles. These determinants can be summarized into three main categories: 1) Disequilibrium between demand and supply, 2) External shocks, and 3) General business influences, Meier and Outreville state.

Even though on both studies the main objective was to examine the possible relationship between underwriting cycles and reinsurance prices, first they used the second-order autoregressive method to find out whether the sample countries' loss ratios still follow this process, as in earlier studies

(Venezian E. C., 1985), (Cummins & Outreville, 1987). In addition, if the loss ratio time series followed the second-order autoregressive process, they calculated the cycle period. On first study focusing on three European countries, they used three different datasets with three different periods, 1982-2001, 1975-2001, and 1965-2001 (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003). The results of the regression were that in France the cycle period was shorter than in Germany and Switzerland and was able to be calculated only with time trend. In Germany the process was significant in two of the three data periods, and the cycle length was between approximately eight and ten years. In Switzerland, the trend variable was significant and without it the loss ratio time series followed the second-order autoregressive process in two of the three data periods. The cycle length was between approximately seven and ten years.

In addition, Meier and Outreville also examined the correlation coefficients of sample countries' loss ratios. Using the same three different datasets as previously, the analysis showed that all three countries are positively correlated with each other. The weakest correlation was in 1965-2001 between France and Germany with coefficient 0.37, and the strongest one in same period between France and Switzerland. Contrary to the expectations, the correlation coefficients were higher between France and Switzerland than between these two countries and Germany, they stated.

On the second study focusing on the United States, they executed a similar second-order autoregressive process with two different data periods, 1957-2002 and 1982-2002 (Meier & Outreville, (Why) is there an Insurance Cycle in the USA?, 2004). The results showed that loss ratios followed the process with time trend in period 1957-2002, but the relationship was not significant anymore in period 1982-2002. With the time trend variable, underwriting cycle length in the United States was 9.71 years.

1.2. Summary of the literature

Berger presented a model that was based on hypothesis of underwriting cycles being a result of previous profitability ratios (Berger, 1988). Increased profitability results in surplus which in turn leads to balancing shifts in supply through a change in required risk premiums. However, it did not consider any expectations about future profits or losses, but suggested only that insurers will make their supply decisions based on previous period profitability and surplus. Even though a simple model, the Author sees that it summarizes well the basic principle of the industry's decision making process and establishes a good starting point for further examination of underwriting cycle theories.

Cummins and Outreville argued that insurance prices are not determined because of supply-related factors, but rather that insurers have rational expectations about the future profits and losses (Cummins & Outreville, 1987). Underwriting cycles exist however due to various institutional and regulatory factors interfering the industry and creating delays in the decision making processes of the companies. However, their model was made based on the hypothesis that regulatory and institutional factors have an effect on ratemaking of insurers, but it was not specified exactly what characteristics these factors would had had in different countries. Eight of the 13 countries examined were European nations, and it can be presumed that each of these countries' regulatory authorities had different regulative principles since the data used was from years 1957-1979, before the forming of European Union and common regulative practices. If the regulative factors are common for all European Union member states, similar regression with more recent data could provide new evidence on this topic.

Leng and Meier tested if loss ratio time series still follow second order-autoregressive model with more recent data (Leng & Meier, 2006). They also studied the breaks in underwriting results. Their aim was to find out whether the possible breaks have a mutual timing in different countries' insurance markets. Contrary to Venezian and Cummins & Outreville studies, they found out that loss ratio time series do not follow second-order autoregression process. They used more recent data that the two before, but also examined only four countries, of which two were European and two non-European countries. Thus, although in their study Germany's and Switzerland's loss ratio time series didn't follow the AR(2) process, it should be studied again with wider sample of European countries. They also found out that Germany's and Switzerland's loss ratio time series were strongly correlated with the United States, and that Japan's was negatively correlated with all the other countries. Also this

should be studied again with more recent data, since Japan's and the United States' economies are closely linked together, which generally could be seen also as loss ratios being strongly correlated.

Meier and Outreville examined the relationship between underwriting cycles and reinsurance price time series in three European countries and in the United States (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003), (Meier & Outreville, (Why) is there an Insurance Cycle in the USA?, 2004). They also conducted a second-order autoregressive method and a correlation coefficient analysis to find out whether the loss ratio time series still follow the process and what kind of correlation relationships there are between three major European economies.

Their findings were that in both in Europe and the United States the AR(2) process was significant with time trend, and the cycle length varied from approximately seven years to ten years. All three European countries were positively correlated with each other, although surprisingly the relationship was stronger between France and Switzerland than between these countries and Germany. Their research used more recent dataset with period lasting until 2002, which gives valuable evidence on AR(2) process existing also in more recent years. However, as in their European study they used three different datasets for different periods and the relationship was not significant in all of those, it does not confirm the hypothesis of loss ratios following the AR(2) process with certainty.

In addition to the studies discussed above, research on this topic has also been done using vector autoregression analysis (Niehaus & Terry, 1993), (Fung;Lai;Patterson;& Witt, 1998). Based on the results it has been argued that no single theory explains the cyclical patterns of underwriting. However, as vector autoregression method will not be conducted in this research these studies will not be further discussed.

2. METHODOLOGICAL PART

2.1. Research design

2.1.1. The second-order autoregression estimation

For testing the second order autocorrelation, AR(2), hypothesis, regression methods are applied for sample countries. Testing method is similar to ones used in previous research, especially in the ones done by Cummins, Meier, Leng, and Outreville. The method was chosen to this research because previously mentioned studies have found evidence on existence of loss ratios following either the second order (Cummins & Outreville, 1987) or first order (Leng & Meier, 2006) regression process. However, samples of these two studies were relatively different, with Cummins & Outreville having 13 sample countries of which 8 were European, whereas Leng & Meier study's sample included four countries, of which two were European states. Hence, this research aims to apply the second-order autoregressive model to 12 European countries to find out whether the European countries loss ratios follow the second or the first order regressive process, or whether no significant relationship on either of the factors can be found.

Since the European Union member states have common regulatory principles and authority, European Insurance and Occupational Pensions Authority (EIOPA), it is assumed that the possible delays in ratemaking and decision-making processes of insurers in member states are relatively equal as well. EIOPA states that their main strategic objective is to establish and enforce common regulatory environment, supervisory standards and practices in the European Union (European Insurance and Occupational Pensions Authority, 2018).

Estimation formula is as follows:

$$\pi_t = x_0 + x_1\,\pi_{t-1} + x_2\pi_{t-2} + \omega_t \quad (5)$$

where

π_t – loss ratio in period t,

x_n – coefficient,

Ω_t – random error term.

Constant variable is loss ratio. Estimation is made using EViews-program. For instructions on autoregression, "Introductory Econometrics for Finance" by Chris Brooks as well as "Application of spectral and ARIMA analysis combined-ratio patterns" by Leng and Venezian are used (Brooks, 2008), (Venezian & Leng, 2006).

Regression results are interpreted by analyzing the first and the second autoregressive variable's relationship with the dependent variable. Each variable with p-value less than 0.005 is considered to have a significant relationship with dependent variable. Results table show each variable's coefficient's value and t-value. Significance level legend is as follows: p-value less than 0.05 = *; p-value less than 0.01 = **; p-value less than 0.001 = ***.

2.1.2. Underwriting cycle length measurement

After conducting the second order autoregressive estimation, possible underwriting lengths will be measured. If hypothesis one is true, and loss ratio time series follow the AR(2) process, lengths of the cycles will be calculated using a following formula:

$$Lenght = \frac{2\pi}{\cos^{-1}\left(\frac{x_1}{2\sqrt{-x_2}}\right)} \quad (6)$$

where

x_n = coefficient.

The formula above is obtained from Cummins and Outreville study, where it was used to empirically measure underwriting cycle lengths in thirteen countries in which loss ratio time series followed the AR(2) process (Cummins & Outreville, 1987). In addition, it was similarly used in later studies of Meier and Outreville (Meier & Outreville, The Reinsurance Price and the Insurance Cycle, 2003), (Meier & Outreville, (Why) is there an Insurance Cycle in the USA?, 2004). The calculations are done

manually by the author using Microsoft Excel. If no significant second-order autoregressive process is found in any of the sample countries, hypothesis one is rejected and length measurement is not conducted.

2.1.3. Correlation coefficient analysis

After examining loss ratios country by country, correlation between these sample countries is assessed. Correlation coefficient analysis is conducted since previous research has argued that if two countries' economies or insurance markets are in close relationship with each other, then also these countries' loss ratio time series are likely to be positively correlated (Leng & Meier, 2006). However, evidence based on correlation coefficient analysis has not perfectly supported this argument, and there has been negative correlation between countries that are economically very closely linked together, such as Japan and the United States. Hence, similar analysis is performed to examine this hypothesis and to bring more evidence on this topic.

To examine correlation between sample countries' loss ratios time series, four of the sample countries are taken into examination and correlation coefficient process is executed. These countries are Germany, Italy, Spain and the United Kingdom. These countries are chosen because they are the ones with the largest nominal GDP of the sample countries. In addition, after this correlation between these countries loss ratio time series and three non-European countries series is examined. These three countries are the Australia, Japan, and the United States. They were chosen because of the size of their economy, to get to examine the possible correlation of loss ratios on international scale, and to combine the results with Leng & Meier study (Leng & Meier, 2006). Correlation coefficient analysis is done using EViews program.

2.2. Data

Dataset applied to the estimation function was gathered by the Author from OECD iLibrary on April 11th 2018 (OECD, 2018). It is based on two data charts, 1) gross premiums written in sample in the reporting country and 2) gross claim payments written in the reporting country. Total number of the countries is 12, of which 11 are European Union countries. The time period for the data is 1993-2016. These two charts were used to calculate annual loss ratios in each reporting country:

$$Loss\ ratio = \frac{Gross\ claim\ payments}{Gross\ premiums\ written} \quad (7)$$

Generally, loss ratio of insurance companies is calculated by total losses incurred in claims plus adjustment expenses divided by the total premiums earned. However, due to unavailability of exact data, the formula is simplified by using gross claim payments. Sample countries loss ratios series can be seen from figure 1. Figure shows the cyclical pattern in loss ratios as well as some level of correlation between sample countries' underwriting cycles.

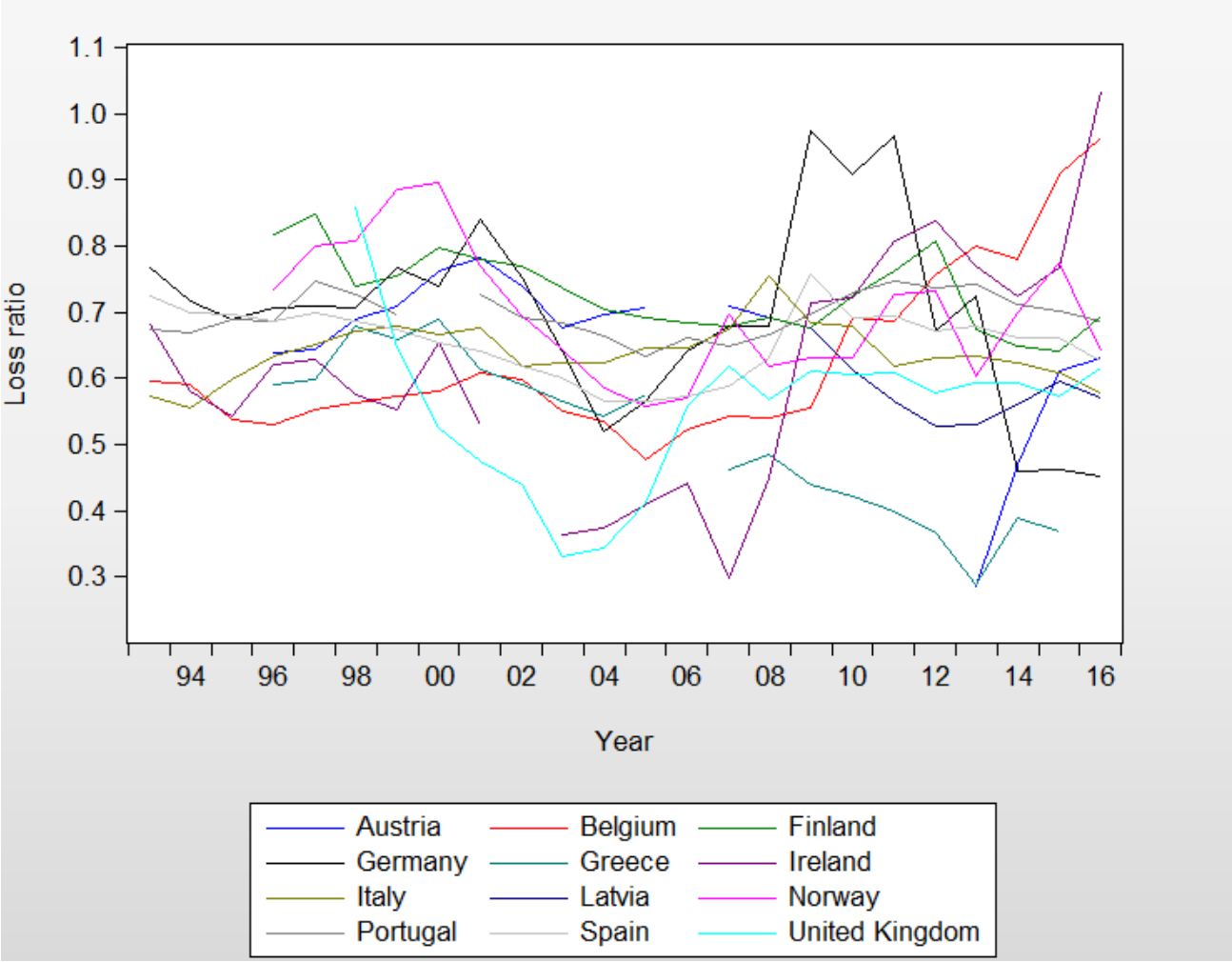

Figure 1. Sample countries loss ratio time series.

Source: OECD database; author's calculations.

3. EMPIRICAL PART

3.1. The second-order autoregression results

This regression method was applied to find out whether the loss ratio series do follow the AR(2) process in European countries, like previous research has argued (Cummins & Outreville, 1987), (Venezian E. C., 1985). Cummins & Outreville also suggested that underwriting cycles are result of various regulatory and institutional factors intervening insurance markets and thus making insurers not able to use the best information available in their rate-making processes, even though their decision making would be based on rational expectations. Thus, with sample consisting mainly of European Union countries this research aimed to find out whether the loss ratios still follow the AR(2) process in countries where regulatory forces can be assumed to be relatively common to every state.

Table 1 shows regression results of four selected sample countries. The interpreting of results will be conducted as follows: For each AR-factor, the relationship will be considered as significant if the p-value is less that 0.05. If the for AR-factors are considered to have a significant relationship the R^2-factor will be examined. The adjusted R^2 -factor shows how much do the model explain the variabilities of the dependent variable about its mean value. Table 2 shows the adjusted R^2-factors for all the sample countries.

Table 1: The second-order autoregression results for four of the sample countries

			AR(1)					AR(2)		
	Coefficient	Standard error		t-value	p-value	Coefficient	Standard error		t-value	p-value
AUSTRIA	1.434403	0.190672		7.522894	0.0000	-0.662108	0.175208		-3.77898	0.0026
GERMANY	0.653827	0.322558		2.027004	0.0562	-0.005771	0.338379		-0.01706	0.9866
IRELAND	1.036161	0.294555		3.517715	0.0023	-0.209229	0.269712		-0.77575	0.4474
UNITED KINGDOM	1.459819	0.275543		5.297973	0.0001	-0.699343	0.215907		-3.2391	0.0055

Source: OECD Insurance database; author's calculations

Thus, for Austria the both AR- factors are considered to have a significant relationship. In addition, its adjusted R^2 is relatively high, 0.74. For Germany, the first AR-factor is almost significant, 0.0562, and the second one is clearly not significant with p-value of 0.9866. For Ireland, the first AR-factor is significant, p-value 0.0023, but again the second one is not. For the United Kingdom, both AR-factors are significant with p-values 0.0001 and 0.0055 and with adjusted R^2-value being 0.68.

Interpreting process described above will be conducted similarly with each of the sample countries.

Regression results in table 2 do not show evidence about loss ratio times series following a second-order autoregressive process in European countries. Of 12 sample countries, only Austria and the United Kingdom had a statistically significant relationship on both AR factors. In addition, the coefficients of AR(1) factors of these two countries were greater than one. This suggests a possibility that the model is explosive and does not necessarily have much of explanatory power. The data used in the regression was not tested for stationarity which might be the reason for these large coefficient values, as non-stationary data can lead to an explosive autoregression process. However, the stationary testing was not conducted as it was not mentioned to been done in previous studies either (Cummins & Outreville, 1987), (Leng & Meier, 2006), although Leng and Meier did conduct the stationary testing after the AR(2) process testing.

However, results show that there is evidence on first order AR factor having significant relationship. In addition to previously mentioned two countries, it has a significant relationship in seven countries and was almost significant in Germany and Greece. However, again the coefficient values suggest a possible explosive regression process. Of these seven countries, two has coefficient value greater than 1. Yet, five of the countries, Finland, Italy, Norway, Portugal, and Spain, the first AR factor is significant. Nevertheless, it can be concluded that loss ratio time series of the sample countries do not appear to follow the second order autoregression process.

Table 2: The second-order autoregression results

COUNTRY	C		AR(1)		AR(2)		
	COEFF.	T-VALUE	COEFF.	T-VALUE	COEFF.	T-VALUE	ADJ.R^2
AUSTRIA	0.613650	9.530587***	1.434403	7.52289***	-0.66210	-3.7789**	0.74
BELGIUM	0.716951	3.663821**	1.128574	3.87716***	-0.17793	-0.609952	0.82
FINLAND	0.732018	30.49075***	0.76121	2.771421**	-0.21884	-0.738944	0.34
GERMANY	0.686164	10.33040***	0.653827	2.027004	-0.00577	-0.017056	0.31
GREECE	0.494831	4.759632***	0.761613	2.021383	0.157555	0.354168	0.80
IRELAND	0.677172	3.849431	1.036161	3.517715**	-0.20922	-0.775748	0.58
ITALY	0.631151	32.69131***	0.779372	3.146923*	-0.10352	-0.317923	0.39
LATVIA	0.581297	14.34100***	1.235254	1.542009	-0.76776	-2.83981*	0.50
NORWAY	0.695804	16.66556***	0.749426	2.903760**	-0.12534	-0.436965	0.38
PORTUGAL	0.695378	52.37635	0.801978	2.939552**	-0.16484	-0.645834	0.44
SPAIN	0.659190	22.75702***	0.818859	4.69637***	-0.08586	-0.378914	0.50
THE UNITED KINGDOM	0.598868	9.542200***	1.459819	5.29797***	-0.69934	-3.2390**	0.68

Source: OECD database; author's calculations

3.2. Underwriting cycle length measurement

Although the previously mentioned large coefficient values in AR 1 factor suggest a possibility of an explosive regression process, the cycle length calculation will be conducted in order to compare the length periods with previous research results. However, as due to methodological issues the regression results suggest uncertainties about the explanatory power of the process, similar level of uncertainty will also apply to these measurements, since the values used are the ones gained from the regression process. Since among the sample countries' loss ratio time series only Austria's and the United Kingdom's follow the second order auto-regression process, cycle period measurement will be conducted using formula number six with these countries. Table 3 shows the results of these calculations.

Table 3: Underwriting cycle length calculation results

		AR(1)			AR(2)			Cycle lenght	
	Coeff.		t-value	Coeff.		t-value			
AUSTRIA	1.434403		7.522894	-0.662108		-3.778979		6.63	years
UNITED KINGDOM	1.459819		5.297973	-0.699343		-3.239098		6.87	years

Source: OECD Insurance database; author's calculations

Results show that for both Austria and the United Kingdom, the underwriting cycle is between six and seven years. This supports the hypothesis that underwriting cycle lengths are relatively close to each other in Europe. In addition, it is in consensus with previous findings of the length being around six years. However, the evidence is not strong since the measurement was done with only two of the 12 sample countries. Also, again the possibility of an explosive regression process decreases the significance of these length measurement results, the author concludes.

3.3. Correlation coefficient analysis results

Table 4 shows that there is correlation between loss ratios time series in four of the sample countries. However, while Spain is correlated with both Germany and the United Kingdom, Italy is not strongly correlated with any of the other three countries. Germany and the United Kingdom are only correlated with one other country, Spain.

Generally, correlation between countries' underwriting cycles shows that the insurance markets or economies are closely linked to each other. In Europe, this should be the case in most countries, since especially European Union member states are in close trade relationship with each other. Data time period, 1993-2016, was chosen especially because the European Union was founded in 1993. However, as the correlation coefficients show, this relationship does not necessary mean strong correlation of underwriting cycles.

Table 4: Correlation coefficients of loss ratios of four sample countries

	GERMANY	ITALY	SPAIN	UNITED_KI...
GERMANY	1	0.45588921...	0.58386378...	0.20419883...
ITALY	0.45588921...	1	0.18252604...	0.22819937...
SPAIN	0.58386378...	0.18252604...	1	0.59467608...
UNITED_KI...	0.20419883...	0.22819937...	0.59467608...	1

Source: OECD Insurance database; author's calculations

Table 5 shows that among sample European countries, only Germany's loss ratio series is strongly correlated with one of the non-European countries' series, the United States. In addition, Italy is negatively correlated with both the United States and Japan. Also, Japan is very strongly correlated with the United States, contrary to the results of the Leng & Meier study (Leng & Meier, 2006). Only country that Japan is negatively correlated with is previously mentioned Italy. The correlation coefficient between Japan and the United States, 0.951, is even stronger than that of between Germany and Spain, 0.839. This supports the hypothesis that if the economies are strongly linked together, as the United States and Japan are, also the loss ratio series are strongly correlated.

Table 5: Correlation coefficients of loss ratios between four sample and three non-European countries

	GERMANY_...	ITALY_US_...	SPAIN_US_...	UNITED_KI...	UNITED_ST...	JAPAN_US...	AUSTRALIA...
GERMANY_...	1	0.33624311...	0.83839835...	0.44414978...	0.51638083...	0.37409890...	0.35275514...
ITALY_US_...	0.33624311...	1	0.23805116...	0.28654911...	-0.1960192...	-0.2325346...	0.13153754...
SPAIN_US_...	0.83839835...	0.23805116...	1	0.57017390...	0.39217472...	0.39011527...	0.20127874...
UNITED_KI...	0.44414978...	0.28654911...	0.57017390...	1	0.29655279...	0.41075259...	0.30949278...
UNITED_ST...	0.51638083...	-0.1960192...	0.39217472...	0.29655279...	1	0.95145210...	0.68585835...
JAPAN_US...	0.37409890...	-0.2325346...	0.39011527...	0.41075259...	0.95145210...	1	0.63336557...
AUSTRALIA...	0.35275514...	0.13153754...	0.20127874...	0.30949278...	0.68585835...	0.63336557...	1

Source: OECD Insurance database; author's calculations

3.4. Discussion of the results

3.4.1. The second-order autoregression

The estimation method did not give evidence on loss ratio time series following second-order autoregressive model in Europe and did not thus support hypothesis 1. For 9 countries, the first AR

factor was significant, but for 9 of 12 countries the second one was not. This was suggested already in Leng & Meier study, but in examination was only two European countries. In two countries, Austria and the United Kingdom, the time series followed the AR(2) process but the large coefficient values in the first AR factor suggest a possibility for explosive regression process. Contrary to many previous studies, time trend variable was not applied to regression model, which could be considered as a limitation of this study. Meier and Outreville found the significant relationship in AR(2) factor in the United States only with time trend included in the model. In Europe however, some of the sample countries followed the AR(2) process also without the time trend variable. Leng and Meier again, did not find a significant relationship with or without it. Nevertheless, the regression results could have been different with conducting the model also with time trend variable included.

The dataset period was selected to match the period where it can be assumed that some level of common regulative practices have been applied in European countries. However, not all the sample countries have a perfect data for this period and thus there are some missing ratios for some countries and years. Regressions could also have been performed with multiple different data periods to get more evidence on the matter, as some previous studies did.

3.4.2. Underwriting cycle length calculations

The cycle lengths calculated were between six and seven years, which supports the hypothesis of cycle lengths being relatively close to each other in Europe. Also, it is in consensus with previous research which suggests the length being around six years. However, the uncertainty of explanatory power of the regression process results in decrease in significance of these measurements. Yet, the calculations were conducted in order to compare the results with the ones gained from previous research. Even though the regression results suggest a possibility of an explosive process for some of the countries' time series, the calculated cycle lengths are still similar to the ones than in previous studies.

However, more recent studies have found that the cycle length, if found to exist, is longer. Meier and Outreville calculated the length to be approximately between seven and ten years in Europe and the United States. The results of this study as well as the ones of previous studies with recent data suggest that there are more variations in the length of the cycle than it was previously suggested. Even if this study shows that the length is between six and seven years, the calculations were done with only two countries. Meier and Outreville found the cycle length in the United States to be close to ten years,

and as it has been showed that there is positive correlation between European and the United States loss ratios it should also be expected that the cycles were relatively close to each other in length. However, of the two countries that had a significant AR(2) factor, only the United Kingdom's correlation coefficient in relation to the United States' one was calculated. It is a positive one, 0.30, but does not suggest very strong relationship.

3.4.3. Correlation coefficient analysis

Correlation coefficient analysis showed that all the four sample countries are correlated with each other. However, the level of the correlation varies from the highest level of correlation coefficient being 0.59 and the lowest 0.18. Positive correlation relationships between sample countries was expected and supports the hypothesis that in countries where insurance markets and economies that are linked together loss ratio time series are correlated. This can be assumed to be the case in Europe, and especially among the European Union member states, which all the four sample countries are.

Correlation coefficients between these four sample countries and three non-European countries also brings interesting evidence on the matter. It shows strong correlation, coefficient over 0.5, only between one European country, Germany, and the United States. However, also Spain and the United Kingdom are still positively correlated with the sample non-European countries. Nevertheless, results show that Italy is negatively correlated with both the United States and Japan. Italy also shows relatively weak positive correlation between other three European countries. Yet, the evidence suggests the third hypothesis of loss ratio time series being positively correlated between European countries and the United States being true. In addition, the analysis shows very strong correlation between the United States and Japan, which was found to be negative in previous research (Leng & Meier, 2006).

One thing that could explain this difference in results are the dataset periods, which were in this study 1993-2016 and in Leng & Meier study 1968-1997. Although Japan's economy was heavily under the influence of the United States right after the Second World War, it could be assumed that the insurance sector was still not as linked to the United States one at that time period as it has been more recently. Nevertheless, the two countries have been economically in close relationship ever since the 1950s and even within that time a positive correlation in loss ratio time series could have been expected to exist. Leng & Meier explain some differences in Japanese business organization structures compared to

Western world, such as keiretsu system, and point out that Japanese insurance sector is highly regulated and with a very little price competition. However, they do not link these factors to the negative correlation relationships but just argue that the results suggest that Japanese insurance industry's underwriting results move into different direction than the ones in the sample Western countries. Yet, this research finds that contrary to the Leng & Meier study, Japan's and the United States' loss ratio time series are very strongly positively correlated, as could be assumed from the two countries' close economic relationship.

CONCLUSION

This study's aim was to find out whether the loss ratio time series follow the second-order autoregressive process in European countries' insurance companies, as well as to examine the lengths of the underwriting cycles. In addition, the objective was to investigate how European loss ratios are correlated with non-European countries' loss ratios. The research method applied was selected due to lack of consensus in previous studies as well as to bring new evidence on the topic with more recent data.

Based on the results of this study it can be concluded that in general loss ratio time series do not appear to follow the second-order autoregressive process in European countries. Of the 12 sample countries, two had a significant relationship in both AR factors. However, the time trend variable was not included in the analysis method, which can be considered as a limitation of this study. Some of the previous studies have found the second-order autoregressive process significant only with time trend variable. Nevertheless, in future research time trend variable could be applied since the results this far are not in consensus.

In addition, based on the results it can be concluded that the underwriting cycle in European countries appear to be between six and seven years. However, the calculations were done with only two of the sample countries and thus the evidence is not strong. In addition, these countries' regression results suggest a possible explosive process. Yet, the calculated lengths are in consensus with previous studies which suggest the cycle length to be approximately six years – however some studies suggest that the length is getting longer. Again, a possible topic for future research could be calculating the cycle lengths with a larger sample, if more countries were found to follow the second-order autoregressive process. This could provide more evidence on the argument that the cycle lengths have been reported extending.

Correlation coefficient analysis showed that there is positive correlation relationship between all the four sample European countries. Since most of the European states are in relatively close economical

relationship with each other, it could be expected that the loss ratios of these countries are also linked together at some level. Furthermore, the same argument should apply on international scale. Thus, the correlation between European countries and three non-European countries was calculated. The results support this hypothesis, although Italy has negative correlation relationship with the United States and Japan. Still, in general it can be concluded that European countries loss ratio time series are positively correlated with each other and also positively correlated with major non-European nations' series.

In addition to previously mentioned suggestions, the Author sees that future research on underwriting cycles could examine following topics:

Based on the hypothesis that regulatory delays have impact on ratemaking and thus formation of underwriting cycles:

1) Is there a visible change in loss ratio time series when the regulatory environment has significantly changed, e.g. before and after the European Union common regulatory practices?
2) How much of the autocorrelation process do the regulatory lags explain?
3) As motor liability insurance is the only legally compulsory insurance type in Europe, and generally the most regulated one, do their loss ratio time series differ from the ones of other non-life insurance types?

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