Introduction

It is well-known that the property-casualty insurance industry, especially long tailed lines of business, experiences alternating periods of soft and hard markets. During soft markets, as insurers seek to increase the business they write in the face of the falling market prices, supply expands and prices fall, leading to a below costs pricing which results in low or negative profits for insurance firms. However, in hard markets, supply contracts and insurers raise their prices to levels that achieve profits or at least rates of return equal to the cost of capital. The said cycle, which has long been known by insurance practitioners and academics as the underwriting cycle, affects, not only primary insurance markets, but also worldwide reinsurance markets and even non-insurance corporations.

Most of the academic research on the underwriting cycle has sought to find rational economic explanations of the phenomenon (e.g., changes in interest rates, loss shocks, data reporting lags, etc.). However, these studies tend to focus on drivers of pricing risk. Thus, the key drivers found in the literature are supply shifts (capital constraints), volatility of losses, solvency constraints, interest rates, market imperfection, imperfect knowledge of the risk and correlation of underwriting performance to volume at times, and the behavioural aspects of insurers' pricing and coverage decisions. Furthermore, many studies explicitly or implicitly assume a pricing model, which is in general based on loss uncertainty, insurer capital and economic factors, in testing hypotheses regarding the underwriting cycle. On another note, Daykin et al. (1994) argue that the insurance market cycle is hard to be analysed by an existing individual explanation alone and that insurers cannot be considered separately. This is a dynamic phenomenon that involves many interactions among different explanations and individual agents. Therefore, a single company's actions cannot represent the dynamics of a whole market because different companies in the market have different motivations and abilities to interact with the changing environment.

In addition to determining the factors causing the cycle, the considerable number of empirical studies that have been carried out on underwriting cycles focused on short-term determination of insurance profits by using conventional regressions. Fewer articles have used cointegration analysis to find out the long-term determination. Furthermore, the limitations of the existing studies, where they encounter difficulties in understanding the equilibrium relationship, is that the time series characteristics of insurance profits is still not totally revealed. In fact, insurance profits, along with the different relevant variables used in a number of studies, exhibit different behaviours, whereas almost every model is constrained and requires certain conditions to be met. Therefore, in our work, we follow the framework of Jiang and Nieh (2012) and Jiang et al. (2019) where they provide evidence of the level relationship between interest rates, industry capacity and insurance profits in the U.S. insurance market at the whole industry level without the necessity for testing unit roots (which represents the limitation of every previous work).

Consequently, compared with the existing literature, our work is an extension of previous research, where it utilises more robust methodologies (by avoiding the arguments of stationary features of insurance profits). In fact, the process of methodologies utilised in this study, the bounds testing procedure and the ARDL model, are both based on a single-equation autoregressive process and could provide both short and long-term implications of insurance profits simultaneously. This cointegration approach, which differs from the existing tests using Engle and Granger (1987) type testing regression, does not test the significance of the coefficients of the cointegrating vector and cointegration residuals, and could provide more robust results. Moreover, families of the autoregressive process are traditionally constructed to portray the dynamics of underwriting profits, thus, are indeed appropriate in this context.

This thesis is divided into two chapters. Chapter 1 provides an introduction to the underwriting cycle, where it defines it, studies its impact on insurers and lists, by referring to the existing literature, the different factors causing the cycle. Afterwards, it focuses on the different schools of thought in this interest. Chapter 2, on one hand, reviews the empirical literature and outlines the methodology used in our empirical study. And on the other hand, it shows the empirical findings, starting by a description of the data and sample, along with a brief presentation of the Tunisian insurance industry, then interpreting the different results of our work (.e., the test for cointegration and the short and long-run dynamics of insurance profits).

Chapter I: An introduction to underwriting cycles

Introduction

Industries evolution is driven by their basic underlying forces, which is naturally exhibited as cycles of growth and decline. However, some particular industries reveal special dynamics and are said to be more cyclical than others. These cycles are particularly important in insurance and reinsurance as they are unpredictable, due to a combination of uncertain market competition and insurers' pricing behaviour. In fact, this pattern of rising and falling premiums, as well as the supply of coverage, is notorious in the property-casualty insurance industry, and it is commonly known as the underwriting cycle.

Understanding the cycle would be useful in the fields of business risk management and in preventing systemic risk in the whole industry. From a business risk management perspective, a Lloyd's director commented: "in the past, insurers have simply accepted the insurance cycle, seeing it as a force of nature with an uncontrollable impact on their business. But … insurers now have the information and the tools they need to manage the cycle much more effectively." From a regulatory perspective, Meyers (2007) mentioned: "… insurance cycle contributes an artificial volatility to underwriting results that lies outside the statistical realm of insurance risk. For internal model development under Solvency II, underwriting cycles must be analysed, because the additional volatility could produce a higher capital requirement…"

This chapter, which reviews the theoretical findings related to underwriting cycles, is divided into two sections. The first defines the underwriting cycle, presents its impact on the insurance industry, and depicts the different factors that cause it. The second section focuses more on the factors and presents the schools of thought by outlining and explaining the different aspects put forth by each school.

I-Underwriting Cycles

The persistent fluctuations of insurance premiums in the non-life insurance market significantly affect the overall business performance of insurance companies. It can have a substantial impact on the stability of non-life insurance industry.

I.1-Definition

Industry professionals know that the cycle, with its peaks and troughs, describes the rise and fall of insurance prices. This cyclical pattern, naturally, alternates between periods when premium rates are stable or falling and coverage is readily available, also known as a soft market, and periods when rates increase, coverage becomes scarce and insurers' profits grow, which is referred to as a hard market. Furthermore, according to the dictionary of insurance terms (Robin, Harvey W. 2013), the underwriting cycle is defined as "the tendency of property and liability insurance premiums, insurers' profits, and availability of coverage to rise and fall with some regularity over time." It is said that a cycle begins with insurers tightening their underwriting standards and sharply raising premiums after a period of severe underwriting losses. Stricter underwriting policies and higher rates lead to an increase in profits, hence, attracting more capital to the insurance industry and raising underwriting capacity. Nevertheless, with higher profitability, insurers tend to write more premiums, leading to a more relaxed underwriting standards and lower premium rates. Profits may erode and even turn into losses. The cycle would start all over with the hardship caused by the relaxation of the underwriting standards and the losses it resulted in. The said cycle is uncontrollable and has a crucial impact on insurance operations.

Interest in the underwriting cycle grew after the American insurance industry suffered of the so-called "liability crisis" of 1985 through 1986 (Boyer et al. 2012). Dramatic changes in the pricing and availability of insurance coverage led to the emergence of a large volume of literature that attempted to explain why insurance markets go through periods of high profitability followed by periods of low profitability. This sudden interest in the underwriting cycle was mainly directed towards knowing the characteristics of the cycle and what causes it. Nevertheless, there was a consensus on how to define the cycle. Scholars typically defined the underwriting cycle as repeating, regular periods of soft and hard markets. In a soft market, coverage is readily available at "reasonable" prices, while a hard market is characterized by high prices and unavailability of coverage or limited coverage for policyholders (Weiss, 2007).

However, industries do not share the same cyclical behaviour, as the cycles differ depending on the factors that affect them. Feldblum (2009) found that underwriting cycles take a different form of profit fluctuations than those experienced by most industries. In fact, unlike other cycles where every price presents an equilibrium, in the underwriting cycle no phase is considered to be an equilibrium. Insurer strategies during profitable years drive rates down, changed strategies during poor years drive rates up. "The insurance cycle is in perpetual disequilibrium."

I.2-Impact of the cycle on the insurance sector

Underwriting cycles usually extend over several years and are particularly pronounced in the industrial lines and in reinsurance. All the corporations affected by it, namely insurers, reinsurers and even non-insurance clients, sometimes have to cope with extreme fluctuations in revenue, expenditure and profits due to these price swings. Furthermore, from the perspective of the affected companies, the fluctuations are detrimental in two ways: they make it difficult to plan ahead for revenues and expenditures, then again, they increase the cost of capital of the company.

Weiss (2007) states that "the underwriting cycles have been the topic of considerable economic and financial research for a couple of reasons." Different studies have reached a consensus that both soft and hard markets are of concern. On the one hand, soft markets are associated with higher insolvency rates among insurers, which is of concern to both policyholders and regulators. On the other hand, hard markets are particularly alarming because they can affect the price of goods and services in the economy. Gron (1994) states that variations in capacity, which is a main cause of underwriting cycles, have a significant negative effect on movements in property-casualty profitability. However, the impact on insurers profitability and its importance is not the same for all insurers as it differs from one insurer to another depending on a multitude of factors (Elango, 2009).

Moreover, Jones and Ren (2006), aiming to understand the impact of the underwriting cycle on ruin probability, explored an insurer's surplus model and found that the ruin probability is positively related to the magnitude of the cycle. They determined that the underwriting cycle can have a significant impact on insurers' stability (ruin probability). This was confirmed by other researchers, where it became known that the underwriting cycle increases the risk of insolvency for insurance companies (Feldblum, 2007). In fact, the cycle, especially the troughs, is considered a significant cause of insurers' insolvencies. In fact, from a practitioner's point of view, the underwriting cycle's impact is most worrisome during the troughs. When the market softens to the point that insurers' profits diminish or become losses, the capital needed to underwrite new business is depleted and insurers can lose millions and become more and more insolvent.

In addition, due to the convergence of segments of the financial services industry, the underwriting cycle is no longer limited to the insurance market. Notably, the cycle seems to propagate from the insurance sector to the international reinsurance market. Any loss suffered by the insurers and adjustments to their prices would impact the reinsurers. Hence, it has an impact on reinsurers' operating results (Berger, 1988). Consequently, the impact of the cycle on the reinsurance market makes reinsurance prices highly volatile. This volatility is "interpreted" by cyclical prices with the cycles being highly correlated across national markets (Cummins, 2009).

I.3-Factors causing underwriting cycles

Researchers have a growing focus on the underwriting cycle, leading to a considerable theoretical and empirical research, which has turned up many factors that helped in elaborating thorough explanations. It appears that the cycles can be at least partially explained by responses to several different features of insurance markets and dynamic market developments. On the one hand, scholars have focused on economic causes of the cycle, such as industry capacity, the cost of paying claims, and interest rates. On the other hand, "market imperfections", such as time lags between the occurrence and reporting of insured losses that will generate claims payments and regulatory delays in approving price changes, were also explored by researchers, as factors that would explain the underwriting cycle (Klein, 2014).

In fact, the factors could be divided into either institutional and regulatory features of insurance, or the effects of real phenomena such as interest rates, loss shocks, asymmetric information in capital markets, capital surpluses and shortages in insurance (Weiss ,2007).

Moreover, arguments have been made that factors driving underwriting cycles are largely country specific, this has led to the existence of several perspectives where studies of different countries resulted in different results. These factors can be summed up into six points. First, competition driven pricing, where the intense competition among insurers leads to aggressive price-cutting and risk-taking. Second, it is naïve rate making process, wherein previous years' profitability encourages insurers to set lower premiums. Third, the capital constraints in the insurance industry caused by lack of external capital during soft markets. Fourth, regulatory and institutional factors, causing the underwriting cycle because they prevent insurers from charging optimal premiums by creating a lag in data dissemination. Fifth, the property-liability insurance business is obviously linked to the general economic performance of the national economy, hence, the general business cycle is believed to have a significant part in causing the underwriting cycle. And last but not least, interest rates are believed to cause underwriting cycles. These various views can be synthesised by considering that the phenomenon of underwriting cycles is a manifestation of complex and multifaceted elements taking place in the industry, which cannot be explained by a single factor (Elango, 2009).

Another point of view was suggested by Meier and Outreville (2006), saying that the underwriting cycle could be somehow caused by the international reinsurance market. They said that if the price of reinsurance falls, reinsurance becomes more affordable for insurance companies, which would be reflected in more capacity, price competition and, finally, a higher loss and combined ratio.

Nevertheless, it was made clear that there is no general accepted view of what the causes of the underwriting cycle might be. Seeing that there exists numerous hypotheses and no general consensus, researchers said that the hypotheses fall in one of two main schools of thought (Chen, Wong and Lee, 1999; Eling and Luhnen, 2009). The first suggests that the causes are irrational behaviour and that underwriting cycles are caused by the insurers themselves because of naïve rate-making methods, competition driven prices, and/or capacity constraints. Whereas the other one is related to the rational expectations/institutional intervention hypothesis and it does not agree that insurance markets and insurers are irrational. Instead, it suggests that the underwriting cycle is caused by external factors and market characteristics that are out of the control of insurers, which are institutional interventions, the general business cycle, and/or interest rates.

II-Schools of thought

Trying to understand the dynamics of underwriting cycles, a multitude of studies emerged. Influenced by insurers' rationality hypothesis, studies focused mainly on factors that may be characterized as exogenous to the insurance business. However, the ways in which insurers themselves operate might have an influence on the pattern of underwriting profits. This is of major importance because it is the one way over which insurers have the most control.

II.1-Underwriting cycles caused by the insurers themselves

II.1.1-Naïve rate-making methods

There are different hypotheses on the functioning of insurance markets. The most common is the perfect market/rational expectations hypothesis. In a perfect market, the price of insurance would be determined by discounting expected cash flows by the appropriate discount rates, and rational expectations would imply that premiums set at a certain time incorporate all prior information. However, in a perfect market, a price cycle would occur only if insurers' expected costs (i.e., the present value of expected losses) were cyclical.

Venezian (1985) was the first to address the matter of naïve rate-making methods. He attributed the cycle to extrapolative methods used in the rate setting process. In fact, in a perfect market with rational expectations, premiums are equal to the present value of expected future losses. However, premiums are not the best predictors of actual losses, which is attributed to the effect of past surplus on premiums. Furthermore, as a way of estimating future rate requirements, insurers often use regressions based on past costs or on loss ratio. Accordingly, premiums are retrospective; that is, past loss experience affects premiums. Venezian (1985) found that a model of this process implies that premiums are not the best predictors of actual losses, and it suggests that these ratemaking methods contribute to the fluctuations of underwriting profits. Therefore, he suggested that past losses would not help explain premiums unless extrapolative rate setting methods were being employed. Additionally, his results indicate that fluctuations in underwriting profits have different frequencies and phases in the various lines of insurance as well as among insurers.

However, limits of his approach were put forward by Cummins and Outreville (1987). Mainly, Venezian's (1985) approach is not reliable for studying insurance prices because he didn't consider the interaction between supply and demand. Normally, prices arise from the interaction between these two market forces, and, in order to develop a viable explanation of insurance prices and underwriting cycles, an approach considering both supply and demand should be used. Besides, Cummins and Outreville (1987) argue that underwriting cycles are not caused by insurers' irrational behaviour. They hypothesize that premiums are set using rational expectations, but that almost all information relevant in forming expectations of future losses is contained in past losses. Hence, past losses would not affect premiums if one could effectively control for expected future losses. However, if expected future losses are measured with error and if this error is correlated with past losses, one may find that they help explain premiums even though premiums are set using rational expectations. Still, this does not explain underwriting cycles, where, under rational expectations framework, the firm can make its best guess about the future from past losses. Therefore, because rational expectations per se would be inconsistent with an underwriting cycle, they hypothesize that the cycles are created in an otherwise rational market through the intervention of institutional, regulatory and accounting factors.

Followingly, Niehaus and Terry (1993) compared the works of Venezian (1985) and Cummins and Outreville (1987). They found that their hypotheses are not mutually exclusive. To sum up, the perfect market/rational expectations hypothesis implies that premiums are forward looking and that premiums are the best predictors of future losses. Consequently, current premiums should be explained by future losses, and past information should not help explain premiums. Market imperfections, however, implies that premiums are influenced by factors other than the present value of expected future losses. It implies that premiums are negatively related to past surplus.

Additionally, Niehaus and Terry (1993) provided new evidence on the determinants of insurance prices. Deriving out of the perfect market hypothesis, where premiums equal the present value of expected future losses and therefore should be the best predictors of future losses, they found that market imperfections prevent premiums from being informationally efficient predictors of losses. In particular, there is some evidence that past losses affect premiums and stronger evidence that past surplus affects premiums. Furthermore, their results were consistent with the capital market imperfection hypothesis and confirm the finding of Venezian (1985). The evidence suggests that past values of surplus affect premiums. Additionally, past values of losses affect premiums. Under this result, premiums may be biased predictors of future losses, because unexpected past losses influence premiums even if these unexpected losses carry no information about future loss payments.

II.1.2-Competition driven prices

From an alternative perspective, certain researchers believe that the insurance industry causes the cycle, more or less on its own, by going through periods of destructive competition followed by cutbacks in supply.

The standard financial theory, which is based on the perfect market model, predicts that break-even premiums equal the risk-adjusted discounted value of expected cash outflows for claims, sales expenses, income taxes, and any other costs. However, competition (under-pricing) could cause prices in soft markets to fall below levels needed ex ante to cover expected costs and ensure solvency. Some firms may price below cost because of moral hazard. They also may price below cost due to heterogeneous information concerning future claim costs that results in low loss forecasts relative to full-information conditional expectations. Other firms may cut prices to preserve market share and thus avoid loss of quasi rents from investments in tangible and intangible capital. Consequently, a subset of firms can cause prices for other firms to fall below costs in the short run, which leads prices to deviate substantially from levels predicted by the perfect market model and the hypothesis that insurance prices can be fully explained by the said model becomes erroneous, (Harrington and Danzon, 1994).

Besides, noting the term "underwriting cycle", Berger (1988) focused on explaining the reported changes in underwriting standards over the course of the cycle. It was proposed that the dynamics of the cycle derive from a feature which lies at the heart of the insurance business; that is, profits feed into surplus, leading to offsetting shifts in surplus. More precisely, when insurance companies' profits are high, they loosen their underwriting standards and take on less desirable risks. This has led to an explanation that became widely used among practitioners; that is, profits increase surplus, leading to aggressive marketing (i.e., more liberal underwriting standards) and declining profitability, which leads to a decline in surplus followed by increased profitability, and so on.

Similarly, as Harrington and Danzon (1994) wanted to discern the different factors that led to the liability crisis of the 1980s, they reached the same conclusion. Industry analysts believed that the soft market that preceded the crisis represented a particularly severe episode of price cutting to preserve market share. Accordingly, price cutting resulted in rates that were inadequate given the available information at the time policies were sold. Consequent operating losses contributed to the subsequent hard market. Therefore, the largest property-liability insurer insolvencies in the mid-1980s are asserted to have been caused by deliberate or irresponsible under-pricing of general liability insurance during the early 1980s.

Furthermore, the theoretical analysis led by Harrington and Danzon (1994) suggests that moral hazard can lead insurers with few assets at risk to price too low. Also, low prices might arise from heterogeneous information across insurers, leading to inadequate pricing by some firms and causing others to cut their prices to retain business that yields quasi rents in future periods. Thus, inadequate pricing by some insurers can induce inadequate pricing by other firms in the short run. This leads to considerable losses in the next years, which causes a hard market.

II.1.3-Capacity constraints

The conventional economic theory of competitive insurance markets assumes that premiums predict efficiently future claims. However, Winter (1988, 1991, 1994) presented the capital constraint theory as an alternative, which is based on a couple of assumptions. Firstly, market capacity, which is necessary to back the contractual promises of paying claims, is determined by insurers' net worth. Secondly, when raising net worth, external equity is more costly than internal equity. The premise of the capacity constraint theory is that capital shortages and overages resulting from capital market imperfections are the primary cause of hard and soft markets for insurance. It focuses on the underwriting capacity of insurers, stating that cycles are caused by impediments to capital flows that result in alternating periods of excessive and inadequate capacity in the industry.

According to Winter (1988), in an insurance market where average claims are uncertain, the net worth of stock insurers measures their capacity to write insurance. The capacity constraint hypothesis suggests that crises can be triggered by a depletion of the said capacity because of cumulative losses. Based on this theory, and seeing that, in an attempt to limit insolvencies, regulators constrain insurers against writing excessive quantities of insurance relative to their net worth, Winter (1991) found that regulation can exacerbate fluctuations in the supply of property-liability insurance. In fact, revenue is used as a measure of aggregate quantity and, in a competitive market with inelastic demand, a constraint on the ratio of revenue to net worth yields a catastrophe process for price dynamics. Therefore, solvency regulation, which restrains insurers' underwriting capacity, is destabilizing. In fact, on the one hand, it may magnify the amplitude of the insurance cycle, and on the other hand, it may also contribute to the suddenness or apparent discontinuity of premium changes. In addition, to limit insolvencies, regulators constrain insurers against writing excessive quantities of insurance relative to their net worth.

Furthermore, Winter (1994) traced features of the insurance market performance to basic market conditions combined with tight capacity. Mainly, the disappearance of gains to trade in certain lines resulted from dependence among the events of losses. Nonlinearity of premiums was due to dependence among the sizes of losses, conditional upon the events of losses. This led to attributing jumps in premiums, not just to contemporaneous changes in expected claims, but also to the accumulation of losses.

Looking for more evidence to support the capital market imperfection hypothesis, Niehaus and Terry (1993) found that the shifts in the supply of insurance, which is constrained by insurers' equity, can generate a cycle. More importantly, a reduction in capital (e.g., due to unexpected losses) causes industry supply to contract and insurance prices to increase. Their results, which confirm that past values of surplus affect premiums, support the hypothesis of market imperfections and show that it plays an important role in insurance pricing and in the cyclical behaviour of insurance markets.

In addition, Gron (1994) related the capacity constraints to real frictions and market imperfections. He assumed that net worth is subject to random shocks and real frictions which would prevent it from quickly adjusting back to the long-run equilibrium. Large adverse shocks to claims or asset values, such as unanticipated inflation, large catastrophes, unexpected increases in interest rates, or declines in the stock market, can substantially reduce industry capacity. These shocks can result in the divergence of the capital from its long-run equilibrium and the cost differential between internal and external equity prevents it from adjusting back. Under these conditions, net worth shocks generate the market conditions associated with the underwriting cycle. Because it is costly to adjust net worth, the industry will not return immediately to long-run equilibrium. The industry supply curve shifts; industry accounting profit increases, reflecting the increased opportunity cost of scarce capital. As new capital and retained earnings increase industry net worth, the supply curve shifts back, causing premiums and profitability to decline toward their long-run equilibrium levels.

On top of that, Cummins and Danzon (1997), focusing on insurance risk and assuming that it is imperfectly diversifiable, provided new theoretical analysis and empirical evidence on the relationship between loss shocks, capitalization and, prices in insurance markets. They found that, though maintaining financial capital is costly due to factors such as corporate taxation and agency costs, insurers must hold equity capital to ensure payment of claims that are larger than expected. However, internal capital is assumed to be less costly than external capital, because "a cost is incurred in the 'round-trip' of paying out a substantial amount of retained earnings… and then immediately raising the same amount through the issuance of equity" (Winter, 1994) or because of asymmetric information.

Besides, Winter (1991, 1988) associated the cost advantage of retained earnings over external capital to the effects of tax and asymmetric information. Due to this cost advantage, capacity will not adjust immediately. Hence, tight markets persist because insurers prefer to rely on the rapid accumulation of retained earnings rather than resort entirely to outside capital; and soft markets persist because of the chance that the excess stock of internal equity will be needed in the future. (Niehaus and Terry, 1993; Cummins and Danzon, 1997; Winter 1988, 1991, 1994)

II.2-Underwriting cycles caused by external factors

Most prior analyses of underwriting cycles have explained cycles as a supply-side phenomenon involving irrational behaviour on the part of insurers. However, other researchers proposed that insurance prices are set according to rational expectations. Although rational expectations per se would be inconsistent with an underwriting cycle, researchers hypothesized that the cycles are created in an otherwise rational market through the effect of other factors that are exogeneous to the supply-side of an insurance market.

II.2.1-Institutional intervention

Researchers emphasized that insurance markets are rational. This led to hypothesizing whether underwriting cycles are caused by external events and market features that are not under insurers' control. The rational expectations/institutional intervention hypothesis points out that reactions to these phenomena make it appear that insurers behave irrationally. These external events include institutional, regulatory, and accounting characteristics.

Cummins and Outreville (1987) hypothesized that market equilibrium insurance premiums are set in a competitive market and reflect rational expectations. However, this would be inconsistent with the existence of any type of profit cycle. Nevertheless, institutional and regulatory factors intervene in insurance markets, leading to an "apparent" cycle in the sense that it has nothing to do with the underlying economic and statistical characteristics of insurance markets, but rather is attributable to institutional and regulatory rigidities. Thus, underwriting cycles are created in an otherwise rational market through the intervention of institutional, regulatory and accounting factors. These findings support the rational expectations/institutional intervention hypothesis and prove that the underwriting cycle is not caused by irrational insurers, but is generated by the influence of intervening factors. To sum up, institutional and regulatory lags, combined with insurers accounting practices, are responsible for the cyclical behaviour of underwriting profits.

Likewise, Lamm-Tennant and Weiss (1997), testing the hypothesis of rational expectations/institutional intervention, also reached results which support the view that factors including loss lags attributable to regulatory or data collection considerations, policy period lengths, and accounting conventions, drive apparent underwriting cycles by affecting premiums directly. Furthermore, besides causing underwriting cycles in the concerned country, they also found that institutional lags and reporting practices cause not only domestic but international underwriting cycles.

On top of that, other researchers found that prior approval of insurance rates and prices by regulatory authorities created an increased variability in underwriting results by delaying the rapid adjustment of prices to new information (Witt and Urrutia, 1983; Harrington ,1984; Tennyson ,1993).

II.2.2-The general business cycles

Although the underwriting cycle does not synchronize with the general business cycle, and is said to be much more regular than the general business cycle, the property-liability insurance business is obviously linked to the general economic performance of the national economy and may be related to changes in real prices or real GDP.

Accordingly, seeing that little credit is given to the general conditions of the economy for fluctuations in the industry’s underwriting performance, Grace and Hotchkiss (1995) examined a long-run relationship between fluctuations in the national business cycle and fluctuations in the insurance underwriting cycle. Their results led them to conclude that the property-liability insurance industry is generally linked to the long-run performance of the national economy, but is not linked to short-run shocks in economic variables. Besides, fluctuations of the property-liability underwriting cycles seem to fit exactly with general economic fluctuations. However, their empirical analysis suggested that shocks to general economic variables had little effect on the performance of the property-liability insurance industry. Yet, the effects on profitability were greater.

What is more, Lamm-Tennant and Weiss (1997) thought it essential to understand how overall demand varies and affects the cycle in order to further explain it and figure out the different factors that lead to its existence. They found that demand effects play a role in understanding premium changes and the underwriting cycle. In fact, as the law of supply and demand suggests that premiums would rise in times of expansion, everything else held constant, their results indicate that overall demand for insurance varies with growth in the economy, with periods of expansion and contraction corresponding to increases and decreases in demand for insurance. They also found that the underwriting cycle is related to changes in real GDP. Yet, the underwriting cycle does not necessarily synchronize with the general business cycle and is in fact much more regular than the general business cycle.

Others were interested in understanding the effects of the general business cycle on the underwriting cycle. Chen, Wong and Lee (1999) reached the same results as previous researchers, and found that underwriting cycles are mainly related to the pace of economic growth. Besides, Leng and Meier (2006) found that factors affecting underwriting cycles, such as the economic environment and regulations, are country specific.

II.2.3-Interest rates

The underwriting cycle appears to be the result of the market's continuing attempts to clear. Therefore, traditional professional explanation of the cycle is that it is a disequilibrium phenomenon, revealing the inability of the market to converge on its clearing prices. Consequently, the cycle is evidence of a rational economic response to prevailing economic circumstances.

By referring to the rational expectations framework, insurance premiums reflect the present value of expected losses and expenses; Thus, higher discount rates imply lower premiums, other things being equal. Therefore, fluctuations in interest rates create insurance pricing cycles. The intuition is that higher interest rates generate greater investment income, which lowers premiums and vice versa. As a result, premiums are inversely related to interest rates, which is a general result of financial pricing models. Therefore, as interest rates rise (and discounted expected losses become smaller), the loss ratio is expected to increase. Thus, interest rates (i.e., prevailing capital market rates) affect the supply of insurance companies.

From another point of view, in a structural system, equilibrium prices are determined by both supply and demand. However, interest rates exhibit great volatility and, presumably, have a great capacity to cause external shocks in spot equilibrium insurance prices. However, though changes in interest rates would probably not result in such a clear cycle if adjustment was instantaneous, Doherty and Kang (1988) explored the fact that insurance prices are sensitive to interest rates and found that the latter do not exhibit a similar cycle to the underwriting cycle. Nevertheless, they suggested that meandering interest rates might be able to stimulate a regular insurance price cycle through the adjustment lags in the insurance market and explained the intertemporal behaviour of underwriting returns in insurance markets as a market clearing process, where equilibrium prices change in lagged response to changing interest rates.

Fields and Venezian (1989) noticed that previous studies analysing the cycles have used data on the underwriting rather than operating profit. Yet, calculation of the required rate of return on equity from entering the insurance business should reflect both underwriting income and income derived from the investment of reserves and net worth. Therefore, they introduced financial variables to reflect the effect of investment returns for individual lines of insurance. Their results show that the effect of interest rates on the profitability of insurers tends to be strong across all the lines. Furthermore, they found a high level of interrelationship between individual lines, which would accentuate the effects of interest rates on the profitability margin, hence, on the underwriting cycle. Besides, Smith (1989) tested the proposition that insurance policies' premiums reflect expected investment returns and found that insurers reflect expected investment income in premiums quoted to policyholders. Also, Haley (1993) studied how changes in interest rates, along with capital market changes, may affect underwriting pricing behaviour and insurers performance. His results indicated that interest rates and underwriting margins for stock property-liability insurers are negatively related and cointegrated. This implies that underwriting margins fluctuate around a long-term equilibrium relationship with interest rates. Therefore, a one-time shock to interest rates has a permanent, negative effect on underwriting margins.

In another attempt to study the influence of interest rates on the underwriting cycle, and by referring to the studies that attributed the cyclical behaviour of insurance profits to capital market constraints, Doherty and Garven (1995) wanted to link the capacity constraint hypothesis with the literature about interest rates. In fact, changes in interest rates simultaneously affect the insurer's capital structure as well as the equilibrium underwriting profit. Besides, insurance pricing models, which are based on financial theory, unanimously show that competitively determined insurance prices are inversely related to interest rates, hence, change as interest rates change. Alternatively, an obvious analysis is that insurers would be affected differently by changing interest rates, depending on the asset and liability maturity structure, capital access, and reinsurance availability. Therefore, as an answer to their question of "how to link the capacity constraints hypotheses with the literature about interest rates?", their argument was that when interest rates change, they affect not only the equilibrium price for insurance contracts, but they also change the market value of the insurer's asset portfolio. Besides, the insurer's liabilities are also sensitive to interest rate changes as well as being vulnerable to catastrophic events and changing liability rules. Thus, insurers are subject to shocks to surplus through both the asset and liability sides of their balance sheet. Moreover, the asset shocks (and to some extent the liability shocks) coincide with changes in the equilibrium prices of the default-free insurance contracts. Consequently, changes in interest rates cause changes in the level of underwriting profits required for market clearing. If the insurer operates with an asset/liability duration mismatch, however, the same interest rate changes also affect the value of the insurer's equity and disturb its capital structure.

Still, the significant factors that determine premiums differ from one line of business to another. Fung et al. (1998) studied premiums' response to unexpected changes in a multitude of variables, thus, providing insight into possible causes for cyclical trends in premiums. They found that, although the significant factors that determine premiums differ according to the line of business in question, interest rates considerably affect the premiums for most lines. Furthermore, one-time shocks to interest rates tend to be relatively permeant and highly volatile, which is in support of the existence of underwriting cycles. Hence, interest rates explain industrywide variations in premiums. They even explain, on different levels, the variations in premiums for a multitude of insurance lines.

Conclusion

Non-life insurance goes through price cycles that extend over several years. Actors in the insurance industry sometimes have to cope with extreme fluctuations in revenue and expenditure due to these price swings, which impact the insurance companies' profits and are detrimental to their performance. Attempts to understand the cycle, its causes and dynamics, showed that these fluctuations can originate from the supply side or from the demand side. Besides, the fundamental determinants of prices include predicted claim costs and underwriting expenses, riskless interest rates and systematic risk of claim costs and associated market risk premia that affects the discount rate for expected claim costs, and the tax and agency costs of holding capital to bond an insurer's promise to pay claims. Not surprisingly, there is abundant evidence that prove the impact of each of these factors on the underwriting cycle and how each contribute to the swings of insurance premiums.

Chapter II: Empirical framework

Introduction

Over the last years, researchers had a growing focus on underwriting cycles and insurance premiums dynamics. Multiple attempts were made to better understand the movements and causes of the cycle, where different possible explanations arose. Evidence for the insurance cycle is usually presented as a time series for underwriting returns accompanied by anecdotal evidence on availability and changes in insurance premiums. The latter are modelled using different insurance pricing models, each attempting either introducing a new approach and hypotheses, or improving an already existing model. However, any model has implications for the underwriting cycle, and it implies that the price depends only on certain variables. Consequently, each model implies that cycles in premiums and profits depend only on those exact variables. Nevertheless, each approach offers a certain insight into understanding underwriting cycles, notably, the cycle's dynamics and the factors that potentially play a role in premium determination.

Therefore, following previous works, which have focused on studying insurers' behaviour and analysing the underwriting cycle and, seeing the different developments this field has gone through, we choose to focus on understanding the dynamics of insurance profits in the Tunisian insurance industry. We have chosen the Autoregressive Distributed Lags model (ARDL) to be the basis of our analysis. This choice was based on the advantages the ARDL model offers, regarding its implementation where it doesn't require variables to be integrated of the same order, as well as in terms of analysis by providing the possibility of doing an extended analysis of both short-term and long-term dynamics.

This chapter is divided into four sections. The first contains an empirical literature review, presenting the evolution and changes in the modelling and hypotheses used by researchers to understand underwriting cycles. The second outlines the methodology that is to be used in our work; it presents the ARDL cointegration analysis, the different steps needed to perform such analysis and its potential in better understanding the cycle. In the third section, we do a brief presentation of the Tunisian insurance sector, along with a presentation of our sample, the relevant descriptive statistics of each variable as well as a couple of stationarity tests. The final section illustrates the different empirical results of our work, where we interpret the bounds test's results and the short and long-term dynamics of insurance profits.

I-Empirical Literature Review

Following the 1980s liability crisis, there was a growing interest in underwriting cycles and insurance premiums' dynamics. A considerable body of insurance literature has developed attempting to explain the recurrence of hard and soft markets in property-liability insurance. Therefore, seeing that a number of economic factors potentially play a role in premium determination (e.g. demand, losses, interest rates), different models were developed where each incorporates certain variables that are believed essential to explain the cycle. And, since any model of insurance pricing has implications for the underwriting cycle, a multitude of models are considered to be relevant to explaining the nature and causes of the cycles.

Venezian (1985) was the first to notice that the pattern displayed by underwriting profits resembles a cosine wave. This was a key factor in explaining underwriting cycles and it sparked research to explain this specific pattern. He hypothesised that this pattern could arise from second-order autoregression in underwriting profits. Therefore, he used a theoretical framework which has its impetus from observed autocorrelation in property-liability insurers' underwriting results and developed a model that portrays the second-order autoregressive behaviour of underwriting profits. This model tests the existence of the cycle and, if a cycle does exist, it would help determine its length. Furthermore, by regressing underwriting profits on a constant, he found empirical evidence supporting his hypothesis. In fact, his empirical findings prove the existence of cycles in several lines of insurance. Besides, he noted that the periods of the cycle among lines do not necessarily coincide. And, as he attempted explaining the causes of the second-order autoregression, he attributed it to insurers' naïve forecasting. However, he was not able to prove it empirically and showing conclusively that the cycle is attributable to extrapolative forecasting.

Following the work of Venezian (1985), Cummins and Outreville (1987) provide a more compelling explanation for the observed autocorrelation in underwriting profits. They develop an alternative model in the context of rational expectations, where second-order correlation among underwriting profits is produced by external factors rather than insurers' naïve rate making. Therefore, as they portray the cyclical behaviour of underwriting margins by a second-order autoregressive process, they note that cycles in reported underwriting profits are consistent with a simple rational expectations model of insurance price determination, provided that external factors (e.g. institutional lags and reporting practices) are taken into account. Their empirical results confirm the hypothesis that profits follow a second-order autoregressive process, which is created by combining informational and regulatory lags with renewal lags and calendar-year reporting practices.

Moreover, Lamm-Tennant and Weiss (1997) test both Venezian's (1985) and Cummins and Outreville's (1987) hypothesized explanations for the underwriting cycle. They test the hypotheses that underwriting profits follow a second-order autoregressive process, which is caused by either insurers' irrational pricing behaviour, or external factors like institutional intervention. Therefore, in order to determine whether underwriting cycles do exist in the insurance industries included in their study, they use a second-order autoregressive model. Their empirical results confirm those of both Venezian (1985) and Cummins and Outreville (1987). Besides, Chen et al. (1999) use the second-order autoregressive model proposed by Venezian (1985) to test for the presence of underwriting cycles in the Asian insurance market. Noticeably, they confirm the previous studies and note that second-order autoregression results support the existence of underwriting cycles. Hence, all the studies mentioned above prove that this methodology, which is used to verify the existence of the cycle as well as its length, is fairly accurate and acceptable.

Though these approaches are considered as a cornerstone in understanding the underwriting cycles, they use models that focus only on the supply side. Whereas, in order to determine equilibrium prices and their movements, it is essential to focus on the interactions between both supply and demand. Doherty and Kang (1988), aiming to explain the temporal movements of insurance prices, chose to enquire if observed price movements are simply changes in the levels required to clear the market. This requires the use of a structural model of the insurance market using functions representing both supply and demand. The essence of their work is to reduce the cycle in actual insurance prices to a cycle in the estimated clearing prices. In fact, their empirical results suggest that the cycle is resulted from the market's continuing attempts to clear, which implies that the insurance market is in a perpetual disequilibrium. Additionally, Lai et al. (2000) also use a model that is based on changes in both supply and demand for insurance. Their model partially synthesizes several stands of literature that tried to explain the underwriting cycle, and provides an additional cause, which is changing expectations about the parameters of corporate net income as causes of cycles and crises.

Nevertheless, though some advancements in understanding the underwriting cycle were made by these studies, the use of time series regressions has certain drawbacks that can lead to erroneous results. In fact, if the analysis uses nonstationary series, it can result in spurious correlation. Non-stationarity of the variables included in such studies was tested by researchers who have found that all variables, except for the interest rate, are non-stationary (Niehaus and Terry, 1993; Fung et al, 1998).

In order to overcome the limits of using regression analysis, Niehaus and Terry (1993) use Granger's and Sims' causality tests to examine hypotheses about the determinants of insurance premiums and causes of the underwriting cycle, which is more powerful in detecting interactions among variables than the methodologies of earlier studies. The aim of using this model is to test whether premiums "cause" losses, in the sense that future losses help predict premiums. Additionally, it tests on one hand, if losses "cause" premiums, and on the other hand, if surplus "causes" premiums. By using a vector autoregressive (VAR) model, they provide new evidence on the determinants of insurance prices. It made it clear how premiums are affected by future losses. Notably, their findings support previous researches and confirm the existence of cyclical behaviour in insurance prices. Besides, in an attempt to examine the causes of the underwriting cycle by testing the causal relationship and the dynamic interactions between premiums and losses in individual lines, Fung et al. (1998) also use a VAR model. They argue that the empirical support for the competing theoretical works has not incorporated a comprehensive study that simultaneously tests the hypotheses. In fact, they examine one specific hypothesis at a time, thus ignoring competing theories that emphasize other variables, which may cause variable specification errors. Hence, the use of VAR modelling, which avoids misspecification problems because it sets no restrictions on the structural relationship of the economic variables.

Still, though drawbacks of using regressions in analysing both insurance price dynamics and the underwriting cycle were put forward, researchers kept using regression analysis in developing new models and testing their hypotheses. As a matter of fact, the capacity-constraint hypothesis, which was introduced by Winter (1988) where he argues that it is necessary to explain the empirical features of underwriting cycles, was further tested and by other researchers over the years.

Winter (1988), putting forward the capacity constraint theory, developed a model of the dynamics of a competitive insurance market to explain the pattern of fluctuations in premiums and capacity.

Gron (1994) independently developed the implications of the capacity-constraint model and offered an impressive array of tests. By doing so, he tests the empirical relationship between capacity and underwriting margins. He provides empirical support for the primary predictions of the capacity constraint theory of property-liability insurance cycles. Besides, Winter (1994) further tests the capacity-constraint model by employing more realistic hypotheses and using a basic model for premium dynamics in a simple supply-demand approach, which offers a number of implications for competitive insurance markets and explains the pattern of relatively sharp changes in industry prices.

Other researchers opted for testing the capacity constraint hypothesis by developing more suitable models. Doherty and Garven (1995), trying a different empirical approach, join the interest rate and the capacity constraint model. Using GLS regression, their empirical results make it possible to explain the effect of interest rate shocks on underwriting profits, and how it can affect underwriting cycles. In fact, they present evidence of an asymmetry between interest rate movements and underwriting profits. Furthermore, their findings support the capacity-constraint hypothesis, where interest rates simultaneously affect the insurer's capital structure and the equilibrium underwriting profits. Other researchers use a model with endogenous capital, by developing a model of insurance supply with capacity constraints and endogenous insolvency risk that incorporates limited liability and potential loss of insurer intangible capital (Harrington and Danzon, 1994; Cagle and Harrington, 1995).

However, seeing that most previous works have focused on a couple of models of insurance pricing as theories of the property-liability underwriting cycle, and that each ignores the other models and their implications in understanding underwriting cycles, Choi et al (2002), with a main aim of constructing an empirical model that is sufficiently general to encompass the alternative models of underwriting cycles, chose to compare alternative models. Overall, their empirical findings present no evidence linking insurers' capacity to underwriting profits. Put differently, they contradict the capacity-constraint theory and state that capacity is not cointegrated with underwriting profits.

Moreover, a multitude of researchers attempt to better understand underwriting cycles by developing more suitable hypotheses and using models that would capture the economical reality of certain factors. Cummins and Danzon (1997), seeing that insurance is provided by firms that are subject to default risk, present the risky-debt hypothesis. They develop a model of price determination which takes into account insurers' default risk, hence, providing a new explanation of the relationships between loss shocks, capitalization, and prices in insurance markets. Their empirical results support their hypothesis and prove that the price of insurance is inversely related to insurer default risk. Furthermore, Ligon and Thistle (2007) develop a model of price competition between insurers where they maximize expected profit subject to a solvency constraint. Their aim was to grasp the economical reality of insurance markets, and how they are characterized by substantial incomplete information.

Previous studies have proven that a multitude of economic factors potentially play a role in premium determination (e.g., demand, interest rates, losses). However, their empirical approaches do not fully capture the dynamics of insurance premiums and underwriting margins. In fact, previous analyses only capture short-term dynamics. Yet, a large number of studies have used cointegration analysis, starting with Haley (1993). The underlying premise of cointegration analysis is that, while time series variables may be non-stationary, sometimes, due to a unique economic relationship between variables, a linear combination of these variables does not contain a unit root. Therefore, cointegration analysis can be of use to determine whether short-term or long-term relationships exist between premiums or underwriting profits and various economic factors (Engle and Granger, 1987). Haley (1993) presents empirical evidence that interest rates and underwriting margins for property-liability insurance are negatively related and cointegrated, implying that underwriting margins fluctuate around a long-term equilibrium relationship with interest rates. Furthermore, Haley (1995) extends his previous work by testing whether the cointegrating relationship that he found at the aggregate level also exists at the micro level. However, his results contradict with the accepted aggregate results, and show that the risk-free interest rate is not cointegrated with the underwriting margins of each line of insurance in the property-liability industry.

Additionally, Grace and Hotchkiss (1995) have used cointegration analysis to see the impact of external factors on the property-liability insurance cycle. Their empirical findings provide evidence of a long-run link between the general economy and the underwriting performance as measured by the combined ratio. Besides, Choi et al. (2002) compare alternative models of insurance pricing theories of the property-liability underwriting cycle. They examine the cointegrating relationship among insurance prices, interest rates, and surplus, and their findings confirm Haley's (1993).

The resort to cointegration analysis is attributed to the presence of unit roots in variables used in different studies, which makes it inappropriate to use conventional regression models. Harrington and Yu (2003) further test the commonly used variables for unit roots, and apply a battery of unit root tests to investigate whether underwriting margins are stationary under different assumptions concerning deterministic components in the data generating process. Their empirical findings, which reject the null hypothesis of a unit root for loss ratios, expense ratios, combined ratios, and economic loss ratios for many of the individual lines and for all lines combined, lead to a disagreement with previous studies that justified the use of cointegration analysis because of the variables' non-stationarity. And, in a series of articles based on varying sample periods, Leng et al. (2002), Leng (2006a, 2006b), and Leng and Meier (2006) also cast doubt on the finding of a unit root in underwriting profits.

These contradicting findings and reviews make it harder to understand the underwriting cycle. A major reason why the equilibrium relationship is difficult to reveal is that the time series characteristics of insurance profits is still not totally revealed. In fact, researchers have not reached a consensus considering underwriting profits' stationarity. And, cointegration is constrained to being conducted under Johansen's VECM framework, which requires underlying variables to be integrated of the same order. This raises a multitude of questions, where empirical results of previous studies imply that in order to better understand underwriting activities of insurance companies, efforts have to be made to develop a robust empirical model without requiring firm knowledge of the time series characteristics of underlying variables.

Jiang and Nieh (2012) sought a more flexible and robust empirical methodology that would overcome the limits of previous models, and they wanted to provide insight into underwriting cycles by simultaneously assessing the long-term and short-term effects. Therefore, they use the ARDL approach to cointegration. This method is applicable to test the single long-term relationship between underlying variables without requiring firm knowledge about variables' unit roots. Given the uncertainty concerning the time series properties of the variables, this methodology appears most appropriate in this context. Besides, it provided evidence of the level relationship between interest rate, industry capacity and insurance profits at the whole industry level.

Consequently, the use of more robust methodologies which would overcome the arguments of stationarity of insurance profits and make it possible to avoid examining whether underlying variables possess unit roots seems to be the suitable solution to better understand underwriting cycles. Jiang et al. (2019) used data generating process of methodologies, namely, the bounds testing procedure (Pesaran, Shin and Smith, 2001) and the ARDL test for threshold cointegration (Li and Lee, 2010). These types of tests are referred to as ARDL tests (Ericsson and Granger, 2002) and could provide both short and long-term implications of insurance profits simultaneously. This approach differs from the existing tests using the Engle and Granger (1987) type testing regression or the error correction model. In fact, an ARDL test does not test the significance of the coefficient of the cointegrating vector and cointegrating residuals. Nevertheless, it could provide more robust results. Furthermore, the authors employed the percentile of error corrections to indicate alternative regimes, which makes it more suitable to specify periods of hard/soft markets rather than using pre-specified periods.

II-Methodology

Following the methodology used in Jiang et al. (2019), we are interested in the relationship between underwriting profits, measured by loss ratio or the combined ratio, interest rates, investment income ratio and industry capacity. Our interest in these specific factors arises from previous works, where evidence has shown that interest rates and loss ratios are cointegrated (e.g., Haley, 1993; Choi et al, 2002). Besides, it is assumed that insurance companies set their underwriting policies for the upcoming year on the basis of current capacity (e.g., Berger, 1988). Jiang and Nieh (2012) propose a robust empirical methodology and provide evidence of the level relationship between interest rates, the insurance industry's capacity and underwriting profits. Moreover, two crucial business activities of insurance companies, underwriting and investment, may be related to each other (e.g., Ellis, 1990; Zou et al, 2012).

Therefore, we consider the following econometric specification at time t:

$$y_t = \alpha_0 + \alpha_1 r_t + \alpha_2 c_t + \alpha_3 IIR_t + u_t$$

Where y_t, r_t, c_t and IIR_t denote the measures of underwriting profits (i.e., measured by the loss ratio or the combined ratio), interest rates, the insurers' capacity (measured by a proxy) and investment income ratio, respectively. α is the estimated parameter and u_t is the equilibrium correction term.

The loss ratio and combined ratio are utilised as measures of non-life insurance underwriting profits of a given year, both are practically and traditionally employed as profit measures for evaluating purposes in the insurance industry, where

$$Loss\ ratio_t = {Claims'expenses_t}/{Earned\ premiums_t}$$

$$Combined\ ratio_t = {(Claims'expenses_t + Management\ fees_t)}/{Earned\ premiums_t}$$

Furthermore, industry capacity is defined as the amount of business insurance industry is able to write and is based on insurance companies' written premiums to their surplus. Following previous studies (e.g., Choi et al., 2002), we use industry capacity as the ratio of lagged aggregate policyholders' surplus to lagged net written premiums, which is a proxy for industry capacity, hence:

$$c_t = {Aggregate\ policyholders'surplus_{t-1}}/{Net\ written\ premiums_{t-1}}$$

Besides, in order to measure the investment performance of the insurance industry, we utilise the investment income ratio (IIR_t) where:

$$IIR_t = {Net\ investment\ income_t}/{Earned\ premiums_t}$$

We expect the estimated slope parameter, α_1, to be positive, since an increase in interest rates should also lead to an increase in loss ratios and combined ratios due to the fact the insurance price is charged based on discounted loss paid. The estimated slope parameter of the industry capacity, α_2, is also expected to be positive, since an appreciation of capacity causes companies to have more confidence to write more business and hence leads to increases in loss ratios and combined ratios. This model implies that there is a level long-run relationship between underwriting profits, interest rates, industry capacity and investment income ratio. Furthermore, according to Balke and Fomby (1997), threshold cointegration is considered as a two-step approach. The initial step consists of testing whether threshold behaviour is present by using the Engle-Granger linear cointegration test. The null hypothesis of no cointegration has to be rejected in order to proceed to threshold cointegration. Although there were improvement attempts to construct jointly a test for non-linearity and cointegration (e.g., Enders and Siklos, 2001; Li and Lee, 2010), we use the bounds test for cointegration provided by Pesaran et al. (2001), which provides profound flexibility for studying underwriting activity because it is irrespective of the order of the underlying variables. In fact, unlike other cointegration techniques, this bounds testing procedure neither requires pre-testing for unit roots, nor underlying variables to be cointegrated of order one. It provides an alternative test for the long-term relationship which could reduce the degree of uncertainty arising from the pre-testing stage of each series in the analysis of levels relations. Moreover, the bounds test is still valid in small samples and can be reliably used to estimate and test the cointegration relationship, and thus is very suitable in such a context (Jiang and Nieh, 2012).

Once the null hypothesis of no level relationship is rejected by the bounds test, we move forward and implement the Autoregressive Dependent Lags model (ARDL). Grouping the characteristics of the autoregressive models (AR) and the distributed lags models (DL), the ARDL model belongs to the dynamic models' family and, by taking into account the variables' temporal dynamics, it allows estimating both short-run and long-run dynamics for cointegrated series or, even series with different orders of integration. The ARDL model is represented as follows:

$$Y_t = \varphi + \alpha_1 Y_{t-1} + \cdots + \alpha_p Y_{t-p} + \beta_0 X_t + \cdots + B_q X_{t-q} + \varepsilon_t = \varphi + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=0}^{q} \beta_j X_{t-j} + \varepsilon_t$$

Where, ε_t is the error term and β_0 represents X_t's short run effect on Y_t. Therefore, to obtain the long-run relationship, noted λ, we have to go through the long-run equation, which is, in general, $Y_t = k + \lambda X_t + \mu$. Hence:

$$\lambda = \sum \beta_j \Big/ (1 - \sum \alpha_i)$$

We focus on evaluating the impact of interest rates, industry's capacity and the investment strategy of insurers on their profits (measured by the combined ratio and the loss ratio), for the whole insurance industry as well as for the general liability insurance, the automobile insurance and, the automobile liability insurance. Hence, we would be computing and interpreting the results of different models where $Y_t = f(r, IIR, c)$. Followingly, Y_t would take the values of either the combined or the loss ratio of the whole insurance industry or of each line of business included in our study.

Furthermore, aside from studying the short-term and long-term dynamics provided by the ARDL model, we are going to estimate an error correction model (ECM), which is a specification of the ARDL model, hence, supposing the existence of cointegration relationships between the variables. This model, compared to previous models, has the particularity of including an error correction term which, when significant, depicts the adjustment speed of the dependent variable, following a shock or any movement away from equilibrium. Hence, the ECM model is as follows:

$$\Delta Y_t = \pi_0 + \pi_t + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q-1} \beta_j \Delta X_{t-j} + \theta u_{t-1} + e_t$$

Where θ is the error correction term, in other words, the adjustment coefficient.

III- The Tunisian insurance industry: Data and sample

1-Tunisian insurance industry

Insurance is a cornerstone of the modern-day financial services sector. In fact, aside from its traditional role of risk management, insurance offers a panoply of services that promote long-term savings, thus, serving as a conduit to channel funds from policyholders to investment opportunities. Consequently, besides from reviewing the underwriting cycle, a worldwide phenomenon affecting the insurance industry as well as the international reinsurance markets, we focus on studying the Tunisian insurance industry to better understand its dynamics and the determinants of insurers' profits. Therefore, as a first step, it is essential to have an overall idea of the Tunisian insurance industry.

The Tunisian insurance market is composed of 22 local companies, including three Takaful providers, five operating in the life segment, one specializing in export credit and one reinsurer. The extensive presence of insurers leads experts to describe the market as overcrowded. Furthermore, though Tunisia's insurance sector has been growing steadily, with a rapid expansion of existing lines of business, such as life insurance, and the development of new ones (Takaful), it still suffers from a low penetration. In fact, as of 2018, the Tunisian insurance market has a penetration of 2.1%, compared to a world average of 6.1%. However, the expected implementation of a revised insurance code, along with efforts to improve key growth and profitability areas, including client services and risk management, should help the sector reach its potential in the future.

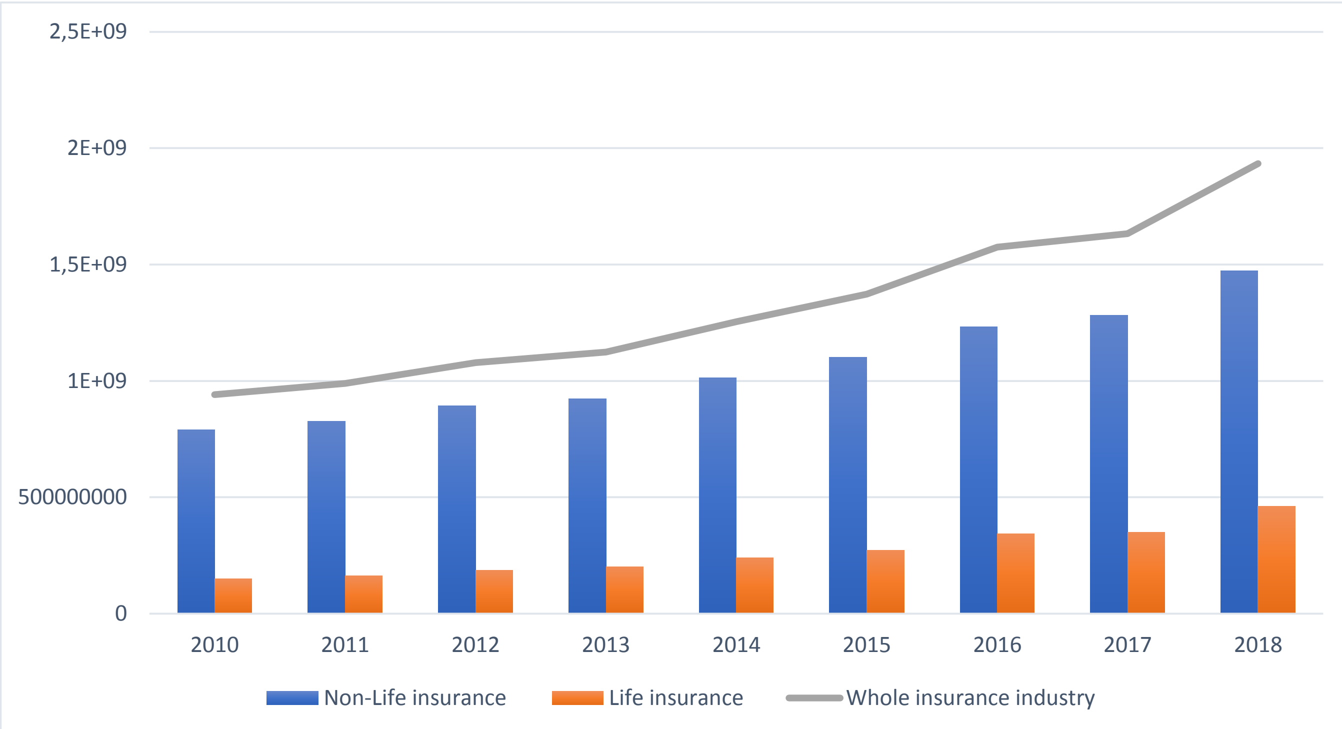

Figure 1: Evolution of the Tunisian insurance sector (Turnover)

Figure 1 illustrates the evolution of the Tunisian insurance sector's turnover over a period spanning from 2010 to 2018. It shows the progress of the non-life insurance, the life insurance and, the whole insurance industry. It confirms the steady growth of the Tunisian insurance industry, where the turnover of each of the non-life insurance and the life insurance are increasing from year to year. However, in contrast to the experience in the developed countries, where life assurance and annuity constitute a significant proportion of market premium income (around 50%), life insurance in Tunisia is still low, representing about 22% of market production in 2018. Furthermore, the non-life insurance is, in its turn, dominated by the automotive segment, mainly because, as in many other markets, third-party civil liability vehicle insurance is mandatory.

This overall idea of the Tunisian insurance market, where we have witnessed the significance of non-life insurance, as well as the turnovers' steady growth (hiding the phenomenon of underwriting cycles), makes it more appealing to study the underwriting cycle and the dynamics of insurance profits in the Tunisian context.

2-Data description

In our work, the loss ratio and the combined ratio are utilised as measures of non-life insurance underwriting profits of a given year. Both are practically and traditionally employed as profit measures for evaluating purposes in the insurance industry. We apply annual Tunisian insurance industry data during the period 2004-2018 from the annual reports provided by insurance companies to the supervisory authority, The General Insurance Committee. Specifically, we investigate not only the whole non-life insurance industry (all lines combined), but also general liability insurance, which is traditionally considered as a “long-tail” business. The tail of an insurance line means the time between the accident event and actual compensation pay-off. The general liability insurance, which can extend over several years to the settlement, is conventionally viewed as a risky line that increases the risk of large errors in forecasting ultimate claims both in payment time and amount. Furthermore, seeing its importance in the Tunisian insurance industry, we choose to study automobile insurance. In fact, in 2018, Automobile insurance represents nearly 44% of the industry’s total turnover, and about 56% of non-life insurance turnover. However, automobile insurance is the leading line of business because the automobile liability insurance (i.e., third party civil liability vehicle) being compulsory. Hence, we incorporate the latter in our study.

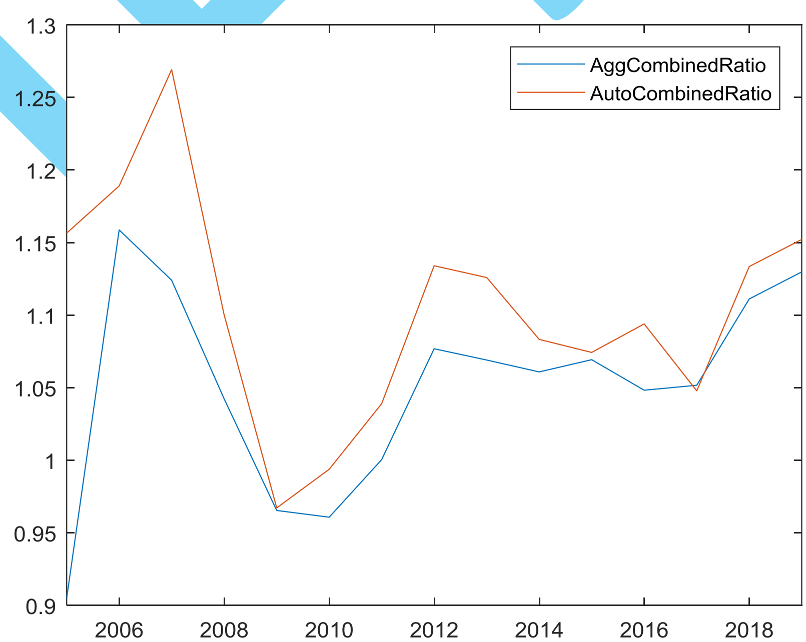

Figure 2: whole insurance industry and Automobile insurance combined ratios

To better accentuate the presence of underwriting cycles in the Tunisian insurance industry, it is essential to, as a first step, start by analysing figures representing the evolution of the combined and loss ratios of each line included in our study as well as of the whole non-life insurance industry. Figures 2 and A.1 represent, respectively, the combined and loss ratios of the whole non-life insurance industry and the automobile insurance. Whilst figures A.2 and A.3 represent those of the general liability and the automobile liability insurance. It is noticeable that, in all figures, the ratios exhibit, though not to the same degree, similar fluctuating behaviour. Not really a regular cycle with predictable pattern, they seem to be a result of a dynamic system with slow adjustment and possibly inadequate damping.

Table 1 Descriptive statistics and stationarity tests for the whole insurance industry and automobile insurance

	Whole insurance industry		*Automobile insurance*				
	Combined Ratio	Loss Ratio	Combined Ratio	Loss Ratio	Industry Capacity	Investment Income Rate	Interest Rates
Mean	1.062002	0.806672	1.100194	0.876947	0.178295	0.101295	4.833571
Maximum	1.158680	0.936540	1.269142	1.084475	0.572597	0.124851	7.240000
Minimum	0.960705	0.746440	0.967098	0.786105	-0.321880	0.081438	3.230000
Std. Dev.	0.058574	0.059873	0.077749	0.089648	0.296929	0.012203	0.915924
Skewness	-0.243422	1.038197	0.304694	1.153156	-0.576750	0.263716	0.920863
Kurtosis	2.366600	3.067553	3.064105	3.382306	2.062976	2.349277	4.849273
Jarque-Bera	0.372290	2.517654	0.219020	3.188053	1.288335	0.409282	3.973528
ADF test (levels)	-2.880846*	-4.167601**	-3.083470*	-2.439104	-1.666265	-4.467127**	-1.113099
ADF test (first difference)	-3.666588**	-3.188819**	-4.251893**	-6.113110**	-2.790005*	-5.307417**	-2.878939*
PP test (levels)	-3.480276**	-2.449222	-1.840802	-2.269546	-2.051880	-7.592898**	-1.113099
PP test (first difference)	-5.137470**	-4.153425**	-2.902999*	-2.543726*	-2.748447*	-8.471381**	-2.878939*
KPSS test (levels)	0.229509**	0.243749**	0.133185**	0.391977**	0.510561*	0.266170**	0.161706**
KPSS test (first difference)	0.136851**	0.125696**	0.241410**	0.156582**	0.205748**	0.198520	0.275044**

Note: *, ** significant at the 10% and 5% levels, respectively

Source: Author's calculations.

PP = Phillips and Perron unit root test with H0: Variables are of I (1); KPSS = Kwiatkowski, Phillips, Schmidt, and Shin unit root test with H0: Variables are of I (0).

In addition to verifying the existence of a cyclical behaviour using the combined and loss ratios' plots, we would now address the variables' descriptive statistics as well as the results of a couple of unit root tests. Tables 1 and A.1 represent the descriptive statistics and the results of unit root tests of relevant variables in this study. We notice that the means of the combined ratios go from 0.689 for the general Liability, to 1.453 for the automobile liability. Similarly, the lowest loss ratio is that of the general liability, with a loss ratio of 0.455, and the highest is 1.254 for the automobile liability insurance. The variables' standard deviations, which measure their fluctuation around their means, are relatively small. This is probably due to the low variability of each variable. As for the Jarque-Bera test, it tests the studied times series' distribution under the null-hypothesis that it is normally distributed. With different skewness and kurtosis levels for each variable, the results of the test indicate that all variables are normally distributed (P-Value > 0.05).

As for testing for the existence of unit roots, we choose to compute different tests, namely the Augmented Dickey Fuller test (ADF), the Phillips-Perron test (PP) and, the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The ADF test statistics suggest that all variables are integrated of order 1 except for the industry capacity and the interest rate. Similarly, the Phillips-Perron test statistics also suggest that most variables are I(1) except for the industry capacity and interest rate, as well as the loss and combined ratios of the Automobile insurance line. KPSS test statistics, however, suggest that all variables are stationary (i.e., all variables are I(0)). The overall unit root test results demonstrate the inconsistency in the integration order of variables in question and support the use of the Bounds testing approach for the subsequent empirical results.

IV-Empirical results

IV.1 Bounds test results

As we are aiming to study both the short and long-run dynamics of insurance profits, along with the impact of interest rates, insurers' capacity and, the investment performance of the insurance industry on the said dynamics, it is crucial to start by testing for the existence of a cointegrating relationship between the different variables. In fact, performing a cointegration test is necessary to establish a long-run relationship. Therefore, we resort to the bounds test, which was put forward by Pesaran et al. (2001). This test is the only one suitable for testing cointegration between variables with different integration orders that don't exceed I(1).

The test's null hypothesis is that there is no cointegration between the variables. By comparing the F-statistic to the different bounds' critical values, we can either reject or accept the null hypothesis. And, in certain cases, the test's results could be inconclusive. In fact, if the F-statistic is greater than the critical value for the upper bound (i.e., I(1)), the null hypothesis of no cointegration is rejected. That is, there is a long-run relationship. Otherwise, if the F-statistic is lower than the critical value for the lower bound I(0), the null hypothesis is accepted and the drawn conclusion is that there is no cointegrating relationship between the variables. However, if the F-statistic is comprised between the critical values of the lower bound and the upper bound, the test is considered inconclusive.

Table 2: Bounds test statistics.

	Combined Ratio		*Loss Ratio*	
	Restricted intercept	Unrestricted intercept	Restricted intercept	Unrestricted intercept
Whole insurance industry	11,12536**	13,04009**	17,71749**	22,14555**
Automobile insurance	1,853042	2,28522	3,260106*	3,94647*
Automobile liability insurance	16,76936**	18,31739**	21,83680**	24,31119**
General liability insurance	1,16688	1,900995	1,16688	1,212176

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: Author's calculations

Table 2 shows that the null hypothesis maintaining non-existence of the level relationship is rejected for the whole insurance industry and the automobile liability insurance, irrespective of whether the underlying variables are I(0) or I(1). However, it is accepted for both the automobile insurance and the general liability insurance, except for the case where automobile insurance profits are measured by the loss ratio, the hypothesis is rejected at the 10% level.

By establishing that there exists a cointegrating relationship between the variables for the whole insurance industry and the automobile liability insurance, we can conclude that models are appropriate for both the restricted intercept and unrestricted intercept cases. Followingly, the econometric specification that there is a level relationship between underwriting profits, interest rates, and the industry capacity is valid as the basis of ensuing threshold cointegration analysis. The latter, based on the fact that series are related and can be combined in a linear fashion, offers an estimation of both long-run and short-run models. That is, even if there are shocks in the short run, which may affect movements in the individual series, they would converge with time (in the long run).

IV.2 ARDL model's results

In order to empirically test the long and short run dynamic interactions among the variables of interest, we apply the autoregressive distributed lag (ARDL) cointegration technique. The ARDL cointegration approach was developed by Pesaran and Shin (1999) and Pesaran et al. (2001). It has three advantages in comparison with other previous and traditional cointegration methods. The first one is that the ARDL does not need that all the variables under study must be integrated of the same order and it can be applied when the underlying variables are integrated of order one, order zero or fractionally integrated. The second advantage is that the ARDL test is relatively more efficient in the case of small and finite sample data sizes. The last and third advantage is that by applying the ARDL technique we obtain unbiased estimates of the long-run model.

IV.2.1 Short term dynamics

We would start by interpreting the short-run dynamics of insurance profits and the effects of interest rates, insurers' investment strategy as well as their underwriting capacity on short term dynamics. Table 3 and Table A.2 represent the ARDL model's results for the short run dynamics of the different insurance lines included in our study, where the combined ratio and the loss ratio are used as endogenous variables, respectively. The short-term effect is represented by current or lagged changes of variables. To better understand the effect of each endogenous variable on insurers' profitability, we would interpret the coefficients of each variable (i.e., level and lagged) independently.

Table 3: ARDL model results – Short-term dynamics of insurance profits

	Whole insurance industry	*Automobile insurance*	*Automobile liability insurance*	*General liability insurance*
Constant	0,808897**	1.165533**	0.068155	0.304417
Y_{t-1}	0,587208**	0.124807	0.647793**	0.149677
Y_{t-2}	-0.283414**	-	-	-
c_t	0.004243	-0.345248	0.315061*	0.170406
c_{t-1}	0.119561	0.306933*	-0.588409**	-
c_{t-2}	-	-	0.747593**	-
IIR_t	-1.475049*	-2.295105	7.446736**	-4.229750
IIR_{t-1}	-0.955196	-	-1.243521	4.837437
R_t	0.208438	1.035203	-4.762527	4.428541
R_{t-1}	2.924245	-	-	-

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.

We choose to focus on the models where insurers' profitability is measured by the combined ratio. First, we would start by studying the effects of the combined ratio's past values on insurers profitability. The one year lagged combined ratio has the same, positive, effect on the profitability of the whole insurance industry, as well as on the profitability of the different insurance lines included in our study. However, when the combined ratio is lagged by two years, it only affects the whole insurance industry, negatively. Second, the capacity proxy shows that insurers' capacity positively affects their profitability, except for the automobile insurance line and, for the automobile liability insurance for the one year lagged capacity. Third, the investment income ratio (both the level ratio and the one year lagged ratio) negatively affects insurers' profitability, except for the level ratio in the case of automobile insurance, and the one year lagged ratio in the case of general liability insurance, where their effects are positive. At last, the level interest rates' coefficients are positive in all the cases except for the automobile liability insurance. As for the one year lagged interest rates, it only affects, positively, the whole insurance industry's profitability.

Moreover, when insurers' profitability is measured by the loss ratio rather than the combined ratio, there is no considerable difference in term of interpretation or impact. In fact, though the coefficients, as we have interpreted, might give an idea of how insurers' profits behave following a change in any of the exogenous variables (i.e., interest rates, insurers' capacity and, investment income), the short-term effect seems to be relatively small due to the insignificance of the coefficients.

IV.2.2 Long term dynamics

Following the bounds test, we have established that a long-run relationship exists for the whole insurance industry and the automobile liability insurance. Whereas, the test indicated that there is no cointegrating relationship for the general liability insurance. As for the automobile insurance, the long-run relationship is only established at the 10% level. Followingly, the long-run results of the ARDL test would only be significant for the lines that do exhibit long-run behaviour. However, we choose to interpret the long-run results of the ARDL model for all the cases in order to acquire an idea on the behaviour of insurers' profitability following a hard market. Table 4 and Table A.3 show the model's long-run form for both the combined ratio and the loss ratio, respectively. Each variable's coefficient represents its impact on insurers' profitability in the long-run.

Table 4: ARDL model results – Long-term dynamics of insurance profits

	Whole insurance industry	*Automobile insurance*	*Automobile liability insurance*	*General liability insurance*
Constant	1.161865**	1.331744	0.193508**	0.358002
c_t	0.177827**	-0.043779	1.346494	0.200401
IIR_t	-3.490698**	-2.622399	17.61239*	0.714654
R_t	4.499649*	1.182828	-13.52194**	5.208068

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.

Focusing on the case where the combined ratio is used to measure insurers' profitability, first, we notice that insurer's capacity positively impacts the dependent variable in all cases, except for the automobile insurance's combined ratio. Second, interest rates too have a positive effect on insurers' profitability in all cases with the exception of automobile liability insurance. Finally, investment income negatively affects insurance profits for the whole insurance industry and automobile insurance, whereas its effects are positive for the other two lines included in our study (i.e., automobile liability insurance and general liability insurance). Now, when the loss ratio is the endogenous variable, there is only a couple of differences. On one hand, insurers' capacity negatively affects the profitability of the whole insurance industry. And, on the other hand, interest rates' effect on general liability insurance is also negative rather than the positive effect it has when profitability is measured using the combined ratio.

Even though the prior analysis gives an overall idea on the effects of each factor on the insurance industry's profitability, we still need to recourse to the Error Correction Model (ECM). Interestingly, the ECM is a restrained form of the ARDL model, and it has the particularity of including a term that estimates the speed of adjustment to equilibrium in a cointegrating relationship. In fact, the coefficient of the said term gives the speed of adjustment from a short-run out-of-equilibrium position to the long-run equilibrium. As shown in Table 5, which presents the results of the Error Correction Model, all the coefficients of the error correction term are significant. In the case where the combined ratio is the measure for insurers' profits, the adjustment speed is the highest for automobile insurance, where 87.52% of any movements into disequilibrium are corrected for within one year, followed by the adjustment speed for general liability insurance, which amounts to 85.03% adjustment percentage per year. The adjustment speed for the whole insurance industry is approximately 70%, whereas the lowest adjustment is that of the automobile liability insurance, which amounts to only 35.22%.

Table 5: Error Correction Model: Adjustment speed to equlibrium

	Combined Ratio	*Loss Ratio*
	Error correction coefficient	Error correction coefficient
Whole insurance industry	-0.696206**	-1.013200**
Automobile insurance	-0.875193**	-1.613868**
Automobile liability insurance	-0.352207**	-0.409074**
General liability insurance	-0.850323**	-0.501046**

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.

The adjustment to equilibrium is also significant for the different models where the endogenous variable is the Loss ratio. However, the speed of adjustment is considerably lower for the general liability insurance, where it amounts to only 50%. Whereas it became around 40% for the automobile liability insurance. Nevertheless, though the coefficients for the whole insurance industry and automobile insurance are significant, the coefficients imply an adjustment speed that exceeds 100%. Thus, a number of interpretations arise. That is, there is an over correction to equilibrium, which could mean that there is no sustainable equilibrium or, that short run dynamics drive the model towards equilibrium (towards a steady state in the long run), which implies that the long-run relationship is not valid.

Conclusion

The body of literature explaining the underwriting cycle has evolved during the years, and the attempts to better understand the cycle kept on trying to overcome the drawbacks and limits of previous works. However, many studies ignore the possibility of cointegrating relationship among variables. For models estimated in difference form, this implies that all effects are considered to be short-run effects. It could also mean that models would suffer from omitted variable bias. Besides, it is important to distinguish between long-run cointegrating relationships and short-run dynamics. Hence, the importance of cointegration analysis in understanding the underwriting cycle became clearer, as it can be used to determine if premiums and underwriting profits are indeed related to the number of economic factors that potentially play a role in price determination.

The adoption of a cointegration approach enabled us of better understanding both short and long-run dynamics of insurance profits. In fact, the results of the ARDL model imply that the short-term effect is relatively small. Hence, the error correction to equilibrium seems to be the main effect of underwriting profits' dynamics, making it move more like a cycle. However, the dynamics of underwriting profits being cyclical may not necessarily mean that it will return to a given level of the past, and can occur around a long-term trend in profitability and availability of insurance. Moreover, the models where the existence of a long-run relationship was proven by the bounds test exhibit a significant positive long-run level relationship between underwriting profits, interest rates and investment income ratio.

Conclusion

The aim of this study is to understand the underwriting cycle's dynamics. Traditional approaches of analysing the cycles are focused on time series analyses, such as using cointegration analysis, or modelling the market performance over time as a second-order autoregression process, or developing a regime-switching model to analyse performance between soft and hard markets. Most of existing theories of underwriting cycle attempt to explain cycles through discovering exogenous factors, such as entry-exit of insurers, unexpected regulatory changes, capital flow in and out from the market, cycle in interest rates, etc. However, the investigation of speculative behaviour in insurance markets, compared with equity markets, is still underdeveloped in the literature. We try to understand the cycle in the Tunisian insurance industry by, first using the bounds testing procedure in order to verify the existence of a long-run relationship between insurers' profits, interest rates, underwriting capacity and investment income. Then, we used the Autoregressive Dependent Lags model (ARDL) to depict the short and long-run dynamics of insurance profits for the whole insurance industry, as well as for automobile insurance, automobile liability insurance and, general liability insurance. The results are in line with the prediction of Ligon and Thistle (2007) in which the underwriting profits should be cyclical and change asymmetrically. Possible explanations of asymmetric adjustments are that insurance companies may not have the same degree of information perception and their expectations may be heterogenous. Consequently, the interactions between these different insurance companies can imply delays and asymmetries in loss ratio/combined ratio adjustment and introduce a visualised cycle in the insurance market. In the current study, we have evidenced the behaviour of insurance profits in the short-run and in the long-run, that is, positive impacts of interest rates, investment income and insurance capacity are pronounced in the long-run, due to their significant coefficients, unlike in the short-run where the insignificance of the coefficients implies that short-term effects are relatively small. This implicates insurance practitioners and regulators alike. On one hand, to gain a competitive hold in a soft market by cutting prices or relaxing underwriting criteria is indeed a gamble. It might make insurance companies appear profitable in the short term but cause greater loss exposures and have to pay more claims in the future. Therefore, to prevent aggressive risky decisions, insurance companies need to monitor their own underwriting policy. On the other hand, insurance markets are competitive, and that competition leads to an efficient supply on insurance. Therefore, regulation should be utilized only when absolutely essential and should be designed not to interfere with the operation of competitive insurance markets or create unintended consequences. However, primary insurance market prices are regulated, where the objective of insurance price regulation is making coverage available and affordable to consumers. Whereas, regulation does not necessarily accomplish these objectives and tends to distort market outcomes, leading to various types of market inefficiencies. In fact, insurance prices regulation leads to inadequate pricing, where the insureds would pay either higher or lower than the real price for the coverage they are purchasing. Besides, it leads to “price stickiness”, which is the inability of insurers to adjust prices quickly in response to changing market conditions. Consequently, regulations that prevent appropriate pricing, as well as instantaneous premiums adjustment, has a detrimental impact on availability and on future premiums, which more than offsets any benefit of lower current rates. The obvious solution for the drawbacks of insurance prices regulations is, as proposed by Cummins (2007), the deregulation of insurance prices.

Additionally, a limitation of this study is that the impact from global reinsurance markets, which may also be subject to cyclical dynamics (Cummins, 2005; Cummins and Weiss, 2009), has not yet been considered in this context. It would be interesting to extend the analysis in the hope of capturing indirect inks between primary insurers’ underwriting activities and reinsurers’ strategies.

Appendix

Figure A.1: Loss ratios of the whole non-life insurance industry and the automobile insurance

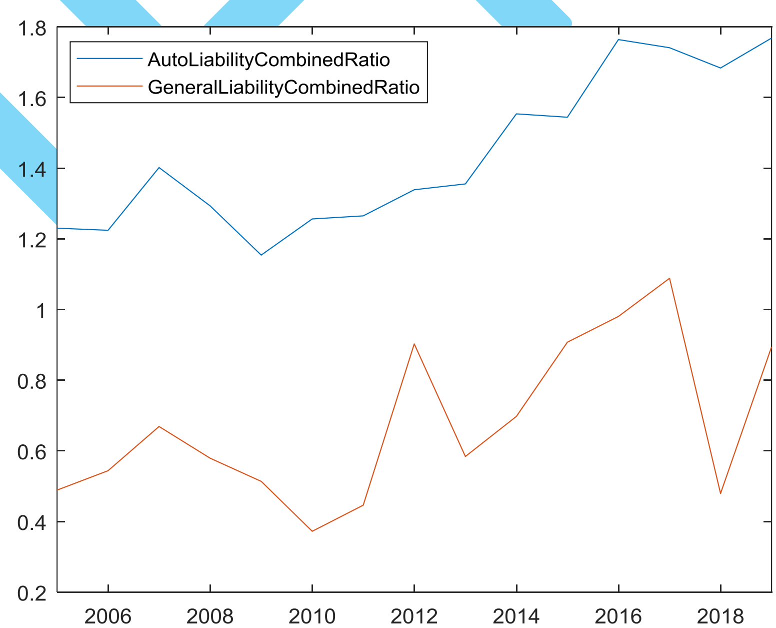

Figure A.2: Combined ratios of the Automobile liability insurance and the General liability insurance

Figure A.3: Loss ratios of the Automobile liability insurance and the General liability insurance

Table A.1: Descriptive statistics and unit root tests for the Automobile liability insurance and the General liability insurance

	Automobile liability insurance		*General liability insurance*	
	Combined Ratio	Loss Ratio	Combined Ratio	Loss Ratio
Mean	1.453211	1.254887	0.689743	0.455773
Maximum	1.768352	1.533560	1.088283	0.801262
Minimum	1.154062	0.989501	0.372144	0.183729
Std. Dev.	0.217891	0.183593	0.225102	0.211086
Skewness	0.305035	0.361982	0.345389	0.328150
Kurtosis	1.598597	1.771565	1.799377	1.681722
Jarque-Bera	1.362734	1.186020	1.119224	1.265009
ADF test (levels)	-0.518436	-0.832457	-2.633636	-3.256396**
ADF test (first difference)	-4.470714**	-4.762887**	-5.212578**	-3.114123**
PP test (levels)	-0.330009	-0.601912	-2.596091	-3.256396**
PP test (first difference)	-4.463515**	-4.974470**	-9.627981**	-11.03964**
KPSS test (levels)	0.524771**	0.510938	0.415627**	0.403281**
KPSS test (first difference)	0.166875**	0.373447**	0.500000**	0.464286**

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.

PP= Phillips and Perron unit root test with H0: variables are of I(1); KPSS= Kwiatkowski, Phillips, Schmidt, and Shin unit root test with H0: variables are of I(0).

Table A.2: Table 3: ARDL model results – Short-term dynamics of insurance profits

	Whole insurance industry	*Automobile insurance*	*Automobile liability insurance*	*General liability insurance*
Constant	0.862792**	1.700615**	-0.124944	-0.051053
Y_{t-1}	0.422642*	0.006806	0.590926**	0.498954
Y_{t-2}	-0.435842**	-0.620674*	-	-
c_t	-0.097869	-0.383018**	0.240161*	-0.929201
c_{t-1}	0.061291	-	-0.633567**	0.989957
c_{t-2}	-	-	0.835585**	-
IIR_t	-1.639012**	-2.598093	8.118731**	0.970630
IIR_{t-1}	-	-	-	15.05091
IIR_{t-2}	-	-	-	-7.225057
R_t	0.679817	1.282780	-4.568310*	-5.566762
R_{t-1}	0.862792**	-	-	8.240037
R_{t-2}	-	-	-	-14.76411

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.

Table A.3: ARDL model results – Long-term dynamics of insurance profits

	Whole insurance industry	*Automobile insurance*	*Automobile liability insurance*	*General liability insurance*
Constant	0.851551**	1.053751**	-0.305432	-
c_t	-0.036101	-0.237329**	1.080926**	0.121258
IIR_t	-1.617658**	-1.609854	19.84660**	17.55626
R_t	2.562814*	0.794848	-11.16744	-24.13121

Notes: *, ** significant at the 10% and 5% levels, respectively.

Source: author's calculation.