A Reexamination of Excess Returns and the Underwriting Cycle in the Property-Liability Insurance Market

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March 27, 2022

Abstract

This paper presents empirical evidence that the underwriting cycle in the property-liability insurance industry is well explained by shifts in the supply of insurance, in accordance with the capacity constraints hypothesis. The shift in supply of insurance is shown to be brought about by changes in the anticipation of excess risk-adjusted returns on writing insurance, as opposed to investing in alternative investment opportunities. The return on alternative investments itself is also shown to be correlated with the underwriting cycle, as is extraordinary catastrophic losses, insurer retirements and the inflation rate. The study uses quarterly data from the period 1980 through 2021 and finds that the insurance industry has grown considerably in financial strength over the study period, which further exhibits a strong relationship with the underwriting cycle.

1. Introduction

The cyclical nature of underwriting profits in the property-liability insurance industry, known as the underwriting cycle, is considered an important phenomenon both in the industry and in the academic literature. It has been studied extensively, across several insurance lines, time periods, and countries. This paper extends the work of Browne and Hoyt (1992) to present evidence that, over a period of 42 years, the underwriting cycle is well explained by shifts in the supply if insurance.

Underwriting cycles are typically portrayed as a sequence of alternating hard markets, or periods of rising premiums and increasing insurer profitability, and soft markets, or periods characterized by declining premiums and decreasing insurer profitability. In a soft market, coverage is readily available, while the supply of insurance is more limited during a hard market.

Three competing theoretical explanations are often suggested to explain the existence of the underwriting cycle, namely the irrational behavior hypothesis, as proposed by Venezian (1985), the rational-institutional hypothesis, as advanced by Cummins and Outreville (1987), and the capacity constraints hypothesis, as put forward by Gron (1994). According to the irrational behavior hypothesis, the underwriting cycle results from insurers reacting, and also over-reacting, to unanticipated events such as claim rates that deviate from prior expectations and interest rate changes. In contrast, the rational-institutional hypothesis emphasizes rationality in the insurance market and argues that the underwriting cycle is attributable to institutional, accounting and regulatory factors outside of the insurers' control. Under the rational-institutional hypothesis, it is often argued that since the underwriting cycle is a result of the characteristics of the insurance market environment, institutional changes could ultimately eliminate the cycle.

The capacity constraints hypothesis posits that the difference in the cost of internally generated capital and external capital leads to the underwriting cycle. According to the capacity constraints hypothesis, shocks to insurer capital will therefore affect both the supply and the cost of insurance.

Empirical work in the 1980s attributed the observed underwriting cycle to reporting delays and the resultant procedural lags in rate-making (Venezian, 1985), regulatory lags and supervisory influences (Cummins and Outreville, 1987; Winter, 1991), and macroeconomic changes, particularly in interest rates (Doherty and Kang, 1988). These studies typically supported either the irrational behavior hypothesis or the rational-institutional hypothesis, with several authors documenting an underwriting cycle with a period of approximately 6 years (Haley, 1993).

In the 1990s, however, a supply-side explanation supporting the capacity constraints hypothesis gained considerable traction. Gron

(1994), in particular, found support for the capacity constraints hypothesis and concluded that the underwriting cycle is not a product of institutional lags and reporting practices, but instead the result of unanticipated decreases in capacity, which lead to higher prices and greater insurer profitability. Doherty and Garven (1995) further argued that the cyclical nature of underwriting profits are exacerbated by the extent of asset-liability mismatches in the capital structure of insurers and the ease with which external capital and reinsurance can be accessed.

The supply-side explanation argues that a growing surplus, accumulated from past industry profits, will result in additional capacity and lead to a shift in the supply and price of insurance (Berger, 1988). An inverse relationship between insurer surplus and premium rates, as observed by Niehaus and Terry (1993), is consistent with the capacity constraints hypothesis. A strong positive relationship between the industry combined ratio and the insolvency rate in the industry provides further evidence of a link between underwriting profitability and the level of competition in the market (Browne and Hoyt, 1995).

In contrast to the theories put forward to explain the existence of the underwriting cycle, Boyer, Jacquier, and Van Norden (2012) and Boyer and Owadally (2015) contend that the pattern of alternating periods of high and low profits in the property-liability insurance industry has no cyclical component. They assert that the pattern of underwriting profits follows a random walk process. In this vein, Henriet, Klimenko, and Rochet (2016) conclude that insurance prices are characterized by asymmetric reversals, rather than pure cycles, and that the market exhibits alternating periods where premiums and profitability rise (hard markets) and fall (soft markets). Henriet et al. (2016) further find that the average duration of hard markets is shorter than that of soft markets, provided that the elasticity of the demand for insurance is not too low.[1]

Our contribution is that we view writing insurance as one of many investments than can be made by an insurance firm. Consequently, we expect more funds to flow towards the writing of insurance when there is greater potential for making an underwriting profit.

While insurance prices may not necessarily be periodic and forecastable, they do reflect past insurance losses. The underwriting "cycle" can thus be viewed as the oscillation between periods when capacity is recovered in a hard market, and a subsequent period when increased competition drives premiums down in a soft market. Shocks to insurer capacity, from large catastrophic losses, changes in the economic environment, and market participant disturbances, are therefore expected to have a significant bearing on the underwriting cycle.

Lamm-Tennant and Weiss (1997) have shown that catastrophic losses, in particular, exert a significant influence on global

[1] The longer duration of soft markets might be a result of barriers to exit from the insurance industry being greater than the barriers to entry.

underwriting cycles and the supply of insurance. Dicks and Garven (2022) argue that it is precisely the uncertain impact of catastrophes that leads to the underwriting cycle, as insurers are at an informational advantage relative to investors in knowing their own catastrophic exposure. The capital-raising ability of all insurers is thus hampered by the occurrence of catastrophes, regardless of the insurer-specific impact (Harrington, 1992). The influence of catastrophic losses on the underwriting cycle is therefore expected to endure, as the accumulation of reserves in anticipation of major catastrophic losses is suppressed by political pressure from consumer advocates who view large reserve accumulations as evidence that premium rates are excessive.

Regardless of whether the interchange between hard and soft markets is indeed cyclical, the property-liability insurance industry continues to recognize the underwriting cycle as part of the property-liability insurance market mechanism and habitually refers to both hard and soft market conditions (Insurance Information Institute, 2021).

The shift in supply is shown to be brought about by changes in the anticipation of excess risk-adjusted profits on writing insurance, relative to alternative investment opportunities. Changes in the alternative investment opportunities themselves, represented by changes in the real risk-free rate, are also shown to be correlated with the underwriting cycle. Extraordinary catastrophic losses, insurer retirements, and the inflation rate are further revealed to be positively correlated with the industry combined ratio. The results of the paper are in accordance with the capacity constraints hypothesis.

The property-liability insurance industry is further shown to have grown significantly in financial strength over the study period. We believe this is a result of the adoption of risk-based capital regulations in the mid-1990s, and the general emphasis on solvency regulation subsequently. We find a negative correlation between the combined ratio and the level of capital in the insurance market, and present this relationship as evidence of market discipline.

The paper proceeds as follows. Writing insurance as an investment decision is discussed in the next section. In Section 3, we describe our method for measuring excess returns on property-liability insurance stock, providing justification for the methodology. Our hypotheses are developed and summarized in Section 4. Our empirical model and results are reported in Section 5, and concluded in Section 6.

2. Writing insurance as an investment decision

We view writing insurance as one of many investments than can be made by a property-liability insurer. In addition to the common investment choices such as purchasing a bond or purchasing stock (equity), property-liability insurers can also invest their capital in the writing of insurance. The use of insurer capital to underwrite risk thus competes with alternative uses of the capital.

Consider a representative property-liability insurer, assumed to be risk-neutral with total capital K. The representative insurer will allocate a fraction τ of its capital to writing insurance and invest the remainder in the capital market. The return earned on the capital invested in underwriting is given by η, so that the value function of the insurer can be expressed as

$$V(\tau) = \tau K\eta + (1-\tau)K\rho,$$

where ρ denotes the return available in the capital market.

The risk-neutral insurer will select τ so as to maximize expected profit, which will depend on the balance of the return available on underwriting (i.e., η) and the return available in the capital market (i.e., ρ). The anticipated *excess* return available on underwriting will therefore be given by $\eta - \rho$.

If a positive excess return is expected on underwriting, more insurance capital will be allocated towards writing insurance, so that τ will increase. Insurers are, however, inhibited by regulatory constraints from writing more business than they have capital to support. Likewise, due to fixed overhead costs such as staff salaries, insurers cannot reduce the proportion of capital invested in writing insurance to zero in the short term. As a result, τ is bound by the equation

$$0 < \tau \leq 1.$$

Within these bounds, τ is selected based on the anticipated loss experience and the expected adequacy of premiums, which will inform the underwriting return η. If demand for insurance is inelastic, an increase in the supply of insurance (i.e., τ), will result in a decline in the premium rate, and thus η will decrease.[2]

In our empirical model in Section 5, we express η as a function of the insurer's combined ratio. Although other measures of underwriting profitability are available, such as the loss ratio for example, we select the combined ratio based on its prevalence in studies of the underwriting cycle.[3] As the ratio of insurance losses and expenses to premium income, the combined ratio holds an inverse relationship with the premium rate, all else being equal.

Our supply-side argument for the existence of the underwriting

[2]The result that η is negtively related to τ is formally derived below.

[3]The expense ratio for the property-liability insurance industry showed little variation over the study period. The average of the annual underwriting expense ratio for the period 1980 through 2020 is 26.8%, and the standard deviation is 1.04%. Consequently, the choice between the combined ratio and the loss ratio as the measure of underwriting profitability is not expected to materially affect our results.

cycle posits that the combined ratio, as a measure of underwriting return, is a function of τ so that we can ultimately specify the underwriting return as

$$\eta(\tau) = 1 - \text{Combined Ratio}(\tau).$$

Using CR as shorthand for the combined ratio, we can incorporate this result into our value function and express the value of our representative property-liability insurer as

$$V(\tau) = \tau K\big[1 - CR(\tau)\big] + (1-\tau)K\rho.$$

Notice that the return available in the capital market, ρ, is assumed to be independent of τ, which represents the insurer's investment decision.[4] From the first-order condition of the value function, $\frac{d}{d\tau}V = 0$, and noting that $\eta(\tau) = 1 - CR(\tau)$ implies that $\frac{d}{d\tau}\eta = -\frac{d}{d\tau}CR$, we can express the investment decision as

$$\tau = \frac{\eta(\tau) - \rho}{-\eta'(\tau)}.$$

This suggests that the fraction of capital allocated towards writing insurance depends on the expected excess return on underwriting (in the numerator) and the rate of change in the expected underwriting return (in the denominator). Substituting

[4]We believe this assumption is appropriate, as we are primarily concerned with the level of expected underwriting return *relative* to the expected return from the capital market, rather than nominally. Hence we can fix the expected return from the capital market at ρ.

this result into the value function therefore produces the result that

$$V(\tau) = \frac{-K\left[\eta(\tau) - \rho\right]^2}{\eta'(\tau)}.$$

For a solvent insurer with positive value (i.e., $V > 0$ and $K > 0$) it will therefore be the case that $\eta'(\tau) < 0$. Simply put, this implies that $\eta(\tau)$ is a decreasing function of τ and that the return earned on underwriting will reduce as a greater proportion of capital is allocated to the underwriting function of the insurer.

3. Measuring excess returns

The underwriting cycle is intertwined with insurance regulation, as the core objectives of property-liability insurance rate regulation are maintaining insurer solvency, and ensuring that insurers should earn a fair, but not excessive, rate of return for the risks that they bear (Rejda, McNamara, and Rabel, 2020). Rate regulation based on results from the capital asset pricing model (CAPM) was first introduced in 1976, when the Massachusetts Commissioner of Insurance adopted a CAPM-based model for rate reviews of automobile and workers' compensation insurance (Fairley, 1979).[5]

Although the CAPM provides a framework for estimating the risk-adjusted cost of capital for property-liability insurers, it considers only systemic risk in relation to the market portfolio and ignores other industry-wide risks faced by insurers. Various authors have thus argued that additional risk measures, capturing more than systemic risk, are needed to adequately estimate insurer cost of capital.

Cummins and Lamm-Tennant (1994), for example, provide evidence that insurer cost of capital is dependent on the ratio of policy reserves to assets and that a higher cost of capital is associated with long-tailed insurance lines. Browne and Hoyt (1995) highlight the importance of allowing for the probability of insurer

[5]Notable revisions to the model proposed by Fairley were later made by Hill and Modigliani (1987) and Myers and Cohn (1987).

insolvency in any CAPM-based rate-making framework. Additional factors, such as liquidity constraints during market downturns and the financial distress following realized catastrophic losses, have also been found to have significant explanatory power for property-liability insurer stock returns (Ben Ammar et al., 2018). The explanatory power of these factors are hypothesized to be amplified by the opacity of the insurance industry (Eckles, Halek, He, Sommer, and Zhang, 2011; Carson, Ellis, Elyasiani, and Wen, 2021).

Despite the noted short-comings of the traditional CAPM model in explaining property-liability insurance stock price movements, CAPM-based models continue to be used in research on insurer cost of capital. Barinov, Xu, and Pottier (2020), for example, argue that since property-liability insurer investment and consumption decisions are made multiple periods in advance, multi-period adaptions of the CAPM, such as the conditional CAPM and intertemporal CAPM, are more appropriate for estimating insurer cost of capital.

We measure excess returns with Jensen's version of the CAPM, based on monthly intervals and an estimation period of 60 months.[6] The estimation period is indicative of the length of time over which property-liability insurers are believed to develop expectations of future underwriting profitability.

[6]A 60 month period is common in the academic literature. For example, in addition to Barinov et al. (2020), both Cummins and Phillips (2005) and Berry-Stölzle and Xu (2018) use a 60 month window to evaluate volatility relative to the market portfolio in estimating the cost of capital for property-liability insurers.

The level of excess returns on property-liability insurance stock is thus measured with the equation

$$R_t - R_{ft} = \alpha + \beta\big(R_{mt} - R_{ft}\big) + \epsilon_t, \quad (1)$$

where,

R_t	=	return in month t on property-liability insurance stock;
R_{ft}	=	risk-free rate in month t;
R_{mt}	=	market return in month t;
β	=	risk of property-liability insurance stock relative to the market;
α	=	level of excess returns on property-liability insurance stock; and
ϵ_t	=	an error term.

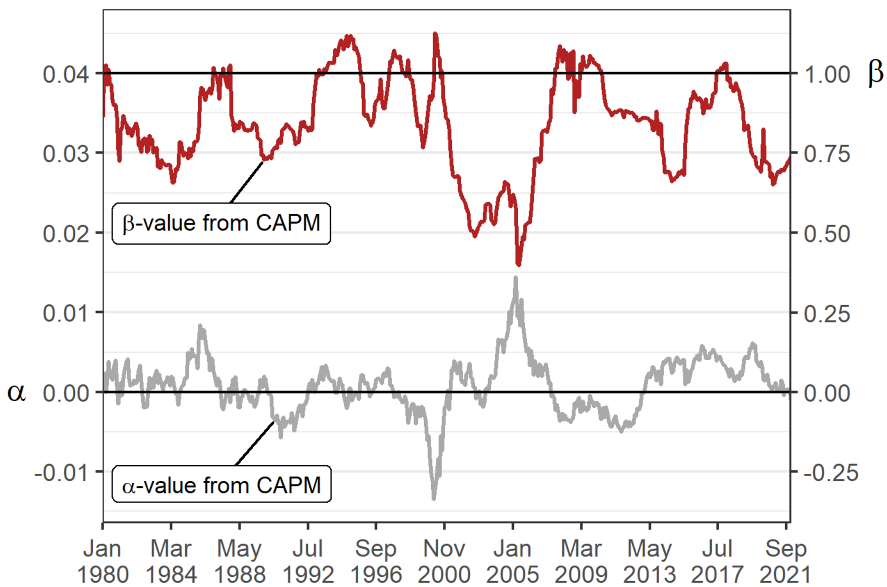
We use Standard and Poor's (i.e., *S&P*) data for estimation of both the market return and the return on property-liability insurance stock. The market return is measured with the return on the *S&P 500 Index*. The return on property-liability insurance stock is measured with the *S&P 500 Property-Casualty Insurance Stock Index*, which constitutes a value-weighted index of companies included in the *S&P 500 Index* which are classified as members of the property and casualty insurance sub-industry.[7] The risk-free

[7]At the end of our study period, the *S&P 500 Property-Casualty Insurance Stock Index* had 22 constituents and comprised approximately 2% of the total *S&P 500 Index* market capitalization.

rate is measured with the three-month Treasury bill rate.

The α-values from Equation 1 are the monthly estimates of excess risk-adjusted return on the property-liability insurance industry. These values, along with the risk of the property-liability insurance industry relative to the market, are summarized in Figure 1.

Figure 1: Monthly excess returns and insurance-specific risk



The average α and β values in Figure 1, respectively 0.08% and 0.84, suggest that the insurance industry has delivered a marginally positive excess return over the study period, despite being less risky than the market portfolio.[8] This is supported by the results from a single CAPM regression over the full study period of 42 years, with monthly intervals, which produces estimation results as indicated

[8]Based on the two-sided Student's t-test, the mean excess return of 0.08% on property-liability insurance stock differs significantly from 0 at a 99% confidence level. Likewise, the mean of the risk parameter β differs significantly from 1 at a 99% confidence level.

below

$$R_t - R_{ft} = 0.09\% + 0.796\big(R_{mt} - R_{ft}\big),$$

where the variables are as defined in Equation 1.

Although Figure 1 provides visual support for excess returns on the property-liability insurance industry being cyclical in nature, it does not yet inform as to the reason for the pattern of returns, nor does it provide a link between the underwriting cycle and insurance stock returns. In Section 5, we test for a relationship between underwriting returns and excess returns on property-liability insurance stock, as well as various other hypothesized drivers of the underwriting cycle.

4. Hypothesis development

As described in the introduction, the underwriting cycle is characterized by an alternating sequence of hard and soft markets, with the underwriting profitability of the property-liability insurance industry increasing and decreasing over time. We use as a measure of underwriting profitability the insurer combined ratio. We consider its relationship with various financial variables that are hypothesized to impact the underwriting cycle and the industry-wide combined ratio.

The combined ratio for stock insurers is selected to correspond to our measure of excess insurer returns. Since the level of excess returns on property-liability insurance stock is measured with the *S&P 500 Property-Casualty Insurance Stock Index*, we consider the combined ratio for stock property-liability insurers only, rather than the combined ratio for the entire property-liability insurance industry.[9] We use quarterly data, obtained from *AM Best's Quarterly By-Line Series*, to calculate the combined ratio for stock property-liability insurers net of policyholder dividends. The combined ratio is defined as the sum of the loss ratio, the expense ratio, and the policyholder dividend ratio.[10]

[9] The combined ratio for the entire property-liability insurance industry would include the results for mutual insurers, reciprocal insurers, state funds and other organizational forms.

[10] The loss ratio is defined as the net loss and loss adjustment expenses incurred, relative to the net premiums earned. The expense ratio is defined as the total underwriting expenses incurred, relative to the net premiums written. The policyholder dividend ratio is defined as the total policyholder dividends, relative to the net premiums earned.

4.1 Excess returns and the underwriting cycle

A graph of the quarterly combined ratio and excess returns for the stock property-liability insurers is given in Figure 2. The figure shows that the combined ratio for stock insurers exceeded 1 throughout the 1980s and 1990s. An industry-wide underwriting profit for stock insurers was not made in a single quarter over this period. Subsequently, underwriting gains have become more common.

Figure 2: Excess returns and the underwriting cycle

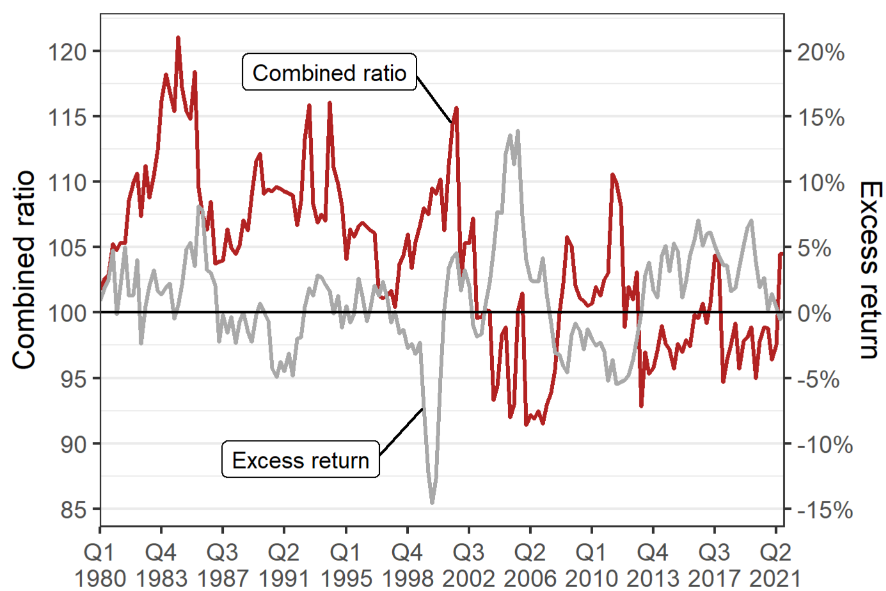


Figure 2 also indicates the annualized excess returns from the model in Equation 1, expressed as a percentage. A graphical analysis supports our hypothesis of a negative relationship between excess returns on property-liability insurance stock and the combined ratio.

We contend that it is the expectation of excess returns on property-liability stock that leads to a shift in the supply of insurance and a consequent change in premium income, as the denominator of the combined ratio, without affecting the numerator.

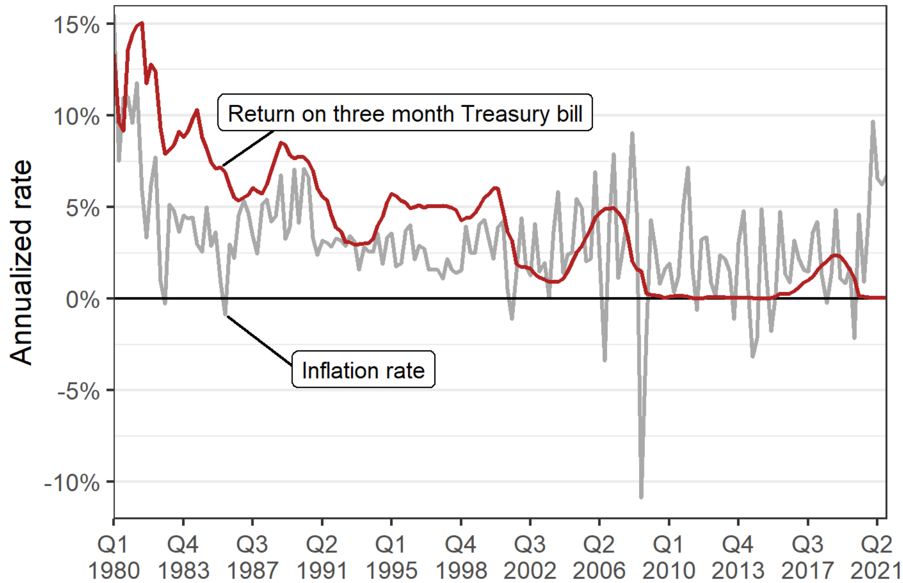
4.2 Investment returns and the underwriting cycle

The theoretical framework in Section 2 indicates that the value of insurance firms depends not only on underwriting returns, but also on the return available in the capital market. The implication is that the level of investment returns available to insurers, in addition to the excess returns available on insurance, holds a significant relationship with the underwriting cycle.

More specifically, a positive relationship between the combined ratio and risk-free rate of return is hypothesized, as a higher expected return from the capital markets is expected to reduce the proportion of funds invested by property-liability insurers in the writing of insurance. This is in accordance with the long-held view that underwriting profit should hold a negative relationship with real investment income (Fairley, 1979).

Figure 3, below, illustrates how the nominal risk-free rate, measured as the return on the three-month Treasury bill rate, has changed over the study period, from annualized returns between 10% and 15% in the early 1980s, to a prolonged period of near-zero returns after the 2008 financial crisis.

Figure 3: Nominal interest and the inflation rate



4.3 Inflation and the underwriting cycle

Figure 3 also shows how inflation, as the percentage change in the Consumer Price Index (CPI), has fluctuated over the study period. Inflation influences both the numerator and the denominator of the combined ratio. This is because higher inflation increases incurred losses and loss adjustment expenses, as the numerator of the combined ratio, but also premiums in the denominator. Consequently, the relationship between the underwriting cycle and inflation will depend on which one of these effects dominates.

Figure 3 further indicates that, in the first half of the study period, the return on the three-month Treasury bill predominantly exceeded the inflation rate, thus yielding a positive real return, but that this has not been the case subsequently. It also is apparent from Figure 3 that the inflation rate has been considerably more volatile than the Treasury bill rate, particularly over the latter half of the study period. Consequently, most of the volatility in real interest rates over this period is driven by volatility in the inflation rate.

4.4 Catastrophic losses and the underwriting cycle

Catastrophic losses are, by definition, difficult to anticipate. For a given period, higher than average catastrophic losses would thus increase total incurred losses, without a corresponding increase in the premiums for that period. This predicts a positive relationship between the combined ratio and higher than average catastrophic losses.

We collect data on quarterly catastrophic losses from the annual Property/Casualty Insurance Fact Books, as published by the Insurance Information Institute. The data is collected by the Property Claim Services (PCS) unit of the Insurance Services Office. The data includes catastrophes that affected a significant number of policyholders and insurers, and resulted in estimated insured losses exceeding a given magnitude.

Up to the end of 1996, the PCS unit defined catastrophes as events that were estimated to have caused more than $5 million in insured losses. At the end of the 1996 calendar year, however, the PCS unit updated their criteria for inclusion in the catastrophe dataset to events that were estimated to have caused insured losses of at least $25 million (in 1997 dollars).[11] As the criteria for inclusion in the catastrophe dataset changed at the end of 1996, we distinguish between catastrophic losses from the period 1980 through 1996, and catastrophic losses from the period 1997 through 2021. We analyze the two periods separately, as indicated in Figure 4, but include in our empirical model in Section 5 a single variable to account for the impact of catastrophic losses.[12]

We believe that the separate analysis of the two periods, respectively before and after the PCS unit's revision of their definition of a catastrophe, minimizes the effect of the revision on our study. Moreover, since Browne and Hoyt (1992) find evidence that the relationship between the combined ratio of the property-liability insurance industry and catastrophic losses in a given period is not linear, we do not expect the change in the definition to materially affect the results of our study.

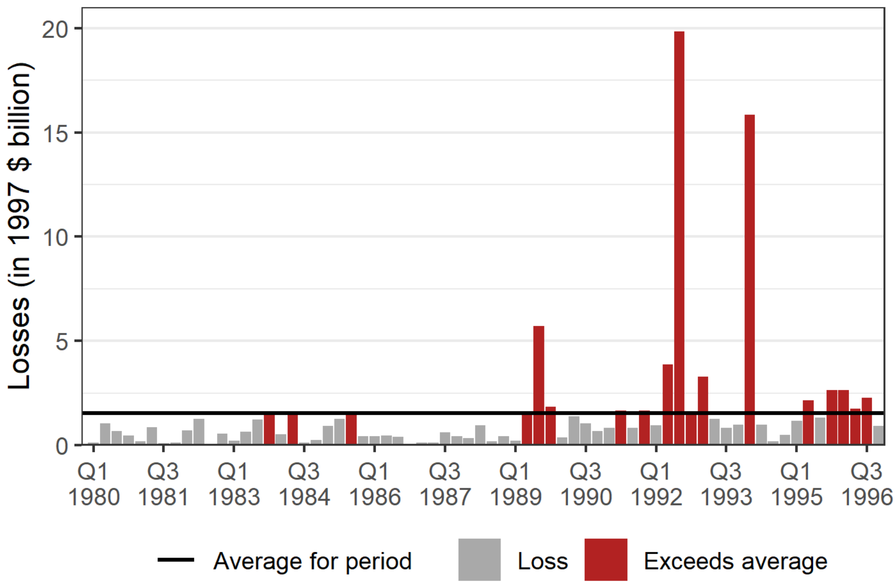
Browne and Hoyt (1992) hypothesize that the non-linear relationship between the industry combined ratio and catastrophic losses is a result of reinsurance arrangements that disproportionately

[11] Losses covered by the National Flood Insurance Program are excluded.

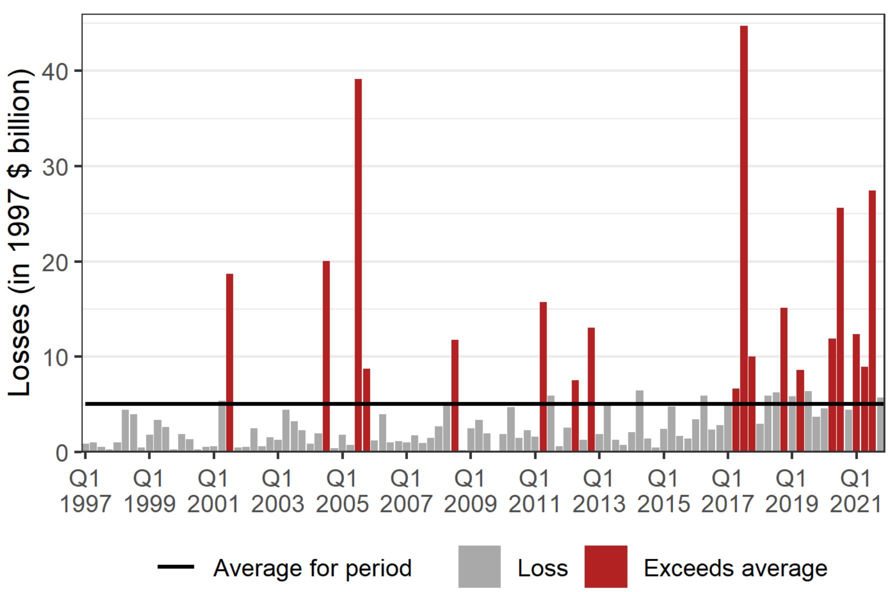
[12] Panel A shows catastrophic losses for the period from 1980 through 1996, when events with estimated insured losses exceeding $5 million were included in the PCS dataset. Panel B shows the catastrophic losses for the period from 1997 through 2021, when events with estimated insured losses exceeding $25 million (in 1997 dollars) were included in the PCS dataset. We compare quarterly catastrophic losses to the average for the respective periods.

Figure 4: Catastrophic losses

Panel A: Catastrophic losses (1980 - 1996)



Panel B: Catastrophic losses (1997 - 2021)



reduce the impact of very large catastrophic losses on primary insurers. Similarly, we hypothesize that it is the relative level of catastrophic losses, rather than the absolute level, that holds a linear relationship with the combined ratio. Consequently, we consider whether catastrophic losses in a particular quarter exceed the average quarterly catastrophic losses over the period when the same definition of a catastrophe, and same criteria for inclusion in the PCS dataset, was in place.

The quarterly losses from both periods, 1980 through 1996 and 1997 through 2021, are rebased to 1997 dollar terms and compared to the average quarterly catastrophic losses from the respective periods. Figure 4 highlights quarters where the catastrophic losses exceed the quarterly average, for that period.

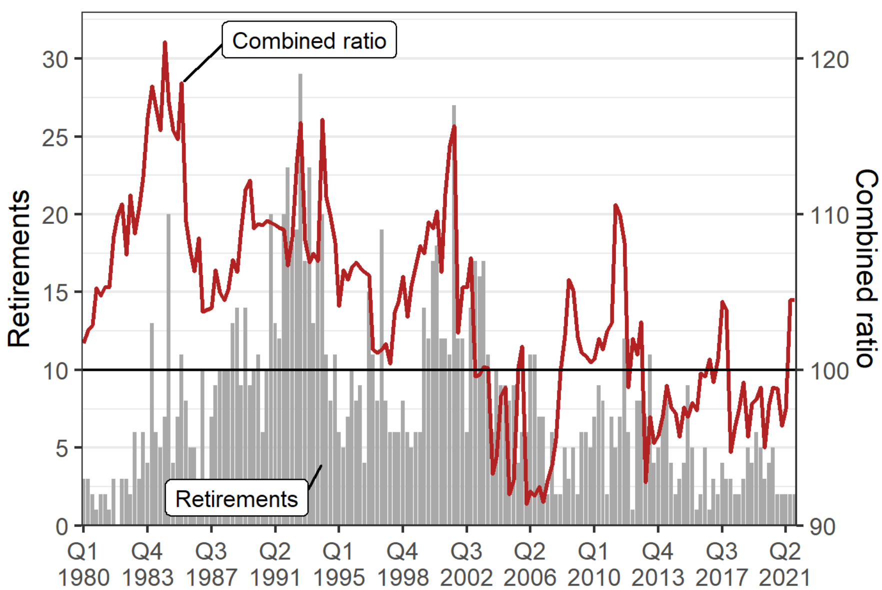
4.5 Retirements and the underwriting cycle

The number of property-liability insurers retiring from the market is an indicator of both market capacity and the level of competition in the market. Retirements have been hypothesized to be related to the underwriting cycle, although the direction of causality has not been definitively shown.

On the one hand, the financial position of insurers will be weakened during soft markets, when the combined ratio is high. Thus poor underwriting returns may lead to a higher insolvency rate. On the other hand, it might be the case that the number of retirements in a soft market must reach a certain level before the supply of insurance and competition in the market is reduced sufficiently for insurers to increases premiums.

Both arguments suggest a positive relationship between the number of retirements from the property-liability insurance market and the industry-wide combined ratio. We consider the number of property-liability insurers involuntarily retiring from the property-liability industry in each quarter of the study period. Figure 5 shows the relationship between the number of retirements and the combined ratio.[13]

Figure 5: Retirements and the underwriting cycle



Browne and Hoyt (1995) find strong evidence of a positive relationship between the industry combined ratio and the number of retirements from the industry. Figure 5 suggests that the positive

[13]Involuntary retirements include liquidation, receivership, rehabilitation, and conservatorship, as reported by AM Best.

relationship persists over our study period. The overall decline in retirements since the mid-1990s has been ascribed to the adoption of risk-based capital regulations in the United States in 1994, while subsequent periodic increases in retirements have been attributed to catastrophic losses (Cummins and Weiss, 2016).

4.6 Financial strength and the underwriting cycle

Lastly, we consider the relationship between the underwriting cycle and the financial strength of the property-liability industry. Various measures of financial strength are commonly used to assess the financial health of insurance firms. These range from financial strength ratings published by proprietary agencies, to simple financial ratios such as the leverage ratio.[14] We select as a financial strength indicator the market capitalization rate at the end of the prior calendar year, measured as the ratio of the total policyholders' surplus in the industry to total industry assets. We choose this measure of financial strength for the property-liability industry as it has no direct link to the current premium rate in the market and should thus not be mechanically related to the industry combined ratio.

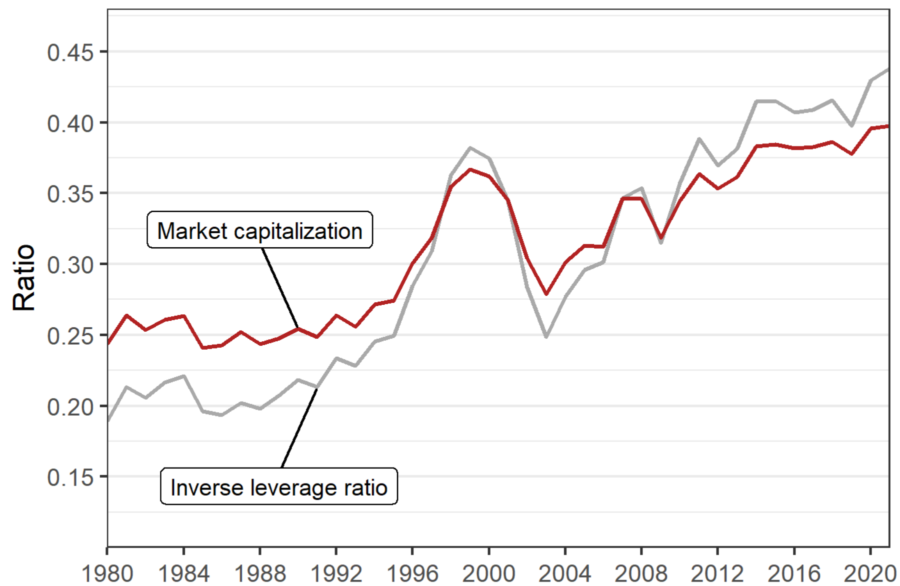
As the market capitalization rate provides an indication of the financial strength of the industry, it is anticipated that a higher market capitalization rate will result in higher premium rates and

[14]The leverage ratio for insurers is defined as the sum of the premiums written and the insurance liabilities, relative to policyholders' surplus.

thus be negatively related to the combined ratio of the industry. This is consistent with Sommer (1996) who found that property-liability insurers with less capital are penalized with lower prices for their products.

Figure 6 shows the market capitalization rate for the industry, as well as the inverse of the leverage ratio as described above.

Figure 6: Industry financial strength



The figure indicates that total policyholders' surplus, relative to both industry assets and the sum of premium income and insurer liabilities, has increased significantly over the period of our study. More specifically, total policyholders' surplus grew at an average compound annual rate 1.2% greater than the average growth rate in industry assets. This suggests that the property-liability insurance industry grew considerably in financial strength over the study period.

4.7 Hypothesis summary

Table 1 summarizes the major hypotheses discussed above.

Table 1: Expected relationships with the combined ratio

Variable	Expected sign	Reasoning
EXCESS	−	Shifts in the supply of insurance are expected to result from insurer's perception of the presence of excess returns on underwriting. The combined ratio is therefore expected to be negatively correlated with excess returns, as premiums are reduced (increased) in the presence of positive (negative) expected excess returns.
RTBILL	+	The long-standing view that underwriting profits and investment returns should be negatively correlated suggests a positive relationship between the combined ratio and the risk-free return.
INFLAT	+ or −	Since inflation is expected to influence both incurred losses and premiums, which are respectively the numerator and the denominator of the combined ratio, the relationship between the underwriting cycle and inflation will depend on which one of these two effects dominate.

(continued on next page)

Table 1: Expected relationships with the combined ratio ***(continued)***

Variable	Expected sign	Reasoning
CATLOSS	+	As above average catastrophic losses would increase total incurred losses without affecting premiums in the same period, a positive relationship between the combined ratio and higher than average catastrophic losses is predicted.
RETIRE	+	As an indicator of market capacity and the level of competition in the market, a positive relationship between the number of retirements from the industry and the combined ratio is expected.
CAPITAL	−	Prior evidence of market discipline in the property-liability insurance industry suggests that at lower levels of capital the industry will be constrained to lower premium rates. A negative relationship between the combined ratio and market capitalization rate is thus expected.

5. Empirical model and results

5.1 Model specification and variable definitions

We test our hypotheses with an empirical model of the form

$$\begin{aligned} CR_t = \; & \beta_0 + \beta_1 EXCESS_t + \beta_2 RTBILL_t \\ & + \beta_3 INFLAT_t + \beta_4 CATLOSS_t \\ & + \beta_5 RETIRE_t + \beta_6 CAPITAL_t + \epsilon_t, \end{aligned} \tag{2}$$

where,

CR_t	=	combined ratio for stock insurers in quarter t;
$EXCESS_t$	=	the excess return estimates from the model in Equation 1, estimated from the 60 months preceding quarter t, and expressed as an annualized percentage;
$RTBILL_t$	=	the average three-month Treasury bill rate in quarter t, minus the percentage change in the CPI over quarter t;
$INFLAT_t$	=	percentage change in the CPI over quarter t;
$CATLOSS_t$	=	indicator variable for catastrophic losses, with $CATLOSS = 1$ if the catastrophic losses in quarter t exceeds the average quarterly catastrophic loss, and $CATLOSS = 0$ otherwise;

$RETIRE_t$ = number of property-liability insurers involuntarily suspending operations in quarter t;

$CAPITAL_t$ = ratio of total policyholders' surplus to total industry assets at the calendar year-end preceding quarter t, expressed as a percentage; and

ϵ_t = an error term.

Table 1 reports summary statistics for our data, which spans the 42-year period from 1980 through 2021 (i.e., 168 quarters).

Table 1: Summary statistics (n = 168)

Statistic	Mean	SD	Min	25^{th} %	Median	75^{th} %	Max
CR	104.0	6.4	91.4	99.2	104.4	108.5	121.1
EXCESS	0.9	4.1	-14.6	-1.6	1.3	3.3	13.9
RTBILL	0.9	3.4	-9.6	-1.0	0.9	3.2	12.3
INFLAT	3.1	2.9	-10.8	1.6	2.9	4.5	15.5
CATLOSS	0.2	0.4	0.0	0.0	0.0	0.0	1.0
RETIRE	7.9	5.5	0.0	4.0	6.0	11.0	29.0
CAPITAL	31.3	5.3	24.1	26.1	31.3	36.2	39.7

5.2 Multicollinearity in covariates

Multicollinearity between the covariates is a concern, particularly during periods of near-zero Treasury bill rates, when the variable $RTBILL$ will simply be the negative of the $INFLAT$ variable (i.e., for the period from 2009 to 2015, as per Figure 3). The correlation matrix for the covariates of the empirical model of Equation 2 are shown in Table 2.

Table 2: Correlation matrix for covariates

	EXCESS	RTBILL	INFLAT	CATLOSS	RETIRE	CAPITAL
EXCESS	1.00	-0.04	-0.01	0.06	-0.19	-0.01
RTBILL		1.00	-0.37	-0.04	0.10	-0.48
INFLAT			1.00	-0.07	-0.12	-0.29
CATLOSS				1.00	0.04	0.02
RETIRE					1.00	-0.34
CAPITAL						1.00

A drawback of examining the correlation matrix of covariates for evidence of multicollinearity, is that it is unclear at what level a high correlation coefficient becomes a concern. Farrar and Glauber (1967), for example, suggest 0.8 as an arbitrary rule of thumb for identifying "harmful multicollinearity". As an alternate test for multicolinnearity, variance inflation factors (VIFs) can be calculated for the variables used in the empirical model. A VIF above 5 for any of the covariates is indicative of high correlation, and a VIF above 10 suggests that multicollinearity is a cause for concern in the model (Wooldridge, 2013). As above, Table 3 also suggests that multicollinearity should not be a concern for this model.

Table 3: Variance inflation factors of covariates

	EXCESS	RTBILL	INFLAT	CATLOSS	RETIRE	CAPITAL
VIF	1.08	2.38	2.11	1.02	1.41	2.65

5.3 Estimation results

The results of the empirical estimation are summarized below in Table 4. Heteroskedasticity-robust standard errors are reported in parenthesis below the estimates of the regression coefficients. The p-values indicated in the table are based on the heteroskedasticity-robust standard errors.

Table 4: Estimation results

	(Expected Sign)	Dependent variable = CR
EXCESS	(−)	-0.356^{**}
		(0.079)
RTBILL	(+)	0.748^{**}
		(0.151)
INFLAT	(+ or −)	0.381^{*}
		(0.156)
CATLOSS	(+)	3.640^{**}
		(0.752)
RETIRE	(+)	0.243^{**}
		(0.091)
CAPITAL	(−)	-0.299^{**}
		(0.099)
Observations		168
R^2		0.528
Adjusted R^2		0.511

Notes: *Heteroskedasticity-robust standard errors in parentheses.* $^{*}p<0.05$; $^{**}p<0.01$.

The negative coefficients of $EXCESS$ and $CAPITAL$ are as expected, and suggest that shifts in the supply of insurance result from the anticipation of excess returns on writing insurance, and that premium rates are determined, at least in part, by the capital strength of the industry. The positive coefficient of $RETIRE$ further suggests that the relationship between the price of insurance and the level of competition in the market is as the market mechanism predicts.

The positive relationship between the combined ratio and the inflation rate ($INFLAT$), further indicates that inflation exerts a stronger influence on insurance losses and loss adjustment expenses, as the numerator of the combined ratio, than on premium income, as the denominator of the combined ratio. Above average catastrophic losses ($CATLOSS$) affect the combined ratio in a predictable way.

The real interest rate variable, $RTBILL$, reflects the level of investment returns available to insurers. Its regression coefficient is also as expected. A positive correlation between real interest rates and the combined ratio, despite declining nominal interest rates and a prolonged near-zero nominal interest rate environment, supports the theoretical argument presented in Section 2. The decision to invest in writing insurance is seen to depend on the expected returns on alternative investments.

6. Conclusion

The negative relationship between the combined ratio and excess return on property-liability insurance stock holds substantial implications for the property-liability insurance industry, as an alteration in insurers' perception of the presence of excess returns is expected to impact the supply of insurance. The observed negative relationship contradicts the earlier result of Browne and Hoyt (1992) who, in a similar setting, find a positive relationship between excess returns on property-liability insurance stock and the underwriting cycle. If we limit our study period to the 1980s, as was the case in the Browne and Hoyt (1992) study, we find a similar negative relationship between insurer stock returns and the industry-wide combined ratio. We believe this result can be attributed to the market conditions of the 1980s.

The inordinately high interest rates of the early 1980s, as indicated in Figure 3, led to a particularly soft property-liability insurance market, characterized by a practice known as "cashflow underwriting".[15] The industry-wide lowering of premiums and acceptance of low-quality risks, evidently with the aim of increasing insurance float available for investment, resulted in a price war (Macdonald, 2005). The industry later paid dearly for its relaxed

[15] Cashflow underwriting refers to the practice of of providing insurance coverage at less than the actuarially fair premium required to pay the expected claims and related expenses, in the belief that high investment returns can be relied on to mitigate the expected underwriting loss.

underwriting standards, as the liability insurance crisis of the mid-1980s, characterized by a proliferation of tort litigation in the commercial liability and medical malpractice lines, soon followed.

Subsequently, the advent of a persistently low interest rate environment in the US economy, in particular the prolonged period of a near-zero Treasury bill rate following the 2008 financial crisis, has created an economic environment in which cashflow underwriting is no longer possible. The reversal of the relationship between the combined ratio and excess returns on property-liability insurance stock, from a positive relationship in the 1980s to a negative relationship thereafter, indicate that the insurance industry has become more disciplined in its underwriting practices.

Ultimately, we find strong support for our hypothesis that the underwriting cycle is explained by shifts in the supply of insurance, in accordance with the capacity constraints hypothesis. By considering the writing of insurance as one of many investment opportunities available to an insurer, we reason that the shift in the insurance supply results from changes in the anticipated risk-adjusted return on underwriting, relative to the return available on alternative investment opportunities. The return on alternative investment opportunities itself is also shown to be correlated with the underwriting cycle. This suggests that a profit cycle may exist not only for underwriting return, but also for total return, as the sum of underwriting and investment returns.

The capacity constraints hypothesis is further supported by the positive relationships between the combined ratio and extraordinary catastrophic losses, and the combined ratio and the number of involuntary retirements from the property-liability industry. In addition, we find that changes in CPI inflation have a greater impact on incurred losses and loss adjustment expenses than on premium income.

Lastly, we find that the insurance industry has grown considerably in financial strength over the period from 1980 through 2021. We ascribe the growth in the financial strength of the industry to the introduction of risk-based capital regulation in the mid-1990s, and the continued focus on solvency regulation subsequently. We find that the combined ratio is negatively correlated with the financial strength of the industry and conclude that this presents evidence of market discipline in the property-liability insurance industry.

We thus contend that the capacity constraints hypothesis, as a supply-side explanation of the observed cycle in the underwriting profits of the property-liability insurance industry, continues to be valid.

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