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

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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 1970 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 52 years, the underwriting cycle is well explained by shifts in the supply of 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 lagged insurer surplus and premium rates, as observed by Niehaus and Terry (1993), is consistent with the capacity constraints hypothesis. A strong negative relationship between the industry underwriting return 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.

In this paper, the shift in supply of insurance 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 negatively correlated with the underwriting cycle. Extraordinary catastrophic losses, insurer retirements, and the inflation rate are further illustrated to be negatively correlated with the underwriting return of the property-liability insurance industry. These results 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 positive correlation between the underwriting return of the industry 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 supply-side argument for the existence of the underwriting cycle posits that the underwriting return is a function of τ. We thus denote the return earned by the representative insurer on the capital invested in underwriting (i.e., the underwriting return) as $\eta(\tau)$. The return available in the capital market is denoted by ρ, so that the value function of the representative property-liability insurer can be expressed as

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

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., $\eta(\tau)$) and the return available in the capital market (i.e., ρ). Notice that the return available in the capital market, ρ, is assumed to be independent of τ, which represents the insurer's investment decision.[2] The anticipated *excess* return available on underwriting will therefore be given by $\eta(\tau) - \rho$.

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

[2] 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.

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 $\eta(\tau)$. From the first-order condition of the value function, $\frac{d}{d\tau}V = K\eta(\tau) + \tau K\eta'(\tau) - K\rho = 0$, 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 excess return on underwriting that is expected (in the numerator) and the rate of change in the underwriting return (in the denominator). Substituting this result into the value function therefore produces the result that

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

For a solvent insurer with positive value (i.e., $V > 0$ and $K > 0$) we expect that $\eta'(\tau) < 0$. 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. 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 $\eta(\tau)$ will decrease, all else being equal.

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 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).[3]

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.

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

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 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 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 both Jensen's version of the CAPM, and the well-known five-factor model of Fama and French

(2015). In addition to the market-wide risk factor from the traditional CAPM, the Fama-French five-factor model includes factors for firm size, value, operating profitability, and investment pattern.[4] The measurement of the excess returns is based on monthly data with an estimation period of 60 months, as is common on the academic insurance literature.[5] The estimation period is indicative of the length of time over which property-liability insurers are believed to develop expectations of future underwriting profitability. The level of excess returns on property-liability insurance stock is thus measured with the equation

$$\begin{aligned} R_t - R_{ft} = \; & \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t \\ & + \beta_4 RMW_t + \beta_5 CMA_t + \epsilon_t, \end{aligned} \tag{1}$$

where,

R_t	=	return on property-liability insurance stock in month t;
R_{ft}	=	risk-free rate in month t;
α_t	=	level of excess returns on property-liability insurance stock in month t;

[4]The results reported in Section 5 are based on excess returns as measured with the five-factor model of Fama and French (2015), but are robust to measurement with the CAPM.

[5]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. Cummins (1990) also notes that "a five year estimation period is common, using monthly or weekly returns in most cases."

MKT_t	=	market return in excess of the risk-free rate in month t;
SMB_t	=	factor for size (small-minus-big) in month t;
HML_t	=	factor for value (high-minus-low) in month t;
RMW_t	=	factor for operating profitability (robust-minus-weak) in month t;
CMA_t	=	factor for investment pattern (conservative-minus-aggressive) in month t; and
ϵ_t	=	an error term.

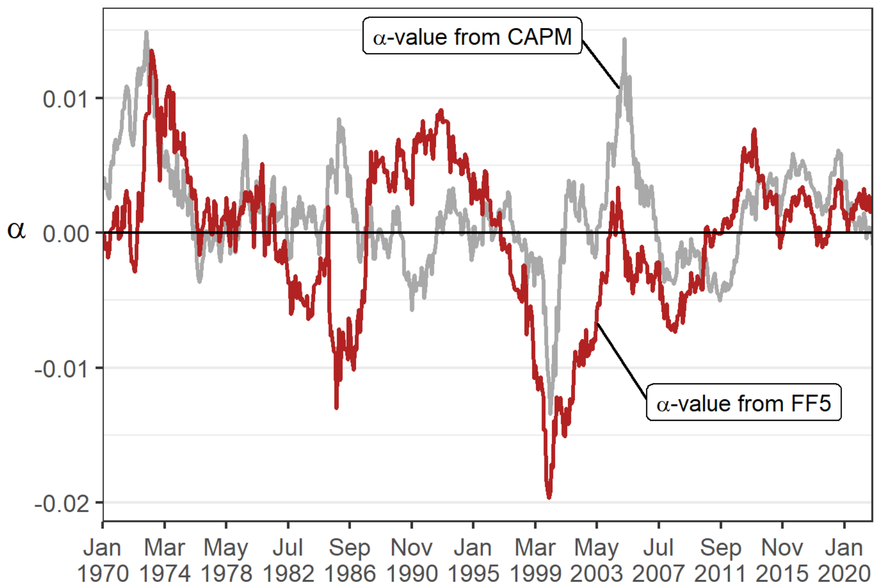
The monthly return on property-liability insurance stock is measured with the *Standard and Poor's 500 Property-Casualty Insurance Stock Index*. The index provides a value-weighted indicator of the stock price movements of the companies included in the *Standard and Poor's 500 Index* that are classified as members of the property and casualty insurance sub-industry.[6] The risk-free rate is estimated as the one-month US Treasury bill rate. The market return is estimated as the value-weighted return of the combined NYSE, AMEX and NASDAQ markets. The risk-free rate, the market return, and the additional risk factors (i.e., SMB, HML, RMW, and CMA) are taken directly from Kenneth R. French's website.[7]

[6] 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.

[7] Available at `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_`

The α-values from Equation 1 are the monthly estimates of excess risk-adjusted return of the property-liability insurance industry, as measured with the Fama-French five-factor (FF5) model. These values, along with similar estimates based on the CAPM, are summarized in Figure 1.

Figure 1: Excess return of the property-liability insurance industry



The average monthly excess return of property-liability insurance industry, as measured with the Fama-French five-factor model, is -0.02%. Based on the two-sided Student's t-test, the average excess return does not differ significantly from zero at a 95% confidence level. However, when measured with the CAPM, the average monthly excess return of 0.15% does differ significantly from zero at a 95% confidence level. This suggests that, over the study

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period, the Fama-French five-factor model leaves a lower degree of the excess return of the property-liability insurance industry unexplained than the CAPM. Our primary measure of the excess return of the property-liability insurance industry is therefore based on the Fama-French five-factor model, although we confirm that our results are robust to measurement of excess stock returns with the CAPM.[8]

Although Figure 1 presents a pattern of excess returns for the property-liability insurance industry, it does not inform whether the pattern is cyclical in nature, nor does it suggest any reasons for the pattern of returns. Figure 1 also does not provide a link between the underwriting cycle and property-liability insurance stock returns. In Section 5, we test for a relationship between underwriting return and excess return 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 represent the underwriting cycle with the total underwriting return

[8]The α-values in Figure 1 are positively correlated with a Pearson's correlation coefficient of 0.33, which differs significantly from zero at a 95% confidence level.

of the property-liability insurers with common-stock ownership structure. Since the level of excess returns on property-liability insurance stock is measured with the *S&P 500 Property-Casualty Insurance Stock Index*, we believe that it is appropriate to consider the underwriting return for stock property-liability insurers only, rather than the underwriting return of the entire property-liability insurance industry.[9]

Although the combined ratio, as a measure of underwriting profitability, is more prevalent in studies of the underwriting cycle than underwriting return, the underwriting return measure allows for a direct interpretation of regression results in the later sections of this paper.[10] Moreover, we estimate the underwriting return for the property-liability insurance industry as a simple function of the combined ratio, so that

$$\text{Underwriting return} = 1 - \text{Combined ratio}.$$

Other measures of underwriting profitability, such as the loss ratio, are also available. However, the choice to base the

[9] The underwriting return of the entire property-liability insurance industry would include the results for mutual insurers, reciprocal insurers, state funds and other organizational forms. To correspond to our measure of excess returns, we consider only the underwriting return for property-liability insurers with common-stock ownership structure.

[10] As the ratio of insurance losses and expenses to premium income, the combined ratio holds an inverse relationship with the underwriting profitability. The combined ratio is defined as the sum of the loss ratio, the expense ratio, and the policyholder dividend ratio. 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.

underwriting return on the combined ratio, rather than the loss ratio, is not expected to materially affect our results.[11] We use quarterly data, obtained from *AM Best's Quarterly By-Line Series*, to calculate the underwriting return for stock property-liability insurers and consider the relationship between the underwriting return and the various financial variables that are hypothesized to impact the underwriting cycle.

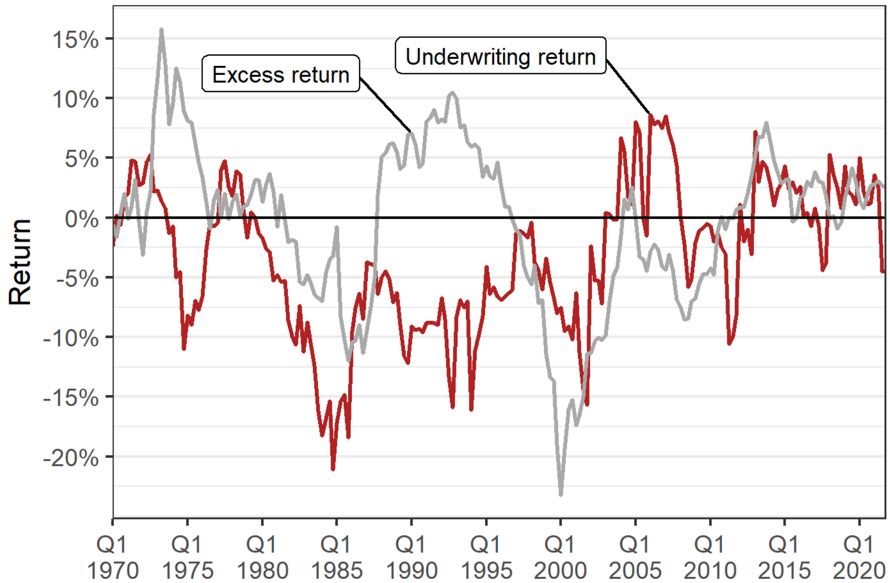
4.1 Excess returns and the underwriting cycle

A graph of the quarterly underwriting return and excess return for the stock property-liability insurers is given in Figure 2. The figure shows that the underwriting return for stock insurers was consistently negative for a prolonged period throughout the 1980s, 1990s, and early 2000s. An industry-wide underwriting profit for stock insurers was not made in a single quarter over this period. Subsequently, positive underwriting return has become more common.

Figure 2 also indicates the annualized excess returns from the model in Equation 1, expressed as a percentage. 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, in the short term, without affecting

[11] 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 1970 through 2020 is 26.8%, and the standard deviation is 1.03%.

Figure 2: Excess returns and the underwriting cycle



the claims rate. This suggest a positive relationship between the underwriting return of the industry and excess return on property-liability insurance stock. In the longer term, however, a change in the supply of insurance is expected to affect the premium rate so that the positive relationship between the underwriting return and prior excess stock returns is not anticipated to persist.

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 return available to insurers, in addition to the excess return available on insurance, holds a significant relationship with the underwriting cycle.

More specifically, a negative relationship between the underwriting return and risk-free rate of return is hypothesized, as a higher expected return from the capital market 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 one-month US Treasury bill rate, has changed over the study period, from annualized returns between 5% and 15% in the early 1970s and 1980s, to more moderate returns subsequently, and a prolonged period of near-zero returns after the 2008 financial crisis.

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. Since inflation influences incurred losses and loss adjustment expenses, but also premium levels, the relationship between the underwriting cycle and inflation can be complex. The relationship between underwriting profitability and inflation will depend on the balance of the inflationary effects, and whether the economy-wide inflation has a greater impact on claim rates or premium rates.

Figure 3: Nominal interest and the inflation rate

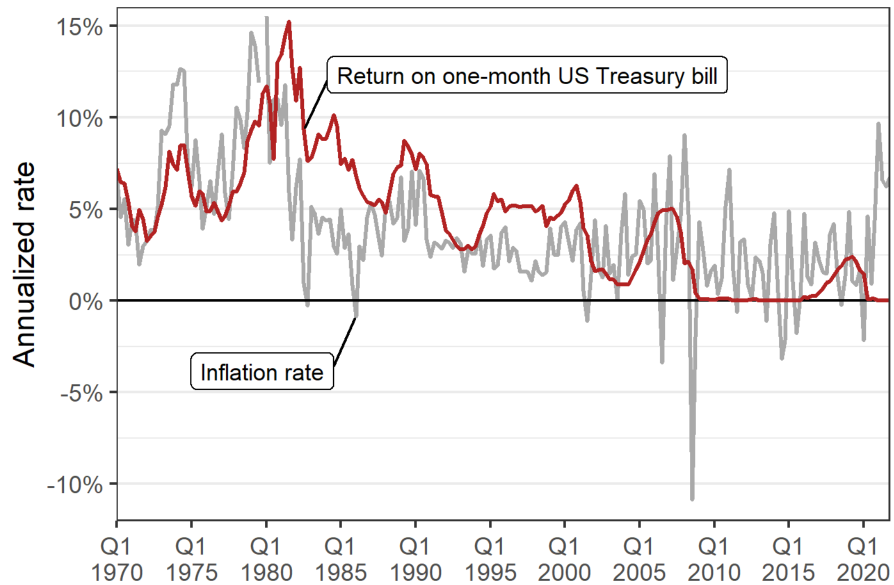


Figure 3 further indicates that, the inflation rate has been considerably more volatile than the one-month US Treasury bill rate, particularly over the latter half of the study period. Consequently, most of the volatility in real interest rates over this period is driven by volatility in the inflation 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 negative relationship between the underwriting return 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.[12] The data includes catastrophes that affected a significant number of policyholders and insurers, and resulted in estimated insured losses exceeding a given magnitude.

Before 1982, the catastrophe data included events that were estimated to have caused more than $1 million in insured losses. At the end of the 1982 calendar year, however, the PCS unit updated their criteria for inclusion in the catastrophe data set to events that were estimated to have caused more than $5 million in insured losses. The criteria for inclusion in the catastrophe data set was changed once more, at the end of the 1996 calendar year, to events that were estimated to have caused more than $25 million in insured losses.[13]

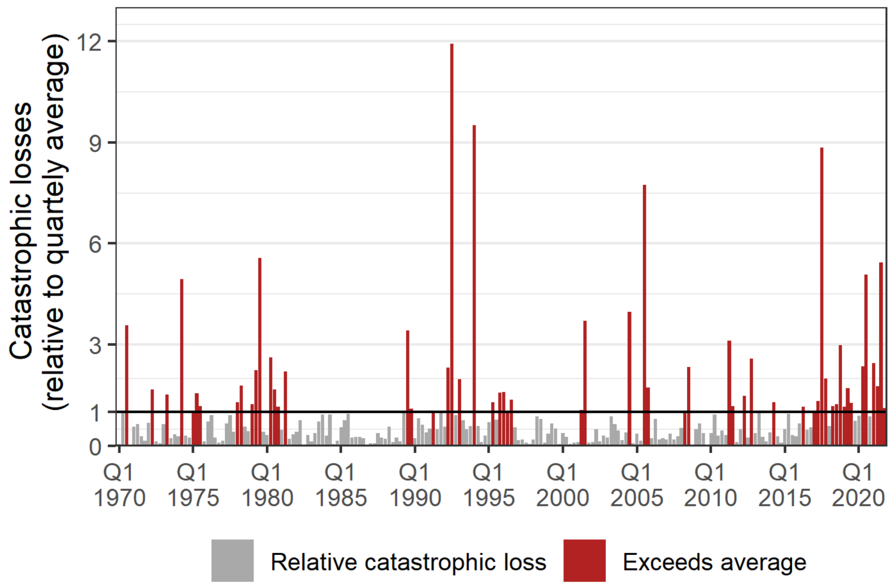
To minimize the effect of the revision in the catastrophe criteria, we restate all catastrophic losses to 2021 dollars, and create a single indicator variable to identify quarters in which the property-liability insurance industry experienced higher than average catastrophic losses. To create a single variable to account for the impact of extraordinary catastrophic losses, we compare the catastrophic losses in a given quarter to the average quarterly catastrophic losses

[12]The data was previously collected by the American Insurance Association and the National Insurance Actuarial & Statistical Association.

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

throughout the period when the same criteria for inclusion in the PCS data set was in place.[14] Figure 4 highlights quarters where the catastrophic losses exceed the quarterly average, for that period.

Figure 4: Above-average catastrophic losses



Browne and Hoyt (1992) find evidence that the relationship between the underwriting return of the property-liability insurance industry and catastrophic losses in a given period is not linear. They ascribe the non-linear relationship to reinsurance arrangements that disproportionately 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

[14]This amounts to dividing the total catastrophic losses in each quarter by the average quarterly losses during the period when the same catastrophe criteria was in place. For the period 1970 through 1982, the average quarterly catastrophic loss (exceeding $1 million) was $665 in 2021 dollars. For the period 1983 through 1996, the average quarterly catastrophic loss (exceeding $5 million) was $2,813 in 2021 dollars. For the period 1997 through 2021, the average quarterly catastrophic loss (exceeding $25 million) was $8,538 in 2021 dollars.

level, that holds a linear relationship with underwriting return. Consequently, we do not expect the changes in the criteria for inclusion in the catastrophe data set to materially affect the results of our study.

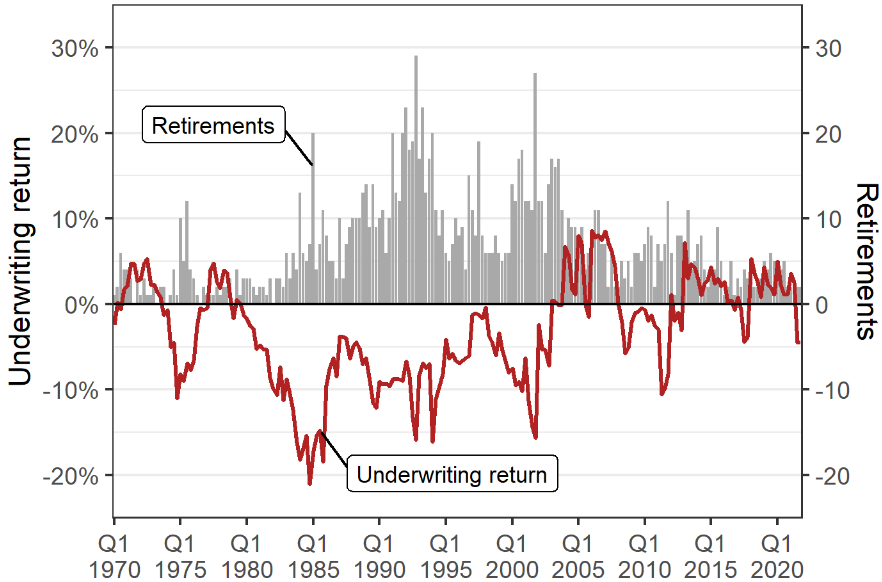
4.5 Retirements and the underwriting cycle

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 underwriting return is low. 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 negative relationship between the number of retirements from the property-liability insurance market and the industry-wide underwriting return. 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 underwriting return.[15]

Figure 5: Retirements and the underwriting cycle



Browne and Hoyt (1995) find strong evidence of a negative relationship between the industry underwriting return and the number of retirements from the industry. Figure 5 suggests that the negative 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).

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

4.6 Financial strength and the underwriting cycle

Finally, 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.[16] 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 underwriting return of the industry.

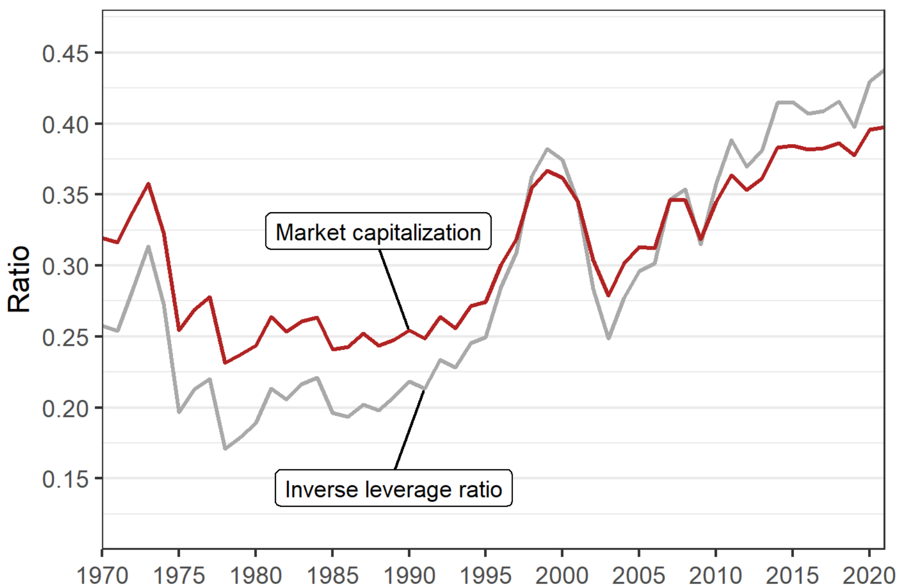
As the market capitalization rate provides an indication of the financial strength of the industry, it is anticipated that a higher market capitalization rate will result in higher premium rates and thus be positively correlated with the underwriting return of the industry. This is consistent with Sommer (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,

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

as well as the inverse of the leverage ratio as described above. 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.

Figure 6: Property-liability insurance industry financial strength



More specifically, total policyholders' surplus grew at an average compound annual rate 0.42% 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

The hypothesized relationship between the underwriting cycle and the various financial variables, as discussed above, are summarized in Table 2, below.

Table 2: Expected relationships with the underwriting return

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 underwriting return is therefore expected to be positively correlated with excess returns, as premium volume is increased (reduced) in the short term 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 negative relationship between the underwriting return and the risk-free rate.
INFLAT	+ or −	Since inflation is expected to influence both incurred losses and premiums, the relationship between the underwriting cycle and inflation will depend on which one of these two effects dominate.

(continued on next page)

Table 2: Expected relationships with the underwriting return *(continued)*

Variable	Expected sign	Reasoning
CATLOSS	−	As extraordinary catastrophic losses increase total incurred losses without affecting premiums in the same period, a negative relationship between the underwriting return and greater than average catastrophic losses is predicted.
RETIRE	−	As an indicator of the level of competition in the market, a negative relationship between the number of retirements from the industry and the underwriting return 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 positive relationship between the underwriting return 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

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

where,

UWR_t	=	underwriting return for stock insurers in quarter t;
$EXCESS_t$	=	the excess return estimates from the Fama-French five-factor model in Equation 1, estimated from the 60 months preceding quarter t, and expressed as an annualized percentage;
$RTBILL_t$	=	the average one-month US 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 52-year period (i.e., 208 quarters) from 1970 through 2021.

Table 1: Summary statistics (n = 208)

Statistic	Mean	SD	Min	25^{th} %	Median	75^{th} %	Max
UWR	-3.3	6.2	-21.1	-7.5	-2.6	1.3	8.6
EXCESS	-0.3	6.7	-23.3	-4.4	0.9	3.6	15.8
RTBILL	0.4	3.4	-9.7	-1.6	0.5	2.5	12.6
INFLAT	4.0	3.5	-10.8	1.8	3.4	5.2	16.8
CATLOSS	0.3	0.4	0.0	0.0	0.0	1.0	1.0
RETIRE	6.8	5.5	0.0	3.0	6.0	10.0	29.0
CAPITAL	32.4	4.6	24.6	28.1	32.5	36.2	41.3

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	-0.29	0.28	0.24	-0.06	-0.10
RTBILL		1.00	-0.53	-0.17	0.20	-0.32
INFLAT			1.00	0.08	-0.29	-0.33
CATLOSS				1.00	-0.12	0.13
RETIRE					1.00	-0.23
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	1.20	2.48	2.76	1.09	1.32	2.25

5.3 Estimation results and interpretation

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.

The positive coefficient of $EXCESS$ is as expected, and suggests the underwriting return of the property-liability insurance industry and the excess return on property-liability insurance stock move in similar directions in the short term. We hypothesize that the positive short-term relationship results from a shift in the supply of insurance, which stems from the anticipation of excess returns on writing insurance. Consequently, more funds flow towards the writing of insurance when there is greater potential of underwriting profits. We do not expect this relationship to persist in the long-term. As the supply of insurance is increased (reduced) when excess positive (negative) insurance stock returns are available, the premium rate is expected to decrease (increase) resulting in a

Table 4: Estimation results of empirical model

	(Expected Sign)	Dependent variable = Underwriting return (UWR_t)
$EXCESS_t$	(+)	0.123^{**}
		(0.041)
$RTBILL_t$	(−)	-0.827^{**}
		(0.150)
$INFLAT_t$	(+ or −)	-0.467^{**}
		(0.124)
$CATLOSS_t$	(−)	-2.298^{**}
		(0.666)
$RETIRE_t$	(−)	-0.424^{**}
		(0.061)
$CAPITAL_t$	(+)	0.203^{*}
		(0.081)
Observations		208
R^2		0.455
Adjusted R^2		0.438

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

decrease (increase) in the underwriting return in the longer term.[17] This longer term relationship between excess stock returns and the underwriting return is analyzed further in the following subsection.

The real interest rate variable, $RTBILL$, reflects the level of investment return available to insurers.[18] The regression coefficient of $RTBILL$ is negative, as expected. A negative correlation between

[17] Arguably, an increase (decrease) in the supply of insurance could also lead to a secondary effect of relaxed (tightened) claims processing and operating expense controls.

[18] The variable $RTBILL$ is defined as the difference between the average one-month US Treasury bill rate, as a proxy for the nominal risk-free rate, and the percentage change in the CPI, over a given quarter. Our results are robust to using the three-month US Treasury bill rate as a proxy for the nominal risk-free rate.

real interest rates and the underwriting return, 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. The negative 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, than on premium income.

Above average catastrophic losses ($CATLOSS$) and a large number of involuntary retirements from the industry ($RETIRE$) both hold the predicted negative relationship with underwriting return. The negative coefficient of $RETIRE$ suggests that the relationship between the price of insurance and the level of competition in the market is as the market mechanism predicts. As expected, the positive coefficient of $CAPITAL$ variable suggests that premium rates are determined, at least in part, by the capital strength of the industry.

5.4 Time-series estimation results

We extend the analysis by considering the longer term relationship between the underwriting return of the property-liability insurance industry and the variables analyzed above. The empirical model of Equation 2 is extended by the introduction of lags to the explanatory variables, as indicated in Equation 3.

$$
\begin{aligned}
UWR_t = \ & \beta_0 + \beta_1 EXCESS_{t-l} + \beta_2 RTBILL_{t-l} \\
& + \beta_3 INFLAT_{t-l} + \beta_4 CATLOSS_{t-l} \\
& + \beta_5 RETIRE_{t-l} + \beta_6 CAPITAL_{t-l} + \epsilon_t,
\end{aligned} \tag{3}
$$

The estimation results based on the lagged explanatory variables are summarized in Table 5.

Table 5: Estimation results with a leading dependent variable

	Dependent variable = UWR_t				
	$l = 0$	$l = 1$	$l = 2$	$l = 3$	$l = 4$
$EXCESS_{t-l}$	0.123**	0.105*	0.092	0.034	−0.010
	(0.041)	(0.048)	(0.049)	(0.043)	(0.046)
$RTBILL_{t-l}$	−0.827**	−0.924**	−0.954**	−1.084**	−1.316**
	(0.150)	(0.159)	(0.162)	(0.151)	(0.162)
$INFLAT_{t-l}$	−0.467**	−0.592**	−0.874**	−1.069**	−1.061**
	(0.124)	(0.136)	(0.144)	(0.134)	(0.138)
$CATLOSS_{t-l}$	−2.298**	−1.565*	−0.344	1.654**	1.127
	(0.666)	(0.786)	(0.789)	(0.642)	(0.649)
$RETIRE_{t-l}$	−0.424**	−0.344**	−0.368**	−0.428**	−0.360**
	(0.061)	(0.062)	(0.064)	(0.068)	(0.062)
$CAPITAL_{t-l}$	0.203*	0.151	0.047	−0.069	−0.103
	(0.081)	(0.085)	(0.086)	(0.075)	(0.083)
Observations	208	207	206	205	204
R^2	0.455	0.394	0.365	0.415	0.422
Adjusted R^2	0.438	0.376	0.346	0.398	0.404
Notes:	Heteroskedasticity-robust standard errors in parentheses.				
	*p<0.05; **p<0.01				

The regression results in Table 5 suggest that the positive relationship between underwriting return and excess property-liability stock return in the short-term does not persist in subsequent quarters. Likewise, previous levels of financial strength do not continue to hold a significant relationship with the underwriting return in subsequent periods.

The effect of extraordinary catastrophic losses on the underwriting return is also seen to subside in the quarters immediately following the catastrophic losses. Although not conclusive, there is some evidence of the losses from past catastrophes being recouped in later quarters.

5.5 Sub-period estimation results

In order to analyze how the above relationships have changed over the study period, we consider the base empirical model of Equation 2 once again, but subdivide the sample into four periods of equal length (i.e., for periods of 52 quarters). The regression results for these sub-samples are summarized in Table 6.

A number of the results from the full sample period are reversed in the sub-period analysis. In particular the excess returns on property-liability insurance stock is seen to be negatively correlated with the underwriting return in the earliest sub-period, as apposed to a positive correlation thereafter. The negative relationship between excess returns on property-liability insurance stock and

Table 6: Estimation results for sub-samples

	Dependent variable = Underwriting return (UWR_t)			
	1970 - 1982	1983 - 1995	1996 - 2008	2008 - 2021
$EXCESS_t$	-0.470^{**}	0.300^{**}	0.409^{**}	0.396^{**}
	(0.149)	(0.096)	(0.124)	(0.133)
$RTBILL_t$	-1.006^{**}	-1.577^{**}	-0.009	1.754^{**}
	(0.178)	(0.277)	(0.427)	(0.586)
$INFLAT_t$	-0.388^{*}	-1.182^{**}	0.239	1.713^{**}
	(0.192)	(0.307)	(0.425)	(0.642)
$CATLOSS_t$	1.078	-1.681	-6.438^{**}	-4.008^{**}
	(0.920)	(1.201)	(1.609)	(1.033)
$RETIRE_t$	-0.441^{**}	-0.533^{**}	-0.493^{**}	-0.294
	(0.168)	(0.102)	(0.124)	(0.211)
$CAPITAL_t$	0.443^{**}	-1.133^{**}	-0.557	0.236
	(0.159)	(0.428)	(0.357)	(0.230)
Observations	52	52	52	52
R^2	0.498	0.541	0.619	0.411
Adjusted R^2	0.431	0.480	0.569	0.333

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

the underwriting cycle up to the early 1980s is in accordance with Browne and Hoyt (1992), who find a similar result over a similar period. We believe this result can be attributed to the market conditions of the 1970s and 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".[19] The industry-wide lowering of premiums and

[19] Cashflow underwriting refers to the practice of of providing insurance coverage at less than

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 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 underwriting returns and excess returns on property-liability insurance stock, from a negative relationship in the early parts of the study period to a positive relationship thereafter, indicate that the insurance industry has become more disciplined in its underwriting practices.

It is also evident that the most recent sub-period of persistently low interest rates and volatile inflation has had a significant impact on the underwriting return of the industry. As the level of investment return available to insurers in the capital market (represented by $RTBILL$) has declined, its relationship with the underwriting return of the industry has apparently changed.

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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.

6. Conclusion

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 overall positive relationship between the underwriting return and excess return on property-liability insurance stock, particularly in the most recent sub-periods, 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.

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 negatively correlated with the underwriting cycle in the long term, although there is some evidence that this relationship is changing. This suggests that although a cycle in the underwriting return of property-liability insurers may be seen to exist, the cycle may not persist for total return, as the sum of underwriting and investment returns. We further find that changes in CPI inflation have a greater impact on incurred losses and loss adjustment expenses than on premium income.

As an indicator of the level of competition in the market, the number of involuntary retirements from the property-liability insurance industry is seen to be negatively correlated to the industry underwriting return. This negatively relationship further supports the capacity constraints hypothesis and the view that a sufficient number of retirements from a soft market must occur before the cycle will turn.

The negative relationship between the underwriting return and extraordinary catastrophic losses is also as anticipated, as these losses directly impact the underwriting return in the period in which they occur. In addition, 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 underwriting return is positively correlated with the financial strength of the industry and conclude that this presents evidence of market discipline in the property-liability insurance industry.

Finally, we find that the impact of past excess returns, past financial strength, and past catastrophes do not continue to hold a significant relationship with the underwriting return in subsequent periods. 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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