Underwriting Cycles: A Synthesis and Further Directions

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Abstract: Underwriting cycles are associated with a mystique that few topics in the area of risk and insurance share. Many explanations and theories have focused on underwriting cycles, but little research exists to discern the relative importance of these theories in explaining insurance pricing and profitability. This research provides an intuitive review of the existing literature on underwriting cycles in the context of a demand and supply model. Specific, unaddressed issues about underwriting cycles are raised in the literature reviewed.

INTRODUCTION

Underwriting cycles are associated with a mystique that few topics in the area of risk and insurance share. The underwriting cycle is typically defined as repeating, regular periods of soft and hard markets. In a soft market, insurance coverage is readily available at "reasonable" prices, while a hard market is characterized by high prices and unavailability of coverage or limited coverage for potential policyholders. Historically, these cycles have averaged six years in length, although some literature questions whether this period has been lengthening. In tracking underwriting cycles, most of the attention tends to be directed at insurance pricing, or, conversely, insurance underwriting profits, rather than amount of coverage available.

Underwriting cycles have been the topic of considerable economic and financial research, and for good reason. Soft markets are associated with

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higher insolvency rates among insurers, and these are of concern to policyholders and regulators alike. To the extent that insurance is desirable or necessary for businesses to function, hard markets are of concern also because they can affect the price of goods and services in the economy (i.e., businesses must cover all costs, including insurance costs, in the long run). And, at the extreme, underwriting cycles can affect the level of certain economic activities. For example, unavailability of liability insurance for day care centers during the liability crisis in the 1980s resulted in the closing of some of these centers. Many other businesses were affected as well.

But even more than this, underwriting cycles have piqued the interest of both economic and financial researchers because their *regularity* is unexpected in perfectly competitive, well-functioning capital markets. The regularity of underwriting cycles may call into question the rationality of insurance market operations. For example, naïve, extrapolative forecasting of losses or "out-of-control" cash flow underwriting can be shown to give rise to a cycle in underwriting profit. But explanations such as these are unsatisfactory to researchers who believe in rational markets. Thus a search for market imperfections or some other rational market phenomenon that can explain a cycle characterizes the underwriting cycle literature.

The search has turned up many different factors that help to explain underwriting cycles, and at this stage it appears that underwriting cycles can be at least partially explained by rational responses to several different features of insurance markets and dynamic market developments. These factors encompass institutional and regulatory features of insurance that give rise to an "apparent" cycle as well as the effects of real phenomena such as interest rate and/or loss shocks, asymmetric information in capital markets, and capital surpluses and shortages in insurance.

The purpose of this article is to provide an overview and synthesis of the predominant underwriting cycle theories.[1] Unanswered questions arising from the underwriting cycle literature are highlighted. This overview starts with a basic demand and supply model. Demand and supply are found to be functions of many factors themselves, and displaying these major factors contributes to the understanding of how all of the disparate underwriting cycle theories fit together.

The remainder of this article is organized as follows. In the next section, a stylized demand and supply for insurance model is presented. In the following section, studies that focus on the time series pattern of insurance prices or underwriting profitability are discussed. This section concludes with unanswered questions relating to this stream of literature. Next, the role of insurance crises in explaining underwriting cycles is addressed, and at the end of this section more unanswered questions stemming from this literature are listed. The last section concludes.

PRICE AND QUANTITY OF INSURANCE MODELS

Insurance is unlike other goods in that there is no price at which customers can buy all of the quantity (coverage) that they desire. Instead, the insurance product is a package that consists of price (p) and quantity (q) (i.e., I(p,q)). Insurance is purchased in a market that consists of customers (policyholders) and suppliers (insurers). In a perfect, competitive market, this can be represented in a simple way at the micro level as:

$$\text{Demand: } I(p,q) = f(\mu_L(I), E, A, \sigma_L{}^2, \sigma_{Ln}, O)$$

$$\text{Supply: } I(p,q) = f(\mu_L(I)\ E, A, \sigma_L{}^2, n_k\sigma_{jk}\,O),$$

where L indicates expected losses, O represents business opportunities,[2] I is expected inflation, n is expected income, A is assets, E is equity, and j and k represent insurance policies j and k. Arguably, one might add more terms to either the demand or supply specification, but this simple model should suffice for the purpose at hand. The market will clear at the I(p,q) package where demand meets supply.

Unfortunately, the insurance package I(p,q) is unobservable, but premiums aggregated by line (at the firm or national level) can be observed, and the premium contains important pricing information. Therefore, premiums play an important role in underwriting cycle research. In theory, premiums can be modeled simply as follows:

$$\text{Premium} = \frac{\mu_L(I_c,I)}{1+r} + \text{Expenses}(T_t) + \tag{1}$$

$$\text{Profit}\left(\sigma_L^2, \sum_{k=1}^{m} \sigma_{jk}, E(r), G, D(\mu_L, \sigma_L^2), Q, tax\right),$$

where I_c is claims inflation, T is state of technology at time t, G represents agency costs, D is demand for insurance, Q is an indicator of financial quality, and tax represents insurer income tax. (All other variables are defined as before.) It is assumed in the above that premiums are paid at the beginning of the year and all losses are paid at the end of the year for simplicity's sake. Equation (1) indicates that premiums reflect discounted losses, which are a function of general and claims inflation and the discount rate r (Myers and Cohn, 1986; Grace and Hotchkiss, 1995), plus underwriting expenses which are a function of technology at time t (e.g., Cummins and Outreville, 1987), and profit (or a risk charge).

The risk charge is affected by many factors, including the variance of losses and their covariance with other business written, the amount of the insurer's equity or surplus (e.g., Winter, 1994, Gron 1994b), agency costs related to information asymmetries between the insurer and capital markets and/or between the insurer and policyholders (Winter, 1994; Cummins and Danzon, 1997), taxes (including taxes on investment income earned on policyholder funds held by the insurer—i.e., reserves) (Myers and Cohn, 1986; Weiss, 1985), financial quality (Cagle and Harrington, 1995; Harrington and Danzon, 1994; Cummins and Danzon, 1997), and demand for insurance in general. Equity is considered a function of the interest rate in equation (1) because insurers' assets and liabilities may be a function of interest rates (Doherty and Garven, 1995). Equity, then, as a balancing item, must be affected by interest rates as well. The functional items listed here are included because they play a role in underwriting cycle research and will be discussed more fully once specific underwriting cycle theories are considered. Arguably, again, one might include more items in equation (1) above, but equation (1) should be sufficient for the present purposes.

Obviously, when any of the factors that underlie premiums change, premiums will change also. However, the extent to which premiums will change is not always clear. Time series analysis of premiums indicates that expected losses and discount rates are strongly related to premiums in the short run (e.g., Cummins and Tennyson, 1992; Danzon, 1985.

As indicated earlier, price or underwriting profit are specifically considered in underwriting cycle studies. Price is typically measured relative to losses incurred (i.e., (Premiums/Losses incurred) or Premiums/PV(Losses incurred)). Losses incurred here are not necessarily the same as μ_L in equation (1), because the only data usually available are ex-post data, not ex-ante data, and this problem underlies all underwriting cycle research (Harrington and Niehaus, 2000). The underwriting profit (π) rate is defined as (Premiums – Losses Incurred – Expenses)/Premiums.

Now the stage has been set for determining how underwriting cycle theories fit into the general model of insurer pricing, or at least into our measure of insurance price. Our cast of characters (E, r, I, G, Q, etc.) have been assembled, and we will see how each of these factors has been used (sometimes uniquely) to explain insurance pricing and profitability.

TIME SERIES ANALYSIS OF PREMIUMS AND UNDERWRITING PROFIT

The premium model in the preceding section indicates that a number of economic factors potentially play a role in premium determination (e.g., demand, losses, interest rates). Cointegration analysis can be used to determine if premiums or underwriting profits are indeed related to these factors. Conditional on these related factors, one would not expect to see any definite patterns in underwriting profits (or a complementary measure such as the combined ratio) if capital markets are perfect and competitive. Instead they should be random, reflecting the random nature of losses. However, the underwriting profit pattern is not random, but autoregressive.

In this section, cointegration studies are reviewed and theories that explain autoregression in underwriting profits are considered. Finally, some open questions of this research are presented.

Unit Roots and Cointegration

Cointegration analysis can be used to determine whether short-term or long-term relationships exist between premiums or underwriting profits and various economic factors (Engle and Granger, 1987). Cointegration of two variables can exist only if both of the variables are nonstationary (i.e., they do not fluctuate randomly around a mean). Thus before cointegration analysis can be conducted, the stationarity in the mean of the underlying variables must be determined. Frequently, stationarity is assessed from analysis of a unit root. Cointegration analysis is meaningful if a unit root exists.[3]

A large number of studies in recent years have used cointegration analysis, starting with Haley (1993). In the latter study, a negative, cointegrating relationship is found between interest rates and underwriting profit. This finding is consistent with the model presented in equation (1). This relationship is confirmed in later research by Choi, Hardigree, and Thistle (2002). In further work, Haley (1995) finds that underwriting profits by line are not necessarily cointegrated with interest rates.

However, other research disagrees with the general findings of cointegration between interest rates and undewriting profit. The main bone of contention among these studies concerns the unit root tests. When adding a time series variable to the unit root analysis, Harrington and Yu (2003) reject the unit root hypothesis in their test of underwriting profits. In a series of articles based on varying sample periods, Leng et al. (2002), Leng (2006a, 2006b), and Leng and Meier (2006) also cast doubt on the finding of a unit root in underwriting profits.

In a study in this issue, Haley takes exception to research that casts doubt on cointegration analysis of underwriting profits. Haley argues that limiting the time period of study as in Leng et al. (2002), Leng (2006a, 2006b), and Leng and Meier (2006) because, for example, of a structural break in the data, is not necessary when conducting tests for stationarity. Further, Haley argues, controlling for a time trend when conducting unit root analysis as in Harrington and Yu (2000) may not be appropriate. Instead Haley argues that the finding of a significant time trend in underwriting profits is evidence, itself, of nonstationarity in the data series.

Grace and Hotchkiss (1995) and Choi, Hardigree, and Thistle (2002) also conduct cointegration analysis. Grace and Hotchkiss (1995) find a positive cointegrating relationship between the combined ratio and the following factors: interest rates, GDP, and the consumer price index. In fact, they find that all four series are cointegrated together. Since the combined ratio is inversely related to underwriting profits, Grace and Hotchkiss support Haley (1993). Interpreting GDP as a proxy for demand at the national level, it is not surprising that interest rates, GDP, and the consumer price index are cointegrated. All of these factors appear in the premium model in equation (1). Findings of cointegration with key economic variables are important because they tie the underwriting cycle to other economic cycles such as the business cycle.

Choi, Hardigree, and Thistle (2002) find that underwriting profits are not cointegrated with the ratio of surplus to premiums written, the ratio of surplus to assets, and the ratio of surplus to a lagged moving average of surplus. The ratios of surplus to premiums written and to assets are frequently used as measures of financial quality, and so these results appear to contradict the modeling of long-term profit as a function of financial quality in equation (1). The ratio of surplus to a lagged moving average of surplus is usually used as a measure of the relative supply of capacity or capital, and this finding, too, contradicts the model in equation (1) when it is interpreted as a long-term model. It should be noted, however, that a short-term relationship between insurance prices and surplus is found to exist. Another potentially important consideration in evaluating this work is that the analysis uses data aggregated to the industry level, while some underwriting cycle theories are most applicable at the firm level.

Apparent Cycles: Autoregression in Underwriting Profits

Venezian (1985) noted that the pattern displayed by underwriting profits over time (both aggregate and by line) resembles a cosine wave. This discovery sparked research to explain this specific pattern in underwriting profits, and this research is briefly reviewed below.

Venezian (1985) recognized that the cosine wave–like pattern observed in underwriting profits could arise from second-order autoregression in underwriting profits. Evidence of a second-order autoregression process was found by regressing underwriting profits π_t on a constant, π_{t-1} and π_{t-2}. The coefficients from this regression model, assuming that they were consistent with the existence of a cycle, can be used to find the period of the cycle. Venezian (1985) found cycles in several lines of insurance and noted that the periods of the cycle among different lines can vary and that the phases of the cycle among lines do not necessarily coincide.

An important question is why second-order autoregression should exist in underwriting profits if insurers price business rationally. Venezian (1985) attributed this second-order autoregression process to naïve forecasting whereby insurers forecast future losses by extrapolating from past trends.[4] Cummins and Outreville (1987) provide a more compelling explanation for the observed autocorrelation in underwriting profits. They posit that the so-called "irrational" pricing behavior is caused by a filtration of rational prices through external events. They develop a model in the context of rational expectations in which external factors can produce second-order correlation among underwriting profits. One such external influence is institutional lags attributed to data collection, regulation, and policy renewal periods. Accounting reporting conventions also contribute to the autoregression. Thus they show that insurers may in fact act rationally, even though the underwriting profit pattern makes it look irrational.

Cummins and Outreville (1987) also hypothesize that if the external factors above are important, they should affect underwriting results not only in the U.S. but internationally. Hence they examine underwriting results for a large sample of countries from 1957 to 1979, and they observe underwriting cycles, as predicted. Lamm-Tennant and Weiss (1997) further the Cummins and Outreville model by more directly linking countries' institutional features with underwriting cycles. Like Cummins and Outreville, they find evidence of cycles in many countries and among lines of insurance. They link changes in premiums with lagged losses, the presence of regulation, and the policy period among their sample of countries.[5]

Additional studies have been conducted to determine whether underwriting cycles exist in other areas of the world and during more recent time periods (e.g., Chen, Wong, and Lee, 1999; Meier, 2006; and Meier and Outreville, 2006). Simultaneous models are also increasingly used to explain premium changes or premium volatility and other aspects of underwriting cycles (e.g., Fung et al., 1998; Wen and Born, 2005).

Recent research in the U.S. may suggest that the cycle may be lengthening or vanishing. Some explanations for this are that computer technology has reduced data lags, price regulation has become less stringent, price changes are more frequent due to intensified competition, and insurers use shorter policy terms in key lines such as auto insurance, allowing them to re-price more often. Whether one finds that the cycle is lengthening or vanishing, however, may depend on the time period chosen for analysis as well as whether a time trend is included in the analysis.

OPEN RESEARCH QUESTIONS REGARDING TIME SERIES PROPERTIES OF UNDERWRITING PROFIT

The following are some questions that have not been satisfactorily answered with respect to the time series properties of underwriting results:

1. How have changes in the regulatory environment and in the types and features of the policies offered affected the time series properties of underwriting profits?
2. How much of the autocorrelation in underwriting profits do accounting issues and regulatory lag explain?
3. How much do changes in expenses contribute to second-order correlation in underwriting profits?
4. Why does regulation and regulatory lag appear to have an impact on some lines such as automobile insurance but not on commercial lines (Stewart, 1987)?
5. If interest rates and interest rate changes are factors associated with cycles, why don't cycles appear in life insurance products?

REAL CYCLES: SHOCK THEORIES AND EXPLANATIONS FOR CRISES

As compelling as the rational expectations model is for explaining underwriting profit patterns, it cannot explain the market disruptions that are associated with hard and soft markets and with insurance crises (i.e., extreme hard markets such as the liability crisis in the mid-1980s). Several shock theories have been developed to explain this real market phenomenon. The types of shocks discussed can be broadly classified as capital shocks (arising from interest rate shocks or loss shocks) or shocks arising from changes in expectations (probability updating for policies issued in the future).

Capital Shock Theories

The familiar cash flow underwriting hypothesis is a basic supply-side explanation for the underwriting cycle. It posits that when the interest rate margin[6] increases, insurers are willing to cut prices (i.e., use a larger discount rate for losses in the premium) to gain market share and obtain assets to invest. But then an adverse loss shock occurs (reducing underwriting profit) or an adverse interest rate shock occurs (reducing return on assets), causing leverage ratios (e.g., the premium to surplus ratio) to increase. This causes the market to harden. Insurers then reduce supply by reducing premium writings and increase price to reduce leverage to more reasonable levels. Conversely, when favorable loss or interest rate shocks occur, then soft markets arise.

Winter (1994) formalizes this basic supply-side explanation and introduces demand into the analysis. Winter posits that insured losses are correlated so that all insurers are hit similarly by shocks. Also, insurers must hold equity to guarantee that they will be able to pay all claims (i.e., insolvency risk is near zero). External capital is assumed to be more costly than internal capital so that capital does not flow freely into and out of the insurance industry (i.e., equity is "sticky").[7] These assumptions can be used to show that the market goes through periods of tight capacity following adverse loss shocks when prices go up. That is, losses accumulate, causing the market to tighten temporarily until higher prices allow capital to be built up again from retained earnings. As capital accumulates from retained earnings, firms go through periods of slack capacity when prices fall.

Thus, in Winter's capacity-constraint hypothesis, the industry's supply curve is flat over part of the price-quantity range and upward sloping when a capacity constraint becomes binding. The industry operates on the flat part of the supply curve during periods of slack capacity (soft markets). For a hard market, an adverse loss shock shifts the supply curve to the left so that the demand curve now intersects it in the upward sloping portion. Both Winter (1994) and Gron (1994a) test the capacity-constraint model, but the capacity-constraint hypothesis does not fully explain the liability crisis of the mid-1980s.[8] Recall, also, that Choi, Hardigree, and Thistle (2002) do not find relative capacity to be cointegrated with underwriting profit.

Rather than a loss shock, Doherty and Garven (1995) model the effect of interest rate shocks on insurance pricing. Both adverse and favorable shocks are explicitly considered. Their model is a firm-specific model rather than an industry-wide model as discussed above. Doherty and Garven (1995) note that the interest rate level is an important determinant of long-run, equilibrium prices in the insurance industry. Changes in interest rates affect the short-run dynamics of the industry by affecting insurer assets and liabilities.[9] Thus an insurer's equity is affected by interest changes as well, and the extent to which an individual insurer is affected by an interest rate change depends on the relative duration of assets and liabilities and the insurer's ability to raise new external capital. If raising new capital is difficult or costly, then capacity constraints (which vary by firm) would cause insurers to cut back on the amount of coverage provided.

In the capacity-constraint model, demand is assumed to remain constant. In addition, it is assumed that insurers hold sufficient capital to maintain the insolvency risk near zero or insurers hold sufficient capital because of regulatory requirements. In other research, these assumptions are relaxed. Harrington and Danzon (1994) and Cagle and Harrington (1995) develop a model in which capital is endogenous and demand is assumed to depend on financial quality (e.g., insolvency risk). For example, Cagle and Harrington (1995) develop a model in which insurers choose the level of capital to operate at based on the benefits (protecting franchise value) and costs of holding capital.

Like Harrington and Danzon (1994) and Cagle and Harrington (1995), in this issue Ligon and Thistle (pp. 46–61) develop a model in which demand is assumed to be downward sloping, capital is costly, insurer insolvencies are possible, and demand for insurance is sensitive to insolvency risk. Using Bayesian rules, insurers are assumed to overreact to new private information and underreact to public information they receive about losses. That is, their reaction to private information is characterized by a psychological bias of overconfidence. Overconfidence then leads to increased volatility in insurance prices and can lead to soft markets if insurers' private information indicates that expected losses are falling. The converse occurs when adverse information is received by insurers.

An alternative to the capacity-constraint model is the risky-debt hypothesis (Cummins and Danzon, 1997). In this model, insolvencies are assumed to be possible, and demand for insurance is assumed to be inversely related to expected insolvency costs so that firms have an optimal capital structure. Insurance is assumed to be priced as risky debt (i.e., price equals discounted expected loss minus an insolvency put option). Shocks can occur that drive insurers away from the optimal capital structure. In response to an adverse shock, the insurer's supply curve shifts inward. However, since policyholders are sensitive to financial quality, the demand curve shifts downward at the same time. Thus it is not possible to predict the immediate effect on price from an adverse loss shock. Insurers initially respond to restoring optimal capital structure through increases in retained earnings from raising prices.[10] Thus this model also assumes that insurers have some market power over prices (e.g., from private information about policyholders). If a price increase is sufficient, insurers will be able to raise external capital. Cummins and Danzon's empirical model supports the risky-debt theory, but not the capacity-constraint theory.

The predictions of the capacity-constraint and risky-debt models may seem contradictory. The capacity-constraint theory predicts that price is inversely related to capacity (surplus), while the risky-debt hypothesis predicts that price should be directly related to capacity (i.e., financial quality). However, the two theories are not necessarily contradictory. The capacity-constraint theory could hold for the market as a whole (as a time series relationship), while the risky-debt model could explain cross-sectional price differences among insurers at a given time (Weiss and Chung, 2004). Research on reinsurance prices by Weiss and Chung (2004) provides support for both the capacity-constraint and risky-debt hypotheses. This might also explain why Choi, Hardigree, and Thistle (2002) did not find financial quality to be cointegrated with underwriting profit.

Finally, a demand and supply model developed by Lai et al (2000) emphasizes the role of changing expectations concerning μ_L and σ_L^2 in explaining insurance crises. They derive a theoretical model with risk-averse policyholders and insurers in a market with perfect competition. Policyholders and insurers are interested in maximizing utility and are assumed to have constant absolute risk aversion. Exposures are assumed to be IID, and in some examples normally distributed. In their model, an adverse change in expectations would reduce supply and make the supply curve more inelastic. At the same time, since demand is assumed to be sensitive to μ_L and σ_L^2 also, the demand curve shifts outward and becomes more inelastic. This exacerbates the effect of reduced supply on quantity and price of insurance, and the end result is an increase in premiums and a reduction in coverage. The opposite occurs when expected losses fall or there is a decline in risk: Demand contracts and supply expands, resulting in lower prices. Their model is robust enough to include the effects of adverse loss or interest rate shocks on capital structure.

Open Questions Regarding Capital Shock Theories and Real Crises

The following are some questions that have not been satisfactorily answered with respect to the time series properties of underwriting results:

1. What is the actual mechanism for jointly determining the premium and quantity of coverage?
2. What is the shape of the demand curve for insurance (e.g., its elasticity), and how has this changed over time with the development of the alternative market in some commercial lines?

3. How can second order autocorrelation in underwriting profits be consistent with capital shock theories, especially the capacity-constraint theory (Winter, 1994)?
4. For the capital shock theories, why do soft markets always appear to exist prior to a shock that depletes capital (e.g., Winter, 1994)?
5. Do regulatory requirements such as minimum premiums to surplus ratios or RBC requirements affect the amount or quantity of insurance written and hence its price?
6. To what degree can costly external capital explain the effect of shocks on insurer pricing?
7. If one traced the history of large loss events (i.e., events producing a loss shock), do all of them result in a hard market?
8. Is it changing expectations that cause premiums to change and supply to constrict or actual loss shocks that deplete industry surplus? (The former does not involve any liability on the part of insurers.)
9. If a loss shock occurred during the general liability crisis, why doesn't Winter's capacity-constraint theory help to explain the general liability crisis?

CONCLUSION

The disparate underwriting cycle theories reviewed here may leave one with the same feeling obtained by looking at a tangled ball of twine. How can these theories be disentangled to determine how much each of them contributes to underwriting cycles, if they contribute at all? For example, how significant is it that underwriting profits are cointegrated with GDP (and hence a business cycle) and that they may be affected by capacity? How much of the change in prices or underwriting profit can be explained by each of these factors? Exactly how much of the underwriting cycle is an artifact of institutional features of the insurance market versus real shocks? If the shock theories are relevant, how much of each hard market can be explained by an interest rate shock versus a loss shock? There are many more questions such as these that deserve attention, both theoretically and empirically. And what about the missing link—the quantity of coverage associated with premium levels? If we had knowledge of this, how would tests of the underwriting cycle theories be affected? Undoubtedly, questions such as these are the next frontier in underwriting cycle research.

NOTES

[1] For a more in-depth discussion of the theories discussed here, see Harrington and Niehaus (2000).

[2] That is, when demand for the policyholder's products is high, then more insurance may be demanded. For example, liability insurance purchases should be related to products produced, and workers' compensation insurance purchases should be related to number of workers, etc. This means that when overall activity is high in the economy, then demand for insurance should be affected.

[3] In a study by Haley in this issue, it is pointed out that finding a unit root is a sufficient but not necessary condition for conducting cointegration analysis.

[4] It is true that insurers do use naïve time trending in rate filings with the state, but these rates might never be used, because they might never be approved or because insurers are still able to engage in individual risk rating and other forms of price cutting.

[5] Changes in premiums are targeted since factors hypothesized to drive apparent underwriting cycles affect premiums directly, and the authors find that changes in premiums are significantly related to lagged losses (for at least some countries) and that changes in premiums are significantly related to regulation. They also develop an empirical model to predict the presence of a cycle in a country.

[6] The net interest margin is defined as the difference between the rate insurers can earn on invested assets and the rate they implicitly pay on debt (the discount rate for losses).

[7] For example, insurers do not pay out excess capital to stockholders during soft markets because of a "trapped equity effect." Informational asymmetries between investors and management of insurers could make it expensive for insurers to raise capital after it has been depleted.

[8] Some of the capacity constraint models concentrate on the effect of adverse loss shocks (hard markets). Other explanations might exist for underpricing in soft markets. Underpricing might occur due to limited liability or due to guaranty fund payments that do not reflect the insolvency risk of the insurer. A "winner's curse" could account for soft markets also if insurers that underprice business because of inaccurate loss forecasts are more likely to be awarded business (Harrington and Danzon, 1994).

[9] Insurers' assets consist largely of investments that by their nature are sensitive to interest rates, especially investments such as bonds, and Doherty and Garven (1995) show that liabilities are sensitive to interest rates as well.

[10] The argument for raising new capital from retained earnings is different from the capacity-constraint hypothesis (i.e., it is not because of market imperfections). Rather, it is because insurers are assumed not to impose a capital loss on new equity (raising new capital would add value to existing policies with no compensation from existing policyholders).

REFERENCES

Cagle, J., and S. Harrington (1995) "Insurance Supply with Capacity Constraints and Endogenous Insolvency Risk," *Journal of Risk and Uncertainty,* 11: 219–232.

Chen, R., K. A. Wong, and H. C. Lee (1999) "Underwriting Cycles in Asia," *Journal of Risk and Insurance*, 66: 29–47.

Choi, S., D. Hardigree, and P. D. Thistle (2002) "The Property/Liability Insurance Cycle: A Comparison of Alternative Models," *Southern Economic Journal,* 68: 530–548.

Cummins, J. D., and P. M. Danzon (1997) "Price, Financial Quality, and Capital Flows in Insurance Markets," *Journal of Financial Intermediation,* 6: 3–38.

Cummins, J. D., and F. Outreville (1987) "An International Analysis of Underwriting Cycles in Property-Liability Insurance," *Journal of Risk and Insurance,* 54: 246–262.

Cummins, J. D., and S. Tennyson (1992) "Controlling Automobile Insurance Costs," *Journal of Economic Perspectives,* 6: 95–115.

Danzon, P. (1985) *Medical Malpractice: Theory, Evidence and Public Policy.* Cambridge: Harvard University Press.

Doherty, N., and J. Garven (1995) "Insurance Cycles: Interest Rates and the Capacity Constraint Model," *Journal of Business*, 68: 383–404.

Engle, R. F., and Granger, C. W. (1987) "Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica,* 55: 251–276.

Fung, H. G., G. Lai, G. A. Patterson, and R. C. Witt (1998) "Underwriting Cycles in Property-Liability Insurance: An Empirical Analysis of Industry and By-Line Data," *Journal of Risk and Insurance,* 65: 539–562.

Grace, M., and J. Hotchkiss (1995) "External Impacts on the Property-Liability Insurance Cycle," *Journal of Risk and Insurance,* 62: 738–754.

Gron, A. (1994a) "Evidence of Capacity Constraints in Insurance Markets," *Journal of Law and Economics,* 37: 349–377.

Gron, A. (1994b) "Capacity Constraints and Cycles in Property-Casualty Insurance Markets", *RAND Journal of Economics,* 25: 110–127.

Haley, J. (1993) "A Cointegration Analysis of the Relationship Between Underwriting Margins and Interest Rates: 1930–1989," *Journal of Risk and Insurance,* 60: 480–493.

Haley, J. (1995) "A By-Line Cointegration Analysis of Underwriting Margins and Interest Rates in the Property-Liability Insurance Industry," *Journal of Risk and Insurance,* 62: 755–763.

Harrington, S. E., and P. Danzon (1994) "Price Cutting in Liability Insurance Markets," *Journal of Business,* 67: 511–538.

Harrington, S. E., and G. R. Niehaus (2000) "Volatility and Underwriting Cycles," in Georges Dionne, ed., *Handbook of Insurance*. Boston: Kluwer.

Harrington, S. E., and T. Yu (2003) "Do Property-Casualty Insurance Underwriting Margins Have Unit Roots?," *Journal of Risk and Insurance,* 70: 715–733.

Lai, G. C., R. C. Witt, H.G. Fund, R. D. MacMinn, and P. L. Brockett (2000) "Great (and Not So Great) Expectations: An Endogenous Economic Explication of Insurance Cycles and Liability Crises," *Journal of Risk and Insurance,* 67: 617–652.

Lamm-Tennant, J., and M. A. Weiss (1997) "International Insurance Cycles: Rational Expectations/Institutional Intervention," *Journal of Risk and Insurance,* 64: 415–439.

Leng, C. C. (2006a) "Stationarity and Stability of Underwriting Profits in Property-Liability Insurance Part I," *Journal of Risk Finance*, 7: 38–48.

Leng, C. C. (2006b) "Stationarity and Stability of Underwriting Profits in Property-Liability Insurance Part II", *Journal of Risk Finance*, 7: 146–159.

Leng, C.C., M. R. Powers, and E. C. Venezian (2002) "Did Regulation Change Competitiveness in Property-Liability Insurance? Evidence from Underwriting Profit and Investment Income," *Journal of Insurance Regulation,* 21: 57–77.

Leng, C. C., and U. B. Meier (2006) "Analysis of Multinational Underwriting Cycles in Property-Liability Insurance," *Journal of Risk Finance,* 7: 146–159.

Meier, U. B. (2006) "Multinational Underwriting cycles in Property-Liability Insurance Part I," *Journal of Risk Finance*, 7: 64–82.

Meier, U. B., and J. F. Outreville (2006) "Business Cycles in Insurance and Reinsurance: the Case of France, Germany and Switzerland," *Journal of Risk Finance*, 7: 160–176.

Myers, S. C., and R. A. Cohn (1986) "A Discounted Cash Flow Approach to property-Liability Insurance Rate Regulation," in J. D. Cummins and S. E. Harrington, eds., *Fair Rate of Return in Property-Liability Insurance*. Boston: Kluwer.

Stewart, R. E. (1987) *Remembering a Stable Future: Why Flex Rating Cannot Work*. New York: Insurance Services Office and Insurance Information Institute.

Venezian, E. (1985) "Ratemaking methods and Profit Cycles in Property and Liability Insurance," *Journal of Risk and Insurance,* 52: 477–500.

Weiss, M. A. (1985) "A Multivariate Analysis of Loss Reserving Estimates in Property-Liability Insurance," *Journal of Risk and Insurance,* 52: 199–221.

Weiss, M. A., and J. H. Chung (2004) "U.S. Reinsurance Prices, Financial Quality, and Global Capacity," *The Journal of Risk and Insurance,* 71: 437–467.

Wen, M. M., and P. Born (2005) "Firm-Level Data Analysis of the Effects of Net Investment Income on Underwriting Cycles: An Application of Simultaneous Equations," *Journal of Insurance Issues,* 28: 14–33.

Winter, R. A. (1994) "The Dynamics of Competitive Insurance Markets," *Journal of Financial Intermediation,* 3: 379–415.