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Original Paper

Insurance Cycles, Spanning and Regulation

Arthur M.B. Hogan[1] & David Nickerson[2*]

[1] Senior Economist, Federal Housing Finance Agency, Washington, D.C., USA

[2] Distinguished Professor, Rogers School of Management, Ryerson University, Toronto, Canada

[*] David Nickerson, Distinguished Professor, Rogers School of Management, Ryerson University, Toronto, Canada

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Abstract

This paper offers a novel explanation of the financial underwriting cycle in the property-liability insurance industry. By doing so it resolves that significant anomaly in asset pricing theory posed by cycles in the efficient pricing of insurance coverage. In contrast to the reliance on a variety of institutional or capital market failures underlying all previous explanations of this cycle, we directly augment the complete-markets environment of traditional asset-pricing models through the presence of a single source of risk that cannot be fully hedged through existing financial markets. We realistically interpret this source of risk as unforecastable noise in the implementation of insurance regulations. Cycles in the value of underwriting insurance coverage can arise in this simple variant of a standard complete-markets pricing model owing to the effect of such regulatory risk. We offer a sufficient condition for a stable cycle to endogenously exist in market equilibrium and illustrate this condition in the context of a representative insurance firm and a regulator pursuing a countercyclical policy with noisy implementation. Interestingly, while insurance pricing is efficient in the absence of the regulator, cyclic pricing and underwriting profitability can be induced by a countercyclical regulator policy designed to stabilize the very cycle it creates.

Keywords

asset pricing, financial markets, insurance, market completeness, regulation

JEL: O16, G13, G15

1. Introduction

The global property-liability insurance industry consistently exhibits recurrent cycles in the pricing, volume and profitability of underwriting coverage. The presence of this cycle compromises the empirical accuracy of the classical martingale pricing model in the theory of finance (Jarrow, Protter, &

Shimbo, 2010). Classical theory predicts that the current efficient value of coverage equals the corresponding current expected value of the cost of providing such coverage. Insurance cycles in economies in Asia, Europe and the United States have been extensively studied in numerous studies. Along with many others, these include Brock and Witt (1982), Venezian (1985), Fung, Lai, Patterson and Witt (1998), Gron (1994), and Weiss (1997), Niehaus and Terry (1998), Chen, Wong and Lee (1998), Leng and Meier (2006), Meier and Outreville (2006), Derien (2008), Lazar and Denuit (2012) and Boyer and Owadally (2015).

Measuring the return to underwriting by the traditional ratio of losses per dollar of underwriting, this paper offers a novel explanation of the pricing cycle in markets for property-liability insurance. Set in the context of an economy with incomplete markets, our explanation is based upon the inability of equity investors to fully hedge the risk associated with insurance underwriting. Such risk consists of the combination of uncertainty over the evolution of losses in the standard environment of complete private capital markets, which we term *exposure risk*, and volatility from one or more sources augmenting this standard environment and which cannot be hedged through private markets. Although our results can arise in any version of this setting, for simplicity we consider only one such source of volatility. We interpret this source as unpredictable randomness in the government implementation and administration of regulations affecting the ability of the insurer to modify premiums and other terms of its coverage. We refer to this as *regulatory risk*. Exposure risk is standard in all insurance markets and is associated with the volatility of future covered losses and the stochastic demand for new coverage. Regulatory risk arises from randomness in monitoring insurers and implementing both existing and new regulations which, in practice, are designed to stabilize the price and availability of insurance coverage.

Previous explanations of the insurance underwriting cycle include institutional frictions in reporting losses and biases in the forecasting of future losses (Venezian, 1985; Cummins & Outreville, 1987; Clark, 2015); capital market failures (Gron, 1994; Winter, 1994; Dicks, 2007); adverse selection and insolvency risk (Cummins & Danzon, 1987; Cagle & Harrington, 1995); unpredictable shifts in the term structure of interest rates (Doherty & Kang, 1988; Madsen, Haastrup, & Pedersen, 2005); strategic pricing and the winner's curse (Harrington, 2004; Emms, 2012) and behavioral biases in the underwriting process (Fitzwilliams, 2004). This paper differs in its explanation of such cycles, however, by avoiding the use of highly specific sources of market failure such as biased forecasting, differential costs of raising capital, adverse selection and bankruptcy costs. Instead, we offer a new and general explanation arising from the presence of a source of risk which cannot be spanned through private capital markets. This market incompleteness allows us to generate underwriting cycles directly through the interaction between uncertainty arising naturally in underwriting in private insurance markets and the unspanned risk endemic to the presence of regulatory policy.

We can, as a consequence, generate cyclic returns to underwriting in an economy that would allow the complete hedging of all risks in the absence of regulatory policy but lacks an adequate number of independent assets to hedge the financial risk arising from the implementation of insurance regulations.

Using the contingent claims method used in standard asset-pricing models to value the flow of underwriting profits in this economy with incomplete spanning, we show that, under suitable parametric restrictions, the ensuing market equilibrium can exhibit a globally stable cycle in the value of underwriting in the presence of noise from the implementation of regulations possibly designed to stabilize the insurance cycle.

The paper is organized as follows. The model of underwriting, along with the valuation equation for insurance underwriting and its solution under the incomplete markets assumption, are developed in Section II. Plausible parametric conditions under which an underwriting cycle can appear are derived and briefly discussed in Section 3. Concluding remarks appear in the final section.

2. A Model of the Insurance Market

2.1 The Underwriting Process

We consider a representative market for insurance within an economy possessed of a set of capital markets which span all private sources of financial risk. Government regulation of insurance premiums and coverage are also present in this economy. Owing to randomness in the imperfect monitoring of compliance and related factors arising in the implementation and administration of these regulations, the private sources of risk in the economy are augmented by the presence of this additional source of risk. Since an implicit actor in our model is the public agency which implements and administers these regulations, this additional source of risk is endogenous and, as a result, cannot be spanned by private capital markets.

Underwriting a unit of insurance coverage involves a contract between an insurance firm and a client in which the firm commits to reimbursing the client for his random future loss $L(t)$ in return for a flow of premium payments $p(t)$. Since an equity position in underwriting insurance coverage is a tradeable asset, a model of insurance underwriting consists of both a specification of the evolution of the stochastic return to underwriting and a corresponding procedure to derive the resulting market value of such equity.

Adopting the conventional measure of profitability in the insurance industry, we assume the instantaneous return to underwriting, is measured by the loss per dollar of coverage, $l = L/p$, and we further adopt the standard assumption that it evolves according to a standard continuous diffusion process,

$$dl = \alpha(l)dt + \eta(l)d\underline{z}(t) \tag{1}$$

The components dz_1 and dz_2 of $d\underline{z} = [dz_1, dz_2]$ respectively represent the sources of exposure and regulatory risk. These are each assumed to be standard white noise and exhibit a negative correlation ρ. The functions $\alpha(t)$ and $\eta(t)$ respectively represent the instantaneous conditional mean and variance of the rate of loss over time.

Consistency of equation (1) with actuarial evidence requires that changes in mean loss per dollar are negative and that the variance of loss is finite, concave and decreases monotonically as the volume of

underwriting diminishes (Note 1). Since our objective is to offer a sufficient condition for the existence of an underwriting cycle, we can consider, for simplicity, a special case of (1) in which $\alpha(l)$ is constant and that $\eta(l) = [\eta_1, \lambda\eta_2]$, with $\eta_1(.)$ and $\eta_2(.)$ being endogenous functions of the loss per dollar of underwriting l and where λ, which denotes $\sqrt{l}$, insures the concavity requirement for the aggregate variance of loss (Note 2). This specification simply implies that increasing uncertainty about regulatory compliance increases uncertainty about losses but at a decreasing rate, consistent with the properties required of the general evolution of loss in (1).

The current market value $V(l)$ of underwriting is the solution to the classical arbitrage-free valuation equation for this asset (Duffie (1988)). Denoting by subscripts the derivatives of V and applying Ito's Lemma to equation (1), the instantaneous return to an equity position in underwriting must satisfy the partial differential equation,

$$dV = V_l\, dl + (1/2)V_{ll}\, dl^2 = \alpha V_l\, dt + \eta_1 V_l\, dz_1 + \eta_2\lambda V_l\, dz_2 + \theta dt \quad (2)$$

where the term

$$\theta = \eta_1^2 + 2\rho\eta_1\eta_2 + \eta_2^2\rho^2 > 0$$

embodies, through the correlation parameter ρ the response of equity value to simultaneous exposure and regulatory risk.

When capital markets are incomplete, the common price of risk across all assets, φ, may have multiple values (Boyle and Wang (2001)). However, in deriving conditions sufficient for an underwriting cycle to exist, we need only to assume that simultaneous activity in financial markets determines a specific value of φ which is common to all traded assets and common knowledge to all investors.

2.2 A Solution for the Valuation Equation

The market value $V(l)$ of underwriting can be, following Black and Scholes (1971), derived by constructing a riskless portfolio, based on an equity position in underwriting and self-financed by borrowing V at the riskless rate r. Assuming, for simplicity, that equation (2) is stationary and substituting in it the risk-adjusted mean in an arbitrage-free market, $(\alpha - \varphi)$, the market value of underwriting can be shown to satisfy the condition

$$0 = \theta V_{ll} + (\alpha-\theta)V_l - rV \quad (3)$$

The current market value of underwriting, $V(t)$, is consequently the solution to the ordinary differential equation (3), subject to the appropriate boundary conditions. These conditions are that the value of underwriting is zero in both the absence of underwriting ($lim_{\lambda\to 0}\, V(\lambda) = 0$) and in the presence of unbounded covered losses ($lim_{\lambda\to\infty}\, V(\lambda) = 0$); and that the marginal loss rate is one for the first dollar of underwriting coverage sold ($lim_{\lambda\to 0}\, V'(\lambda) = 1$).

Using these boundary conditions, we can solve this differential equation to obtain a generic solution for $V(t)$:

$$V(I) = \left(\frac{d}{a-b}\right)\left[e^{1-2\delta^2\rho}\left(e^{\psi\sqrt{I}} - e^{-\psi\sqrt{I}}\right)^{\frac{1}{2\delta(1+\delta\rho)}}\right] \quad (4)$$

where the values a, b and φ are:

$$a = \frac{1 - 2\delta^2\rho - \sqrt{(1 + 2\delta^2\rho) - 4\delta(1 + \delta\rho)r}}{2\delta(1 + \delta\rho)}$$

$$b = \frac{1 - 2\delta^2\rho + \sqrt{(1 + 2\delta^2\rho) - 4d(1 + \delta\rho)r}}{2\delta(1 + \delta\rho)}$$

$$\varphi^2 = (1 + 2\delta^2\rho) - 4\delta r(1 + \delta\rho) \quad (5)$$

and $\delta^2 = 2\eta_1$.

3. Results and Discussion

Our objective is to show that an equilibrium insurance underwriting cycle could occur in our model. Such a cycle will exist if the generic value of underwriting in (4) possesses, for suitable parameter values, a stable and periodic solution.

Chiarella, Kang and Meyer (2014) and Sayevand (2014) have shown the global stability of solutions to the class of differential equations that includes (3). The periodic solution we desire will exist if the differential equation (3) determining the value of underwriting *V(l)* possesses harmonic roots as well as real ones. Our choice of parameter values must generate this underlying pair of harmonic roots. Since the term φ in the expression (4) for *V(l)* represents the discriminant for these roots, the range of possible parameter values must satisfy the restriction that

$$(1 + 2\delta^2\rho) < 4\delta r(1 + \delta\rho)$$

A sufficient condition for this restriction is that any values for the riskless interest rate r and the correlation between exposure and regulatory noise ρ simultaneously satisfy the inequality

$$\rho < \frac{r^2}{r-(1/2)} \quad (6)$$

This range of values for ρ, the correlation between the respective sources z_1 and z_2 of exposure and regulatory risk, is consistent with a negative relation between these risks and, as a consequence, with a countercyclical regulatory policy intended to stabilize insurance rates, the availability of coverage and the value of underwriting. Conditional on the actual value of this correlation, the instantaneous riskless interest rate r must not exceed fifty percent, a range consistent with that of virtually every OECD economy.

4. Concluding Remarks

Consistent observations of cycles in the pricing and profitability of property-liability insurance have long been an anomaly in the classical theory of asset pricing. In contrast to previous explanations of this cycle, which rely on a variety of specific institutional or informational market failures, this paper offers a new and more fundamental explanation. Rather than positing specific inefficiencies in financial markets, including biased forecasting procedures or a divergence between the internal and external cost of funds in capital markets, this explanation is based directly on the incompleteness of such financial markets and so includes these specific market failures as special cases. We demonstrate that, under

plausible parametric values, a cycle in insurance underwriting can arise in an otherwise efficient private economy when a public authority creates an unspannable source of risk through its imperfect implementation of countercyclical regulatory policy within the insurance market. In such an environment, a representative insurance firm is simultaneously exposed to standard risk from its exposure to random loss from existing coverage and also to risk associated with random errors in the implementation of regulatory policy. Since such risk is an endogenous consequence of the behaviour of the regulator, it cannot be spanned through private capital markets. Ironically, our explanation suggests that one potential cause of underwriting cycles in global insurance markets is the implementation of regulatory policy intended to mitigate that cycle.

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Notes

Note 1. This means, in technical terms, that each of functions η_i are twice continuously differentiable, with positive (negative) first (second) derivatives and that as actual losses $L \rightarrow 0$, $var(dl) \rightarrow 0$.

Note 2. See Cox, Ingersoll and Ross (1985) for a detailed description of this process.