Markets for Risk Management

Insurance Cycles: Interest Rates and the Capacity Constraint Model

Neil A. Doherty and James R. Garven

1995 *Journal of Business*

Motivation

- Financial pricing models imply that underwriting returns of property-liability insurers should conform to an unpredictable time series process; e.g., $r_{u,t} = E(r_{u,t}) + \varepsilon_t$.

  - However, cycles are widely reported.

  - Is the "underwriting cycle" an illusory statistical artifact, or is it real?

Previous Literature

- <u>Feedback/lag (aka "irrational insurer") models</u>; e.g. Brockett and Witt (1982 *JRI*) and Venezian (1985 *JRI*) – debunked by Cummins and Outreville (1987 *JRI*), who model the insurer as a rational expectations decision-maker.

- <u>Financial pricing models</u>; Doherty and Kang (1988 *JBF*) – underwriting returns are inversely related to interest rates; cycles are statistical artifacts of data and regulatory lags (and therefore not "real").

Previous Literature

- <u>Capital Constraint Models</u>; e.g., Winter (1994 *JFI*) and Gron (1994 *RJ*)

  - Insurers experience sharp price spikes and reduction in underwriting capacity following surplus shocks because of the high cost of accessing external capital markets.

    - Following an adverse surplus shock, the quantity of insurance traded falls (due to the withdrawal of supply and its impact on prices).

    - Price can be subject to even further upward pressure since the demand for insurance may rise.

Previous Literature

- Capital Constraint Models (Continued)

  - Slowly, capital is replenished internally and the product market returns to a long run equilibrium.

  - If the price spike is sufficiently severe, short-term profit opportunities can overcome the additional costs of external capital and new capital will flow in.

Insurance Cycles: Interest Rates and the Capacity Constraint Model

This paper's contributions

- Synthesis of the financial pricing and capacity constraint literatures.

- We show how changes in interest rate simultaneously affect the insurer's capital structure and the equilibrium level of underwriting profit.

This paper's contributions

- Depending upon firm-specific factors such as asset and liability duration, access to capital markets, and availability of capital substitutes (e.g., reinsurance), insurers will be differently affected by changing interest rates.

- The average market response to changing interest rates roughly tracks market clearing prices, although the response is somewhat muted.

Insurance Pricing Models (w/out default)

$$r_u = \frac{P - L}{P},$$

where

r_u = rate of return on underwriting;

P = insurer's aggregate premiums (net of expenses), and

L = insurer's incurred losses.

Insurance Pricing Models (w/out default)

- In a single period setting, $P* = E(L)/(1+r)$, where r is the nominal (riskless) interest rate; thus

$$E(r_u) = \frac{P^* - E(L)}{P^*} = -r .$$

Insurance Pricing Models (w/out default)

- Interest rate sensitivity is greater for lines of insurance with long claim delays compared with lines of insurance with short claim delays, an effect captured by the insurance CAPM:

$$E(r_u) = -kr_f + \beta_u \lambda, \qquad (1)$$

where k is the average claim delay, β_u is the underwriting beta, r_f is the risk free rate, and λ is the market risk premium.

Insurance Pricing Models (w/out default)

- Assuming that β_u and λ are constants, expected underwriting returns respond to interest rates as follows:

$$dE(r_u) / d(kr_f) = -1 \qquad (2)$$

- $E(r_u)$'s interest rate sensitivity is determined by k; $\therefore$ cross sectional differences in k $\Rightarrow$ differences in the response of underwriting returns to interest rate changes.

Insurance Cycles: Interest Rates and the Capacity Constraint Model

Figure 1: The Gron-Winter Model
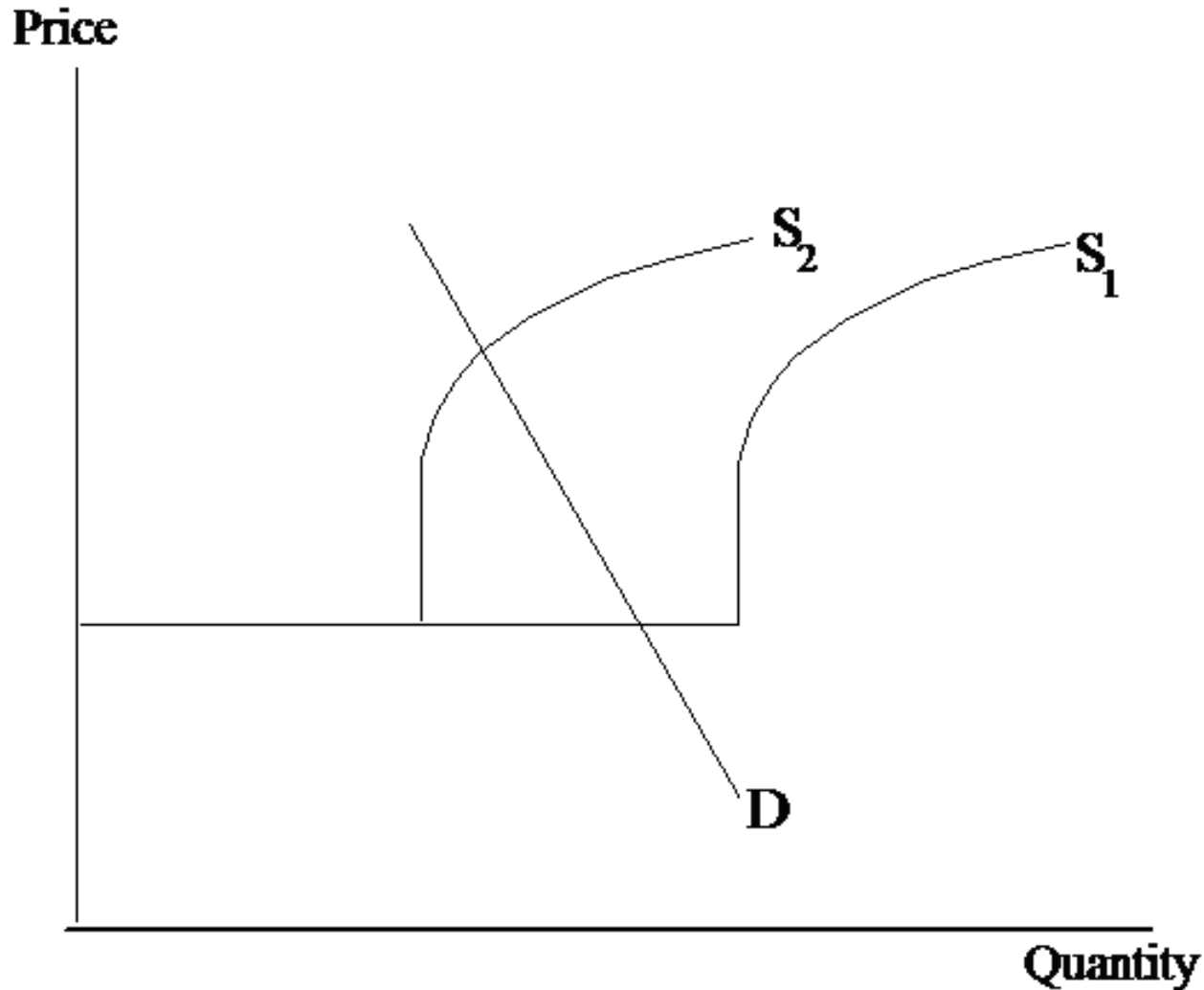
The Gron-Winter Model

- A preference for internal capital, combined with a given probability of insolvency, generates a particular shape for the short run supply curve.
  - For a given level of equity, there is a limit on the number of policies that can be sold at a given price without increasing the probability of insolvency.
  - Beyond this limit, the price <u>must increase</u> in order to maintain the same level of insolvency risk. Thus, the supply function is kinked, being elastic for quantities below the kink and inelastic thereafter.

Integration of Gron-Winter with Interest Rate Effects

- The capacity constrained model may be summarized by the predicted *short run* relationship between $E(r_u)$ and the insurer's equity Q: $dE(r_u)/dQ \leq 0$.

- Next, consider the effects of interest rate changes on insurer surplus.

- The sensitivity of insurer surplus to changes in interest rates depends upon duration of the insurer's equity D_Q.

Integration of Gron-Winter with Interest Rate Effects

- If $D_Q > 0$ (<0), then $dQ/dr_f < 0$ (>0).
- If $D_Q = 0$, then $dQ/dr_f = 0$; this is implicitly assumed by the insurance CAPM!
- $\therefore$ the *short term* effects of interest rate changes are given by equation (3a):

$$\frac{dE(r_u)}{d(kr_f)} = \frac{\partial E(r_u)}{\partial Q}\frac{\partial Q}{\partial(kr_f)}$$

$$= \begin{cases} \geq -1 \text{ if surplus duration is positive} \\ = -1 \text{ if surplus duration is zero} \\ \leq -1 \text{ if surplus duration is negative} \end{cases} \qquad (3a)$$

Insurance Cycles: Interest Rates and the Capacity Constraint Model

Integration of Gron-Winter with Interest Rate Effects

Following Babbel and Staking (1995 *JRI*),

$$D_Q = (D_A - D_L)[V(A)/V(Q)] + D_L, \quad (4)$$

where

D_A = duration of the insurer's assets;

D_L = duration of the insurer's liabilities; and

$V(A)/V(Q)$ = the ratio of the value of the insurer's assets divided by the value of surplus.
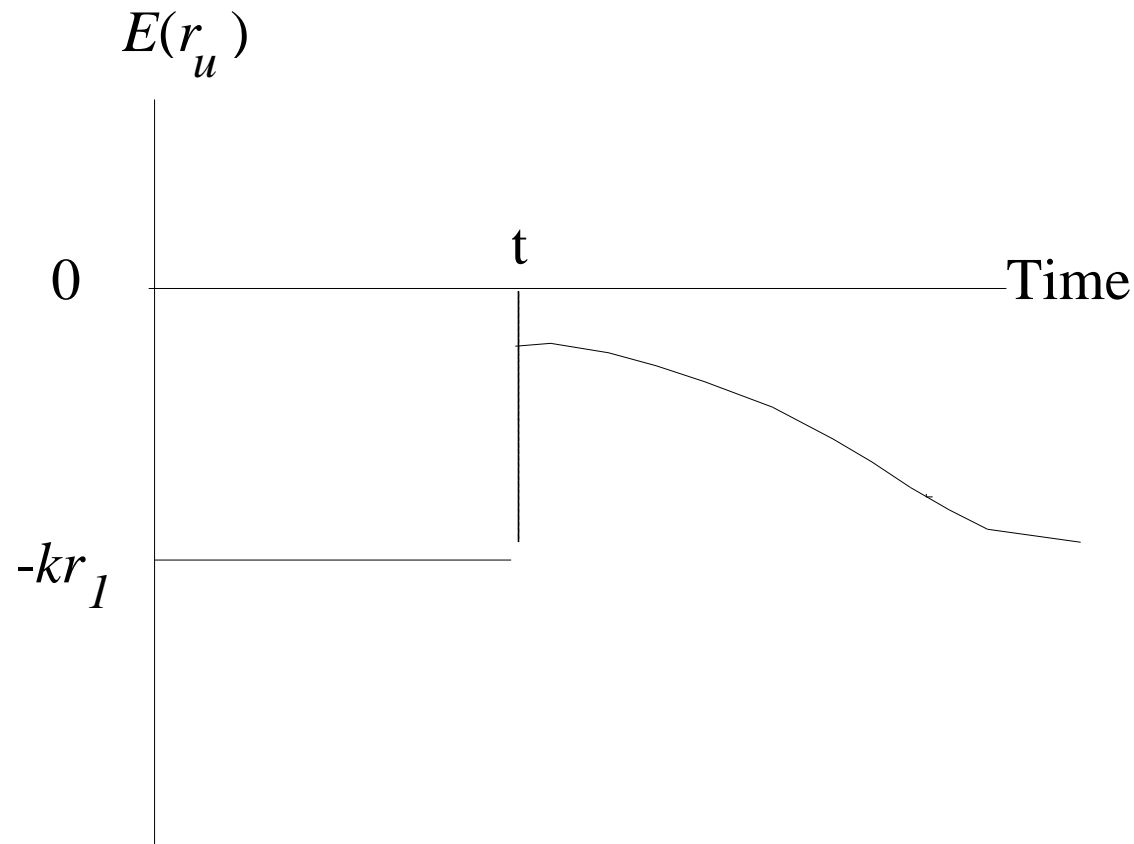
Figure 2: The Gron-Winter Model

$E(r_u)$

0

t

Time

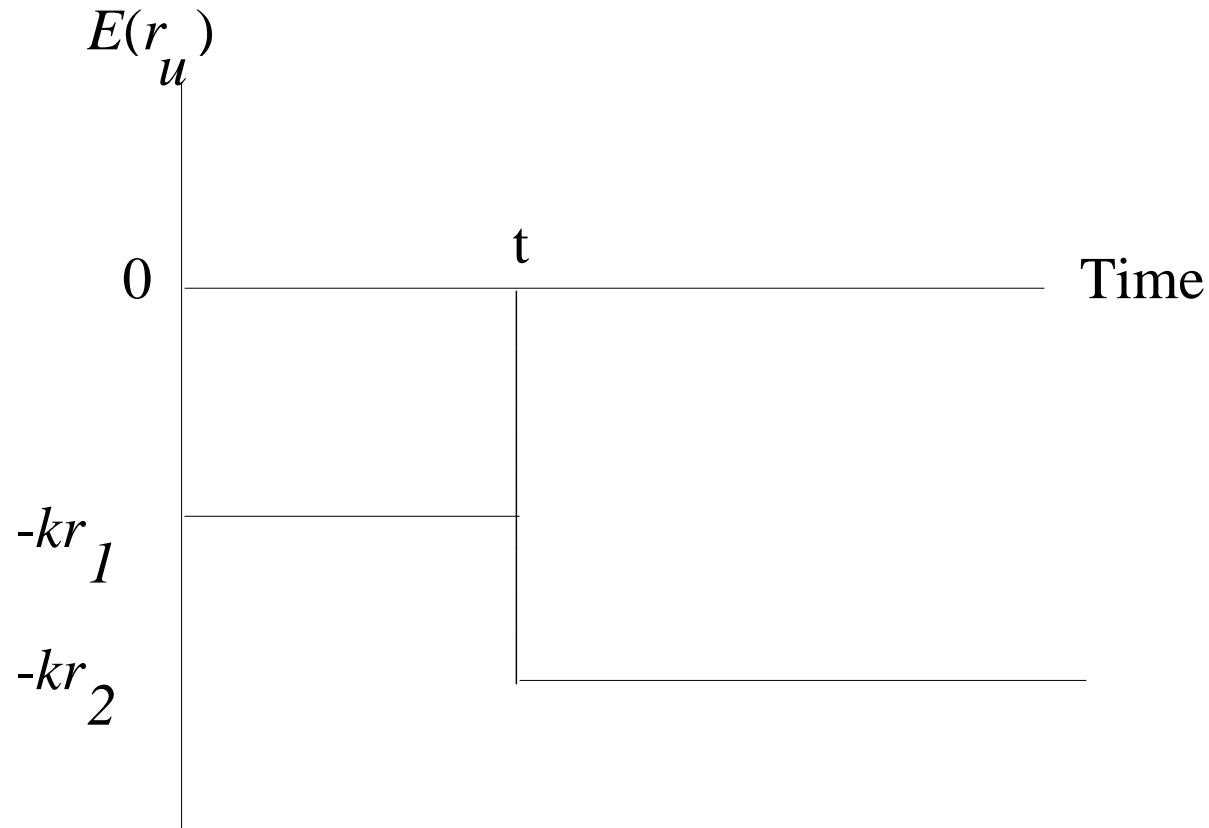$-kr_1$

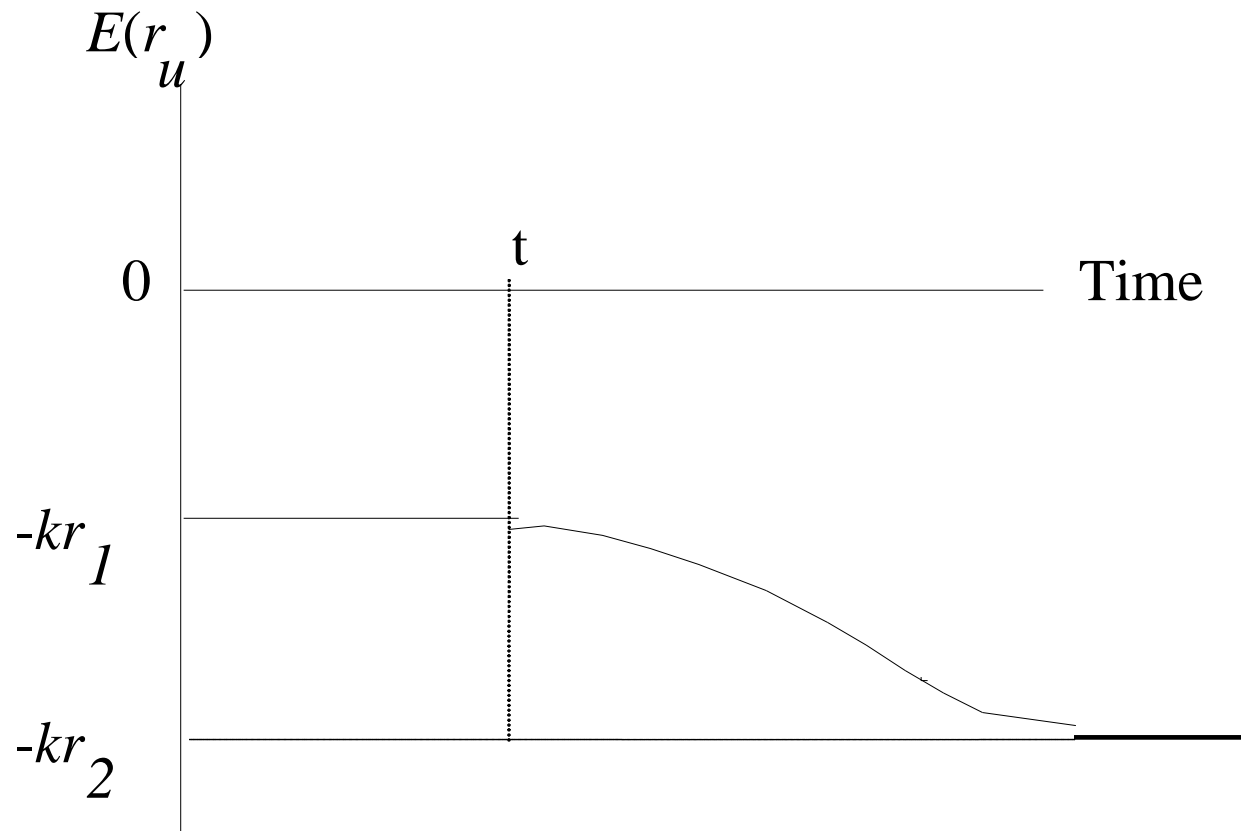# Figure 3: The Interest Rate Model

Figure 4: Synthesis of Gron-Winter with Interest Rate Model

Determinants of short-run return responses

- In addition to the duration effects, we also study the effects of transaction and adverse selection costs related to accessing the capital and reinsurance markets.

- Proxies for capital and reinsurance access
  - <u>Public vs. Private</u> - Publicly traded stock insurers have lower transaction costs for raising new equity than private stock and mutual insurers.
  - <u>Size</u> - Large firms can raise new capital more cheaply than small firms.
  - <u>Reinsurance</u> – firms with more costly access to reinsurance markets have higher $dE(r_u)/d(k_{rf})$.

Insurance Cycles: Interest Rates and the Capacity Constraint Model

Cross-Sectional Model

$$\frac{dE(r_u)}{d(kr_f)} = f(\underset{-}{QDUR}, \underset{+}{PUBLIC}, \underset{+,-}{PRIVATE}, \underset{+}{REINS}, \underset{+}{SIZE}) \quad (5)$$

where

$QDUR$ = equity duration;
$PUBLIC$ = 1 if publicly traded, 0 if private or mutual;
$PRIVATE$ = 1 if privately held, 0 if public or mutual;
$REINS$ = measure of reinsurance access; and
$SIZE$ = firm size.

Aggregate (1939-88) Time Series Results

$$r_{ut} = \alpha_0 + \alpha_1(kr_{ft}) + \varepsilon_t \qquad (7)$$

$$r_u = \underset{(4.013)}{4.8390} - \underset{(-4.945)}{0.7570}(kr_f)$$

$$r_{ut} = \alpha_0 + \alpha_1(kr_{ft}) + \alpha_2(kr_{ft})^2 + \varepsilon_t, \qquad (6)$$

$$r_u = \underset{(4.556)}{6.3587} - \underset{(-3.616)}{1.4185}(kr_f) + \underset{(1.782)}{0.0383}(kr_f)^2$$

Cross-Section Analysis: Data

- <u>Data</u>: AM Best, 1976-1988 panel of 277 property-liability insurers (groups and unaffiliated single companies).

- 136 firms were stock companies, and 141 were mutuals.

- 57% of stock insurers were privately held; 43% were publicly traded.

- <u>Groups</u>: 52.5% (74) mutuals, 57.7% (45) private stock insurers, and 91.4% (53) publicly traded stock insurers.

Two pass regression procedure

- The first pass equation was specified in the following manner:

$$r_{ujt} = \alpha_{0j} + \alpha_{1j}(kr_{ft}) + \varepsilon_{jt}. \qquad (8)$$

- The second pass equation was specified in the following manner:

$$\alpha_{1j} = \beta_{0j} + \sum_{i=1}^{n}\beta_{ij}X_{ij} + \mu_j \qquad (9)$$

where X_{ij}'s represent the variables listed in equation (5).

Table 1 – Empirical Results

Regression 1			Regression 2		
Variable	Coefficient	p value (1-tail test)	Variable	Coefficient	p value (1-tail test)
INTERCEPT	-4.6792	0.0001	*INTERCEPT*	-3.8091	0.0001
QDUR	-0.0154	0.0589	*ADUR*	-0.2007	0.0006
			LDUR	0.5882	0.0001
PUBLIC	-0.0028	0.4930	*PUBLIC*	0.0647	0.3429
PRIVATE	-0.6740	0.0001	*PRIVATE*	-0.7870	0.0001
SIZE	0.1386	0.0001	*SIZE*	0.0492	0.0096
REINS	0.0782	0.0841	*REINS*	0.0606	0.1398
GROUP	1.1712	0.0001	*GROUP*	1.2795	0.0001
GROUPRE	0.0175	0.4031	*GROUPRE*	0.0316	0.3266
ADJUSTED R^2	0.0590		ADJUSTED R^2	0.0845	

Summary of Results

- Results are consistent with the capital constraint predictions.

- Policy implication – Since underwriting returns are underresponsive to interest rate changes, by making prices even less responsive, the "optimal" response by insurers is to ration supply; thereby aggravating the insurance availability problem.

Insurance Cycles: Interest Rates and the Capacity Constraint Model