INTEREST RATES, FINANCIAL STRUCTURE AND CYCLES IN INSURANCE MARKETS

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Abstract. Although financial pricing models imply that profits of property-liability insurance firms should conform to an unpredictable time series process, cycles are widely reported. Some controversy exists as to whether the "underwriting cycle" is a mere accounting artifact or whether it has real resource effects. We show that changes in interest rates simultaneously affect the insurer's capital structure and the equilibrium level of underwriting profit. Depending on factors such as asset and liability durations, access to capital markets, and availability of capital substitutes such as reinsurance, insurers will be differently affected by changing interest rates. Over time, we find that the average market response to changing interest rates roughly tracks market clearing prices although the response is somewhat dampened. However, firms with mismatched assets and liabilities, as well as those with more costly access to new capital and reinsurance, are more likely to respond to interest rate changes by either rationing or abnormal price changes.

Keywords. Underwriting cycle, financial pricing models, duration, financial structure.

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It is widely believed that insurance markets are cyclical. The supporting evidence relates primarily to the accounting measures used by insurers to record their underwriting profits.[1] Underwriting profits appear to follow a second order autoregressive process with a period averaging about six years. This "underwriting cycle" is both persistent and pervasive, being observed over long time periods (see Smith (1980), Venezian (1985), and Doherty and Kang (1988)) and in many countries (Cummins and Outreville (1986)).

Financial pricing models posit that 1) equilibrium rates of underwriting profit are inversely related to interest rates, and 2) insurance prices are informationally efficient predictors of the present values of future claims costs.[2] Consequently, if the adjustment of underwriting profits to changes in interest rates was instantaneous, we would expect that underwriting profits would display the same time series properties as interest rates. This clearly is not so and we are left with the conundrum of how interest rates, which clearly do not behave cyclically, can spawn an underwriting profit series that does. Cummins & Outreville and Doherty & Kang both note that cyclicality may be introduced by the presence of lags which, during some time periods, may prevent markets from clearing. Such frictions appear to be consistent with the frequently reported supply shortages and abnormal price changes that are usually associated with the insurance cycle.

If insurers chose an asset management strategy that perfectly hedged the interest rate sensitivity of their liabilities, one might expect that changes in interest rates would be reflected immediately in spot rates of underwriting profit[3]. Without perfect hedging of assets and liabilities the value of the insurer's equity, and therefore its capital structure, will be perturbed by changes in interest rates. Assuming that raising new capital is costly, a plausible capital structure policy

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[1]One possible explanation for the cycle is that it is an accounting fiction; the accounting measure of underwriting profit simply fails to reflect the underlying economic value. As Watts and Zimmerman (1986 pp 144-146) have noted, the time series properties of accounting numbers can be altered substantially depending on the choice of accounting method. They cite an example in which "smoothing" transforms a deterministic earnings series into a reported series that conforms to a random walk.

[2]The capital asset pricing model (see Biger and Kahane (1978), Fairley (1979), Hill (1979), Hill and Modigliani (1987) and Myers and Cohn (1987)), the arbitrage pricing model (see Kraus and Ross (1982), and Urrutia (1987)) and the option pricing model (see Cummins (1988), Derrig (1989), and Doherty and Garven (1986)), have been applied to the derivation of the risk adjusted rate of return on equity that capital markets require of property-liability insurers. Although details vary, these models are generally organized around the principle that the rate of underwriting profit be set to produce a "fair" or competitive rate of return on equity.

[3]Unless perhaps regulators, in attempting to regulate prices, constrained changes in underwriting profit levels.

would include control of insurance supply. In this way, interest rate changes may stimulate availablility problems and/or abnormal price changes in insurance markets. If so, temporal variation in underwriting profits will not only reflect a changing cost of capital, but will also be associated with real resource effects.

Prior explanations for the cycle can be divided into two broad camps. The first type of explanation focusses on internal instability within the insurance market. The classic form of this argument is presented by Stewart (1984)[4] who models the cycle as a cobweb in which prices fail to converge smoothly on an equilibrium. The key factor in this approach is that shifting expectations and industry structure induce insurers to overy and undery market demand in a repetitive sequence. The basic deficiency of these models are unsatisfactory in that they do not attempt to identify an equilibrium time path for underwriting profit. In consequence, these models all seek to explain why markets fail before establishing even a prima facia case that there has been some market failure in the first place.

A second class of models attempts to explain the cycle in terms of the responses of the insurance market to external stimuli. These papers include some which look only at the 1980's and the set of events generally termed the "liability insurance crisis"[5]. Notable in this set are the papers of Harrington 1988 and Winter 1988. Both examine external shocks to the insurer's cost function. Since our purpose here is to explain the persistence of the underwriting cycle over longer periods, we focus more on other papers. Hylton, (1989), has argued that cost shocks will differently affect high and low quality firms and consequently price changes will differ between these different firms and consumers will switch. Hylton's model is rich in its predictions but is unaccompanied by empirical testing. A different model is presented by Doherty and Kang (1988), who look at the effect of interest rate changes on market clearing prices for insurance transactions. While the evidence on interest rates and underwriting profit changes is consistent with their model given lags in the adjustment process, their model fails to address the effects of those interest rate

[4]See also Venezian 1985.

[5]During the years 1984-1986, the market for liability insurance featured sharp increases in premiums accompanied by significant curtailing of coverage (and in some cases coverage was unavailable altogether) in a number of liability insurance lines especially medical malpractice, products liability, municipal liability, pollution liability and directors and officers liability insurance. As this was occurring, the industry suffered an average underwriting loss of 14.1% compared with an average underwriting gain of 0.54% during the fifty year period from 1939-1988.

changes on the capital structure.[6]

Tennyson, (1989), uses cross sectional tests to discriminate between the broad competing explanations of the insurance cycle (autocorrelated expectations versus lagged adjustment). Her evidence is mixed. Large, purportedly efficient, firms exhibit underwriting profit paths that are consistent with the lagged adjustment model. But smaller firms appear to make systematic errors in estimating their loss exposures.

Perhaps the work which comes closest to ours is that of Gron (1989). She examines the effects of capacity constraints on insurance pricing and, using aggregate measures of market capacity, finds that the time series of underwriting profit are consistent with her capacity constrained pricing model. Our work differs in major respects. Gron fails to exploit the simultaneous effect of changing capital market rates (a) on the equilibrium rate of underwriting profit and (b), on the value of its equity operating through the respective durations of the insurer's assets and liabilities. We will focus more heavily on the financial management decisions of the insurer, (in particular its choice of capital structure) and how these are affected by changing financial conditions.[7]

In Section I of the paper we model the determination of equilibrium levels of underwriting profit in a world without default risk and reproduce the well known result that equilibrium underwriting profit are inversely related to interest rates. Sections II introduces the prospect of insurer default. We argue that financial leverage becomes important and that changing interest rates will disturb the capital structure of the insurer. This will not interfere with the insurance market's ability to clear if insurers are able to raise new equity costlessly. However, with costly access to new equity, interest rate changes will affect supply. This section presents a set of predictions on the responses of insurance markets, and of different firms, to changes in interest rates. Section III conducts time series analysis on aggregated data. While underwriting profit is responsive to interest rates as predicted, the effect is somewhat dampened. Furthermore, the asymmetry of these responses between rising and falling interest rates is indicative of capacity frictions at different phases of the cycle. Cross sectional analysis provides further support for the

[6]Another model which looks at cost changes is that of Cummins and Outreville (1986) who argue that, given appropriate lags in the assimilation of information, random shocks to insurer cost functions can produce non random profit results even with rational expectations.

[7]Moreover, Gron uses aggregated market data to test her model and loses some ability to discriminate between her hypothesis and competing models. In contrast, we will use firm specific data in search of more focussed tests for the effects of firm capacity.

capacity hypothesis. Firms with differing equity durations and with differential costs of accessing capital markets are differently affected by changes in the cost of capital.

I. Simple Competitive Equilibria Without Default

In a competitive insurance market, the premium net of expenses, P, will be equal to the discounted value of the expected claims (see for example Kraus and Ross, 1982).

$$P = E(L_I \mid \phi_0)/(1+r_{n1}) \tag{1}$$

where incurred losses, $E(L_I)$, is defined as the expected value of losses paid during the policy period and the reserve for outstanding losses at the end of the year. r_{n1} is the nominal discount rate for payments to be made at time 1. The discount rate is assumed to reflect the risk characteristics of L. Information available to the underwriter from which to estimate losses when the policy is written, time zero, is denoted ϕ_0.

Now a re-arrangement of equation 1, gives:

$$\{ P - E(L_I \mid \phi_0) \}/P = -r_{n1} \tag{2}$$

If expenses are ignored, the left hand side of equation (2) is the expected rate of the underwriting profit. If expectations on losses represent an unbiased forecast, the realized rate of underwriting profit for the year ending at time 1, u_1*, can be stated as:

$$u_I^* \equiv -(P - L_I)/P = -r_{n1} + \varepsilon \tag{3}$$

where ε is white noise.

This specification of underwriting profit assumes, not unreasonably, that reserves for outstanding losses at year end are the **discounted** value of the estimated future losses. However, past actuarial practice has been to compute reserves on an **undiscounted** basis. Undiscounted reserves would clearly be higher than discounted reserves, and the difference would be higher, the longer the time required to discharge claim payments. With undiscounted reserves included in incurred losses, denoted L_I*, equation (3) can be rewritten as:

$$u_1^* \equiv -(P-L_I^*)/P = -K(r_{n1})+\varepsilon \qquad (3')$$

where K is the average time to settle claims.

The preceding analysis examines the competitive underwriting profit for a policy written on the first day of the accounting year. Now consider that contracts are written daily throughout the year and the insurer continues in business for successive years. For simplicity, we assume that an equal volume of insurance is written on each day of the year. Now, the accounting value of underwriting profit will be a weighted average of the rates of underwriting profit for all contracts which were in force for some time during the accounting year. The weights will be the proportion of the accounting year that each policy was in force.

$$U_1^* = -K \sum_{t=1}^{364} [r_n+\varepsilon]_{T-t} [(365-t)/365] - K \sum_{t=0}^{365} [r_n+\varepsilon]_{T+t} [(365-t)/365] \qquad (4)$$

Equation 4 can be rewritten in the following terms, in which $R_{n,T}$ is the weighted average of discount rates in the year surrounding time T, and E_T is the aggregated error term, both of which are shown:

$$U_I^* = -K R_{n,T} + E_T \qquad (5)$$

The error term is again treated as white noise.

Equation (5) can be used to examine the temporal behavior of accounting underwriting profit. The discount rate composite, $R_{n,T}$, is the weighted average of discount rates surrounding the beginning of the accounting year and adjusting for the riskiness of the loss payout. Rather than getting mired in a discussion of how such risk adjustments are made, one might simply note that, if the risk characteristics of loss payouts are stable over time, temporal **changes** in competitive underwriting profit will reflect **changes** in riskless interest rates. In general, temporal movement in underwriting profit will mirror temporal movements in interest rates. If interest rates do not follow a cyclical process neither do competitive rates of underwriting profit. Whatever the process of interest rates, equation (5) provides a simple method of testing whether insurance policies are

competitively priced.

II. Default Risk, Regulation And Related Imperfections

(a) A Model of Insurer Output and Capital Structure

The analysis of the preceding sections implicitly assumes that, following exogenous shocks, supply and demand will respond immediately and markets will clear immediately at the competitive prices shown. This assumption is now relaxed.

Denote, E(L) as the expected losses facing the population of policyholders and α as the proportion of losses insured. With default risk, policyholders will only be paid in full if the assessed value of insured losses, αL, does not exceed the value of the insurer's assets, Y_1. The policyholder payoff is $H_1 = MIN(\alpha L, Y_1)$. The present value of policyholders' claims can be written as:

$$V(H_1) = m\alpha E(L) \tag{6}$$

where m represents the present market value per dollar of contracted liability, αL, given the option like payoff described by H_1. We do not address tax liabilities so that shareholders have the residual claim on the assets Y_1. i.e.

$$V(Q) = V(Y_1) - V(H_1) \tag{7}$$

Using a one period model, the value of the assets of the firm to be allocated to claimholders at the end of the period, Y_1, will depend on the opening value of the assets, Y_0 and the investment income which accrues at a rate r_i. Opening assets values depend on the opening level of equity, Q, premiums, P and insurer expenses from writing policies, xP. Thus:

$$Y_1 = (Q+P(1-x))(1+r_i) \tag{8}$$

The option like qualities of the policyholders' and equityholders' claims have been modelled by Doherty and Garven (1986), Cummins (1988) and Garven (1990). Using the broad properties of these models, and noting from (6), and (8) that the probability of default will increase as (i) equity Q falls holding α constant or (ii) α increases with Q constant, we make the following statement:

$$\partial m/\partial Q > 0 \tag{9}$$

Intuitively, (9) simply states that the present market value of a dollar of contractual liability declines as the probability of default increases.

If policies were sold at $V(H_1)$ insurers would earn only a normal profit. Insurers are assumed to be value maximizers, i.e. to maximize V(Q)-Q, and will gross up premiums by some factor $(1-k)^{-1}$, where k>0. Thus:

$$P = (1-k)^{-1}V(H_1) = (1-k)^{-1}m\alpha E(L) \tag{10}$$

While the insurer may face less than perfectly elastic demand for its services, it is assumed to operate in a perfectly competitive capital market; thus we assume $V(Y_1) = Y_0$. We also impose the following assumptions on the properties of the demand and cost functions.

$$\begin{aligned} &\text{a.} \quad \partial\alpha/\partial Q > 0 \\ &\text{b.} \quad \partial\alpha/\partial k < 0 \\ &\text{c.} \quad \partial x/\partial Q < 0 \\ &\text{d.} \quad \partial x/\partial\alpha > 0 \end{aligned} \tag{11}$$

Assumptions (11 a & b) state that demand for contracted dollars of compensation rises, (i) as the default probability decreases and (ii) as the price falls. These are not trivially satisfied for all risk averse utility functions (see Doherty and Schlesinger 1990). Assumptions (11c) and (11d) state that there is some additional expense to the firm which arises from an increase in leverage. This might take the form of the expected value of the transaction costs in bankruptcy or an agency cost (e.g. the cost of resolving owner manager conflicts).

Noting the competitive capital market assumption, and using (6), (7), (8) and (10), the firm's objective function can be written in the following form:

$$\underset{k,Q}{MAX}\ [V(Q)-Q] = \underset{k,Q}{MAX}\ m\alpha E(L)\ [(k-x)/(1-k)]$$

Insurers are not completely free in their choice of leverage. Regulators monitor the financial condition of insurers. The "early warning system" operated by the National Association of Insurance Commissioners flags insurers for attention if (amongst other things) their premium to

equity ratio exceeds three. Action is not automatically taken against offending insurers, though there will be a careful examination of leverage (i.e. the value of liabilities E(L) relative to equity). Accordingly, we impose a leverage constraint in the form $\alpha E(L)/Q \leq \psi$. Thus, the insurer's constrained maximization problem is:

$$\underset{k,Q}{MAX}\ m\alpha E(L)\,[(k-x)/(1-k)] \qquad (12)$$
$$\text{s.t.}\ \ \alpha E(L)/Q \leq \psi$$

Using Z to denote the function to be maximized and λ for the multiplier, the first order conditions are:

$$Z_k = 0,\ \ Z_Q = 0,\ \ \text{and}\ \ Z_\lambda = 0. \qquad (13)$$

(b) Equity Shocks and Insurance Supply

Without frictions, the value maximizing insurer would adjust price (output) and equity such that conditions (13) are satisfied. Now suppose that the value of equity changes suddenly and the insurer is unable to readjust immediately to its value maximizing conditions. For example, an interest rate increase would lead to a reduction in the value of the insurer's asset portfolio which comprises mostly bonds. Moreover, the same change in interest rates is likely to affect the value of liabilities. The net effect of these change in interest rates on the equity would depend on the respective durations of the assets and liabilities and upon leverage of the firm. Without default risk, the relationship between the duration of equity D_Q and that of assets, D_A, and liabilities, D_L, is given by[8]:

$$D_Q = (D_A - D_L)[V(Y_1)/V(Q)] + D_L \qquad (14)$$

Suppose the insurer suffers a decline in equity from changing interest rates (i.e. duration is non zero). The insurer may be unable to replace this equity immediately; even if the insurer is a stock firm, new issues take time and are costly. Thus a decline in equity can leave the firm with a sub optimal capital structure. Faced with an increase in leverage, the insurer can readjust its optimal price (or output). To see this, consider the effects of such an equity shock on the first order condition.

[8]See Babbel and Staking, 1989.

$$dZ_k = Z_{kk}dk + Z_{kQ}dQ = 0$$

which implies

$$\text{SIGN } dk/dQ = \text{SIGN } Z_{kQ}$$

Now:

$$Z_{kQ} = X\left[\frac{1}{(k-x)^2}\left(\frac{\partial x}{\partial Q}+\frac{\partial x}{\partial \alpha}\frac{\partial \alpha}{\partial Q}\right)\left(1-\frac{\partial x}{\partial \alpha}\frac{\partial \alpha}{\partial k}\right)-\frac{1}{\alpha^2}\frac{\partial \alpha}{\partial k}\frac{\partial \alpha}{\partial Q}\right]-\lambda\frac{E(L)}{Q^2}\frac{\partial \alpha}{\partial k} \qquad (15)$$

The sign of (15) cannot be established with complete generality. The ambiguity in the sign arises because changes in equity have two effects which implicitly correspond to supply and demand shifts. This is further complicated by the possibility that the constraint may, or may not, be binding. Much of this ambiguity can be resolved by appealing both to data on property liability insurers and to the characteristics of the marketplace.

First, consider equity durations. In the sample we use for later analysis, the mean and standard deviation of equity duration are 7.44 and 5.67[9]. Accordingly, for the great majority of insurers a rise (fall) in interest rates will lead to a fall (rise) in the value of equity. Second, as noted by Garven (1987), the mean premium to equity ratio of property liability insurers in the U.S. for 1981-5 was 1.62 and the standard deviation 1.42. This ratio will only attract regulatory attention if it exceeds 3.0. Only 8% of insurers exceeded 3.0. Accordingly we assume that moderate changes in interest rates generally will not lead to violations of the regulatory constraint; i.e. it is assumed to be non binding. Third, noting that policyholders in all states are protected from insolvency of insurers under guarantee schemes, we assume that changes in equity do not affect the demand for insurance, i.e. $\partial\alpha/\partial Q = 0$.

Under the second and third assumptions of the previous paragraph and using (9) and (11), the sign of (15) is negative. This permits us to make a set of testable predictions on the effects of interest changes on underwriting profits. We will describe these predictions then briefly discuss the implications of relaxing these assumptions.

[9]Similar estimates are obtained by Babbel and Staking.

Under our assumptions, an increase in interest rates will lead to a reduction in equity (reverse reasoning applies to interest rate declines). With no transaction costs, new equity would be raised instantaneously and costlessly, and the underwriting profit would adjust as described in (5). With transaction costs to new equity, the increased leverage would shift the insurer's supply function to the left and the price of insurance would rise (from eq 15). Thus:

$$dU_I^*/dkR_{n.T} = -1 \text{ (without transaction costs)} \quad (16a)$$

$$dU_I^*/dkR_{n.T} \geq -1 \text{ (with transaction costs)} \quad (16b)$$

Now, with given transaction costs, the greater the duration of equity, the greater the displacement in (16b) from negative unity; i.e. $dU_I^*/dkR_{n.T}$ is positively related to duration. However, for any given duration, the lower the transaction costs, the closer will (16b) be to negative unity, i.e. $dU_I^*/dkR_{n.T}$ is negatively related to transaction costs of raising new equity. We will use various proxies to measure transaction costs. We expect publicly traded firms to have lower transaction costs than private firms. Similarly we expect stock firms as a whole to have lower transaction costs than mutual insurers. In similar vein, we expect that large firms would be able to raise new capital more cheaply than small firms. Our final proxy for transaction costs relates to reinsurance. Insurers can readjust leverage, not by changing their equity, but by selling liabilities to other insurers, i.e. by reinsuring. However, changing the net volume of reinsurance sold is costly; in addition to the usual broking charges, such transactions involve all the information costs associated with new insurance transactions.[10] Accordingly we predict that $dU_I^*/dkR_{n.T}$ is lower (closer to negative unity) for firm with more costly access to reinsurance markets.

These predictions can be summarized in a form which facilitates testing. Assuming instantaneous adjustment for any firm i,

$$a_i \equiv \frac{\partial U_I^*}{\partial K_i(R_n)} = -1 \quad (16)$$

from equation (5).

Without instantaneous adjustment for all firms, then cross sectional variation in a_i is predicted to

[10]See for example D'Arcy and Doherty (1990).

follow the following pattern with predicted signs shown:

$$\frac{\partial U_I^*}{\partial K_i(R_n)} = f(\underset{+}{QDUR}, \underset{-}{PUBLIC}, \underset{-}{PRIVATE}, \underset{-}{REINS}, \underset{-}{SIZE}) \tag{17}$$

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

Of the assumptions used to generate these predictions we suspect the strongest to be that demand is insensitive to changes in the probability of default due to the presence of solvency guarantees. If this assumption is removed then the directional effect of a change in equity on price k, is unclear. Both the supply and demand functions will shift and the issue rests on which effect dominates. With supply dominance, the predictions of (17) but the signs will be reversed with demand dominance. Our cross sectional result provide a joint test of the model and of this assumption.

The above predictions can be emented by a secondary set. Responses to rising and falling interest rates are unlikely to be symmetric. As interest rates rise and bond prices fall, insurers are faced with the question of whether to float new equity. Raising new equity involves several transaction costs including the underwriting and issue of new floatations (if external capital is used) as well as the adverse selection costs arising from information asymmetry between insurance management and external investors[11]. Similar transaction costs arise if the insurer responds not by raising equity but by increasing its ceded reinsurance[12]. If the insurer finds itself under-leveraged due to a fall in interest rates, it is less costly to adjust to its desired capital structure. The distribution of equity through dividends is less costly than the raising of new issues. Similarly the reduction in the net value of reinsurance ceded is likely to be less costly than an increase[13]. The extreme case of asymmetry is the case of mutuals where the cost of raising capital

[11]See Myers and Majluf (1984) for a general discussion of this cost and Winter (1988) and Gron (1989) for some applications to insurance.

[12]For example, a new reinsurance contract encounters the costs of information asymmetry between the ceding and reinsuring firms.

[13]The assumption implicit here is that the transaction costs from reinsurance transactions (including those due to information asymmetry) are borne by the ceding firm. Such an assumption is consistent with most models of

in the short run (i.e. above immediate earnings) theoretically is infinite. However, the mutual is perfectly free to distribute equity to its policyholders whenever it sees fit to do so. The asymmetry is stated as:[14]

$$\{ dU_I^*/dk_i(R_n) \mid dR_n>0 \} \quad > \quad \{ dU_I^*/dk_i(R_n) \mid dR_n>0 \} \tag{18}$$

Before leaving this section, it may be noted that equity shocks can arise in other ways. In addition to interest rates changes, equity can be affected by catastrophic losses such as hurricanes or earthquakes. Each would cause loss payments to exceed amounts reasonably reserved. Similarly, unanticipated inflation would have a similar effect on realized loss payments. Such effects would reduce equity in much the same way that in increase in interest rates would reduce bond values. Similar reasoning suggests that the equity reduction would trace through to the product market and would be revealed in price and quantity changes.

III. Empirical Results

(a). Aggregate time series results

The first task in the empirical section of this paper is to see whether the time path of underwriting profit can be explained simply from the spot equilibrium prices required to deliver to the insurer a fair rate of return on equity. This result would be consistent with the notion that the cycle is a purely monetary phenomenon. The simplest test of this hypothesis is suggested by equations 5 and 16. The following equation is estimated using generalized least squares (GLS)

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adverse selection in competitive insurance markets in which information costs are borne by policyholder in general or some subset thereof (see for example Rothschild and Stiglitz (1976)). For example, if the firm responds to under-leverage by assuming more reinsurance, one would expect that the transaction costs to be borne by the ceding firm. If the firm responds by reducing the amount ceded to reinsurers, then the firm may simply let existing treaties lapse.

[14]We have assumed the leverage constraint to be non binding. Had this constraint been binding, then similar asymmetries would be likely. Interest rate rises, which tend to increase the premium to equity ratio, would bring increasing numbers of insurers to the 3:1 effective constraint and, barring new equity issues, these insurer would tend to respond by reducing the quantity of insurance sold. Whilst rising interest rates would reduce the equilibrium rate of underwriting profit, the excess demand resulting from capacity shortage would temper the fall in underwriting profit. Interest rate falls would be accompanied by rising bond prices and reduced leverage and would not capture regulatory attention. One would expect that the effects of interest rate changes would be asymmetric, rising rates causing moderate falls in underwriting profit (with excess demand) and falling rates producing more vigorous rises in underwriting profit rates.

analysis.[15] The independent variable is the average settlement delay, K, times the weighted average of monthly spot "T" bill rates (rather than daily rates which were unavailable over the entire period of the analysis, 1939-1988).

$$U_I^* = a_0 + a_1(K.R_n) + \varepsilon \tag{19}$$

A word on the expected values of the coefficients will be helpful. The interest rate is a "T" bill rate used as a proxy for the riskless rate of interest. In fact, equation 5 uses a risk adjusted rate r_n. If the risk premium required on the underwriting contracts is stable over time, the intercept term a_0 will provide an estimate of this risk premium. If the capital asset pricing model (or arbitrage pricing model) were to be used to generate the appropriate risk premiums, then clearly their value would depend on the correlation between underwriting profit and the market portfolio (or priced factors). Most empirical work (see for example, Cummins and Harrington 1985) suggests that such betas are small or not significantly different from zero. If this were the only term in the intercept, we would expect the intercept to be fairly close to zero. However, the intercept might embody other factors such as various tax effects and the costs of restrictions on investment choice (see D'Arcy and Doherty 1988, page 45). We simply expect the intercept to have a positive value.

Second, the slope parameter, a_1, should be insignificantly different from negative unity if policies are continually priced at their current competitive level as suggested in Section II. A slope of negative unity implies that competitive rates of return on equity are expected at all phases of the cycle in underwriting profit and is consistent with the view that there is no capacity fluctuation over the cycle. A slope in excess of minus one suggests that the insurance market there are frictions that prevent the insurer from adjusting leverage. Accordingly interest rate increases are followed by supply cutbacks, i.e. excess demand for insurance, and interest falls are followed by excess supply.

The generalized least squares regression result is based on underwriting results for all U.S. property-liability lines written by stock companies for the fifty year period 1939-1988 is:

[15] Estimation of this relationship using ordinary least squares produces residuals which display first and second order autocorrelation. GLS was used to correct this problem.

$$(A)U_I^* = \underset{(4.013)}{4.8390} - \underset{(-4.945)}{0.7570(k.R_n)}^{16**} \qquad \text{ADJ. } R^2 \ .8137 \quad \text{DW } 1.9419$$

Averaged over a very long period and over all P-L insurance lines, the insurance market responds to changes in the capital market rates broadly as one would predict; interest rate increases reduce the rate of underwriting profit. The fact that the estimated slope coefficient exceeds negative unity is consistent with the presence of capacity frictions. This interpretation requires some caution. The data available for estimating the funds generating coefficient, "k", are not ideal. In particular, we do not have discounted values for insurer's loss reserves. This implies that the values used for "k" are too high and the slope coefficient is probably overestimated. Given this caution, we look for other evidence of capacity frictions.

While the above result should dispel the view that fluctuating underwriting profit <u>per se</u> is evidence of a dysfunctional market, the result is highly aggregated and it is possible responses might differ between firms, between lines or perhaps over different stages of the cycle. For example, the simple model in section II would predict symmetric sensitivity to rising as to falling interest rates. Thus, the inclusion of a slope shift dummy to distinguish rising from falling rates should have little effect and the dummy parameter should not differ significantly from zero. Contrary, if capacity and related imperfections are present, then asymmetric responses are predicted as shown in inequality (18). The result shows clear evidence of this predicted asymmetry; underwriting profit being significantly more responsive to falling rates than to rising rates[17].

$$(B) \quad U_1^* = \underset{(3.897)}{5.8134} - \underset{(-5.544)}{1.1796(k.R_n)} + \underset{(3.852)}{0.3966(SLOPESHIFT)}$$

$$\text{ADJ. } R^2 = 0.8046$$
$$\text{DW} = 1.3401$$

where $SLOPESHIFT = \begin{cases} (1.0)k.R_n & \text{if } R_n \text{ is rising} \\ \text{zero} & \text{if } R_n \text{ is falling} \end{cases}$.

There is some further incidental evidence that is consistent with this interpretation of the

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[16]Here, the slope differs from -1.0 at a .06 significance level.

[17] The direction of the asymmetry is inconsistent with another commonly cited view of underwriting cycles. Consider that there is some restriction on premium changes. The obvious case would be the intervention of regulation on prices or underwriting profit. The expected consequences would be for prices rises to be constrained by regulation but for price falls to be unconstrained. With such a regime, the slope parameter for rising interest rates should be higher (in absolute value) than that for falling rates. Result (B) shows exactly the opposite effect.

asymmetric response. Insurer insolvencies have been concentrated in periods of low underwriting profitability, at least in recent cycles (see for example, Gron 1989, Figure 1). However, this observation and Result (B), while consistent with the capacity model developed here, does not provide a strong test of that model. To provide a more rigorous test, we look to individual firm data. This will enable us to see whether cross sectional differences in the responses of different firms to changing interest rates correlate with differences between firms in equity duration and in their access to capital markets or to other markets that provide substitutes for capital.

(b).Cross Section Analysis; Data and Methodology.

A panel consisting of year-end data from 1976-1988 for 277 property-liability insurers was constructed from Balance Sheet-Income Statement, Premiums-Losses-Expenses, and Schedule P Summary tapes produced by the A. M. Best Company. The criteria applied in the selection of the sample were as follows:

1. The firm must have complete data for the period 1976-1988.
2. The firm must be organized as either a stock or mutual company.
3. The firm must either be a group or unaffiliated single company.

Furthermore, since a number of variables used in the study involve ratios or natural logarithms, only those firms reporting positive (non-zero) values for data used in the construction of those variables were included.[18] The imposition of these criteria resulted in a sample of 277 firms; 136 are organized as stock companies and 141 as mutuals. Within the stock organizational category, 78 of the firms and/or their parent organizations were privately held during the sample period, whereas 58 were traded on either national or regional exchanges. Of this total, 52.5% or 74 of the mutual firms are group companies, compared to 57.7% or 45 of the private stock firms and 91.4% or 53 of the publicly traded stock organizations. The χ^2 test of independence between ownership structure and group affiliation reveals that the difference in percentages between publicly traded stock firms and the other organizational forms is statistically significant; i.e., there

[18]The required variables include earned premiums, net premiums written, policyholders surplus, admitted assets, the sum of assumed plus ceded reinsurance, and total investment in the following asset categories: long term government bonds, long term obligations of government agencies, and other long term bonds.

exists a significant association between ownership structure and group affiliation in the sample.[19]

A two pass regression procedure was adopted. In the first pass, the generalized least squares regression described by the following equation was estimated for the sample of firms described above; viz.,

$$U_{j,t} = \alpha_{0,j} + \alpha_{1,j} kR_{n,T} + \varepsilon_{j,t}, \tag{20}$$

where $U_{j,t}$ is the period t underwriting return for firm j,[20] and the term $kR_{n,T}$ corresponds to the period t product of the funds coefficient multiplied by the annualized weighted average of monthly returns on 1 year Treasury bills in the year surrounding time T.[21]

The parameter estimates $\alpha_{1,j}$ were then used in a second pass ordinary least squares regression in order to test for cross-sectional differences in the responsiveness of $\alpha_{1,j}$ to a number of firm specific variables. The second pass equation was specified in the following manner:

$$\alpha_{1,j} = \beta_{0,j} + \sum_{i=1}^{7} \Sigma \beta_{ij} X_{ij} + \mu_j \tag{21}$$

where X_{1j} = $SIZE_j$ = natural logarithm of firm j's size, measured in terms of admitted assets;

X_{2j} = $QDUR_j$ = mean value of equity duration for firm j during the period 1980-1986;

X_{3j} = $REINS_j$ = the slope coefficient determined from the OLS regression of the reinsurance variable against returns on 1 year Treasury bills;

X_{4j} = $PUBLIC_j$ = 1 if firm j or its parent is a publicly traded stock corporation, 0 otherwise;

X_{5j} = $PRIVATE_j$ = 1 if firm j or its parent is a privately held stock corporation, 0 otherwise;

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[19]This significant association between organizational form and group affiliation obviously makes it especially important to include group affiliation as a control variable in the regression analysis that follows.

[20]The rate of return on underwriting was calculated by employing the standard method of subtracting the period t combined ratio for firm j from one.

[21]In addition to the model described in equation (26), another model in which the period t return on a one year Treasury bill was substituted for the weighted average return was also estimated. Since the parameter estimates are very similar for both alternative model specifications, only the results for the model described in equation (26) are reported here.

X_{6j} = $GROUP_j$ = 1 if firm j is an insurance group, 0 otherwise;

X_{7j} = $GROUPRE_j$ = the product of $GROUP_j$ and $REINS_j$.

An explanation of the rationale behind how the variables were constructed is clearly in order. The QDUR variable was determined by a two-step procedure. First, asset and liability durations were calculated annually for each firm during the period 1981-1986.[22,23] Once these values were determined, they were combined linearly with contemporaneous values of the asset/liability ratio in the manner indicated in equation 21.[24] Since we wish to test for the effect of access to reinsurance, we measured the sensitivity of net ceding transactions to changes in interest rates by regressing the reinsurance variable[25] against returns on 1 year Treasury Bills. The slope coefficients from these regressions form the reinsurance access variable used in the cross section analysis. The control variables were GROUP and GROUPRE[26].

(c) Cross Sectional Analysis.

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[22]The calculations of asset and liability duration were based on detailed regulatory filings. Equities were assumed to have the same duration as the average of the S&P 500 portfolio, whereas bond durations are based on the average life. In the case of bond durations, adjustments are made in order to account for differences in durations of government, municipal and corporate bonds. Finally the duration of liabilities was calculated in two ways. The duration of schedule P lines was calculated by implementing the modified Taylor separation procedure described in Staking and Babbel (1990), while the short tail lines are based on industry duration factors computed by Babbel, Klock and Polachek (1988).

[23]The year 1981 was chosen as the initial year because the data requirements of the algorithms used in the calculation of the liability duration, combined with the lack of availability of Schedule P data prior to 1976, make it the first year for which such a calculation is possible. Since duration numbers are generally fairly stable for most firms over time, little is gained from extending the calculations much beyond five years; Consequently, 1988 was chosen as the terminal year for these calculations.

[24]Ideally, it would be preferred to calculate the leverage ratio in (21) with the market values of assets and surplus. Market values are unavailable and book values were used.

[25]The dependent variable in this regression is determined by calculating the ratio of ceded reinsurance into the sum of ceded plus assumed. By construction, it is designed to assume a minimum value of zero and a maximum of unity. If a value of 0 (1) is realized, all reinsurance activity is due to assumption (ceding).

[26]An interaction effect between the GROUP and REINS is incorporated since, prior to 1988, the annual statement forms on which the Best's tapes are based did not discriminate between reinsurance transactions with affiliated versus unaffiliated firms. Since unaffiliated firms can only reinsure with other unaffiliated firms, one would expect that reinsurance data for groups are likely to differ systematically from the reinsurance data for unaffiliated firms.

The cross sectional tests are based around the predictions summarized in eqs. 22 and 23. A two pass procedure was adopted. In the first pass, time series regressions were used to estimate the slope parameters, a_{1i} for each of the 277 firms in our sample. The a_{1i} for the sample firms exhibit considerable diversity, and in the second pass a single equation, eq 23, is estimated to see whether cross sectional variation is consistent with the presence of capacity frictions.

Two versions of the cross sectional regression were run. The first regression, includes a measure of equity duration as described above. This measure is subject to error since the equity duration is assembled from asset and liability duration estimates using a leverage term (see eq. 14) which is measured using accounting values. However, the market value of leverage is sensitive to interest rate changes. For this reason, we show a second regression using separate left hand side variables for asset duration, ADUR, and for liability duration, LDUR.

The preceding model predicts that firms, for which changes in financial structure are most costly will exhibit greatest difficulty in adjusting to equilibrium prices following changes in interest rates. The predicted negative signs for the capital and reinsurance access variables (PUBLIC, PRIVATE, REINS and SIZE) are confirmed and all are significant. The coefficient for equity duration does not display the predicted sign but it is insignificantly different from zero. When equity duration is decomposed into asset duration and liability duration, the results are substantially similar.

These results generally support the model, however, the result for duration does raise some questions. One possible explanation for this result arises from the data used to estimate durations. While we have used, or tried to estimate, market values wherever possible some assets and liabilities are measured at book value. This introduces an "errors in variables" problem which would tend to bias the coefficient towards zero. Another possible explanation is offered on the duration result. Our cross sectional results were obtained for the period 1981-6 which spanned the liability insurance crisis mentioned earlier. During this period there was a simultaneous large decline in interest rates and a large upward revaluation of insurer loss reserves which can be attributed to factors largely unrelated to interest rates (see Winter 1988 and Cummins and Danzon 1991). This might well have swamped any underlying relationship between interest rates and equity duration. Finally, the anticipated positive sign to equity duration in our model was predicated on the assumption that default risk did not affect demand. If present, such demand effect could well have produced an ambiguous sign as discussed in Section II above.

IV. Conclusion

Changes in interest rates cause changes in the level of underwriting profits required for market clearing. However, if the operates with an asset/liability duration mismatch, the same interest changes also affect the value of the insurer's equity and disturb its capital structure. If it is costly to change capital structure (by new issues, repurchases, etc.), one would expect that firms would attempt to re-establish a more appropriate leverage by adjusting the quantity of insurance ied. Time series analysis confirms that cycles do seem to be dampened from the equilibrium path pointing to the presence of capacity frictions. Asymmetric responses to rising and falling interest rates provide further support for the presence of capacity frictions. The cross sectional analysis reveals that price disturbances are more pronounced in those firms for whom adjustments of leverage are most costly. Firms with more costly access to new equity, or with less flexible access to reinsurance markets, show more evidence of frictions in responding to changing capital market changes. These frictions imply that temporal variations in underwriting profits do not track an equilibrium path and that there is periodic rationing of insurance. The differential effects on firms suggest that consumers might switch insurers at different points of the cycle if the costs of reforming new contractual relationships are not too high[27].

The results carry some policy implications. During the past decade, the insurance industry has witnessed many regulatory initiatives ranging from the extension of direct price regulation (e.g. Proposition 103 in California), through initiatives to require insurers to supply insurance[28] to current bills in Washington that aim at substituting Federal for state regulation. Part of the impetus behind this regulatory activity is an apparent desire to stabilize insurance prices in the face of changing interest rates. On balance, our analysis suggests that prices are **under-responsive** to interest rate changes. If true, attempts at direct stabilization would simply lead to more extensive use of rationing to clear markets. The so called "insurance availability problem" discussed so often in the press would simply be aggravated.

It is also possible that other forms of regulation contribute to the real resource costs imposed in the cycle. Regulatory monitoring effectively constrains the leverage of insurers below

[27]Hylton also has pointed out the incentive to switch though, in his model, switching would arise between insurers with high and low default probabilities.

[28]In many states, regulators have threatened to withdraw licenses from insurers that attempt to withdraw from sale of individual lines of insurance.

a premium to equity ratio of 3:1. This is the target ratio used in the National Association of Insurance Commissioners' "Early Warning System". If such a constraint is indeed binding, and accessing capital markets is costly, such intervention will tend to increase the frictional costs associated with the cycle. Insurers that approach the constraint will tend to contract supply in so far as they are able. This suggests that, in policy terms, there is a trade off to be drawn between benefits of solvency monitoring and the costs of increased use of rationing to clear markets.

TABLE 1

REGRESSION 1		REGRESSION 2		
VARIABLE		VARIABLE		
INTERCEPT	−0.247	INTERCEPT	−0.196	
QDUR	−0.004	ADUR	0.039	DURATION
		LDUR	0.062**	VARIABLES
PUBLIC	−0.235***	PUBLIC	−0.220***	CAPITAL ACCESS
PRIVATE	−0.363***	PRIVATE	−0.384***	VARIABLES
SIZE	−0.028**	SIZE	−0.048***	
REINS	−0.182***	REINS	−0.181***	CAP SUBSTITUTE
GROUP	0.577***	GROUP	0.599***	CONTROL
GROUPRE	0.203***	GROUPRE	0.204***	VARIABLES
ADJ R SQD	0.0527	ADJ R SQD	0.0543	

Notes. Two tailed tests used for QDUR, ADUR and LDUR; otherwise one tail t tests used.

*** significant @ the 0.001 level
** significant @ the 0.05 level
* significant @ the 0.1 level

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