Property-Liability Insurance Underwriting Cycles: An Overview

Based upon "Property-liability Insurance Underwriting Cycles" (Fall 2003),
by J. David Cummins*

*This lecture note represents an abridged and (lightly) edited version of a Fall 2003 lecture note by J. David Cummins entitled "Property-Liability Insurance Underwriting Cycles" (Copyright 2003 by J. David Cummins), which was used with his permission.

Defining Underwriting Profits

Underwriting profits = Premiums – Losses – Expenses

r_U = Return on underwriting = Und profits/Premiums

= 1 – (Incurred Losses + LAE)/Earned Premiums
– Expenses/Written Premiums

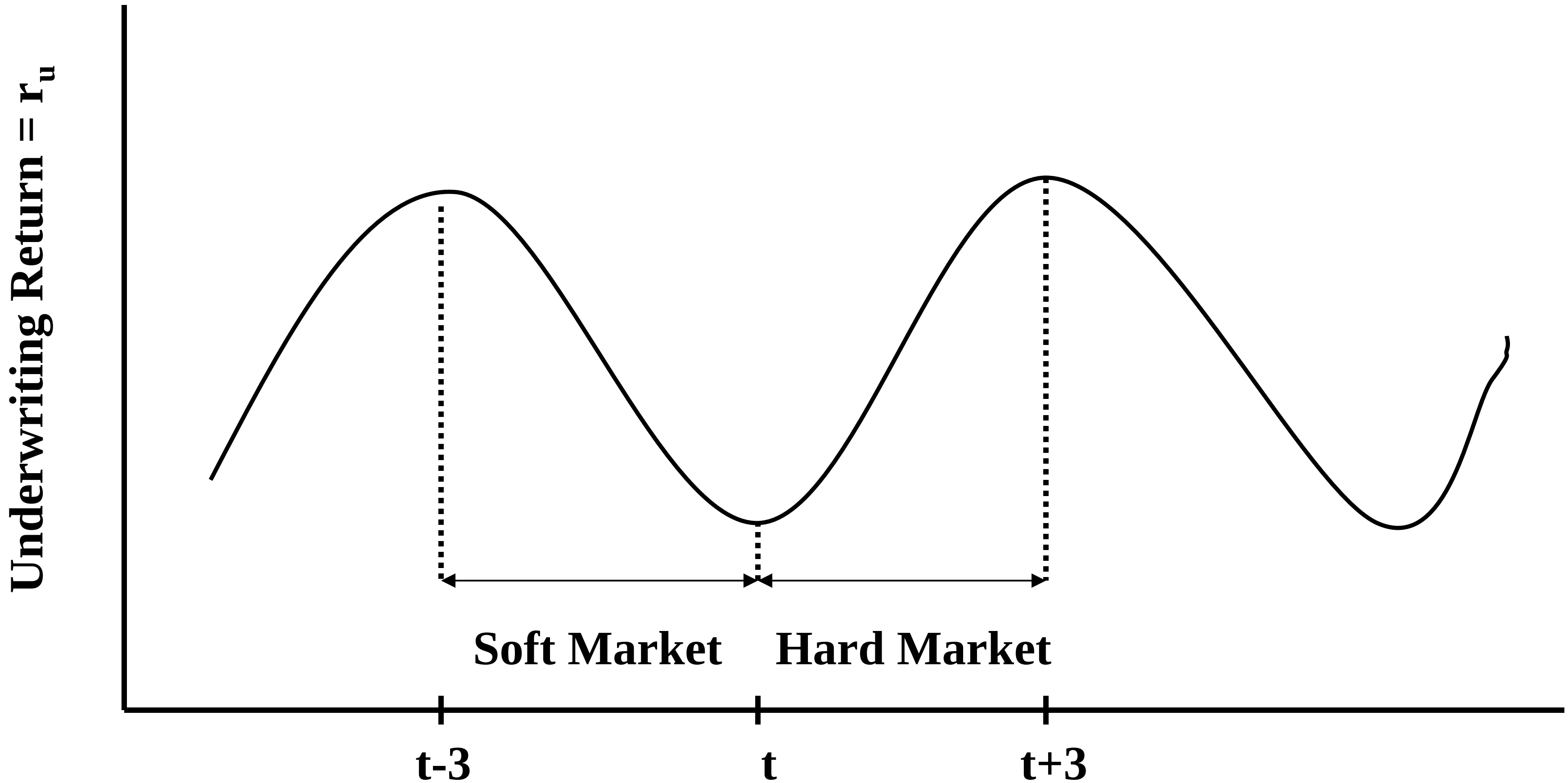
= 1 – Loss Ratio – Expense Ratio

= 1 – Combined Ratio

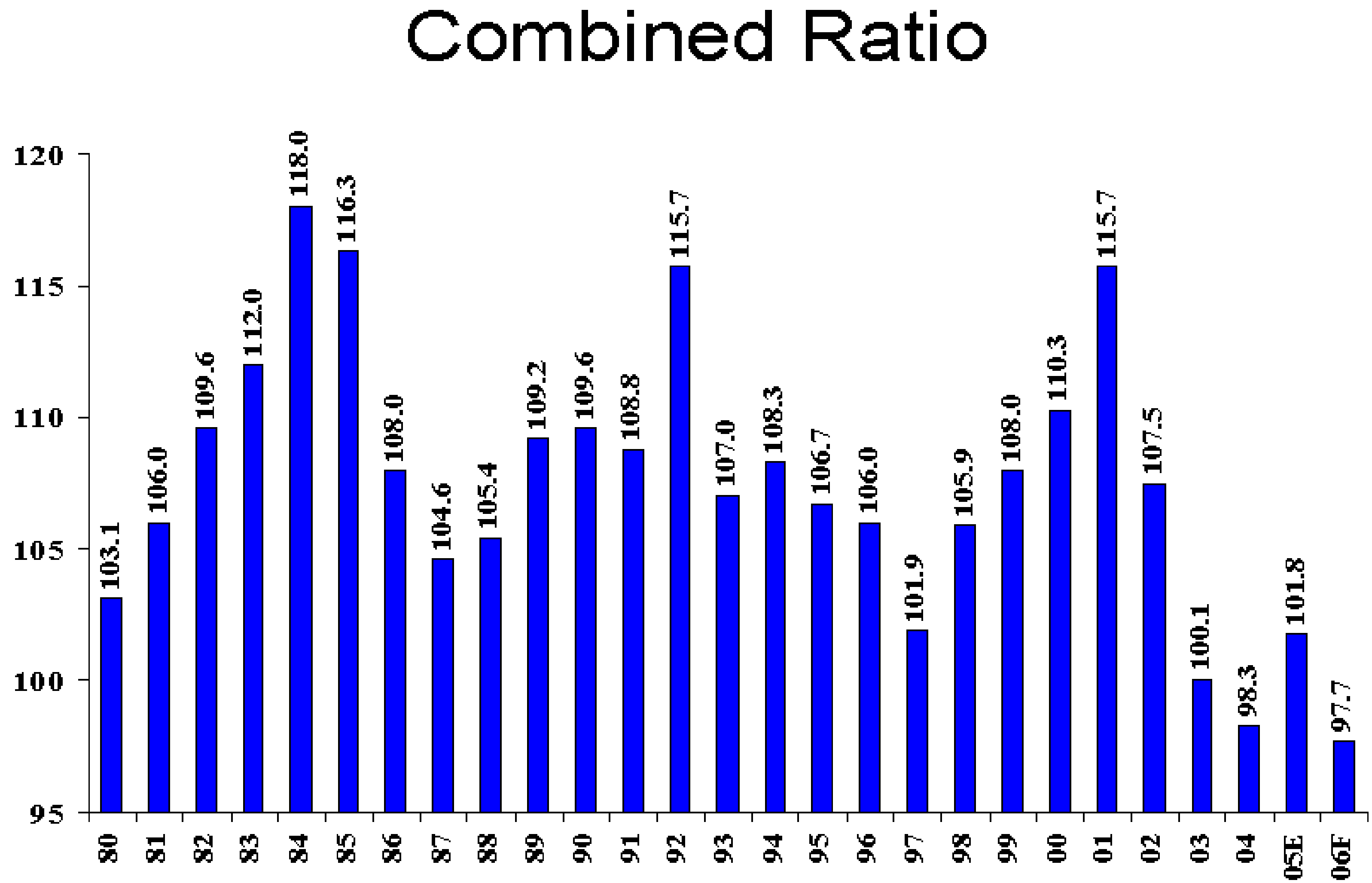
Combined ratio <1 $\Rightarrow r_U > 0 \Rightarrow$ Underwriting Profit

Combined ratio >1 $\Rightarrow r_U < 0 \Rightarrow$ Underwriting Loss

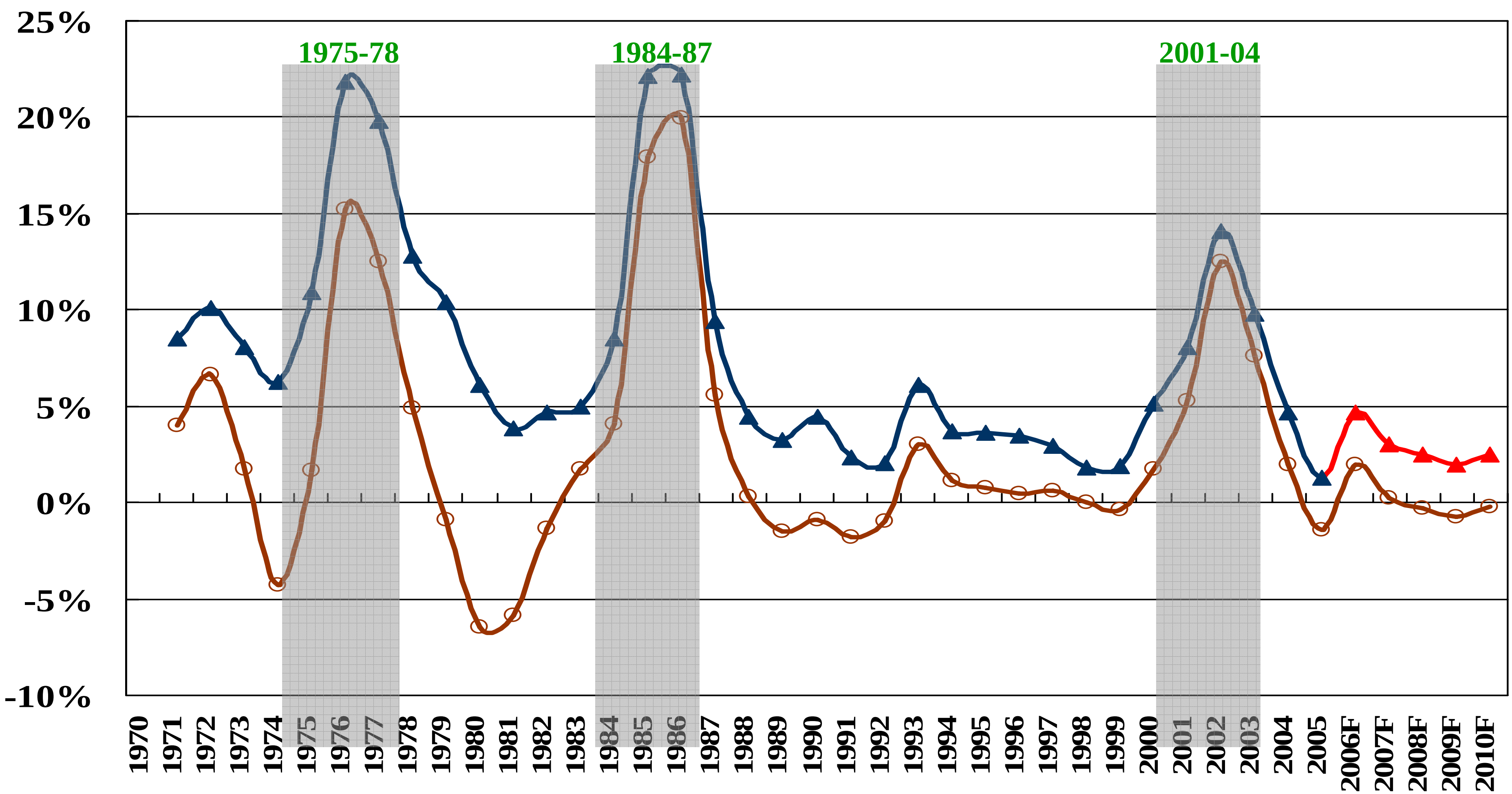
Underwriting Cycles: Hard & Soft Markets



Underwriting Cycles: Hard & Soft Markets



Real NWP Growth Rates, 1971-2010



Note: Shaded areas denote hard market periods.
Source: Dr. Robert Hartwig, Insurance Information Institute.

Return on Equity

Net Income = Underwriting Income (UI)

+ Investment Income (II);

$\therefore$ Return on Equity = Net Income/Equity

= UI/Equity + II/Equity

= r_U * (P/E) + r_A * (A/E),

where

P/E = premium/surplus ratio (insurance leverage), and

A/E = assets/surplus ratio (investment leverage).

Further Analysis of ROE

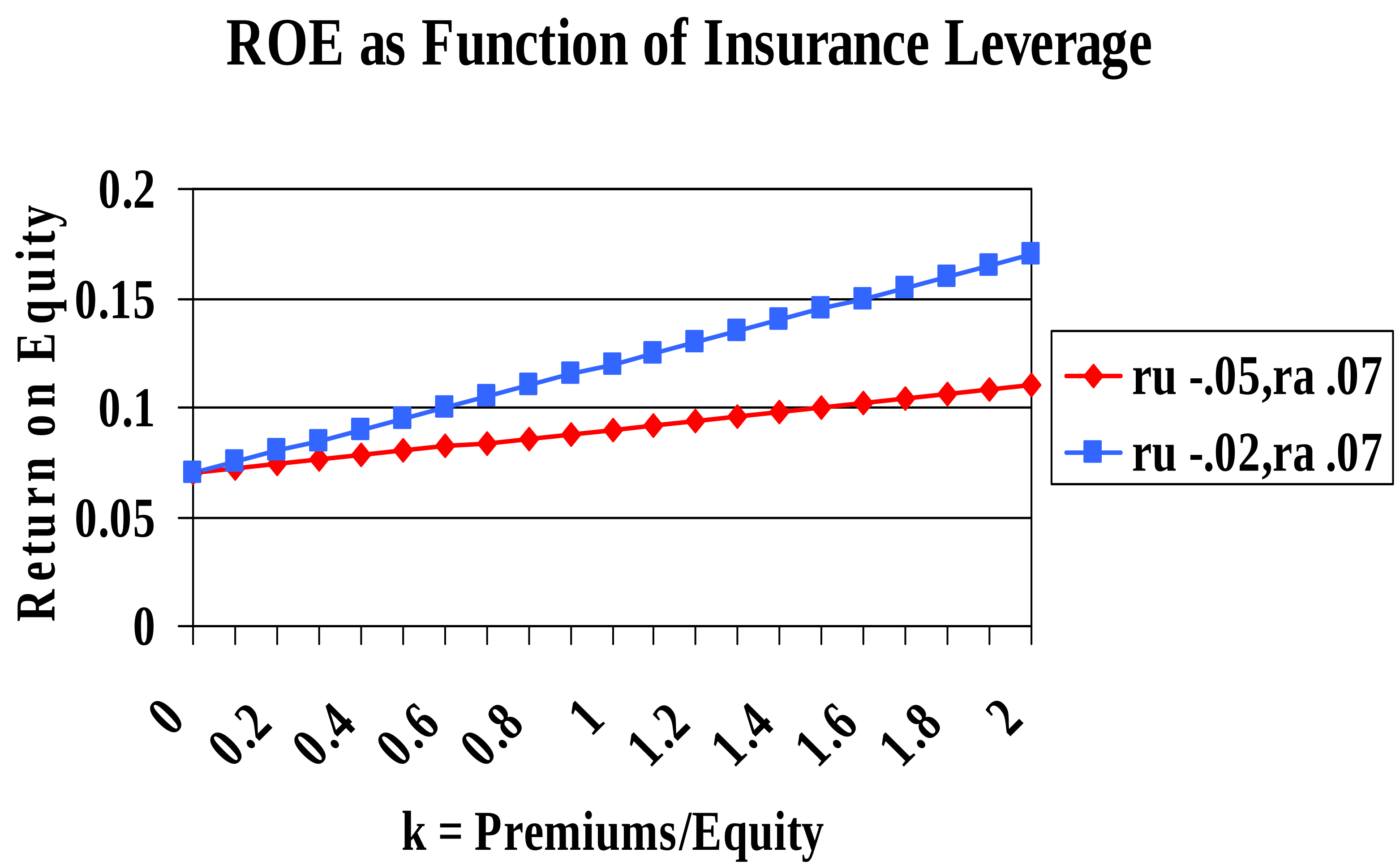
Return on Equity = $r_U * (P/E) + r_A * (A/E)$

Define $A = P + E$ and $k = P/E$; then,

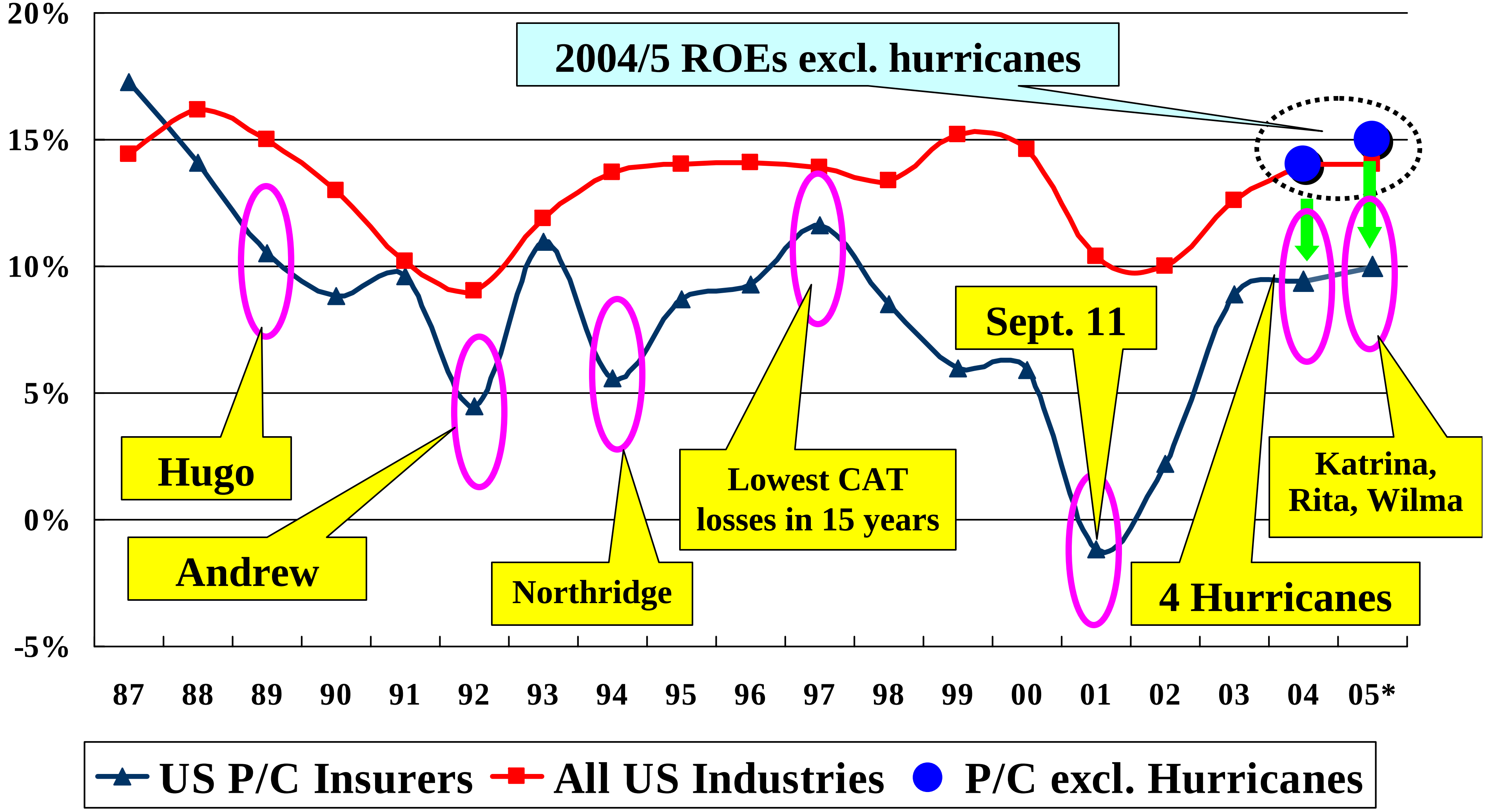
$$ROE = r_U * k + r_A * (P+E)/E$$
$$= r_U * k + r_A * (k+1) = r_A + k*(r_U+r_A)$$

- If $P = 0$ (firm writes no insurance), $ROE = r_A$ and the firm is a mutual fund (Recall that $k = P/S$).
- If $P > 0$, $ROE \geq r_A$ as long as $r_U \geq - r_A$

Model of ROE: re = ra + k*(ru + ra)



ROE: P/C vs. All Industries 1987–2005E



Underwriting Cycles Research Findings

- Losses are not cyclical.
- Cycles primarily come from premium changes triggered by shocks in interest rates, loss costs, and capacity constraints.

Cycle Math

Consider the following equation:

$$r_{u,t} = a_0 + a_1 r_{u,t-1} + a_2 r_{u,t-2} + \omega_t.$$

- An underwriting cycle is present if $a_1 > 0$, $a_2 < 0$, and $a_1^2 + 4a_2 < 0$;
- The periodicity of the cycle is determined by the equation: Period = $P = 2\pi / \text{acos}(a_1 / 2\sqrt{a_2})$; e.g., if $a_1 = 0.9$ and $a_2 = -0.8$, then $a_1^2 + 4a_2 = -2.39 < 0$ and $P = 2\pi/\text{acos}(0.503115) = 6.2832/1.0436 = 6.021$ years.

Cycle Math

Table 2

AUTOMOBILE INSURANCE LOSS RATIO REGRESSIONS FOR SIX MAJOR NATIONS

	a(0)	a(1)	a(2)	Time	R-SQ	Cycle Period
Canada*	1.297	0.851	−0.635	−0.014	0.78	6.24
		5.012	3.764	3.985		
France	0.696	0.946	−0.431	−0.007	0.90	8.20
		4.802	2.612	2.955		
Italy	0.741	1.261	−0.612	−0.014	0.87	9.92
		7.619	4.016	1.320		
Sweden	0.802	0.816	−0.397	−0.001	0.43	7.26
		3.781	2.087	0.150		
Switzerland	1.758	0.445	−0.409	−0.010	0.46	5.17
		2.219	2.242	2.522		
United States	1.347	0.735	−0.653	−0.007	0.73	5.72
		4.816	4.657	3.896		

NOTE: The estimation period is 1957–1979, unless otherwise indicated. The estimation equation is: $CR(t) = a(0) + a(1)CR(t-1) + a(2)CR(t-2) + u(t)$ where $CR(t)$ = the premiums to claims ratio in year t and $u(t)$ = a random error term. All equations were estimated by ordinary least squares. Absolute values of t-statistics appear below coefficients.

*Estimation period for Canada is 1958–1979.

Why are underwriting returns autoregressive?

- Assume that interest rates are 0 and that insurer estimates of E(L) are unbiased; i.e., $L_t = E(L_t) + \epsilon_t$, where ϵ_t is "white noise" (i.e., $\epsilon_t \sim N(0,\sigma_\epsilon)$ and $E(\epsilon_t \epsilon_{t-i}) = 0, i \neq 0$).
- Then underwriting profit is $\Pi_U = P – L = E(L) – L = E(L) - [E(L) + \epsilon_t] = - \epsilon_t$.
- Since underwriting profit is white noise, so is the return on underwriting; i.e., $r_U = \Pi_U/P = - \epsilon_t/P$.
- Therefore, if r_U is empirically observed to be autocorrelated, then insurers either make systematic pricing errors or autocorrelation enters r_U in some other fashion.

What causes underwriting cycles?

- Assuming that insurer estimates of E(L) are on average unbiased, two possible explanations for cycles include:
  - Pricing lags
  - Accounting conventions

Insurance Pricing Lags: Pricing at Time t (end of year t)

• Center of loss data	t – 0.5
• Data available to actuaries	t + 0.25
• Rates filed with regulator	t + 0.5
• Rates approved by regulator	t + 1.0
• Average renewal date	t + 1.5
• Avg claim under new rates	t + 2.0
• Total elapsed time	2.5 years

A Model of Rational Pricing (w/ lags)

Model of loss evolution:

$$L_t = E(L_t) + \epsilon_t + \nu_t,$$

where

ϵ_t = "transitory" or unsystematic component of the difference between L_t and $E(L_t)$, and

ν_t = "permanent" or systematic component of the difference between L_t and $E(L_t)$ (due to lags).

Consequently, $E(L_{t+1}) = E(L_t) + \nu_t$.

A Model of Rational Pricing (w/ lags)

- Now suppose that various data lags prevent the insurer from observing ν_t. Therefore, $P_{t+1} = E(L_{t+1}) = E(L_t)$.
- Next, we compute $\Pi_{U,t+1}$ and $\Pi_{U,t}$:

$$\Pi_{U,t+1} = P_{t+1} - L_{t+1}$$
$$= E(L_t) - [E(L_{t+1}) + \epsilon_{t+1} + \nu_{t+1}]$$
$$= E(L_t) - [E(L_t) + \nu_t + \epsilon_{t+1} + \nu_{t+1}]$$
$$= -(\nu_t + \epsilon_{t+1} + \nu_{t+1})$$
$$\Pi_{U,t} = -(\nu_{t-1} + \epsilon_t + \nu_t)$$

- Therefore, $E(\Pi_{U,t+1}\,\Pi_{U,t}) = E(\nu_t^2) \neq 0$.

Accounting Averaging: 2^{nd} Order Effect

- Insurance accounting leads to averaging of prices from different time periods, i.e., reported underwriting profits are

$$\Pi^{R}_{U,t+1} = \alpha\Pi_{U,t+1} + (1-\alpha)\Pi_{U,t} = f(\nu_{t-1}, \nu_{t}, \nu_{t+1}).$$

- Thus $\Pi^{R}_{U,t+1}$ will be 2^{nd} order autoregressive, since its value at t+1 depends in part upon the values taken on by 2 of its own lagged random shock terms, ν_{t-1} and ν_{t}.

Implications of Model

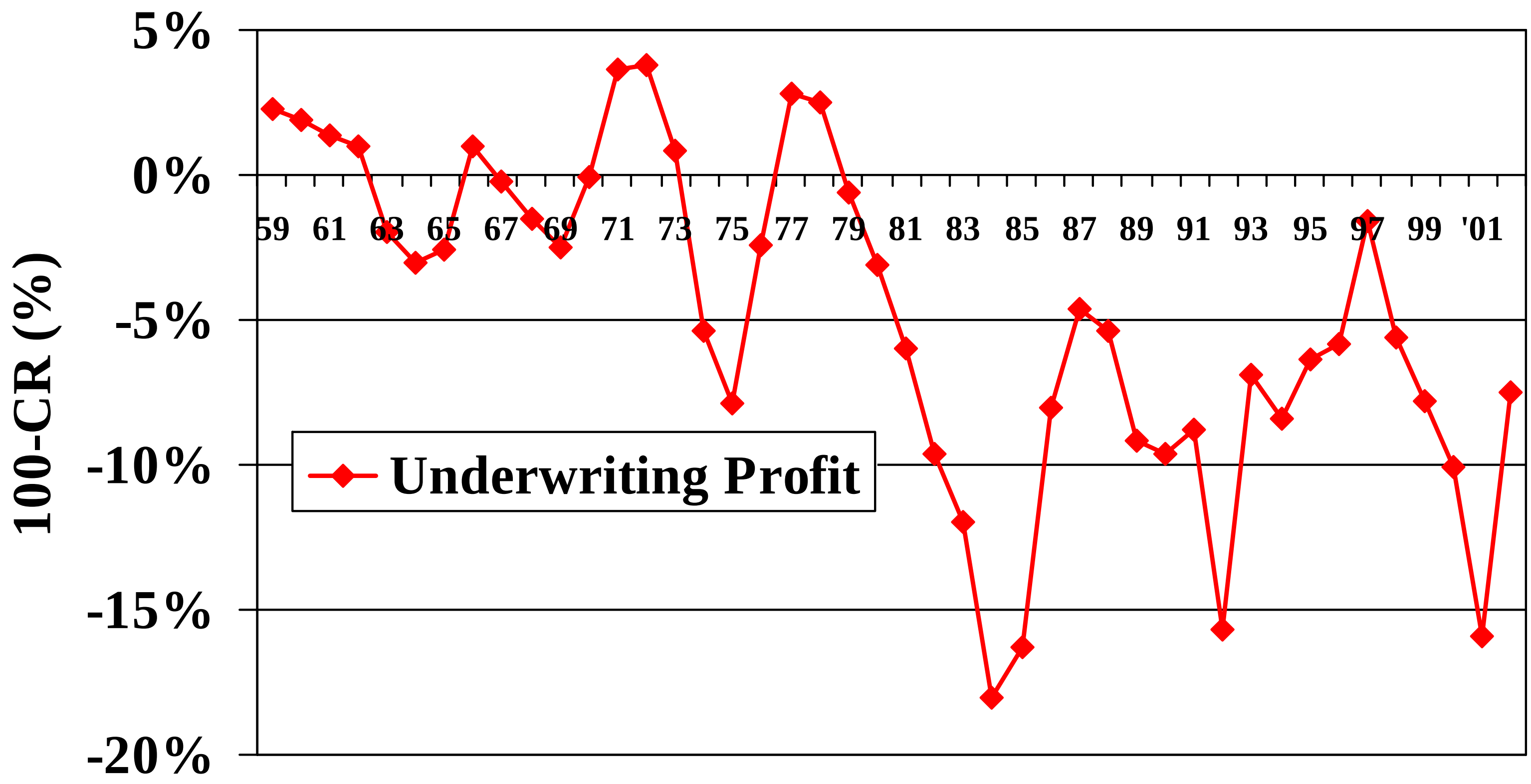
With data lags and accounting averaging,

- Observed r_U will be cyclical, even if insurers price according to rational expectations.
- Therefore, the cycle is at least partly *illusory*.

Testable Hypotheses

- The Cummins-Outreville model implies that r_U will be second order autoregressive, even if insurers behave according to the rational expectations model
- Furthermore, virtually all of the financial pricing literature suggests that r_U will be inversely related to interest rates.

The P/L Underwriting Cycle



Underwriting Profit Regressions

UNDERWRITING PROFIT REGRESSIONS

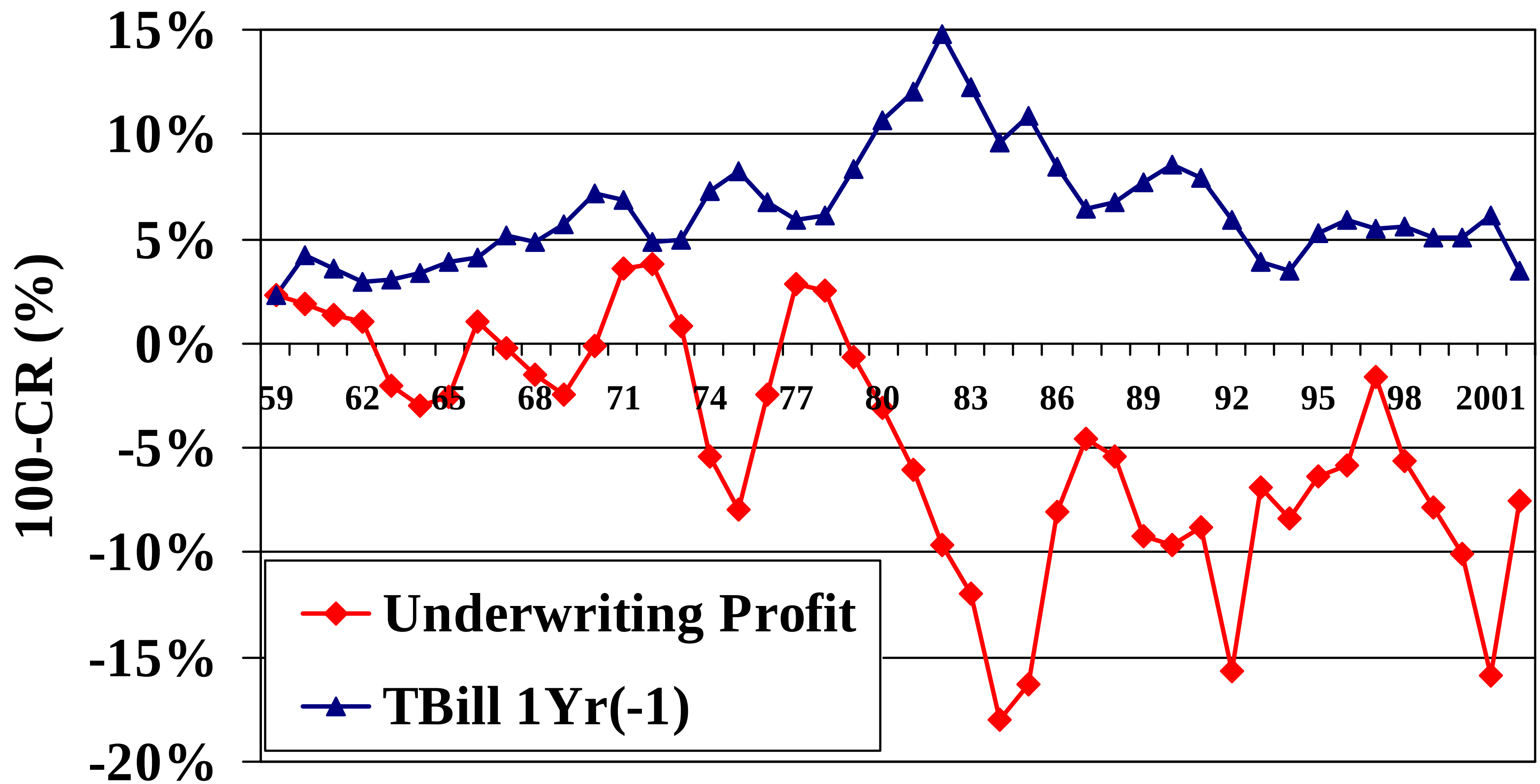
1961-1980 & 1981-2001

Method: Least Squares					Method: Least Squares				
Sample: 1961-1980					Sample: 1981-2001				
Included observations: 20					Included observations: 21				
Variable	Coefficient	Std. Error	t-Stat		Variable	Coefficient	Std. Error	t-Stat	Prob.
C	-0.55	0.36	-1.54		C	-5.55	2.04	-2.72	0.02
ULOSSL1	0.93	0.14	6.63		ULOSSL1	0.66	0.24	2.69	0.02
ULOSSL2	-0.82	0.14	-5.95		ULOSSL2	-0.25	0.23	-1.10	0.45
R-squared	0.755				R-squared	0.333739			
Adjusted R	0.727				Adjusted R	0.255356			
Conditions for Cycle:					Conditions for Cycle:				
a1 > 0		Yes			a1 > 0		Yes		
a2 < 0		Yes			a2 < 0		Yes, not significant		
a1^2 + 4 a2 < 0		Yes			a1^2 + 4 a2 < 0		Yes		
Cycle Period		6.10			Cycle Period		7.35		

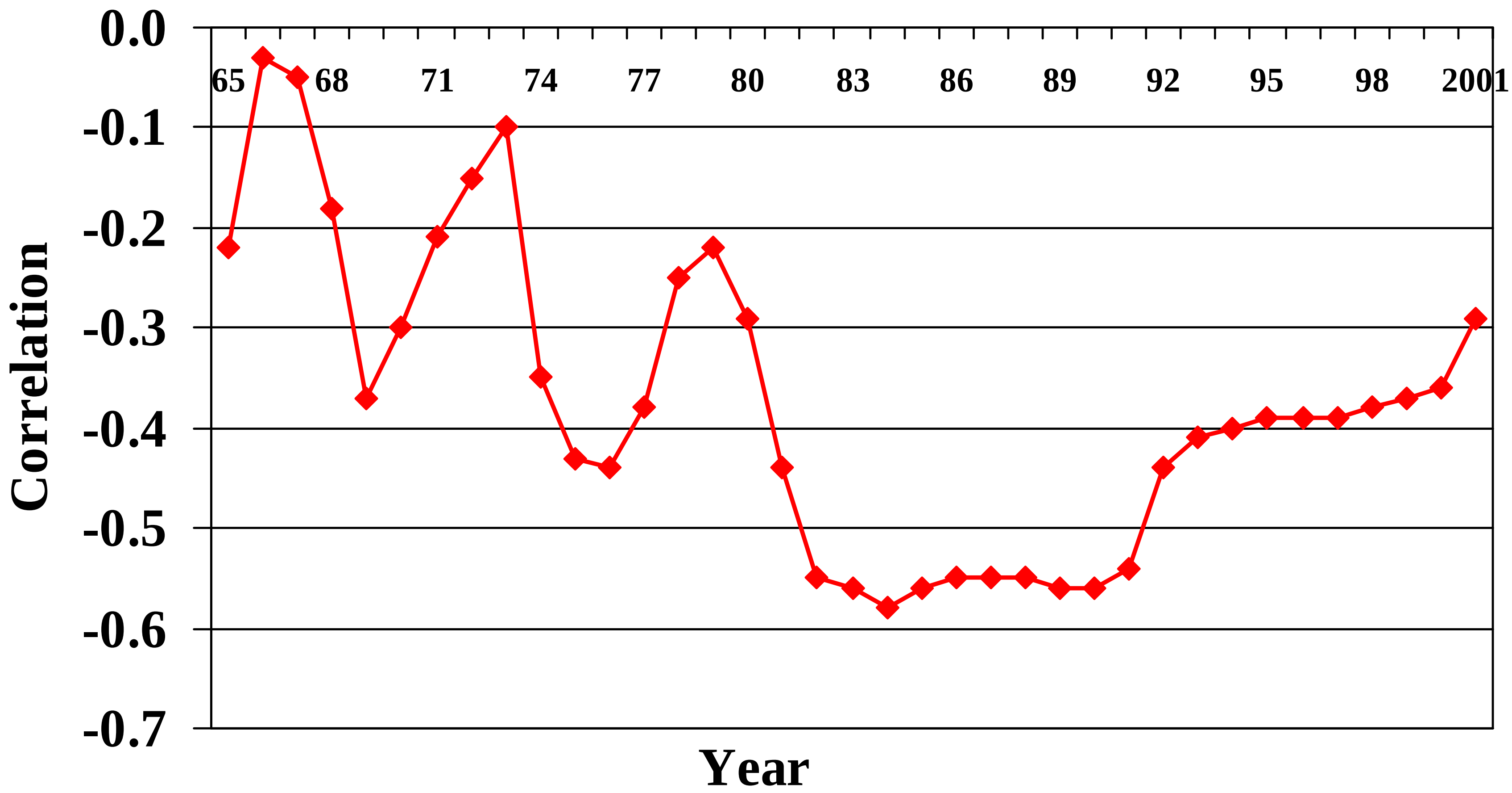
Why the Cycle May Be Lengthening or Vanishing

- Innovations in information technology have reduced data lags over time.
- U.S. insurance markets have become more competitively structured and less regulated over time, thus reducing the magnitude of the other nonstochastic influences listed earlier.

Relationship between r_u and (lagged) r_f



Correlation between Underwriting Returns and (Lagged) T-Bill Yields



Underwriting Profit and Interest Rates: AR(1) Regression: 1961-2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.542	4.151	1.576	0.146
TBILL(-1)	-0.774	0.372	-2.079	0.044
TIME	-0.311	0.128	-2.436	0.042
AR(1)	0.634	0.140	4.531	0.000
R^2	0.674	Mean DepVar		-5.188
Adj R^2	0.647	S.D. DepVar		5.599

"Real Cycles": Hard and Soft Markets

- Traditional cycle may be partly illusory and lengthening, but hard and soft markets seem to persist.
  - Hard market: Supply of coverage is limited and prices are high.
  - Soft market: Supply of coverage is high and prices are low.

Explanations for Hard/Soft Markets: Supply Side View

- (Naïve) Supply Side View
  - When underwriting profits are high, companies cut prices to gain market share and obtain funds to invest (aka "cash flow underwriting").
  - Prices and profits fall until insurers incur "excessive" underwriting losses and are forced to reduce supply and raise prices.

Supply Side View: How Naïve Is It?

- The supply side view may be consistent with Michael Jensen's "free cash flow" theory.
  - If the firm has sufficient financial slack, managers might be inclined to pursue growth in lieu of paying dividends, even if investments aren't particularly compelling in terms of prospective profitability.
  - Somewhat consistent with supply side cycle explanation; i.e., at the onset of a "soft" market when the insurer enjoys financial slack, its managers pursue premium growth even though the profitability of such a strategy may be questionable.

Supply Side View: How Naïve Is It?

- The supply side view may also be consistent with the Myers-Majluf "pecking order" theory.
  - Since managers are better informed about the firm's investment opportunities than outside investors, they may be reluctant to use external finance due to adverse selection costs in the capital markets.
  - Similar to hard market supply side story where insurers <u>reduce supply</u> rather than <u>raise new capital</u>.

An Alternative (Sophisticated) Supply Side View

- Recall that ROE = $r_A + k^*(r_U + r_A) = r_A + k^*(-r_D + r_A)$.
  - When "net interest margin" $(r_A - r_D) > 0$, insurers cut prices (raise r_D) to gain market share and obtain assets to invest (*cash flow underwriting*).
  - Suppose that an unexpected interest rate or underwriting shocks occurs; i.e., $\Delta r_A < 0$ or $\Delta r_u < 0$. Other things equal, such shocks increase leverage ratios.
  - $\therefore$ Insurers cut supply (reduce premium writings) and increase prices in order to reduce their insurance leverage to a "more acceptable" level.

Alternative Supply Side View Predictions

- Hard markets follow adverse interest rate and underwriting shocks.
- Soft markets follow favorable interest rate and underwriting shocks.
- Relatively high leverage ratios trigger market turning points (in this case, from a soft to a hard market; low leverage ratios should have the opposite effect).

Underwriting Profit, Interest Rates, and Leverage (Prem/Surplus): 1961-2001

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.76	3.26	-0.54	0.592
TBILL1	-1.06	0.28	-3.82	0.0005
TIME	-0.17	0.06	-2.74	0.0095
P/S(t-1)	5.47	2.19	2.49	0.0174

R^2	0.568	Mean DepVar	-5.027
Adj R^2	0.533	S.D. DepVar	5.623

Changes In Und Profit, Interest Rates, and (Prem/Surplus): 1961-2001

- Dependent Variable = Log[CRAD/CRAD(-1)]

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.02	0.01	2.41	0.0225
D[TBILL(-1)]	0.06	0.03	2.16	0.0392
D[Surplus(-1)]	-0.27	0.10	-2.68	0.0119
D[Prem/Surp(-1)]	-0.32	0.11	-3.01	0.0054

R^2	0.350	Mean DepVar	0.004
Adj R^2	0.283	S.D. DepVar	0.037

Discussion of Regression

- Hard markets driven by the follow set of shocks (adverse changes): Δ Investment returns < 0, Δ Underwriting returns < 0 and Δ Leverage ratios > 0.
- Results
  - Increases in P/S ratio inversely related to combined ratio change – more leverage reduces combined ratio, supporting supply side view.
  - Increases in equity inversely related to combined ratio change – more equity reduces combined ratio, contrary to supply side view.
  - Conclusion – <u>mixed</u> evidence regarding the predictions of supply-side interpretation of cycle.