A Further Examination of Insurance Pricing and Underwriting Cycles

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Problem Statement

- Property and casualty insurers' profitability has long been depressed relative to the risk they assume. To resolve this problem, one must understand the "underwriting cycle". Yet, it is not well understood by the industry itself.

- The underwriting cycle is usually shown as the "combined ratio" over time. This is total losses plus expenses relative to premium charged. Thus, any ratio over 100% suggests that more was paid out in losses and expensed that was charged:

$$CR_t = \frac{L_t + E_t}{P_t}$$

- If we can understand the underwriting cycle, we may be able to change our behavior and make the industry a more attractive place for capital.

The Time Series

$P_{Actual,t}$, $L_{Actual,t}$, $E_{Actual,t}$ — Actual premium, losses and expenses

$$CR_t = \frac{L_{Actual,t} + E_{Actual,t}}{P_{Actual,t}}$$

Actual combined ratio

$$P_t = \mathrm{E}^P\left(\frac{(X-k)^+}{1+r_t}\right)$$

Discounted expected value of future cash flows under P-measure

$$Q_t = \mathrm{E}^Q\left(\frac{(X-k)^+}{1+r_t}\right)$$

Discounted expected value of future cash flows under Q-measure

$$Q_t^{VIX} = \mathrm{E}^{Q^{VIX_t}}\left(\frac{(X-k)^+}{1+r_t}\right)$$

Discounted expected value of future cash flows under Q-measure with volatility adjusted according to Vix index

Review:

The Property & Casualty Insurance Underwriting Cycle

Madsen & Pedersen in 2003 showed that basic option pricing can help us understand the underwriting cycle

In particular, we found that the industry has a tendency to under-price relative to the risk-neutral price and that this explains much of the uw cycle

$$CR_t = .2027 + .08836 \cdot CR_{t-1} + .3979 \cdot CR_{t-2} + .4258 \cdot C_{t-1}$$

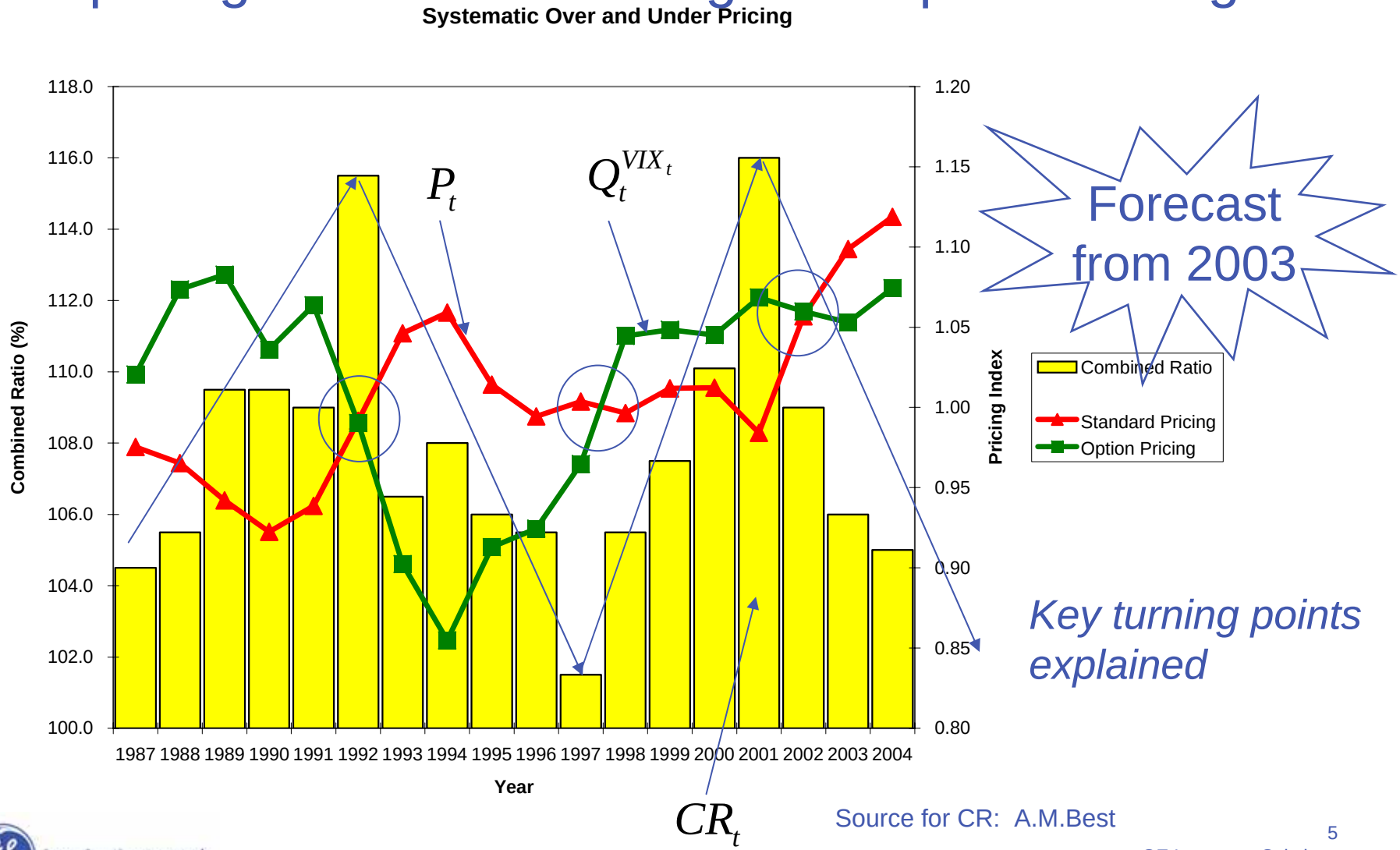
Combined Ratio

Insurance is a call option on losses – yet when the value of that option increases, so does the combined ratio. Insurers are not reflecting the increased price of risk essentially allowing consumers to arbitrage

Option price index

Review:

Comparing "Standard" Pricing with Option Pricing



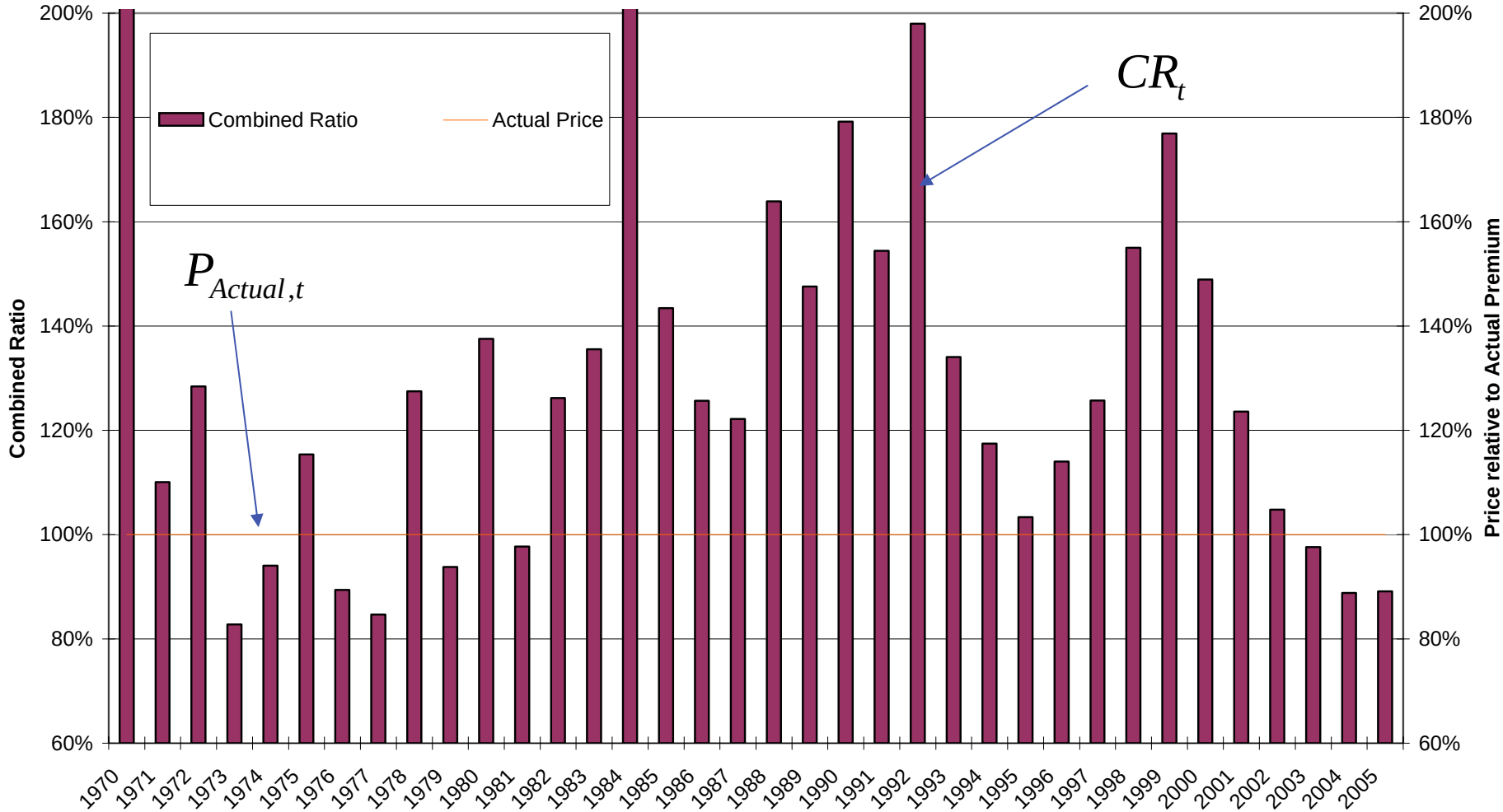
Source for CR: A.M.Best

Review

Feedback to 2003 Paper

- Industry combined ratio is on reported results. As such it contains reserving biases and will lag actual performance
- To further test our hypothesis, it would be interesting to look at a single homogeneous line of business with real reserving data without the inherent lag

Combined Ratio Versus Pricing Methods



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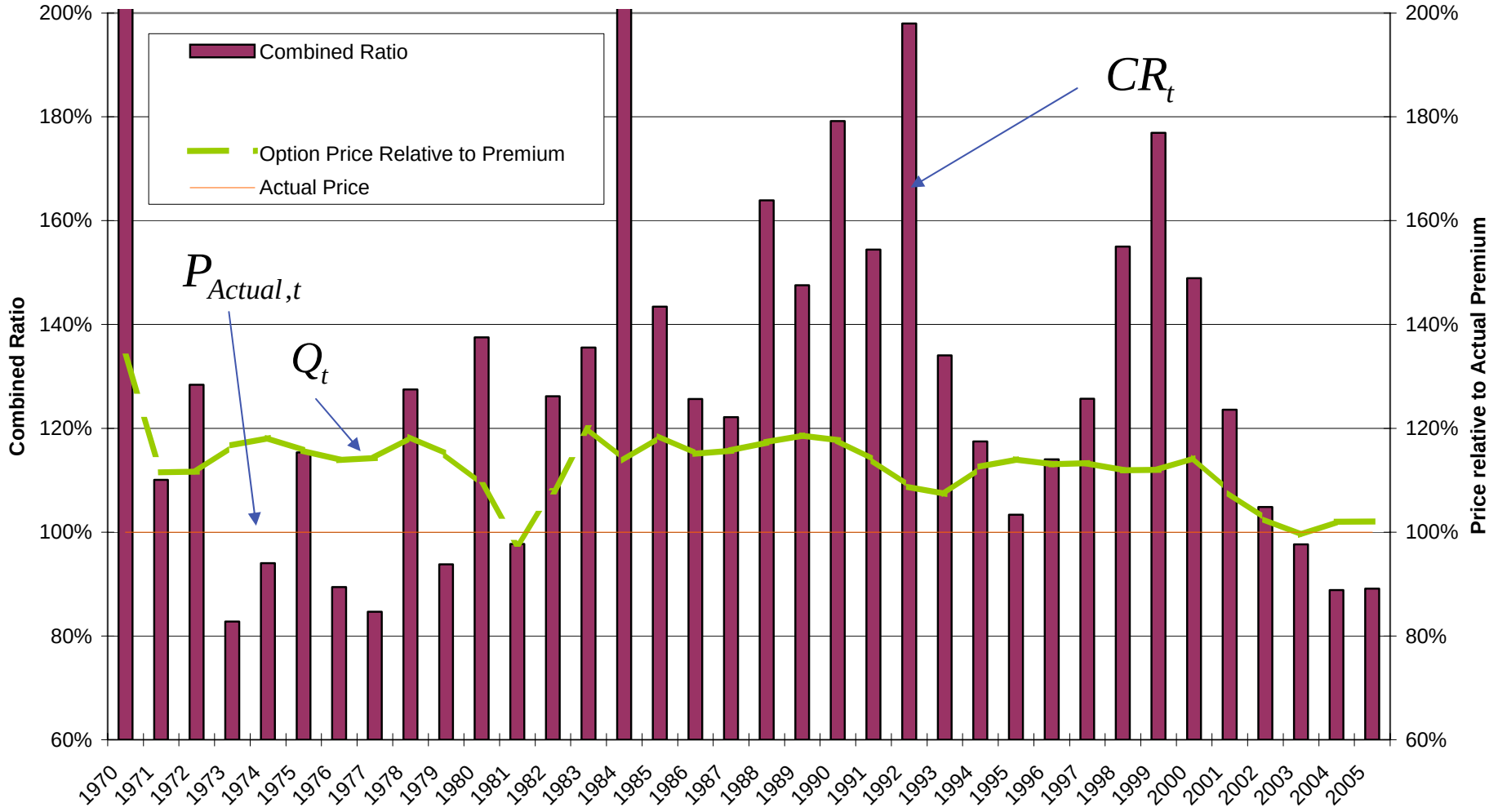

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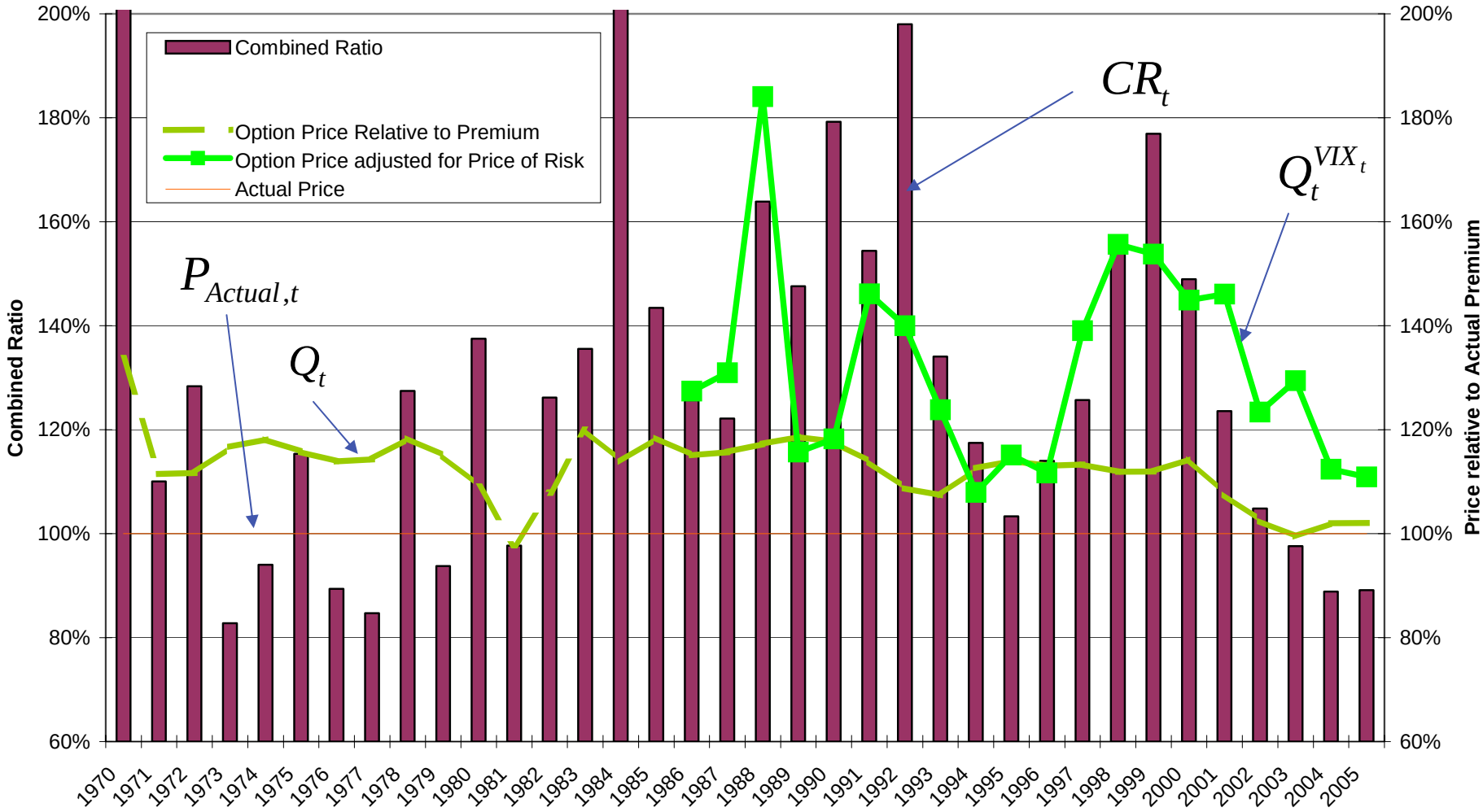
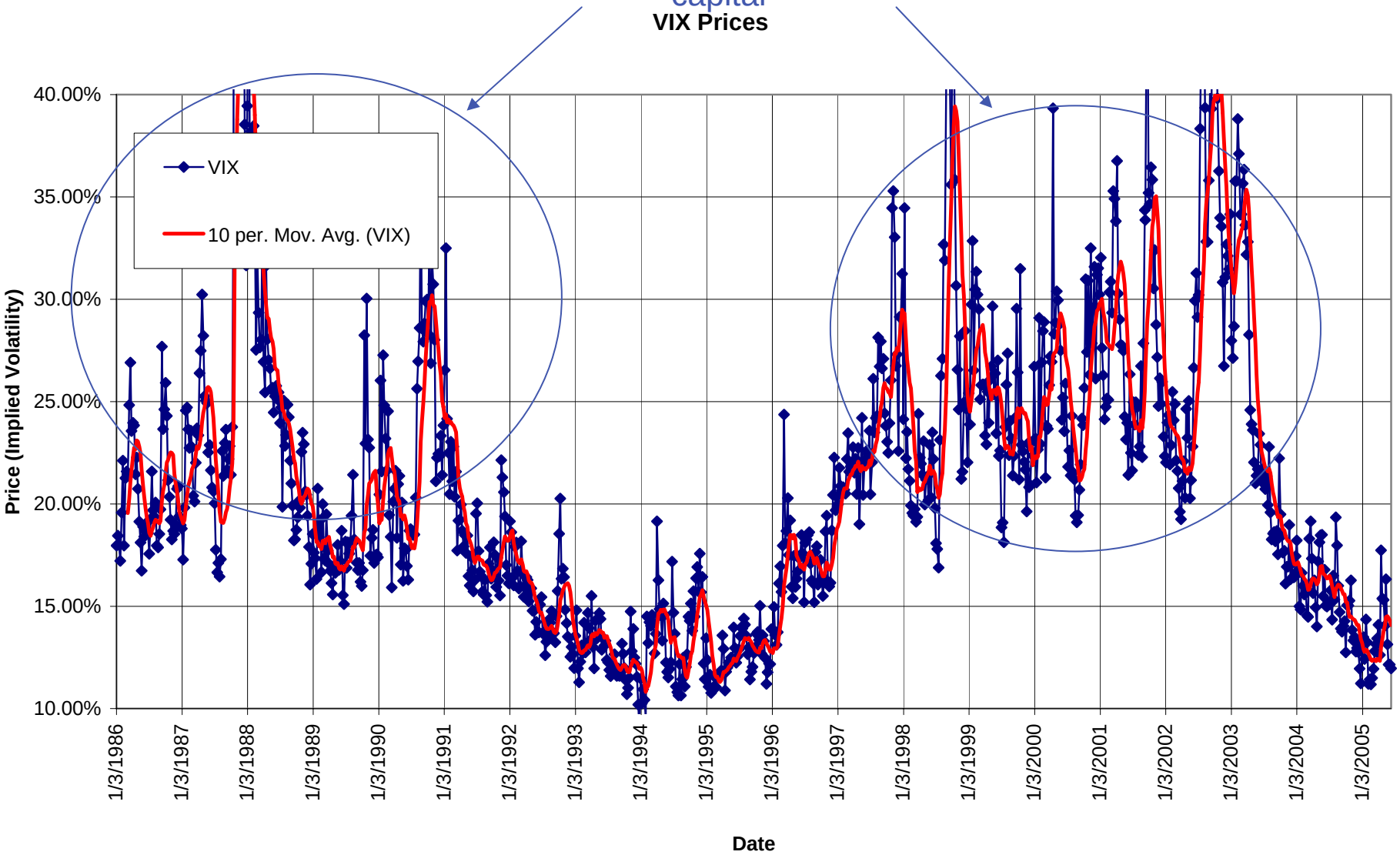


VIX: The CBOE Volatility Index

- The CBOE Volatility Index - more commonly referred to as "VIX" - is an up-to-the-minute market estimate of expected volatility that is calculated by using real-time S&P 500 (SPX) index option bid/ask quotes.
- VIX uses nearby and second nearby options with at least 8 days left to expiration and then weights them to yield a constant, 30-day measure of the expected volatility of the S&P 500 Index.
- The underlying for options is an "Increased-Value" Volatility Index (VXB), which is calculated at 10 times the value of VIX. For example, when the level of VIX is 12.81, VXB would be 128.10.
- The VIX began trading in 1986.

These should be “good times”, since consumers are willing to pay relatively more. Instead, the industry prices too low allowing consumers to arbitrage, which is a direct drain on industry capital



Why Can This Exist?

Classic incomplete market (bilateral, where buyers and sellers find each other and make direct contact)

- Prof. Vernon Smith's behavioral economics study: People, when given a choice, choose to stay in an incomplete market. This is "survival economics" rather than "maximization of profits"
- Impetus needed to move from incomplete to complete. Players prefer incomplete markets because they feel better.

No recognition that insurance can be arbitraged

- Reinsurance coverage can be replicated by selling insurance and buying bonds. This enables arbitrage, but on a limited scale since transaction costs are high (insurance license, staff etc)

Pricing Framework

We make two important changes to the status quo

- We price under the *Q* measure
- We create the implied volatility of an insurance contract and use this in our pricing

Pricing Framework

Traditional insurance pricing (status quo)

$$P = \mathrm{E}^{P}\left[e^{-rt}\left(L_t - K\right)^{+}\right] = \frac{1}{R}\left(p \cdot C_u + (1-p) \cdot C_d\right)$$

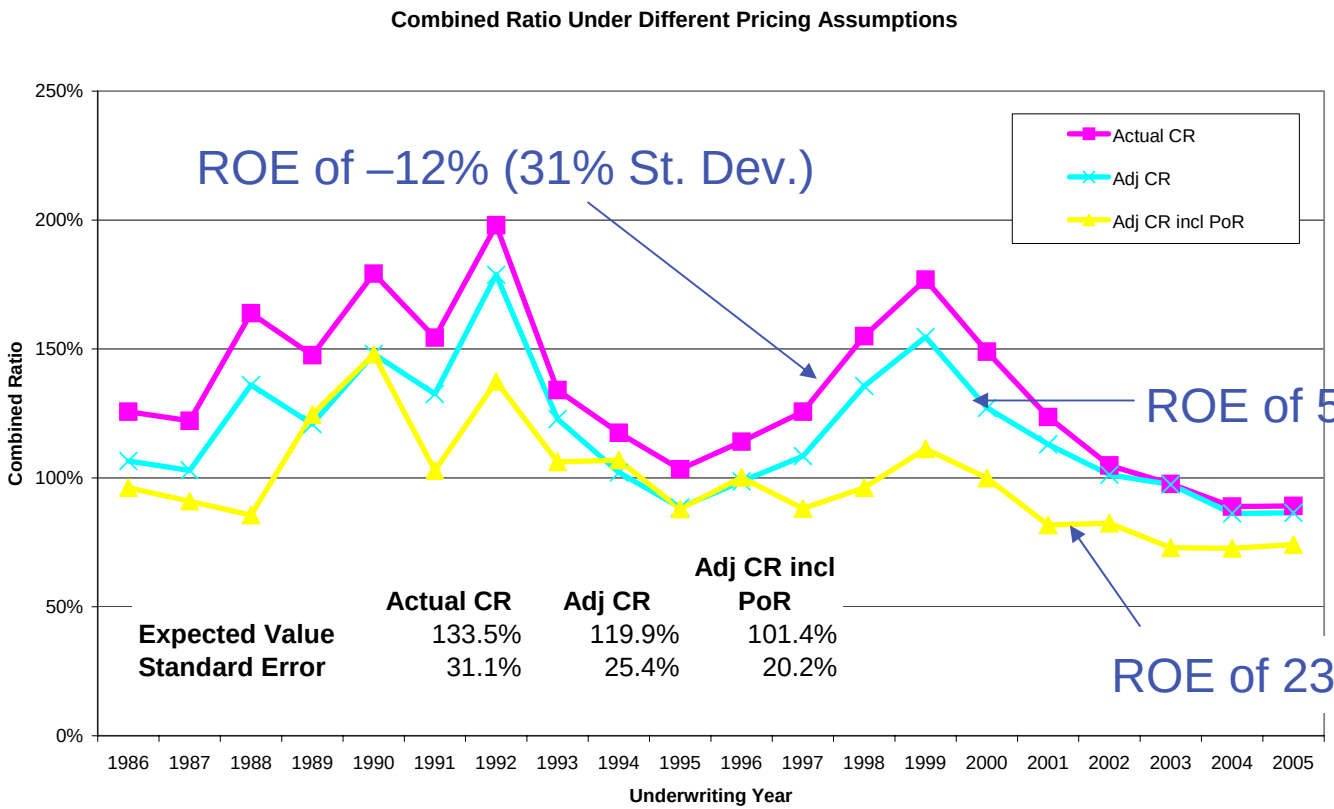
Option pricing

$$C = \mathrm{E}^{Q}\left[e^{-rt}\left(L_t - K\right)^{+}\right] = \frac{1}{R}\left(q \cdot C_u + (1-q) \cdot C_d\right)$$

$$q = \frac{R-d}{u-d} = \frac{R - e^{-\sigma_t\sqrt{\Delta t}}}{e^{\sigma_t\sqrt{\Delta t}} - e^{-\sigma_t\sqrt{\Delta t}}} = \frac{R - e^{-\sigma\lambda_t^{*}\sqrt{\Delta t}}}{e^{\sigma\lambda_t^{*}\sqrt{\Delta t}} - e^{-\sigma\lambda_t^{*}\sqrt{\Delta t}}}$$

$$\lambda_t^{*} = \frac{vix_t}{\overline{vix}} \qquad \overline{vix} = \frac{\sum_{t=1}^{N} vix_t}{N}$$

What If Industry Pricing Reflected This



Conclusion

We have showed the the VIX index can help explain the general underwriting cycle as well as a segment specific cycle

Fascinating area – dire need for more research

More publicly traded insurance linked securities will make arbitrage easier forcing better pricing and supporting theory

Thanks

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Appendix

A Historical Perspective

- Regulated market place (~1983 and prior)
  - Average combined ratio of 109.5% (excl. 1970)
  - Standard deviation of combined ratio of 20.0%
  - Price are set centrally and jointly. Reinsurers are very profitable and there is little competition on price. Pricing did not matter, as prices were generally high.
- Market place in transition (~1984 through ~1993)
  - The market begins to change in some locations allowing price to fluctuate. Pricing begins to matter and more actuaries are hired.
  - Average combined ratio of 163.1%
  - Standard deviation of combined ratio of 42.2%
- Deregulated market place (~1994 and later)
  - Market prices fall where they may. Actuaries price deals extensively but no coherent pricing theory exists and there is always uncertainty about the right price leaving room for parameters to be modified and pricing biased.
  - Average combined ratio of 120.4%
  - Standard deviation of combined ratio of 27.5%