

Crop Insurance Premium Rating

Barry J. Barnett

Department of Agricultural Economics



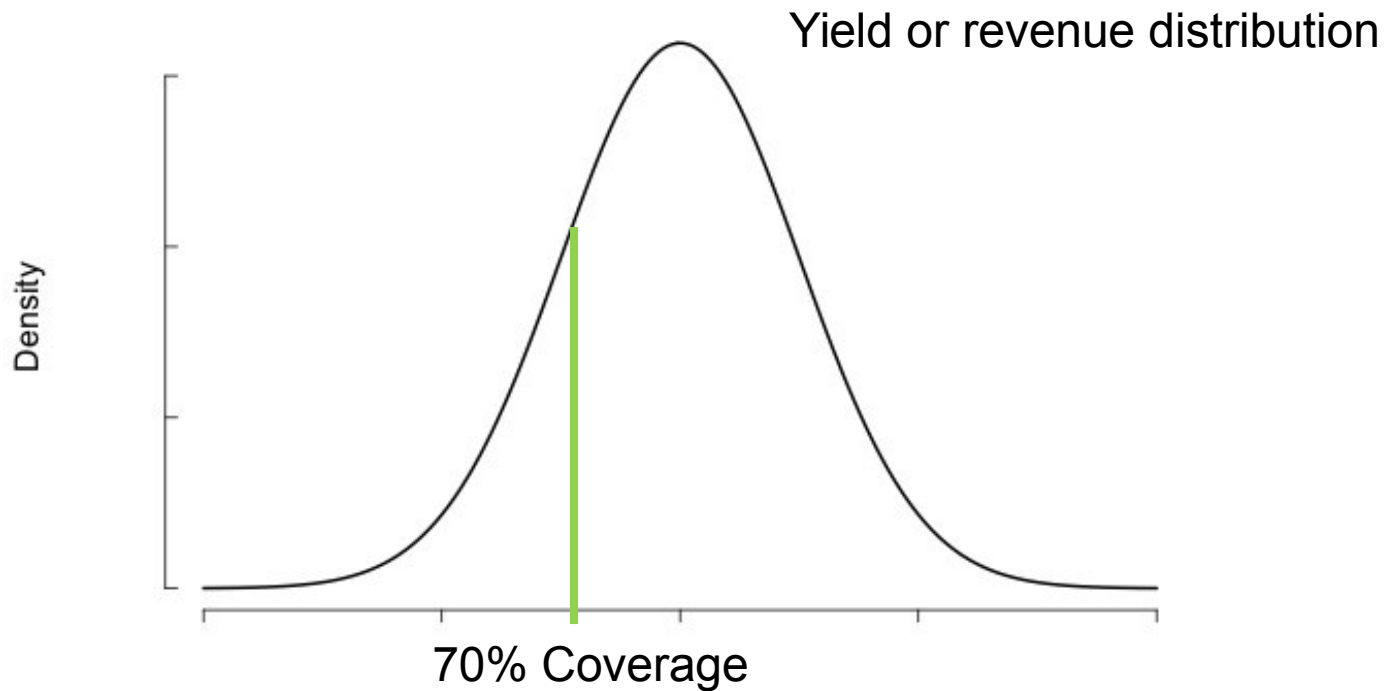
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What is a Premium Rate?

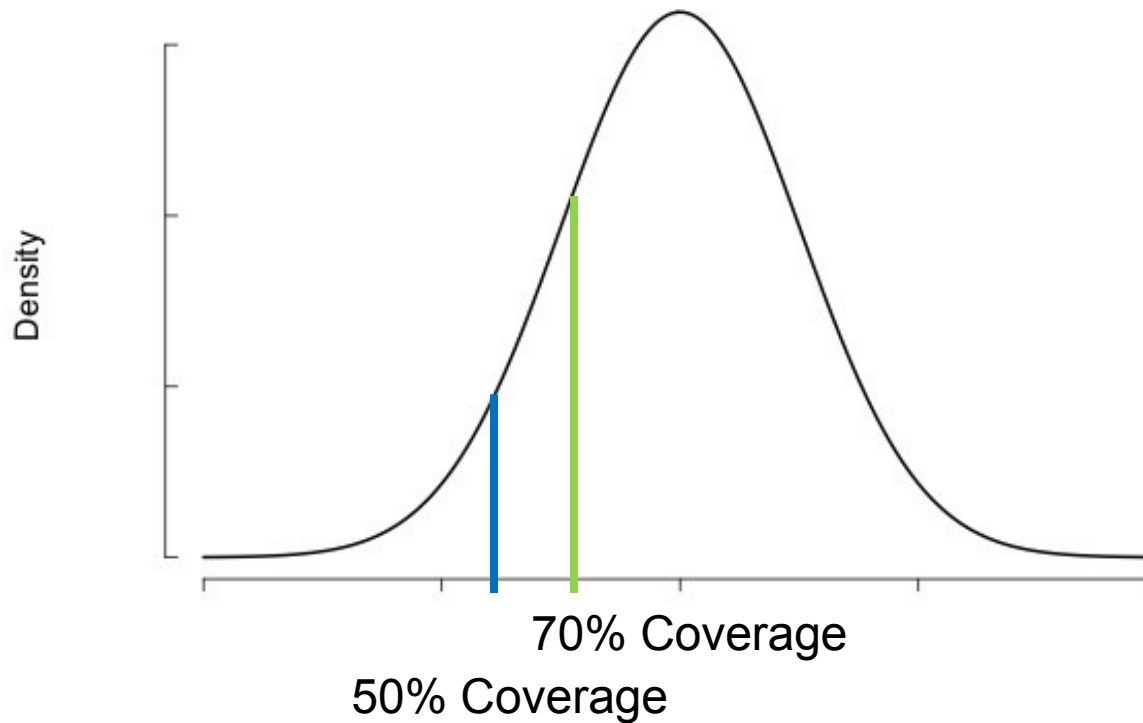
- Premium rate = premium / liability (or premium per dollar of liability).
- Insured's total premium = premium rate × insured's liability (liability = dollar amount of protection).
- Crop insurance producer premium = total premium × (100% - % subsidy).
- How does one calculate a premium rate?



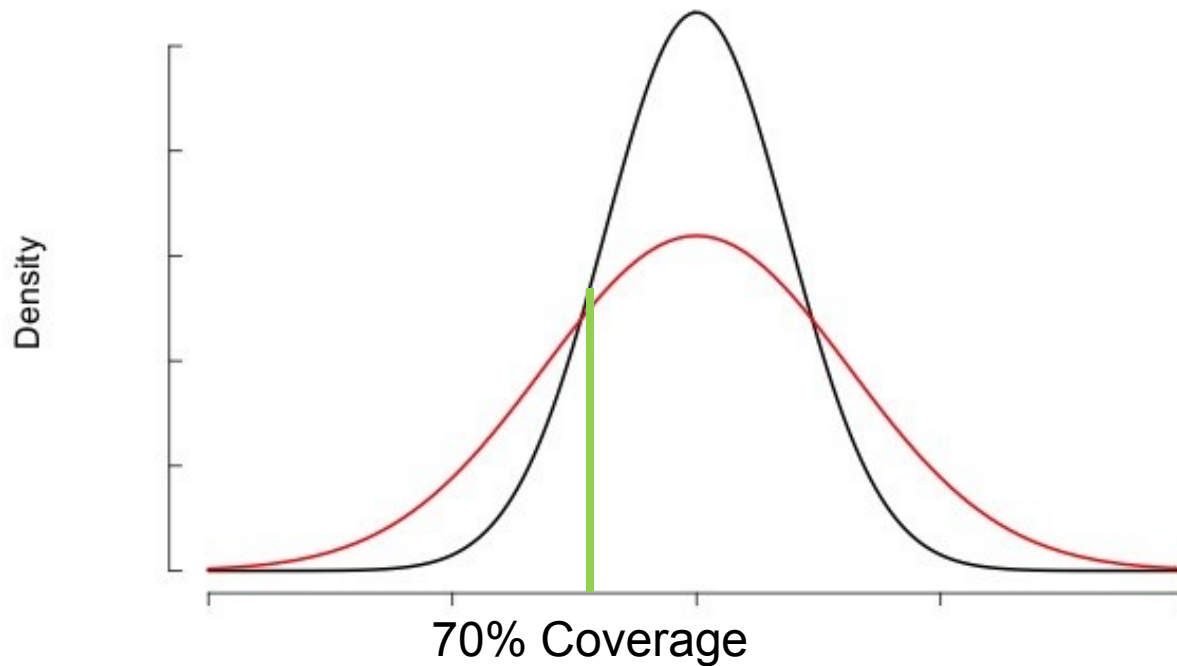
Premium Rate for 70% Coverage



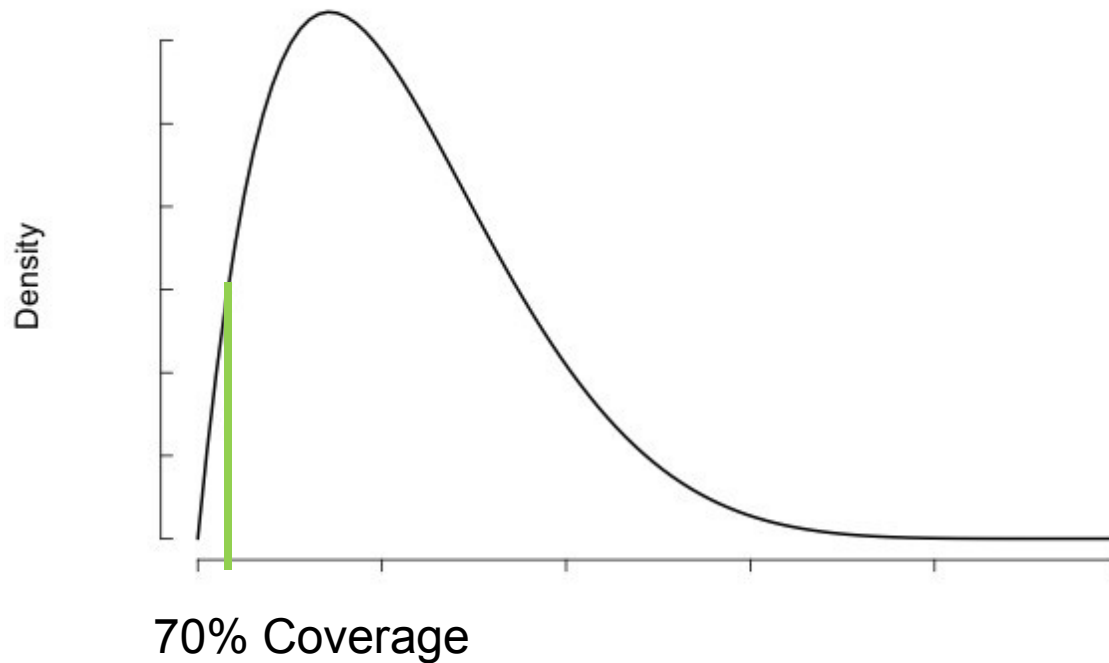
Premium Rate Varies with Coverage Level



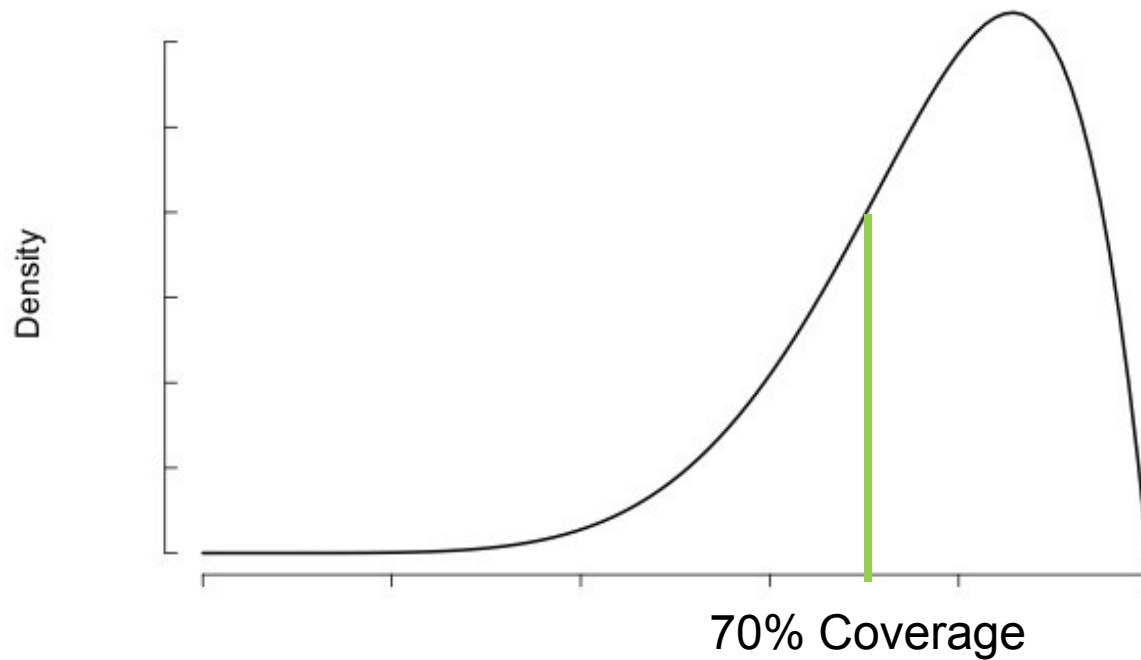
Higher Risk Implies Higher Premium Rate



Higher Moments Also Matter



Higher Moments Also Matter

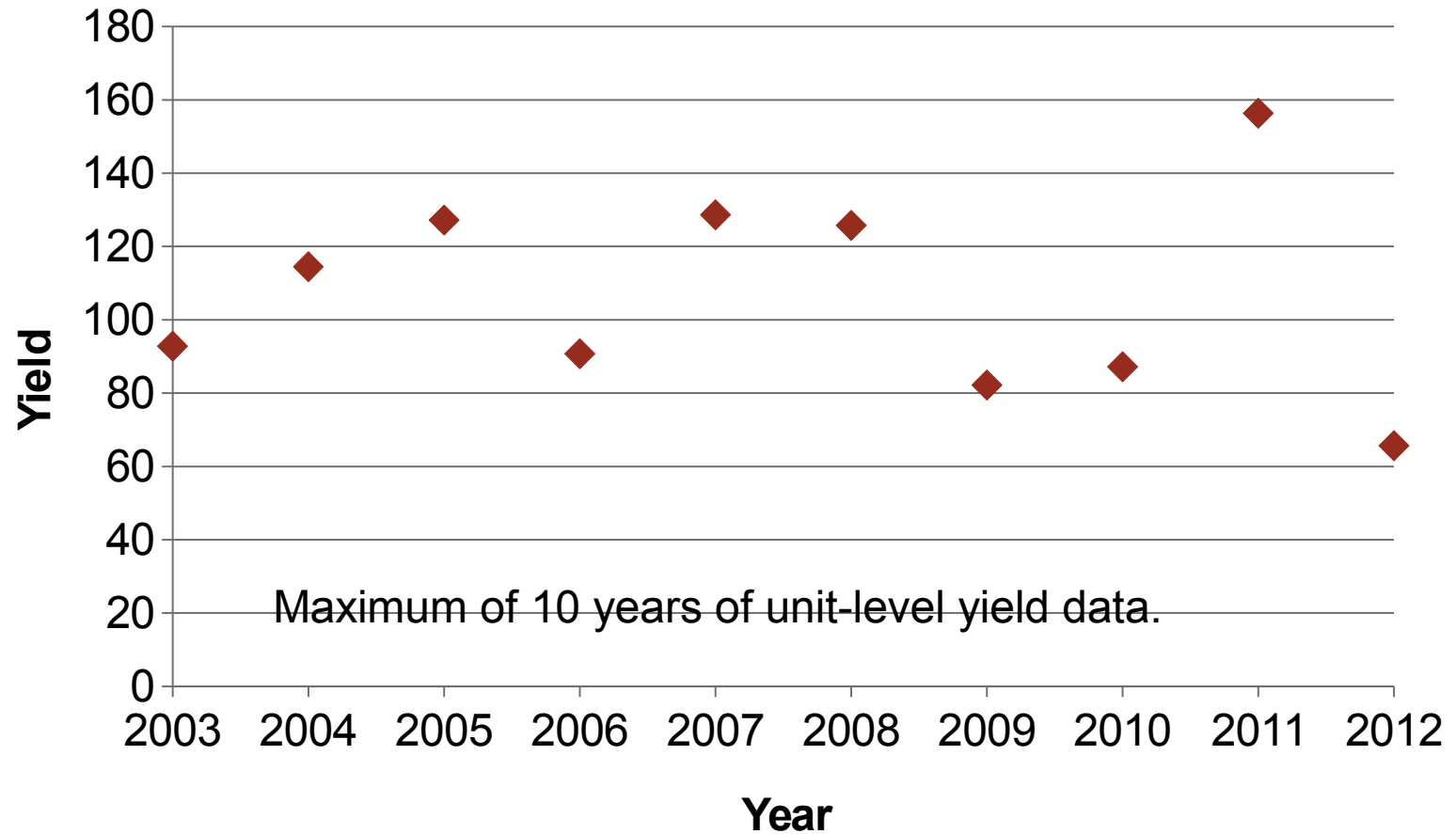


Yeah but . . .

- We never actually observe unit-level yield or revenue distributions.



What we Actually Observe (unit-level products)



So Now What?

- Obviously 10 observations is insufficient to fit a probability distribution.
- Instead, these observations are used to estimate the central tendency of the yield distribution for the insured unit.
 - Can be large errors in estimating the central tendency with only 10 observations – especially for riskier crops/regions.



So How are Crop Insurance Premium Rates Actually Calculated?

- Details are mathematically tedious and vary somewhat across products.
- Which translated means, “I don’t really know.”
- Focus on high-level concepts rather than details.



Loss Cost

- Loss cost = indemnity/ liability.
 - Impossible to predict loss cost for a given year.
- Actuarially-fair premium rate = $E(\text{Loss Cost})$.
- Rather than trying to fit a distribution for each insured unit, actuaries generally attempt to estimate the $E(\text{Loss Cost})$ for various classifications of insured units.



Premium Rate Loads

- Private-sector total premium rate = Actuarially-fair rate + loads.
 - Loads reflect factors such as administrative cost, product research and development, cost of contingent capital, return on equity, and ambiguity regarding the estimate of $E(\text{Loss Cost})$.
- Crop insurance only adds a reserve load and a catastrophic loss load.



So How is $E(\text{Loss Cost})$ Estimated?

- For yield insurance products:
 - $E(\text{Loss Cost})$ varies by crop.
 - $E(\text{Loss Cost})$ varies by region.
 - $E(\text{Loss Cost})$ varies by production practices.
 - $E(\text{Loss Cost})$ varies by types/varieties.
 - $E(\text{Loss Cost})$ could even vary by producer or even by parcel.
- For revenue insurance products, there are also:
 - Differences in price risk for different crops and differences in price-yield correlation for different crops and regions – all of which impact $E(\text{Loss Cost})$.



Estimating Yield Insurance E(Loss Cost)

- E(Loss Cost) for 65% coverage is estimated empirically for specific crop/county combinations using 20 years of historical loss cost data.
 - Will later adjust premium rates for policy-specific factors such as type, practice, and producer or parcel characteristics.
- Historical revenue insurance loss cost data must be converted to a yield insurance basis.
- Historical loss cost experience for all coverage levels must be converted to a 65% coverage level basis.



Estimating Yield Insurance E(Loss Cost)

- Until recently a simple average of the historical loss cost data were used to generate a 65% coverage level yield insurance E(Loss Cost) for the crop/county.
 - Implicitly assumes each historical loss cost outcome has equal probability.
- Now a weighted average is used where each historical loss cost outcome is weighted by a probability derived from climate division weather data available from 1895-present.



Catastrophe Loading

- For each county/crop combination in the state, catastrophic historical losses are removed from county experience. The average catastrophic experience across all counties in the state is then added back into the $E(\text{Loss Cost})$ estimate for each county/crop combination.



Revenue Insurance Premium Rates

- Iman and Conover simulation procedure:
 - Assumption of censored normal distribution with variance that would generate the 65% coverage yield $E(\text{Loss Cost})$.
 - Assumption of lognormal price distribution with predicted price (from futures market) and implied price volatility (from options market).
 - Empirically estimated area yield-price correlation.
- Simulate both yield and revenue $E(\text{Loss Cost})$ at 65% coverage. Difference is the revenue load which is added to earlier calculated yield premium rate



Other Adjustments

- Mathematical formulas are used to infer premium rates for other coverage levels relative to the premium rate for 65% coverage.
 - Conceptually, imposing structure on the underlying yield distribution.
 - Imposed structure is based on historical loss experience at different coverage levels.
- Mathematical formulas (based on historical loss experience) are used to adjust premium rates for differences in $E(\text{Loss Cost})$ across different types and practices.



Other Adjustments

- Premium rates are initially calculated at the optional unit level. Formulas are used to adjust those premium rates for basic or enterprise units.

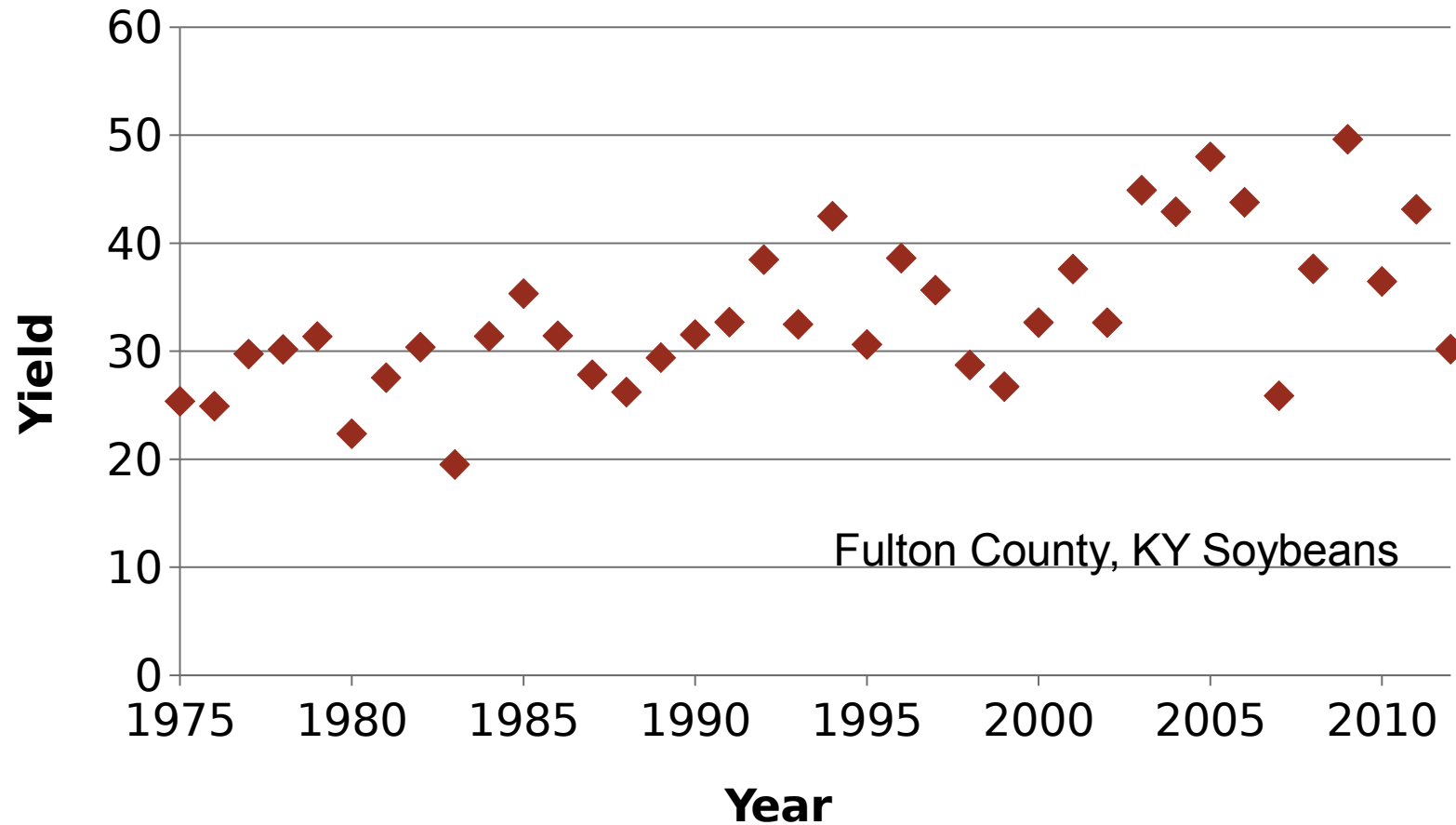


Risk Differences Across Insured Units for a Crop/County/Type/Practice

- May be due to differences in soil quality, drainage, producer ability, etc.
- In some cases (e.g., high risk land in a flood plain) explicit premium rate loads are applied.
- In other cases (where differences are not easily attributable to a specific factor):
 - For a given county/crop/type/practice combination, $E(\text{Loss Cost})$ for insured units is assumed to be lower (higher) the higher (lower) the estimate of yield central tendency (APH yield).



What we Actually Have (area products)



How is E(Loss Cost) Determined?

- Not by actual historical loss cost data.
 - Products have not existed long enough.
- Instead a backcast simulation process is employed.
 - For area yield insurance, use historical NASS yield data to simulate what the loss cost would have been had the product been in place.
 - For area revenue insurance, also take into account implied price volatility and yield-price correlation.



How is E(Loss Cost) Determined?

- The yield distribution may not be stationary.
 - 1- or 2-knot spline trend adjustment.
- Deviations from central tendency may be heteroskedastic. If so, correction procedures are used.
- How many years of historical data are sufficient to reflect the probability distribution?
 - Weather weighting?
- Challenges:
 - Data sources (reduced NASS reporting).
 - Changing composition of types/practices within a county. NASS data may not be



In the Words of Forrest Gump

- “That’s all I have to say about that.”

