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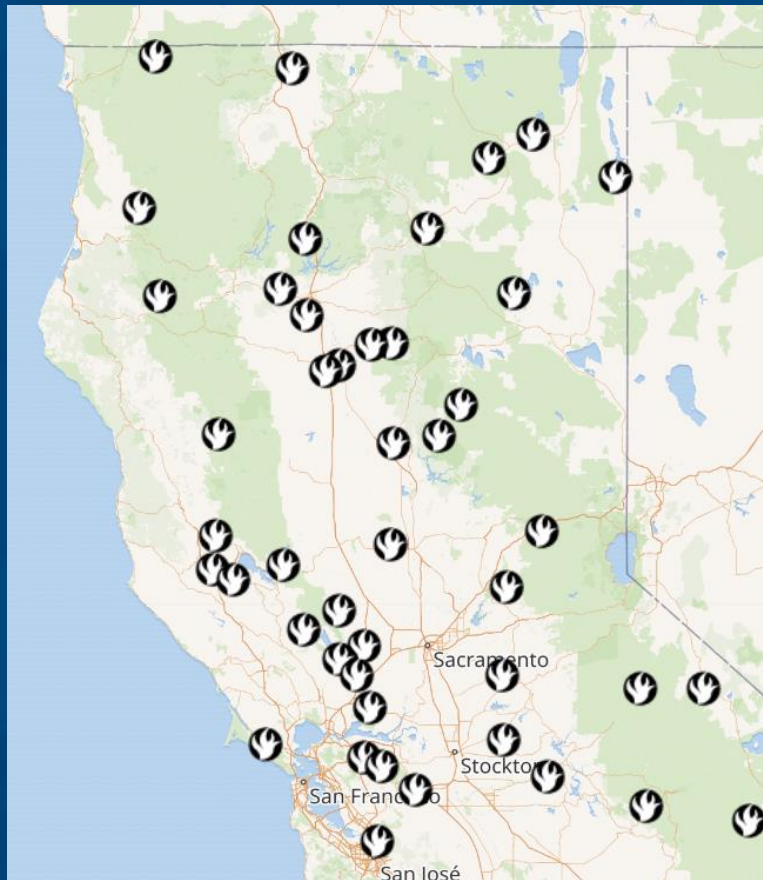
FOOD & RESOURCE  
ECONOMICS  
DEPARTMENT

# Crop Insurance for Wine Grapes: Wildfires and Subsequent Smoke Taint

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# California Wildfires



- 2017:
    - 9,133 fires
    - 1,381,405 acres
  - 2018:
    - 8,527 fires
    - 1,893,913 acres
      - Largest burned in a fire season
- (California Department of Forestry and Fire Protection)

2018 Wildfires

Source: San Francisco Chronicle

# What is smoke taint?

- Smoke exposure can lead to:
  - “ashy,” “burnt” and “smoky” aromas
  - “an excessively drying” back-palate and retro-nasal “ash” perception
- Caused by volatile phenols such as guaiacol, 4-methylguaiacol, syringol, m-cresol, o-cresol and p-cresol
- Often not detectable in the grape but expressed in the wine
- Reduces the value of the wine or leads to rejection by consumers

(Härtl and Schwab 2018)

# What is smoke taint?

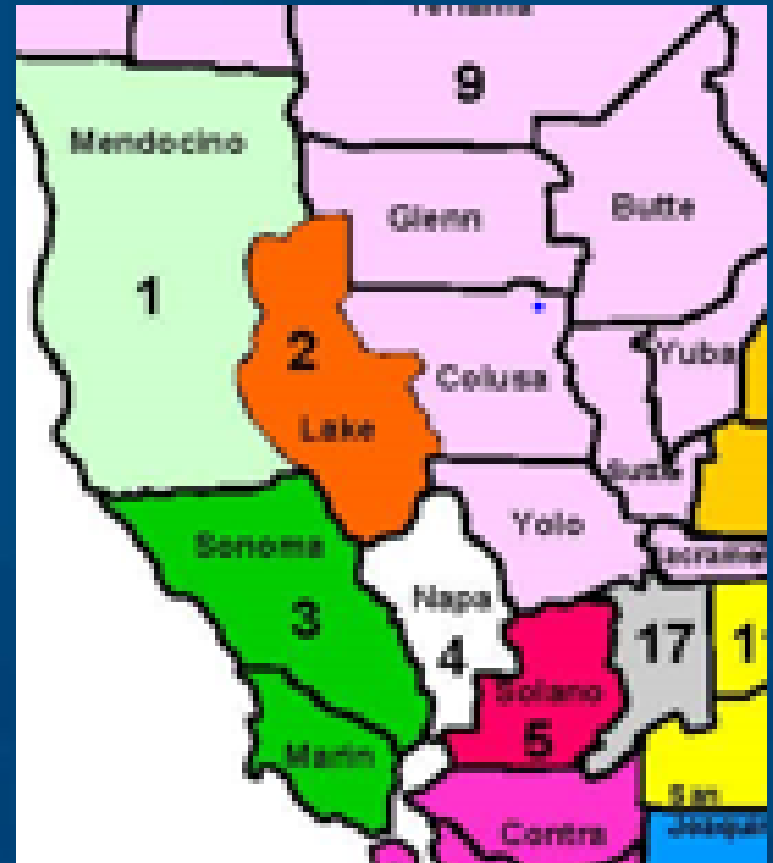
- Big issue because 2018 fires occurred prior to harvest & late in the growing season
  - Wineries rejected delivery of grapes
- \$37.1 million of losses in Lake County alone (Lake County Winegrape Commission)

# Contracting

- 95% of Napa AVA is forward contracted (Robinson)
- Length:
  - Fixed – set contract length
  - “Evergreen” – continues unless cancelled
  - “Look-see” – set length that converts to evergreen unless cancelled prior to end of initial period (90 days notice)
- Price:
  - Fixed
  - Formula – bottle pricing
  - Third party index – % of average crush district price

# Pricing

MAP AND DEFINITIONS OF CALIFORNIA GRAPE PRICING DISTRICTS



# Berryhill Act

- Clare Berryhill Grape Crush Report Act of 1976 (Food & Agric. Code §55601.5)
- Processor must report tonnage and pricing to Department of Food and Agriculture
- Price determination of all contracted grapes must occur by January 10 following harvest
- Requires processor to pay for crop within 30 days of delivery unless different payment date set in contract



# Contracting

- Quantity:
  - Fixed
  - Plot – Rows  $X$ , of block  $Y$ , in plot  $Z$ 
    - Winery bears quantity risk (and quality risk to some degree)
- Quality
  - Specified in contract
  - Winery can reject

# Contracting

| Variety         | Block | Clone | Rootstock | Estimated Tons | Estimated Tons / Ac |
|-----------------|-------|-------|-----------|----------------|---------------------|
| Cab Franc       |       |       |           |                |                     |
|                 |       |       |           |                |                     |
| <b>Total CF</b> |       |       |           |                |                     |
|                 |       |       |           |                |                     |
| Zinfandel       |       |       |           |                |                     |
|                 |       |       |           |                |                     |
| <b>Total Z</b>  |       |       |           |                |                     |

|      | Minimum | Target | Maximum |
|------|---------|--------|---------|
| Brix |         |        |         |
| Acid |         |        |         |
| pH   |         |        |         |

# Contracting

- Repeat game
- Winery rejects grapes if the expected cost of damaging brand (reduction of NPV of brand equity) due to smoke taint (or other quality defects) exceeds expected loss of not producing current vintage of wine
  - If grower disagrees with rejection, quality is assessed by third-party with winery fee liable for evaluation

# Insurance

- RMA
- Based on producers actual production history (APH)
  - Rolling average (min of 4 yrs. – max of 10 yrs.)
- Coverage rates: 50 - 85%
- Growers can't cherry pick coverage
  - Must insure all acres of same varietal within the county at same coverage level

# Insurance

- Is smoke taint is covered?
  - Some growers do not have insurance
  - Seeking compensation under the Wildfires and Hurricanes Indemnity Program (WHIP)
  - Those that do have insurance missed the window to file:
    - RMA requires notice of loss within 72 hours of the event causing the damage
    - Must prove smoke taint through independent laboratory tests screening for “elevated levels” of guaiacol and 4-methylguaiacol
    - Provide a rejection letter from the contracted winery stating the reason for rejection or price reduction (Pregaman and Courtney, 2018)

# Insurance

- Statewide 75% of vineyards insured (Farm Bureau)
- 61% Lake County (Farm Bureau)
- 70% of Napa acreage is insured (AgCredit)

# Methods

- Formalize the repeat game between growers and using game theory
- Model the value of insurance for protecting against losses due to smoke taint
  - 2 price (quality) distributions
    - No smoke
    - Smoke – lower mean; skewed toward lower prices; leptokurtotic (fatter tails); inferior distribution (stochastically dominated)

# Methods

- Use Hyperbolic Sine (IHS) transformation to normality introduced by Moss and Shonkwiler (1993)
  - Modification of the transformation introduced by Burbidge, Magee, and Robb (1988)

$$f(x, \mu, \theta, \sigma, \psi) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(g(x, \theta, \mu) - \psi)^2}{2\sigma^2}\right) \times \frac{1}{\sqrt{1 + (x - \mu)^2 \theta^2}}$$



# Methods

## Non-central moments of the IHS transformation (Moss 2010)

$$m_1(\psi, \theta, \sigma) = \exp\left(\frac{1}{2}\theta^2\sigma^2\right) (\exp(\psi\theta) - \exp(-\psi\theta)) / (2\theta)$$

$$m_2(\psi, \theta, \sigma) = \frac{\exp(2\psi\theta + 2\theta^2\sigma^2) + \exp(-2\psi\theta + 2\theta^2\sigma^2) - 2}{4\theta^2}$$

$$m_3(\psi, \theta, \sigma) = \frac{\exp\left(3\psi\theta + \frac{9}{2}\theta^2\sigma^2\right) - 3\exp\left(\psi\theta + \frac{1}{2}\theta^2\sigma^2\right) + 3\exp\left(-\psi\theta + \frac{1}{2}\theta^2\sigma^2\right) - \exp\left(-3\psi\theta + \frac{9}{2}\theta^2\sigma^2\right)}{8\theta^3}$$

$$m_4(\psi, \theta, \sigma) = \frac{(6 + \exp(-4\psi\theta + 8\sigma^2\theta^2) - 4\exp(-2\psi\theta + 2\theta^2\sigma^2) - 4\exp(2\psi\theta + 2\theta^2\sigma^2) + \exp(4\psi\theta + 8\sigma^2\theta^2))}{16\theta^4}$$

# Methods

- Estimating distribution of prices with smoke:
  - Could use observed prices – but we don't have price data
  - So take variation of the distribution function around the estimated parameters
    - Similar to mean-preserving spreads developed by Rothschild and Stiglitz (1970)

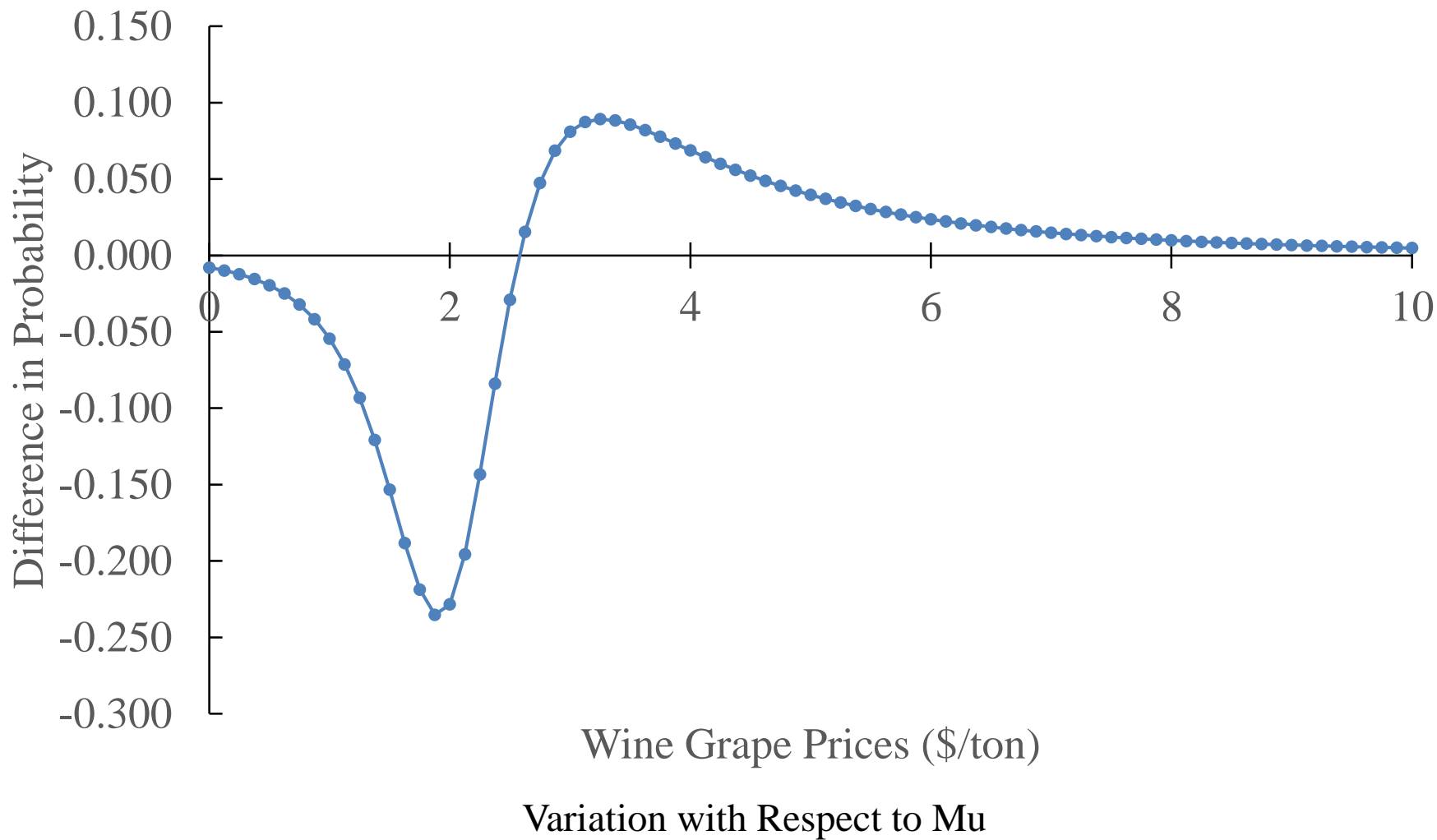
$$\delta f(x, \mu, \theta, \sigma, \psi) = \frac{\partial f(\cdot)}{\partial \mu} \Big|_{\mu=\hat{\mu}, \theta=\hat{\theta}, \sigma=\hat{\sigma}, \psi=\hat{\psi}} (\mu - \hat{\mu}) + \frac{\partial f(\cdot)}{\partial \theta} \Big|_{\mu=\hat{\mu}, \theta=\hat{\theta}, \sigma=\hat{\sigma}, \psi=\hat{\psi}} (\theta - \hat{\theta}) + \frac{\partial f(\cdot)}{\partial \sigma} \Big|_{\mu=\hat{\mu}, \theta=\hat{\theta}, \sigma=\hat{\sigma}, \psi=\hat{\psi}} (\sigma - \hat{\sigma}) + \frac{\partial f(\cdot)}{\partial \psi} \Big|_{\mu=\hat{\mu}, \theta=\hat{\theta}, \sigma=\hat{\sigma}, \psi=\hat{\psi}} (\psi - \hat{\psi})$$

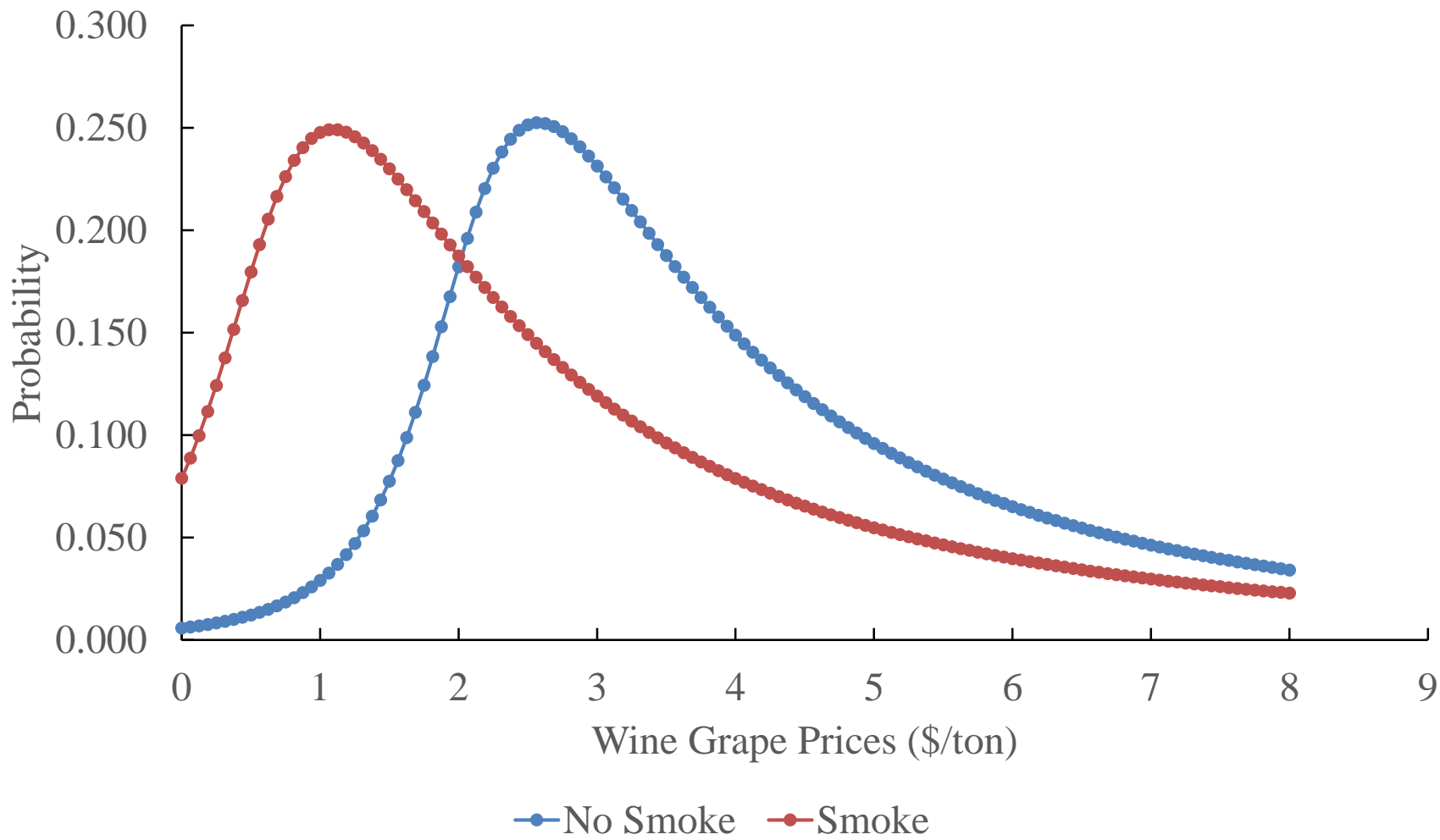
# Methods

- Mean = 5.895 (in thousands)
- Variance =  $(1.35 \text{ Mean})^2 = 63.3337$
- Skewness =  $1.05 \text{ Variance}^{(3/2)} = 1,019.98$
- Kurtosis =  $3.75 \text{ Variance}^2 = 36,077.3$

| Parameter | No Smoke | Smoke   |
|-----------|----------|---------|
| Mu        | 2.01828  | 0.52985 |
| Delta     | 1.23926  | 1.25236 |
| Sigma     | 1.01269  | 1.04361 |
| Theta     | 1.23203  | 1.19440 |

- Coverage Rate 2.54266 (85% coverage)





# Results

- Price 1 (Insurance Price for Original Distribution) = 0.156014
- Price 2 (Value of Insurance under Shifted Distribution) = 1.19033
- Price 3 (Value Recognizing a Probability of Smoke) = 0.371497

# Conclusion

- Insurance is valuable if a loss of quality due to smoke taint
- Smoke taint is rare but widespread when it occurs
- Smoke taint is hard to detect
  - Grower bears the risk that winery will reject grapes; hence do not always report when they should

# Questions





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## Food and Resource Economic Department (FRED)



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