

Misstructured Subsidies in Pasture, Range, & Forage Insurance

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Pasture, Range, & Forage Insurance

- Rainfall insurance for grazing/haying lands
- If it rains less than your coverage level in the timeframe you're covered, you get paid
- Your premium is based on the county base production value of your land in the time frame you insure and your coverage level
- Your payment is based on your county's base production value, coverage level, and the historical average rainfall in your "grid"

PRF within Crop Insurance landscape

- In traditional crop insurance products (YP, RP), you insure **OUTPUT**, or the **Product Itself**
 - YP: **Yield Guarantee** – threshold of crop production below which you receive compensation
 - RP: **Revenue Guarantee** – threshold of crop revenue below which you receive compensation
 - Main difference b/w: YP insures 1 of 2 income determinants, RP insures composite of both
- It's more difficult to insure pasture, range, or forage (henceforth, “forage”) directly because of how production is measured

Trad Crop Ins: You insure what pays you



PRODUCT

\$\$\$



POS

Insurance
Policy

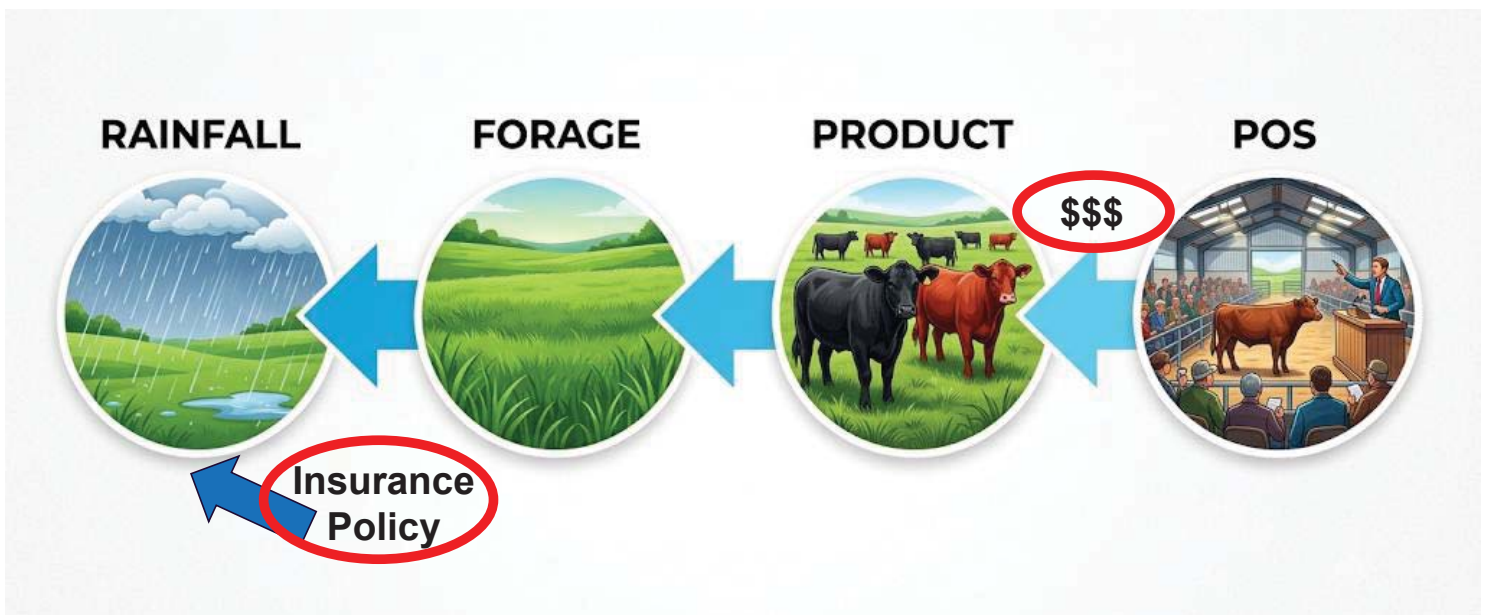


PRF within Crop Insurance landscape

- You're not insuring forage, but **RAINFALL**
 - Insurance product assumes rainfall is forage's only meaningful **Limiting Production Factor** (factor constraining production potential)
 - It is an important limiting factor, but it's **not the only one**, and it's **not uniform**
- Let's think about all the permutations of income variation sources:
 - POS: price, cwt (product)*
 - Product: forage, other
 - Forage: rainfall, other
 - Even if "other" is lumped as a single source of variation, there are eight income variation sources: PRF insures **One**
 - Whereas price effect on income scales linearly with yield and vv. In YP & RP, distribution of rainfall, effect of rainfall on forage, and effect of forage on product, all affect income **nonlinearly**, despite linear insurance measures

*You can also use PRF to insure hay production, in which case rainfall is only once-removed from the product, causing one power fewer sources of income variation.

PRF: You insure a twice-removed production factor



PRF Product Design - Measurement

- The factor PRF insures –rainfall— is measured as an index based on **Historical Index (HI)** within a two-month time period
 - Ex. If the 2-mo. period of May-June historically averages 10” of rainfall, then in that period, HI: 10” = 100%.
 - If that period gets 8” in a certain year, then the **Actual Index Value (AIV)** for that year would be (8”/10”) = 80%.
 - HI’s for each period are based on geographic **Grids**, which are 0.25° latitude by 0.25° longitude
 - At KS latitudes, these are 17.3 miles N to S, and between 13.3 (at N border) and 13.8 miles W to E (at S border)
 - About 230 sq. mi., or about 1/4 to 1/3 the size of a KS county
 - Do **not** follow any political boundaries (state, county, etc.)

Actual Rainfall Indices Example

Wed Oct 01 2025 13:58:32 GMT-0500 (Central Daylight Time)												
Location Information												
State	County	Grid										
Kansas	Barton	22327										
Index Values												
Year	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	
2025	67.3	17.3	87.7	126.5	119.4	127.2						
2024	142.5	47.4	12.6	50.3	82.2	79.6	117.4	114.9	47.8	194.1	260.3	
2023	60.3	23	35.1	59.6	112.4	138.7	115.8	84.4	58.6	100.7	171.9	
2022	30.8	68.4	55.1	114.6	148	110.6	48.6	31.8	44.5	40.3	75.7	
2021	77.5	162.1	165.7	114.6	95.7	51.6	88.4	147.7	135	81.8	10.3	
2020	246.2	108.1	46.4	70	97.9	154.2	131.5	60.2	42	64.6	122.3	
2019	142.1	101.8	83.5	237.2	214.3	64.9	136.1	167.5	51.8	44	134.7	
2018	27	55.2	64	89.4	90.4	107.1	143.4	140.8	247.4	268.6	168.3	
2017	19.1	81.8	181.4	172.9	99.8	42.5	51.2	92.9	146.8	125.5	8.7	
2016	70.1	42	178.4	181.1	94.5	102.2	158.4	153.2	80.1	38.2	62.3	
2015	56.6	30.7	53.1	157.3	129.2	89.7	95	59.6	53.5	130.3	293.5	
2014	43.3	26.3	28.9	46.6	141.8	148	74.2	136.5	159.7	92.2	70.3	
2013	251.4	129	66.5	102.6	110.1	175.5	210.7	147	103	88.5	50	
2012	90.5	108.1	112.9	63.3	43.7	48.3	72.8	90.9	58.4	92.3	106.9	
2011	85.1	80.6	59.8	80.6	67.9	41.7	86.3	91.9	54.1	103	234.3	
2010	66.7	86.9	103.8	102.2	92.8	104.7	95.1	82.6	60.9	84.9	139	
2009	30.3	73.3	134.1	100.4	78.7	101.3	127.5	137.4	133.8	118.6	84.7	
2008	124	81.2	96.3	117.2	121.8	119.6	129.4	139.5	180.2	213.1	83.2	
2007	203.5	211.9	176.6	294.4	246.9	126.9	146.5	165.6	145.3	66.6	194.6	
2006	5.7	52.8	92.8	67.2	73	76	131.4	167.5	86.6	49.2	180.6	
2005	206.5	130.3	101.2	61.1	74.5	93.7	88.6	81	60.2	82.6	75.3	
2004	92.7	162.8	153.3	87.4	97.4	126.3	87.8	88.6	118.7	116.1	106.8	
2003	90.2	211.5	187.7	98.3	68.2	35.3	71.6	134.2	91.8	47.9	97.9	
2002	83.4	49.1	64.8	85.4	83.1	60.4	86.1	96.4	175.5	219.4	13.9	
2001	350.3	183.2	88.3	112.1	114.1	104.8	101.5	149.8	144.9	43.9	17.6	
2000	224.6	282	175.5	83.4	92.6	112.8	69.8	11.6	104.9	163.5	79.8	
1999	144.2	48.5	124.6	138.8	123.9	129.6	122	93.6	38.6	8.8	52	
1998	177.3	202.7	139.5	62	61.2	140.5	135.8	64.6	126.4	256.8	220	
1997	124.9	69.2	45.3	70.2	81.7	88.2	130.2	159.4	133.5	103.9	104.2	
1996	50.8	65.6	69.3	130.5	142	104.4	122.2	157	111.9	101	123.3	
1995	70.1	67.8	95.7	214.2	168	59.6	69.4	80.8	53	12.4	24.6	

PRF Product Design - Selections

- You choose: Intervals, Coverage Level, and Productivity Factor
- Coverage is for 2-mo. **Intervals** (e.g., Jan-Feb, Feb-Mar, etc.)
 - Cannot overlap mos. (i.e., no adjacent intervals)
 - Distribute coverage across 2-6 intervals
 - No interval can have more than 60% of coverage share
- **Coverage Levels (CL)** range from 70-90%
 - Subsidy level by coverage level:

• 70%	59%
• 75%	59%
• 80%	55%
• 85%	55%
• 90%	51%
- **Productivity factor** is a weight you select based on how well you think your land performs relative to county average
 - Both premium and indemnity flex based on weights
 - 61-150% of county base production value

PRF Product Design - Payment

- Payment is based on: County Base Value and Payment Calculation Factor
- **County base value** estimates average value of production of grazing/haying lands in your county (e.g., DP = \$52.30/ac, MT = \$27.00/ac, etc.)
 - Dollar amount of protection is county base value times CL (e.g., \$52.30/ac * 70% = \$36.61)
- **Payment Calculation Factor (PCF)** is your payment per dollar amt. of protection, using formula:

$$PCF = \frac{CL - AIV}{CL}$$

- For final payment, multiply PCF by covered Interval share, sum, and multiply by dollar amt. of protection and acres

$$Pmt = \sum (PCF_i * Share\%_i) * (BaseVal * CL) * Ac$$

Payment Calculation Factors Example

← Coverage Intervals →

← Years →

0	0.322857	0.82	0.281429	0	0	0	0	0.317143	0	0
0.138571	0.671429	0.498571	0.148571	0	0	0	0	0.162857	0	0
0.56	0.022857	0.212857	0	0	0	0.305714	0.545714	0.364286	0.424286	0
0	0	0	0	0	0.262857	0	0	0	0	0.852857
0	0	0.337143	0	0	0	0	0.14	0.4	0.077143	0
0	0	0	0	0	0.072857	0	0	0.26	0.371429	0
0.614286	0.211429	0.085714	0	0	0	0	0	0	0	0
0.727143	0	0	0	0	0.392857	0.268571	0	0	0	0.875714
0	0.4	0	0	0	0	0	0	0	0.454286	0.11
0.191429	0.561429	0.241429	0	0	0	0	0.148571	0.235714	0	0
0.381429	0.624286	0.587143	0.334286	0	0	0	0	0	0	0
0	0	0.05	0	0	0	0	0	0	0	0.285714

PRF Product Design - Premiums

- **Premium rates** vary by interval and grid
 - More expensive to insure drier months than wetter months
 - Grid #20224 (BA) @70%CL: Nov-Dec rate = 23.29¢/\$protection;
Jun-Jul rate = 8.58¢/\$protection
 - More expensive to insure drier grids than wetter grids
 - Grid #20516 (SW) @70%CL: Driest interval rate = 29.96¢/\$protection
 - Grid #20840 (CK) @70%CL: Driest interval rate = 14.55¢/\$protection

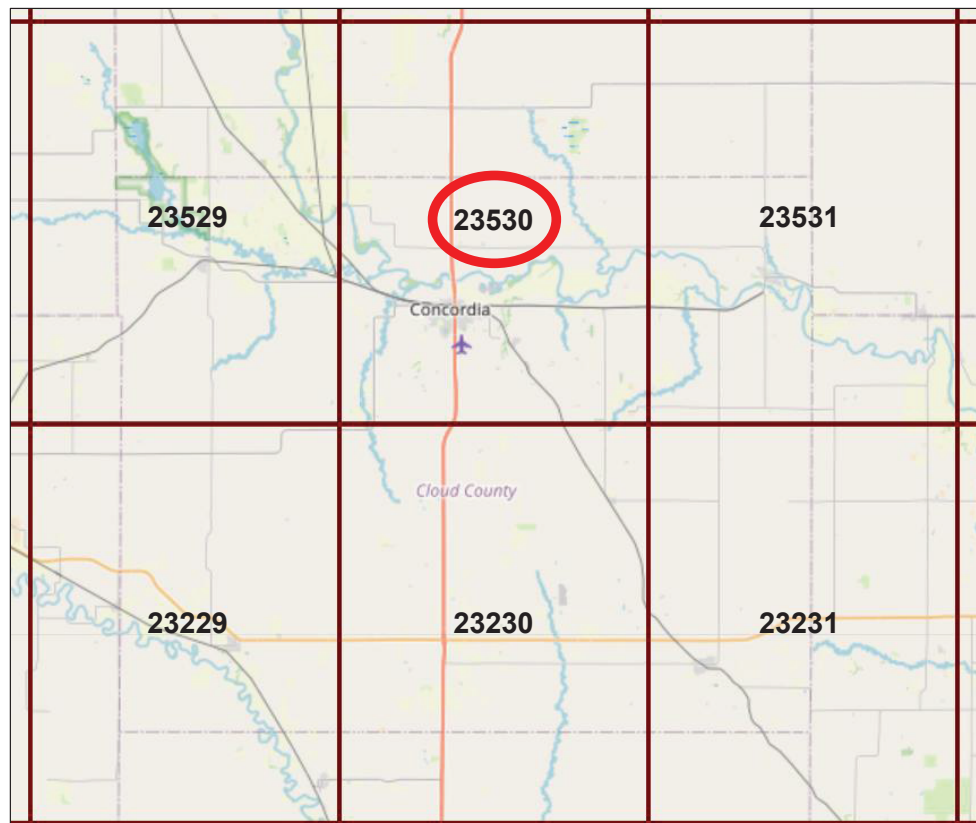
- Premium formula

$$Pmt = \sum (Rate_i * Share\%_i) * (BaseVal * CL) * (1 - SubRate) * Ac$$

- Premium subsidies are structured to produce adverse selection

PRF Selection Example

Cheyenne CN	Rawlins RA	Decatur DC	Norton NT	Phillips PL	Smith SM	Jewell JW	Republic RE	Washington WS	Marshall MS	Nemaha NM	Brown BR	Doniphan DP
Sherman SH	Thomas TH	Sheridan SD	Graham GH	Rooks RO	Osborne OB	Mitchell MC	Cloud CD	Clay CY	Riley RL	Pottawatomie PT	Jackson JA	Atchison AT
Wallace WA	Logan LG	Gove GO	Trego TR	Ellis EL	Russell RS	Lincoln LC	Ottawa OT	Clay CY	Geary GE	Wabaunsee WB	Shawnee SJ	Leavenworth LV
Greeley GL	Wichita WH	Scott SC	Lane LE	Ness NS	Rush RH	Barton BT	Ellsworth EW	Saline SA	Dickinson DK	Morris MR	Osage OS	Franklin FR
Hamilton HM	Kearny KE	Finney FI	Hodgeman HG	Pawnee PN	Stafford SF	Reno RN	Rice RC	McPherson MP	Marion MN	Chase CS	Lyon LY	Coffey CF
Stanton ST	Grant GT	Haskell HS	Gray GY	Ford FO	Kiowa KW	Pratt PR	Kingman KM	Harvey HV	Sedgwick SG	Butler BU	Greenwood GW	Woodson WO
Morton MT	Stevens SV	Seward SW	Meade ME	Clark CA	Comanche CM	Barber BA	Harper HP	Sumner SU	Cowley CL	Chautauque CQ	Montgomery MG	Labette LB



PRF Selection Example

Premium

- County base value: \$49.30/ac
- Coverage level: 85%
- Premium subsidy: 55%
- Intervals
 - Feb-Mar: 30% at 16.11¢/\$protection
 - May-Jun: 40% at 5.34¢/\$protection
 - Sep-Oct: 30% at 10.61¢/\$protection
- $49.3 * 0.85 * (1 - 0.55) * (.3 * .1611 + .4 * .0534 + .3 * .1061) = 1.91$
- \$1.91/ac

Indemnity

- Actual Indices
 - Feb-Mar: 62.5%
 - May-Jun: 98.4%
 - Sep-Oct: 48.1%
- **Payment Calculation Factor (i.e., coverage-weighted rain shortfall)**
 - Feb-Mar: $(85-62.5)/85 = 26.47\text{¢}/\$protection$
 - May-Jun: $(85-98.4)/85 = -15.76\text{¢} \rightarrow (0)$
 - Sep-Oct: $(85-48.1)/85 = 43.41\text{¢}/\$protection$
- $49.3 * 0.85 * (.3 * .2647 + .4 * 0 + .3 * .4341) = 8.78$
- \$8.78/ac
- Net Indemnity = \$6.87/ac

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General Strategy

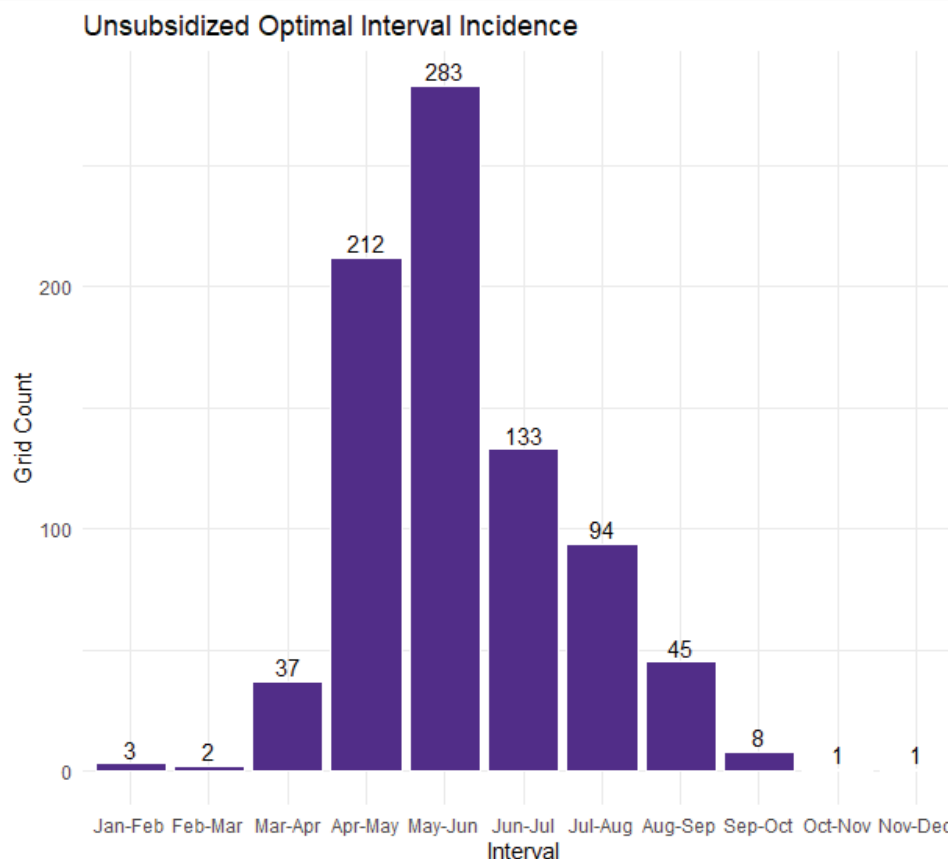
- Example was one grid in one county in one year. There are:
 - 350+ grids in KS
 - 105 KS counties
 - 77 years of available actual rainfall data
- There is a **General Strategy** for choosing policy parameters that:
 - Maximizes **Value** of net indemnity, AND
 - Maximizes **Frequency** of positive net indemnity
- Choose:
 - Highest CL (90%)
 - Highest Productivity Factor (150%)
 - Driest Intervals (Jan-Feb, Nov-Dec)

K-STATE RESEARCH AND EXTENSION

Key Findings

- **Premium Subsidy** makes all the difference in which Interval maximizes net indemnity and maximizes positive net indemnity frequency
- Premium rate per dollar of coverage varies dramatically across coverage intervals because of **annual rainfall distribution**
- Since subsidies are a percent of premium rate, Intervals with higher premium rates will receive **higher gross subsidy** amounts (drier months)
- When magnitude & range of **premiums shrink** but range of indemnities stays constant, there is higher marginal value choosing **higher** expected **indemnity** intervals regardless of premium level (assuming actuarially fair premium rating).
- **Within-interval** historical rainfall **outcomes** are more densely **clustered below CL** in drier months, triggering payment more frequently in those months

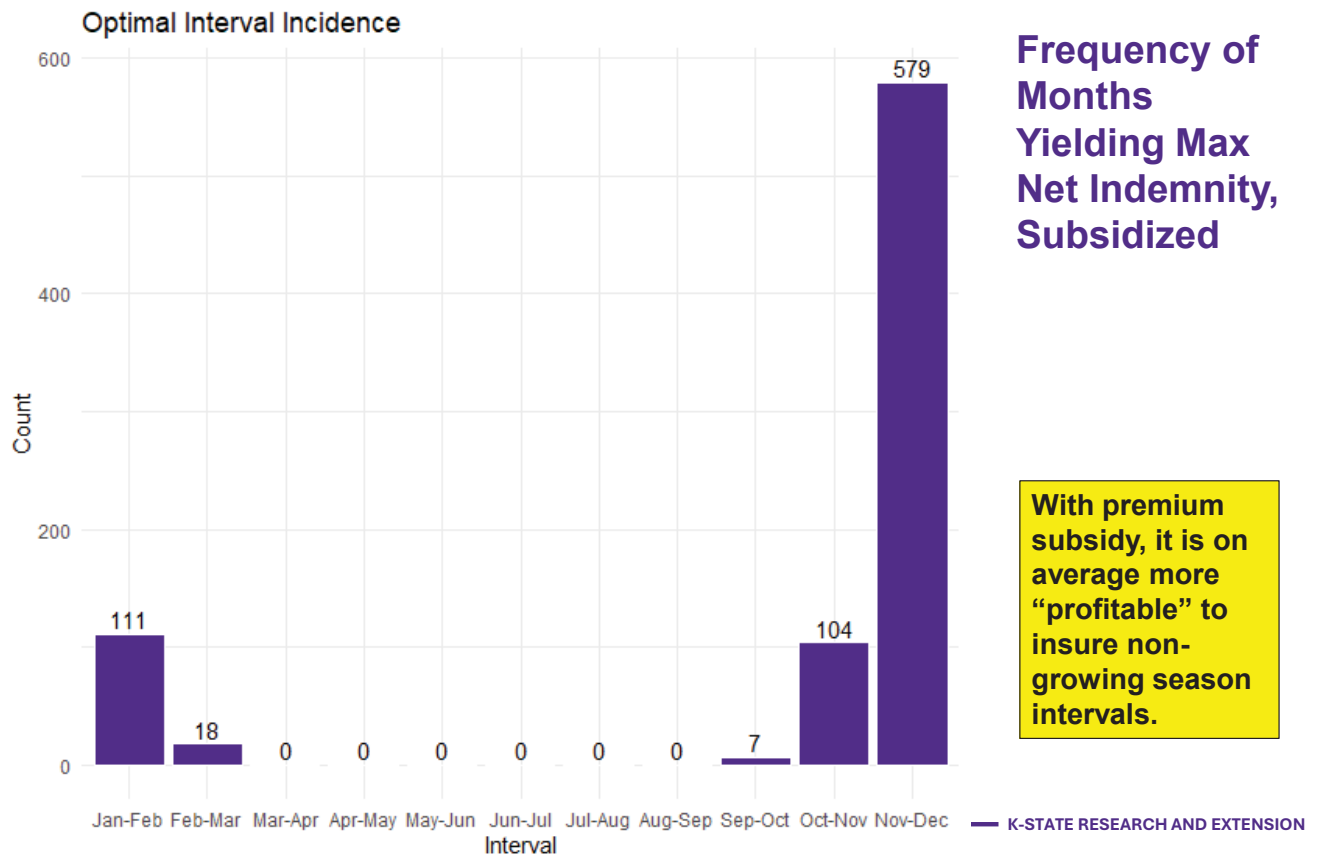
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Frequency of Months Yielding Max Net Indemnity, Unsubsidized

Without premium subsidy, it is on average more “profitable” to insure growing season intervals.

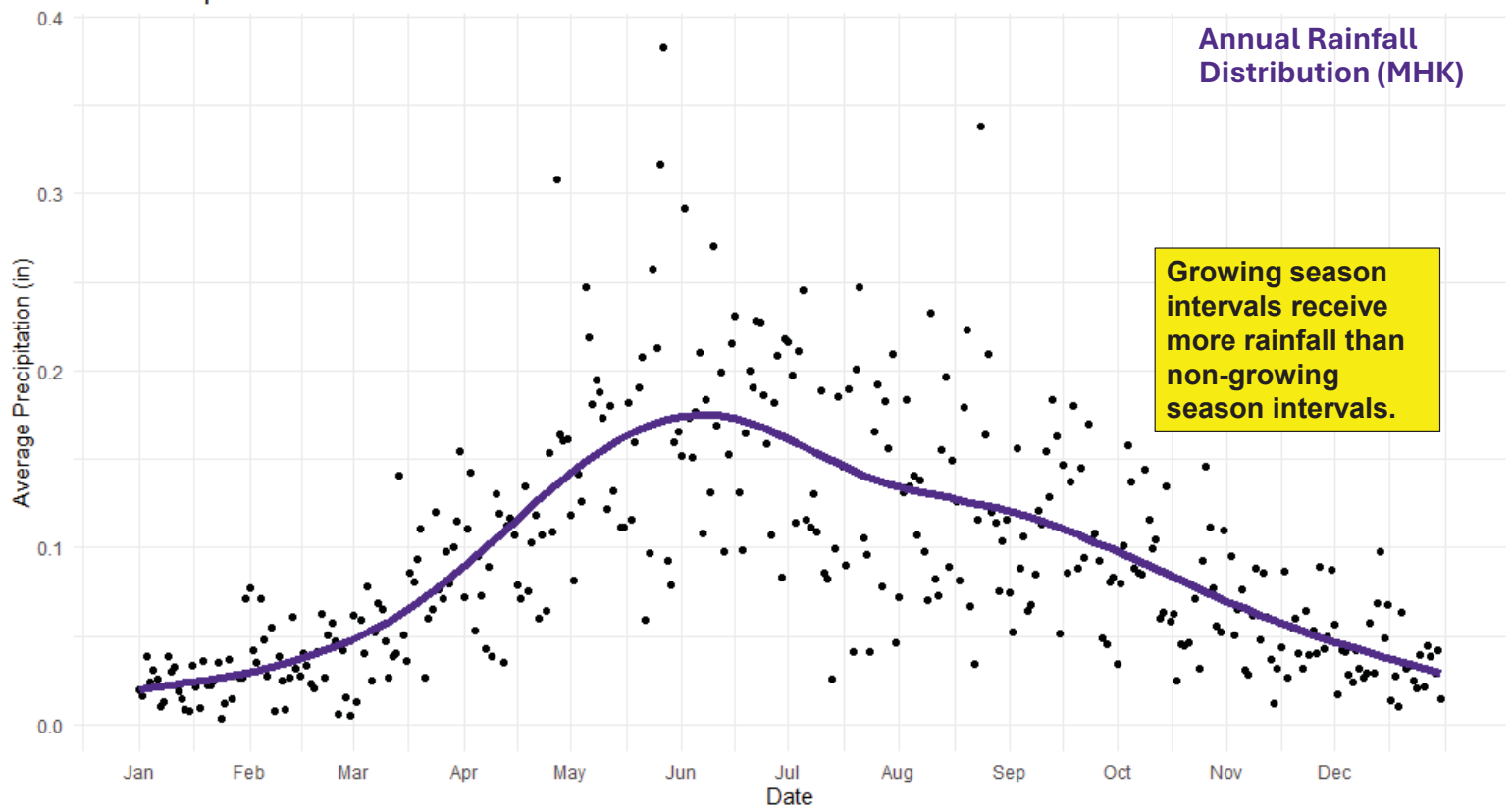
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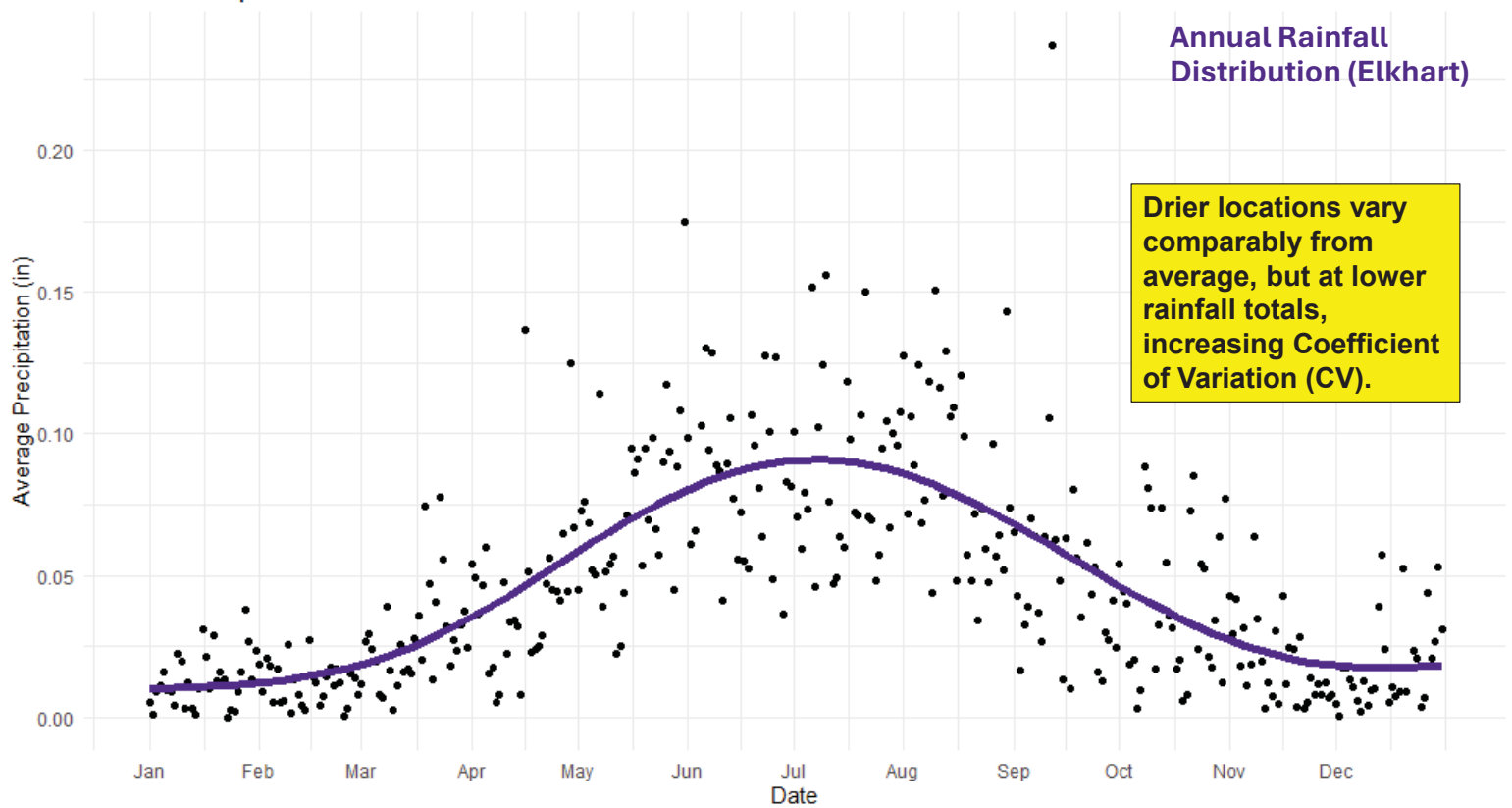
Decomposition #1

Premium rate per dollar of coverage varies dramatically across coverage intervals because of **annual rainfall distribution**

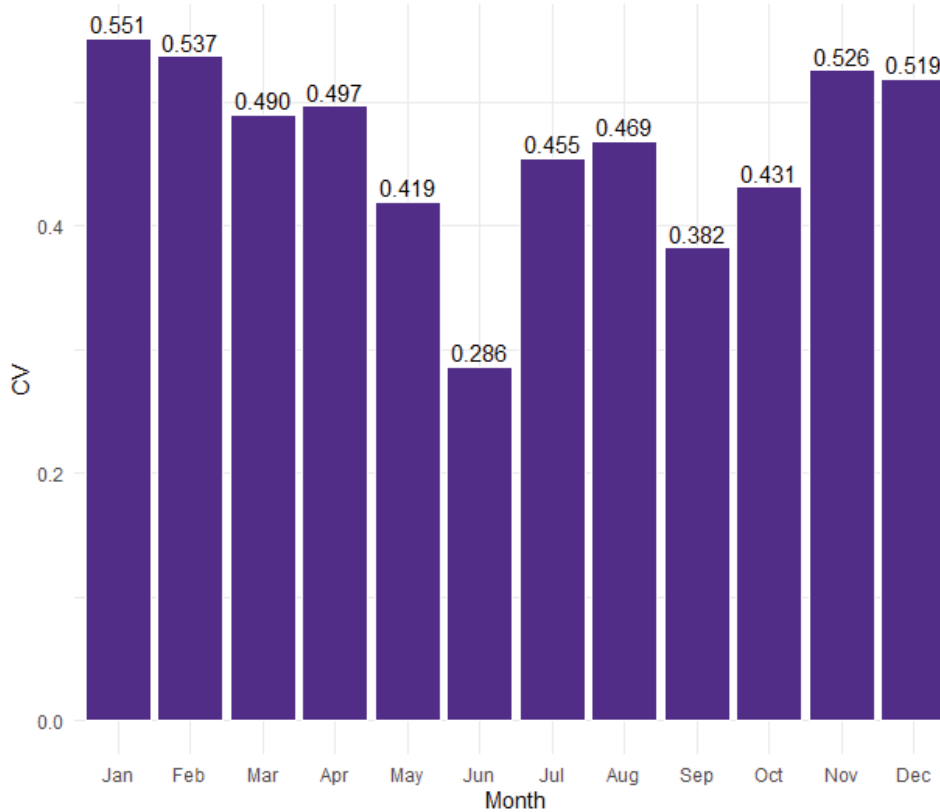
MHK Precipitation Distribution 1981-2025



Elkhart Precipitation Distribution 1981-2025



Monthly Precipitation Coefficients of Variation



Historical Precipitation Coefficient of Variation (Manhattan)

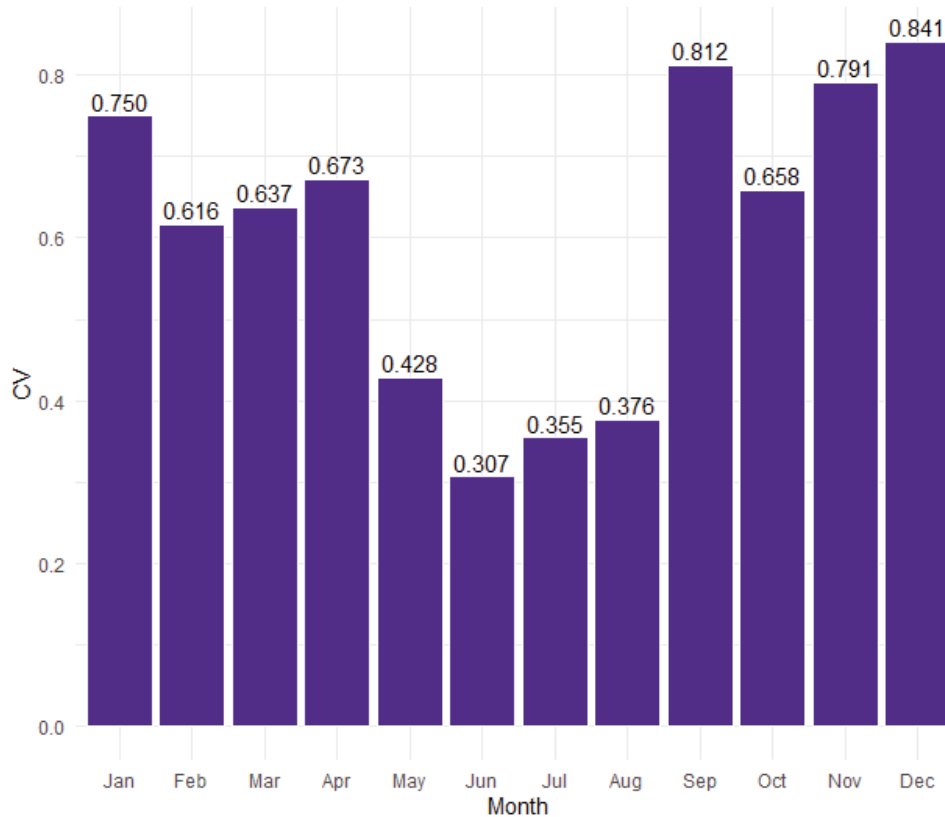
CV= Std. Dev / Mean

Drier intervals have lower mean rainfall but vary more with respect to that mean.

Variation with respect to mean is a key measure of risk.

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Monthly Precipitation Coefficients of Variation



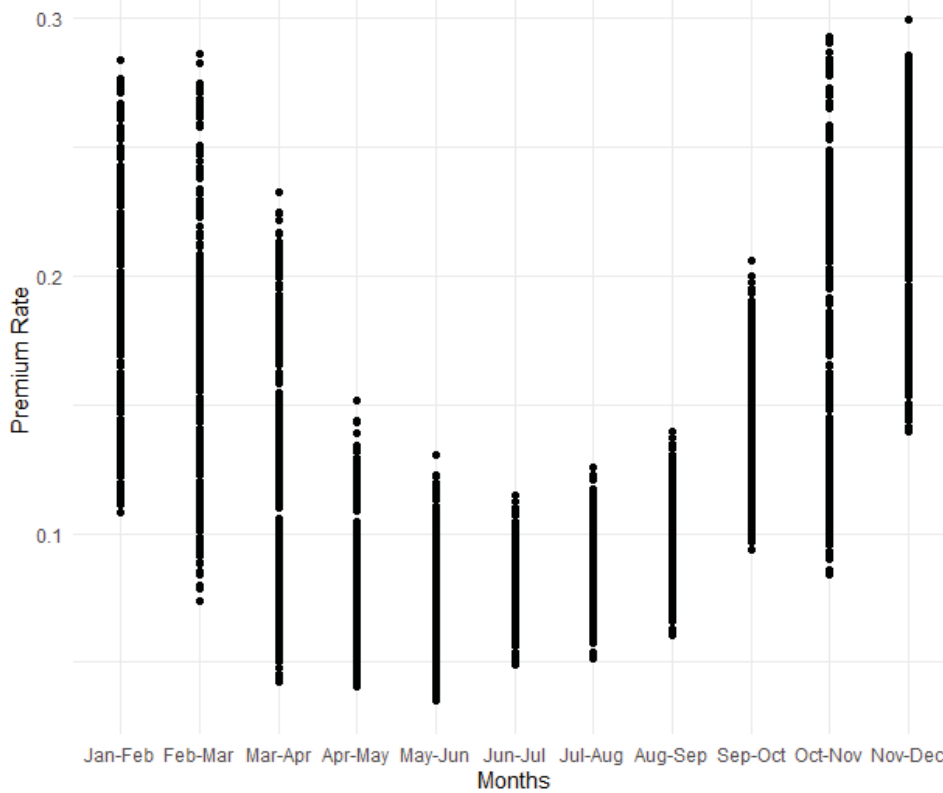
Historical Precipitation Coefficient of Variation (Elkhart)

Insurers (RMA) rate premiums to align with risk measurement (actuarial fairness).

Drier locations often have higher risk, thus higher premiums (per dollar of coverage).

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Premium Rate by Coverage Interval



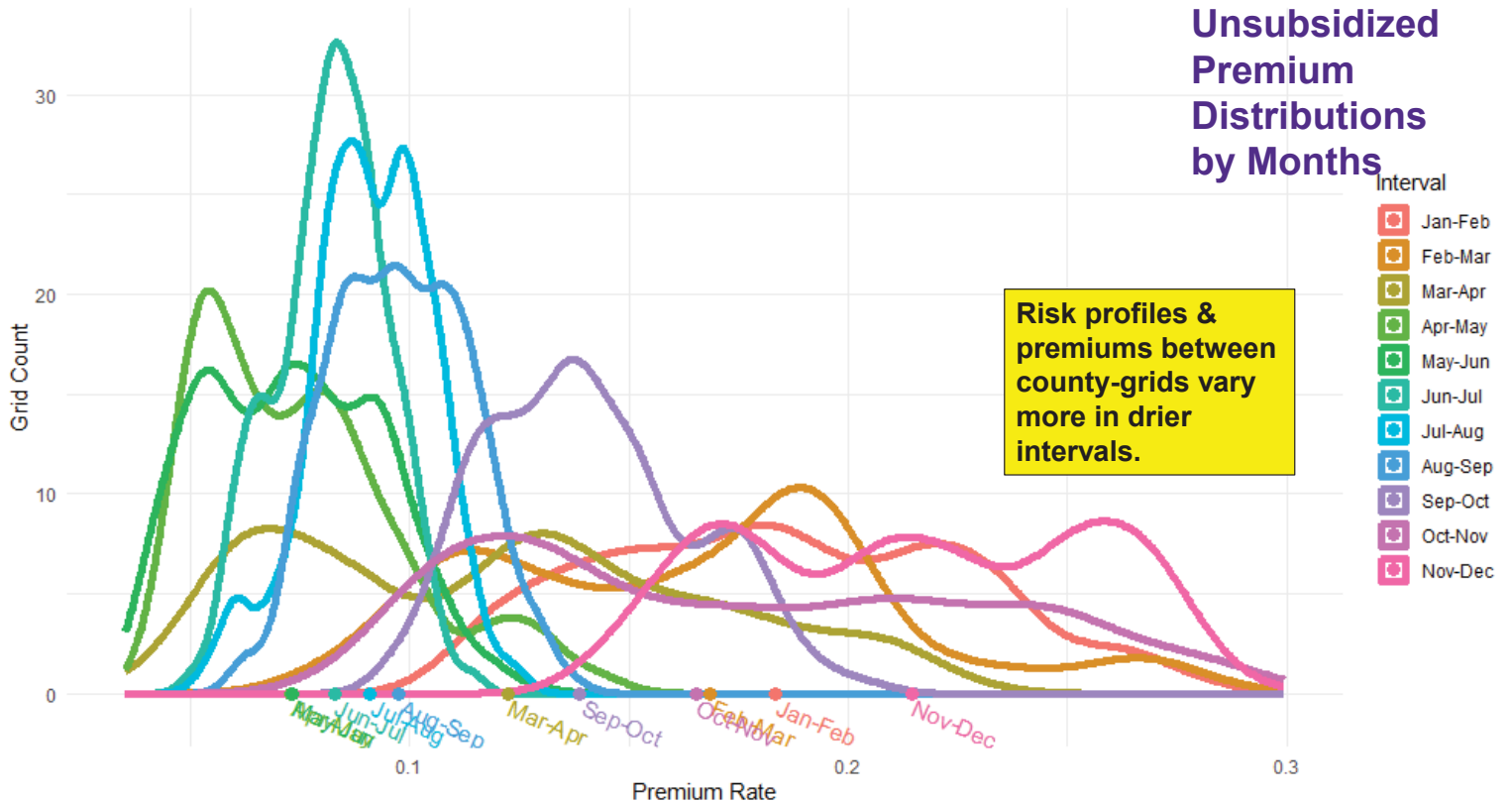
Unsubsidized Premiums by Months

This graph shows all KS county-grids.

Drier intervals often have higher risk, thus higher premiums.

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Distribution of Premium Rates by Interval



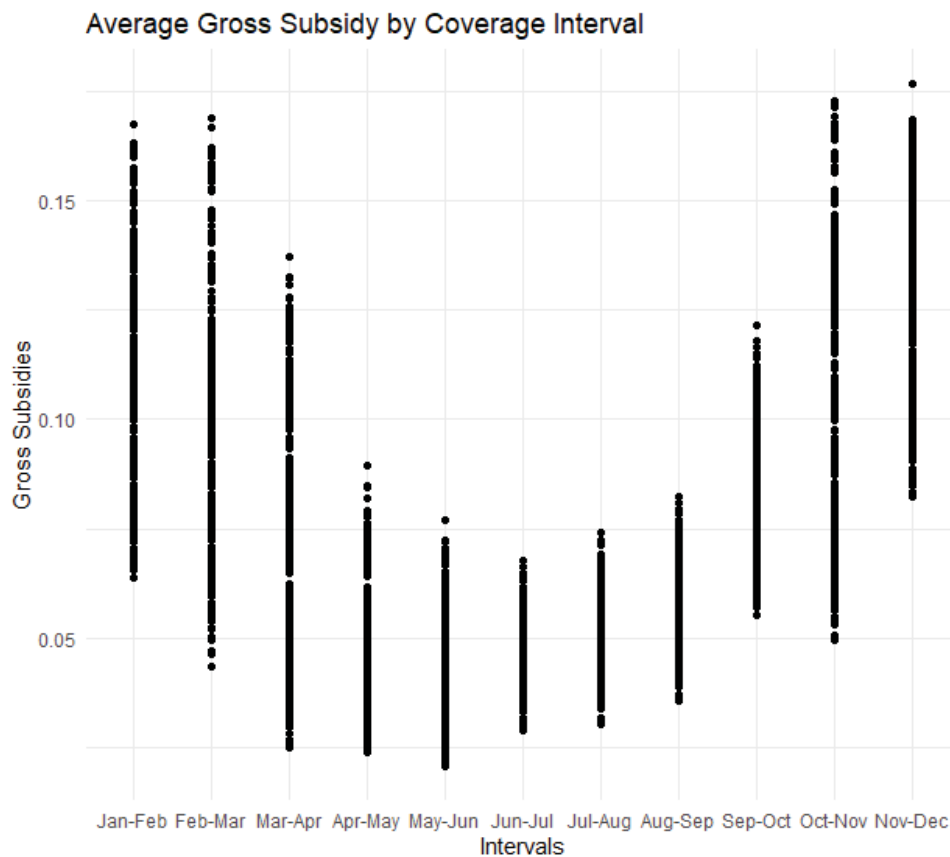
Unsubsidized Premium Distributions by Months

Risk profiles & premiums between county-grids vary more in drier intervals.

Decomposition #2

Since subsidies are a percent of premium rate, Intervals with higher premium rates will receive **higher gross subsidy** amounts (drier months)

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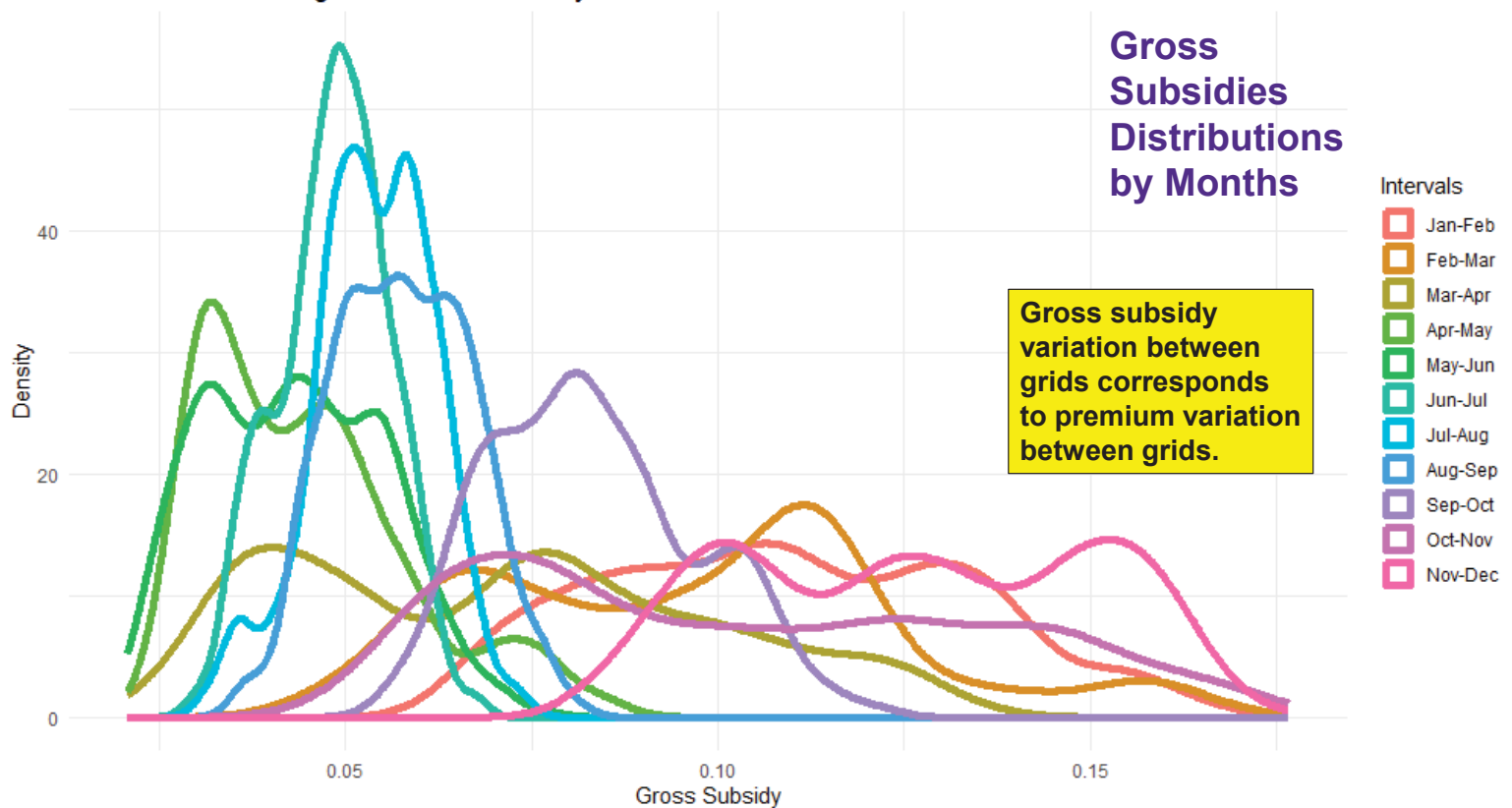


Gross Subsidies by Months

Because subsidies are percent-based, county-grids with higher premiums receive higher gross subsidies.

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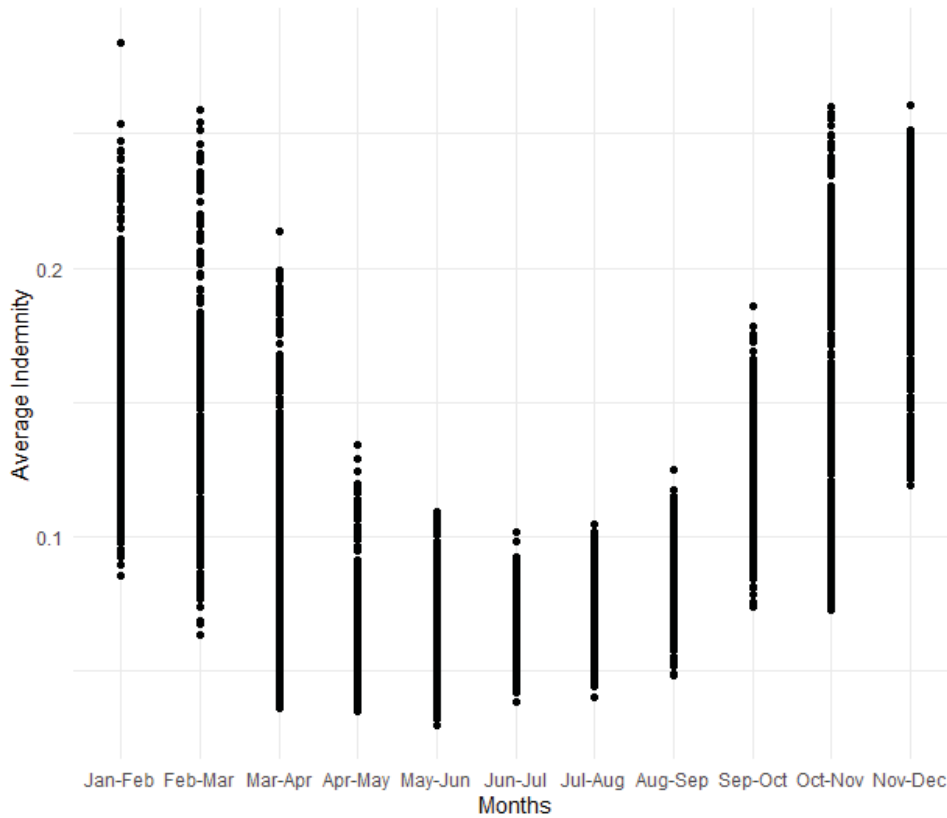
Distribution of Average Gross Subsidies by Interval



Decomposition #3

When magnitude & range of **premiums shrink** but range of indemnities stays constant, there is higher marginal value choosing **higher** expected **indemnity** intervals regardless of premium level (assuming actuarially fair premium rating).

Historical Average Indemnity by Coverage Interval

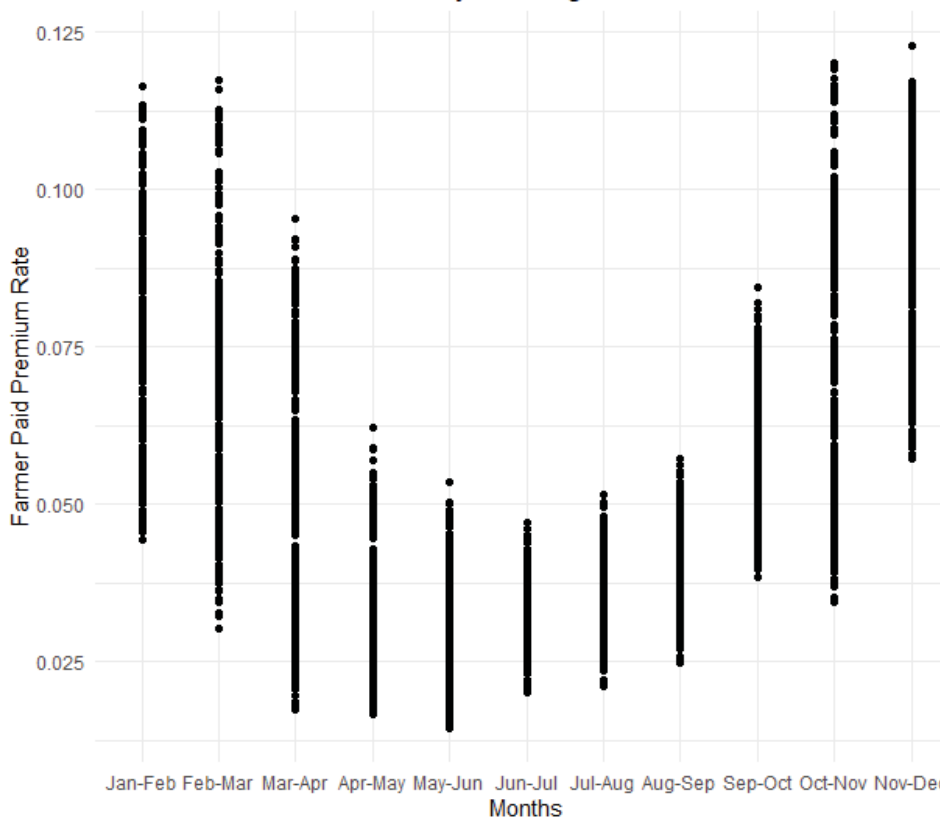


Indemnity by Months

Indemnity is based on rainfall variations, so average gross indemnities follow same patterns as premiums.

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Farmer Paid Premium Rate by Coverage Interval



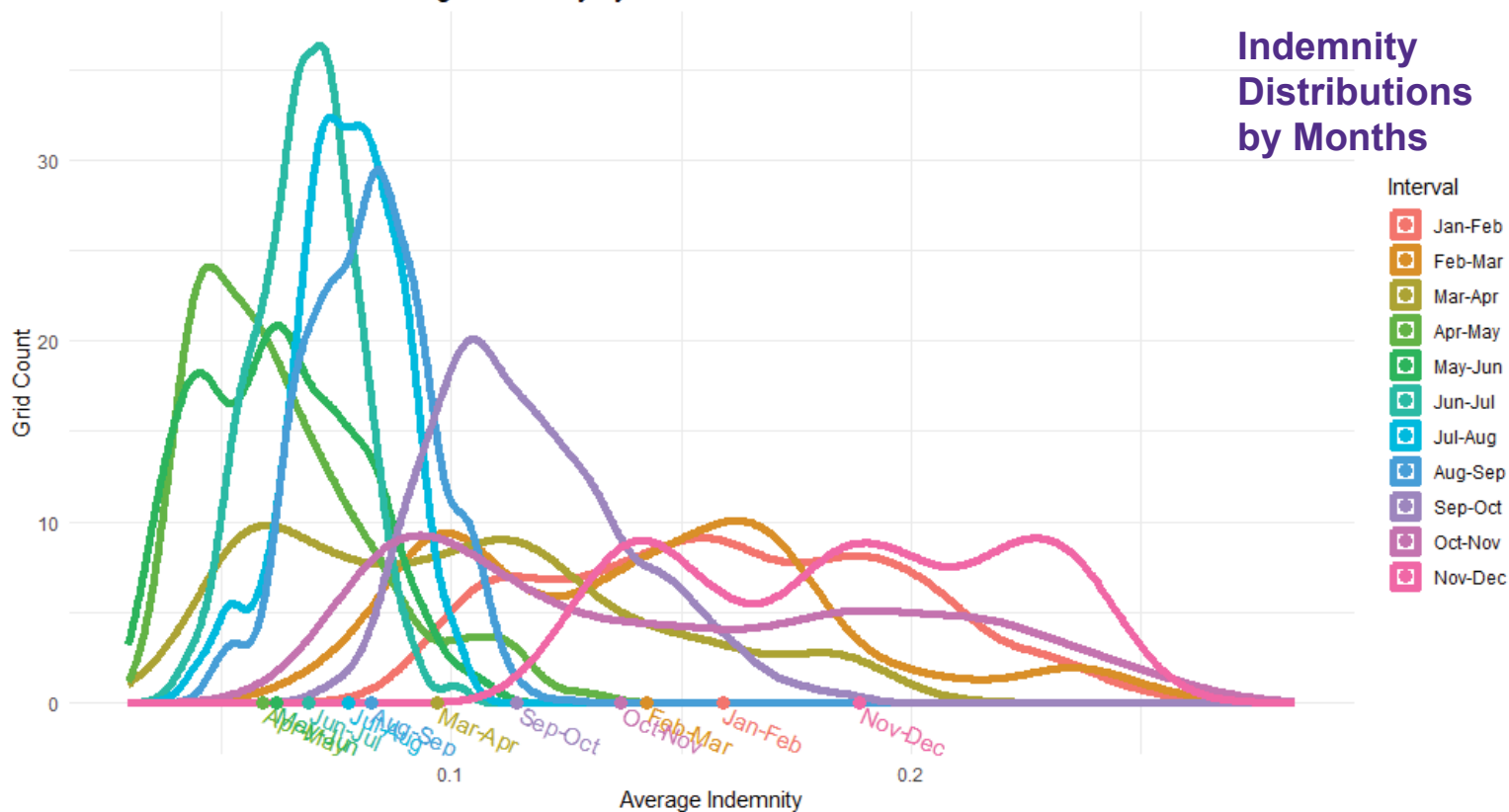
Subsidized Premiums by Months

Farmer-paid premiums have same shape between intervals, but scale is compressed.

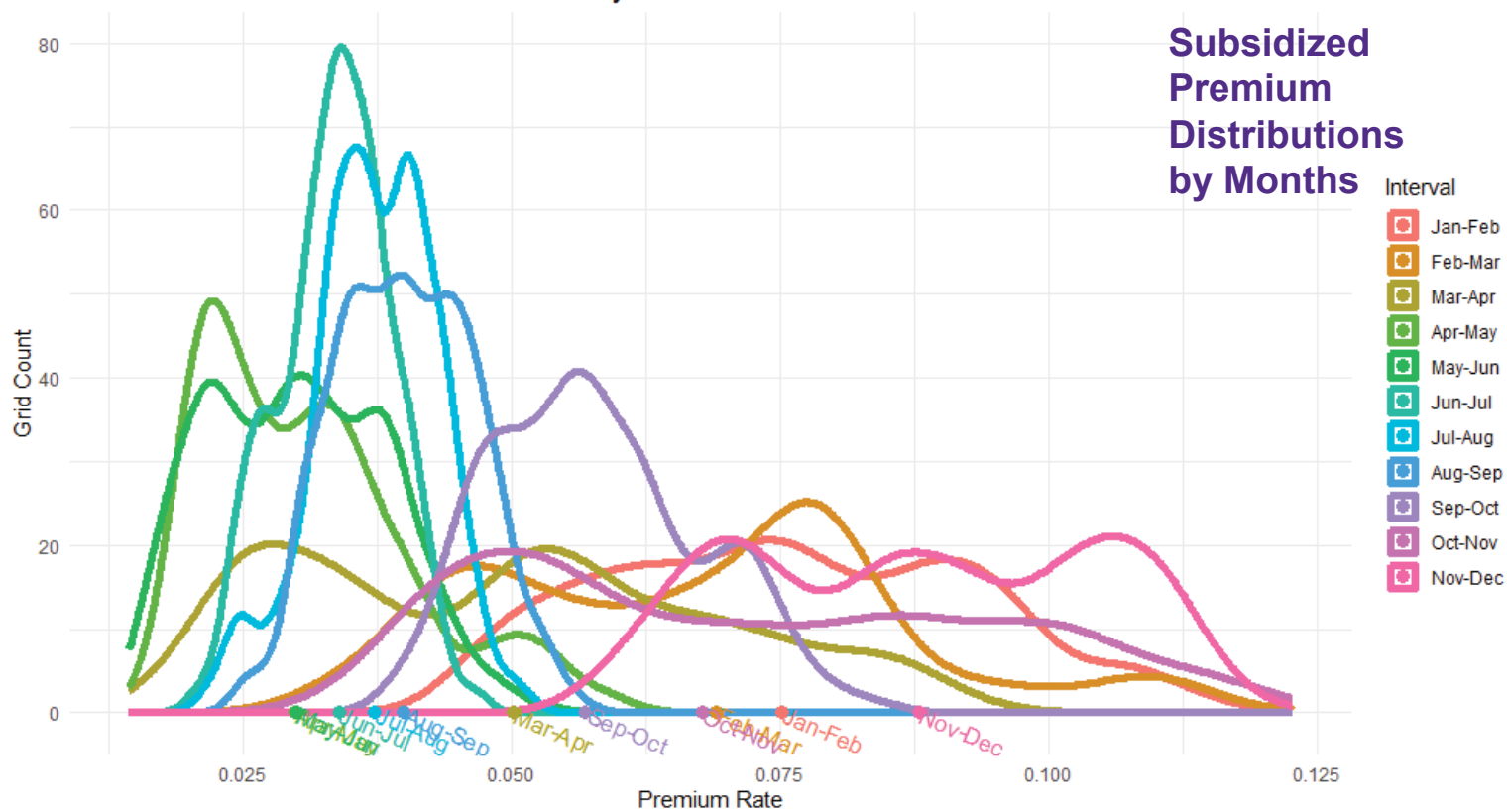
Higher premiums get higher gross subsidies, so drier intervals get premiums reduced by more.

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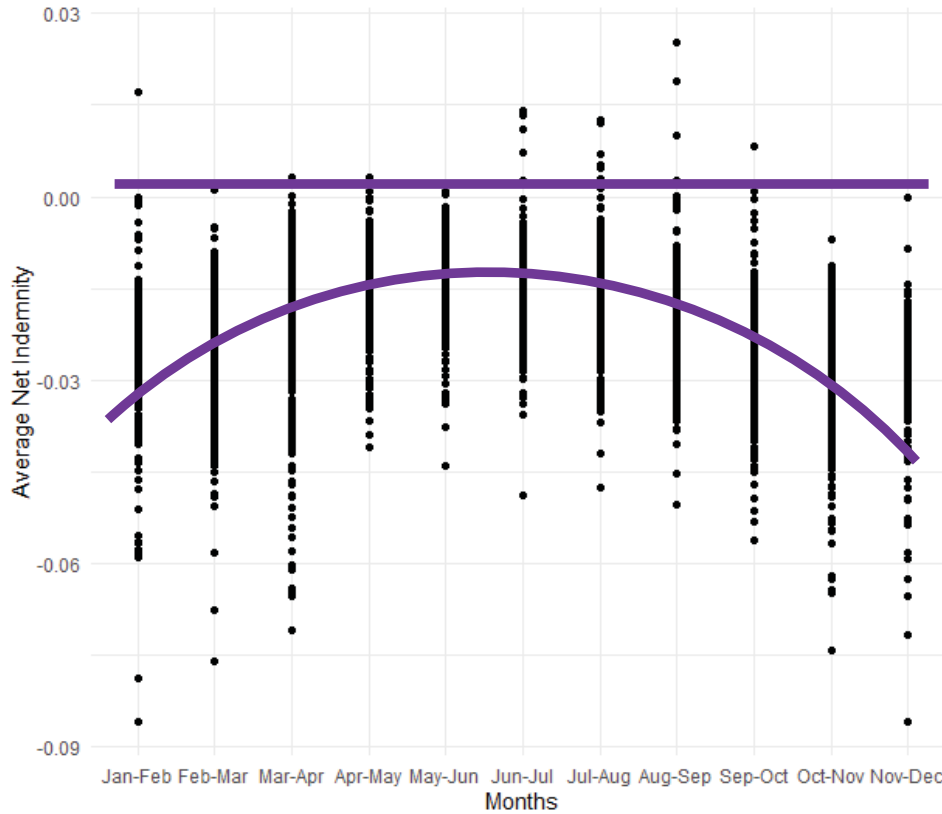
Distribution of Historical Average Indemnity by Interval



Distribution of Farmer Paid Premium Rates by Interval



Net Indemnity by Coverage Interval



Unsubsidized Net Indemnity by Months

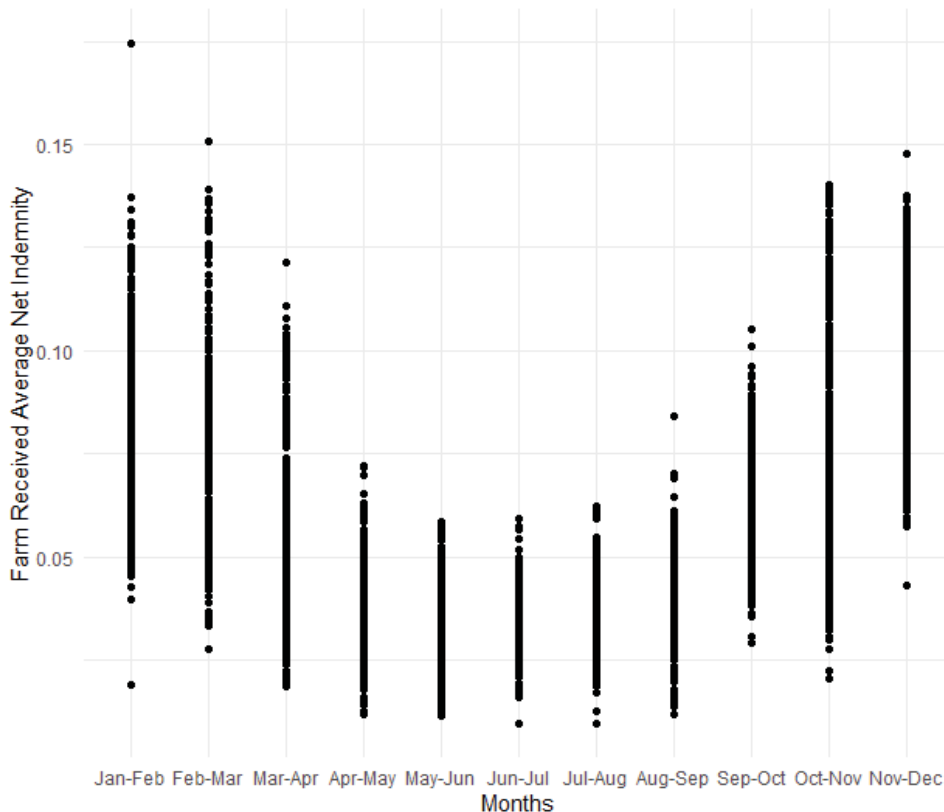
Without subsidy, most grids average a (-) net indemnity (premiums paid > indemnities received) across all intervals.

Wetter, less risky, lower premium, growing season intervals average higher net indemnity.

Compare to with completely actuarially fair premiums.

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Farmer Received Net Indemnity by Coverage Interval



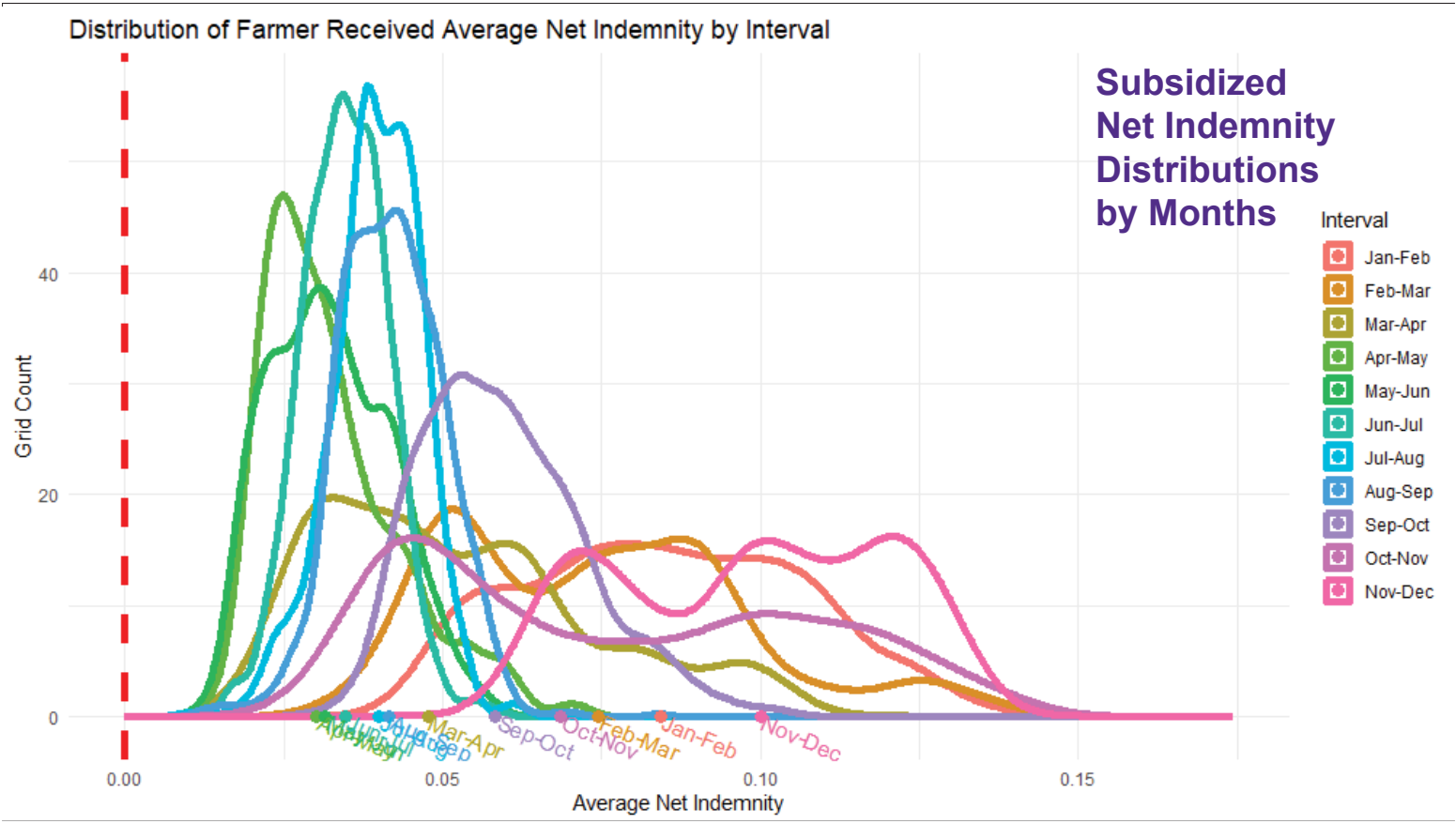
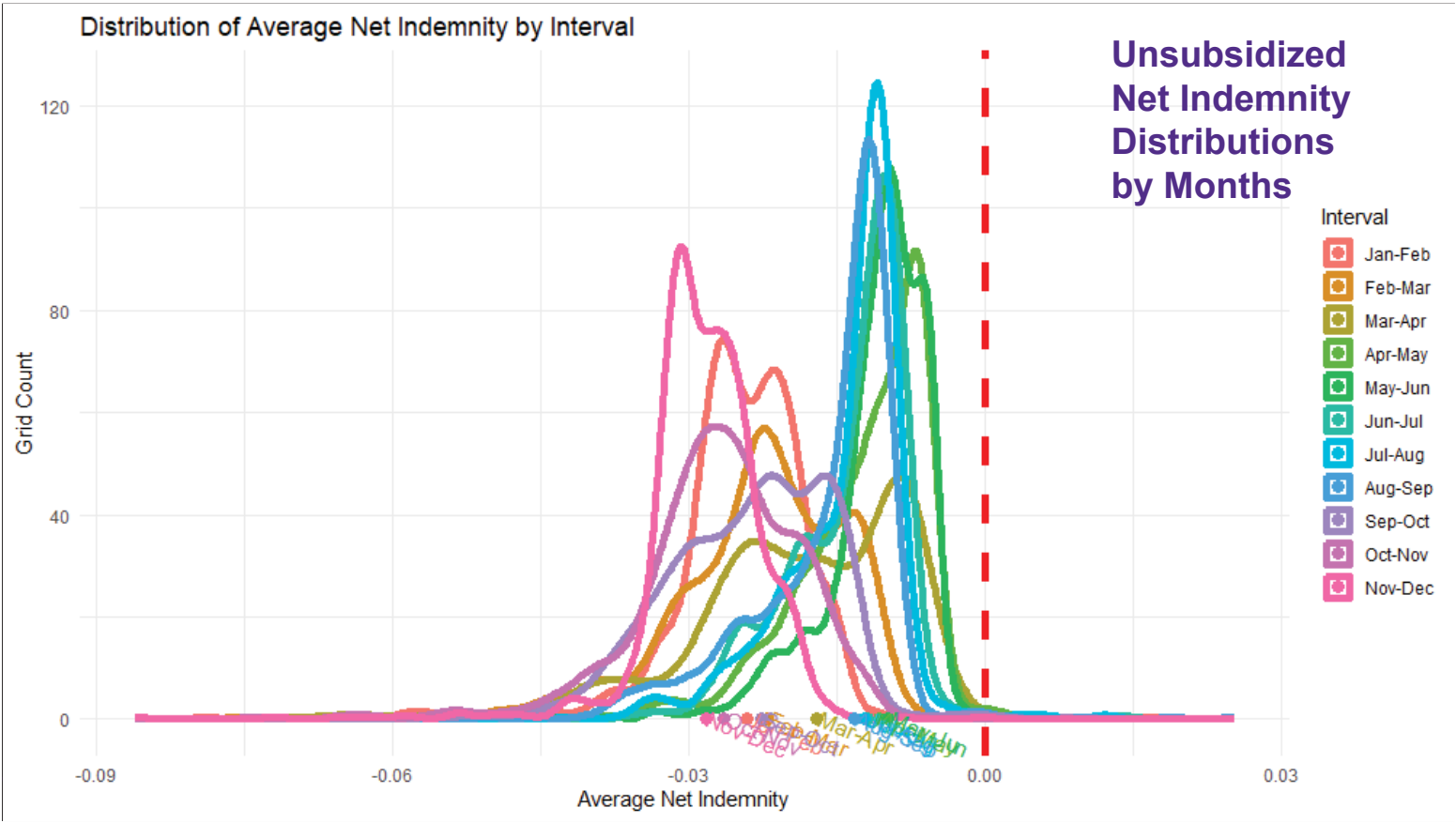
Subsidized Net Indemnity by Months

Drier, riskier, higher premium, non-growing season intervals average higher net indemnity.

Gross indemnity doesn't change, but premium shrinks by more in drier intervals.

With actuarially fair premiums, this happens necessarily.

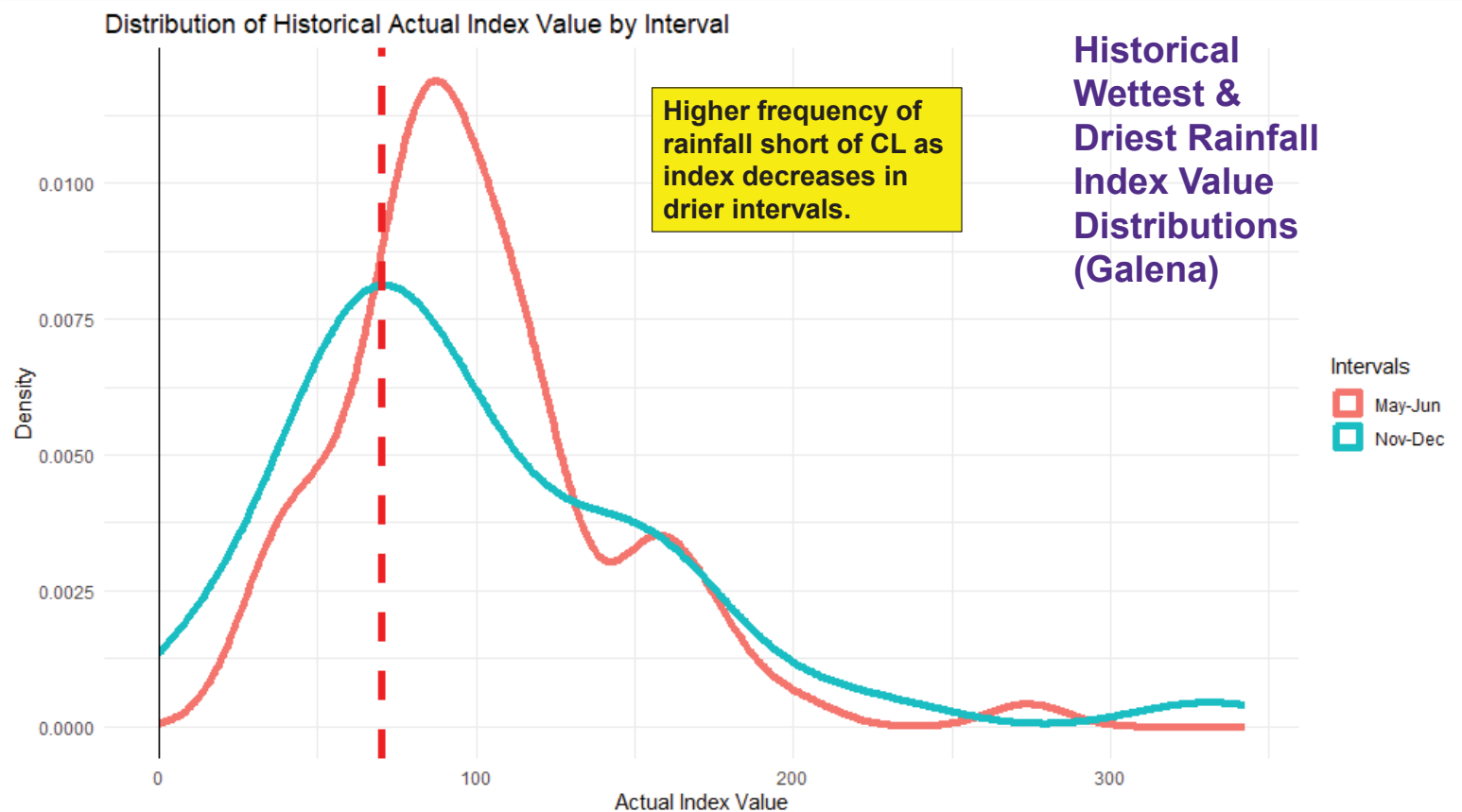
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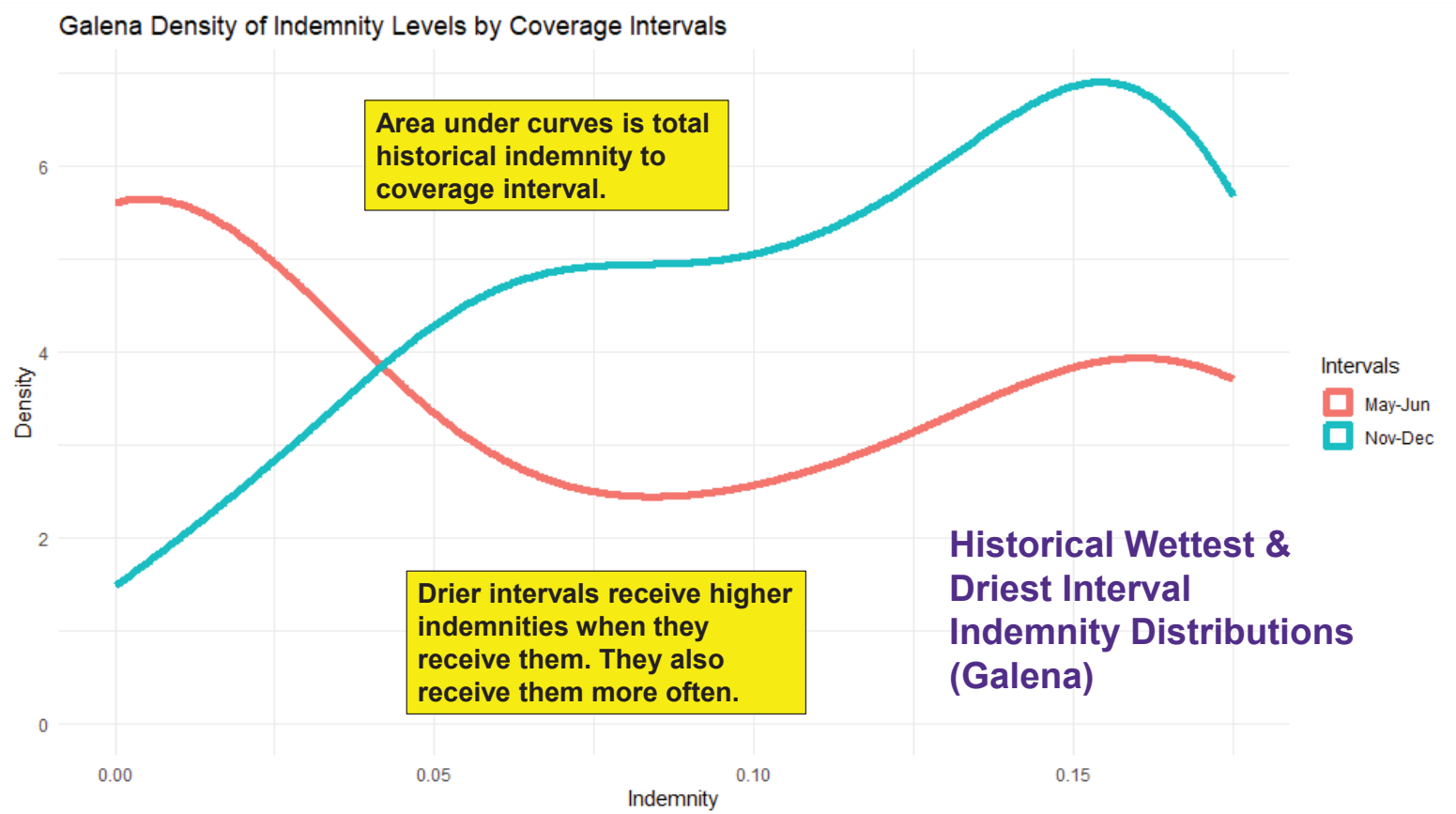
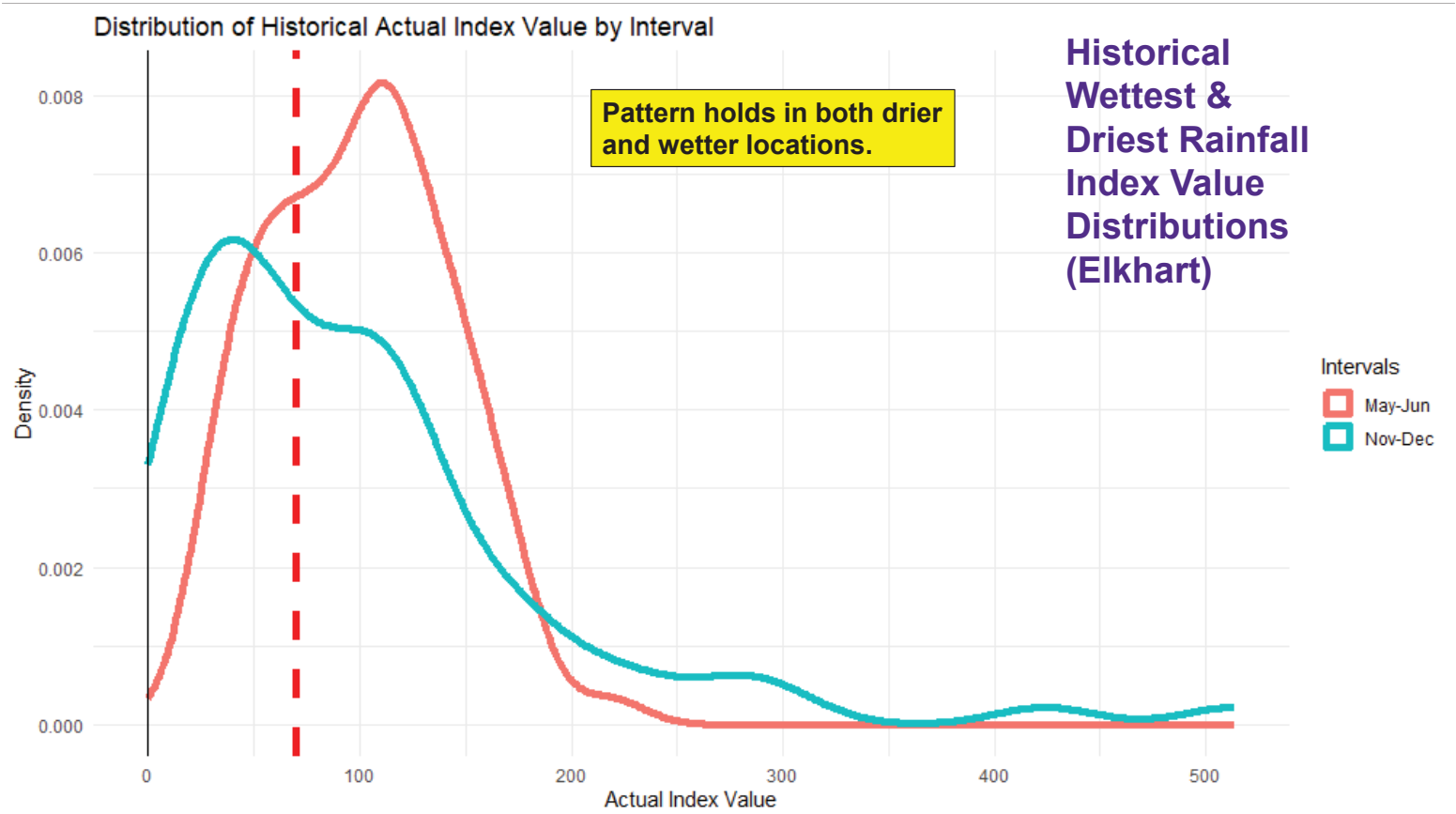


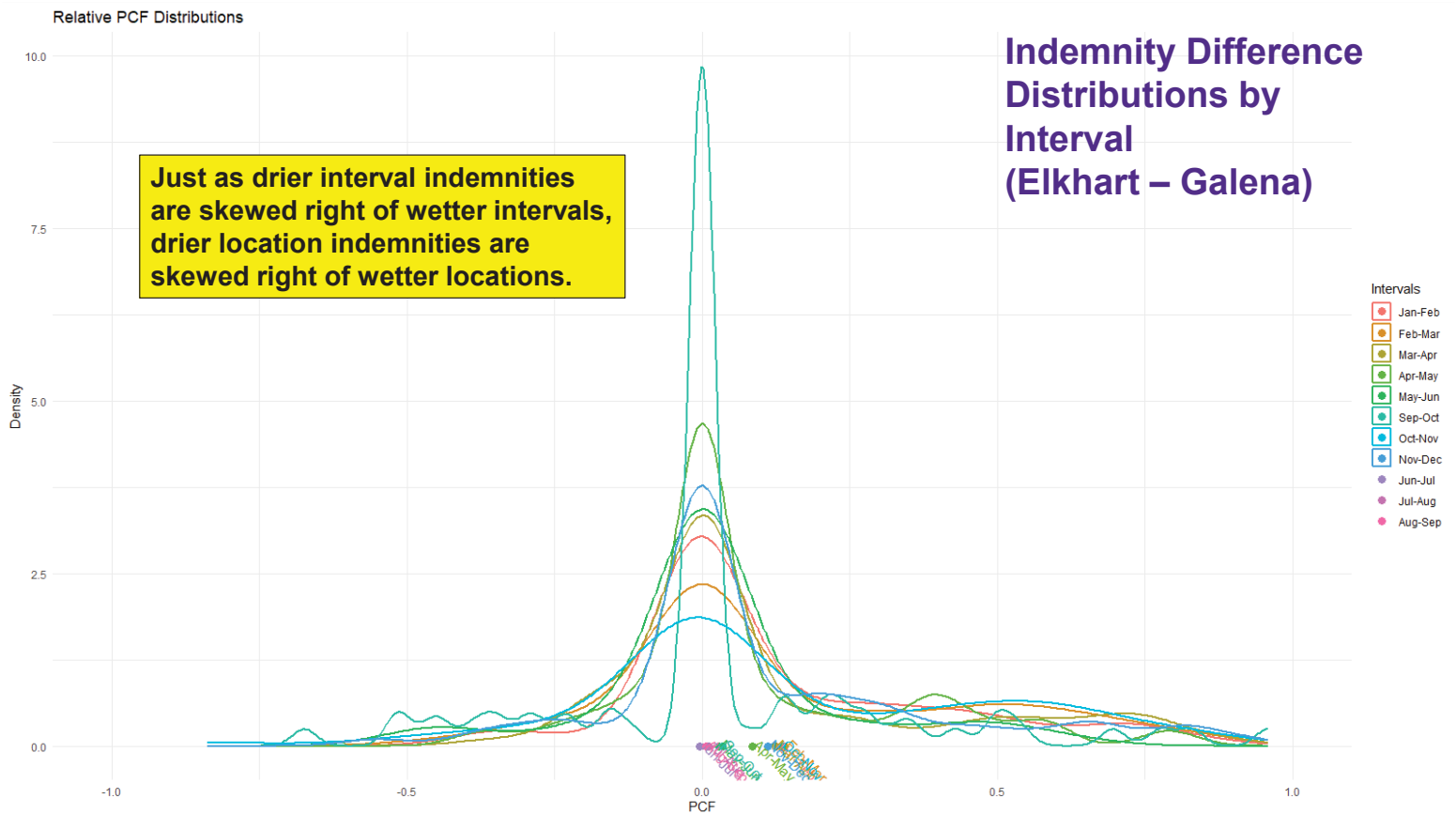
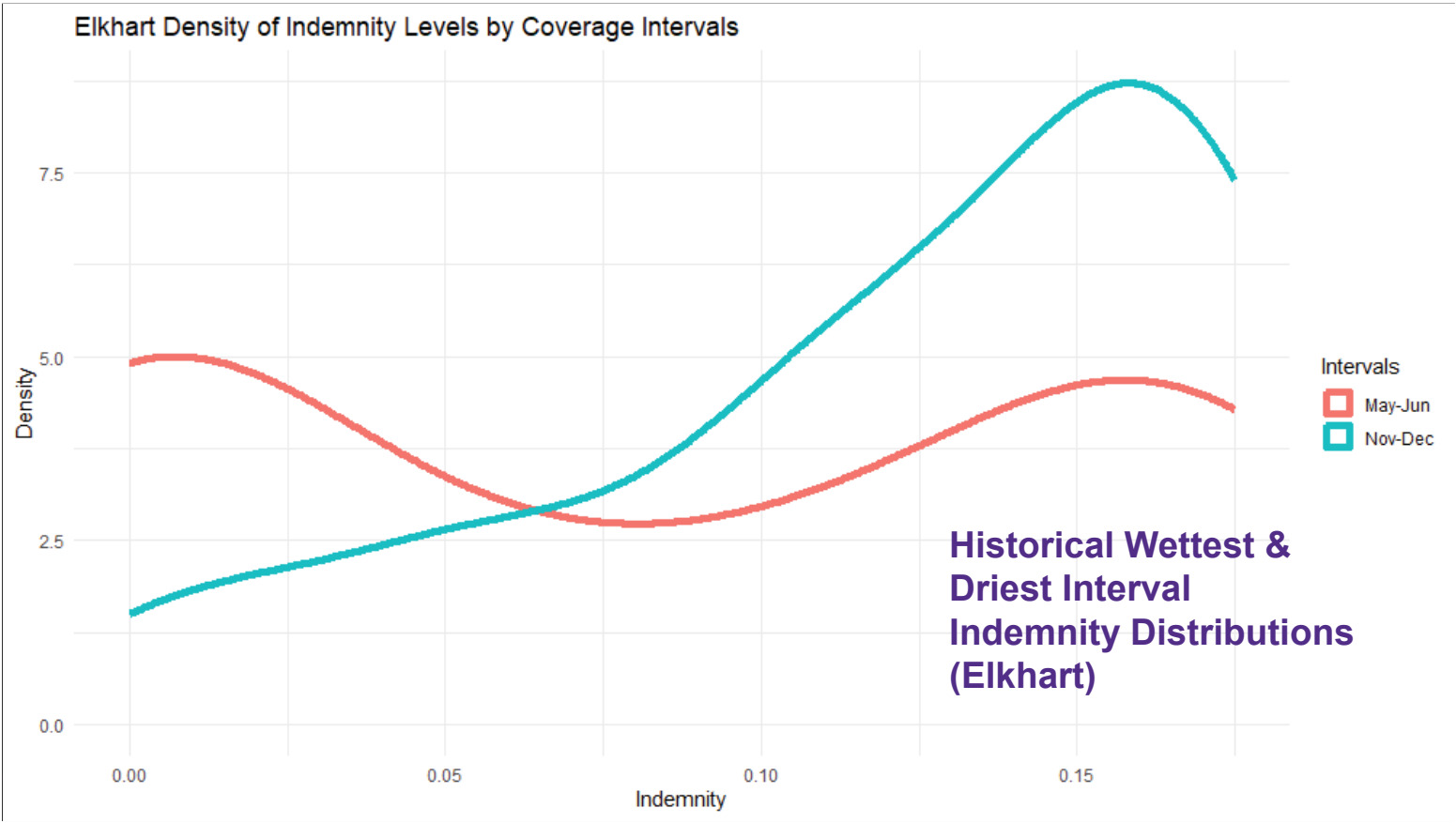
Decomposition #4

Within-interval historical rainfall **outcomes** are more densely **clustered below CL** in drier months, triggering payment more frequently in those months

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Key Findings

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Conclusions

- Because of rainfall distribution, subsidies do not just raise participation rate, they change the optimal strategy for PRF enrollment
- Rather than insuring coverage intervals when rainfall is most critical to grazing lands production, profit is maximized during off-season
- Does not operate like an actual insurance policy, because you are best insured when you are not insuring what you're actually insuring
- Works like a support program rather than an insurance product
- To fix, premium **subsidies** would need to be calibrated to rainfall distribution like premium rates are



THANK YOU!

Questions?

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