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Disparity in Yields from NASS and RMA Data: Implication for ARC-CO Program

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Title I: ARC-CO Program

- Agricultural Risk Coverage County (ARC-CO) program
 - New program introduced by the 2014 Farm Bill, through the Farm Service Agency (FSA)
- Triggered by county level revenue:
national price × **county yield**
- Complaints: Disparities between payments in neighboring counties
- Challenge: Obtaining accurate **county yield data**

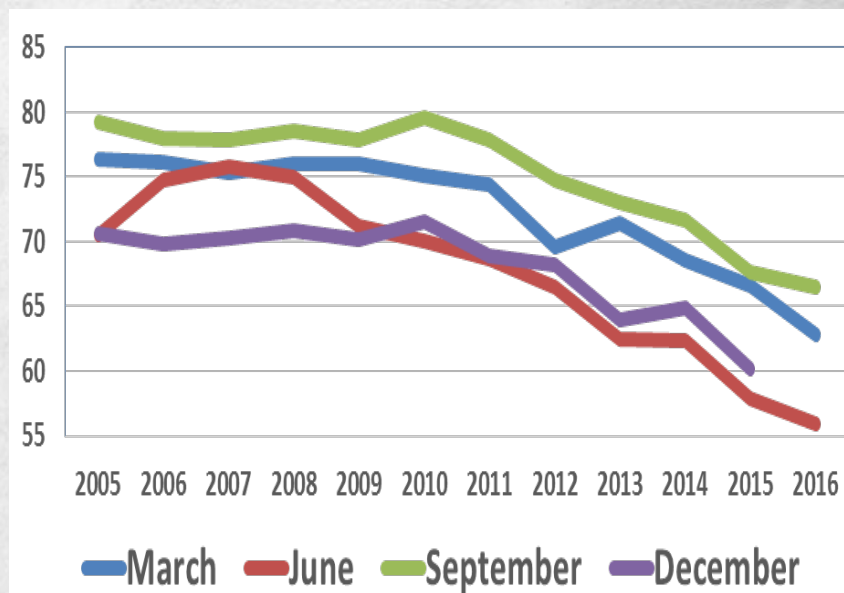


Two Sources of Data

- Source 1: **NASS** (National Agricultural Statistics Service)
 - Survey-based data
 - Clear statistical design
 - Small sample
 - Declining response rate

Falling Response Rates to USDA Crop Surveys: Why it Matters

By Robert Johansson, Anne Efland, and Keith Coble



Two Sources of Data

- Source 2: **RMA** (Risk Management Agency)
 - Individual participants report data
 - Unknown statistical properties
 - High participating rates (close to 90%)

RMA Market Penetration Report

- Corn 84% insured
- Soybeans 84% insured

<https://www.rma.usda.gov/pubs/2013/portfolio/>



Current Practice

- FSA procedure:
 - The actual county average yield for ARC-CO is based on county-level National Agricultural Statistics Service **(NASS) data**, if available. When county-level NASS yield data do not exist for the county, FSA uses the next best data sources available to establish yields going next to county level **RMA data**.



The Political Fallout

- “With regard to the county ARC-CO program, yield data from **RMA should be used**, where available, rather than the current policy of using NASS data. For counties that lack RMA data, RMA yields from similar or adjacent counties should be used or averaged to **reduce discrepancies in yields and payments in neighboring counties.**”
 - 2017 testimony by the American Soybean Association before the U.S. Senate Agriculture, Nutrition, and Forestry Committee stated,
- American Farm Bureau supports a reprioritization of the data used for ARC-CO – putting **RMA data first** with NASS data as the alternative.
- Senators Heitkamp and Ernst submitted legislation directing USDA to use **RMA as the first choice** in yield calculations; and providing FSA state committees discretion to adjust yield data estimates to **reduce variation between neighboring counties or states.**



Research Objective

- Despite the debates and opinions, **little research** on comparing NASS vs. RMA data
- This study statistically compares the NASS vs. RMA yield data, and their implications for the ARC-CO payments



Counties with Continuous Yield data from 1991 to 2015

Crop Practice	Corn			Soybean			Winter wheat		
	RMA	NASS	Match	RMA	NASS	Match	RMA	NASS	Match
ALL	2113	883	880	1713	847	846	1780	449	442
Irrigated Yield	1656	33	32	1068	23	22	857	5	5
Non-irrigated Yield	2239	30	30	1862	23	22	2247	5	5



Comparison 1

Mean and **variance** of yield data

- Not statistically different
- For counties with differences, RMA data tend to have higher means and variances



Comparison of Mean Yields from RMA and NASS (1991-2015)

Crop	Practice	Percentage of Counties		
		RMA>NASS	RMA=NASS	RMA<NASS
Corn	All	31.7%	68%	0.3%
	Irrigated Yield	0.0%	100.0%	0.0%
	Non-irrigated Yield	0.0%	100.0%	0.0%
Soybean	Average Yield	5.9%	93.7%	0.4%
	Irrigated Yield	0.0%	95.5%	4.5%
	Non-irrigated Yield	22.7%	77.3%	0.0%
Wheat	Average Yield	52%	47.5%	0.5%
	Irrigated Yield	0.0%	100.0%	0.0%
	Non-irrigated Yield	20.0%	80.0%	0.0%



Comparison of **Variance** of Yields from RMA and NASS Data (1991-2015)

Crop	Practice	Percentage of Counties		
		RMA>NASS	RMA=NASS	RMA<NASS
Corn	All	4.4%	94.9%	0.7%
	Irrigated Yield	0.0%	100.0%	0.0%
	Non-irrigated Yield	0.0%	100.0%	0.0%
Soybean	Average Yield	0.2%	99.3%	0.5%
	Irrigated Yield	4.5%	95.5%	0.0%
	Non-irrigated Yield	0.0%	90.9%	9.1%
Wheat	Average Yield	6.6%	88.2%	5.2%
	Irrigated Yield	0.0%	100.0%	0.0%
	Non-irrigated Yield	20.0%	80.0%	0.0%



Comparison 2

Simulate **ARC-CO payments**: NASS vs. RMA

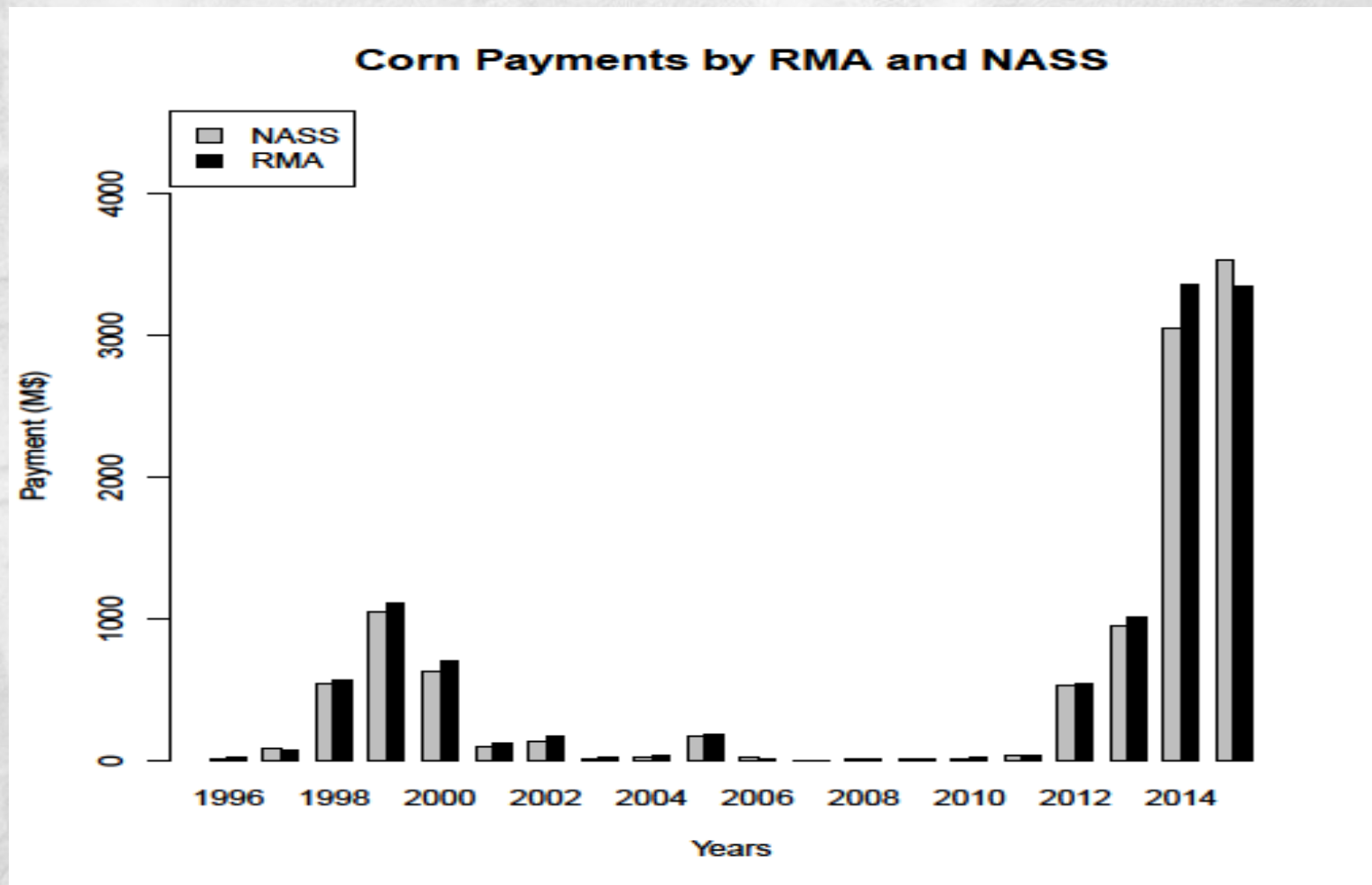
5-year Olympic average, from 1996 to 2015:

$$ARC - CO \text{ Payment}_c = PayAcres \times \min \{ \max(0, 0.86 \times OlyAveRev_c - Rev_c), 0.1 \times OlyAveRev_c \}$$

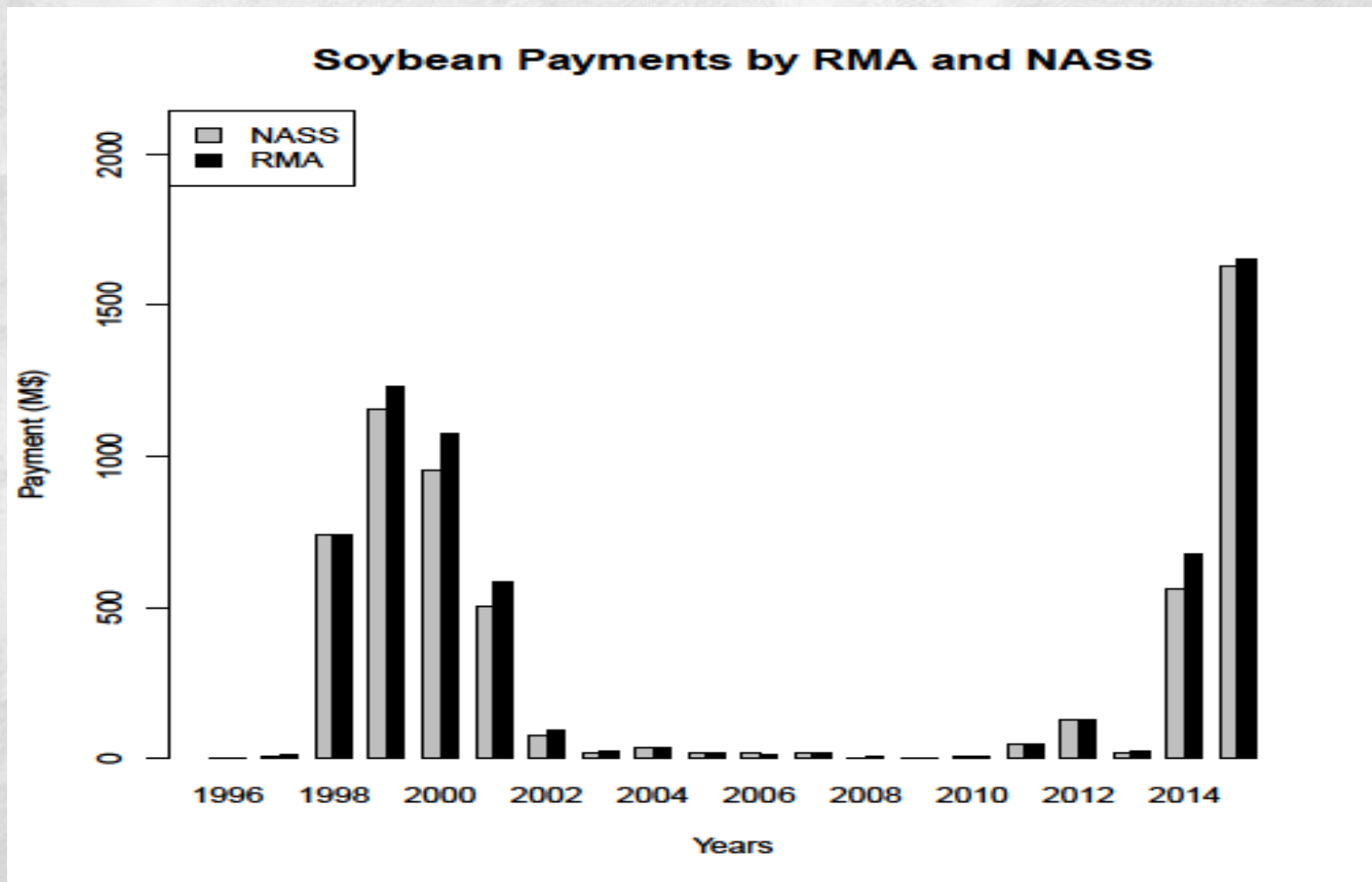
- National aggregate payments: Differences are small
- County level: Spatial pattern is random
- → No data set is favored than the other



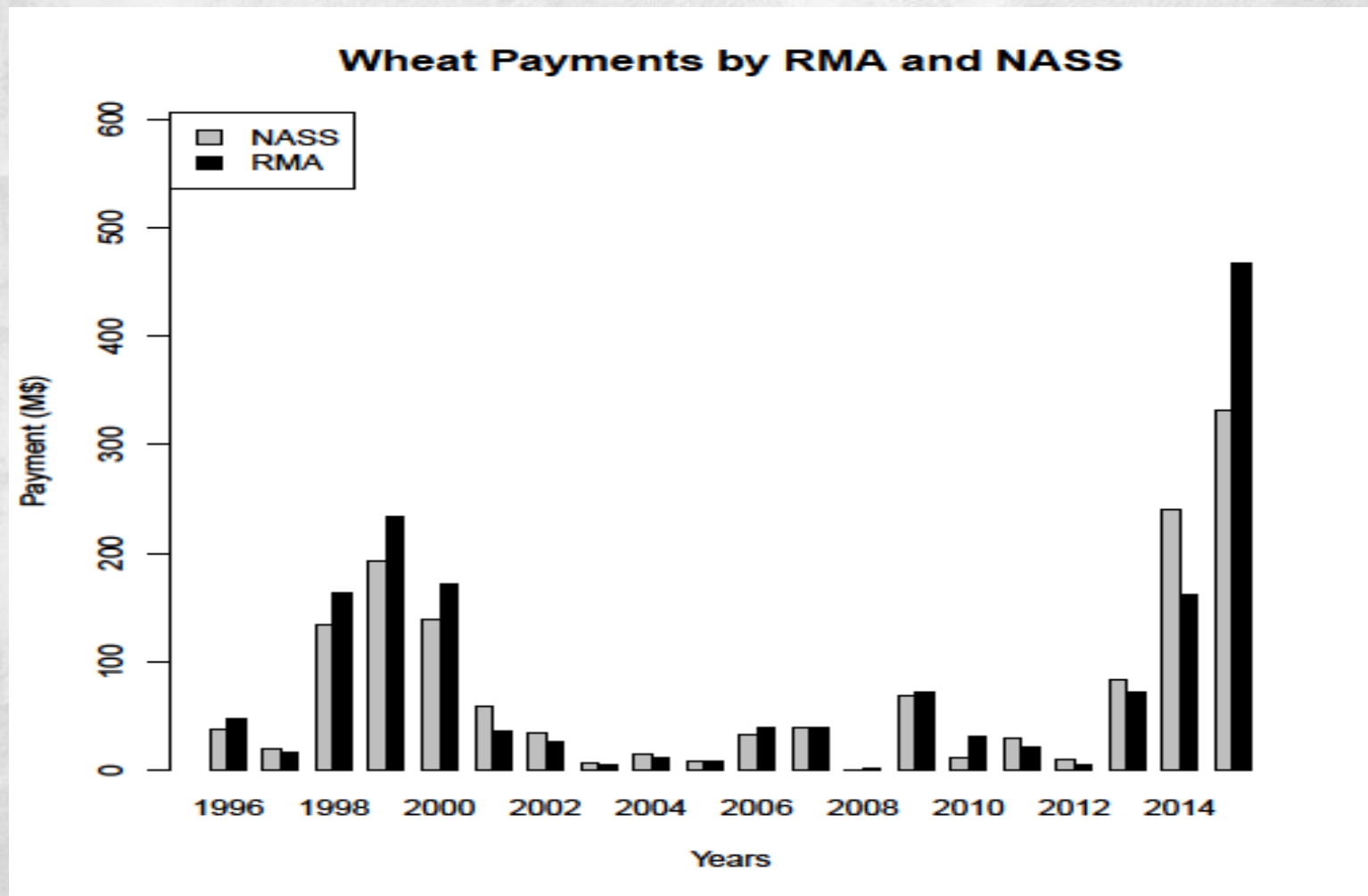
Aggregate ARC-CO payments



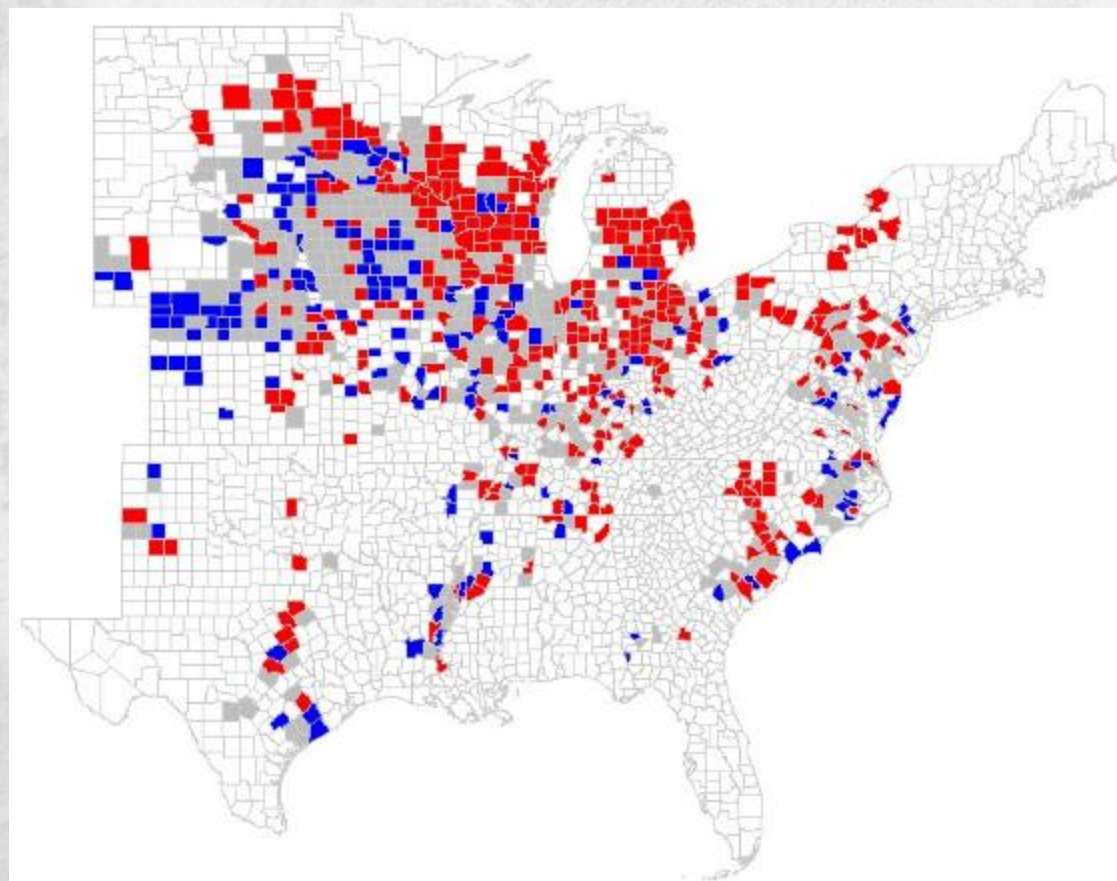
Aggregate ARC-CO payments



Aggregate ARC-CO payments



ARC-CO payment difference by county (RMA – NASS)

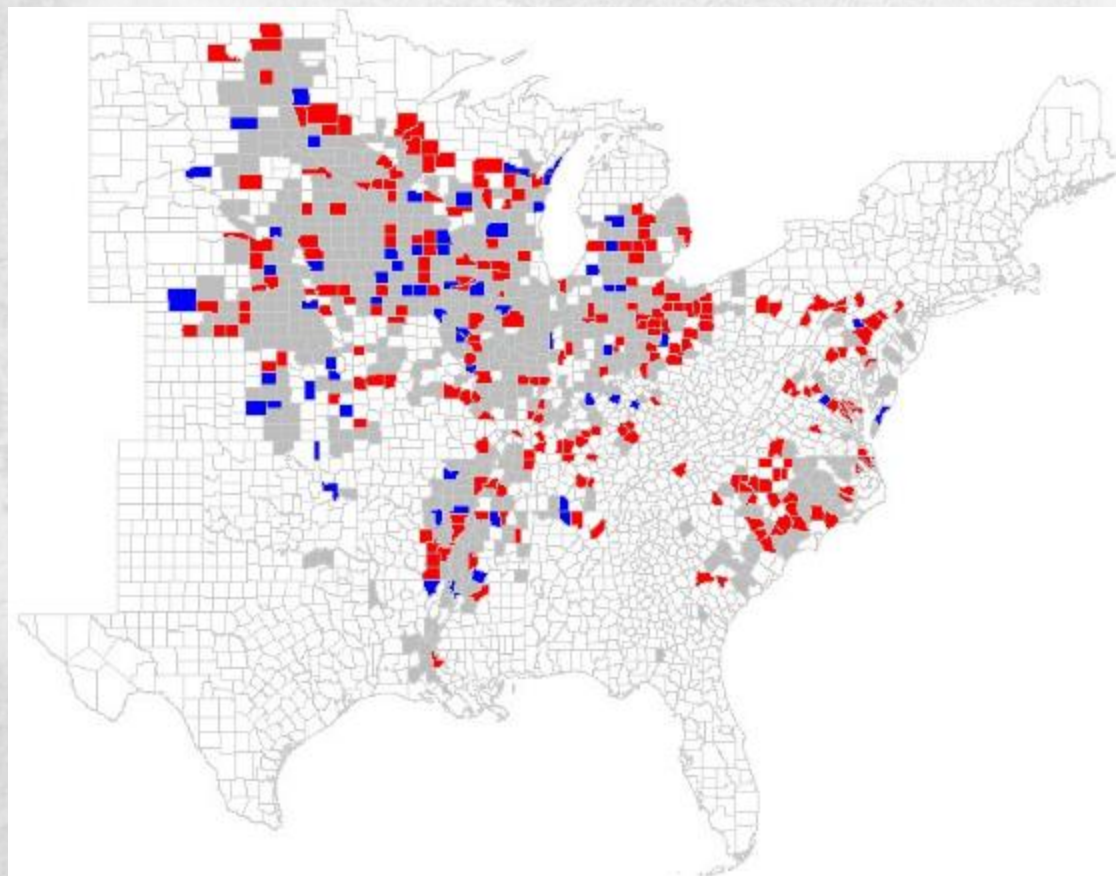


Corn

- No difference
- RMA > NASS
- RMA < NASS



ARC-CO payment difference by county (RMA – NASS)

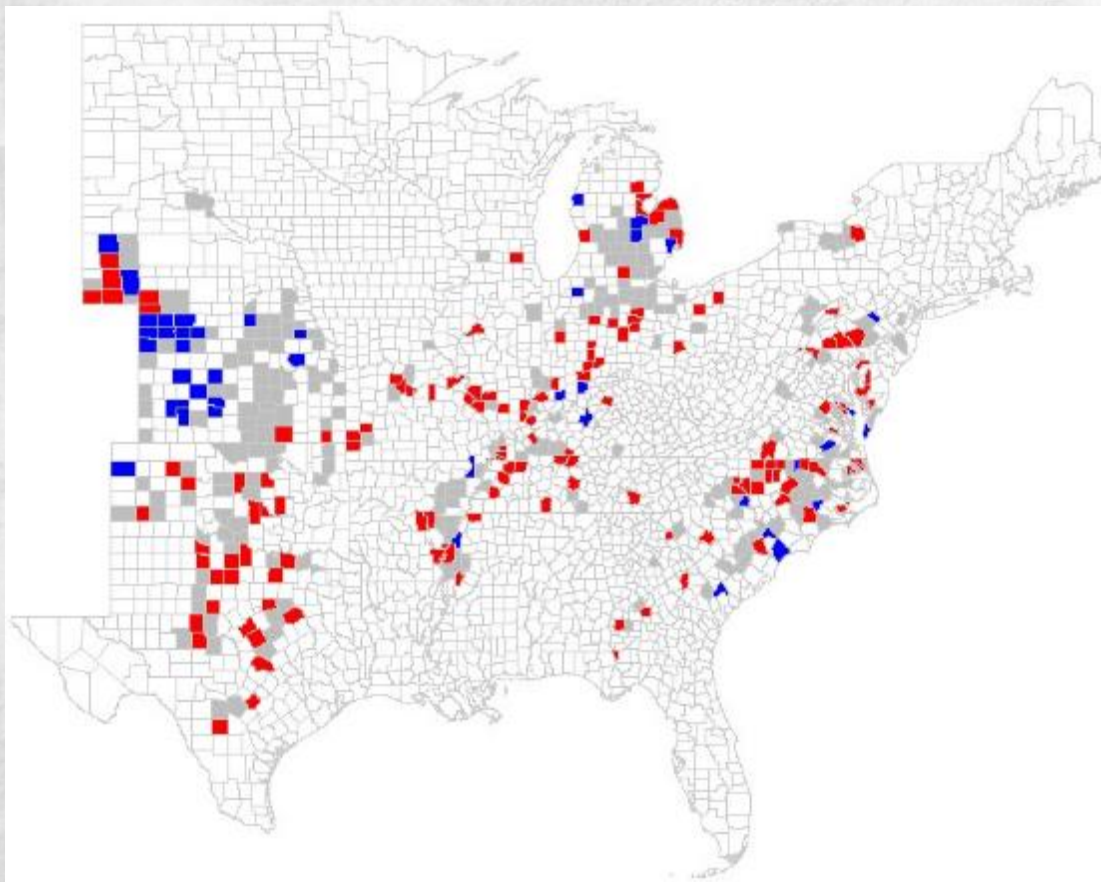


Soybean

- No difference
- RMA > NASS
- RMA < NASS



ARC-CO payment difference by county (RMA – NASS)



Wheat

- No difference
- RMA > NASS
- RMA < NASS



Comparison 3

Spatial similarity across neighboring counties

Measure 1: **Correlation** between yields of a **target county** (y_c) and its **nearest neighbor** ($y_{c'}$) for 1991-2015:

$$\rho_c = \frac{\text{Cov}(y_c, y_{c'})}{\sigma_c \sigma_{c'}}.$$

On average:

- RMA data have larger correlation, i.e., spatially more similar
- But the differences are not large



Average Correlation of Yields and ARC-CO Payments between Neighbor Counties

Crop	Correlation Measure	1991-2015	
		NASS	RMA
Corn	Yield	0.864	0.884
	Payment	0.784	0.822
Soybean	Yield	0.866	0.855
	Payment	0.799	0.839
Wheat	Yield	0.766	0.838
	Payment	0.746	0.855



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Comparison 3 (cont'd)

Spatial similarity across neighboring counties

Measure 2: **Disparity index** constructed by this study.

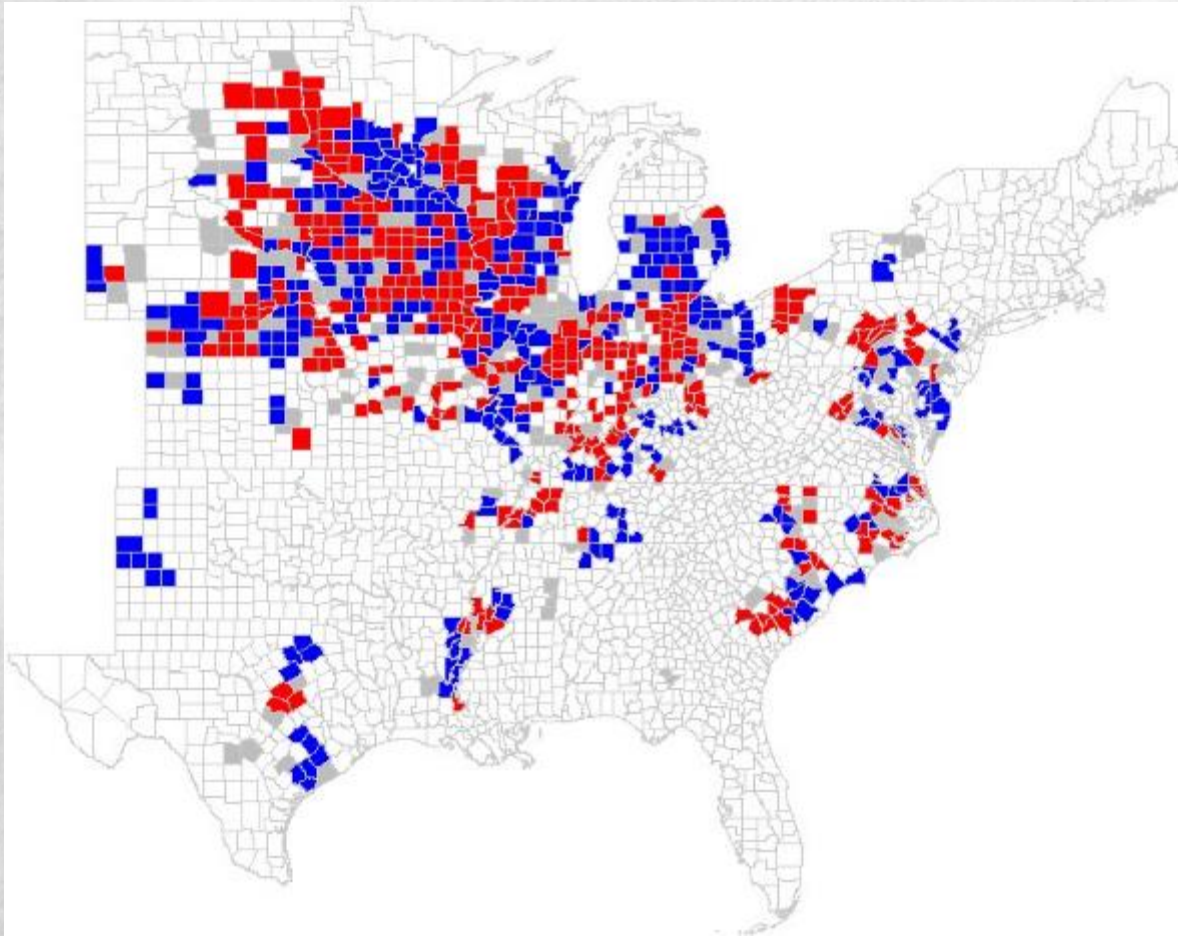
$$DI_c = \frac{1}{K} \sum_{k=1}^K |y_c - y_k|$$

K is the total number of neighboring counties to county c .

- Spatial pattern of DI is quite random
- Switching between NASS and RMA data does not systematically mitigate payment disparities



Disparity index of ARC-CO payment by county (RMA – NASS)

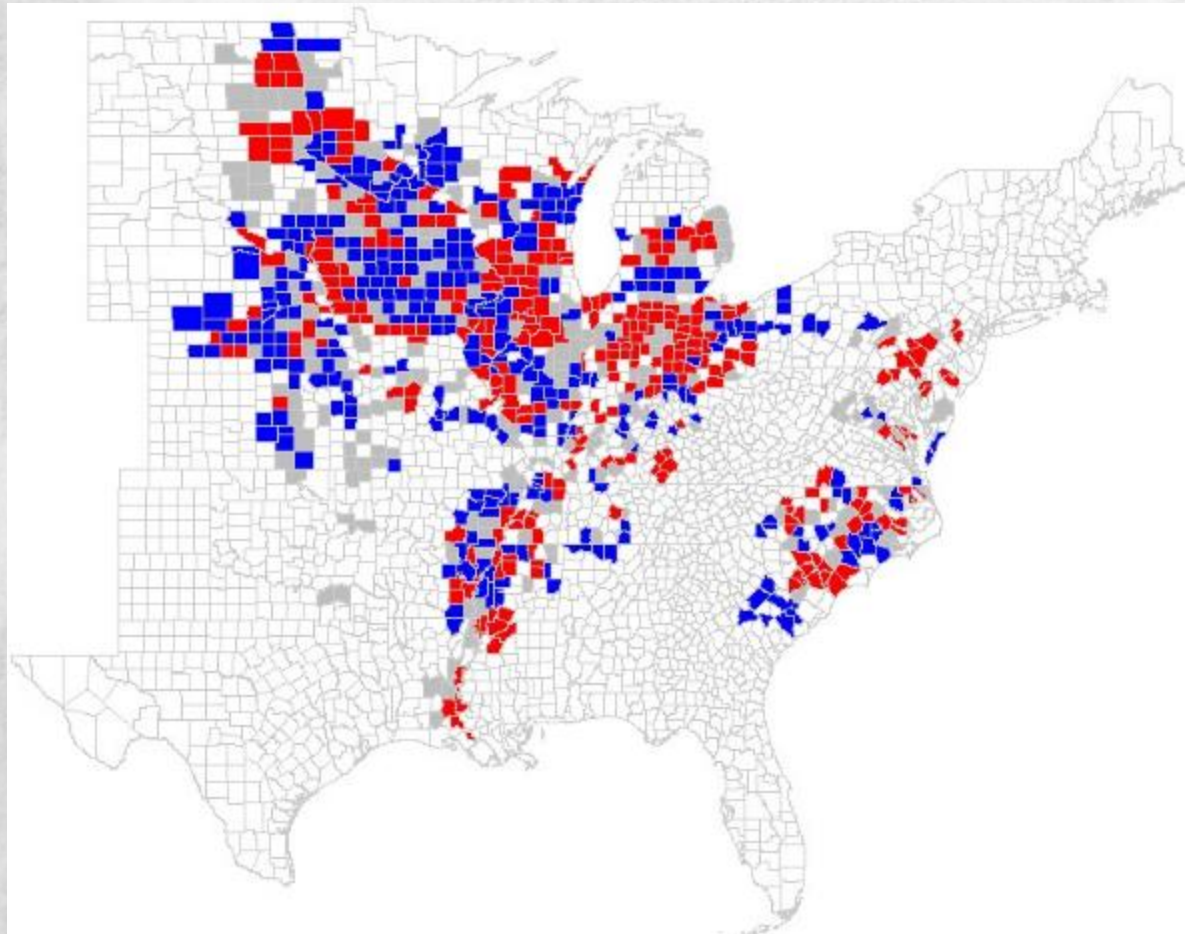


Corn

- No difference
- RMA > NASS
- RMA < NASS



Disparity index of ARC-CO payment by county (RMA – NASS)

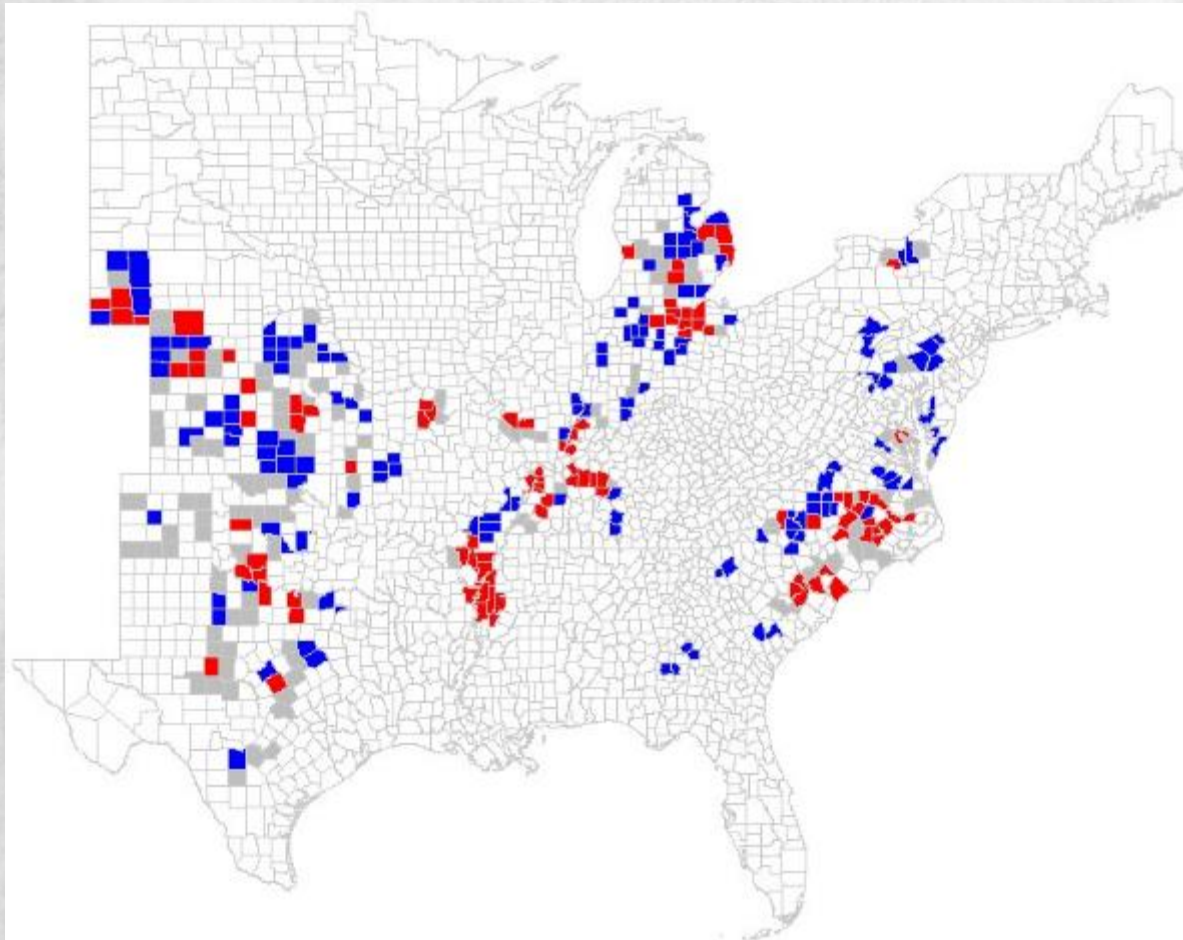


Soybean

- No difference
- RMA > NASS
- RMA < NASS



Disparity index of ARC-CO payment by county (RMA – NASS)



Wheat

- No difference
- RMA > NASS
- RMA < NASS



Comparison 4

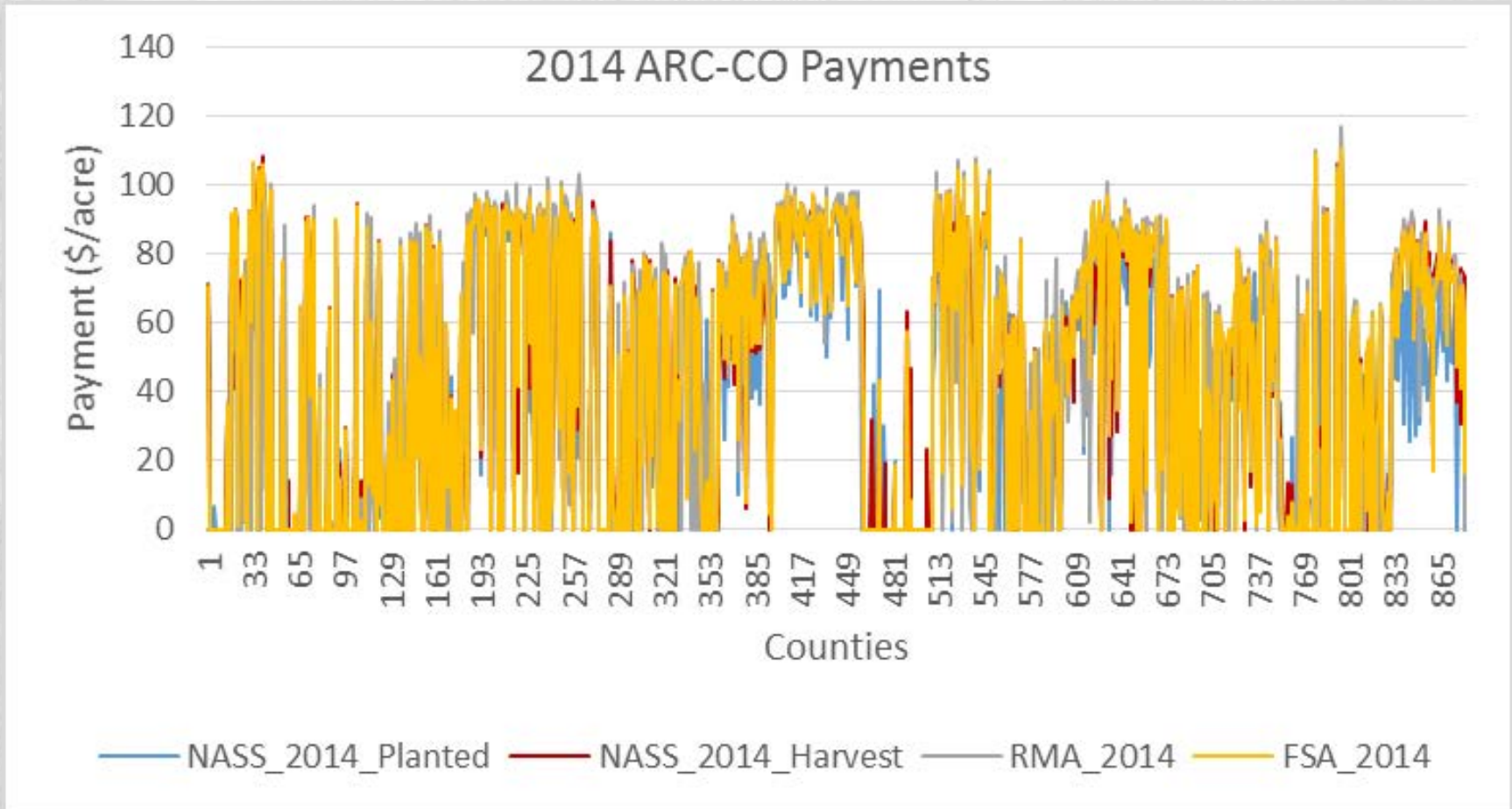
Compare with **actual ARC-CO payment** by FSA

2014 and 2015:

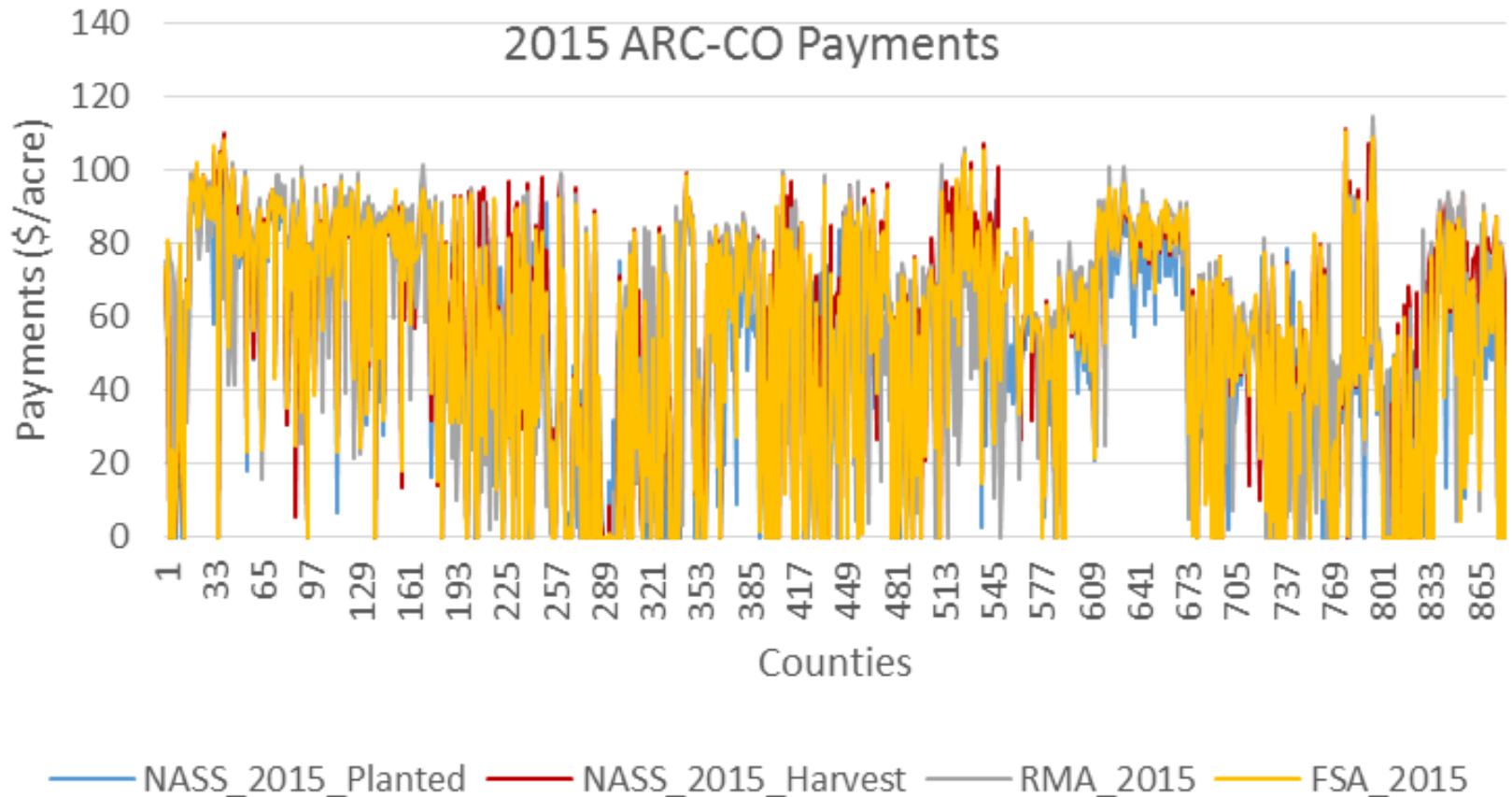
- Substantial overlap
- FSA and RMA payments are sometimes higher than NASS
- Some regionality in one year; but the pattern changes in the second year



ARC-CO payments from difference data sources (RMA, NASS, FSA): Corn



ARC-CO payments from difference data sources (RMA, NASS, FSA): Corn



Mitigation of spatial disparity among neighboring counties

- Approach 1: **Smooth yields** among adjoining counties

– Linear smoothing: $y_i^s = (1 - \lambda)y_i + \lambda\tilde{y}_i$

y_i : original yield for county i ;

\tilde{y}_i : average yield of i 's neighboring counties

λ : smoothing weight (from 0 to 1)

y_i^s : smoothed yield

- ➔ Smoothed yields reduce payment disparities
- ➔ But also increases uncertainty between actual loss and payment



Mitigation of spatial disparity among neighboring counties

- Approach 2: **Expansion of historical Olympic years**

5-year Olympic average → 7-year Olympic average

- ARC-CO payments decrease
- Smaller payment disparities among neighboring counties



Conclusions and Discussions

- RMA vs. NASS data do **not** have **statistically different** mean and variance
- **Neither data source** can systemically 'fix' the payment disparity among adjacent counties
- If the objective were only to mitigate spatial disparity among neighboring counties, **some statistical smoothing** techniques should work
- To improve county yield data accuracy, **survey** needs to be **augmented** (respondent burden also arises: simulate)
- Longer term study: Utilize the increasing **fine spatial resolution data** (sub-county, grid, etc.) to define an alternative type of 'area" by **homogeneous agronomic regions**, and replace politically defined county boundaries



Thank You



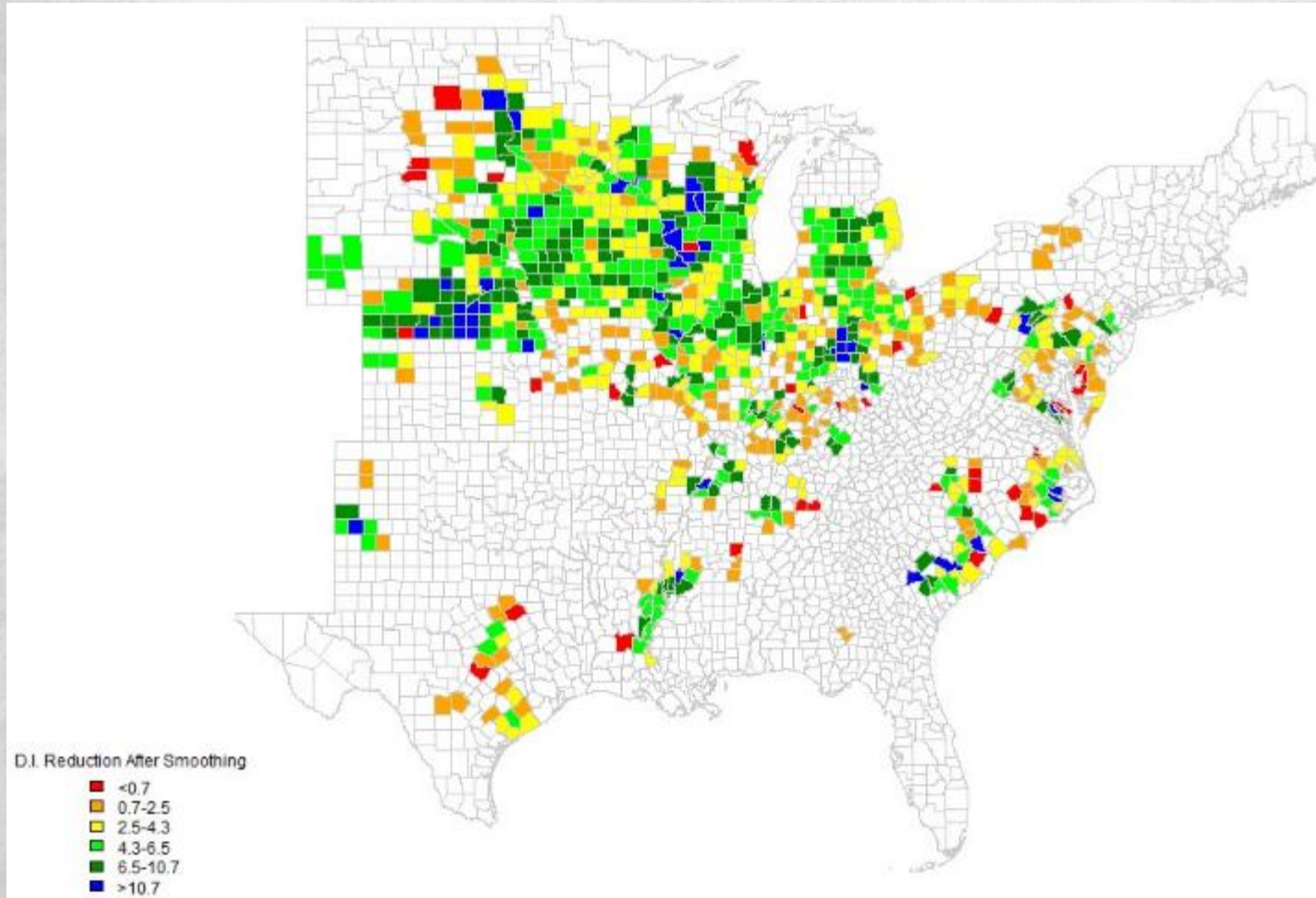
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Appendix



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The Effect of Smoothing Yield Data on Disparity Index (NASS Data, $\lambda=0.4$)

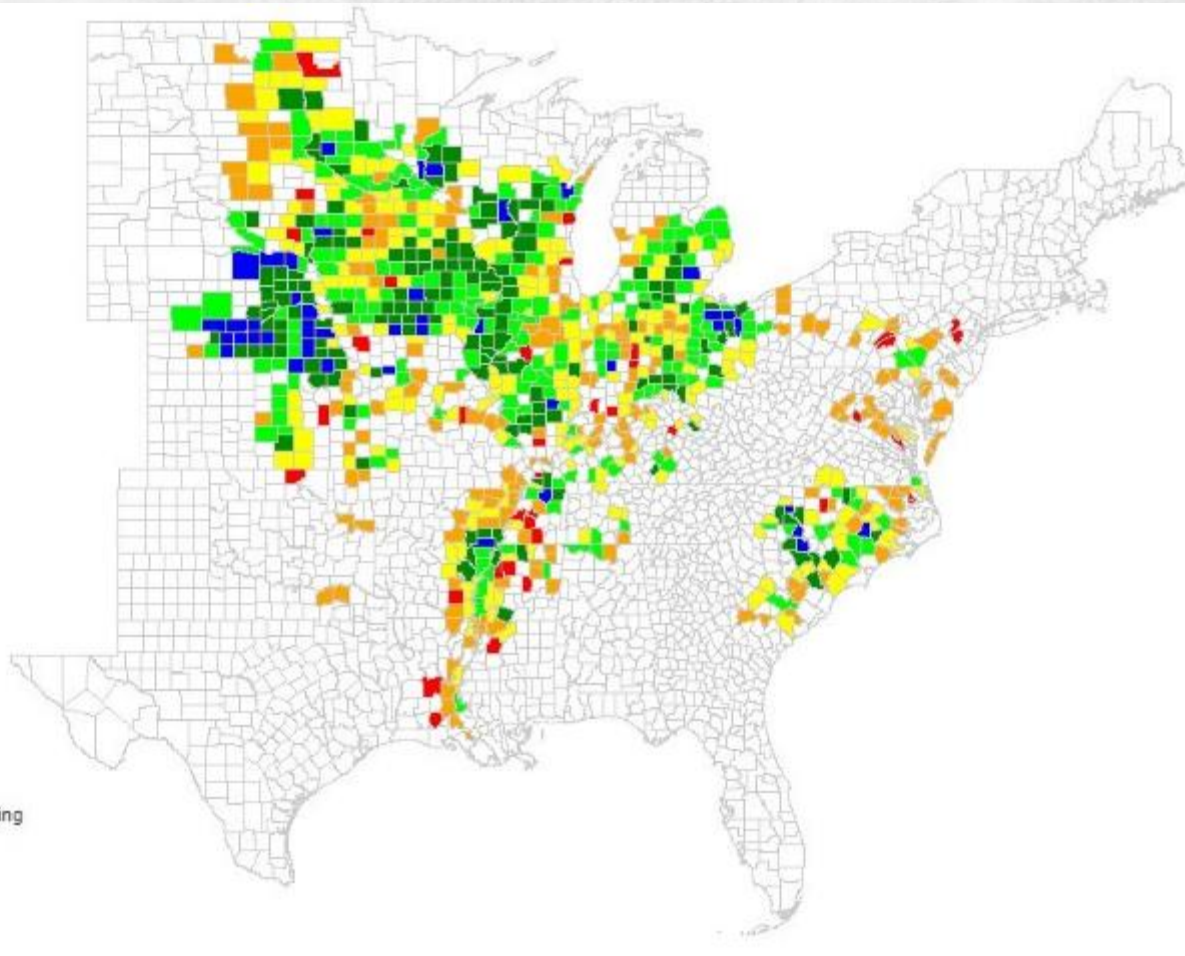


Corn



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The Effect of Smoothing Yield Data on Disparity Index (NASS Data, $\lambda=0.4$)

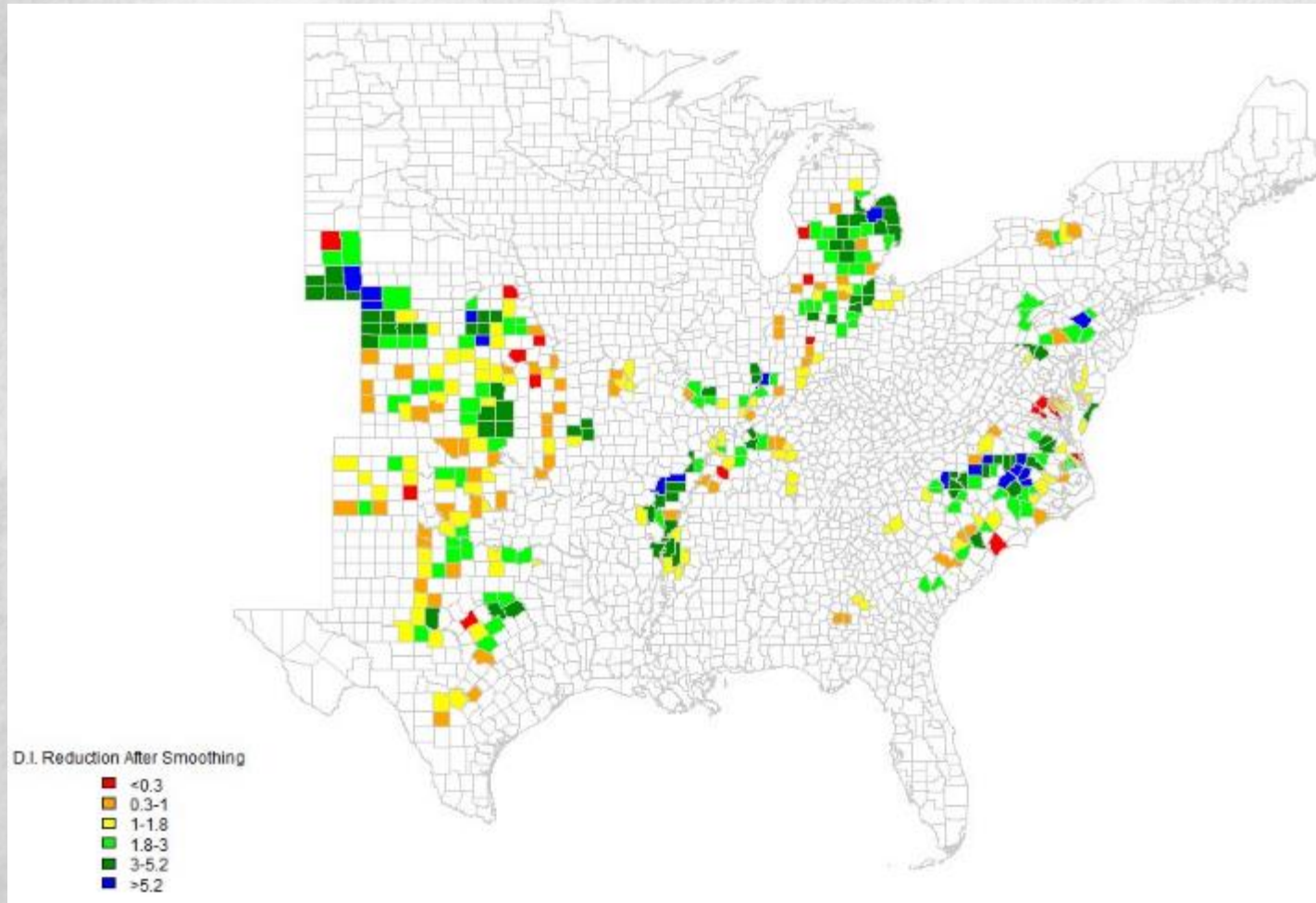


Soybean



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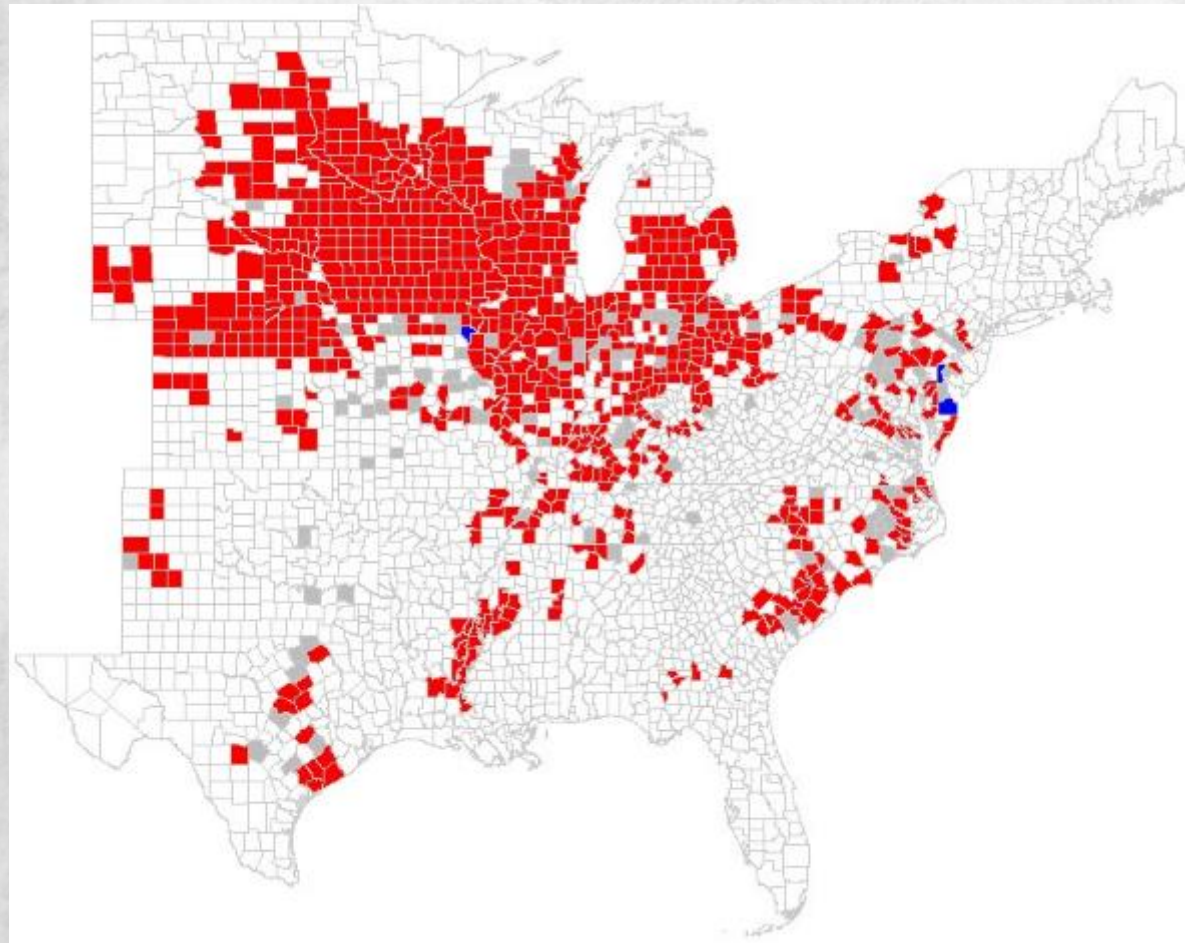
The Effect of Smoothing Yield Data on Disparity Index (NASS Data, $\lambda=0.4$)



Wheat



Payment Difference with Different Olympic Averages (NASS Data)

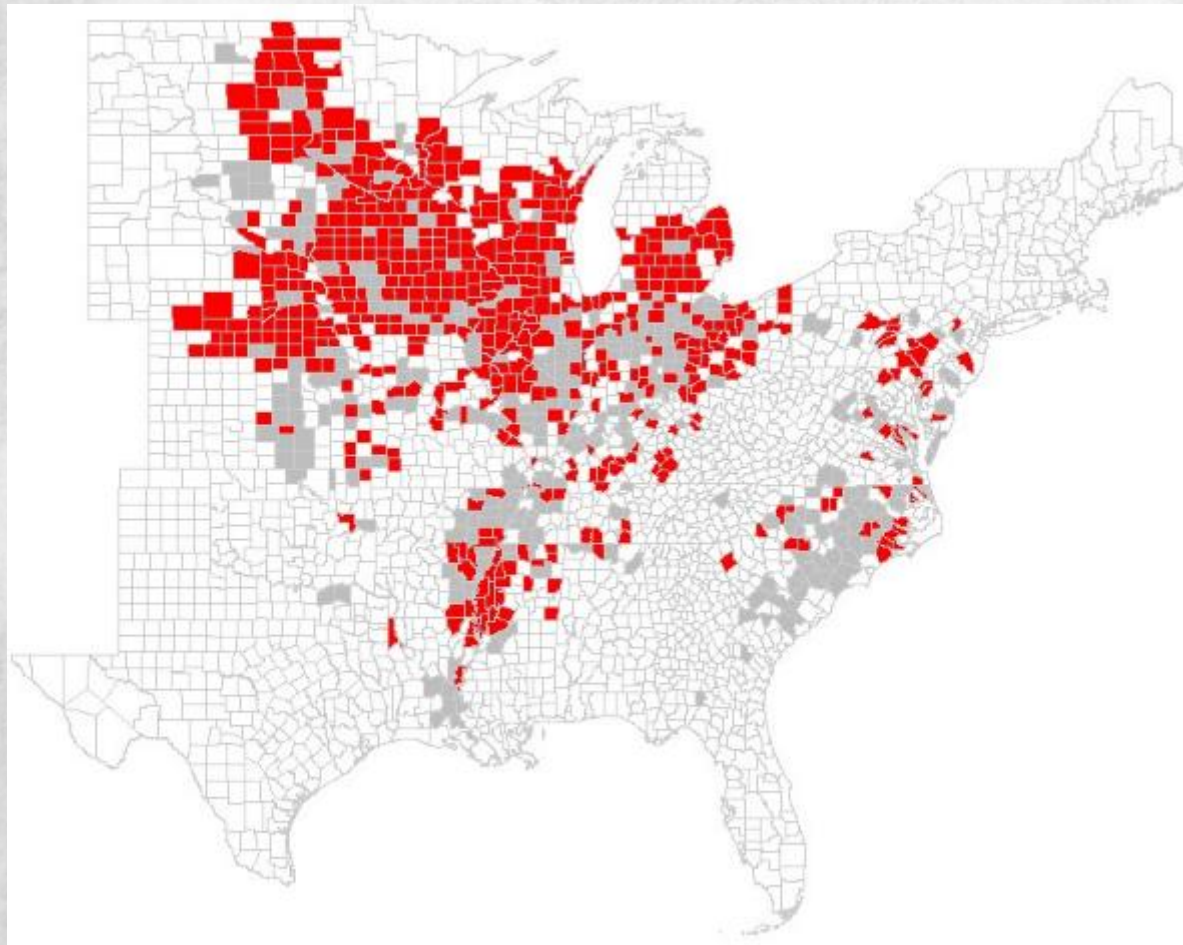


Corn

- No difference
- 5-year > 7-year
- 5-year < 7-year



Payment Difference with Different Olympic Averages (NASS Data)

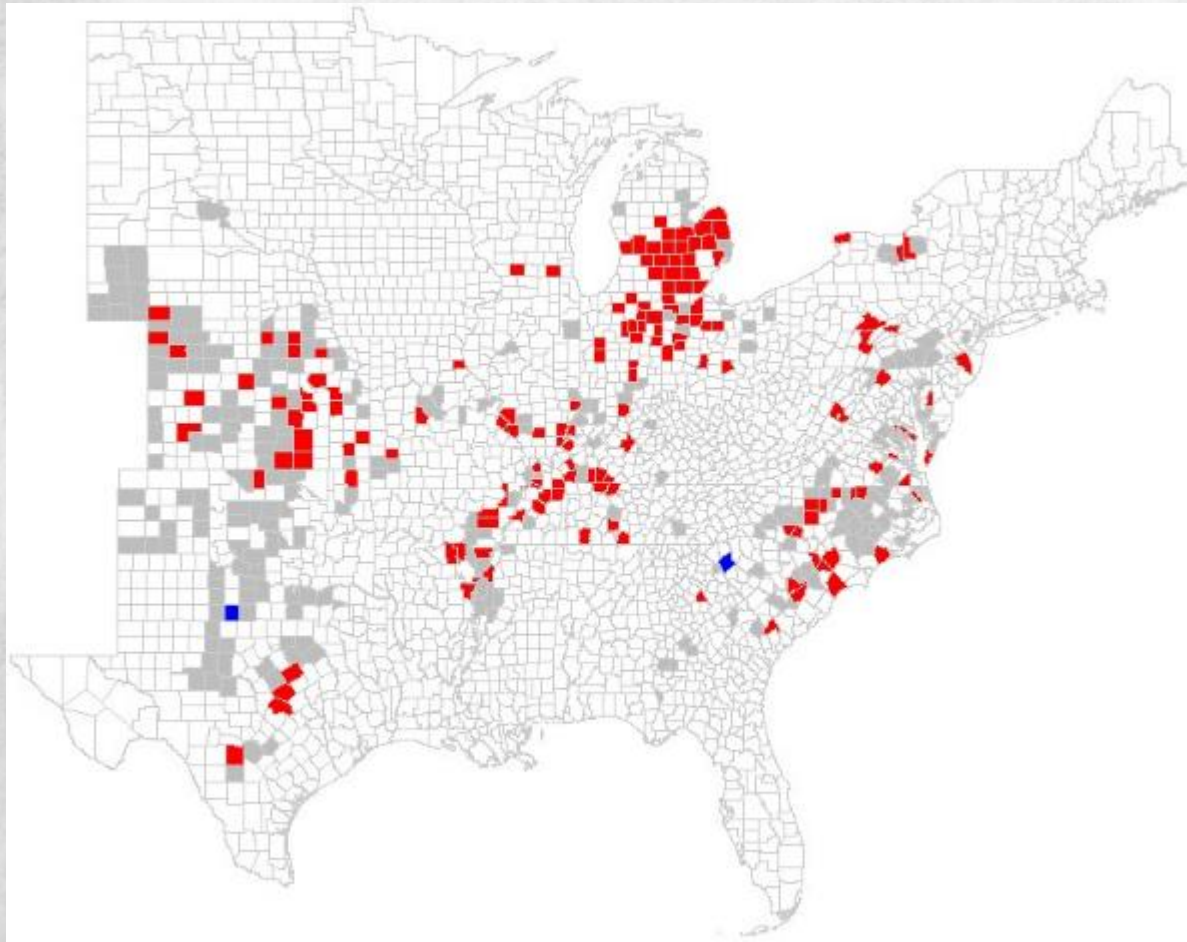


Soybean

- No difference
- 5-year > 7-year
- 5-year < 7-year



Payment Difference with Different Olympic Averages (NASS Data)



Wheat

- No difference
- 5-year > 7-year
- 5-year < 7-year



How large the survey should be: Our Simulation Exercise

- Given a population of 376,000 spatially correlated farms across 1,500 corn production counties
- Two Questions:
 - How many random surveys needed to achieve 95% confidence of +/- 2 bu of true national yield?
 - **Answer: 0.68% of all farms**
 - How many random surveys needed to achieve 95% confidence of +/- 2 bu of true county yield in all counties?
 - **Answer: 81% of all farms**



The narrow range of shallow loss ARC payments

