Does Crop Insurance Enrollment Exacerbate the Negative Effects of Extreme Heat? A Farm-level Analysis

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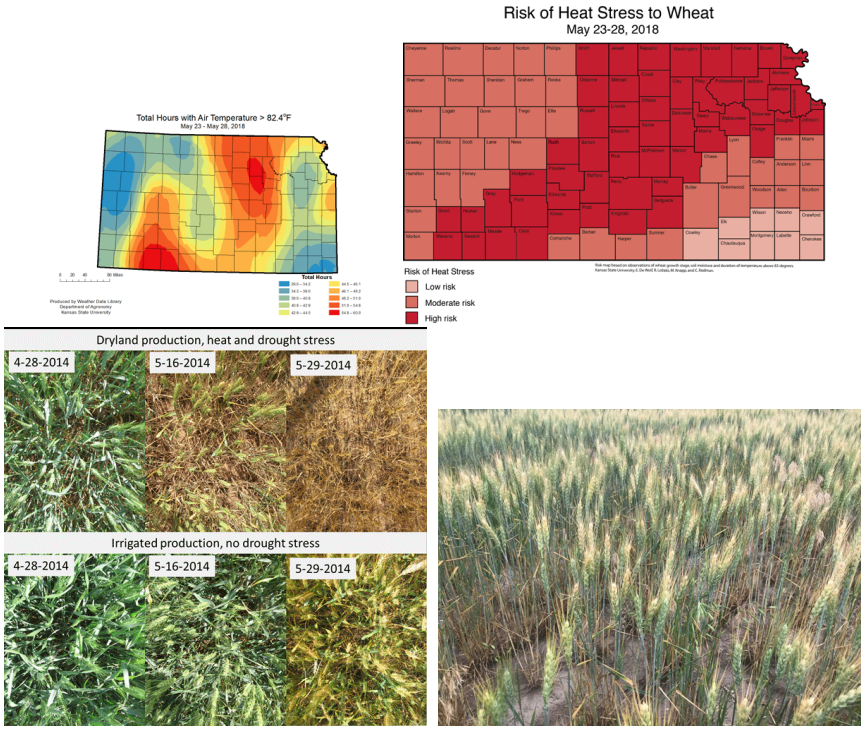
Crop Insurance

- Federal Crop Insurance Act of 1980
- Mandatory participation to receive deficiency payments in 1994
- Major issues: adverse selection and moral hazard (Goodwin, 1993)
- Many studies on premium rates and yield variation (Annan et al., 2013; Goodwin, 1994)
- Annan and Schlenker (2015): influence of insurance on the observed effect of weather outcomes on crop yields.

Research Question

- Annan and Schlenker (2015): the sensitivity to extreme heat is 67 percent (43 percent) larger for insured corn (soybeans).
- This finding has not been replicated using farm-level data, nor for crops other than corn and soybeans.
- **Does Crop Insurance Enrollment Exacerbate the Negative Effects of Extreme Heat ?**

Heat Stress in Wheat

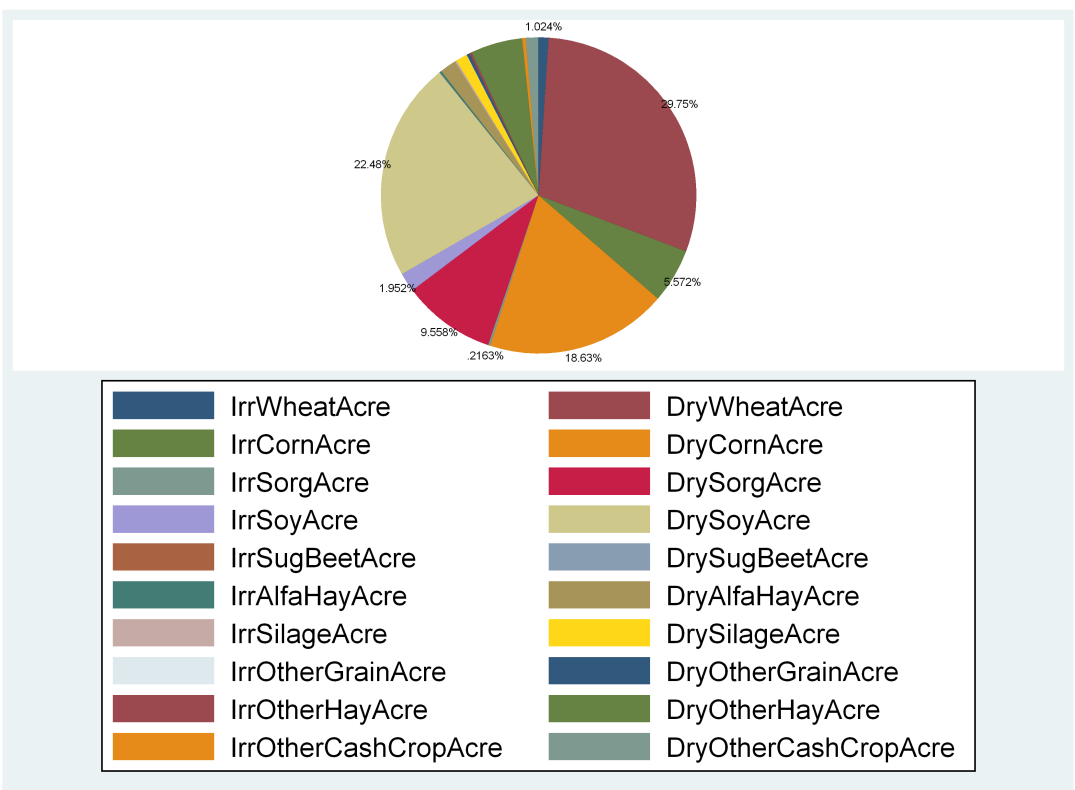


Source: K-State Research and Extension-Extension Agronomy

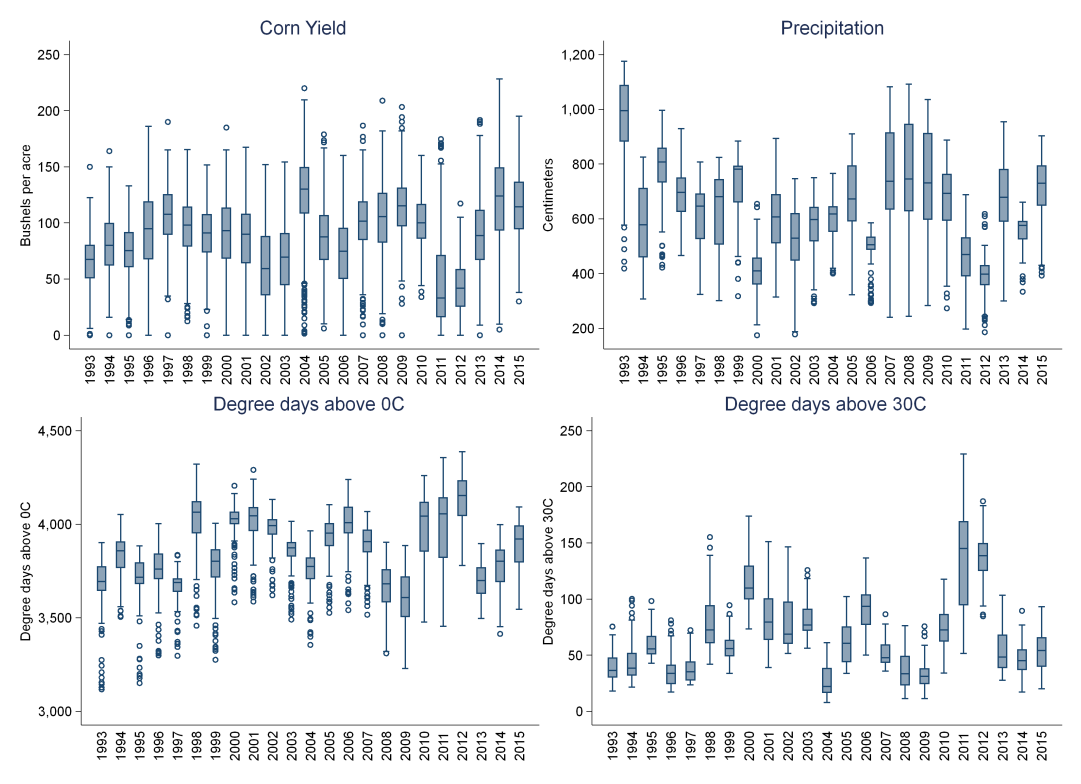
Data

- KFMA farm level unbalanced panel data from 1993-2015
- Includes farms with at least 10 years of data
- KFMA provides farm households insurance payment
- Assumption: farmers pay most insurance for crop with highest share
- Expected indemnity per acre is estimated following Tack et al. (2018)
- More variation in *insured acres* than in *insurance participation*

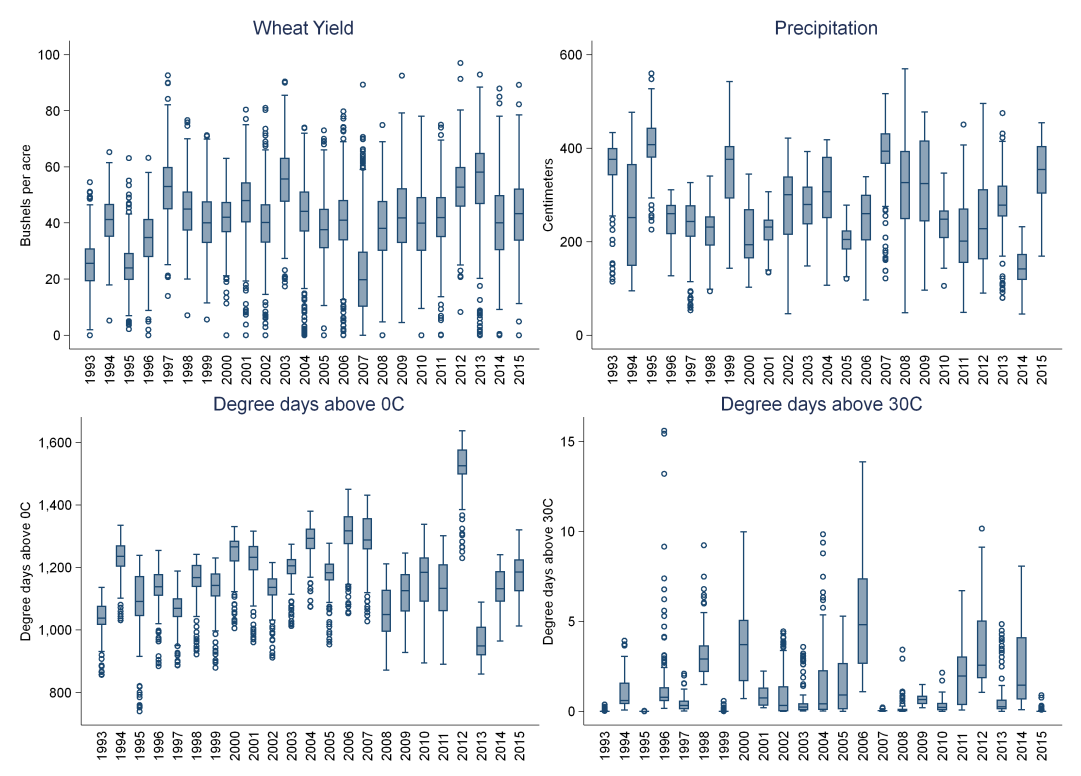
Share of Crop Acres



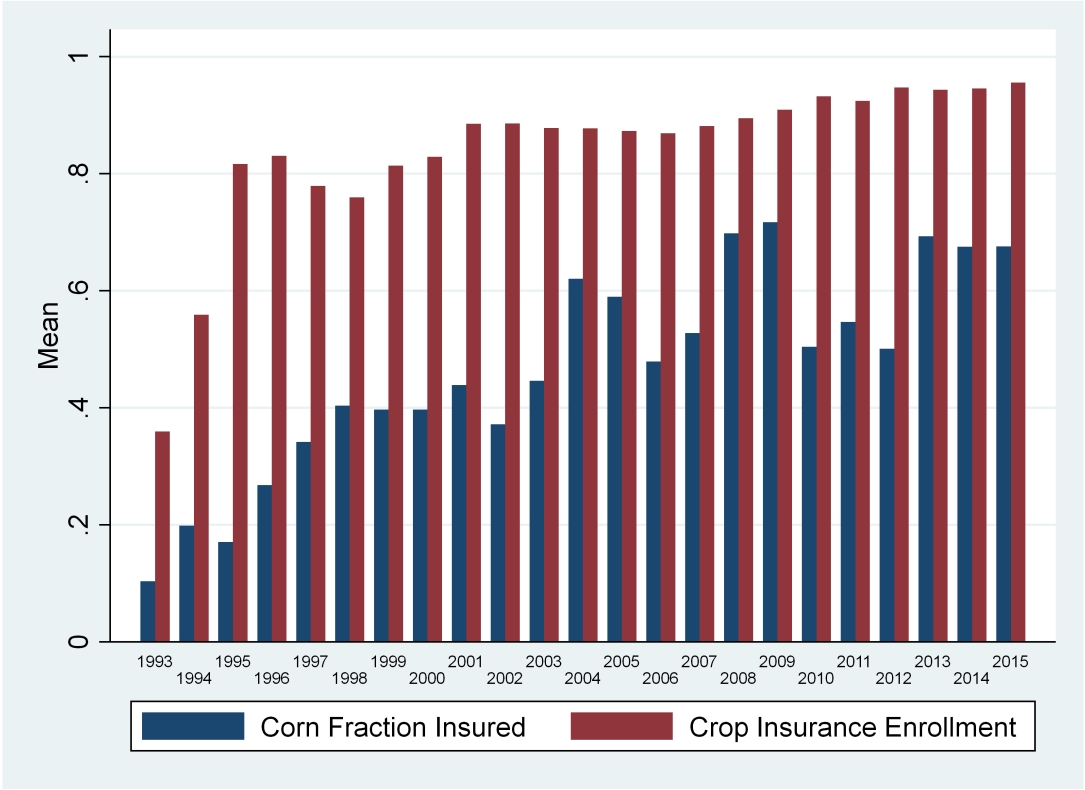
Corn Yield and Growing Season Weather



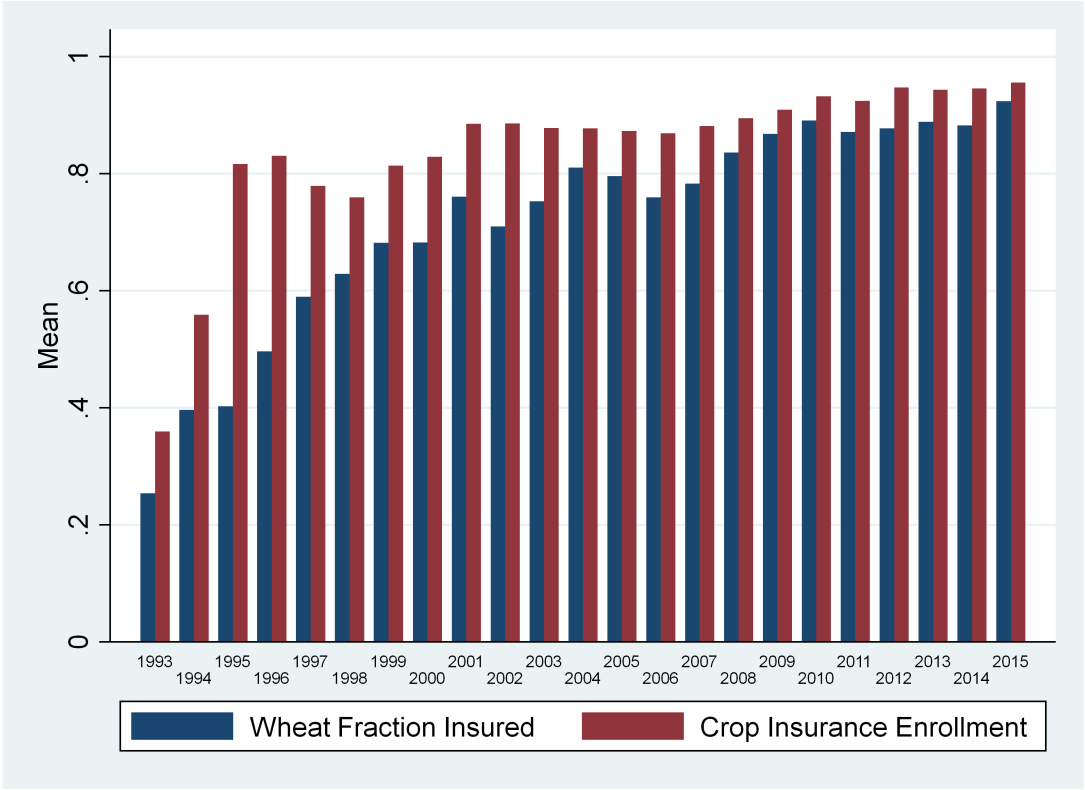
Wheat Yield and Spring Season Weather



Corn Insured Acres



Wheat Insured Acres

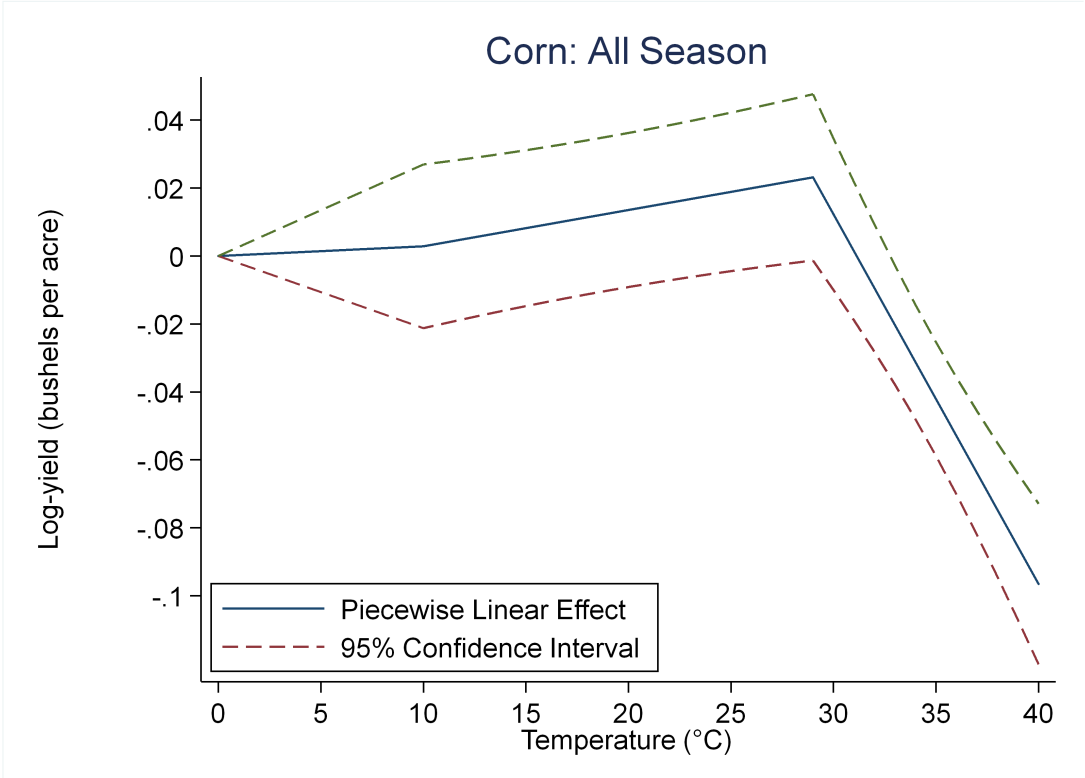


Empirical Estimation

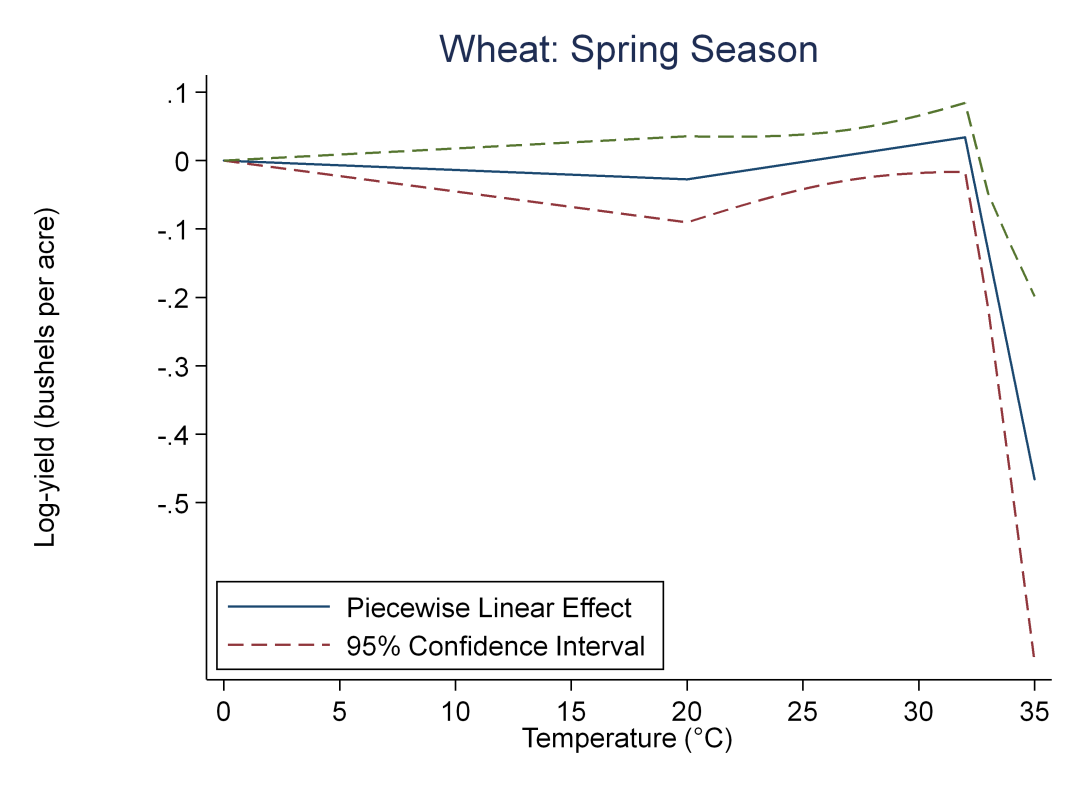
$$Y_{ijt} = \beta_{c_1} C_{jt} + \beta_{c_2} C_{jt} f_{ijt} + q_i(t) + \gamma_i + \mu_{ijt} \quad (1)$$

- Dryland corn or wheat yields (Y_{ijt}) for a farm i in county j and year t is regressed on weather variables (C_{jt}), weather-insurance interaction, quadratic time trends ($q_i(t)$) vary by farms and farm level fixed effects (γ_i).

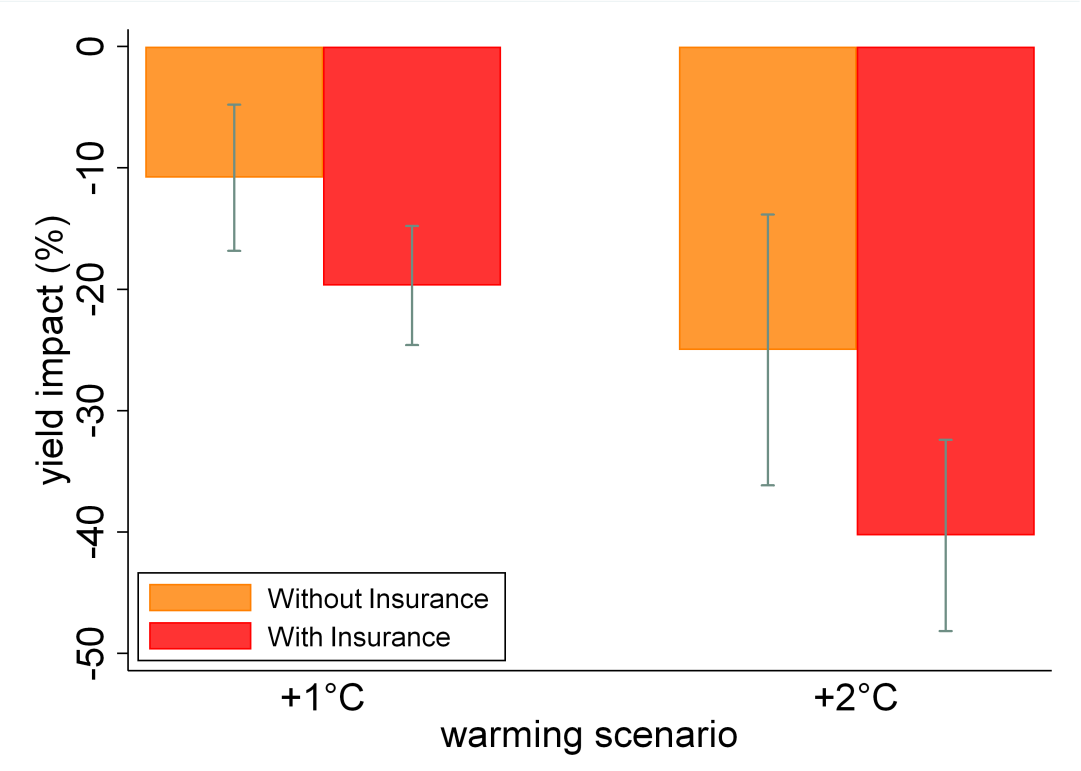
Corn Piecewise Linear Estimation



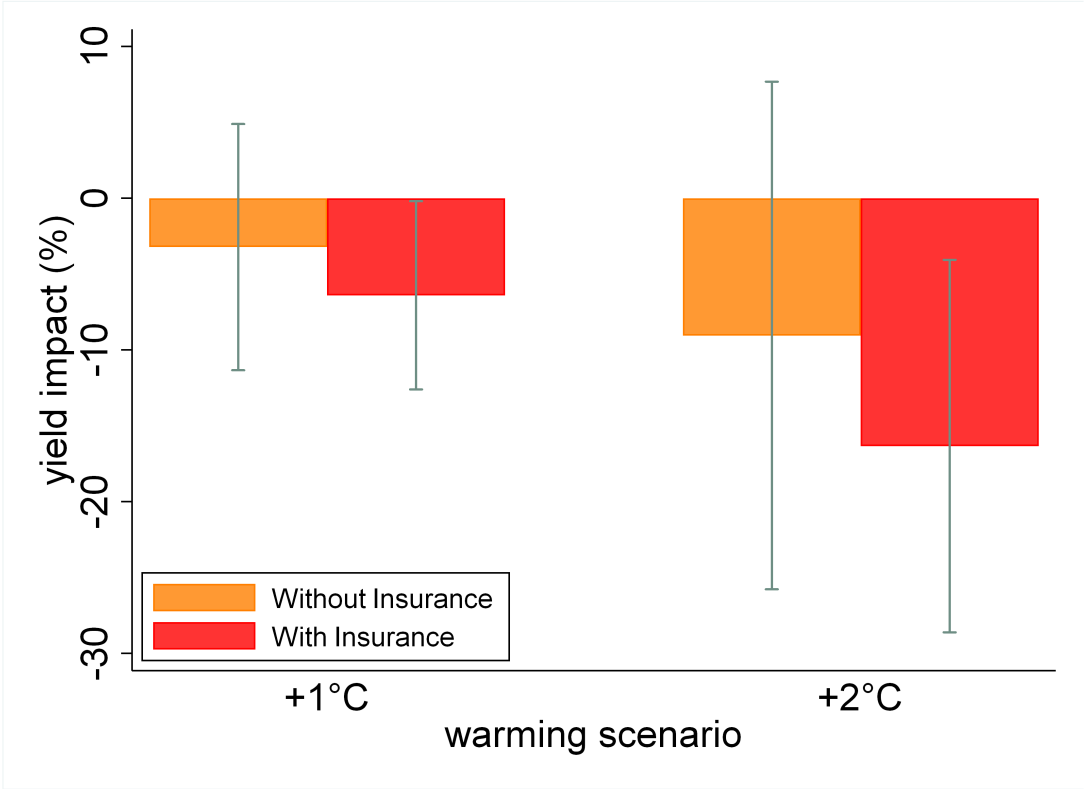
Wheat Piecewise Linear Estimation



Corn Warming Impacts



Wheat Warming Impacts



Results: For Corn

Table: Panel Regression for Corn Yield

	(1) 65%	(2) 65%	(3) 70%	(4) 70%
Precipitation	0.384***	0.303***	0.384***	0.315***
	(0.122)	(0.108)	(0.122)	(0.112)
Precipitation squared	-0.029***	-0.023***	-0.029***	-0.024***
	(0.008)	(0.007)	(0.008)	(0.007)
Low heat	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Moderate heat	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Extreme heat	-0.010***	-0.008***	-0.010***	-0.008***
	(0.001)	(0.002)	(0.001)	(0.002)
Precipitation × Fraction insured		0.221**		0.231**
		(0.098)		(0.108)
Precipitation squared × Fraction insured		-0.016**		-0.017**
		(0.007)		(0.008)
Low heat × Fraction insured		-0.000		-0.000
		(0.000)		(0.000)
Moderate heat × Fraction insured		-0.000		-0.000
		(0.000)		(0.000)
Extreme heat × Fraction insured		-0.003**		-0.003**
		(0.001)		(0.001)
Farm Fixed Effects	Yes	Yes	Yes	Yes
TemprInteraction		0.000		0.000
PrecInteraction		0.060		0.081
WeatherInteraction				0.002

Notes: Table shows the regression of log corn yield on quadratic trend, quadratic precipitation, moderate heat (10 to 29°C) and extreme heat (29°C to infinity), for 65% and 70% expected indemnities. Column (2) and (4) extend these regressions by adding the interaction of corn insured acreage with heat variables and also with quadratic precipitation. All columns include farm fixed effects. Standard errors in the parentheses are clustered at year level. ***, ** and * respectively denotes statistical significance at 1%, 5% and 10% level.

Results: For Wheat

Table: Panel Regression for Wheat Yield

	(1) 65%	(2) 65%	(3) 70%	(4) 70%
Precipitation	0.555***	0.398**	0.555***	0.406**
	(0.153)	(0.181)	(0.153)	(0.176)
Precipitation squared	-0.109***	-0.093***	-0.109***	-0.093***
	(0.028)	(0.030)	(0.028)	(0.030)
Freeze	-0.014	-0.018	-0.014	-0.017
	(0.026)	(0.025)	(0.026)	(0.025)
Low heat	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Moderate heat	0.004	0.003	0.004	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
Extreme heat	-0.151***	-0.096**	-0.151***	-0.099**
	(0.044)	(0.046)	(0.044)	(0.046)
Precipitation × Fraction insured		0.194		0.195
		(0.180)		(0.179)
Precipitation squared × Fraction insured		-0.018		-0.019
		(0.029)		(0.029)
Freeze × Fraction insured		0.004		0.003
		(0.009)		(0.009)
Low heat × Fraction insured		-0.000		-0.000
		(0.000)		(0.000)
Moderate heat × Fraction insured		0.002		0.002
		(0.002)		(0.002)
Extreme heat × Fraction insured		-0.071*		-0.070*
		(0.040)		(0.040)
Farm Fixed Effects	Yes	Yes	Yes	Yes
TemprInteraction		0.130		0.142
PrecInteraction		0.095		0.103
WeatherInteraction		0.048		0.056

Notes: Table shows the regression of log Wheat yield on quadratic trend, quadratic precipitation, moderate heat (20 to 32°C) and extreme heat (32°C to infinity), for 65% and 70% expected indemnities. Column (2) and (4) extend these regressions by adding the interaction of Wheat insured acreage with two heat variables and also with quadratic precipitation. All columns include farm fixed effects. Standard errors in the parentheses are clustered at year and farm level. ***, ** and * respectively denotes statistical significance at 1%,5% and 10% level.

Conclusions

- The purpose of this study is to estimate yield risk due to crop insurance under extreme heat.
- Using KFMA Data from 1993-2015, we find that higher intensity of CI use under extreme heat reduces the dryland crop yields.
- We estimate that insured corn is 38% more sensitive to extreme heat than uninsured corn.
- We obtain that the insured wheat is 74% more sensitive to extreme heat than uninsured wheat.
- Thus, evidence exits that federal crop insurance create disincentives to adapt to extreme heat for both dryland corn and wheat in Kansas.

Annan, F. and Schlenker, W. (2015). Federal crop insurance and the disincentive to adapt to extreme heat. *The American Economic Review*, 105(5):262–266.

Annan, F., Tack, J., Harri, A., and Coble, K. (2013). Spatial pattern of yield distributions: Implications for crop insurance. *American Journal of Agricultural Economics*, page aat085.

Goodwin, B. K. (1993). An empirical analysis of the demand for multiple peril crop insurance. *American Journal of Agricultural Economics*, 75(2):425–434.

Goodwin, B. K. (1994). Premium rate determination in the federal crop insurance program: What do averages have to say about risk? *Journal of Agricultural and Resource Economics*, pages 382–395.

Tack, J., Coble, K., and Barnett, B. (2018). Warming temperatures will likely induce higher premium rates and government outlays for the us crop insurance program. *Agricultural Economics*.

Thank you!

Suggestions?

Questions?