Race and Premium Misrating in the U.S. Federal Crop Insurance Program

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Two Stylized Facts

1. History of racial discrimination within USDA programs
   - 1999 *Pigford v. Glickman* class action settlement
     - USDA found to have discriminated against Black farmers by providing inadequate access to farm loans, disaster payments, crop payments, and other federal financial aid
     - Less than 1% of disaster payments between 1990 to 1995 went to Black farmers while 97% went to White farmers
   - Focus on FSA programs and access to credit (loan programs)

2. Documented misrating of crop insurance premiums
   - Woodard et al. (2012): "substantial" misrating across space resulting in net premium transfers of $\approx 26\%$ of total premiums annually
   - Chen, Dall'Erba, & Sherrick (2020): Roughly 40% of US counties display some degree of misrating with a significant pattern of spatial autocorrelation.

Research Question

Does producer race have explanatory power in a model of crop insurance misrating?

Analytic Approach

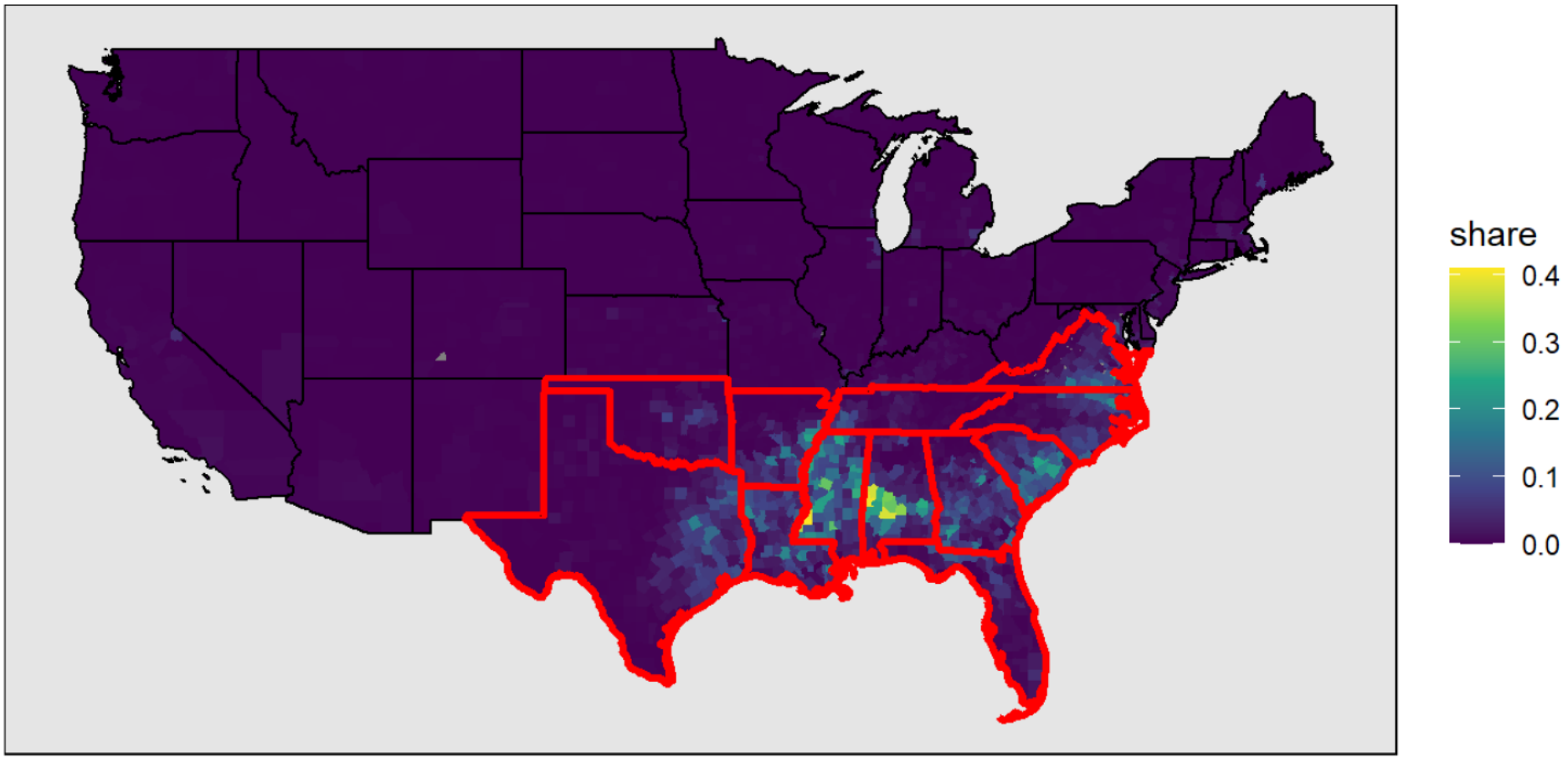
We adopt and expand the approach of Woodard et al. (2012) to account for producer race in a model of crop insurance misrating:

1. Gather county-level crop insurance data from USDA Risk Management Agency's Summary of Business

2. Merge with county-level yield (NASS) and producer demographic data (Census of Agriculture)

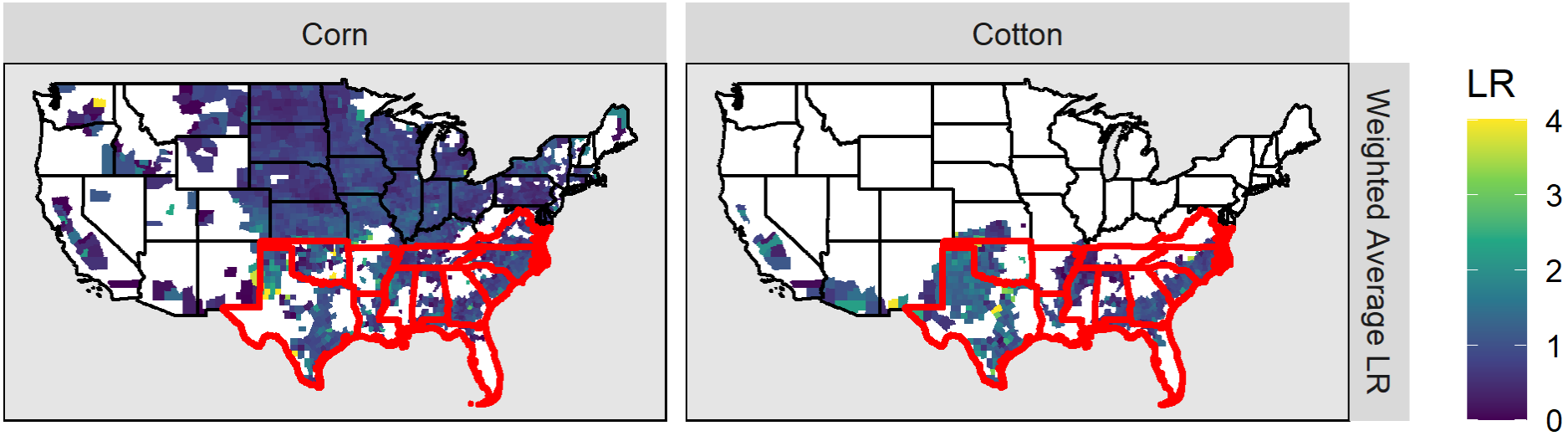
3. Estimate a spatial econometric model of county-level loss ratios and see if producer race has explanatory power

Black and African American (BAA) Producers in the US



Share of producers who are Black and African American (BAA), 2002–2017.
Red borders signify the 12 states with the highest BAA share.
Data Source: USDA Census of Agriculture (2002, 2007, 2012, & 2017).

Maps of Loss Ratios (LR) for Corn and Cotton



Weighted average LR for corn and cotton, 2000–2019.
Data Source: USDA RMA Summary of Business.

Model

Since crop insurance rates are established at the county level, we conduct our analysis at the county level. Following Woodard et al. (2012), we estimate a spatial lag model using spatial two-stage least squares (S2SLS):

$$\mathbf{L} = \rho\mathbf{W}\mathbf{L} + \mathbf{X}\beta + \mathbf{u}$$

where:

- **L** is a county's expected loss ratio.
- **W** is a spatial queen weights matrix for contiguous counties.
- ρ is a spatial autoregressive coefficient.
- **X** are systematic factors measured at the county level.
  - Demographic, Insurance Choice, and Yield Information
- **u** is an error term.

If ρ or any element of β is statistically significantly different from zero, it is evidence of premium misrating.

Estimated Effects and Elasticities for *BAA Share*

	Premium Weighted Average Loss Ratio			
	Total Effect		Elasticity	
	Direct	Multiplier	Direct	Multiplier
Corn, All States				
Pooled	0.893**	1.183**	0.017**	0.023**
1st	-0.436	-0.761	-0.008	-0.014
2nd	0.62+	1.372+	0.015+	0.034+
3rd	0.057	0.195	0.001	0.003
4th	1.118**	2.657**	0.028**	0.065**
Corn, High BAA Share States				
Pooled	0.359	0.396	0.018	0.02
1st	0.298	0.268	0.018	0.016
2nd	-0.509	-0.752	-0.026	-0.039
3rd	0.074	0.13	0.004	0.007
4th	0.06	0.357	0.004	0.021
Cotton, All States				
Pooled	-1.328**	-2.068**	-0.064**	-0.099**
1st	0.166	0.284	0.007	0.012
2nd	-0.836*	-2.249*	-0.048*	-0.13*
3rd	-0.506	-8.353	-0.03	-0.492
4th	-0.744*	-3.361*	-0.04*	-0.18*
Cotton, High BAA Share States				
Pooled	-0.99*	-1.897*	-0.051*	-0.098*
1st	0.294	0.605	0.013	0.028
2nd	-0.892*	-2.15*	-0.054*	-0.13*
3rd	-0.366	-16.695	-0.023	-1.07
4th	-0.65*	-9.355*	-0.038*	-0.547*

Statistical significance markers refer to regression output tables included in the appendix:
+ p <0.1, * p <0.05, ** p <0.01, *** p <0.001
1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.

Overview of Findings and Important Caveats

- Findings
  - For corn, evidence that counties with higher proportions of Black and African American (BAA) producers have higher loss ratios (face premiums that are actuarially too low)
  - For cotton, evidence that counties with a higher share of BAA producers have lower loss ratios (face premiums that are actuarially too high)

- Caveats
  - Demographic data are not specific to individual crops.
  - We do not have data on crop insurance participation by race.
  - We cannot isolate the mechanism by which race explains misrating.
  - We are not making a claim about causality; there are many potential explanations for the patterns we find (access to credit, crop choices, farm sizes, etc.).

Appendix

Data: systematic factors

As in Woodard et al. (2012), we include the following systematic factors as elements of $\mathbf{X}$:

- *Trend*: county-crop-specific historic yield trend since 1975
- *CV*: county-crop yield variability since 1975 (coefficient of variation)
- *Cover*: index of coverage level choices
- *Rev*: index of revenue plan participation
- *Group*: index of group plan participation
- *DownDevRatio*: ratio of downside yield deviations across sample periods

We also include a county-level measure of producer race:

- *BAA share*: share of agricultural producers in a county who are Black and African American (BAA)

Selected Summary Statistics

	AvgLR	*wAvgLR*	*Cover*	*Rev*	*Group*	*CV*	*Trend*	*DownDevRatio*	*BAA share*	Number of observations
Mean										
Corn, full sample	0.71	0.87	0.72	0.79	0.03	0.26	1.6	1.08	0.02	1945
Corn, high BAA share states	0.64	0.93	0.68	0.71	0.01	0.32	1.63	1.13	0.05	629
Cotton, full sample	0.67	1	0.69	0.66	0	0.32	8.97	0.98	0.05	505
Cotton, high BAA share states	0.67	1	0.69	0.67	0	0.32	8.86	1	0.05	466
Median										
Corn, full sample	0.66	0.82	0.72	0.88	0	0.25	1.57	0.96	0	1945
Corn, high BAA share states	0.63	0.87	0.69	0.77	0	0.32	1.49	1.04	0.03	629
Cotton, full sample	0.61	0.96	0.69	0.72	0	0.31	9.44	0.85	0.02	505
Cotton, high BAA share states	0.62	0.96	0.69	0.73	0	0.32	9.32	0.86	0.03	466
Standard deviation										
Corn, full sample	1.01	0.44	0.06	0.24	0.09	0.08	0.87	1.26	0.04	1945
Corn, high BAA share states	0.33	0.57	0.05	0.24	0.03	0.08	1.06	1.23	0.06	629
Cotton, full sample	0.36	0.56	0.04	0.24	0.02	0.09	13.01	1.23	0.06	505
Cotton, high BAA share states	0.35	0.56	0.04	0.22	0.02	0.09	9.29	1.26	0.06	466

Note: Summary statistics are reported for our full study period of 2000–2019. For each crop, our "full sample" includes relevant counties from all 48 contiguous U.S. states. The "high BAA share states" include Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

Results: corn, all states

	Average Loss Ratio					Weighted Average Loss Ratio				
	Pooled	1st	2nd	3rd	4th	Pooled	1st	2nd	3rd	4th
ρ	0.494	0.715	0.717***	0.753***	0.613***	0.245	0.427***	0.549***	0.706***	0.579***
	(0.366)	(0.449)	(0.095)	(0.050)	(0.089)	(0.159)	(0.119)	(0.120)	(0.050)	(0.113)
Intercept	-0.323	-0.589	0.048	-0.817**	-0.326	-0.150	-0.456	-0.023	-1.193***	-0.349
	(0.779)	(0.716)	(0.139)	(0.267)	(0.242)	(0.291)	(0.366)	(0.208)	(0.293)	(0.369)
BAA share	-0.040	-0.881	0.106	-0.119	0.622*	0.893**	-0.436	0.620+	0.057	1.118**
	(0.191)	(0.637)	(0.204)	(0.202)	(0.261)	(0.308)	(0.389)	(0.327)	(0.273)	(0.374)
Cover	1.108	1.612+	-0.083	1.246**	0.782*	0.991*	0.894	0.125	1.855***	1.206*
	(1.357)	(0.972)	(0.228)	(0.427)	(0.352)	(0.418)	(0.620)	(0.350)	(0.479)	(0.504)
Group	-0.328	-0.923+	0.127	-0.085	-0.259	-0.193	-0.240	0.1	-0.512**	-0.526**
	(0.600)	(0.538)	(0.105)	(0.218)	(0.183)	(0.171)	(0.296)	(0.159)	(0.164)	(0.181)
Rev	-0.128	-0.323	0.076	-0.013	-0.078	0.055	0.116	0.069	0	-0.392*
	(0.493)	(0.580)	(0.048)	(0.097)	(0.100)	(0.094)	(0.131)	(0.072)	(0.118)	(0.155)
Trend	-0.044	-0.004	-0.038**	-0.021	0.012	-0.062**	-0.125***	-0.071***	-0.051**	-0.019
	(0.033)	(0.153)	(0.013)	(0.015)	(0.014)	(0.023)	(0.035)	(0.019)	(0.017)	(0.020)
CV	0.19	0.076	0.547**	0.191	-0.206	0.446**	1.202***	1.045***	0.385*	0.102
	(0.149)	(1.219)	(0.194)	(0.153)	(0.155)	(0.156)	(0.249)	(0.311)	(0.174)	(0.188)
DownDevRatio	0.012	-0.039	0.016	0.098***	0.108***	0.02	0.175***	0.022+	0.120***	0.147***
	(0.021)	(0.220)	(0.010)	(0.016)	(0.022)	(0.023)	(0.032)	(0.012)	(0.016)	(0.029)
N	1945	1842	1810	1743	1710	1945	1842	1810	1743	1710

Robust standard errors in parentheses. + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.

Results: corn, high BAA share states

	Average Loss Ratio					Weighted Average Loss Ratio				
	Pooled	1st	2nd	3rd	4th	Pooled	1st	2nd	3rd	4th
ρ	-0.004	0.460**	0.545***	0.483***	0.794***	0.094	-0.112	0.323*	0.433***	0.830***
	(0.191)	(0.155)	(0.130)	(0.116)	(0.096)	(0.251)	(0.252)	(0.150)	(0.125)	(0.097)
Intercept	0.482	-0.114	-0.205	-0.242	-1.047*	0.18	-0.560	-0.692	0.278	-1.673*
	(0.313)	(0.247)	(0.282)	(0.528)	(0.473)	(0.693)	(0.491)	(0.439)	(0.611)	(0.657)
BAA share	0.243	0.031	-0.161	-0.140	0.023	0.359	0.298	-0.509	0.074	0.06
	(0.202)	(0.245)	(0.247)	(0.291)	(0.267)	(0.392)	(0.435)	(0.393)	(0.356)	(0.363)
Cover	0.099	0.322	0.415	0.923	1.735*	0.863	1.198	1.430+	0.105	2.844**
	(0.487)	(0.393)	(0.463)	(0.868)	(0.702)	(0.999)	(0.763)	(0.769)	(1.017)	(0.928)
Group	0.986*	-0.311	0.292	-0.129	25.221	0.837	0.572	0.193	-0.156	-99.311**
	(0.477)	(0.299)	(0.295)	(1.319)	(84.856)	(0.686)	(0.756)	(0.423)	(0.806)	(37.481)
Rev	0.303**	0.174**	0.104	0.13	-0.014	0.273	0.580**	0.169	0.327+	-0.216
	(0.099)	(0.061)	(0.090)	(0.154)	(0.133)	(0.172)	(0.185)	(0.135)	(0.195)	(0.182)
Trend	-0.054*	-0.086**	-0.064**	-0.004	0.037	-0.051	-0.178**	-0.114***	-0.018	0.005
	(0.023)	(0.032)	(0.022)	(0.021)	(0.026)	(0.048)	(0.056)	(0.031)	(0.031)	(0.031)
CV	-0.220	0.679*	0.841*	-0.661+	-0.457	-0.238	1.699***	1.526**	-0.616	-0.237
	(0.207)	(0.271)	(0.330)	(0.380)	(0.347)	(0.379)	(0.478)	(0.485)	(0.523)	(0.395)
DownDevRatio	0.012	0.082*	0.021+	0.075**	0.072+	0.019	0.148***	0.039*	0.122***	0.100*
	(0.013)	(0.035)	(0.013)	(0.024)	(0.037)	(0.026)	(0.045)	(0.019)	(0.030)	(0.045)
N	629	577	555	514	498	629	577	555	514	498

Robust standard errors in parentheses. + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.

Results: cotton, all states

	Average Loss Ratio					Weighted Average Loss Ratio				
	Pooled	1st	2nd	3rd	4th	Pooled	1st	2nd	3rd	4th
ρ	0.424**	0.372*	0.622***	0.992***	0.895***	0.358*	0.417**	0.628***	0.939***	0.779***
	(0.155)	(0.161)	(0.111)	(0.086)	(0.108)	(0.181)	(0.140)	(0.108)	(0.076)	(0.146)
Intercept	0.039	-0.295	-0.266	-0.439	-0.221	-1.113*	-2.344***	-1.318***	-0.829*	-0.836*
	(0.367)	(0.245)	(0.222)	(0.335)	(0.367)	(0.511)	(0.353)	(0.327)	(0.377)	(0.424)
BAA share	-0.662*	0.354	-0.655*	-0.319	-0.407	-1.328**	0.166	-0.836*	-0.506	-0.744*
	(0.303)	(0.345)	(0.260)	(0.265)	(0.275)	(0.476)	(0.457)	(0.354)	(0.341)	(0.315)
Cover	0.363	0.741*	0.655+	0.709	0.513	2.438**	3.566***	2.086***	1.192+	1.522*
	(0.511)	(0.355)	(0.341)	(0.541)	(0.488)	(0.748)	(0.730)	(0.538)	(0.630)	(0.669)
Group	0.283	0.714	0.082	-2.428	-15.879	-1.364	0.209	-0.141	-5.352*	3.807
	(0.555)	(0.637)	(0.152)	(1.853)	(25.273)	(0.851)	(0.826)	(0.298)	(2.179)	(49.083)
Rev	0.163+	0.233*	-0.026	0.098	-0.014	-0.088	0.211+	0.154	0.127	-0.028
	(0.090)	(0.093)	(0.065)	(0.133)	(0.125)	(0.139)	(0.126)	(0.115)	(0.176)	(0.330)
Trend	-0.002	0.003**	-0.003*	-0.003	-0.005	-0.005+	0.001	-0.004*	-0.002	-0.008*
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
CV	-0.052	0.301	0.199	-0.390	-0.133	0.525	1.556*	0.705+	-0.067	0.081
	(0.205)	(0.218)	(0.213)	(0.262)	(0.274)	(0.349)	(0.621)	(0.371)	(0.323)	(0.285)
DownDevRatio	0.054***	0.068***	0.066***	0.057*	0.070+	0.086***	0.109***	0.076**	0.053	0.07
	(0.009)	(0.021)	(0.015)	(0.023)	(0.039)	(0.021)	(0.024)	(0.023)	(0.034)	(0.046)
N	505	456	451	403	385	505	456	451	403	385

Robust standard errors in parentheses. + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.

Results: cotton, high BAA share states

	Average Loss Ratio					Weighted Average Loss Ratio				
	Pooled	1st	2nd	3rd	4th	Pooled	1st	2nd	3rd	4th
ρ	0.461*	0.468***	0.729***	0.989***	0.928***	0.478*	0.513***	0.585***	0.978***	0.931***
	(0.188)	(0.141)	(0.128)	(0.090)	(0.107)	(0.200)	(0.135)	(0.127)	(0.085)	(0.099)
Intercept	0.195	-0.334	-0.227	-0.356	-0.326	-0.693	-2.151***	-1.250***	-0.780*	-0.706+
	(0.454)	(0.272)	(0.230)	(0.318)	(0.379)	(0.565)	(0.389)	(0.355)	(0.359)	(0.402)
BAA share	-0.573+	0.291	-0.598*	-0.294	-0.420	-0.990*	0.294	-0.892*	-0.366	-0.650*
	(0.310)	(0.343)	(0.297)	(0.248)	(0.256)	(0.497)	(0.509)	(0.411)	(0.304)	(0.284)
Cover	0.129	0.719+	0.559	0.612	0.804	1.746*	3.083***	2.042***	1.187*	1.281*
	(0.619)	(0.393)	(0.346)	(0.493)	(0.510)	(0.837)	(0.820)	(0.587)	(0.530)	(0.558)
Group	0.394	0.76	0.115	-1.913	-14.954	-0.881	0.429	-0.155	-4.879*	5.572
	(0.555)	(0.632)	(0.151)	(1.911)	(24.617)	(0.730)	(0.819)	(0.320)	(2.246)	(46.797)
Rev	0.142	0.166+	-0.024	0.039	-0.151	-0.118	0.174	0.151	0.021	-0.099
	(0.127)	(0.092)	(0.065)	(0.101)	(0.136)	(0.162)	(0.139)	(0.118)	(0.133)	(0.161)
Trend	-0.004	0.004**	0	-0.003	-0.006	-0.012***	0.001	-0.005	-0.004	-0.005
	(0.004)	(0.001)	(0.002)	(0.003)	(0.006)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
CV	-0.034	0.332	0.061	-0.325	-0.083	0.533	1.638*	0.748+	-0.046	0.076
	(0.213)	(0.229)	(0.234)	(0.284)	(0.265)	(0.370)	(0.705)	(0.401)	(0.349)	(0.289)
DownDevRatio	0.053***	0.060***	0.050**	0.067**	0.053	0.086***	0.102***	0.078*	0.062+	0.001
	(0.012)	(0.016)	(0.019)	(0.025)	(0.042)	(0.020)	(0.024)	(0.031)	(0.037)	(0.043)
N	466	426	419	377	361	466	426	419	377	361

Robust standard errors in parentheses. + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.

Interpreting effects

How "big" are our results?

- **Total effect**: estimated coefficient for each variable
- **Elasticity**: total effect multiplied by the mean of the independent variable, divided by the mean of the dependent variable (i.e. elasticity calculated at mean values)

How do we consider spatial spillovers?

- **Direct effect**: the average impact an independent variable has on the loss ratio taking into account only the own county's independent variable impacts
- **Multiplier effect**: account for the proportion of the independent variable effect that impacts the loss ratio via the spatial lag term

$$\text{Multiplier effect} = \frac{\text{Direct effect}}{1 - \hat{\rho}}$$

Estimated effects and elasticities for *BAA share*

	Average Loss Ratio				Premium Weighted Average Loss Ratio			
	Total Effect		Elasticity		Total Effect		Elasticity	
	Direct	Multiplier	Direct	Multiplier	Direct	Multiplier	Direct	Multiplier
Corn, All States								
Pooled	-0.04	-0.078	-0.001	-0.002	0.893**	1.183**	0.017**	0.023**
1st	-0.881	-3.088	-0.017	-0.061	-0.436	-0.761	-0.008	-0.014
2nd	0.106	0.374	0.003	0.012	0.62+	1.372+	0.015+	0.034+
3rd	-0.119	-0.482	-0.002	-0.008	0.057	0.195	0.001	0.003
4th	0.622*	1.608*	0.018*	0.047*	1.118**	2.657**	0.028**	0.065**
Corn, High BAA share States								
Pooled	0.243	0.242	0.018	0.018	0.359	0.396	0.018	0.02
1st	0.031	0.058	0.003	0.005	0.298	0.268	0.018	0.016
2nd	-0.161	-0.354	-0.012	-0.026	-0.509	-0.752	-0.026	-0.039
3rd	-0.14	-0.27	-0.01	-0.019	0.074	0.13	0.004	0.007
4th	0.023	0.11	0.002	0.009	0.06	0.357	0.004	0.021
Cotton, All States								
Pooled	-0.662*	-1.149*	-0.047*	-0.082*	-1.328**	-2.068**	-0.064**	-0.099**
1st	0.354	0.564	0.023	0.036	0.166	0.284	0.007	0.012
2nd	-0.655*	-1.734*	-0.057*	-0.151*	-0.836*	-2.249*	-0.048*	-0.13*
3rd	-0.319	-37.814	-0.027	-3.148	-0.506	-8.353	-0.03	-0.492
4th	-0.407	-3.86	-0.028	-0.264	-0.744*	-3.361*	-0.04*	-0.18*
Cotton, High BAA share States								
Pooled	-0.573+	-1.062+	-0.044+	-0.082+	-0.99*	-1.897*	-0.051*	-0.098*
1st	0.291	0.546	0.02	0.037	0.294	0.605	0.013	0.028
2nd	-0.598*	-2.208*	-0.055*	-0.204*	-0.892*	-2.15*	-0.054*	-0.13*
3rd	-0.294	-27.556	-0.027	-2.514	-0.366	-16.695	-0.023	-1.07
4th	-0.42	-5.867	-0.031	-0.433	-0.65*	-9.355*	-0.038*	-0.547*

Statistical significance markers refer to regression output tables included in the appendix and are provided for reference: + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

1st period: 2000–2004; 2nd period: 2005–2009; 3rd period: 2010–2014; 4th period: 2015–2019.