Producer Heterogeneity in Crop Insurance Product Decisions within Major Corn Producing States

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Objectives and relevance

- Farmers' preference regarding insurance coverage has shifted continuously from Yield based to Revenue based insurance products.
- This research aims to provide insight into the following aspects:

  - » Examine ex-ante risk factors on decision making regarding choice of the insurance products.
  - » Identify the impact of implied price volatility on the selection of insurance products.
  - » Capture spatial dynamics due to spatial heterogeneity in ex-ante risk variables.

Outline of Presentation

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VARIABLE AND RELATIONSHIPS

MODEL AND ESTIMATION

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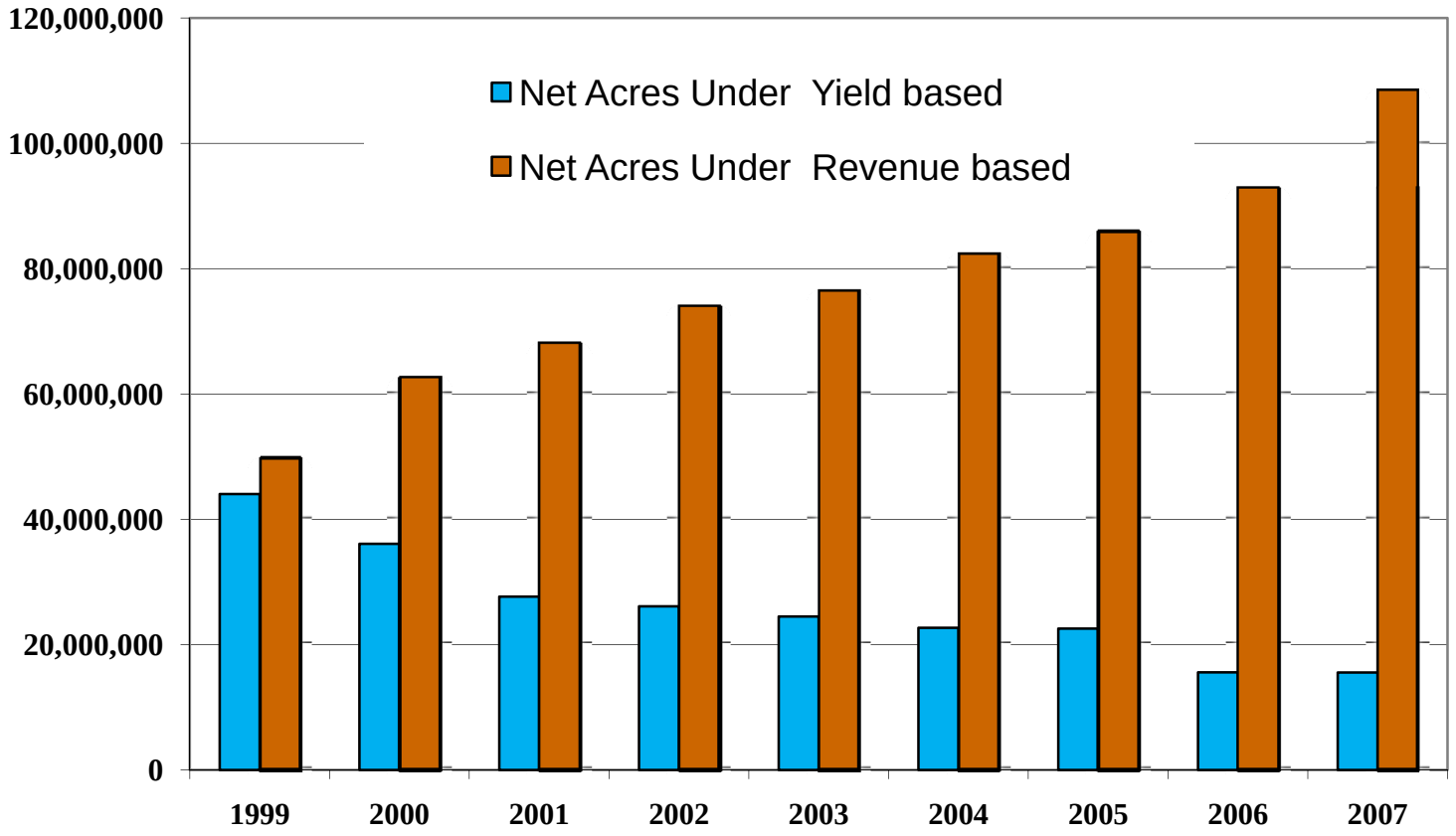
Background

- Farmers' participation has been one of the key indicators for the success of the crop insurance program.
- Subsidy is important for increasing participation in crop insurance program
  - » Demand for insurance is generally inelastic with respect to the premium (Barnett and Skees 1995, Coble and Knight, 2002, Shaik et. al, 2008).
  - » The marginal costs of enrolling additional acres into the program are high. However, price elasticity of revenue insurance is relatively high.
- Modeling of decision on yield or revenue protection is particularly important for modeling insurance participation from broader and dynamic perspective.
- Along with modeling of choice between insurance products, the heterogeneity in insurance decision should be well understood in order to predict future direction of participation.

Acreage Under Yield and Revenue Based Insurance



Background

- Key variables driving insurance purchase decision include:
  - » Expected yield
  - » Yield coefficient of variation
  - » Market price at the time of insurance purchase
  - » Price volatility
  - » Yield price correlation
- Dynamics of these variables for the decision regarding choice of yield based insurance products or revenue based insurance is the central issue addressed in this paper.

Literature Review

- Past research agrees that increased welfare is one of the most important justifications to increasing crop insurance participation(Coble et al, 1996; Coble et al, 1997, Wang et al, 1998; Makki and Somwaru, 2001)

- Sherrick et al (2003) evaluated farmers' preference for particular insurance products based on insurance product attributes.

- The revenue product is uniformly superior to yield insurance under both current (2002) and proposed (2008) Farm Bill structures of government payments (Vedenov and Power, 2008).

- Shaik et al (2008) used subjective probability approach to evaluate choice between yield and revenue insurance. They found that the price elasticity of revenue insurance is reported to be relatively more elastic (-0.88) than yield insurance.

Motivation

The intension of this research is to expand existing research in the following way:

- Explore the pattern of the substitution between yield and revenue insurance.
- Explore the spatial heterogeneity in insurance risk classification variables.
- Quantify spatial dynamics within the context of insurance decisions.

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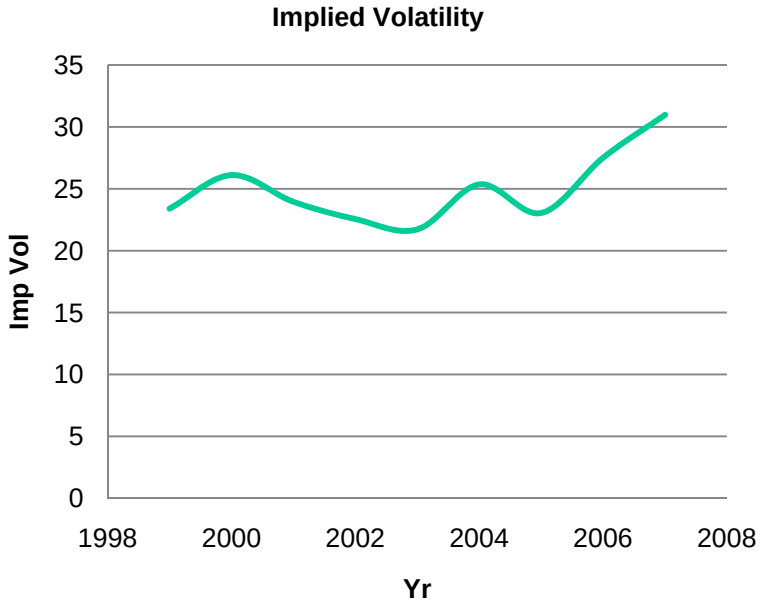
Data

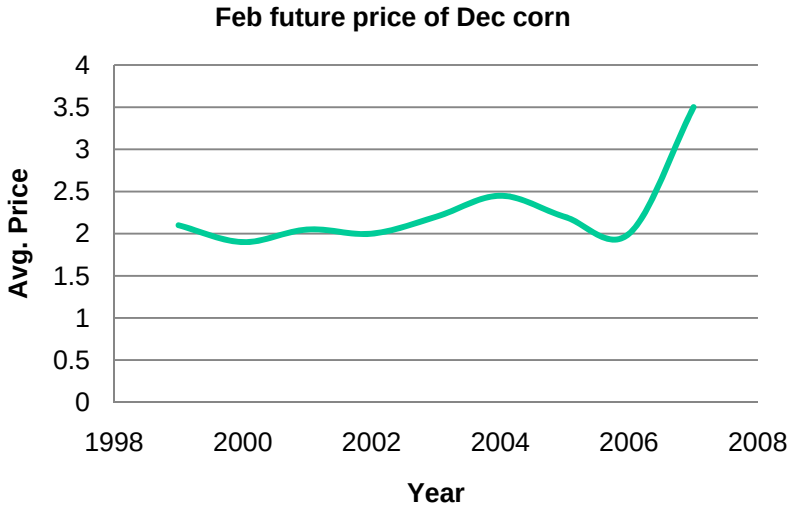
- Crop insurance data aggregated to the county level for the years 1999 to 2007 was taken from RMA website
- Corn yield data for the period of 1940 to 2007 was downloaded from NASS
- Futures and options price data for the year 1999 to 2007 were obtained from CBOT
- Data covered 102 counties in Illinois, 99 counties in Iowa and 91 counties in Nebraska

Variables

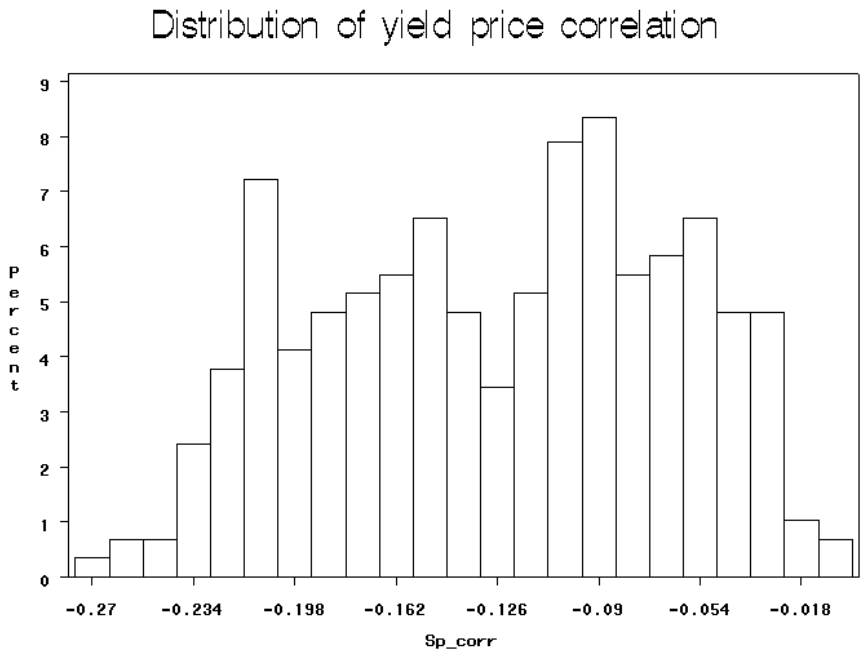
Variables	Variable Description	Mean	StdDev	Min	Max
PC_Rev_Acre	Percentage Acreage under Revenue based insurance	82.16	14.75	0.00	98.65
CV	Historical yield coefficient of variation for a particular county (county-specific)	24.17	2.64	19.09	33.10
Corr	Historical absolute value of correlation and squared absolute value of correlation between prices and yields (county-specific)	-0.13	0.06	-0.27	-0.01
Corr2		0.02	0.02	0.00	0.07
Vol	Implied volatility, based on average of Feb futures for contract due in Dec (time-specific)	24.95	2.74	21.72	27.97
Yield	Yield (county-specific)	88.23	34.86	7.90	173.10
Price	February future price of Dec corn based on same as volatility (time-specific)	2.26	0.46	1.90	3.50

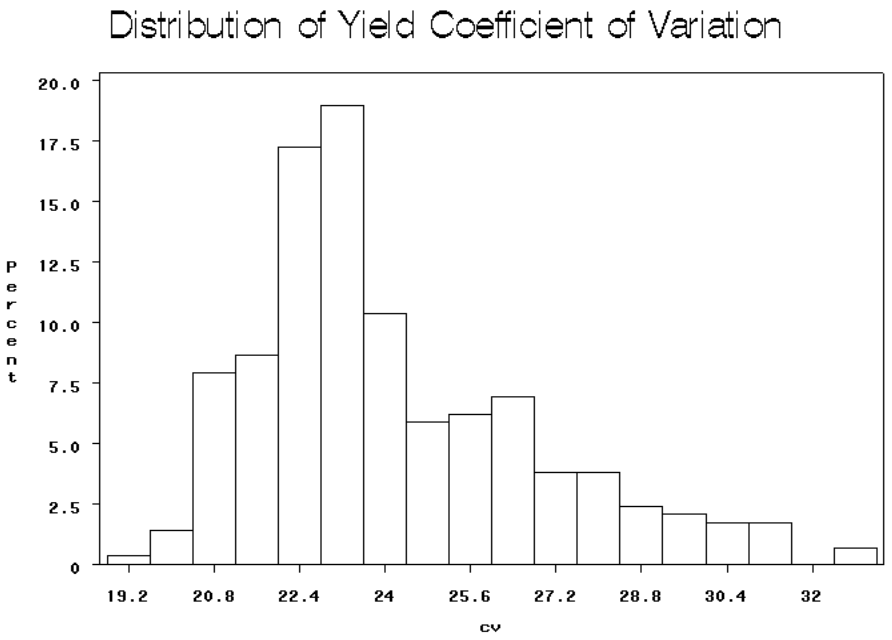
Variables


Implied Volatility
35
30
25
20
15
10
5
0
Imp Vol
1998
2000
2002
2004
2006
2008
Yr

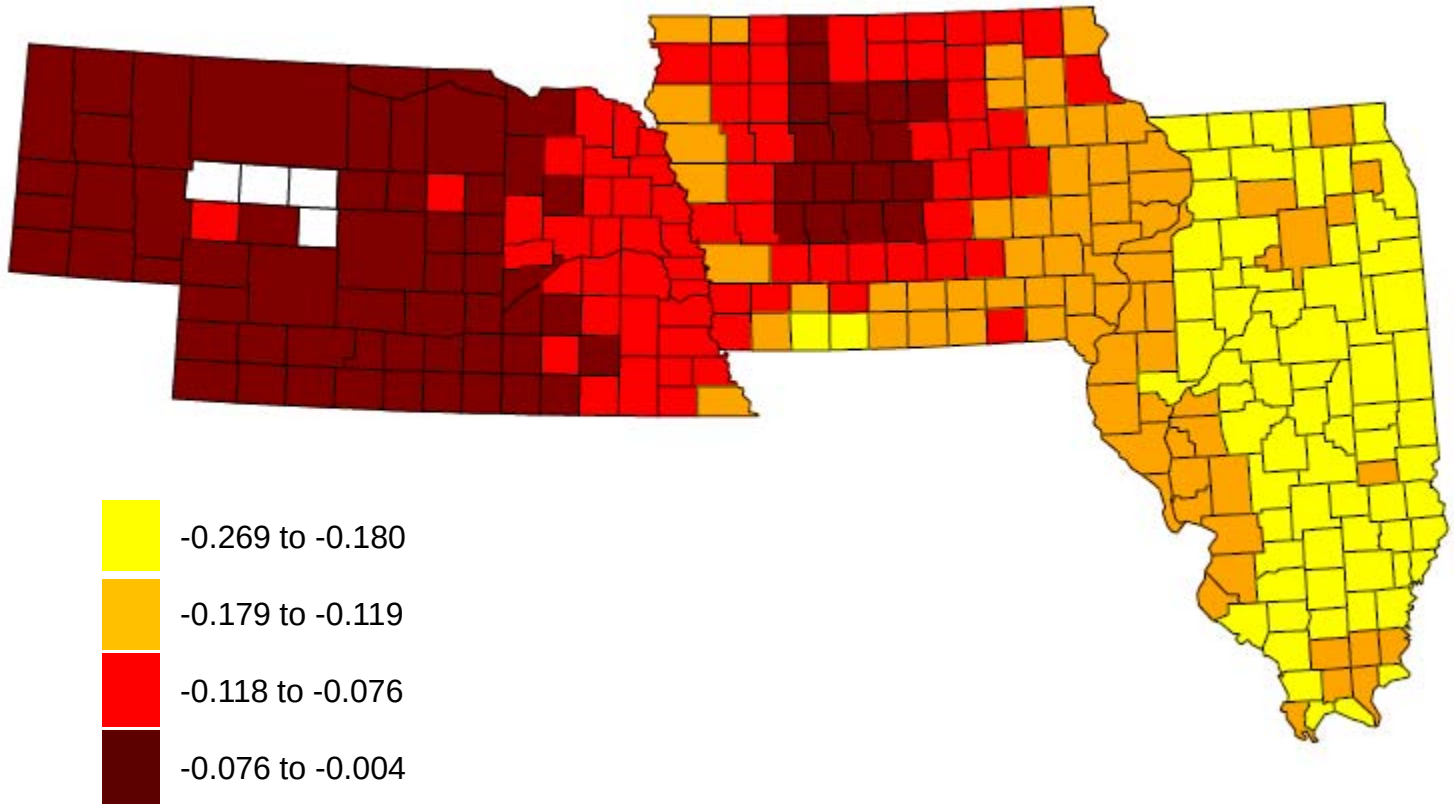

Feb future price of Dec corn
4
3.5
3
2.5
2
1.5
1
0.5
0
Avg. Price
1998
2000
2002
2004
2006
2008
Year

Variables

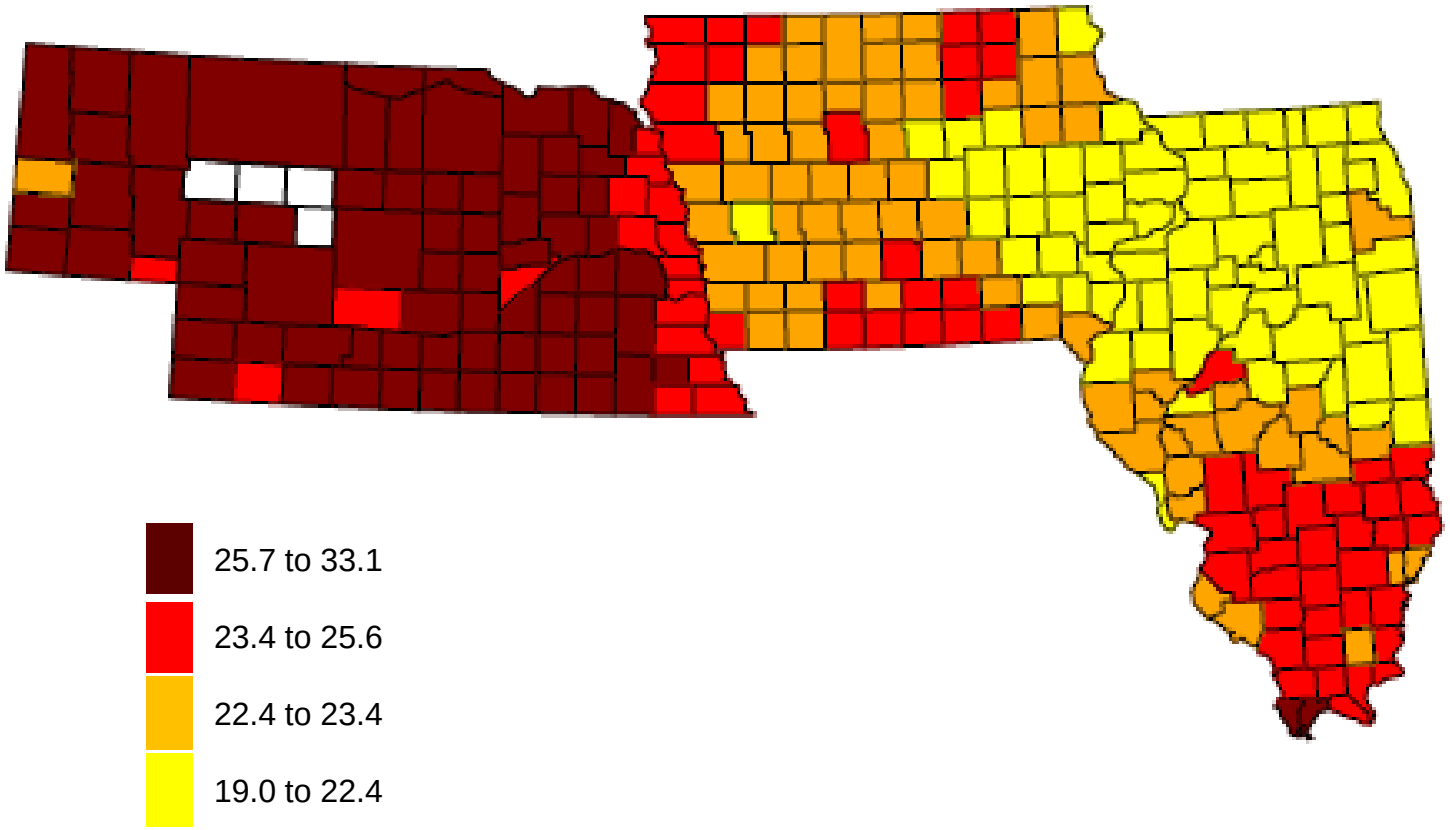

Distribution of yield price correlation
Percent
0
1
2
3
4
5
6
7
8
9
-0.27
-0.234
-0.198
-0.162
-0.126
-0.09
-0.054
-0.018
Sp_corr


Distribution of Yield Coefficient of Variation
Percent
0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
19.2
20.8
22.4
24
25.6
27.2
28.8
30.4
32
cv

Historical Yield-Price Correlation



Historical Yield Coefficient of Variation



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Modeling

- Spatial autocorrelation within the error components was tested from OLS regressions using Moran's I statistic (Moran, 1950), where the null is distributed according to N(0,1).

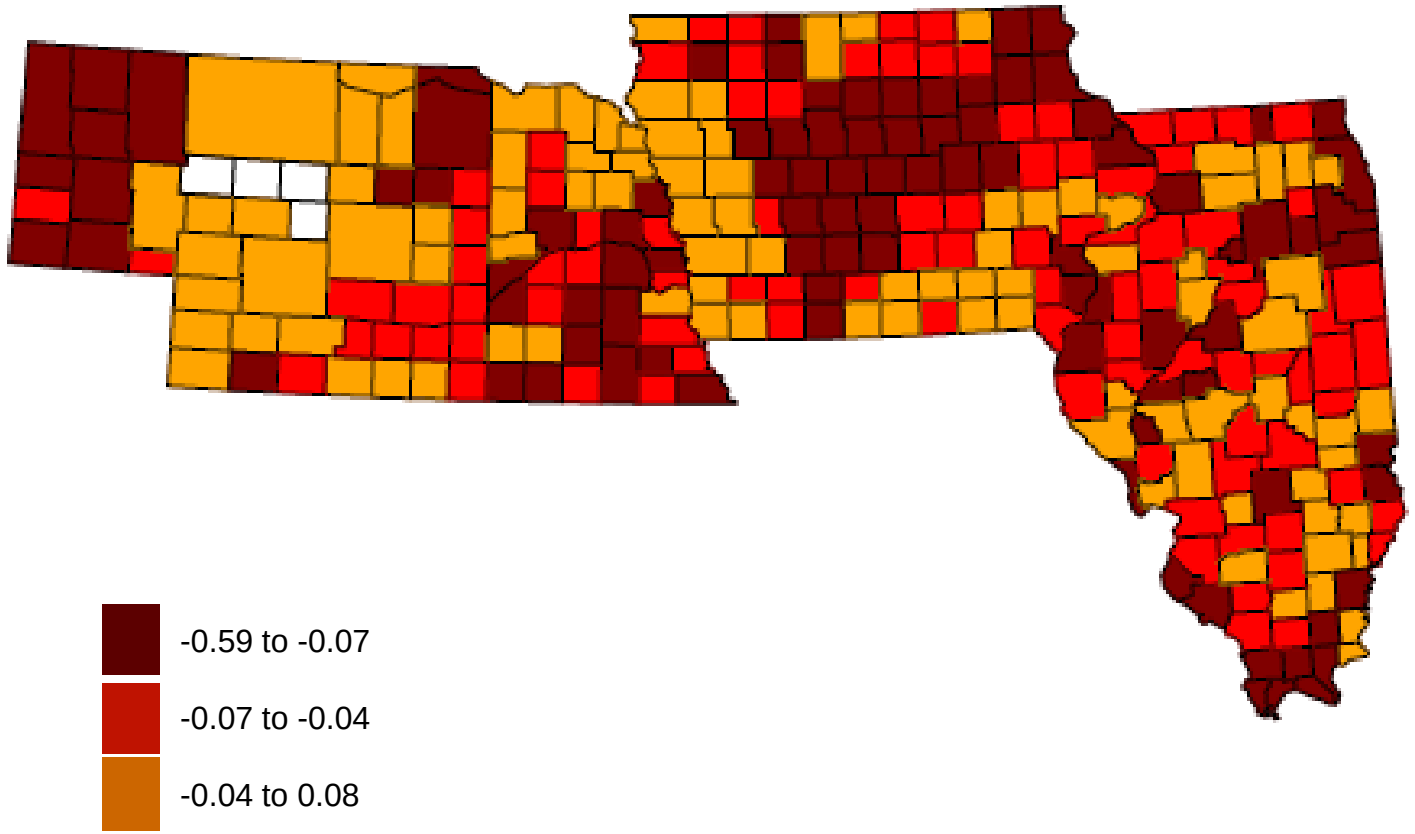
- Since this is a panel series, we can test for spatial correlation within time periods.

- All except for 2001 and 2004, the residuals exhibit significant positive spatial correlation.

Test for Spatial Autocorrelation

Year	Moran's I Statistic
2000	20.494
2001	0.456
2002	6.865
2003	12.828
2004	2.113
2005	17.651
2006	28.944
2007	18.428

Map of Spatially Correlated Residuals in 2006



Modeling

- The model is specified as follows:

$$y_{it} = \lambda y_{it-1} + \rho[W y_t] + \beta x_{it} + \varepsilon_{it}$$

- Where, y_{it} is the log of percentage acres insured by revenue-based plans, relative to yield and revenue-based insured acres in county *i* and time *t*.

- W is an *nxn* spatial weighting matrix that relates neighboring counties, such that rows sum to one and non-zero elements are equal for all neighboring counties.

Modeling

- The model is estimated using MLE methods, with the following Log-Likelihood function for a spatial lag model as specified by Anselin (1988):

$$LL = -\left(\frac{n}{2}\right)\log(2\pi\sigma^2) + \log(|\mathrm{I} - \rho\mathrm{W}|) - \frac{1}{2\sigma^2}(y - \rho Wy - X\beta)'(y - \rho Wy - X\beta)$$

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Parameter Estimates

Dependent Variable: Log(percentage of Acreage on Revenue based insurance)

Parameter	Estimate	Se	t
Lag1	0.520	0.012	44.877
Intercept	1.957	0.136	14.412
Cv	-0.009	0.001	-6.575
Corr	-1.293	0.212	-6.115
Corr2	3.939	0.742	5.278
Log(Yield)	-0.089	0.015	-5.921
Log(Vol)	0.367	0.031	11.835
Log(Price)	-0.253	0.019	-13.213
Rho	0.256	0.021	12.367
Sig2	0.016		

Parameter Estimates

Price Effect

$$y = -1.29\, corr + 3.94\, corr^2$$

$$\frac{dy}{dcorr} = -1.29 + 7.88\, corr$$

$$At\ mean\ corr, \frac{dy}{dcorr} = -0.234 \text{ and max y at corr } = -0.16$$

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Implications

- Addresses an important question on existence of spatial heterogeneity in decisions regarding the choice of insurance products.
  - Farmers exposure to risk and choice of insurance products are not consistent within the area
    - existence of external factors such as marketing drives by insurance companies or neighboring spill-over effect.
  - Decision regarding yield or revenue protection is not predicted solely by the conventional risk variables.

- Future work
  - Evaluation of the external variables that lead to the spatial heterogeneity is essential to predict the choice between two broad categories.
  - Alternative model specification to include spatial random effects
  - Evaluation of spatial heterogeneity by using individual farm data provide further insight into dynamics of heterogeneity.