Geographic Determinants of Preferences along U.S. Crop Insurance Subsidy Schedule

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Introduction

A LARGE VARIETY of subsidized crop insurance products are available to U.S. crop growers. Table 1 provides the subsidy rates presently available for crops insured at the unit level, where ϕ is the fraction of imputed yield that is covered and s is the premium subsidy rate. Figure 1 provides acreage-weighted revenue insurance coverage choice by county for corn in 2010, where the pattern is similar for yield insurance and for other crops. The coverage level chosen is greatest in the Central Cornbelt. We seek to explain this phenomenon. Empirical study of Risk Management Agency data on corn, soybean and wheat insurance contract choices lend support our model inferences.

Table 1. Crop insurance premium aubsidies on yield- and revenue-based products (government-paid portion of premium as a fraction of total premium)

Coverage level ϕ	CAT	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85
Subsidy rate s	1.0	0.67	0.64	0.64	0.59	0.59	0.55	0.48	0.38

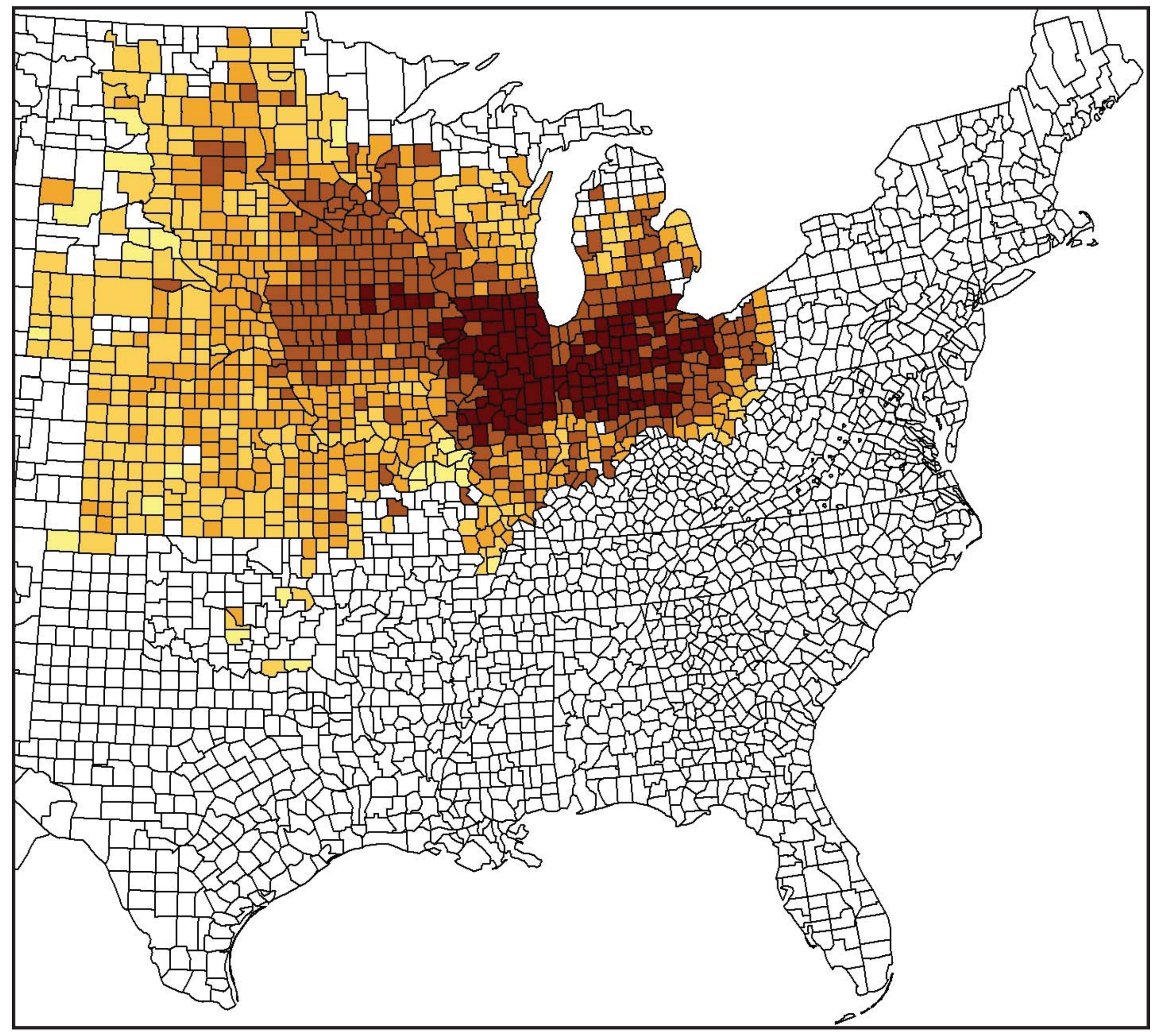

Figure 1. Acreage weighted revenue/yield insurance coverage levels, 2010

Data

WE EMPLOY CROP insurance contract choice data for the crop year 2010 as obtained from the Summary of Business. Reports and Data maintained by Risk Management Agency of U.S. Department of Agriculture (RMA). The dataset contains county-level crop insurance purchase information, including insured acreage under a variety of insurance contract choices and coverage levels for the major crops across the U.S. We focus on corn, soybean, and wheat for the analysis.

The yield-based insurance plan considered was Actual Production History (APH). Revenue-based insurance plans considered were Income protection, Crop Revenue Coverage and Indexed Income Protection. To calculate coverage level choices, acres insured under certain coverage levels across all insurance plans are aggregated. We focus on 13 states (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, OK, SD, and WI) for corn and soybean, and 11 states for wheat (omitting IA and WI). Only non-irrigated crops were considered.

Land Capability Class (LCC) data are obtained from the National Resource Inventory database. We aggregate the acreage in a given county under LCC I and II and calculate its percentage in the total acreage under LCC I-IV to represent the average soil quality in the county. This share is the LCC variable used below. For climate variables we employ the dataset developed in Schlenker and Roberts (2009) over 1975-2005. Growing-degree-days (GDD) is the sum of degrees in the range between lower and upper thresholds during the growing season. Temperature thresholds for corn and soybean are 8°C and 32°C, while they are 0°C and 25°C for wheat. We choose April-September as the growing season for corn and soybean, and April-August for wheat. GDD is calculated as the county-level average growing degree days. To capture the effect of over-heating on crop yield distributions, we construct the variable GDD34, calculated as the county average growing degree days beyond the threshold of 34°C. The precipitation variable denoted by Prec is constructed as the average growing season precipitation for each county.

Theory

STOCHASTIC YIELD IS assumed to depend on vector v of geographic conditioners such as land capability class and climate measures so that mean yield depends on soils and climate Stochastic yield is given by the Just-Pope (1979) technology

$$y = \mu(v) + \sigma(v)\varepsilon, \qquad (1)$$

where ε has mean zero distribution $G(\varepsilon):[\underline{\varepsilon},\bar{\varepsilon}] \to [0,1]$. Write $\psi(v) \equiv (\phi - 1)/\tau(v) < 0$ where $\tau(v) = \sigma(v)/\mu(v)$ is the coefficient of variation. A grower with geographic conditioners v takes out yield insurance at selected price p. The grower chooses (ϕ, s) from Table 1 in order to maximize the expected size of budget transfer B. Put differently, some algebra shows that the objective is

$$\max_{(\phi,s)} sp\sigma(v)J[\psi(v)] \quad \text{s.t.} \quad (\phi, s) \text{ from Table 1}; \qquad (2)$$

$$J[\psi(v)] = \int_{\underline{\varepsilon}}^{\psi(v)} G(\varepsilon)d\varepsilon.$$

We demonstrate

Proposition 1: Suppose that $J(\psi)$ is log-concave in ψ, i.e., $d^2\ln[J(\psi)]/d\psi^2 \le 0$. Then the chosen value of coverage level ϕ increases (resp., decreases) with an increase in the value of some ordinate v_i in v whenever $d\tau(v)/dv_i \le 0$ (resp., $d\tau(v)/dv_i \ge 0$).

Figure 2 illustrates when the coefficient of variation is decreasing in a geographic metric then crop production becomes less risky along that metric. Choosing low coverage results in low expected transfers and the more efficient means of extracting transfers is to increase yield coverage.

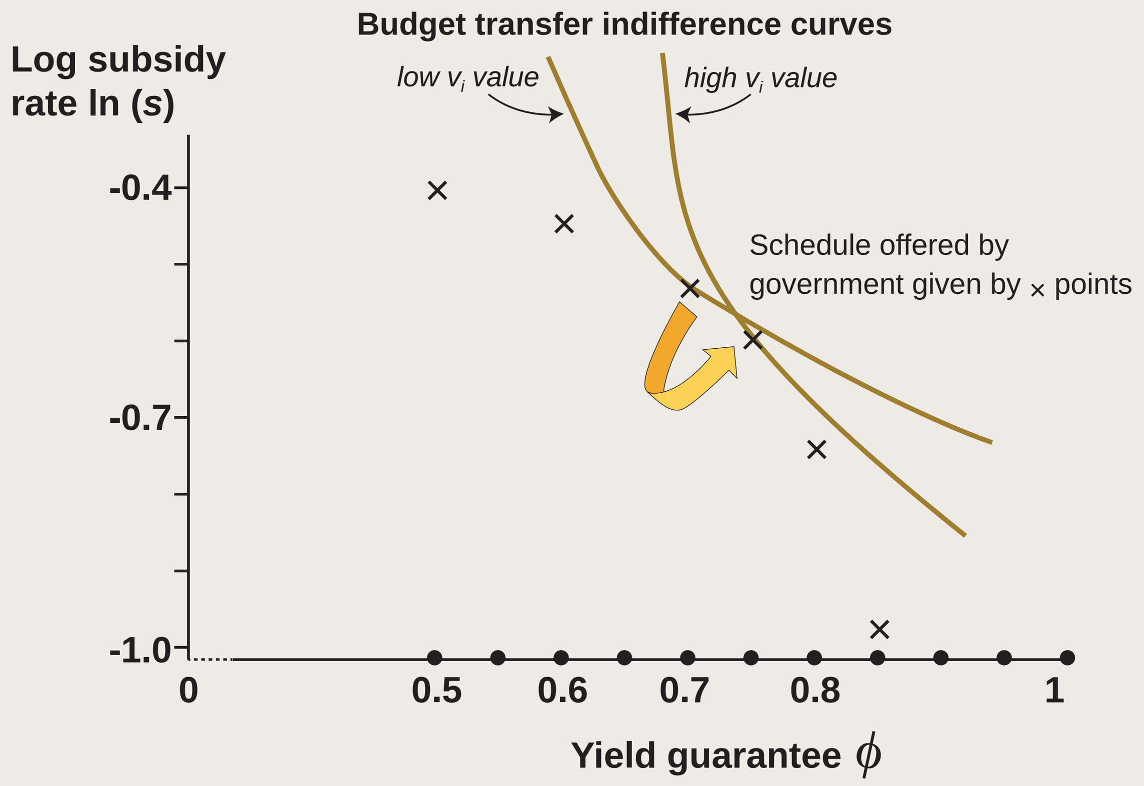

Figure 2. Change in insurance schedule choice when a v_i increases and coefficient of variation is decreasing in that v_i

Empirical Analysis

RMA UNIT-LEVEL DATA were used to estimate the average coefficient of variation for each county and these were regressed on geographic variables. Results are presented in Table 2. The effects are as anticipated except for GDD with wheat and Prec with soybeans. Residuals from the Just-Pope estimation were checked, and confirmed to have the requisite log-concavity property. Thus the conditions for Proposition 1 apply.

RMA data on contract choice were regressed on the geographic variables. A sample regression is provided in Table 3 where the regressand is $\ln(x_j/(1-x_j))$ and x_j is share of contracts at the j^{th} coverage level. "Distance" is distance from the center of a crop's production, where Barnett and Coble (2012) suggest that its effect on price yield correlation might affect contract choices. With or without distance, better land tends to be insured at higher coverage levels as predicted by Proposition 1. More beneficial climate also tends to promote higher coverage level choices, although the evidence is less clear.

Table 2. Estimation results of the coefficient of variation

	Corn	Soybean	Wheat
LCC	-0.002[c]	-0.001[c]	-0.001[c]
GDD	-0.0001[c]	-0.0001[c]	0.0001[c]
GDD34	0.01[c]	0.01[c]	0.005[c]
Prec	-0.006[c]	0.0004	-0.004[c]
Constant	0.92[c]	0.43[c]	0.35[c]
R^2	0.88	0.96	0.97

Note: a, b, and c denote significance at 0.10, 0.05, and 0.01 levels, respectively.

Table 3. Regression results of insurance contract choices—coverage levels for corn under yield insurance

	50%	55-60%	65-70%	75-85%	50%	55-60%	65-70%	75-85%
LCC	-0.01[c]	-0.01[c]	-0.008[c]	0.01[c]	-0.01[c]	-0.01[c]	-0.008[c]	0.01[c]
GDD	0.0007[b]	-0.00009	-0.0009[c]	0.0004	0.0006[b]	-0.0001	-0.0009[c]	0.0004
GDD34	-0.04[b]	0.011	0.14[c]	-0.11[c]	-0.04[b]	0.01	0.14[c]	-0.12[c]
Prec	-0.02[b]	-0.02[b]	0.009	0.0004	-0.003	0.002	-0.004	-0.02[b]
Distance					0.009[c]	0.01[c]	-0.008[c]	-0.01[c]
Constant	-1.73[c]	-0.88[b]	1.18[c]	-2.63[c]	-2.05[c]	-1.30[c]	1.42[c]	-2.28[c]
R^2	0.05	0.07	0.21	0.2	0.06	0.09	0.22	0.21
obs.	804	693	890	764	342	372	716	703

Note: a, b, and c denote significance at 0.10, 0.05, and 0.01 levels, respectively.

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