Data and analysis for complex agricultural issues

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Enhancing Data for Complex Agricultural Establishments

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Main Points of the Presentation and Paper

- Agricultural establishments are and have long been complex in many dimensions.
  - Relevant data and analysis must develop in ways consistent with complexities for the analysis to be relevant to current and future agricultural issues.
- Practical analysis seeks the most appropriate data from a variety of sources
  - Some useful data is collected for general purposes or policy administration or regulation
  - But, increasingly economists are turning to specialized sources collected to help determine important parameters
- Issues and questions drive the choice of data and we never have all we need of the sort of data we want.
  - Economists' data demands evolve to stay always in front of data supply!

Outline of Presentation

The presentation will reinforce the main points through a series of examples of quite different data collection or assembly efforts that show how different data contribute to empirical analysis of vital issues facing public and private decision makers.

These examples relate to complex farming operations and relationships along the supply chain.

1. Animal Welfare -- Cost of Regulations about of the farm animal housing , confidential accounting data
2. Hedonic pricing and identification of willingness to pay for product attributes, data from field and lab experiments
3. Supply elasticities for corn and soybeans incorporating rotations and spatial heterogeneity, use of digitized satellite data, and other spatially explicit information

Regulation of the Treatment of Farm Animals

This issue is of increasing importance in the United States, but is mostly arising in the context of State rather than federal policies.

- **California Proposition #2. Passed in 2008 to be enforced in 2015 – regulates production in California**

"Shall certain farm animals be allowed, for the majority of every day, to fully extend their limbs or wings, lie down, stand up and turn around?"

Assembly Bill No. 1437, Passed in 2010.

Applies Prop 2 hen housing standards to all shell eggs consumed in California, including those shipped into the state.

Our recent research on the issues

- Sumner, D. A., J. T. Rosen-Molina, W. A. Matthews, J. A. Mench, and K. Richter. 2008. "Economic effects of proposed restrictions on egg-laying hen housing in California." University of California Agricultural Issues Center, Davis. Available at: http://aic.ucdavis.edu/publications/eggs/egg_initiative.htm
- Sumner, D. A., W. A. Matthews, J. A. Mench, and J. T. Rosen-Molina. 2010. "The economics of regulations on hen housing in California." *J. Agr. Appl. Econ. 42*. (3). Available at: http://ageconsearch.umn.edu/handle/92577.
- Mench, J.A., D. A. Sumner, and J. T. Rosen-Molina. 2011. "Sustainability of egg production in the United States—The policy and market context." *Poult. Sci.* 90:229-240. Available at:
  http://ps.fass.org/cgi/content/abstract/90/1/229
- Sumner, D.A., H. Gow, D. Hayes, W. Matthews, B. Norwood, J. T. Rosen-Molina, and W. Thurman. 2011. "Economic and market issues on the sustainability of egg production in the United States: Analysis of alternative production systems." *Poult Sci.* 90:241-250. Available at:
  http://ps.fass.org/cgi/reprint/90/1/241

Major concern: Data on costs of egg production

In order to assess impacts on competitiveness and consumer expenditures we must assess the costs of production of conventional and cage free systems. How big will be the shift in the marginal cost curve under changed regulations? Cage free accounts for less than 5 percent of current output.

- No publically available data on itemized costs of egg production, especially no data to compare costs across housing systems and no standard itemization of costs across farms
- Major producers supply both conventional and cage free markets. We gathered cost of production data from individual farming companies a high % of California eggs under both conventional and non-cage systems.
- We aggregated data across farms and reported ranges and an average of differences of costs across the two systems by item.

Itemized comparison of production costs between cage production system and non-cage production system in California in cost per dozen

Production factor	Cage System	Non-Cage System	Cost Differential using mid-points	Cost differential using low costs
	range and median (dollars per dozen)			
Pullets	0.09 - 0.11 0.10	0.14 - 0.17 0.155	0.55	0.05
Feed	0.28 - 0.45 0.365	0.35 - 0.50 0.425	0.06	0.07
Housing	0.05 - 0.14 0.095	0.09 - 0.37 0.23	0.135	0.04
Labor	0.03 – 0.04 0.035	0.07 – 0.19 0.13	0.095	0.04
Total Cost	0.57 - 0.92 0.745	0.97 – 1.13 1.05	0.305	0.40

Comparison of total production costs between cage production system and non-cage production system in cost per dozen

Production factor	Cage System	Non-Cage System	Cost Differential using mid-points	Cost differential using low costs
	dollars per dozen			
Sum of costs and difference at the mid-points	0.595	0.94	0.345	
Sum of costs and differences at the low costs	0.45	0.65		0.20
Percentage cost difference based on the sum of items			0.345/0.595= 58%	0.20/0.45= 44%
Percentage cost difference			0.305/0.745 = 41%	0.40/0.57 = 70%

Effects of California housing restrictions on the California egg industry

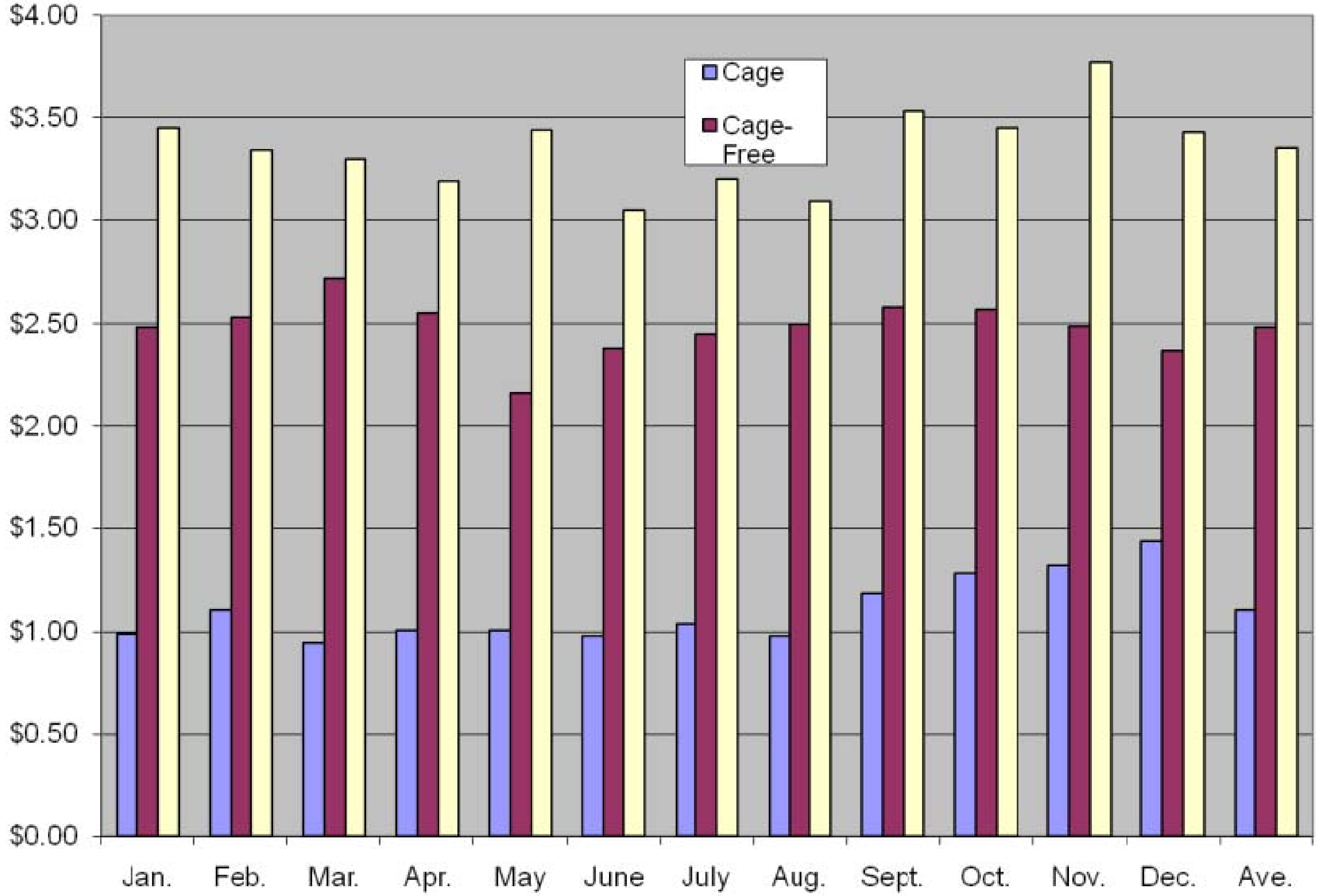
- Our result: with restrictions on local production almost all egg production would leave California

January 10, 2010 Wall Street Journal "A year after Californians approved stricter rules…, Idaho and other states are trying to lure away … egg farmers with promises of friendlier regulations and lower costs."

- With legislation on eggs consumed in California, this effect no longer holds. Instead, consumer prices for eggs will rise.
- The on-farm cost increase now applies to all eggs shipped in, but the data on egg marketing margins is difficult to determine by type.
- The large margin currently on cage free eggs may no apply when they become the new conventional.

2007 Monthly Consumer Egg Prices For One Dozen Large Eggs

Based upon the USDA Weekly Retail Shell Egg Feature Reports for 17,000 Retail Grocery Stores Across the U.S.



National implications of changing hen housing

- Our ongoing project involves monitoring a single commercial–scale operation with multiple modes of production under controlled conditions
- We are working with major suppliers and buyers to measure differences in costs across several alternative housing arrangements with detailed experimental data
- But, data on costs of production do not tell us the retail side of pricing
  - We don't know what is driving marketing margins
  - Difficult to predict final effects on consumers without better data!
- Economic experiments may allow us to isolate demand side parameters under and assess the importance of price discrimination in current retail pricing

Data from economic experiments for industry relevant parameter estimation

Both field and lab experiments can generate useful data and allow unbiased estimates not available with other data or approaches

Gustafson, C.R. T.J. Lybbert and D.A. Sumner. 2011. *"Consumer Characteristics, Identification, and Hedonic Valuation of Wine Attributes: Exploiting Data from a Field Experiment."* Working Paper, University of California, Davis, Agricultural Issues Center. http://www.aic.ucdavis.edu For presentation at the AAEA Annual Meeting, Pittsburgh, July 27

Gustafson, C.R. 2011 "*Experimental Economic Analysis of Willingness to Pay for Wine Attributes: Integration of Economics and Sensory Science.*" Ph.D. Dissertation, UC Davis.

Experimental Economic Valuation

- Experimental economic valuation methods have been employed to study observed attributes or farming methods for products such as eggs and pork chops and beef.
- These examples all included relatively simple product and market settings relative to the wine aisle where prices vary by factors of 10 or 20 based on attributes
- The Gustafson experiment on cabernet sauvignon in the UCD sensory laboratory allowed both label information and taste to influence willingness to pay for specific attributes.

The retail wine aisle – many choices and many prices

Procedure for data collection in a field experiment

- Each of 250 participants completed a questionnaire collecting demographic information and wine purchasing data.
- The participant privately completed the valuation experiment evaluating 6 alternatives (chosen from wines in inventory that varied in appellation or variety) relative to their chosen wine.
- Finally, each participant completed a wine knowledge quiz.
- So we had data on about 1500 price comparisons and on 250 chosen wines and consumer characteristics.

Summary Data of Prices for Original and Alternative Bottles

	Field Experiment Summary Data *Participant-Selected Wine*	*Alternative Wine*
Observations	**250**	**1474**
Mean Shelf Price	**13.85**	**14.02**
Mean WTP	**NA**	**11.19**
Standard Deviation	**5.86**	**5.37**
Minimum	**4.00**	**0.00**
Maximum	**48.00**	**46.50**

Field Experiment Venue

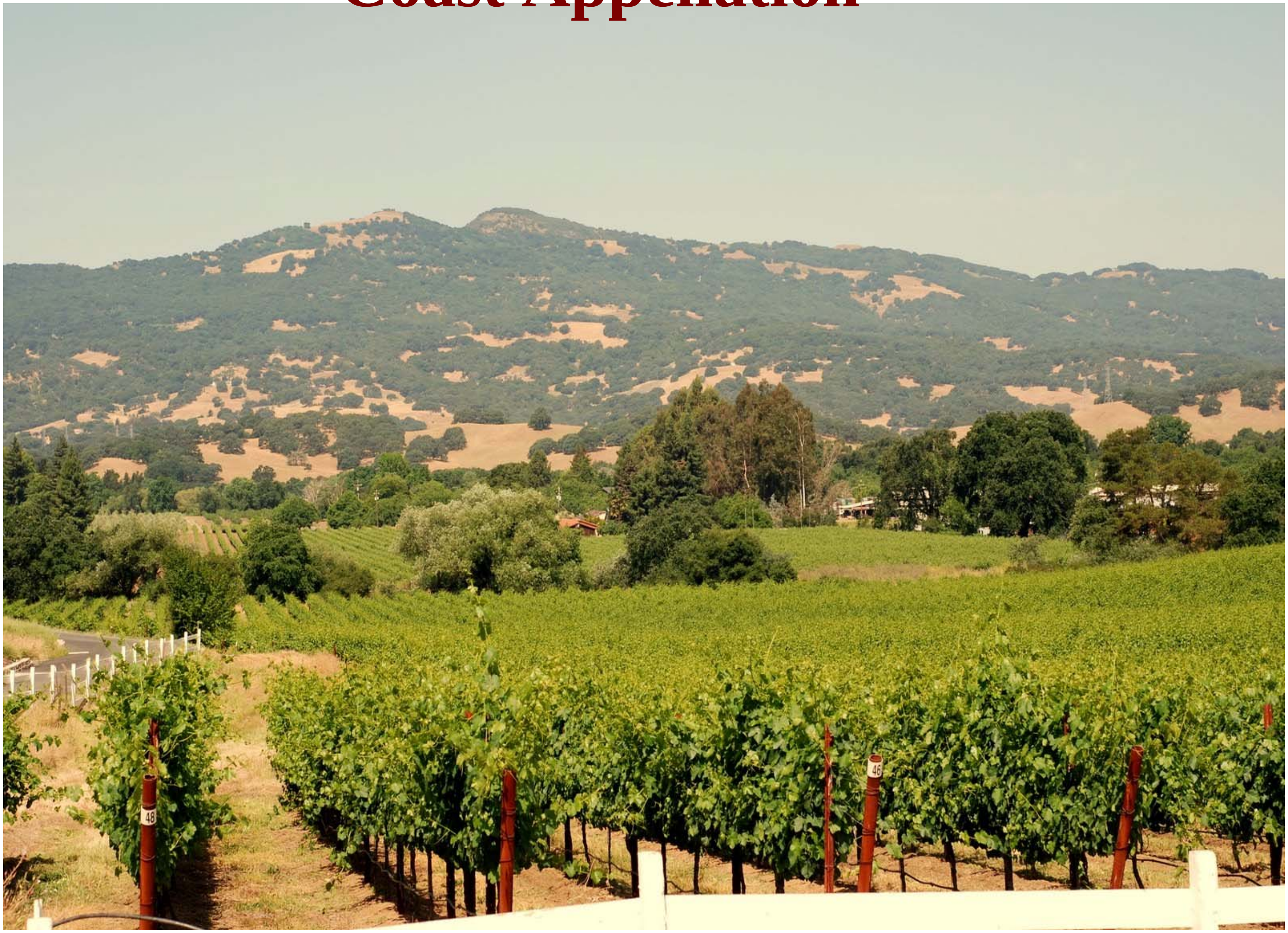
Participant Wine Experience and Demographic Characteristics

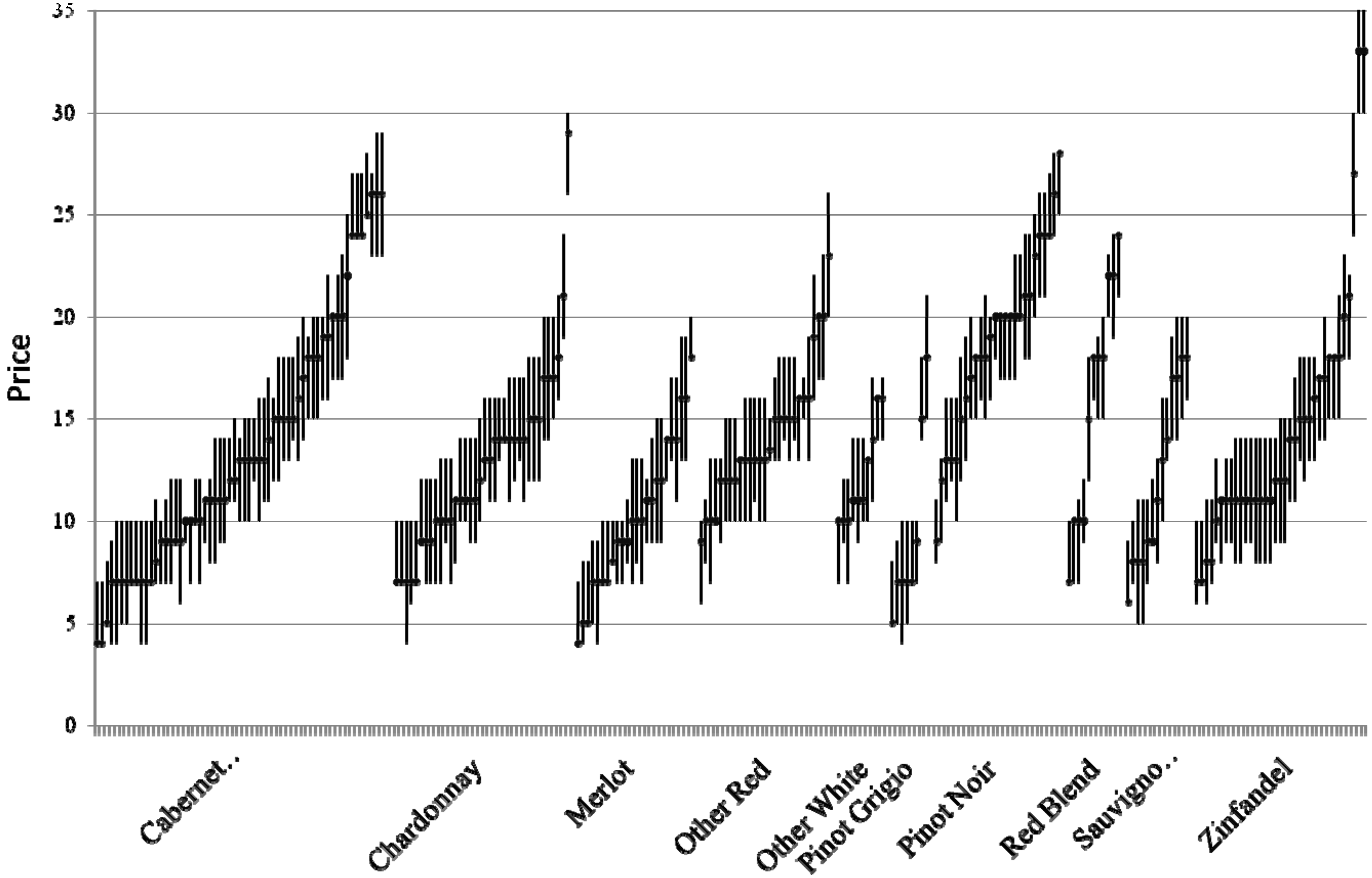
Variable	Mean	Standard Deviation
Monthly Bottles Purchased	6.41	5.84
$ Spent Per Bottle	13.12	5.02
Years Buying Wine	12.61	11.31
Wineries Visited Per Year	3.73	4.73
Quiz Score	0.42	0.16
Class on Wine	0.29	0.45
Read Wine Literature	0.28	0.45
Female (Percentage)	0.52	0.50
Age (Years)	38.24	14.48
Household Income ($1000s)	79.80	64.06
Schooling (Years)	16.41	1.63

Data Analysis Issues

- Two conditions make unbiased estimation of the WTP function difficult in empirical settings:
  - Identification problems that are rooted in demand-supply interaction
  - Sorting, or correlation between product attributes and consumer characteristics and preferences.
- Without introducing into the statistical model controls for price segment, the supply-side enters into WTP data because of the range of prices at which the different attributes are offered.
- And, without fixed effects unobserved consumer characteristics affect WTP parameter estimates

California Wine grapes in the North Coast Appellation





Shelf prices of wines selected by variety, with bars for minimum and maximum shelf prices of alternative wines presented to participants.

Estimating Equations

Participant-expressed WTP as the dependent variable and appellation and variety as central explanators:

- Conventional hedonic regressions introduce supply-side influences into WTP estimates even with experimental data
- Controls for the shelf price of alternatives eliminates supply-side costs that vary by variety and especially appellation
- Fixed effects account for unmeasured individual characteristics that are correlated with product attributes

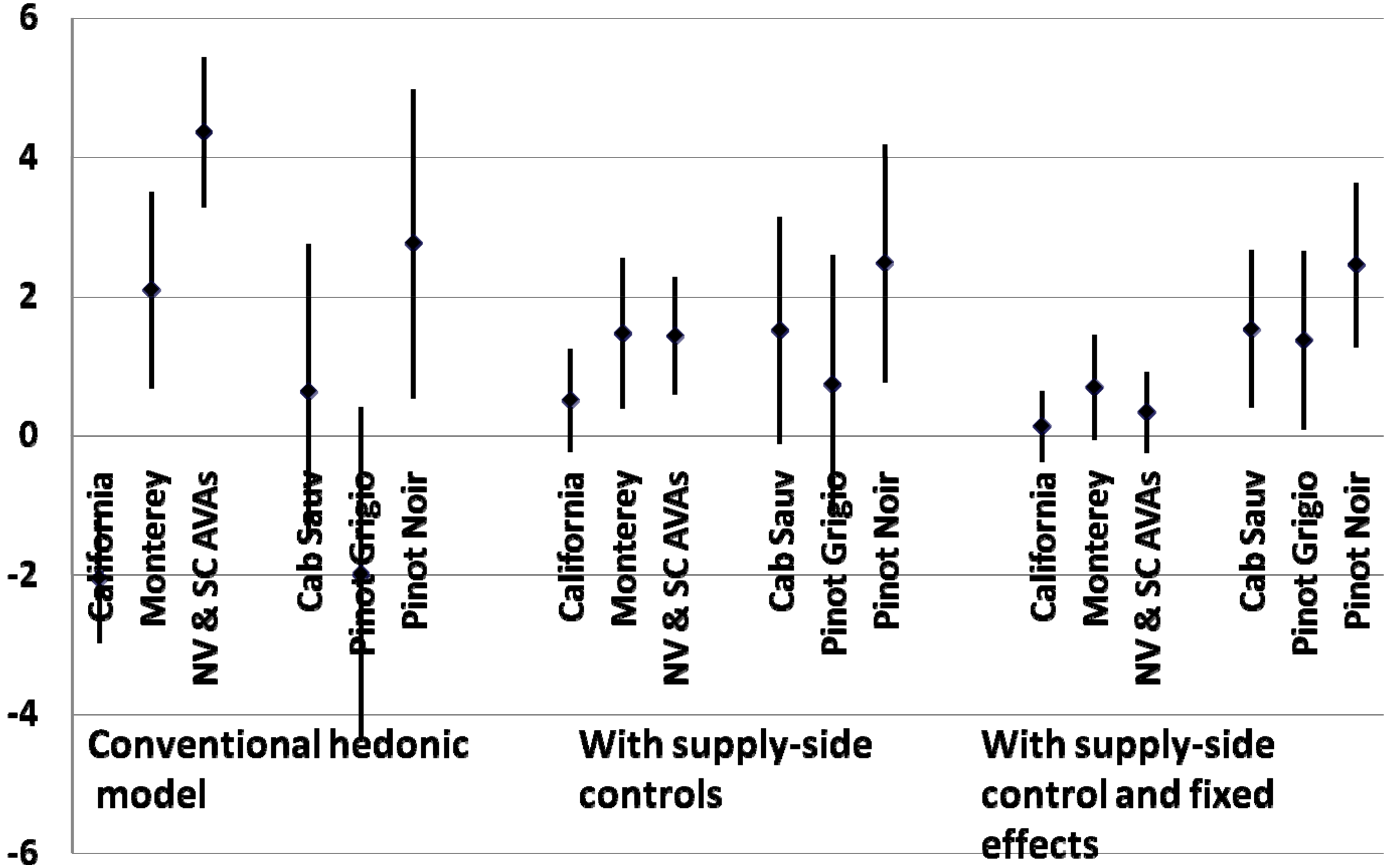
Appellation effect reflects both cost and demand-side in model 1, but the demand-side WTP effect is identified in model 3.

Estimates of Willingness to Pay for wine attributes

(Base: C.Val. -White Blend. Model includes other varieties and appellations)

Dependent Variable: WTP	Conventional Hedonic Model		(Alt. Shelf Price)		(Alt. Shelf P. & Fixed Effects)	
Cab. Sauv.	0.63	(1.15)	1.51	(0.94)	1.53**	(0.66)
Pinot Grigio	-1.99*	(1.20)	0.73	(1.00)	1.37*	(0.71)
Pinot Noir	2.76**	(1.31)	2.47**	(1.07)	2.45**	(0.72)
Sauv. Blanc	-1.53	(1.24)	0.67	(1.05)	1.10	(0.72)
California	-2.04**	(0.49)	0.51	(0.44)	0.13	(0.25)
Monterey [b]	2.08**	(0.93)	1.47**	(0.65)	0.69*	(0.40)
Napa Valley	4.06**	(0.81)	1.71**	(0.53)	0.47	(0.34)
SubAVAs N&S	4.35**	(0.88)	1.43**	(0.62)	0.34	(0.37)
Alt. Shelf Price	-		0.63**	(0.051)	0.081*	(0.044)
R2	0.21		0.54		0.78	

Estimated WTP Coefficients for Selected Appellations and Varieties



Estimating aggregate long-run and short-run acreage elasticities for Midwest corn and soybeans with spatial data over 12 years

Hendricks, N.P. 2011. "The Dynamics and Spatial Heterogeneity of Crop Acreage Response to Price: Problems of Aggregation and Pooling" PhD dissertation, University of California, Davis.

Hendricks, N.P. and D.A. Sumner. 2011. "Spatially Explicit Estimates of Crop Rotation Responses." Poster prepared for presentation at Agricultural and Applied Economics Association 2011 Annual Meeting, July 24-26, 2011, Pittsburgh, Pennsylvania.

Data analysis with conventional farms, but complex economic dynamics at the field level

- Estimate aggregate acreage response to price recognizing that
  - Aggregate data can have very different dynamics than disaggregated data
  - The sum of all disaggregate responses is difficult to identify with aggregate data
- Estimates of spatial heterogeneity of acreage response may itself be of interest for environmental or commercial concerns—where supply is most elastic matters

Newly available satellite data arranged at the field level, matched with regional price data and other information from soils maps and weather stations is used to estimate key parameters

- So considering carefully a conventional issue about supply response of conventional farms requires unconventional data and estimation procedures

Estimate aggregate acreage response to E(Price_{it})

$$A_t = \sum_i acres_i C_{it},$$

$$C_{it} = \gamma_i C_{i,t-1} + \beta_i p_{it} + \alpha_i + \varepsilon_{it},$$

$$\left.\frac{\partial A_t}{\partial p_{it}}\right|_{short-run} = \sum_i acres_i \beta_i,$$

$$\left.\frac{\partial A_t}{\partial p_{it}}\right|_{long-run} = \sum_i acres_i \frac{\beta_i}{1-\gamma_i}.$$

A = aggregate acres; C = probability of growing corn; P = expected 'price' (which includes expected per unit program benefits)

Crop rotations are the major issue in corn supply dynamics

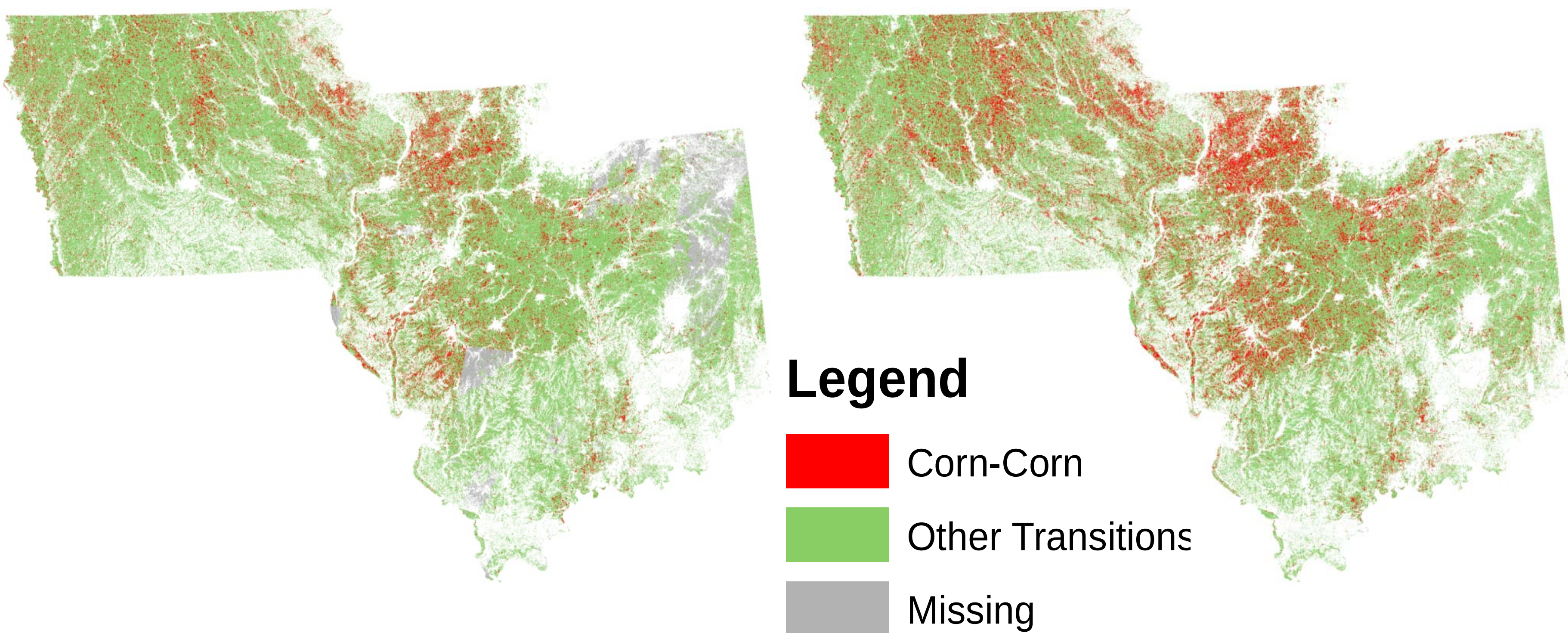
- Crop rotations are major aspect of planting decisions, but the rotations are by field not in aggregate or by county

Hennessy (2006) gives conceptual model, and estimates rotation incentives with agronomic experiment station data, but this does not capture field-level commercial plantings

- NASS provides crop planted derived from satellite imagery about a decade for corn-belt states
- Resolution of about 0.22 acres or 0.77 acres, lots of data…
  - About 247 million pixels per year with corn or soybeans in 1999-2005, 2010; 64 million pixels per year in 2006-2009
- Accuracy of classifying corn or soybeans about 95% (less for other land uses

Maps of corn planting transitions in the 3-state region showing the effect of the jump in expected price on more corn after corn in 2008

Corn 2005, Corn 2006 **Corn 2007, Corn 2008**



Use of Common Land Unit Boundaries (FSA) to aggregate pixels to limit spatial correlation

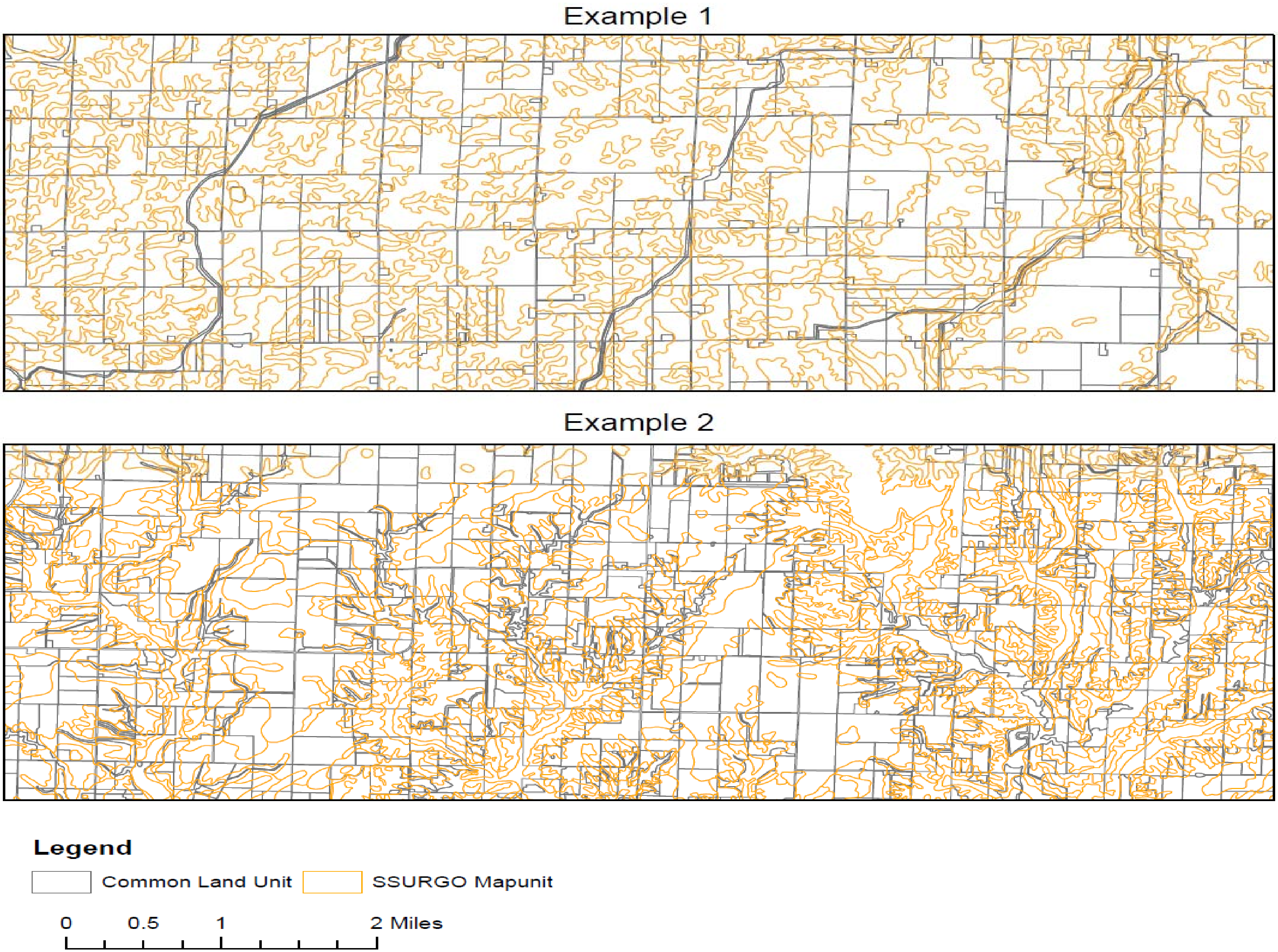
- Digitized farm tract and field maps maintained by USDA Field Service Centers
  - Reconciled to boundaries visible from aerial photography
  - No attribute information, only “field” boundaries
- Publicly available from 2004 until banned by the 2008 Farm Bill… problem that these important data are now not available to researchers to provide crucial policy-relevant information
- Only include Common Land Units >15 acres in analysis
  - 1.17 million fields with corn or soybeans at least once during the period

Estimation dependent variable is of whether corn is grown on the field or not, a transition probability for the field


Example 1
Example 2
Legend
Corn
Soybeans
Winter Wheat
Double Wht/Soy
Alfalfa
Grassland
Woodland
Water
Developed
Common Land Unit
Unit of Analysis
0
0.5
1
2 Miles

Spatial records of actual planting-time rain (by year) and permanent land attributes

- April-May precipitation from PRISM climate group, Oregon State (USDA official data) based on NOAA weather stations – accounts for prevented corn planting
- Land attributes -- SSURGO from NRCS is a GIS data layer of "mapunits" which identifies location of soils, and attributes are linked to mapunits
- Allows estimate of spatial distribution of environmental impacts that relate to slope and soil


Example 1
Example 2
Legend
Common Land Unit
SSURGO Mapunit
0
0.5
1
2 Miles

Effects of expected 'Prices'

- **Corn and soybean futures prices for 10 years**
- **Expected loan deficiency payments using options market data**
- **Expected basis for 10 years using cash prices in March for about 90 locations from Cash Grain Bids Inc. interpolate to the field**

Preliminary Results

Most acreage response for corn or beans comes from rotation adjustments, extensive margin impacts (new land coming into these crops is small in the corn-belt)

Short run acreage response elasticities are about 0.5, since lagged dependant variable impacts are negative to long run acreage response elasticities are smaller

Lessons for government data collection

- Practical data analysts seeking useful contributions for public and private decision makers will seek out data from any source.
- Traditional government general-purpose data or administrative records is still vital, but often not the only or best source of information
- Alternative data is needed especially for large farms, vertically integrated farms, farms that do not rely of government subsidy and farms in regions with complex geography and crop mixes
- Often data analysts are driven by supply chain, environmental and other issues such as animal welfare
- That means linking farm data up the marketing chain and back down to resource use

Final remarks

- Agricultural data is crucial for quality decision making for vital issues from drivers of world supply and demand balances to policy issues such as environmental effects of alternative livestock production facilities and impacts of country of origin labeling
- Much of the data will come increasing from non-governmental sources but agencies have a crucial role to play and must keep ahead of shifts in agricultural realities including configurations of firms with complex organizations and relationships.
- The very definition of terms such as market price need to be regularly re-evaluated
- A three-way conversation between data users, decision makers and data suppliers is crucial.