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Impacts of Urbanization and Bio-fuels Production on the Price of Land in the Corn Belt: A Farm-Level Analysis

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Purpose and Methodology

- Use hedonic techniques to estimate the impact of urban influence, bio-fuels production, and environmental factors on land prices in the Corn Belt
- Hypothesize that urban influence and ethanol production increase land prices on Corn Belt farms.
- We find strong evidence that land prices are higher on urban-influenced farms compared to more rural farms and regional ethanol impacts.

Background

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Urban Influence Changes the Profitability and Operating Structure of Remaining Active Farms

(Heimlich and Barnard, 1992, 1997)

- Urban influence creates opportunities for those farms that can adapt; but raises land prices and imposes costs upon traditional farms (Berry; Lopez, Adelaja, and Andrews; Larson, Findeis, and Smith).
- Crop and livestock producers are likely to bear added costs from (environmental) constraints on agricultural practices and the disappearance of input suppliers and output markets (Herriges, Secchi, and Babcock).

Urban Influence - 2

- Nehring et al. (*AJAE* 2006) found urban proximity (associated with higher levels of off-farm income) raised the costs and decreased the viability of traditional farms.
- Suggests strong competitive pressures on traditional farms in urban areas, inducing dramatic reductions in livestock herds.

Procedure

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Given the inherent heterogeneity in crop agriculture in the Corn Belt, we …

- Employed the hedonic procedures used by Waugh(1929) and Court(1939) for measuring quality-adjusted land and assessing the impacts of urban influence, bio-fuels production, and environmental factors on land prices.
- Data are ***farm-level*** obs. (ARMS), Corn Belt.

We proceed by …

- Estimating quality-adjusted land for our sample of Corn Belt farms.
- **1st Stage**: Calculate quality-adjusted land by ASD, conditioned on climatic effects, agronomic effects, and irrigation.
- **2nd Stage**: Regress quality-adjusted land on key drivers, including the level of urbanization, county level ethanol capacity, government payments/acre, the level of conservation payments, and corn revenues/acre.
- We exclude urbanization from 1st stage to assess the relative strength of key drivers on the level of quality-adjusted land.

USDA's Annual ARMS Survey and Data Construction

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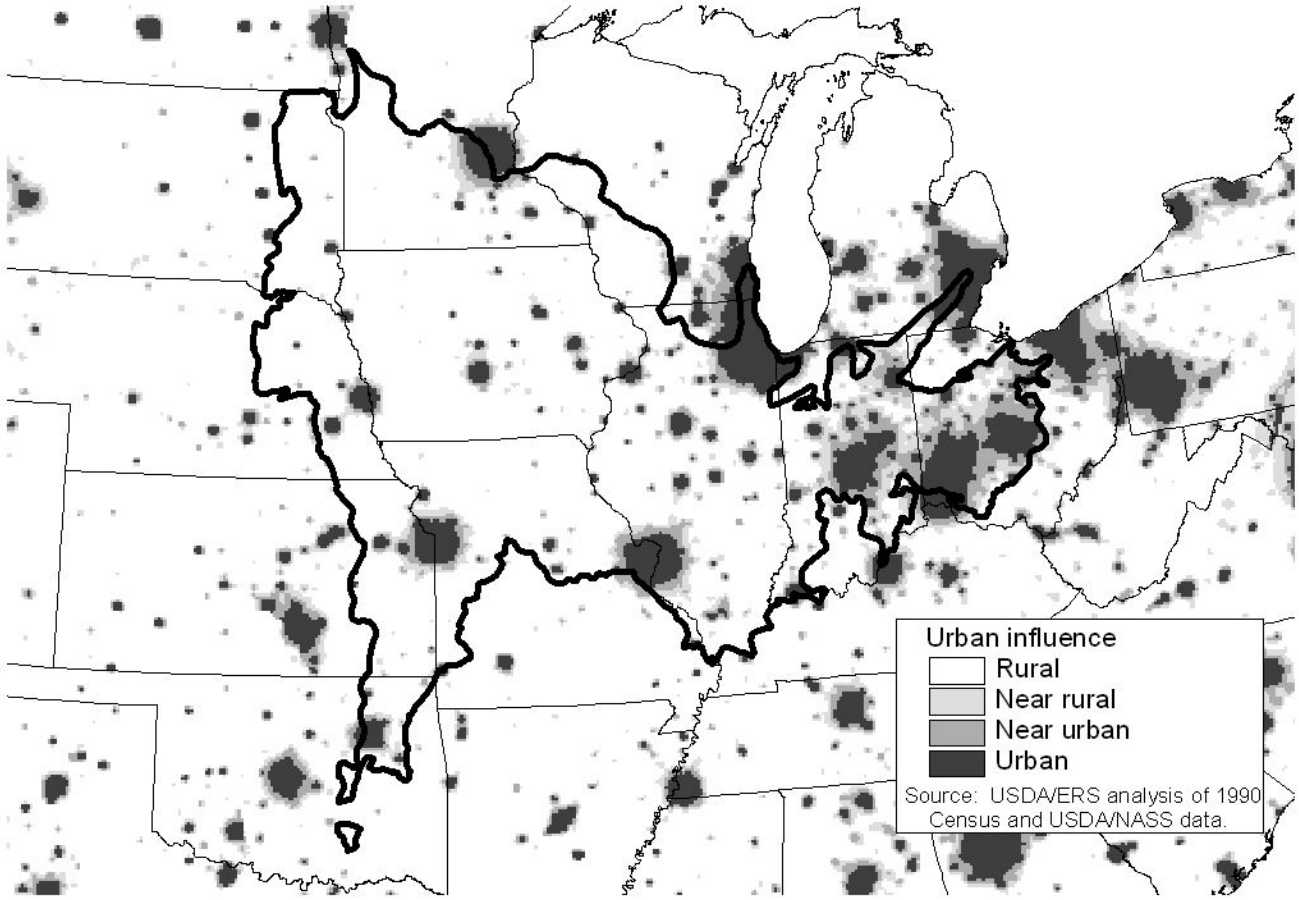
The USDA ARMS Survey and Data Construction

- The rich data in ARMS make our analysis possible.
- ARMS: annual survey covering farms in the 48 contiguous States.
- Incorporates information from both a list frame of farmers producing selected commodities and a random sample of farms based on area (USDA/ERS 2002).

Figure 1. A USDA-defined region (most of the Corn Belt) was selected (IL, IN, IA, MN, MO, NE, SD, OH, and WI).



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The USDA ARMS Survey and Data Construction - 2

- Soil types, climate, and crop patterns/rotations relatively homogeneous, helping us to isolate the effects of urbanization.
- Key drivers like government payments measured as annual farm benefits: off-farm income as total off-farm income per acre; corn revenue/harvested acre; conservation reserve payments/acre operated.

Estimation of Quality-Adjusted Land Price

- Characteristics of land derived from climatic and geographic data bases:

  -- USDA soils data in STATSGO,

  -- supplemented by land resource data from the World Soils Research Program of the USDA's Natural Resources Conservation Service.

  -- also included a variable that reflects the size of nearby population centers and distance from population center (von Thunen effects).

Using a semi-log model…

- Price of land in 2005 (ARMS Survey, farm-level) was regressed on:

  -- 31 Agricultural Statistical District (ASD) dummies (representing 3,947 obs),

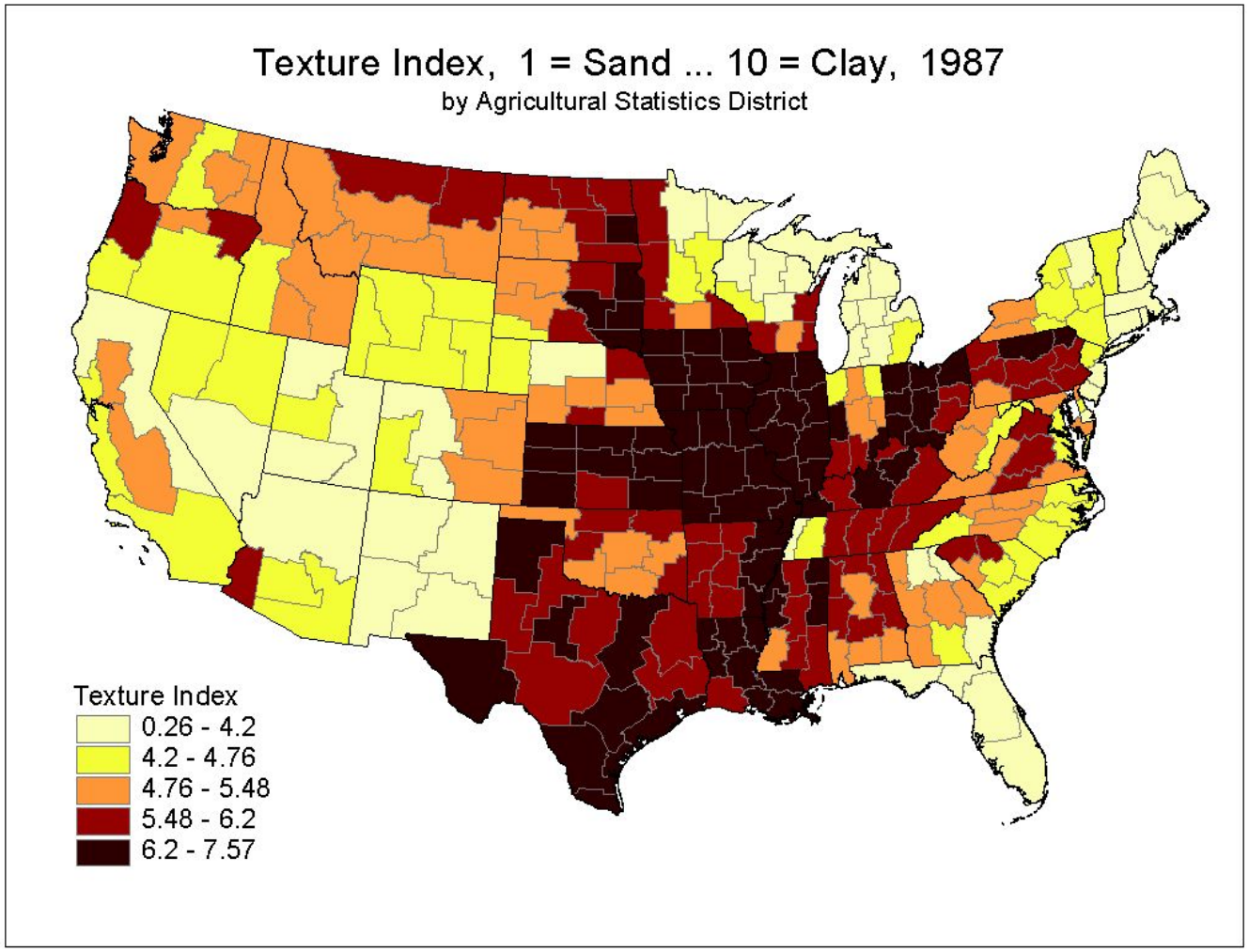
  -- level of urban influence

  -- 5 climatic characteristics

  -- 8 physical characteristics

  -- and percent of cropland irrigated

Texture Index



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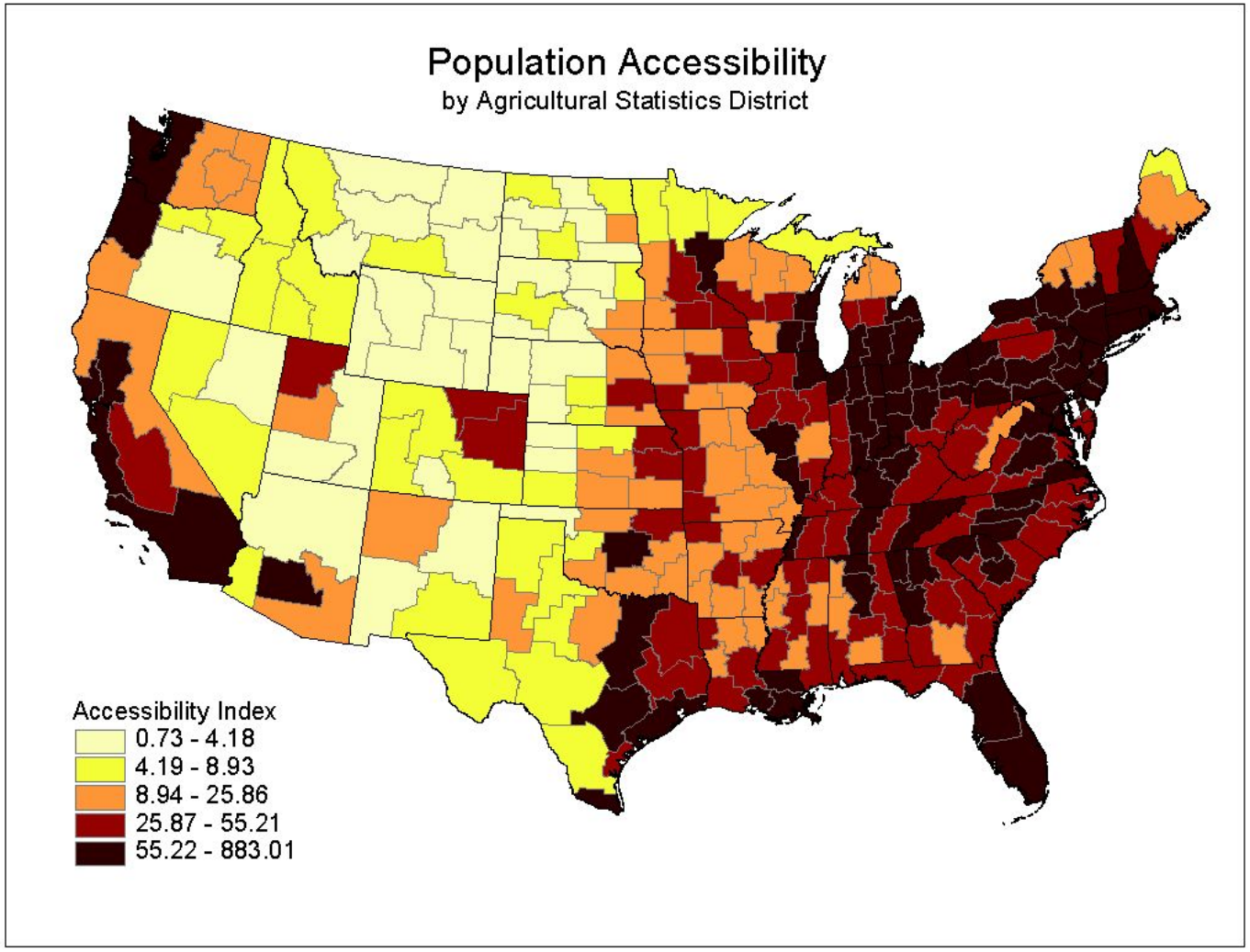
Population Accessibility



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County Level Ethanol Capacity

- Energy Policy Act of 2005 (H.R.6). This legislation includes a nationwide renewable fuels standard (RFS) that will double the use of ethanol and biodiesel by 2012.
- County level ethanol capacity reported as millions of gallons per year of production.
- Production is well connected to rail links.
- Close to 1 billion bushels of corn were processed in the Corn Belt in 2005.

Figure 4. Current ethanol capacity density estimate

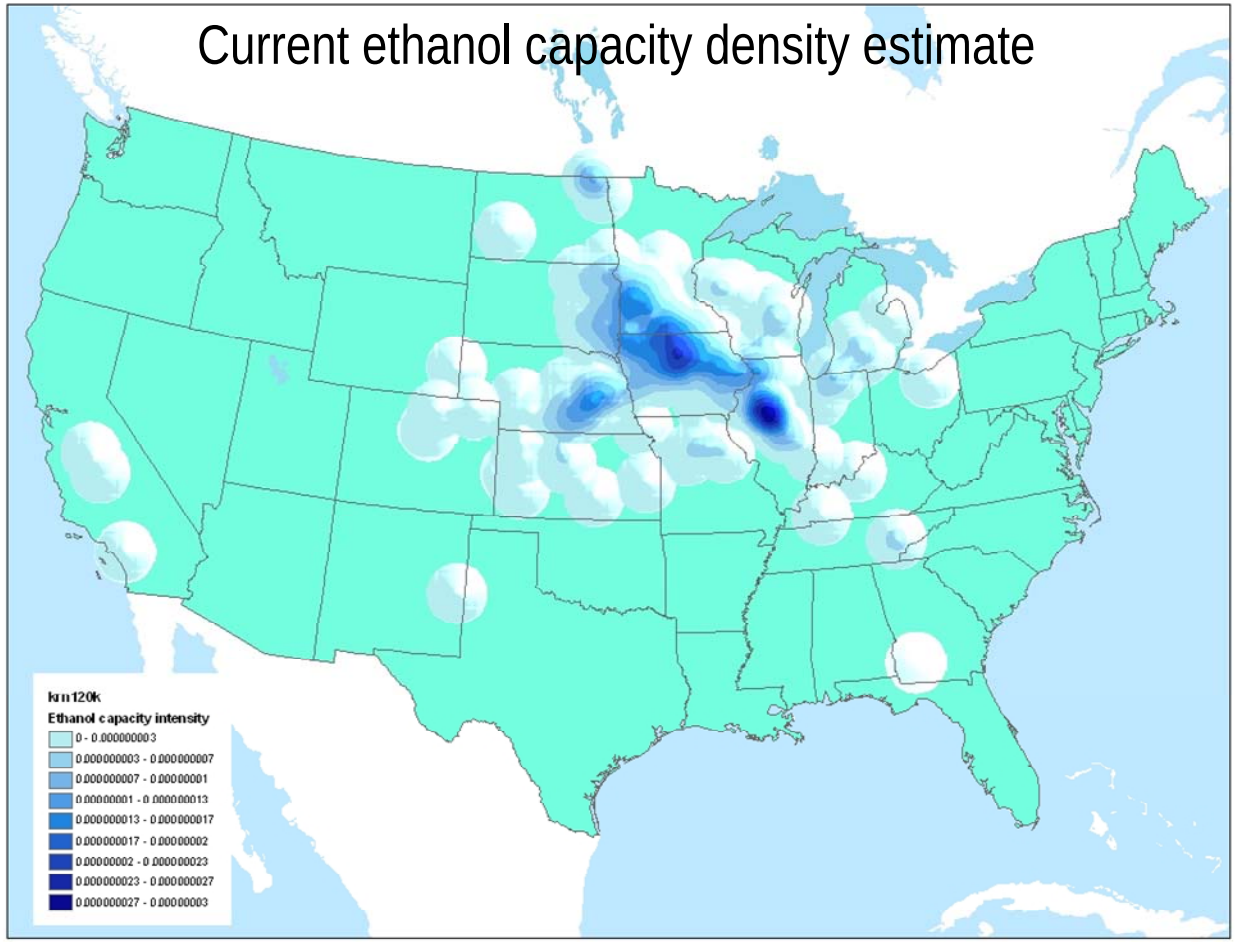

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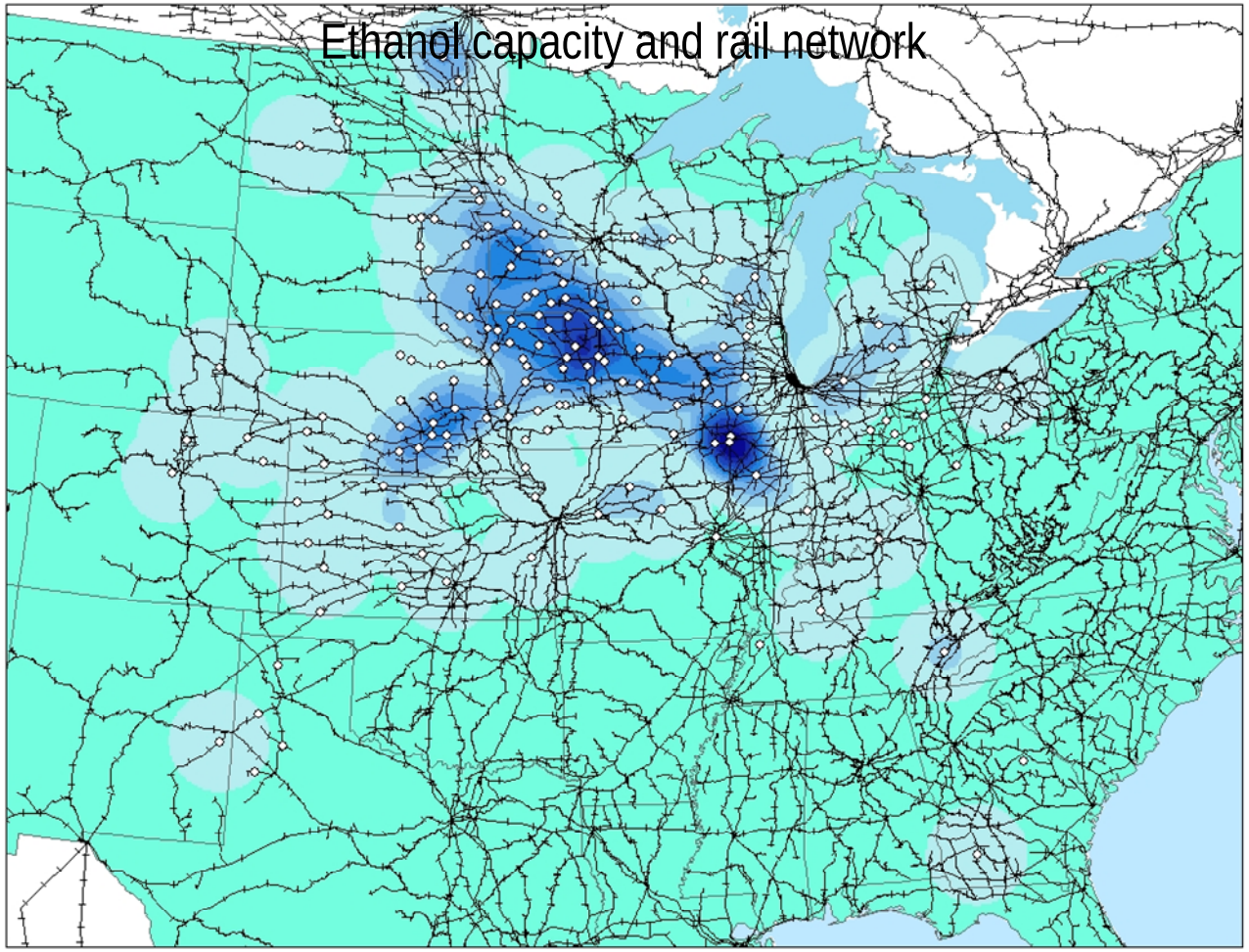
Figure 5. Ethanol capacity and rail network



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Urban-Influence Variables

- Our two urban-influence variables (Barnard, Wiebe, and Breneman) are a ***continuous*** index and a ***categorical variable*** created from the continuous index.
- An index number was calculated for each cell using a GIS function based on the concept of a “gravity” model of urban development.
- The continuous index increases as population increases, and/or as distance to the population decreases.
- The index number assigned for each county is the value of the index as measured at the geographic center of the county (centroid).

Urban-Influence Variables - 2

- Regional variations in the level of urban-influence are important.
- 30 percent of farms in the Corn Belt are urban-influenced, with pronounced urban influence in the eastern Corn Belt.
- Smaller urban influence occurs even in the heavily agricultural areas of the western Corn Belt.
- Close to 100 percent of farms in Ohio are urban influenced, 82 percent in Indiana, 32 percent in Illinois, and 17 percent in Iowa.

Specification of Stage 1: Estimating Quality-adjusted Land Value

$$w(\lambda_0) = \sum_{n=1}^{N} \alpha_n X_n(\lambda_n) + \sum_{m=1}^{M} \gamma_m D_m + \varepsilon.$$

- Our basic theoretical model is defined above.

Specification of Stage 2: Assessing the Impact of Key Drivers on Quality-adjusted Land Value

$$\ln Yi = \beta_0 + \beta_E \ln (X_{E,t}) + \beta_G \ln (X_{G,i}) + \beta_{CRP} \ln (X_{CRP,i}) + \beta_{PA} \ln (X_{PA,,i})$$
$$+ \beta_{CR} \ln (X_{XCR,i}) + \beta_{EAST} (D_{EAST,i}) + \beta_{CENTRAL} (D_{CENTRAL,i}) + vit,$$

where subscripts i refer to the i-th farmer.

Quality-adjusted land price (YLD),

ethanol (XE),

government payments per acre operated (XG),

conservation payments per acre operated, (XCRP),

corn revenue per acre harvested (XCR),

and the quality-adjusted price of land (YLD)

are all measured as logs of monetary terms.

Population accessibility (XPA) is measured as the log of the urbanization index.

Comparison of Key Characteristics by Ethanol Production Region

- We compare key economic indictors in major ethanol production regions:

  1) W. Illinois, No. Iowa, and So. MN,

  2) rest of the Eastern Corn Belt, and

  3) rest of the Western Corn Belt.

Comparison of Key Characteristics by Ethanol Production Region

- Ethanol production is centered in E. Illinois and No. Iowa Land prices, as expected, follow a clear pattern as our index of urbanization increases, jumping from
  - -- $2,968/acre on rural farms in No. IA and So. MN
  - -- $3,605/acre on highly urban-influenced farms in No. and Central IL
- Land prices fall off somewhat in the rest of the E. Corn Belt States (MI, IN, MI and OH) to
  - -- $2,775/acre.
- Rural and somewhat less productive areas in the W. Corn Belt (MN, MO, S. IA, SD and NE) exhibit by far the lowest land prices
  - -- $1,226/acre.

Table 1. USDA Agricultural Resource Management Survey estimates, by group, 2005

Variable	No.and Central IL	So. MN and No. IA	Other Eastern Corn Belt	Other Western Corn Belt
Number of ARMS observations	246	618	1,659	1,888
Number of farms	11,680 BCD	34,265 ACD	88,255 ABD	111,438 ABC
Percent of value of production	5.1	28.2	26.5	40.1
Price of land per acre[a] ($)	3,605 BCD	2,968 AD	2,775 AD	1,226 ABC
Population accessibility score	137.6 BD	67.8 AC	157.4 BD	61.3 AC
Ethanol capacity (millions gallons)	745	1,691	663	1,339
Ethanol capacity per county (m.g.)	56.5	62.6	1.83	5.56
Government payments per acre ($/acre)	48 BCD	63 ACD	32 ABD	18 ABC
Government payments per acre[b] ($)	*15.938 BD	28.243 ACD	16.348 BD	7.766 ABC
Conservation payments per acre[b] ($)	*1.335	1.908	1.062	1.188
Total off-farm income per acre[b] ($)	85.388 BD	53.574 AC	97.352 BD	42.862 AC
Net return on assets (percent)	0.062 B	0.108 ACD	0.053 B	0.058 B

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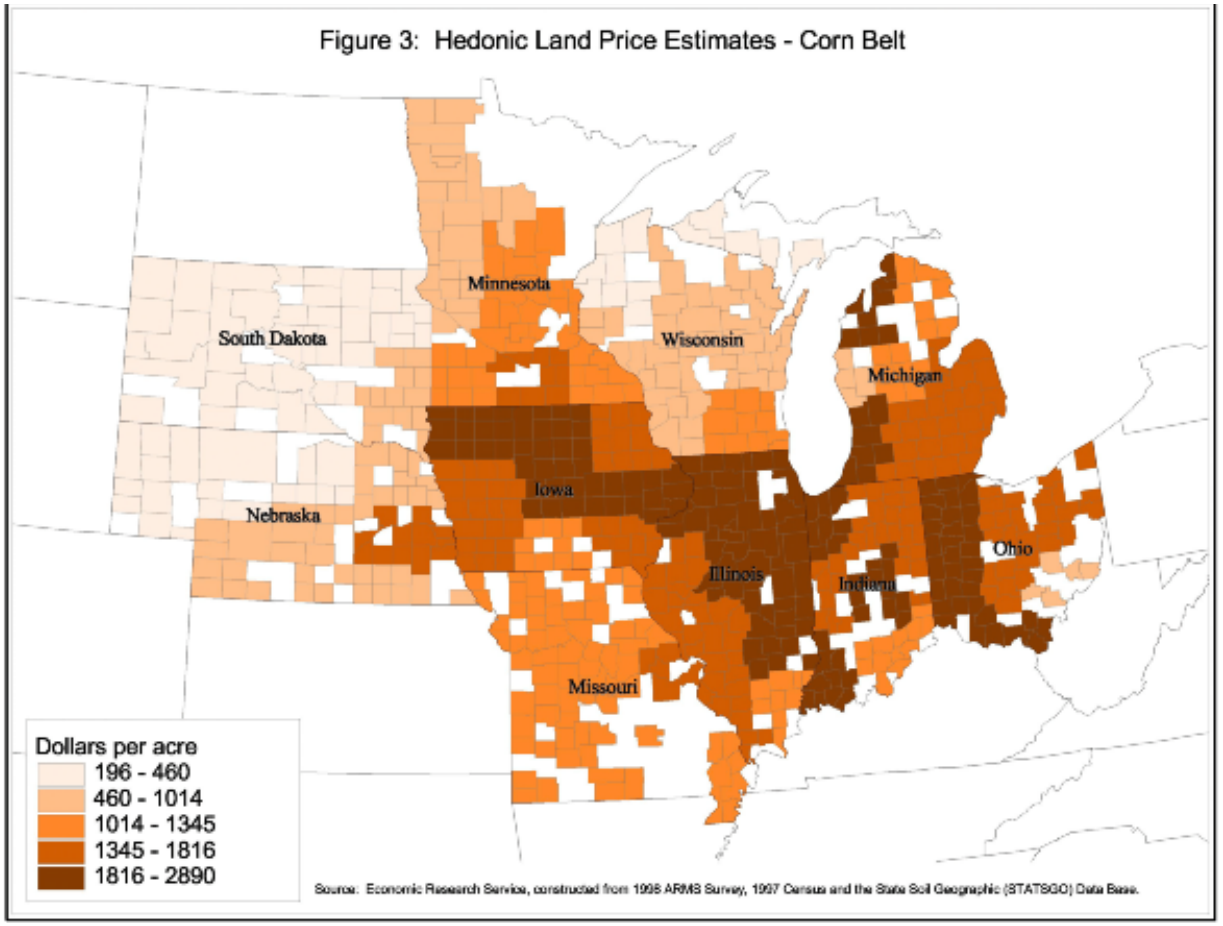
Table 1. USDA Agricultural Resource Management Survey estimates, by group, 2005

Item	No.and Central IL	So. MN and No. IA	Other Eastern Corn Belt	Other Western Corn Belt
Water holding capacity	9.3 BCD	11.4 ACD	8.2 AB	8.0 AB
Soil texture	7.1 BCD	6.4 ACD	5.4 ABD	6.1 ABC
Corn yield in bushels per acre	137.08 B	181.34 ACD	144.08 BD	130.00 BC
Soybean yield in bushels per acre	47.94 BCD	53.97 ACD	45.11 ABD	38.85 ABC
manurenp per harvested acre ($/acre)	5 BCD	13 ACD	20 ABD	9 ABC
manurepp per harvested acre ($/acre)	*4 BC	8 AD	9 AD	5 BC

Empirical Results – First stage

- ***First stage results*** .
- More than half of the coefficients for the semi-log specification are significant (good fit).
- The significant and positive signs on wet tempustic, texture, and irrigation percentage and the significant and negative signs on frigid wet tempustic, frigid typic udic xeric, and the K factor are as we would expect.
- The resulting quality-adjusted land prices tend to be highest in OH ADSs near urban centers and in IL and IOA ASDs traditionally characterized as having high-quality land.

Figure 3. Hedonic Land Price Estimates – Corn Belt



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Empirical Results – Second stage

- ***Second stage* results**…we find that the whole Corn Belt sample, the quality-adjusted land price conditioned on climatic, agronomic, and irrigation characteristics (but not population accessibility) is ***positively and significantly affected by***
- greater *ethanol capacity* per county,
- higher levels of *government payments per acre*,
- *conservation payments per acre*,
- *corn revenues per acre*,
- *off-farm income per acre*, and by
- higher county level *population accessibility* score.

Empirical Results – Second stage

- ***Second stage*** *results*
- Four alternative cuts on the data
  - -- entire Corn Belt sample
  - -- only farms receiving government payments
  - -- only farms located in the W. Corn Belt
  - -- only farms located in the E. Corn Belt

Empirical Results

- **Population accessibility** is the stronger driver followed by ethanol capacity, corn revenues per acre, conservation payments per acre, off-farm income and government payments.
- A 10 percent increase in population accessibility is consistent with a 2 percent increase in the quality-adjusted land price.
- A 10 percent increase in ethanol capacity is consistent with a 0.33 percent increase in the quality-adjusted land price.
- A 10 percent increase in government payments, CRP payments, corn revenue/acre, and off-farm income are consistent with 0.10, 0.11, 0.27, and 0.10 percent increases in the quality-adjusted land price, respectively.

Empirical Results

- ***Second stage results****…*
- The regional cuts indicate ***no influence*** of ethanol capacity on quality-adjusted land prices in the E. Corn Belt, but population accessibility remains important.
- ***In contrast***, ethanol capacity is a highly significant driver in the W. Corn Belt, along with conservation reserve payments and population accessibility.
- 10 percent increase in GPs is consistent with a 0.3 percent increase in the quality-adjusted land price.

Stage 2
Land Quality Price Adjusted determinants

- The Regional Cut indicates no influence of ethanol capacity on quality-adjusted land prices in the Eastern Corn Belt, but *population accessibility* remains important.
- In contrast, *Ethanol capacity* is highly significant in the Western Corn Belt, along with *conservation payments* and *population accessibility*.

Summary and Conclusions

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Summary and Conclusions

- **We hypothesize that growing urban influence and ethanol production increase land prices on Corn Belt farms.**
- **Although not all Corn Belt states are entirely subject to urban influence and ethanol production impacts, some states are intensely affected.**
- **Despite regional variations in urban influence, Corn Belt states have soil types, climate, and crop patterns/rotations that are relatively homogeneous, helping us to isolate the effects of urbanization and biofuels.**
- **We find that land prices in the Corn Belt are significantly increased by the presence of urbanization and biofuels plants.**

For additional information

General ERS website: http://www.ers.usda.gov/

More on ARMS at:
http://www.ers.usda.gov/Briefing/ARMS

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