Striking a Balance between Communities and the Industry

- Tale of Swine Production -

KICA Seminar

2012. 3. 30

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Foreword
Challenges for CBA

- Decision rule or decision process?
- From micro analysis to macro analysis
  - Definition of externality and multiplier effect
- Distribution objectives
- Dynamic evaluation

Reference:
김동건, 1st Anniversary Seminar for KICA, Feb 17, 2012

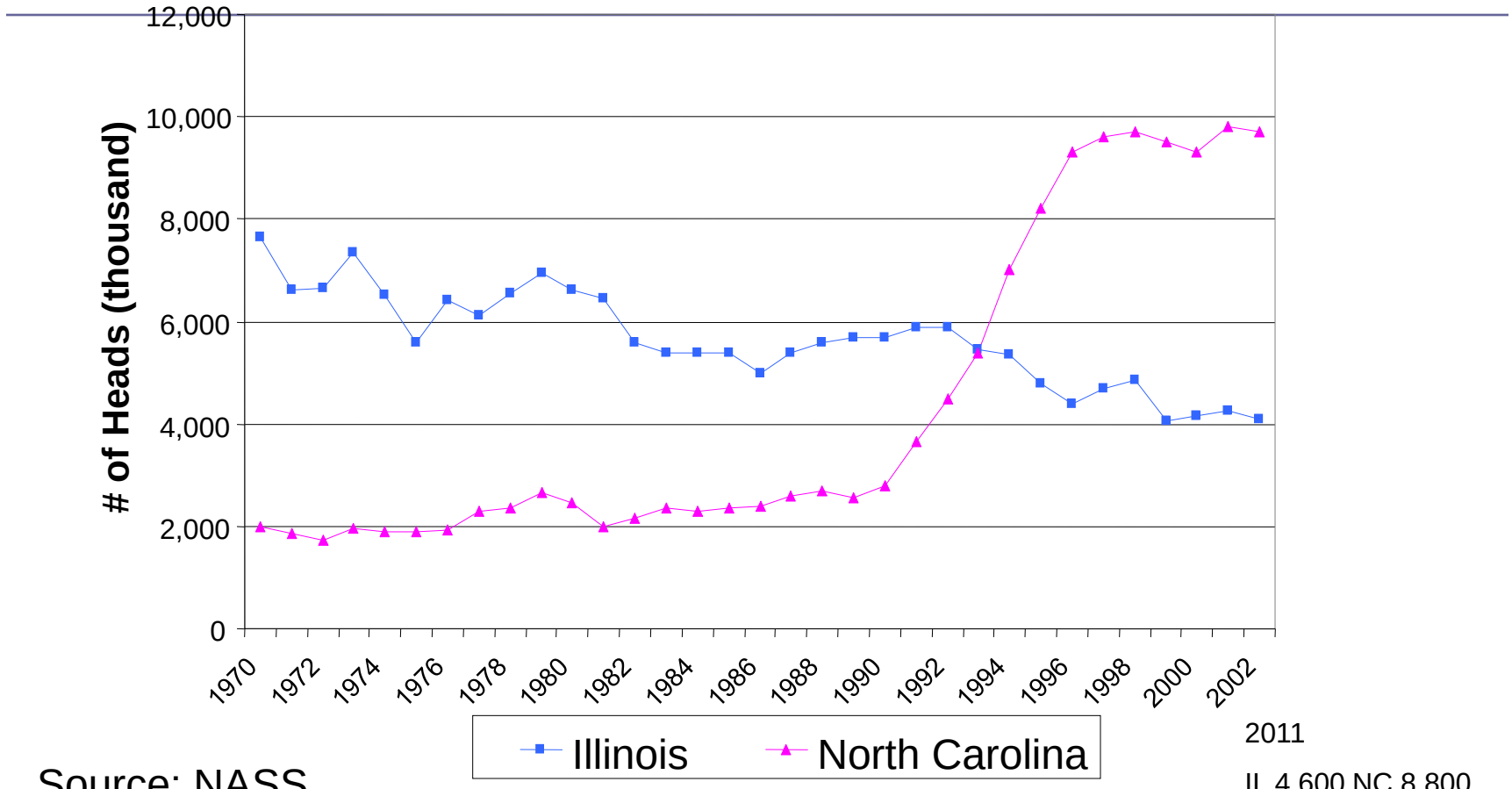
Contents

- Background
- Research Objective
- Literature Review
- Spatial Model
- Main Findings
- Application
- Conclusion and Implications
- Discussion

Background

- Urbanization cause externalities (or pollution) from incompatible land use
  - Landfill, Highway, Airport, Nuclear Power Plant
- Difficult to measure the extent of harm and benefit
  - Hog farms in Craven, North Carolina as study case

Hog Inventory, 1970-2002



Source: NASS

2011

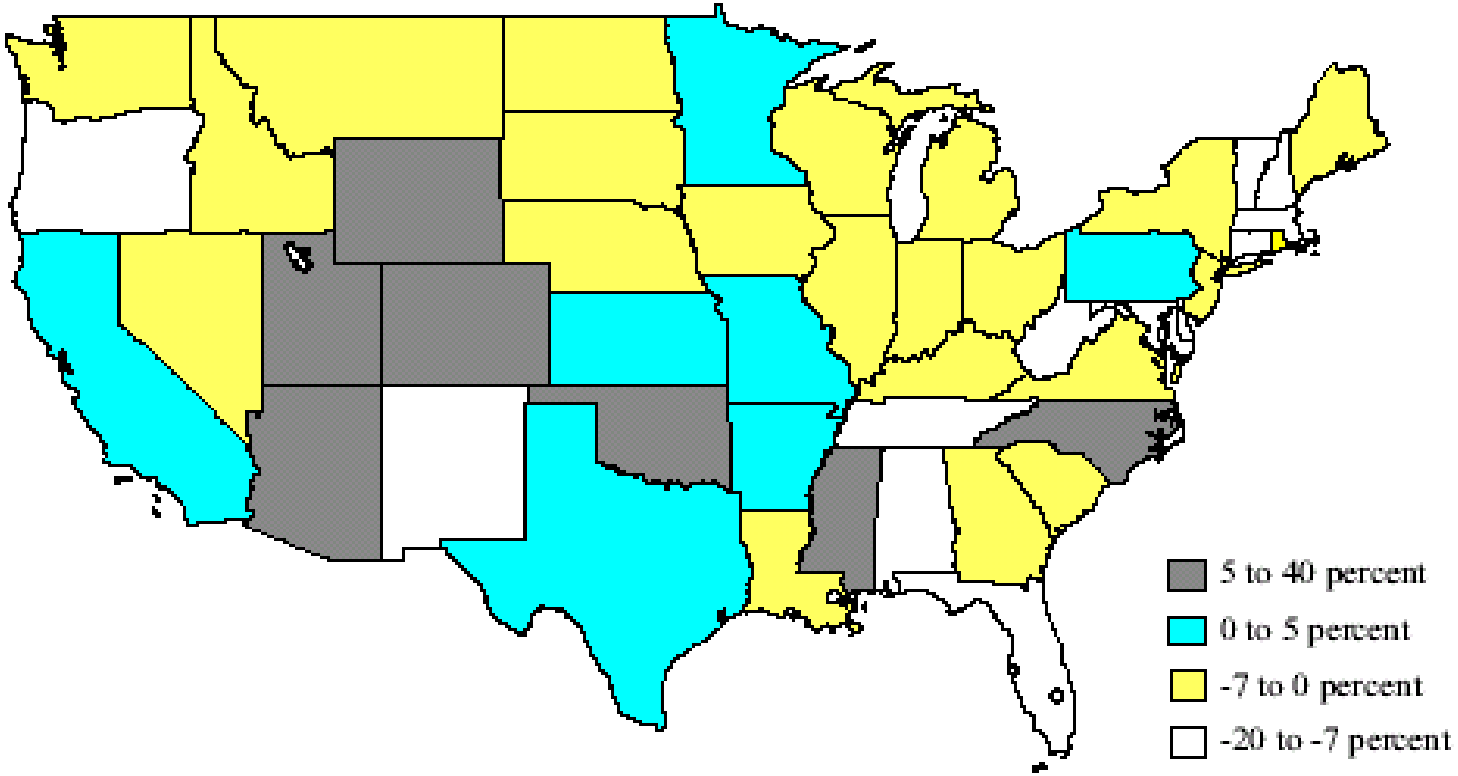
IL 4,600 NC 8,800

Hog farms situation in NC

- Number of farms
  - 15,000 farms in 1986 to 2,300 farms in 2006
- Statewide moratorium in 1997
  - Specifically, as a result of environmental concerns regarding hog waste, the North Carolina state government passed a bill in 1997 that placed a moratorium on construction of any new farms with over 250 hogs. This has severely curbed the growth of the hog farming industry in the state. The renewal of the moratorium in 2003 ensures that slow growth will continue for at least four more years.

    Source:
    http://www.soc.duke.edu/NC_GlobalEconomy/hog/overview.shtml

Annual Pig Crop Change, ’90-’97



Source: USDA cited in Drabenstot (1998)

Hog Farm and Lagoon

CAFOs as Social Issues

- Health issues
  - Okun, 1999; University of Iowa and Iowa State University study, 2002; Thu et al., 1997; Wing and Wolf, 2000; and Schiffman et al., 1995
- Quality of life issues
  - Thu et al., 1997; Kleiner, Rikoon, and Seipel, 2000; Smithson, 2001; Wright et al., 2001; North Central Regional Center for Rural Development, 1999

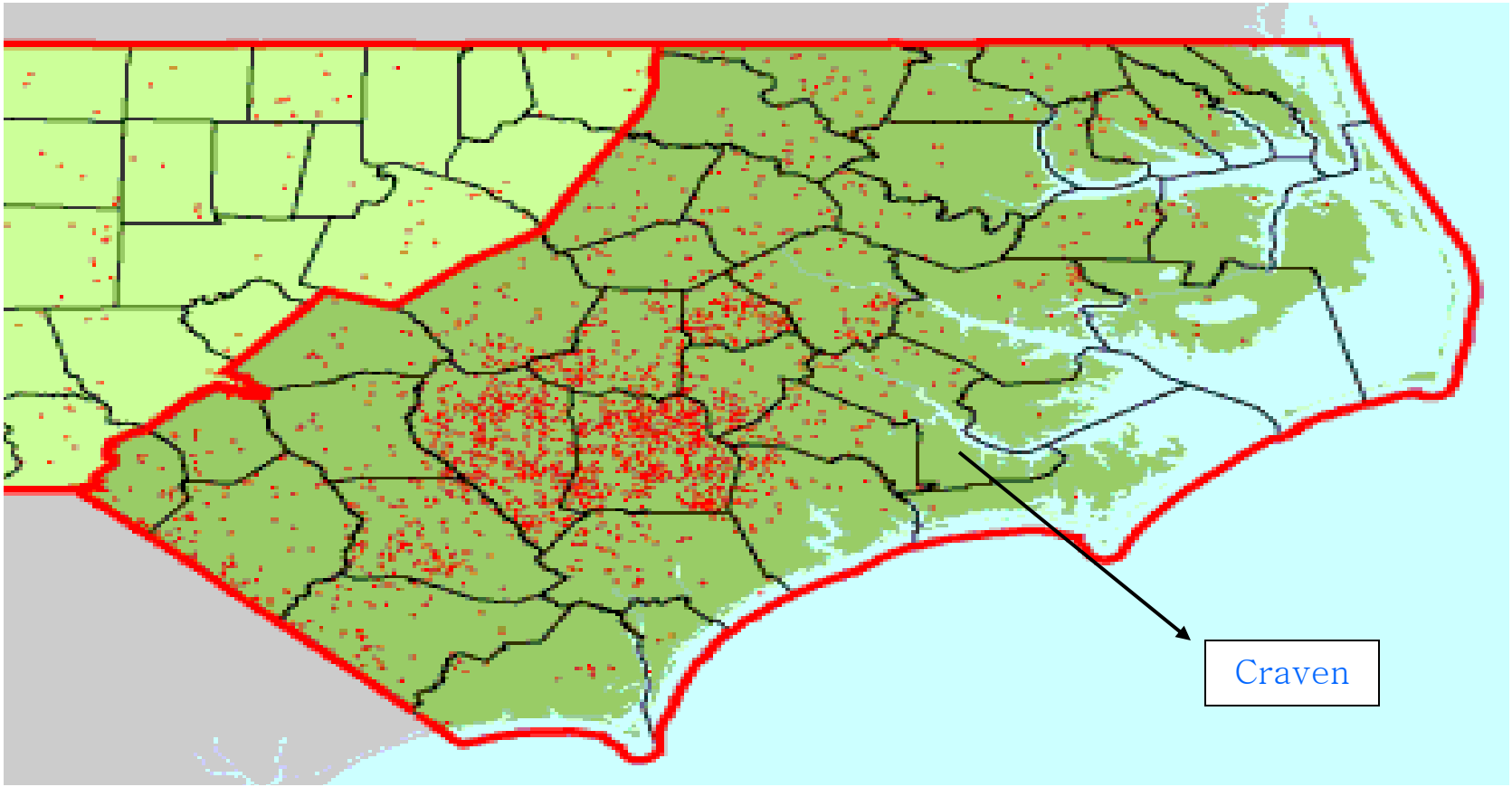
Research Objective

- Hog farm produces disamenities such as odor, traffic noise, and light.
- The farm also produces economic output, employment, tax revenue.
- How then can we measure both the harm and the benefits?

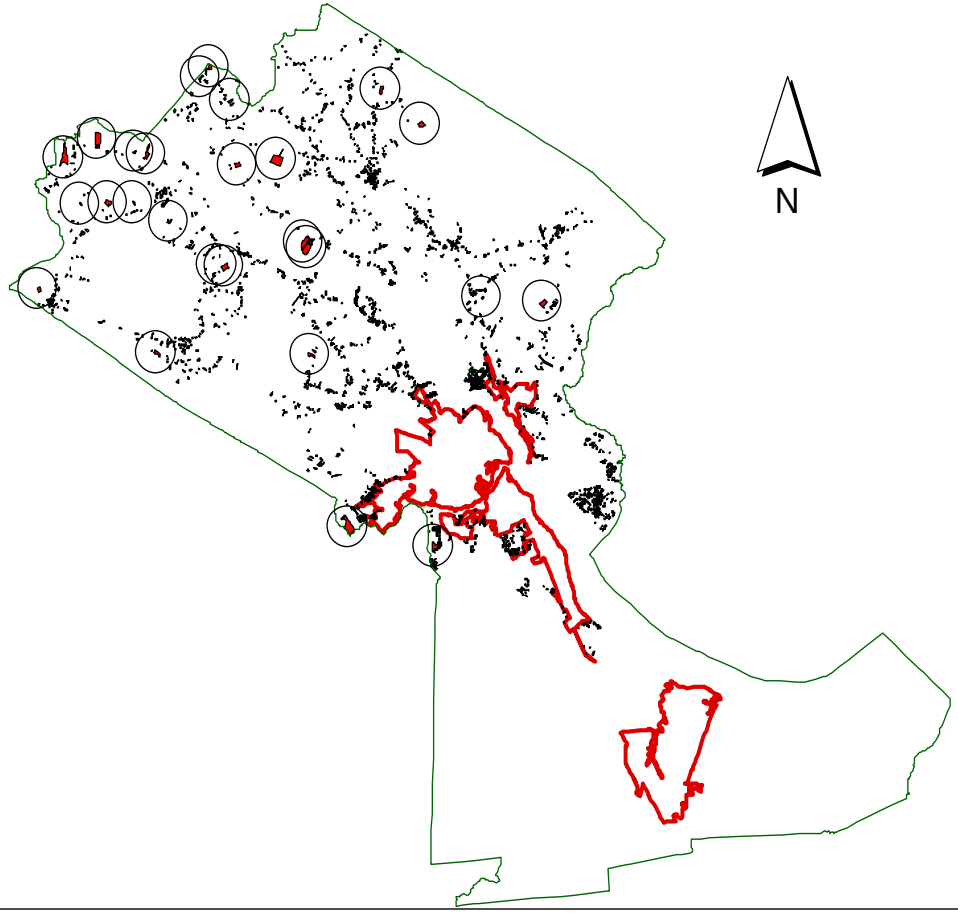
Methodology

- To measure benefits, input-out analysis is employed
- To measure harm, spatial hedonic model employed
  - None of previous hog impact studies addressed spatial autocorrelation.
    - Palmquist et al. (1997)
    - Abeles-Allison (1990); Taft et al. (1996); Hamed et al. (1999); Ansine et al. (2003); Herriges et al. (2003); Ready and Abdalla (2003); Hwang et al. (2003)

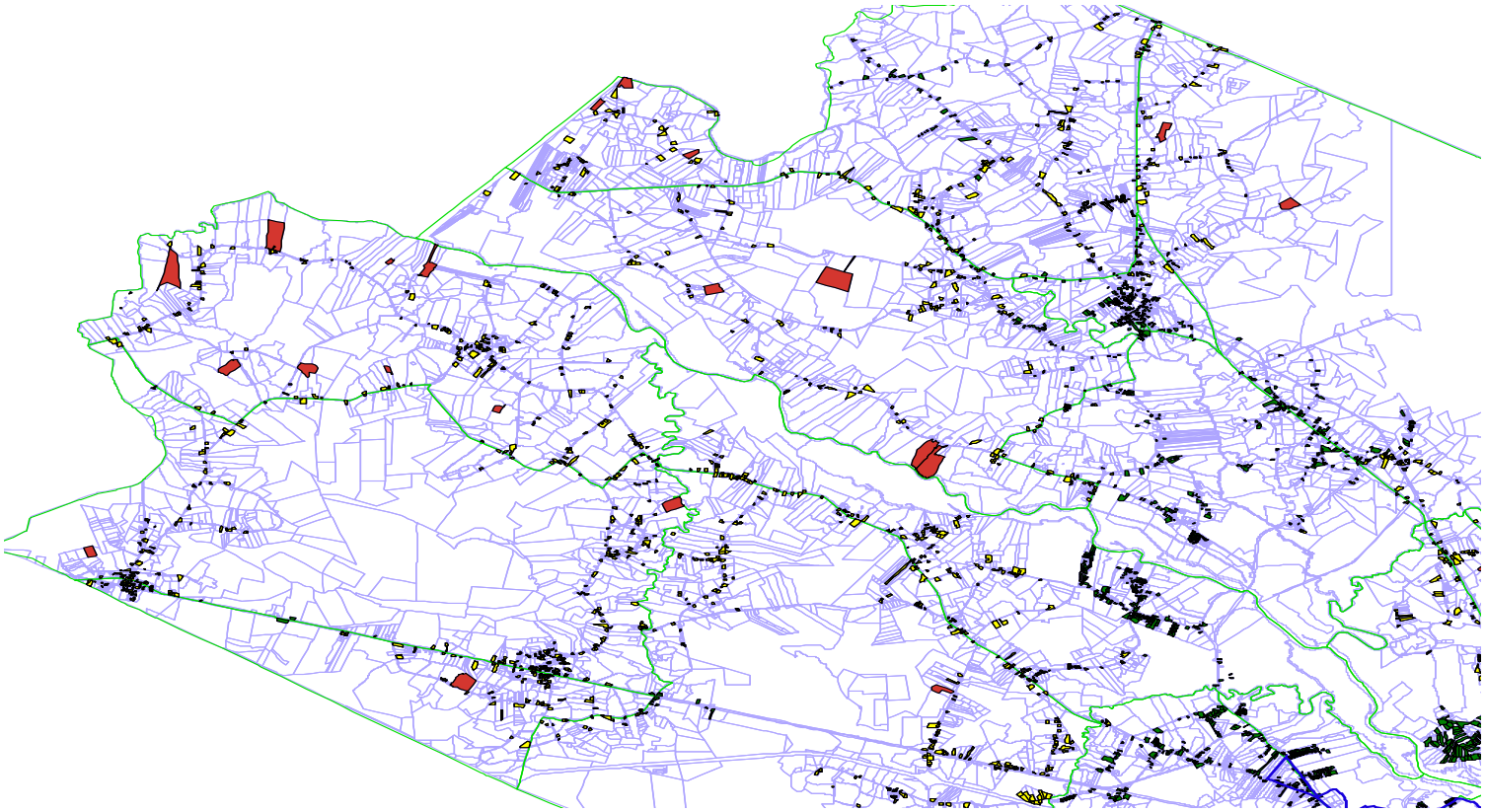
Craven County, North Carolina



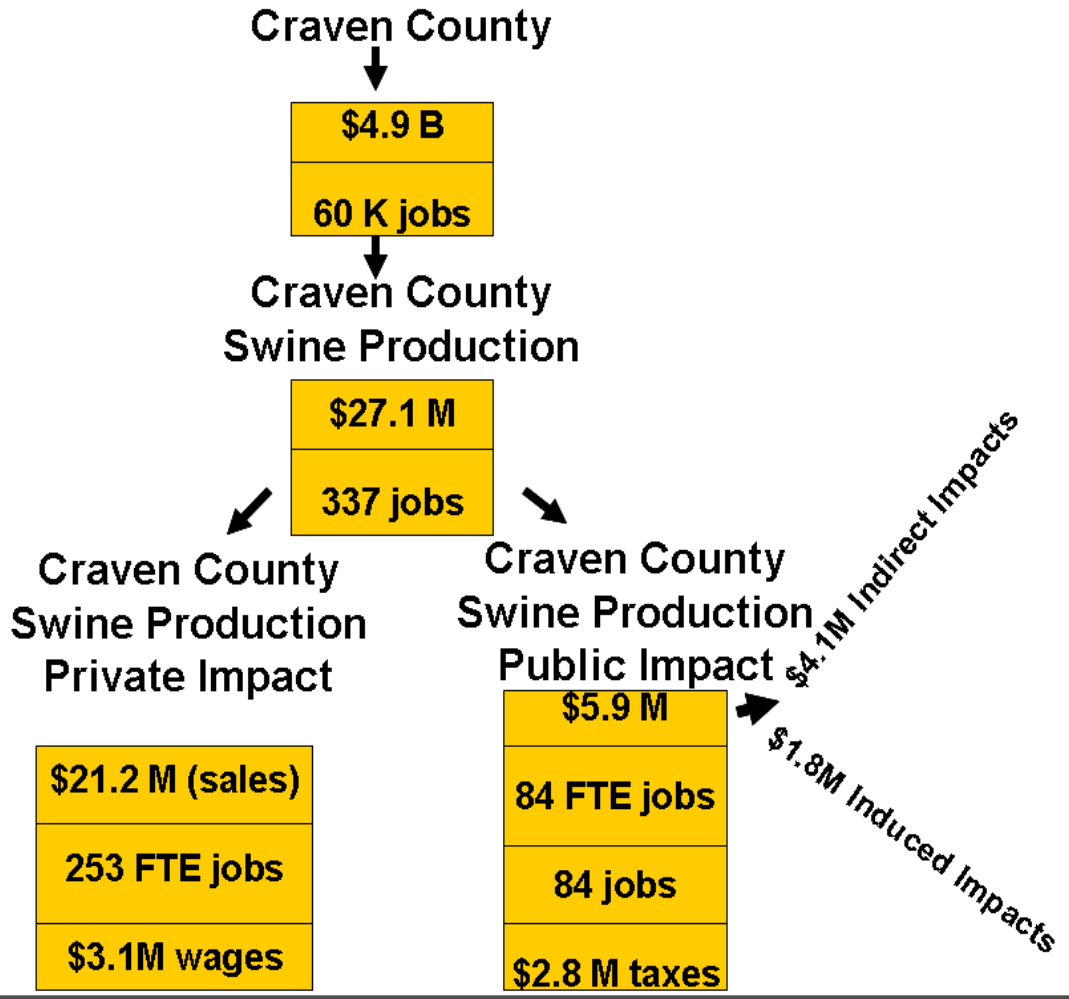
Hog farms in Craven County



Hog Farms and Rural Houses in Craven



Economic Impact Overview



Spatial Hedonic Model

- Traditional hedonic model does not take spatial autocorrelation into account.
  - 1) Property values are affected by neighborhood.
    - Share same location amenities (Dubin; Basu and Thibodeau)
  - 2) Mismatch in spatial scale (Anselin and Bera) arises due to
    - Applying aggregate data, e.g. median household income by Census Track to parcel level
    - Environmental impact spilling over observations (houses)

Real Estate Literature Review

- Findings
  - Ignoring spatial autocorrelation leads to biased or inefficient estimates in OLS.
- Spatial Lag Model
  - Can (1990)
  - Can and Megbolugbe (1997)
  - Kim, Phipps, and Anselin (2003)
- Spatial Error Model
  - Pace and Gilley (1997)
  - Beron et al. (in press)

Planning Literature Review

- 홍남희, 이명훈, 2011. “지속가능한 개발 관점에서의 서울시 도시공간구조 변화특성에 관한 연구; 토지이용변화를 중심으로”, 국토계획 , 46(1)
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Spatial Model Estimation

- Testing spatial autocorrelation with OLS
  - Langrange Multiplier (LM) test
  - Different spatial weights matrix
  - Contiguity, distance, and k-nearest neighbors
- Estimation of spatial lag or spatial error model follows.

Spatial Model Specification

- Spatial Lag Model

$$y = \rho W y + X\beta + \varepsilon$$

W , a spatial weights matrix
ρ, spatial autoregressive parameter

- Spatial Error Model (AR)

$$\varepsilon = \lambda W \varepsilon + \xi$$

λ, spatial autoregressive parameter
ξ uncorrelated error term

Spatial Lag Model Specified

$$VTF = \beta_0 + \rho\, W \cdot VTF + \beta_1\, BASEAREA + \beta_2\, ROOM + \beta_3\, BATHROOM + \beta_4\, LOTSIZE + \beta_5\, AGE + \beta_6\, INCOME + \beta_7\, DCBD + \beta_8\, DOPEN + \beta_9\, DSCHOOL + \beta_{10}\, HOG\_D + \beta_{11}\, SIZE$$

where VTF is Box-Cox transformed assessed property values and *W* is a spatial weights matrix

Variables	Definition	Mean	Std. Dev.	Min.	Max.
VALUE	Assessed property values ($)	106,068	74,730	6,260	956,250
BASEAREA	Base area (sq. ft)	1,532	465	288	4,304
ROOM	Number of rooms	5.83	1.15	2	13
BATHROOM	Number of bathrooms	1.75	0.60	1	6
LOTSIZE	Lot size (acres)	1.09	1.42	0.05	10
AGE	Age of house (yrs)	25.41	22.32	1	173
INCOME	Median household income by census block-group ($1,000)	38.71	10.25	21.71	61.45
DCDB	Distance to the central business district (miles)	9.77	6.16	1.07	26.70
DSCHOOL	Distance to the nearest school (miles)	3.0	1.86	0.03	9.28
DOPEN	Distance to the nearest open space (miles)	0.26	0.22	0.001	1.34
HOG_D	Number of hogs divided by distance to the nearest farm	1,677	2,172	210	32,556
SIZE	1 if a farm is large (> 2,500 head)	0.50	0.50	0	1

Spatial Model Findings

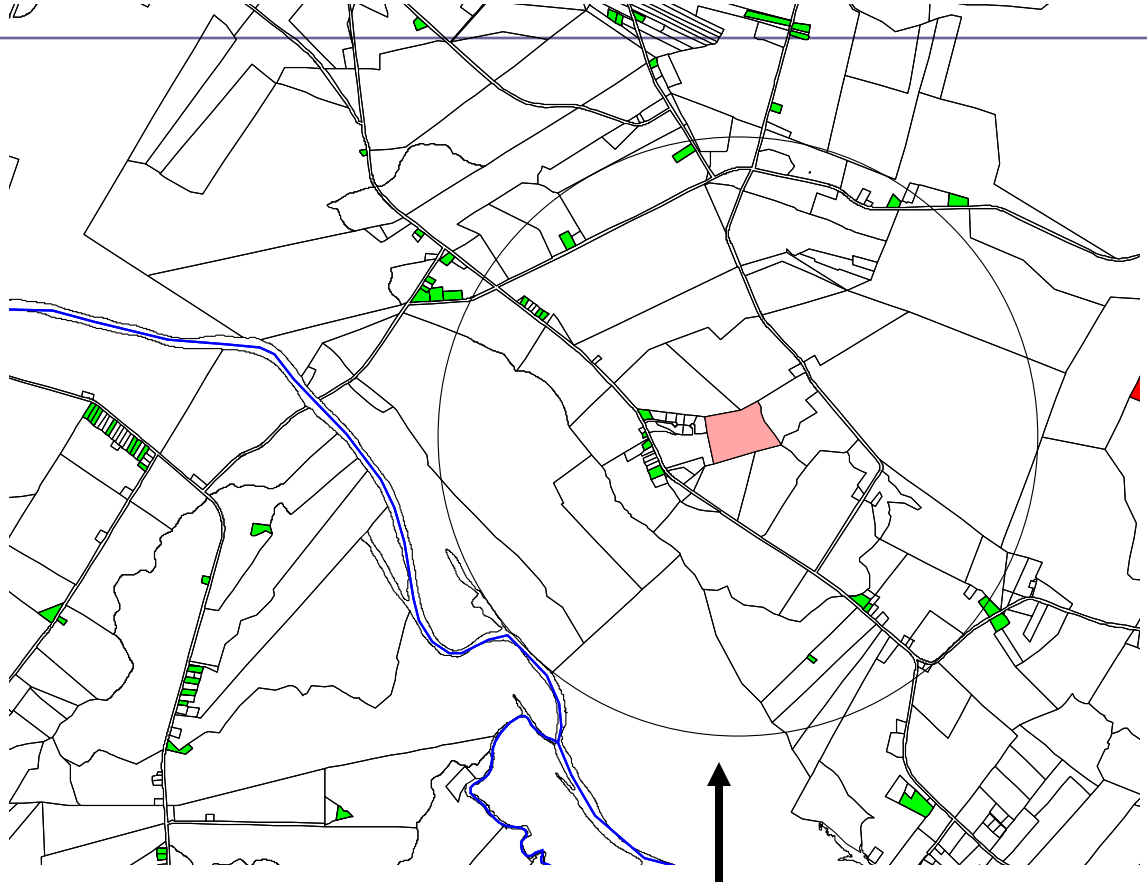
- Property values are negatively associated with the distance to a farm.
  - The impact is distance-decayed up to 1.75 mile away from a farm.
- When spatial lag dependence is taken into account, the impact is mitigated by 18% on average.

Summary of Impact (per hog)

Distance (mile)	Box-Cox (OLS)	Spatial Lag (2SLS-Robust)	% Change
0.75	-$0.51	-$0.47	Δ 8.6
1	-$0.68	-$0.52	Δ 23.3
1.25	-$0.53	-$0.42	Δ 21.8
1.5	-$0.35	NA	
1.75	-$0.32	NA	

The impact on the value of median house ($63,520) that is 1 mile from a farm with 10,000 head is $5,200 or 8%.

Hog Farm (853 hogs) and Surrounding Houses

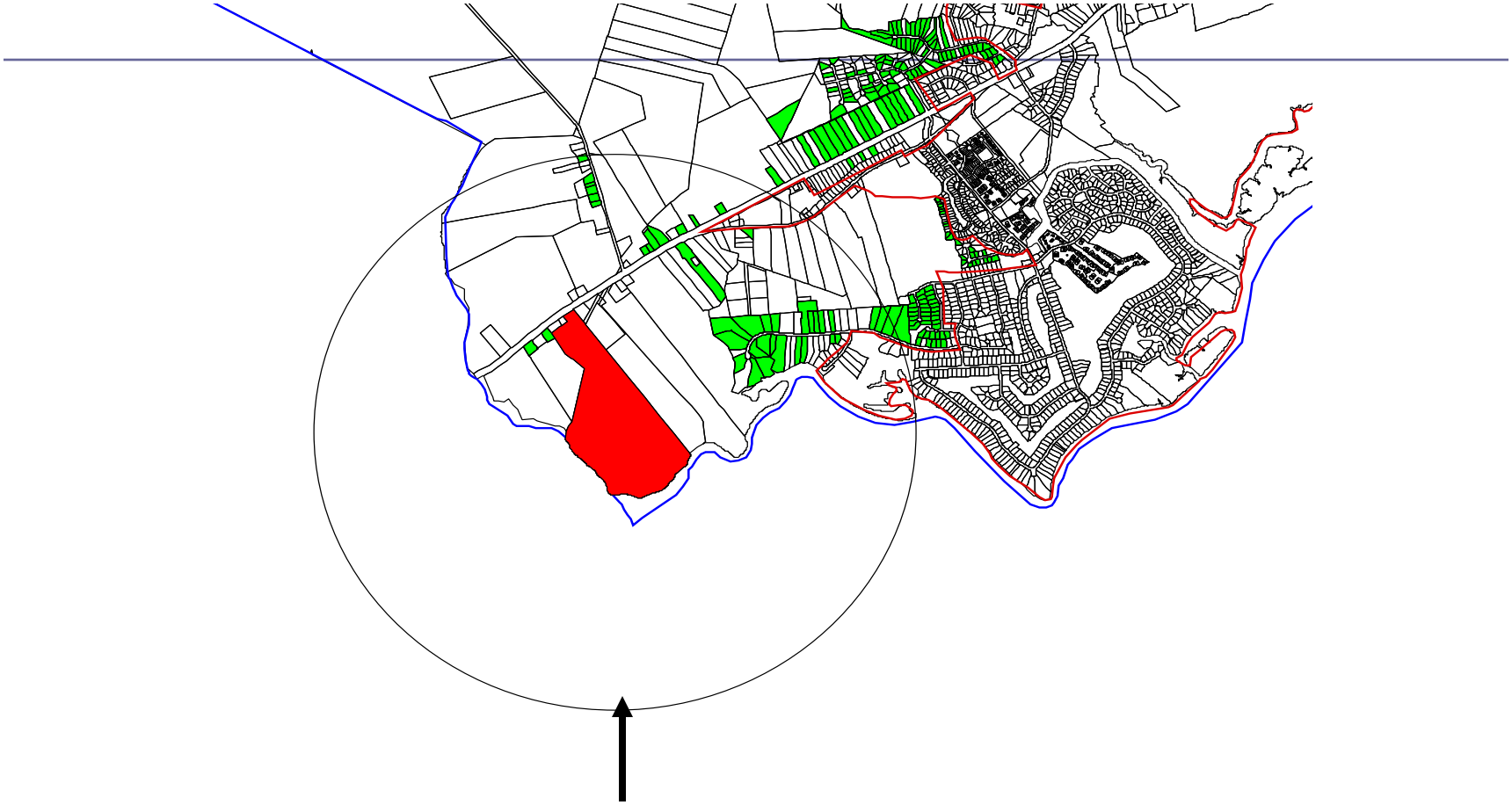


1.25 mile radius (13 houses)

Estimated Cost of Farm to Surrounding Property Values

House No.	Assessed Value	Distance to a Farm (Mile)	Estimated Impact	% Change
1	$37,690	0.40	-$620	-1.6%
2	$31,510	0.41	-$538	-1.7%
3	$36,690	0.41	-$590	-1.6%
4	$29,490	0.42	-$501	-1.7%
5	$28,920	0.86	-$239	-0.8%
6	$43,140	0.90	-$303	-0.7%
7	$44,070	0.97	-$287	-0.7%
8	$25,500	0.99	-$190	-0.7%
9	$100,770	0.99	-$503	-0.5%
10	$35,260	1.07	-$222	-0.6%
11	$128,020	1.09	-$542	-0.4%
12	$66,990	1.16	-$322	-0.5%
13	$146,350	1.19	-$544	-0.4%
Sum	$754,400		-$5,401	-0.7%

Hog Farm (12,590 hogs) and Surrounding Houses



1.25 mile radius (43 houses)

- Estimated Cost of Farm to Surrounding Property Values

House No.	Assessed Value	Distance to a Farm (Mile)	Estimated Impact	%
1	$177,220	0.43	-$25,499	-14.4%
2	$44,470	0.45	-$9,142	-20.6%
3	$259,680	0.53	-$27,390	-10.5%
4	$218,310	0.54	-$23,534	-10.8%
5	$230,280	0.57	-$23,313	-10.1%
6	$337,810	0.58	-$30,061	-8.9%
7	$157,890	0.61	-$16,679	-10.6%
8	$226,170	0.61	-$21,439	-9.5%
9	$281,450	0.63	-$24,251	-8.6%
10	$160,540	0.65	-$15,840	-9.9%
11	$55,600	0.68	-$7,135	-12.8%
12	$135,660	0.68	-$13,266	-9.8%
13	$252,300	0.69	-$20,459	-8.1%
14	$92,450	0.69	-$9,954	-10.8%
15	$133,510	0.70	-$12,782	-9.6%
16	$70,850	0.71	-$8,046	-11.4%
17	$168,000	0.73	-$14,373	-8.6%
18	$48,090	0.75	-$5,797	-12.1%
19	$53,010	0.77	-$6,053	-11.4%
20	$256,420	0.77	-$18,478	-7.2%
21	$349,380	0.79	-$22,396	-6.4%
22	$58,330	0.82	-$6,086	-10.4%
23	$194,280	0.86	-$13,563	-7.0%
24	$120,450	0.87	-$9,602	-8.0%
25	$49,920	0.87	-$5,110	-10.2%
26	$119,750	0.89	-$9,346	-7.8%
27	$27,890	0.90	-$3,269	-11.7%
28	$134,400	0.91	-$9,918	-7.4%
29	$58,950	0.92	-$5,455	-9.3%
30	$123,430	0.92	-$9,180	-7.4%
31	$55,390	0.93	-$5,163	-9.3%
32	$130,520	0.95	-$9,341	-7.2%
33	$151,120	0.95	-$10,312	-6.8%
34	$72,390	0.97	-$6,018	-8.3%
35	$56,560	0.97	-$5,044	-8.9%
36	$54,810	0.99	-$4,812	-8.8%
37	$139,370	1.02	-$9,079	-6.5%
38	$63,370	1.11	-$4,748	-7.5%
39	$200,960	1.12	-$10,713	-5.3%
40	$271,150	1.15	-$12,925	-4.8%
41	$216,280	1.18	-$10,674	-4.9%
42	$201,310	1.20	-$9,980	-5.0%
43	$203,400	1.21	-$9,977	-4.9%
Sum	$6,413,120		-$536,203	-8.36%

Public Economic Impact and Cost for Example Farms

	Hogs	Affect Homes Within 1.25 miles	Total FTE Jobs	Wages Paid	Total Taxes Paid	Total Impact	Direct Impact	Indirect Impact	Induced Impact	Public Economic Impacts	Cost (Public)	EI/C Ratio
Farm 10	853	13	3	$32,009	$27,533	$272,044	$211,792	$41,836	$18,416	$60,252	($5,401)	11.16
Farm 24	12,590	43	50	$472,595	$406,507	$4,016,553	$3,126,977	$617,677	$271,899	$889,576	($536,203)	1.66
Sum	13,443	56	53	$504,604	$434,040	$4,288,597	$3,338,769	$659,513	$290,315	$949,828	($541,604)	

Conclusion and Implications

- Overall, the economic impacts are greater than the costs by about 2.7 to one.
- Allows policymakers to know who is being harmed, by how much and by whom.

Contributions

- Four options for industry
  - Do nothing
  - Each firm bears the costs individually
  - An impact-based tax levied for compensation
  - Identify optimal siting
- Methodologies contribute to minimize cost, to employ feasibility study & financing

Discussion

- CBA as problem-solving tool
  - dual function for decision rule & decision process
- Macro analysis requires
  - Broader perspectives, i.e., environment and quality of life issues
  - Significance of “spatial” dimension
- Welfare issues
  - income and time effects
- Dynamic evaluation
  - extensive time-series data

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