The Effects of Policy and Strategic Factors on Investment in Fuel-Ethanol Plants

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Agenda

- Investment in Corn-Ethanol Plants in the Midwestern United States (with Karen Thome)
- Investment in Fuel-Ethanol Plants Worldwide (with Fujin Yi)

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Research Question

- What factors affect decisions about when and where to invest in building new ethanol plants?

Sources of strategic interaction

- Competition for inputs
  - corn
- Competition in output markets
  - Ethanol (still semi-local)
  - Co-product markets (getting more important)
- Benefits from existing infrastructure
  - marketing and shipping infrastructure
  - educated workforce

Policy variables

- Federal MTBE ban
  - Ban came into effect at different times for each state
  - We chose to not include federal tax breaks, credits or the small-producer subsidy because they do not vary enough in our time period to identify them
- State producer tax credits
  - Not all states in the sample have these policies, and those that do were in place for plants that opened in different years
  - Describing this variable is complicated by the fact that each state places different contingencies on receiving funds; for example, some states support large plants, others only small or community owned plants
    - Because of these differences we represent these policies with a binary variable

Methodology

- Reduced-Form Model
  - Discrete response model
- Structural Model
  - Discrete dynamic game

Reduced-Form Model

Reduced-form models

- Fixed effects logit
- Multinomial logit by type
  - Cooperatively-owned
  - Ethanol-only firms
  - Conglomerates

Reduced Form Results: Fixed Effects Model

VARIABLES	(1)	(2)
Other Plant	-15.54***	-15.42***
Spatial Lag Other Plant	0.229	0.254
Biodiesel Plant	0.979	1.041
Soy Price	-1.584	-0.383
Corn Price	0.0889	1.958
Natural Gas Price	-0.158	0.089
Ethanol Price		-1.480
Oil Price		-0.086
Corn Intensity	18.96	17.50
Spatial Lag Corn Intensity	-13.88	-12.88
Soy Intensity	2.270	-1.272
Cow Density	2.063	1.922
Subsidy	0.798	0.922
MTBE Ban	-0.604	-0.801
Year		1.074***
Year Dummies	YES	

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Robustness

- Also grouped the competing firms by type:
  - Cooperatively-owned
  - Ethanol-only firms
  - Conglomerates
- Result:
  - Local plants of all types have significant negative effect on entry (=> plants compete locally for inputs)
  - Spatially lagged conglomerates and large ethanol-only firms have significant positive effect on entry (=> agglomeration)

Robustness

- Entry of different types of plants:
  - Cooperatively-owned
  - Ethanol-only firms
  - Conglomerates
- Multinomial logit
- Results: entry by cooperatives and ethanol-only plants is deterred by existence locally of other large plants

Reduced-Form Results

- Summary
  - Other plants deter entry
  - Corn intensity is positively correlated with entry
  - Federal MTBE ban and state producer tax credits (subsidy) have positive effects on entry

Structural Model

Structural model

- Follows Pakes, Ostrovsky, Berry (2007) and Lin (2010)
- Step 1: Estimate continuation values & predicted investment probabilities
- Step 2: Use generalized method of moments (GMM) to match predicted probabilities with the actual probabilities in data

Effects of Other Plants

- There is an important strategic component

Effects of Feedstock

- Intensity of corn production is important in determining local investment in both models
  - Corn is bulky and transportation is not cheap
  - It is beneficial for plants to locate where they have good access to feedstock

Effects of Prices

- We find mixed results of the effects of input and output prices across the different models and specifications
- This inconsistency is potentially due to the data resolution, which, at state and national level, is not ideal
- That said, we were still able to find some effect of prices indicating that:
  - they do matter
  - even with less than ideal data source, our model is strong enough to tease out some of these effects

Effects of Policy

- Mixed results
  - State producer tax breaks are important in reduced-form model
  - MTBE ban is significant in structural model
- Further analysis of the effects of policies on investment in ethanol plants is subject of ongoing work

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Background

- Fuel-ethanol plants in the world
  - There were 191 fuel-ethanol plants in the world excluding the U.S. in 2009
  - 82% of them were built after 2005
  - The production of fuel-ethanol increased by 17.7% from 2007 to 2008
- Diversification of feedstocks
  - Corn
  - Wheat
  - Sugar beet
  - Rice
  - Sugar cane

Research objectives

- Analyze investment decision in ethanol plants worldwide
- Analyze choice of feedstock
- Apply discrete dynamic game structural econometric methodology of Bajari, Chernozhukov, Hong, and Nekipelov (2009)
  - Players can choose among several actions each period

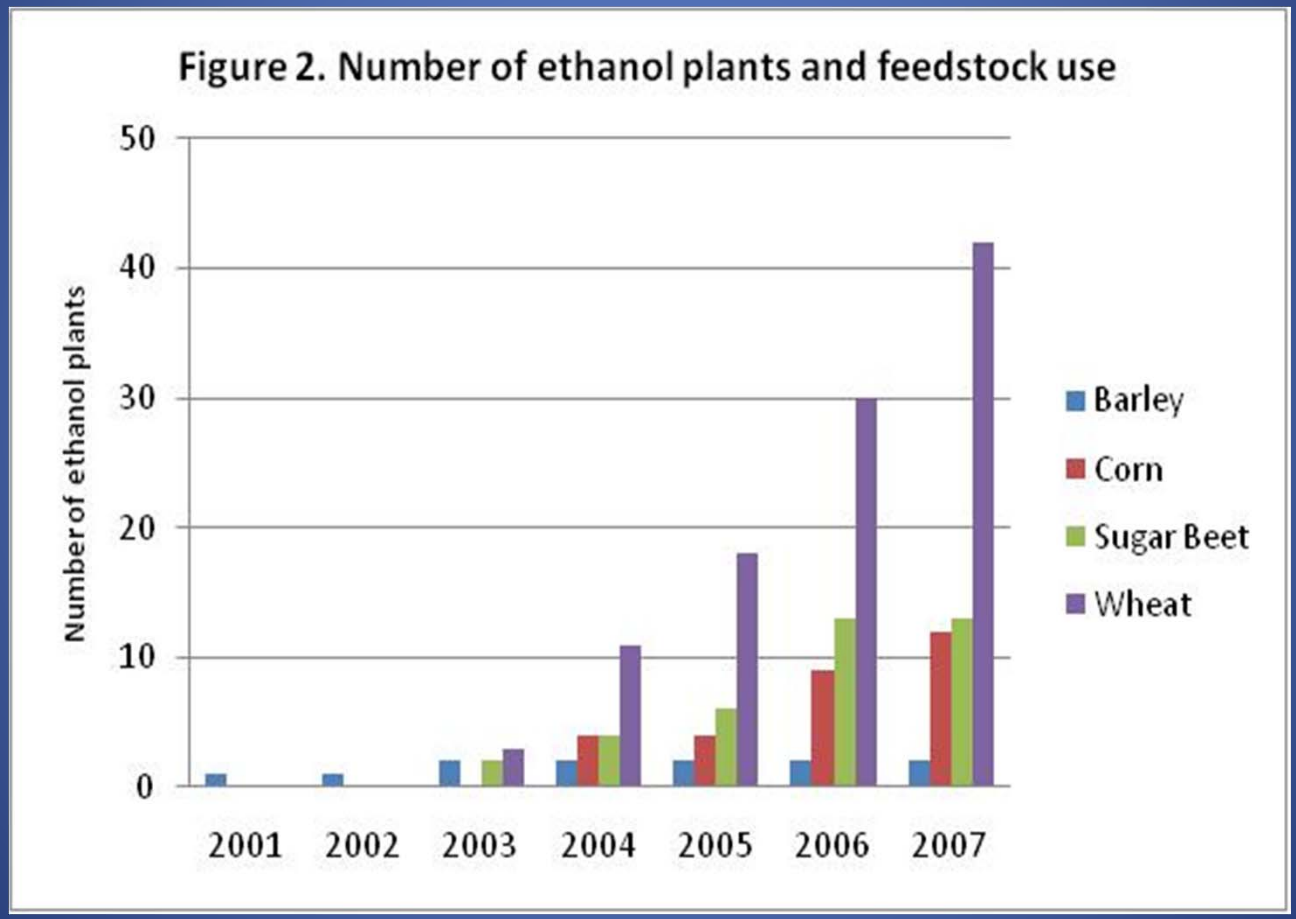
Estimation strategy

- Step 1: Estimate the choice probabilities flexibly using a sieve multinomial logit
  - Apply the Hotz-Miller inversion to learn $\hat{V}_i(k,s) - \hat{V}_i(0,s)$
- Step 2: Estimate $\hat{V}_i(0,s)$
- Step 3: Estimate $\hat{\Pi}_i(a_i, s_m)$
- Step 4: Estimate the parameters semiparametrically by matching the payoff function in Step 3 to a parametric form of $\Pi_i(a, s_i; \theta)$ integrated over others' choices

Research questions

- What factors affect the decision to invest in ethanol plants?
- How do they make their location decisions?
  - What feedstock do they choose to produce fuel-ethanol?
  - How to model the investment decision of a potential fuel-ethanol plant?

Ethanol in Europe



Results

- Ethanol plants are dependent on government support policies
  - Tax credit
  - Blending mandate
  - R&D support
- Several market factors such as ethanol prices are not significantly important
- Interaction effects from incumbents and new entrants are different
  - Incumbents harm the potential entrant's profits
  - Interactions from other new entrants are not obviously identified

Canada

- Feedstocks:
  - Corn
  - Wheat
- 15 ethanol plants
- Earliest one started production in 1981

Canada: Results

- Ethanol price has positive effect on investment
- Natural gas price has negative effect
- Gasoline price has positive effect
- Feedstock price has negative effect
- Strategic effects are negative if the other plants are of the same feedstock
- Strategic effects are positive if the other plants are of different feedstock
- Government policy effects vary across fuel ethanol plants that are based on different feedstocks

Brazil

- Feedstock:
  - Sugarcane
- Over 400 ethanol plants
- Earliest plant started operating in 1840
- Most started operating after 1970s

Brazil: Results

- These factors improve profits:
  - higher ethanol prices
  - plenty of feedstock
  - improved demand derived by the introduction of the flex fuel vehicle

China

- Feedstocks
  - Corn
  - Wheat
  - Cassava
- 5 ethanol plants
- Earliest plant started operating in 2000

India

- Feedstock:
  - Sugarcane
- 6 ethanol plants
- Earliest started operating in 2001

Conclusion

- There is an important strategic component
- It is beneficial for plants to locate where they have good access to feedstock

Thank you