Location and Spatial Pricing in Agricultural Markets

Marten Graubner, Alfons Balmann, Richard J. Sexton

Research Associate, Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO), Theodor-Lieser-Str. 2, 06120 Halle (Saale), Germany, +49 345 2928 320, graubner@iamo.de.

Professor, Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO), Theodor-Lieser-Str. 2, 06120 Halle (Saale), Germany, +49 345 2928 300, balmann@iamo.de.

Professor, Department of Agricultural and Resource Economics, University of California – Davis, 2148 Social Sciences & Humanities, Davis, CA 95616, (530) 752-4428, rich@primal.ucdavis.edu.

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Marten Graubner[1], Alfons Balmann[1], Richard J. Sexton[2]

[1] Leibniz Institute of Agricultural Development in Central and Eastern Europe (IAMO), Halle, Germany
[2] Department of Agricultural and Resource Economics, University of California, Davis (CA)

Introduction

Agricultural markets often feature significant transport costs and spatially distributed production and processing (Figure 1) which causes spatial imperfect competition [1,2]. Spatial economics (as a theoretical framework to investigate those markets) considers the firms' decisions regarding location and spatial price strategy separately, usually on the demand side, and under restrictive assumptions. Therefore, alternative approaches are needed to explain, e.g., the location of new ethanol plants (Figure 1) at peripheral as well as at central locations and the observation of different spatial price strategies in the market [3].
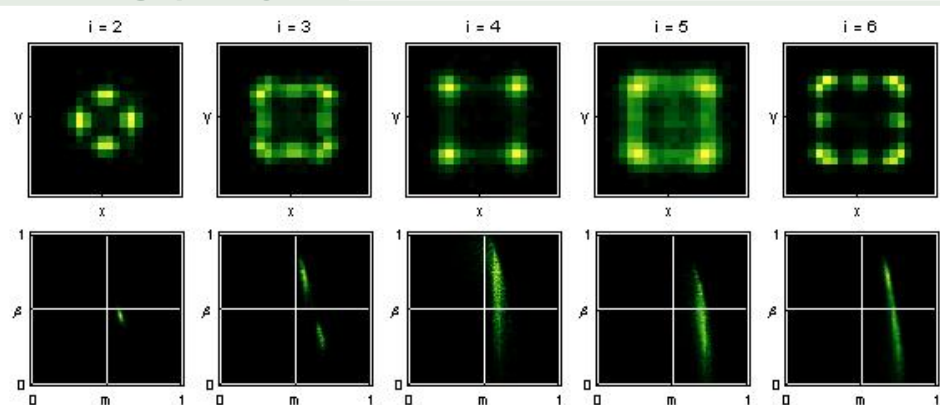
Objectives

- Analyzing location and spatial pricing in a general model under multi-firm competition, two-dimensional space, and a continuum of potential price strategies
- Determining the effect of crucial assumptions on the model's outcome
- Linking spatial differentiation and spatial price discrimination to support theoretical model development and to explain real world observations

Methodology

An agent-based simulation model of spatially interacting input producers and processors is used. Producers are price taker and exhibit a linear, isoelastic supply function. There are 400 uniformly distributed producers in a two-dimensional bounded region (x-y plane) of constant size. Processors identify the optimal location and price strategy via numerical simulations. The price strategy is a linear price distance function [4]: $p(r)=m-(1-\beta)tr$. The local price $p(r)$ consists of the processor's mill price m (the price at the processor's location) less some portion $1-\beta$ of the transport costs $t*r$ to location r with t being the constant transport rate. $\beta \in [0,1]$ is the degree of spatial price discrimination ($\beta=0$: free-on-board (FOB); $\beta=1$: uniform delivered (UD) pricing). The number of processors is i. The output price of the processed input is normalized ($\rightarrow m \in [0,1]$).

Figure 1: U.S. Corn production and location of ethanol plants 2008

Corn Production (Bushels)
- Not Estimated
- < 1,000,000
- 1,000,000 - 4,999,999
- 5,000,000 - 9,999,999
- 10,000,000 - 14,999,999
- 15,000,000 - 19,999,999
- 20,000,000 +

Ethanol Plants
- Construction
- Producing
- Not producing

U.S. Department of Agriculture, National Agricultural Statistics Service

Results

Four scenarios of the static, non-cooperative game are simulated: **a) Duopsony,** $i=2$ and selected values of the transport rate in $t \in [0,5]$; **b) Oligopsony:** as a) but $t=2.0$ and $i=\{2,3,4,5,6\}$; **c) Unbounded space:** as b) but region is a torus (e.g., $x=0$ is direct neighbor of x_{max}); and **d) Inelastic supply:** as c) but unit supply instead of linear supply functions. Results are presented by two density plots of the processor's four decision variables: location (x,y) and price strategy (m,β). The brighter a point in the x-y or m-β plane the more frequent this combination is observed as the outcome of the game.
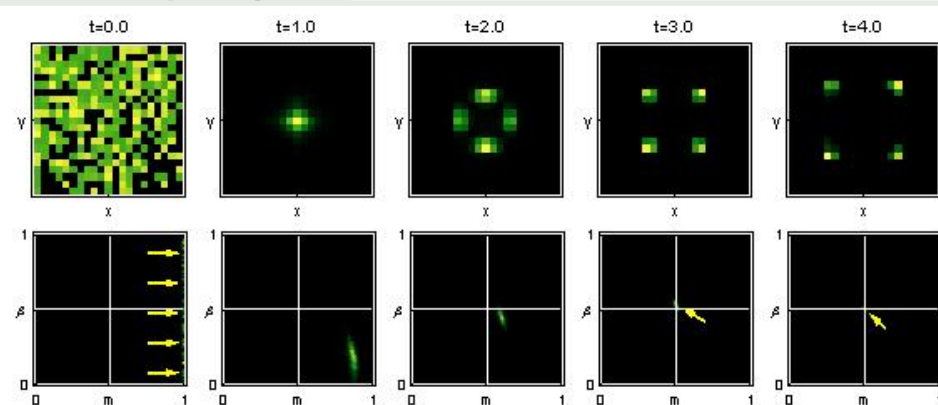
b) Oligopsony

The market becomes more competitive with increasing number of firms. Processors seek equidistant locations. If this is not possible, we observe both differentiation in the processors' location and price strategies ($i=3$). Thereby, higher price discrimination relates to locations of fierce competition.

a) Duopsony

If $t=0.0$, perfect or Bertrand competition ($m=1$) occurs because neither the location nor β influence local prices. For high market competitiveness ($t=1.0$) minimum differentiation and low price discrimination (close to FOB pricing) is observed. With increasing transport costs spatial differentiation (two location equilibria) and price discrimination increases.

c) Unbounded space
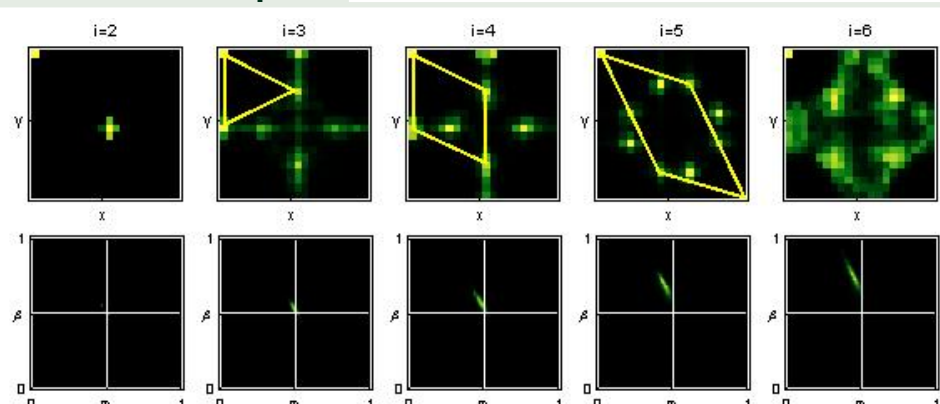
The lack of borders enables equidistant locations in most cases. Multiple equilibria arise (feasible constellations are highlighted). Only if $i=6$, the algorithm is not able to solve the coordination problem. Price discrimination increases with increasing competition.

d) Inelastic supply
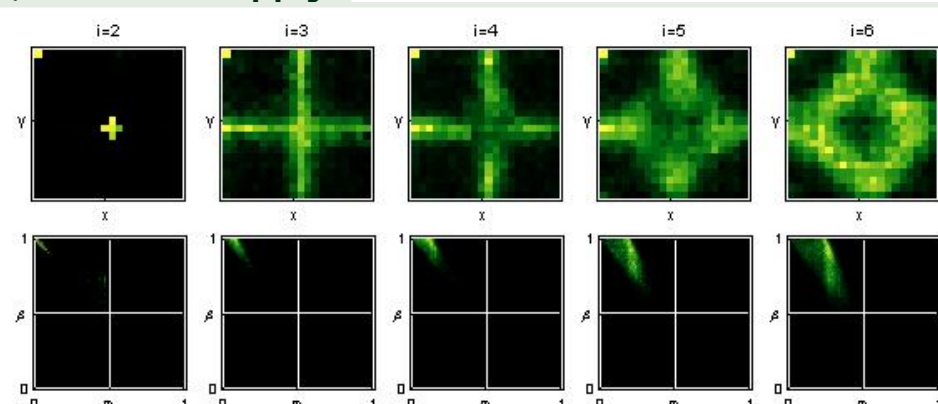
Only if $i=2$ pure strategy equilibria in location can be observed. Unit supply yields high price discrimination (in terms of UD pricing). Increasing competition forces processor to pay more than the producer's reservation price (which is set to zero).

Conclusion

- The simulation enables the analysis of pricing *and* location under a general spatial competition framework.
- Results are consistent with theoretical findings and real world observations, e.g., in the case of ethanol production.
- Depending on the location of a processor, different price strategies can be observed.
- Market competitiveness increases with the number of firms or lower transport costs. In the latter (former) case price discrimination decreases (increases) if the market is bounded (unbounded).
- Elasticity in the producers' supply functions is identified as stabilizing factor of processor's location.

References

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IAMO, Marten Graubner
Theodor-Lieser-Straße 2, 06120 Halle, Germany
phone: +49 (0) 345 2928-320 Email: graubner@iamo.de

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