Location and Spatial Pricing in Agricultural Markets

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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 ($xy$-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]: \( p(r) = m + \beta r \). 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 \( Tr \) to location \( r \) with \( r \) being the constant transport rate. \( \beta \in [0,1] \) is the degree of spatial price discrimination (\( \beta = 0 \): free-on-board (FOB) pricing, \( \beta = 1 \): uniform delivered (UD) pricing). The number of processors is \( i \). The output price of the processed input is normalized \( \lambda = m/[0,1] \).

Results
Four scenarios of the static, non-cooperative game are simulated:
- **a) Duopsony**, \( in=2 \) and selected values of the transport rate in \( t \in \{0.5\} \).
- **b) Oligopsony**: as a but \( t \in \{2.0 \} \) and \( \beta \in \{2,3,4,5,6\} \).
- **c) Unbounded space**: as a but region is a torus (e.g., \( x=0 \) is direct neighbor of \( x=x_{max} \)).
- **d) Inelastic supply**: as c) but unit supply instead of linear supply functions.

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 (\( \beta \)). Thereby, higher price discrimination relates to locations of fierce competition.

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

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.

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References