Spatial Competition and Welfare Ranking of Biofuel Policies

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Summary
This study examines the welfare effects of input- and output-based policies. We adopt a game-theoretic approach that allows us to model firms' conduct under alternative structures of spatial markets. A key finding is that the welfare ranking of policies is fundamentally influenced by the intensity of spatial competition for the feedstock input. In particular, all else constant, input-based policies become more attractive as the competition for the feedstock intensifies. Moreover, input-based policies shift surplus upstream towards biomass producers. The extent of this effect is positively correlated with competition intensity.

Background and Contribution
Two different types of policies have been proposed and implemented to incentivize expansion of biofuels: subsidies for collection and sale of biomass, and the renewable fuel standard (RFS). Biomass subsidies have been operationalized through the Biomass Crop Assistance Program (BCAP), through which the federal government matches each dollar offered for biomass by certified biofuel processors. Alternatively, the RFS requires gasoline blenders to purchase a minimum amount of biofuels, thereby increasing demand for biofuels and biomass. While a large and fast-growing literature has examined different aspects of these policies, less attention has been paid to their interactions with feedstock market structure. We demonstrate that the welfare effects of these policy instruments depend on market structure, and explore how market conditions affect the welfare ranking of alternative policies.

Methods
Following previous analyses of spatial agricultural procurement markets (Graubner, Balmann, and Sexton, 2011) we employ a Hotelling's line representation of spatial markets. We modify Zhang and Sexton (2001)'s canonical model so that it can be empirically implemented. The Hotelling's line model is a more appropriate empirical representation of most spatial economies due to the existence in reality of central and peripheral operating conditions and the ability of input suppliers to travel direct routes between competitors. This is especially true for the Corn Belt, which has varying corn planting density and dense transportation infrastructure. Moreover, we assume a symmetric spatial configuration which, under high relocation costs as it is the case for biofuel firms, has been proven to emerge as an equilibrium in the Hotelling's line with two (D'Aspremont et al., 1979) or more firms (Economides, 1993).

Empirical implementation of alternative market structures requires estimation of the stover supply schedule faced by plants. To quantify supply, we consider an area comprising Jasper County and White County in Indiana. This region is considered a good candidate for plant location as it has the highest corn planting densities and yields in the state. Two points at opposing extremes of the geographic area (northwest of Jasper County and southeast of White County) were chosen and the distance between these points was calculated to be fifty miles using Google Maps's distance-measuring tools. Data from USDA-NASS is used to determine corn planting patterns, and production parameters. Total biomass available at each point on the line is calculated under the assumption that production is uniformly distributed along the fifty-mile line joining the corners of Jasper and White Counties in Indiana.

Since primary data necessary to estimate a participation rate curve are not available, we simulate profit-maximizing land allocation decisions (incorporating corn with stover removal as a land use alternative) with the Purdue Crop Linear Programming model (PCLP) (Doster et al., 2009). This simulation provides a counterfactual scenario (i.e., acres allocated by farmers to corn with stover removal at different stover prices) based on which supply density can be estimated. For each farm in our sample, we use PCLP to calculate the profit-maximizing allocation of land to competing crop rotations for a range of stover prices. From this solution the share of corn area with stover removal (i.e., the participation rate) is calculated. We then conduct a linear approximation to the simulated participation rates as a function of stover price.

Due to non-smoothness in the choice of input price as a function of policy levers (i.e., biofuel price in the case of the RFS, and input supply in the case of BCAP), our model does not yield an analytical solution. Therefore we resort to numerical methods. The solution algorithm first finds firms' profit-maximizing prices under alternative pricing strategies, free-on-board (FOB) and uniform delivered (UD). Optimal prices are used to calculate profits under FOB and UD pricing. Profits are compared and the best pricing strategy is chosen. Price and quantity under this pricing strategy are inserted into the farm sector's supply curve and surplus. Next, economic surplus of farmers and biofuel plants is calculated. We replicate the algorithm for alternative policy scenarios and distances between plants, which is meant to capture interactions between policy and competition intensity. Finally, we compare total surplus under alternative instruments over a range of competition intensities.

Conclusions and Policy Implications

Initial results indicate that input-based policies generate a larger surplus than output-based ones when competition is intense; and a larger share of that surplus is accrued by the farm sector. The output-based policy results in larger total surplus when competition is sufficiently weak. This result points to the importance of local market conditions for optimal policy design. Competition intensity can vary widely across space. Therefore, spatially homogenous polices are unlikely to attain a first best, or even a cost-effective outcome. This result is not unlike those derived in other environmental and resource economics literatures. But unlike those cases, in this application such result is not only caused by differences in agro-environmental conditions, but also by heterogeneous market structures.

Finally, the paper suggests important directions for future research. Understanding how policies can influence location and competition intensity seems particularly important. This amounts to endogenizing the location decision, and explicitly exploring an additional channel of interaction between policy and market structure.

References

Graubner, Marten, Alfons Balmann, and Richard J. Sexton. "Spatial price discrimination in agricultural product procurement markets: a computational economics approach." *American Journal of Agricultural Economics* 93, no. 4 (2011): 949-967.

Zhang, Mingxia, and Richard J. Sexton. "FOB or uniform delivered prices: Strategic choice and welfare effects." *The Journal of Industrial Economics* 49, no. 2 (2001): 197-221.

D'Aspremont, C., J. Jaskold Gabszewicz, and J. F. Thisse. "On Hotelling's 'Stability in Competition'." *Econometrica* 47, (1979): 1145-1150.

Doster, D.H., C.L. Dobbins, G.F. Patrick, W.A. Miller, and P.V. Preckel, 2009b. "Purdue PC-LP Farm Plan." Department of Agricultural Economics, Purdue University, July 2009.

Economides, Nicholas. "Hotelling's 'Main Street' with More Than Two Competitors." *Journal of Regional Science* 33, no. 3 (1993): 303-319.