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Spatial Competition in Agricultural Markets: A Discrete-Choice Approach

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1 Introduction

The agricultural economics literature is increasingly acknowledging the role that spatial pricing issues play in agricultural procurement markets (e.g. Sexton, 1990; Durham, Sexton, and Song, 1996; Alvarez et al., 2000; Fousekis, 2011; Graubner, Balmann, and Sexton, 2011; Graubner et al., 2011). As transportation costs account for a significant fraction of the value of agricultural commodities (Fackler and Goodwin, 2001; Rogers and Sexton, 1994), spatial pricing is a particularly important issue in these industries. This is further underscored by the fact that so few buyers exist relative to the number of sellers in these industries.

Work in the agricultural market spatial competition literature is varied, but has focused mainly on modeling equilibrium spatial pricing policy choices of handlers, price transmission rates, and transportation inefficiency under different behavioral assumptions regarding handlers. Depending on the structure of the industry in question, researchers make various behavioral assumptions for handlers in the industry such as the type of objective function the handler is maximizing, the conjectural variation for the level of competition in the market, and the type of spatial pricing policy employed by handlers.

A major problem encountered in the current literature dealing with spatial competition is nonexistence of pure-strategy Nash equilibria in competitive models due to discontinuous best response functions.[1] Researchers studying spatial pricing models propose several methods to deal with this issue. One, which Beckmann (1973), Osborne and Pitchik (1987), and Shilony (1977) propose, is to consider mixed-strategy equilibria in the models.[2] In another proposed solution introduced by Espinoza (1992) for the duopoly case and adapted for the duopsony case by Zhang and Sexton (2001), is to analyze pricing decisions of handlers in the context of a repeated game framework. A third proposed solution, which has been the most popular in the agricultural economics literature, is to assume collusive behavior on the part of handlers (Durham, Sexton, and Song, 1996; Alvarez et al., 2000; Huck and Salhofer, 2005; Huck, Salhofer, and Tribl, 2006; Tribl, 2009; Fousekis, 2011; Graubner et al., 2011). A fourth, more recent proposed solution to the nonexistence issue set forth

[1] See Dasgupta and Maskin (1986) for a general discussion of pure-strategy equilibria nonexistence problems in games with discontinuous best response functions and Beckmann (1973), d'Aspremont, Gabszewicz, and Thisse (1979), Schuler and Hobbs (1982), Beckmann and Thisse (2001), Anderson, de Palma, and Thisse (1989), Kats and Thisse (1989), and Zhang and Sexton (2001) for discussions in the context of spatial pricing models.

[2] See Graubner et al. (2011) and Iozzi (2004) for discussions related to agricultural procurement markets involving cooperatives.

by Graubner, Balmann, and Sexton (2011) takes a computational economics approach to simulate equilibrium strategies of handlers in regard to pricing.[3]

A major issue with all of these approaches is that they quite unrealistically assume that farmers will simply sell to the handler offering the highest price. To the contrary, it is well known that many factors other than price matter in farmers' selection of milk handlers. Examples of some of these factors include reliability of purchase and payment, services offered, family tradition and loyalty, and friendliness of handler personnel (Misra, Carley, and Fletcher, 1993; Kilmer, Lee, and Carley, 1994; Sayers et al., 1996).

In a fifth proposed solution to the nonexistence issue developed in the seminal work of de Palma et al. (1985) and adapted to spatial competition models by Anderson and de Palma (1988), Anderson, de Palma, and Thisse (1989), and Anderson, de Palma, and Thisse (1992), the researcher assumes that decision-makers incorporate factors other than price into their choices.[4] This approach, which has never been used to my knowledge in the case of agricultural procurement markets, has several distinct advantages over traditional models. The first is that it maintains smoothness of best response functions, thus permitting existence of pure-strategy Nash equilibria under a wide variety of conditions. The second advantage is that with it a more realistic assumption can be made with respect to how farmers choose which handler they want to sell their milk to. A third strength of this model is that it allows for overlap in the procurement markets without having to assume collusive behavior on the part of handlers.[5] The forth, and perhaps most important, advantage of this model is that it provides a readily adaptable framework for empirical analysis of agricultural procurement markets.

In this paper we develop a model of spatial competition in agricultural procurement markets using an adapted version of the model of de Palma et al. (1985) and Anderson and de Palma (1988). Due to the prominence of cooperatives in agricultural procurement markets (e.g. Liebrand, 2012), special consideration is made in regard to how mixed markets [6] play out in this model.

[3]This approach, for example, has also been used by Graubner and Balmann (2012) in an a theoretical analysis of land rental markets.

[4]Some examples of recent empirical studies that adapt this approach for the case of consumer markets are Houde (2012) and Miller and Osborne (2012).

[5]Indeed, anecdotal evidence suggests the presence of a fairly large amount of overlap in the Wisconsin milk industry (**?**) and empirical evidence indicates competitive pricing in the Wisconsin dairy industry (Freije, 2011).

[6]This term, most often used in the agricultural economics literature, refers to markets where both cooperatives and traditional profit-maximizing firms play significant roles.

1.1 Traditional Spatial Competition Models

One major emphasis of the spatial price theoretic literature is the role of spatially discriminatory pricing policies on economic outcomes (Greenhut, Norman, and Hung, 1987). The traditional spatial price theoretic literature, which focuses on spatial pricing issues in consumer markets, identifies three major pricing policies: 1) free-on-board, 2) uniform-delivered, and 3) optimal-discriminatory. The free-on-board pricing policy (which is nondiscriminatory in the sense that every consumer pays the same net, per-unit price for her commodity) involves each consumer bearing the full cost of transporting the product from the firm to her location. The uniform-delivered pricing policy, on the other hand, involves each consumer being charged the same price for transporting the product from the firm to her. The optimal-discriminatory pricing policy involves each consumer at a particular market location being charged the same transport price but with prices at market locations differing (Capozza and Van Order, 1978; Greenhut, Norman, and Hung, 1987).

Yet another interest of the spatial price theoretic literature is to classify impacts of various spatial conjectural variations concerning firms' beliefs about how other firms respond to their behavior. Three of these conjectural variations studied in great detail are: 1) Löschian competition, 2) Hotelling-Smithies competition, and 3) Greenhut-Ohta competition (Capozza and Van Order, 1978; Greenhut, Norman, and Hung, 1987).

Löschian competition (Lösch, 1954) supposes that each firm believes that if it makes a price change then every other firm will follow suit by making the exact same price change. This conjectural variation is thus useful in markets where there is believed to be a high degree of collusion among firms.

Hotelling-Smithies competition (Hotelling, 1929; Smithies, 1941), on the other hand, conjectures that the prices of other firms will remain fixed no matter what the firm does. This conjectural variation is useful when there is believed to be a high amount of competition among firms.

Greenhut-Ohta competition (Greenhut and Ohta, 1972) supposes that the price on the firm's entire border (the outermost market locations the firm serves) will remain constant even if the firm changes its price. An implication of this is that if the firm increases its price then all other firms will respond by lowering their prices by the same amount so that the price on the firm's entire border remains fixed.

Yet another conjectural variation that has been considered in the literature is the one used by Greenhut and Greenhut (1975), which supposes that each firm believes that the quantity it sells does not affect the quantity sold by other firms and then that firms compete in quantities (à la Cournot). This conjectural variation is used by Greenhut and Greenhut to study the impacts of varying degrees of competition in a market due to increasing numbers of firms.

The framework of de Palma et al. (1985) and Anderson and de Palma (1988) we are using here is an adaptation of Hotelling-Smithies competition whereby handlers compete in prices (à la Betrand). Due to the presence of spatially discriminatory and nonuniform-pricing in many agricultural procurement markets we consider only the case of the optimal discriminatory pricing policy.

Applications of spatial price theoretic models to agricultural markets focus on competition in procurement markets. Here, buyers, which we will refer to as handlers, procure raw commodities from farmers at various market locations. Particularly important to this paper, Löfgrent (1986), Sexton (1990), and Zhang and Sexton (2001) were the first to apply spatial competition models to procurement markets. This context has proved useful in everything from analyzing markets where cooperative handlers play a competitive role (Sexton, 1990; Huck, Salhofer, and Tribl, 2006; Tribl, 2009; Fousekis, 2011), to studying and estimating overlap caused by discriminatory pricing (Durham, Sexton, and Song, 1996; Alvarez et al., 2000; Huck, Salhofer, and Tribl, 2006; Tribl, 2009), to examining equilibrium pricing policies employed by handlers (Zhang and Sexton, 2001; Graubner, Balmann, and Sexton, 2011), to examining various types of market overlap occurring under discriminatory pricing (Alvarez et al., 2000; Graubner et al., 2011).

1.2 Discrete-Choice Models of Spatial Competition

The discrete-choice models of spatial competition we employ here were the result of a reexamination of an issue examined in Hotelling (1929), a classic work on spatial competition. One of Hotelling's main conclusions known as the "principle of minimal differentiation" was originally criticized as untenable first by Lerner and Singer (1937) for the case of three firms and then in the general case by d'Aspremont, Gabszewicz, and Thisse (1979) and Vickrey (1964) independently. de Palma et al. (1985), however, showed that if consumers valued factors other than the firms' place in the product space that the principle of minimal differentiation could, in fact hold. Subsqeuent work by

Anderson and de Palma (1988), Anderson, de Palma, and Thisse (1989), and Anderson, de Palma, and Thisse (1992) adapts this framework to spatial competition models.

Empirical research into discrete-choice models of spatial competition has especially benefitted from work by McFadden (1974), which introduced and popularized a theoretical econometric framework for discrete-choice models. Since McFadden, increasingly complex empirical models of spatial competition have developed. A prominent example of this type of work is found in Bresnahan (1987), Berry (1994), Berry, Levinsohn, and Pakes (1995), Feenstra (1995), and Nevo (2001), which use econometric techniques such as instrumental variable methods, contraction mappings, and generalized methods of moments to estimate supply and demand in discrete-choice spatially differentiated product markets.

1.3 Theory of Cooperatives and Mixed Markets

Because cooperatives play such a dominant role in the agricultural sector (Liebrand, 2012), agricultural economists have a rich tradition of taking special consideration of the role that cooperatives play in the sector. Formal consideration of a theory of cooperatives, which started with Nourse (1922), has taken four separate routes (Staatz, 1989; Cook, Chaddad, and Iliopoulos, 2004): 1) the cooperative as a form of vertical integration, 2) the cooperative as a firm, 3) the cooperative as a coalition, and 4) the cooperative as a nexus of contracts.[7]

In terms of industrial organization analyses involving cooperatives, it is most often assumed that cooperatives behave as a firm with their own objective function. Much debate has ensued with regard to what type of objective function the cooperative maximizes.[8] In terms of deciding which objective function a cooperative truly follows, Ladd (1982) has suggested that the welfare-maximization solution as first offered by Enke (1945) and Ohm (1956) is the correct one. Indeed, this approach has been the convention in most industrial organization studies involving cooperatives (e.g. Albæk and Schultz, 1998; Hoffman, 1997; Huck, Salhofer, and Tribl, 2006; Tennbakk, 2008; Tribl, 2009; Fousekis, 2011). Sexton, Wilson, and Wann (1989) alternatively provides empirical evidence that suggests that cooperatives price where the price is the highest (or lowest) that it can

[7] LeVay (1983); Sexton (1984); Cotterill (1987); Staatz (1989); Sexton (1990, 1995); Cook, Chaddad, and Iliopoulos (2004) provide excellent reviews of developments in the theory of cooperatives literature.

[8] A partial list of coontributors to this discussion would include Enke (1945); Clark (1952); Gislason (1952); Ohm (1956); Helmberger and Hoos (1962); Helmberger (1964); Ladd (1982); LeVay (1983); Sexton (1984, 1986); Sexton, Wilson, and Wann (1989).

be given the break-even constraint of the cooperative as proposed by Clark (1952); Phillips (1985); Sexton (1986).

In studying mixed markets where cooperatives play significant roles[9], researchers have suggested several ways in which cooperatives could create beneficial market outcomes. The classic example is what Nourse (1945) referred to as the "'yardstick' operation" of cooperatives:

> In a word, the place economically indicated for the cooperative in our national economy is not to displace other forms of business, but to occupy certain strategic points and there to set a plane or pace of competition which will assure for the farmer efficient service at true long-run cost.

Researchers have attempted to formalize and quantify this impact, which has come to be known as the competitive yardstick hypothesis, with varying degrees of success (e.g. Cotterill, 1987; Sexton, 1990; Hoffman, 1997; Fousekis, 2011)

Cotterill (1987) was the first to provide a formal analysis of the impacts of cooperatives in mixed markets. Using a methodology known as followship curves, he analyzes different scenarios of mixed market outcomes involving cooperatives. Using his framework, for example, he shows that closed-membership marketing cooperatives will not have a competitive yardstick effect in mixed markets.

Hoffman (1997) uses simulations to study markets where profit-maximizing firms, cooperatives, and public firms exist together. She finds that open-membership cooperatives create beneficial outcomes in markets when firms behave as if they follow the Bertrand conjecture of competition in pricing.

Tennbakk (2008) obtains welfare rankings under scenarios where a profit-maximizing firm competes with a) another profit-maximizing firm, b) a cooperative, and c) a public firm. Assuming a specific cost function he shows that that overall welfare is greatest when the profit-maximizing firm competes with a public firm, second greatest when it competes with a cooperative, and third

[9]The term mixed markets as used here refers to markets where at least one of a limited number of firms in the market has an objective function that is different from other firms in that market. In the case where the market of interest is an output market, the setting is referred to as a mixed oligopoly. (Cooperatives in this setting are traditionally referred to as supply cooperatives or consumer cooperatives depending on what type of goods they supply.) When the side of the market under study is an input market, the setting is referred to as a mixed oligopsony. (Cooperatives in this setting are usually referred to as cooperative handlers or marketing/bargaining cooperatives depending on what degree they process the raw inputs.)

greatest when it competes with another profit-maximizing firm.[10]

Albæk and Schultz (1998) considers the case where a cooperative and a profit-maximizing firm exist in a market where both firms are interested in maximizing profit but cooperative members do not take into account the effect of other members producing . They find that under these assumptions, cooperatives are a more profitable form of business for farmers.

Sexton (1986), Fulton and Giannakas (2001), and Karantininis and Zago (2001) study mixed market models in which potential members of a cooperative make decisions as whether to patronize a cooperative or not. Sexton (1986) considers an approach to cooperative formation that employs the game-theoretic concept of the core, thus enabling the development of a more coherent model of cooperative formation than provided under the firm objective function approaches. Fulton and Giannakas (2001) f that the propensity for consumers to do business with a cooperative, depends a lot on the cooperative's ability to credibly represent itself as effectively serve member interests. Karantininis and Zago (2001) study key aspects that determine whether a farmer decides to join a cooperative or not. They find, for example, that cooperative members produce less on a per-farmer basis, but that the cooperative as a whole produces more than a profit-maximizing firm.

Fousekis (2011) considers a two-stage spatial competition model where a cooperative and a profit-maximizing firm first chose between free-on-board- and uniform-delivery-pricing and then choose an optimal price. Due to the asymmetric nature of the game (with the cooperative introducing a different objective function into the mix), he is able to avoid the existence issues and derive equilibrium prices. These equilibrium prices depend on the relative importance of space in the market (defined as the ratio of the transportation rate to the output markup rate). Fousekis (2011) further considers a version of the competitive yardstick effect defined as the distance between the price that a profit-maximizing handler pays as a spatial monopsonist and the price that a profit-maximizing firm would pay in the presence of direct competition with a cooperative.

Much work has been done to examine other important functions of cooperatives in mixed markets. Fulton and Ketilson (1992), for example, have studied the important role that coooperatives play in communities. Hueth and Marcoul (2006) have examined the beneficial impact of cooperatives with regard to information sharing and price discovery in agricultural markets.

[10]Tennbakk (2008) also considers the first-best case where both firms price according to $P = MC$, where he finds that this obtains even higher welfare under the assumptions.

In the next section we develop the discrete model of spatial competition in an agricultural procurement markets focusing particular attention on the role of cooperative handlers in mixed markets. In Section 3 we discuss the implications of these results, including how they illustrate the competitive yardstick effect suggested by Nourse and others. In the last section, we conclude by summarizing the advantages of the model and suggesting future ideas for research based on this model.

2 The Model

An important point to note with regard to previous research involving cooperatives is that the typical assumption made with regard to farmer welfare is that all that matters to farmers is the explicit monetary returns associated with doing business with the cooperative. The model we consider below will relax this assumption and thus provide a more realistic framework for understanding mixed markets with cooperatives.

2.1 The Setup

Following the usual approach in the literature, consider a line market of length 1 where two handlers are located on the line market consisting of a continuous distribution of farmers with density normalized to 1. Let z_i, denote the location of handler i $(i = 1, 2)$ on the line market. For simplicity, assume that the handlers are symmetrically and exogenously located so that $z_1 = 1 - z_2$.

Assuming each farmer produces 1 unit of milk,[11] the conditional indirect utility that a farmer at location z on the line market receives from selling his milk to handler i under optimal discriminatory pricing is assumed to be

$$V_i(z) = w_i(z) + exp(\mu)\,\varepsilon_i(z) \tag{1}$$

where $w_i(z)$ is the equilibrium price that handler i offers to the farmer at location z (defned as the Nash equilibrium where each handler is choosing the price that is an "optimal strategy" given

[11] The assumption of inelastic supply here is invoked for two reasons: 1) we view it as more realistic for agricultural procurement markets as there are many reasons that farmer supply is fixed in the short run and 2) making supply fixed allows my model to focus on just the aspect of "competitive" behavior among handlers on price without introducing a quantity impact.

what all other handlers are doing) and $exp(\mu)\,\varepsilon_i(z)$ is a term that represents the extra utility (or disutility) that the farmer receives from selling to handler i.[12] As mentioned above, this term could include things like reliability of purchase and payment, services offered, family tradition and loyalty, and friendliness of personnel of handler i.

Assuming that $\varepsilon_i(z) - \varepsilon_j(z)$ is distributed according to the cumulative density function F, the probability that the farmer at location z buys from handler i as opposed to handler j is thus

$$P(V_i(z) > V_j(z)) = F\left(\frac{w_i(z) - w_j(z)}{exp(\mu)}\right) \tag{2}$$

Due to the expected demand that handler i has from the farmer at location z being $F\left(\frac{w_i(z)-w_j(z)}{\mu}\right)$, handler i's profit function is

$$\pi_i(z) = [\rho_i - \tau_i|z_i - z| - w_i(z)]\,F\left(\frac{w_i(z) - w_j(z)}{exp(\mu)}\right) \tag{3}$$

where ρ_i is the per-unit net revenue of the processed product for handler i and τ_i is the per-unit distance transportation cost of transporting the milk from the farm gate to the handler for handler i.

The typical assumption on the distribution of $\varepsilon_i(z) - \varepsilon_j(z)$ first introduced into the economic literature by McFadden (1974) and into the spatial pricing literature by de Palma et al. (1985), Anderson and de Palma (1988), Anderson, de Palma, and Thisse (1989), and Anderson, de Palma, and Thisse (1992) is that $\varepsilon_i(z) - \varepsilon_j(z)$ are distributed $Logistic(0,1)$. When this is the case, handler i's profit function takes the form

$$\pi_i(z) = [\rho_i - \tau_i|z_i - z| - w_i(z)]\left[1 + exp\left(\frac{w_j(z) - w_i(z)}{exp(\mu)}\right)\right]^{-1} \tag{4}$$

2.2 Profit-Maximizing Handlers

When the objective of handler i is to maximize profit, its goal will be to choose $w_i(z)$ that maximizes its profit equation in (4). The first order condition of this equation that defines the optimal value

[12] We select $exp(\mu)$ instead of μ as the functional form of the preference heterogeneity parameter in order to make identification in the empirical model more reliable as shall soon become clearer.

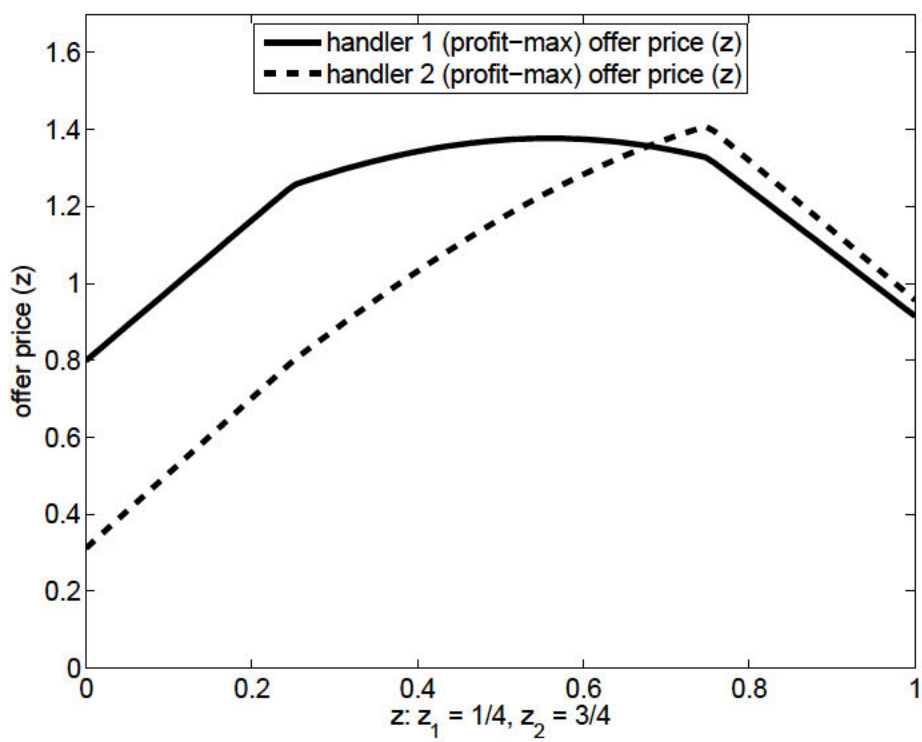
of $w_i(z)$ is

$$w_i(z) = \rho_i - \tau_i|z_i - z| - exp(\mu)\left[1 + exp\left(\frac{w_i(z) - w_j(z)}{exp(\mu)}\right)\right] \tag{5}$$

This equation thus implicitly defines the best response of handler i in terms of $w_i(z)$ to $w_j(z)$, the price offered by handler j. handler j's best response to handler i is then defined in the same way and the Nash equilibrium occurs at the fixed point intersection of the best response functions.

An example graph of Nash equilibrium prices at every market location in the line market is provided in Figure 1. Here, ρ_1, ρ_2, τ_1, τ_2, μ, z_1, and z_2 have arbitrarily been set to 3, 2.5, 1.5, 2, $log(0.5)$, 1/4, and 3/4, respectively.

Figure 1: Profit-Maximizing Handler Prices at Different Values of z



2.3 Cooperative Handlers

In terms of cooperative handlers, the objective of the cooperative is traditionally analyzed by considering the level at which the cooperative produces relative to the cooperative's net average revenue product (NARP), net marginal revenue product (NMRP), and the farmers supply function

(S). NARP is simply the average (in terms of the raw input) of the revenue from the processed product minus the cost of processing the product. Similarly, NMRP is the marginal contribution of the revenue from the processed product minus the cost of processing the product obtained by increasing the amount of the raw input used. S is the maximum amount of inputs the farmers in the cooperative would be willing to supply at a given amount.

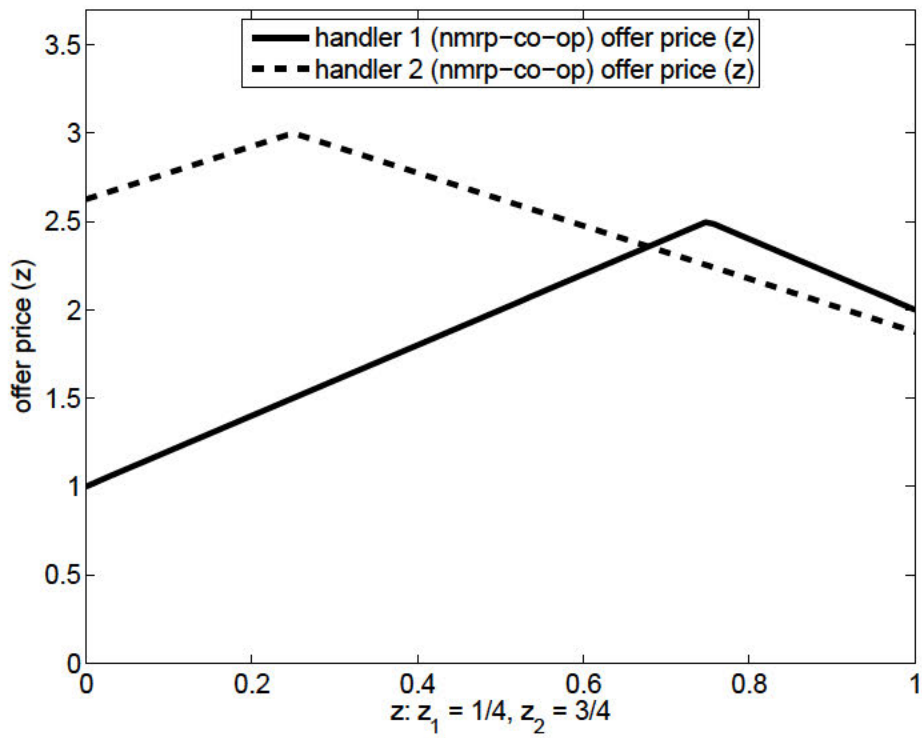
Based on convention (e.g., Sexton (1990) and Fousekis (2011)) and empirical evidence provided by Sexton, Wilson, and Wann (1989), the most commonly used assumption for the processing cooperative objective function is that it will choose the price that equates S with NMRP, which maximizes joint welfare of cooperative members. In the case presented here, NMRP-based pricing results in the following pricing function for the cooperative

$$w_i(z) = \rho_i - \tau_i |z_i - z| \tag{6}$$

Calculation of prices for cooperative handlers is thus a much simpler exercise as the price charged by the other handler does not come into play in the cooperative's decision. It simply prices based on the farmer's distance to the plant and the net revenue it can obtain from procuring the one unit of milk.

Again, an example graph of Nash equilibrium prices at every market location in the line market with the same values for ρ_1, ρ_2, τ, μ, z_1, and z_2 is provided in Figure 2 below.

Figure 2: NMRP-Based Cooperative Handler Prices for Different Values of z

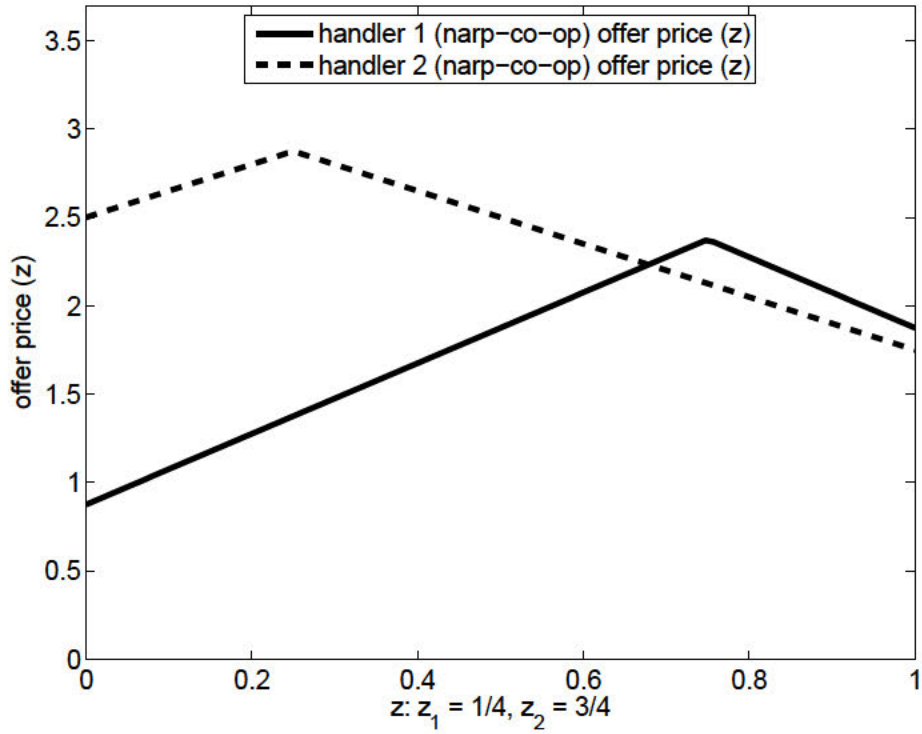


Alternatively, for the case of a cooperative pricing according to NARP (i.e., when a cooperative chooses the price that equates S with NARP), the cooperative's pricing function is instead

$$w_i(z) = \rho_i - \tau_i |z_i - z| - f(z) \tag{7}$$

where $f(z)$ is cooperative fixed costs for serving location z. When $f(z) = 0$, it is thus the case that NMRP-based pricing and NARP-based pricing result in equivalent pricing schedules. This is, however, not the case in general circumstances. The equivalence here is attributed both to the assumption of an inelastic farmer supply curve (i.e., $S(z) = 1$) and to the assumption of a fixed cost for serving location z that is not dependent on z. An example graph of Nash equilibrium prices at every market location in the line market with the same values for ρ_1, ρ_2, τ_1, τ_2, μ, z_1, and z_2 and where $f(z)$ is arbitrarily set to 0.125 is provided in Figure 3 below.

Figure 3: NARP-Based Cooperative Handler Prices for Different Values of z



As has been noted by many cooperative theorists, although NMRP-based pricing provides the cooperative with a welfare maximizing solution, the fixed costs incurred using this pricing structure most be compensated by some additional activity, such as membership fees or nonlinear pricing (e.g. Vercammen, Fulton, and Hyde, 1996).

2.4 Mixed Markets

In the case of mixed markets, there is both a profit-maximizing handler and a cooperative handler in the market. An example graph of Nash equilibrium prices at every market location in the line market for the case of a cooperative pricing according to NMRP and with the same values for ρ_1, ρ_2, τ_1, τ_2, μ, z_1, and z_2 (where the profit-maximizing handler is assumed to be located at 0.25 an the cooperative handler is assumed to be located at 0.75) is provided in Figures 4 below. Figure 5 provides the cooperative prices according to NARP.

Figure 4: Mixed Market Handler Prices at Different Values of z (NMRP-Pricing Cooperative)

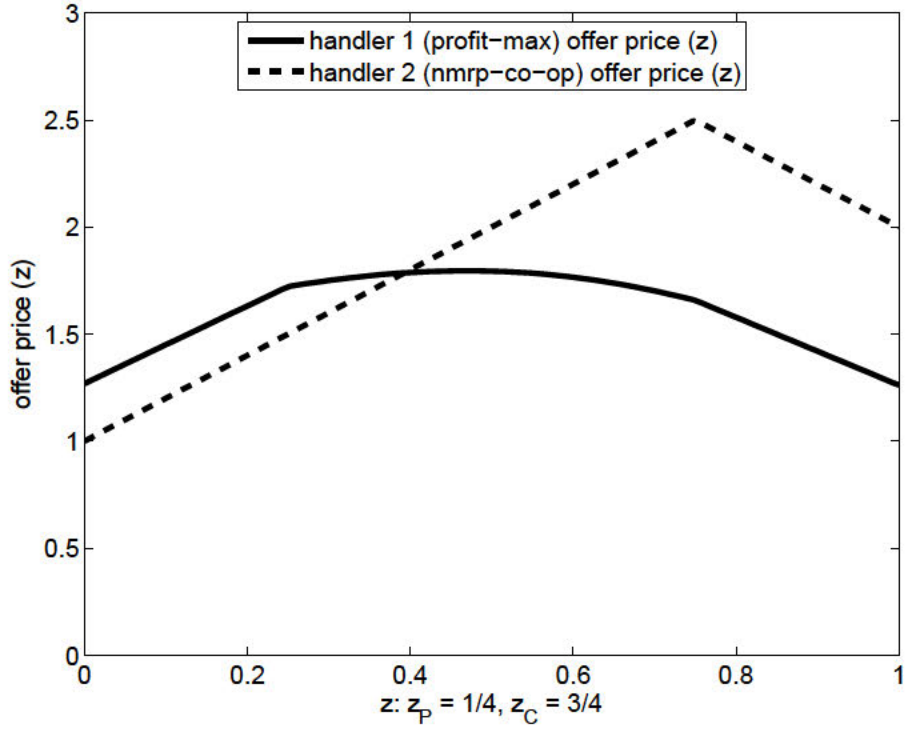
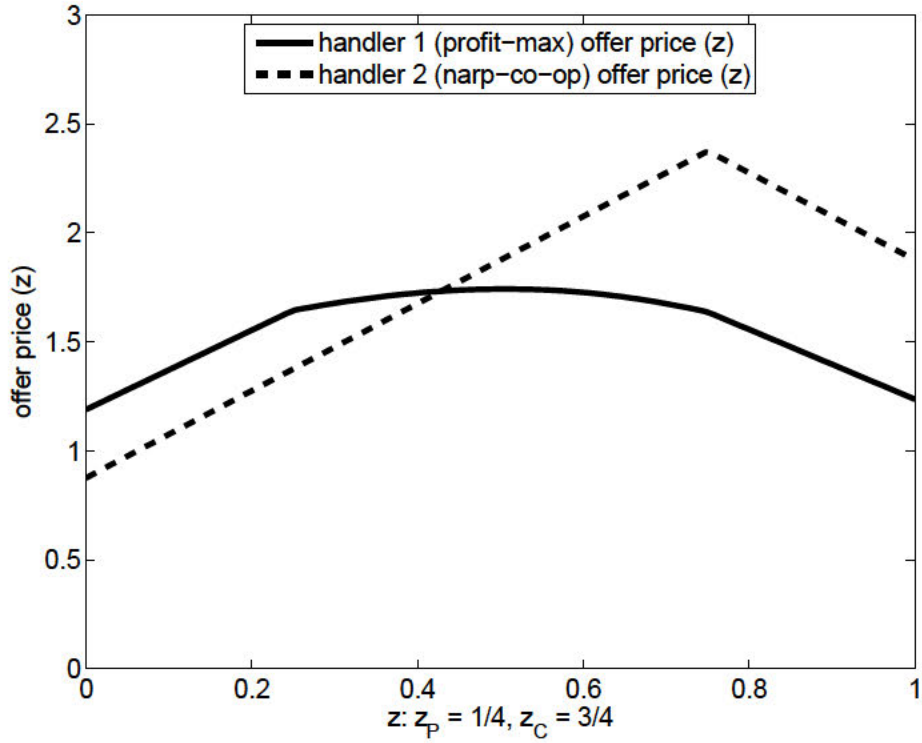


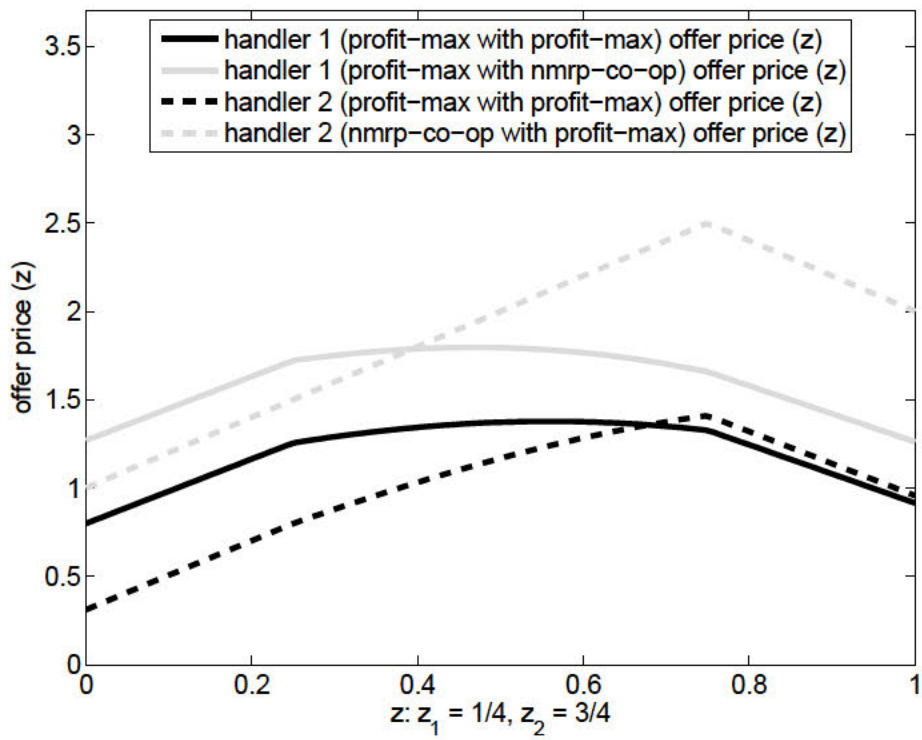
Figure 5: Mixed Market Handler Prices at Different Values of z (NARP-Pricing Cooperative)



3 Discussion

One item of particular interest from the model illustrated above can be seen by comparing the results of the profit-maximizing handlers only market (non-mixed market) and the mixed market case. Figure 6 plots the results illustrated in Figures 1 and 4 together. The non-mixed market results are indicated with black-colored lines, with the profit-maximizing handler (handler 1) offer price represented with a solid line and the profit-maximizing handler (handler 2) offer price represented with a dotted line. The mixed market results are indicated with gray-colored lines, with the profit-maximizing handler (handler 1) offer price represented with a solid line and the cooperative handler (handler 2) offer price represented with a dotted line.

Figure 6: Comparison of Non-Mixed Market and Mixed Market Outcomes



This plot graphically illustrates the competitive yardstick effect of the cooperative handler. Because the cooperative handler pays the farmer exactly what it costs to service that market location without factoring in how paying that high of a price would influence potential strategic gains for the cooperative, the cooperative plays a pro-competitive role in the market as compared to a profit-maximzing handler facing the same per-unit net revenue and transportation cost parameters.

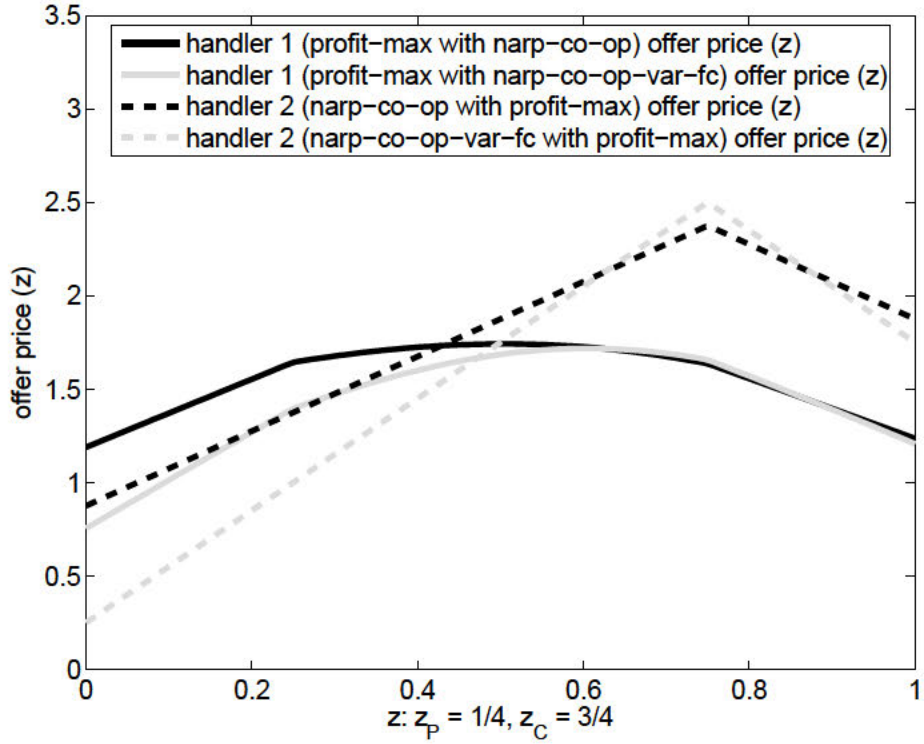
This result is generalizable to any case where the cooperative handler faces the same per-unit net revenue and transportation cost parameters as any would be profit-maximizing handler.

One point of interest that may not be readily apparent from the results above is that even though the price offered by a particular handler may be below the price offered by the other handler, this does not necessarily imply that the farmer at location z would necessarily choose the handler with the higher offer price. Indeed, as indicated in the construction of the model, the farmer at location z also receives an extra non-price benefit for choosing handler i equal to $exp(\mu)\,\varepsilon_i(z)$. As a result, even if it is the case that $w_j^* > w_i^*$, then it could still be the case that $w_i^* + exp(\mu)\,\varepsilon_i(z) \geq w_j^* + exp(\mu)\,\varepsilon_j(z)$ so that the farmer at location z would choose handler i instead of handler j. This point clearly helps to explain why farmers are observed choosing handlers that offer lower prices.

Yet another point of interest that this analysis suggests as being a topic of interest is to look at how how handlers with varying degrees of the per-unit net revenue parameter (related to handler characteristics such as vertical integration and risk tolerance of the handler) and the transportation cost parameter (related to handler characteristics such as the scale and the efficiency of the handler). As an example, some research has suggested that a reason that cooperatives handlers typically offer lower prices than profit-maximizing handlers is that they are typically less vertically integrated (e.g., Royer and Bhuyan, 1995). It is possible that an adapted version of the model presented here could be used to study this issue further.

A final point of interest that has merit for further analysis is how making fixed costs for a NARP cooperative handler serving a particular location dependent on that location. As an example, Figure 7 provides the mixed market results for the case where $f(z) = |z - z_2|$ and all other parameters for handler 1 (the profit-maximzing handler) and handler 2 (the NARP-pricing variable fixed costs cooperative handler). The results for the case where the NARP cooperative handler does not have variable fixed costs are indicated with black-colored lines, with the profit-maximizing handler (handler 1) offer price represented with a solid line and the cooperative handler (handler 2) offer price represented with a dotted line. The results for the case where the NARP cooperative handler has variable fixed costs are indicated with gray-colored lines, with the profit-maximizing handler (handler 1) offer price represented with a solid line and the cooperative handler (handler 2) offer price represented with a dotted line.

Figure 7: Mixed Market Handler Prices at Different Values of z (NARP-Pricing Variable Fixed Costs Cooperative)



As can be seen from this figure, the impact of the cooperative handler having higher fixed further away from the cooperative handler location results in both the cooperative offer price and the profit-maximizing handler offer price decreasing a a greater rate than before the closer the market location is to the profit-maximizing handler.

4 Conclusions

In the analysis provided above, we have developed a discrete-choice spatial competition model of agricultural procurement markets. This model has four strengths over traditional models of spatial competition in agricultural procurement markets: 1) it overcomes the nonexistence of pure-strategy equilibria in spatial competition models, 2) it allows for variation in relative preferences for handlers other than price, 3) it allows for overlap in the procurement markets without having to assume collusive behavior on the part of handlers, and 4) it provides a readily adaptable framework for empirical analysis of agricultural procurement markets.

This work provides grounds for much future theoretical and empirical work pertaining to spatial competition in agricultural procurement markets. An obvious application of this work as an example would be to develop a methodology for empirically estimating some of the parameters of this model. If this could be done, then it would be possible to directly estimate the competitive yardstick effect using an inferred counterfactual analysis.

Other extensions of this model that present opportunities for further research would be to examine the impacts of the cooperative-handler being a closed-membership cooperative or to introduce elastic farmer supply functions. There could also be potential applications in which selling cooperatives such as consumer cooperatives or supply cooperatives could be studied (as opposed to cooperative handlers whiich are buying cooperatives).

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