Pricing behavior in a mixed spatial duopsony with an agricultural cooperative under asymmetric information

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Abstract

The present study examines the pricing behavior of an investor owned firm (IOF) in a mixed spatial duopsonistic game with an agricultural cooperative (COOP), under asymmetric/incomplete information. Results indicate that, the higher is the probability that the coordination cost per member of the COOP is high, the higher are the profits and the market share for the IOF, both under accommodation and under entry deterrence. Accordingly, the IOF has a vested interest in creating a "bad" reputation regarding the COOP's member coordination cost. Hence, unlike the findings of the relevant literature that COOPs act as disciplinarians for the IOFs under complete information, in the present mixed spatial game of asymmetric information, IOFs might increase their profits as compared to the outcome of the equivalent game of complete information .

Keywords: Mixed spatial duopsony; asymmetric information; cooperatives; coordination cost; investor owned firms

JEL classification: L10; Q13; R10

1 Introduction

Mixed markets involve the co-existence of firms with different objective functions (Fousekis, 2011a; Fraja and Delbono, 1990; Tribl, 2009). For example, in the agri-food system, an investor owned firm (IOF) may interact with a cooperative (COOP). The main objective of an IOF is profit maximization. On the other hand, a COOP is a form of business with objectives other than profit maximization (Fousekis, 2011a; Nilsson, 2018; Qian and Olsen, 2018; Schmit et al., 2018).

In agricultural markets, pure oligopolies/oligopsonies are typically not observed, especially at levels close to the primary production sector. Instead, cooperatives are often involved in these sectors (Giannakas and Fulton, 2005; Grau et al., 2015; Gruber et al., 2000; Kaynak and Meulenberg, 2017; Martínez-Victoria et al., 2018; Rogers and Sexton, 1994). Cooperatives are producers' or consumers' coalitions that intend to curtail the market power of the IOFs (Fousekis, 2016; Giannakas and Fulton, 2005). The functions of the agricultural cooperatives can be grouped into two broad categories: farm/raw input supply COOPs and marketing/processing COOPs (Agbo et al., 2015; Cotterill, 1987; Fousekis, 2016). Supply cooperatives constitute a backward integration of their members whereas marketing COOPs constitute a forward integration of their members. More specifically, marketing/processing cooperatives are formed by producers to process and market the farm input of their members. Thus, the members, as well as owners of the marketing cooperative, are part of the supply side of the COOP's market, since they supply the cooperative with the farm input that is necessary at the processing stage of the marketing supply chain.

In the US agricultural sector, cooperatives account for 25 to 30 percent of the total farm marketing and supply expenditures (Drivas and Giannakas, 2010). In the European Union, COOPs contribute more than 50% of the added value in the production, processing and commercialization of farm products (Fousekis, 2011a).

Pricing behavior in spatial markets has been the subject of economic research for over seventy years (Beckmann, 1973; Hoover, 1937; Panagiotou and Stavrakoudis, 2018; Thisse and Vives, 1988; Tribl, 2009). In pure spatial markets where IOFs compete against each other, the relevant literature has investigated pricing decisions when the market power lies within the buyers (Espinosa, 1992; Kats and Thisse, 1993) as well as pricing strategies when the market power lies withing the sellers (Tribl, 2009; Zhang and Sexton, 2001). Fousekis (2011b) examines the pricing behavior in another form of a pure spatial market, where two COOPs compete against each other. When it comes to mixed markets in the agricultural sector, Fulton and Giannakas (2001) and Panagiotou and Stavrakoudis (2018) examine mixed oligopolies whereas Tribl (2009) and Fousekis (2011a) examine pricing behavior in mixed duopsonies. In general, the presence of the COOP(s) in the market has a disciplinary effect on the pricing strategies of the IOF(s).[1]

All of the aforementioned studies examine pricing decisions in games of perfect and complete information. In game theory, a sequential game has perfect information if each player, when making any decisions, is perfectly informed of all the events that have previously occurred. In games of complete information, the players' payoff functions are common knowledge.

In the light of the preceding, the objective of this paper is to examine the effect of asymmetric information on the behavior of the IOF when a COOP is present in the market. Unlike games of complete information, where the players' payoff functions are common knowledge, in a game of asymmetric (incomplete) information, at least one player is uncertain about another player's payoff function (Gibbons, 1992). In the present study, information incompleteness arises from the fact that there is asymmetric information regarding the member coordination cost of the COOP: the cooperative knows its coordination cost but the IOF assigns probabilities to it. Hence, it is the investor owned firm that is uncertain about the payoff function of the processing cooperative.

In what follows, section 2 provides the theoretical model. Section 3 presents the IOF's pricing behavior under accommodation and section 4 the IOF's pricing behavior under entry deterrence. Conclusions are offered in section 5.

2 Model description

We consider a market where producers/farmers are continuously dispersed along the line interval [0,R] according to the uniform density, with D=1. The IOF is located at the left end of the market, namely point 0, and the COOP at a distance a from the right side of the market.

[1] Fousekis (2011a) and Panagiotou and Stavrakoudis (2018) reveal that as competition in the spatial market escalates, we move from quasi–collusive Nash equilibria, when there are only IOFs in the market, to more aggressive strategic pricing configuration when COOPs replace some or all the IOFs in the market. In the present study, as well as in the aforementioned studies, COOPS are pricing according to the net average revenue product (NARP). Pricing according to NARP is consistent with the maximization of the COOP's member welfare subject to break even constraint in processing. This behavior renders the cooperatives as very aggressive players and disciplines the investor owned firms.

The IOF and the COOP have access to the same technology: in order to convert the raw farm input into the final product they incur a constant average cost (c) and zero fixed costs. Subsequently, the finished processed output is sold into a perfectly competitive market at a unit price, P.

However, besides processing costs, the cooperative faces coordination costs (γ) per member (Fousekis, 2016). As Sexton and Sexton (1987) point out, cooperatives need explicit coordination among many heterogeneous players in order to capitalize and patronize the organization.

The pricing strategy of both the IOF and the COOP is free on board (FOB): they offer a (mill) price for the raw farm input and let the producers pay for the costs of transportation. Transportation costs are linear in distance. Each producer supplies only one unit of the raw farm input (unit supply), provided that the net price exceeds a common to all producers reservation level of utility U and supplies none, otherwise (Fousekis, 2016). In order to simplify the analysis we assume that the reservation level of utility is zero and the length of the market is set equal to one (R=1).

The IOF offers a mill price m per unit of the raw farm input, where m stands for the maximum price that the IOF can pay for the farm commodity when maximizing its profits. Following Fousekis (2016), we re-parameterize the model by setting $\rho = P - c$. Hence, for the producer who is located at distance r from the left side of the market (location of the IOF), the net price that he/she enjoys is $m = P - c - rt = \rho - rt$, where t is the cost per unit of distance (freight rate).2

On the other hand, the processing cooperative does not have as an objective

to maximize profits like the IOF does. The relevant literature proposes a number of different objectives for the agricultural COOPs. These objectives include maximizing member welfare, maximizing processing margins and maximizing the (net) price the producers receive for their raw farm input (Cotterill, 1987; Fousekis, 2016). In the present work, following Fousekis (2011a) and Tribl (2009), the processing cooperative prices according to its net average product (NARP). NARP is the revenue from processed sales, net of any other costs, divided by the volume of the processed commodity. The net average revenue product is the maximum price the COOP can pay, per unit of the raw farm input, without suffer- ing operation deficits. Given that the cooperative employs FOB pricing like the IOF does, the total costs of the COOP are the processing plus the coordination costs. Hence, the maximum price the cooperative can pay per unit of the farm input without suffering operation losses is equal to $NARP = P - c - \gamma = \rho - \gamma$. Following the literature (Fousekis, 2011a), a COOP that is pricing according to its NARP, is a very aggressive player relative to the profit maximizing IOF. Ac- cordingly, the presence of such a player in a this mixed spatial market escalates price competition, disciplines private firms and has a negative effect on the level of profits for the IOFs (Fousekis, 2015; Sexton, 1990).

In this study, the IOF and the COOP are engaged in a spatial mixed duopsony game of incomplete information. Information incompleteness arises from the fact that there is asymmetry in information regarding the coordination cost per mem- ber of the cooperative (γ). More specifically, the COOP knows its coordination cost per member but the IOF, as well as the potential members of the cooperative, know only that the coordination cost per member of the COOP is high (γH), with probability θ and low, (γL) with probability $(1 - \theta)$.

[2] The freight rate t stands for the absolute importance of space and the ratio t/ρ stands for the relative importance of space in the market.

3 IOF's pricing behavior under accommodation

Under accommodation, the locations of the IOF and the COOP have already been established in the market as described in section 2: the IOF is located at the left end of the market and the COOP at distance α from the right end of the market. The producer who is indifferent between becoming a COOP member or an IOF patron is located at distance $\hat{x}$ from the location of the IOF (left end of the market). Like the IOF, the indifferent producer (and every producer) who constitutes a potential member of the cooperative, knows that the COOP's coordination cost per member is high (γ^H) with probability θ and low (γ^L) with probability (1 − θ). For the indifferent farmer, the following expression holds:

$$m^A - t\,\hat{x} = \rho - \theta\,[\gamma^H + t(1-\hat{x}-\alpha)] - (1-\theta)\,[\gamma^L + t(1-\hat{x}-\alpha)], \qquad (1)$$

where m^A is the accommodation price for the IOF. The left hand side of equa- tion 1 represents the net price that the indifferent producer will get if he becomes the IOF's patron. The right hand side of equation 1 accounts for the expected net price that the indifferent producer will enjoy if she/he becomes a member of the agricultural cooperative.

We proceed with the analysis considering that $(1 - \hat{x} - \alpha) > 0$, which means that the indifferent farmer is located on the left side of the COOP. Panel (a) in figure 1 depicts the aforementioned case.

Solving equation 1 for $\hat{x}$ (market share of the IOF), we get:

$$\hat{x} = \frac{(\gamma^H - \gamma^L)\,\theta - (\alpha-1)t - \rho + m^A + \gamma^L}{2t} \qquad (2)$$

Given that the COOP is located at point α from the right end of the market and it prices according to its NARP, the IOF chooses mA to maximize:

$$\Pi^A = (\rho - m^A)\hat{x} = (\rho - m^A)\,[\frac{(\gamma^H - \gamma^L)\,\theta - (\alpha-1)t - \rho + m^A + \gamma^L}{2t}] \qquad (3)$$

where Π^A stands for the profits of the IOF under accommodation.

Profit (Π^A) maximization with respect to m^A yields the maximum price that the IOF offers to the producers of the raw farm input in the duopsony game under incomplete information:

$$m^A = \frac{(\gamma^L - \gamma^H)\,\theta + (\alpha-1)t + 2\rho - \gamma^L}{2} \qquad (4)$$

Taking the derivative of equation 4 with respect to θ we obtain:

$$\frac{\partial m^A}{\partial \theta} = (\gamma^L - \gamma^H) < 0 \tag{5}$$

Equation 5 indicates that as θ increases (probability that the member coordination cost of the COOP is high), the price that the IOF offers to the farmers decreases.

Substituting the expression of equation 4 into equation 2 we get:

$$\hat{x} = \frac{(\gamma^H - \gamma^L)\,\theta - (\alpha - 1)t + \gamma^L}{4t} \tag{6}$$

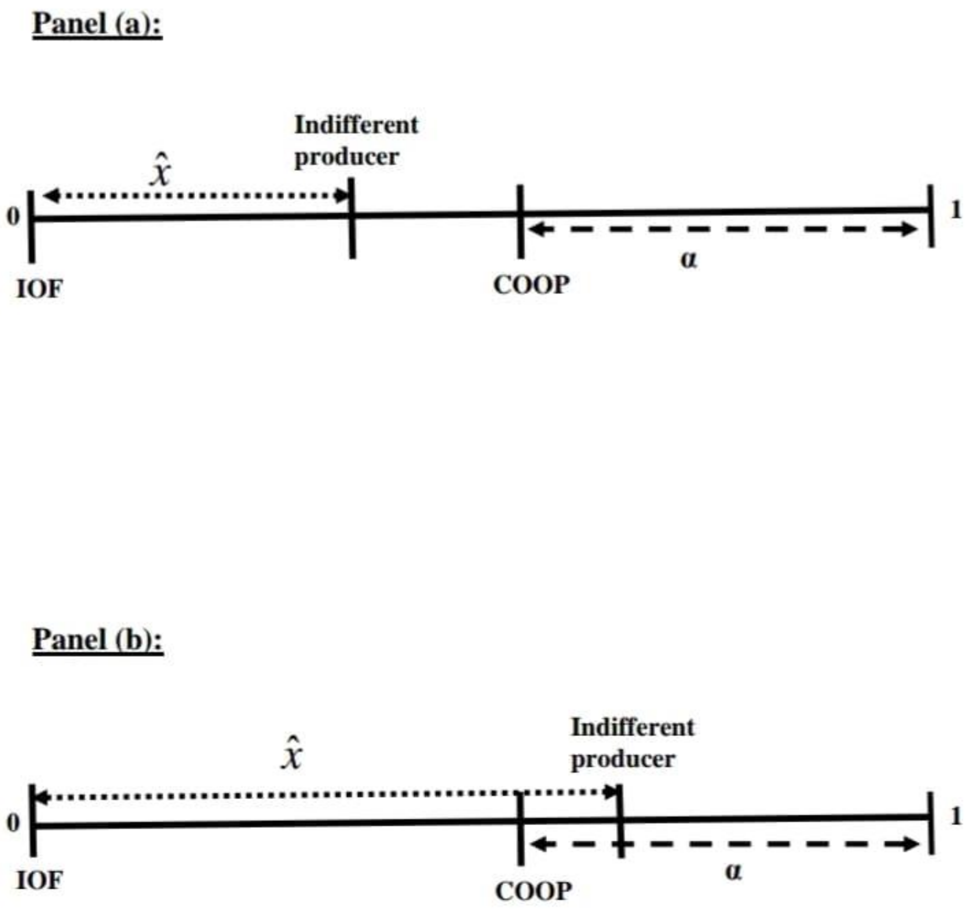

Figure 1: *Mixed spatial duopsonistic game*

Taking the derivative of equation 6 with respect to θ yields:

$$\frac{\partial \hat{x}}{\partial \theta} = (\gamma^H - \gamma^L) > 0 \tag{7}$$

Equation 7 indicates that as θ increases (probability that the member coordination cost is high), the market share of the IOF increases.
Substituting the expressions of equation 4 and equation 6 into equation 3 we get:

$$\Pi^A = \frac{[(\gamma^L - \gamma^H)\theta + (\alpha - 1)t - \gamma^L]^2}{8t} \tag{8}$$

If we take the derivative of equation 8 with respect to θ yields:

$$\frac{\partial \Pi^A}{\partial \theta} = \frac{(\gamma^L - \gamma^H)[(\gamma^L - \gamma^H)\theta + (\alpha - 1)t - \gamma^L]}{4t} = \frac{(\gamma^H - \gamma^L)(\rho - m^A)}{2t} > 0 \tag{9}$$

Equation 9 indicates that as θ increases (probability that the member coordi- nation cost is high), profits for the IOF increase in this mixed duopsontic game under asymmetric information.

According to the results of equations 4, 7 and 9, as θ increases, namely as the probability that the coordination cost per member of the COOP is high increases, then: i) the price per unit of the farm input(mA) that the IOF has to pay the farmers decreases, ii) the market share of the IOF increases, and iii) the level of profits of the IOF increase.

In the light of the aforementioned findings, the IOF has an incentive to create a "bad" reputation regarding the level of the member coordination cost of the cooperative. The higher it is, the higher are the profits for the IOF.

4 IOF’s pricing behavior under entry deterrence

In this section we consider that the IOF is a spatial monopsonist that deters en- try of the COOP.[3] Accordingly, the IOF offers a price that renders the producer located at point 1 (right end of the market) indifferent between being the IOF’s patron and becoming a member of the processing COOP. As a consequence, there are no farmers joining the cooperative.

3 In the case where the COOP enters the market, it will be located be at a distance α from the right side of the market (exogenous determined at the first stage of the game).

The IOF's deterrence price (m^D) needs to satisfy the following condition:

$$m^D - t = \rho - \theta(\gamma^H + t\alpha) - (1-\theta)(\gamma^L + t\alpha) \quad (10)$$

Re-arranging equation 10 we get:

$$m^D = \rho - \gamma^L + t(1-\alpha) - \theta(\gamma^H - \gamma^L) \quad (11)$$

Taking the derivative of equation 11 with respect to θ yields:

$$\frac{\partial m^D}{\partial \theta} = -(\gamma^H - \gamma^L) < 0 \quad (12)$$

According to the result of equation 12, the IOF's deterrence price m^D decreases as θ increases.

When there is entry deterrence and under the assumption that the IOF covers the whole market (market radius equals to one : R = 1), profits for the monop- sonist IOF are equal to:

$$\Pi^D = (\rho - m^D) = \rho - [\rho - \gamma^L + t(1-\alpha) - \theta(\gamma^H - \gamma^L)] \quad or$$

$$\Pi^D = \gamma^L - t(1-\alpha) + \theta(\gamma^H - \gamma^L) \quad (13)$$

Taking the derivative of equation 13 with respect to θ yields:

$$\frac{\partial \Pi^D}{\partial \theta} = (\gamma^H - \gamma^L) > 0 \quad (14)$$

The outcome of equation 14 reveals that profits for the IOF increase as θ increases. Thus, according to the findings of equations 12 and 14, as θ increases, namely as the probability that the coordination cost per member of the COOP is high increases, then: i) the (deterrence) price per unit of the farm input (m^D) that the IOF has to pay the farmers decreases, and ii) the level of profits (Π^D) of the IOF increase. Hence, as it was the case under the pricing behavior of the IOF under accommodation, the IOF has an incentive to create a "bad" reputation regarding the level of the member coordination cost of the COOP: the higher it is the higher the profits.

In the present study, both under accommodation and entry deterrence, the IOF increases its profits, the higher is the probability that the cooperative's coordination cost per member is high. Hence, in a mixed spatial game of incomplete information, IOFs might increase their profits as compared to the outcome of the equivalent game under complete information. Unlike the findings of the relevant literature that cooperatives act as disciplinarians for the IOFs (Fousekis, 2011a; Panagiotou and Stavrakoudis, 2018), the results of the present work reveal that, in a mixed spatial game of incomplete information, IOFs might increase their profits, under certain conditions.

Up to this point, the findings of the present study have been based on the fact that $(1 - \hat{x} - \alpha) > 0$. We now are going to examine what happens when $(1 - \hat{x} - \alpha) \leq 0$. In order to present our case, it is sufficient to examine what the

outcome will be when $\hat{x} = 1 - \alpha$ (Fousekis, 2016), which is depicted in panel (b) in figure 1. At $\hat{x} = 1 - \alpha$, the market boundary between the IOF and the COOP (if entry and accommodation take place) is the same with the cooperative's gate.

If we insert $\hat{x} = 1 - \alpha$ in equation 1 we will obtain:

$$m^A - t(1-\alpha) = \rho - \theta\left[\gamma^H + t(1-(1-\alpha)-\alpha)\right] - (1-\theta)\left[\gamma^L + t(1-(1-\alpha-)\alpha)\right] \tag{15}$$

Rearranging equation 15 we get:

$$m^A = \rho - \gamma^L + t(1-\alpha) - \theta\left(\gamma^H - \gamma^L\right) = m^D \tag{16}$$

The result of equation 16 suggests that, when $\hat{x} = 1 - \alpha$, the IOF's price under accommodation is the same with the IOF's price under entry deterrence. Provided that the IOF's profits are positive when $m^A = m^D$, entry in the market by the COOP is deterred, since the potential cooperative members are indifferent between the two competing agents.[4] Furthermore, if deterrence takes place for $\hat{x} = 1 - \alpha$ then it will occur for $\hat{x} > 1 - \alpha$, where the COOP faces competition in its backyard (Fousekis, 2016).

5 Conclusions

In the agri-food marketing system, investor owned firms compete against cooperatives, especially at levels close to the primary production sector. There are two distinct differences between IOFs and COOPs. The first one is that the owners of the COOP are also the users of the services provided by the organization. The second one is that IOFs and COOPs have different objective functions. IOFs seek to maximize profits. On the other hand, COOPs seek either to maximize member welfare or maximize processing margin or maximize the price the farmers of the the raw input receive.

[4] In the case where $\hat{x} = 1 - \alpha$, the IOF's profits under entry deterrence equal to $\Pi^L = (\rho - m^D)$ whereas its profits are equal to $\Pi^A = (\rho - m^A)(1 - \alpha)$ under accommodation.

The purpose of this work is to examine the pricing behavior of an IOF in a mixed spatial duopsony with an agricultural cooperative, under asymmetric information. The asymmetry in information is regarding the level of the COOP's coordination costs. Previous studies have examined asymmetries in the governance structure (Bijman et al., 2013). The main issue is principal-agent asymmetric information, namely between the board of directors (BoD) and professional management. Other studies have examined asymmetric information on the quality of farm products produced by food processing cooperatives (Mikami and Tanaka, 2008). This is the first work to examine asymmetries in the level of the coordination cost of the members of a cooperative and its effect on the pricing behavior of investor owned firms.

The main findings of the present study are: i) as θ increases, the profits of the IOF increase both under accommodation and under deterrence, ii) as θ increases, the price that the IOF has to pay in order to purchase the farm input decreases, both under accommodation and under entry deterrence, and iii) under accommodation, as θ increases, the market share of the IOF increases.

As one can infer, both under accommodation and entry deterrence, the higher is the probability that the cooperative's coordination cost per member is high, the higher are the profits for IOF. Hence, in a mixed spatial game of asymmetric information, investor owned firms might increase their profits as compared to the outcome of the equivalent game under complete information.

In the light of the preceding, the social implications of the findings of the present study can be summarized as:

i) The primary producers of the farm input will suffer losses.
ii) COOPs will lose part of their share market and not be benefited.
iii) Investor owned firms will gain, and
iv) if the decrease in the price of the farm input is passed onto the consumers of the final product, then consumers will be benefited.

In the light of the preceding, the cooperative(s) will have to convince potential members about the efficient level of their internal as well as their external organization, reducing this way any ambiguity regarding the level of the COOP's coordination costs. As Cook and Iliopoulos (2016) point out, a remedy for reducing or minimizing coordination/ownership costs is the solution of transparency. According to the aforementioned authors, transparency includes mechanisms de- signed to allow member of the COOP to choose their preferred level of risk, mea- sure the performance of the cooperative and enables them to monitor management quite efficiently.

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