SPATIAL COMPETITION IN A MIXED MARKET OF FOOD PROCESSORS – THE CASE OF UNIFORM DELIVERED PRICING

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ABSTRACT

Markets of food processors are characterized by a high and increasing concentration. This fact might facilitate the exercise of market power towards agricultural producers. One way for farmers to evade market power is to form a marketing cooperative such that the market becomes a mixed one consisting of, both, investor-owned firms and cooperatives. The "competitive yardstick hypothesis" states that cooperatives can impel investor-owned firms to a more competitive behaviour. We analyze this hypothesis by setting up a spatial mixed market model under the assumption of uniform delivered pricing. By confronting the results with a pure market of investor owned firms a competitive yardstick effect can be verified. In addition, the results show that if the cooperative is the leader in a leadership game, the pro-competitive effect of the presence of a cooperative is higher than if the investor-owner firm is the leader.

Keywords: spatial competition, uniform delivered pricing, duopsony, food processing, cooperatives, mixed market

1 INTRODUCTION

In most markets for agricultural products farmers as suppliers of raw products are confronted with a high and increasing concentration of the food processing industry (COTTERILL, 1999). In addition, input markets for food processing are subject to bulky and/or perishable products (milk, for example), resulting in significant transportation costs, limited mobility, high storage costs, and limited access of producers to alternative buyers of their products (ROGERS AND SEXTON, 1994; SEXTON AND LAVOIE, 2001). These characteristics might facilitate the exercise of market power towards input suppliers, which implies lower prices for farmers as well as deadweight losses for society.

So far, most research in agricultural economics has focused on oligopoly power of the food processing industry (see SEXTON AND LAVOIE, 2001, and SHELDON AND SPERLING, 2003 for literature reviews) rather than on oligopsony power. In addition, only a few papers are dealing with the spatial dimension of this problem (see, for example, ALVAREZ ET AL. (2000) and SEXTON (1990).

One way for farmers to mitigate market power of food processors is to form a marketing cooperative (COOP) such that the market becomes a "mixed" one consisting of, both, investor-owned firms (IOF) and COOPs. In a mixed oligopsonistic market, the objective function of at least one processor differs from that of other processors (DE FRAJA AND DELBONO, 1990).[1] According to the "yardstick of competition"-hypothesis, COOPs constitute

[1] In Germany, for example, about 33% of the 243 milk processing operations are owned by COOPs processing 56% of total milk supply (ZMP, 2003). This mixed market structure, in which COOPs compete alongside IOFs, is the predominant market structure in the southern region of Germany. The northern region is served almost

a competition-improving legal form, which can provide a beneficial effect on market performance by mitigating oligopsony power of IOFs (COTTERILL, 1987; SEXTON, 1990).

The outcome of spatial competition depends on two assumptions: First, on the pricing scheme, and, second, on the processors' conjecture regarding the reaction of competitors. Referring to the first, the spatial competition literature mainly distinguishes between the pricing schemes uniform delivered (UD-)pricing and free on board (FOB- or mill-) pricing. Under UD-pricing producers of the raw product receive an identical farm-gate price irrespective of their distance to the processor. If processors bear transportation costs, this is an extreme case of price discrimination across space in favour of more distant producers. Given UD-pricing, overlapping of competitor's market areas can be facilitated. Under FOB-pricing, however, producers receive the same mill price at the plant gate of the processor and bear transportation costs by themselves.[2] Referring to the conjectures, mostly the Löschian or the Hotelling-Smithies conjecture is assumed. Under the Löschian conjecture firms assume that rivals will react identically to price changes of competitors (GREENHUT ET AL., 1987). In a non-spatial world, this would be identical to collusion. In contrast to this, the Hotelling-Smithies conjecture (or zero conjectural variation) implies that firms assume that its competitors will not react to any change in own prices (BECKMANN, 1973; EATON AND LIPSEY, 1975) – the non-spatial analogue to this is Bertrand pricing.[3]

Models accounting for overlapping market areas are analyzed by GRONBERG AND MEYER (1981), GREENHUT ET AL. (1987), OHTA (1988), and ALVAREZ ET AL. (2000).[4] ALVAREZ ET AL. (2000) consider an IOF duopsony given UD-pricing and Löschian competition and analyze market overlap in between the location of processors as well as market areas beyond the location of the competitor. GRONBERG AND MEYER (1981) derive some set of UD-prices and distances between oligopolistic firms that can arise as a free entry competitive equilibrium. Under the assumption of price matching behaviour firms can either collude and split the market between them equally (which is the Löschian assumption of a fixed market

exclusively by COOPs and former Eastern Germany by IOFs. In Austria, about 50% of the 93 milk processors (comprising 105 processing operations and additional 11 milk collection points) were owned by COOPs in 2004 (BMLFUW, 2005).

[2] Generally, FOB-pricing requires net prices received by farmers to be equal at the common market boundary of two neighbouring processors such that spatial competitors operate in distinct, non-overlapping market areas.

[3] Generally, no market overlap is possible under Hotelling-Smithies competition: Under UD-pricing one firm will always have an incentive to outbid its competitor and capture the total market area. For example, in milk procurement, overlapping market areas can be observed (see ALVAREZ ET AL., 2000, and HUCK ET AL, 2005), such that in these markets Löschian competition or any other kind of competition like Cournot or Stackelberg must be at work.

[4] Similar to ALVAREZ ET AL. (2000) for the case of IOFs under the assumption of UD-pricing, HUCK ET AL. (2005) analyze a pure COOP market and provide empirical evidence of spatial competition by estimating a reduced form regression model for milk processing COOPs in Northern Germany.

area), or customers in the contested market area are randomly selected by the firms. The first option yields non-overlapping market areas, in the second option, overlapping market areas remain.

To our knowledge, only few analytical models consider mixed markets of COOPs and IOFs in a spatial setting. Prominent examples of (non-spatial) mixed market models are TENNBAKK (1995) and ALBAEK AND SCHULTZ (1998). In a spatial setting and assuming FOB pricing, SEXTON (1990) analyzes the relative producer-processor price spread of an IOF under several conjectural variations, both in pure IOF markets and in mixed markets with a COOP as competitor. One outcome of his paper is the so-called "competitive yardstick effect": The presence of COOPs in a market will impel IOFs to a more competitive behaviour.

Given the importance of COOPs in food processing and given the spatial dimension of these markets, this paper aims to analytically analyze spatial competition in mixed markets. Contrary to SEXTON (1990) we analyze a mixed market under the assumption of UD-pricing. We adopt the modelling approach by ALVAREZ ET AL (2000) in order to address the question to which extent a COOP might contribute to a competitive yardstick result. To simplify the analysis we do not consider the case of overlapping market areas but consider only the case of non-overlapping market areas as in GRONBERG AND MEYER (1981).

This paper is organized as follows: In the following chapter, we, first, analyze a pure IOF market model. Second, we develop a spatial duopsony model of COOPs and analyze the differences to the IOF market. Finally, we assume a mixed market structure and determine the existence of the competitive yardstick effect. We finish by discussing our results in chapter 3.

2 MODELS

We adopt the theoretical model of ALVAREZ, FIDALGO, SEXTON AND ZHANG (2000), in the following referred to as *AFSZ*. They develop a model of IOFs with buyer monopsony/duopsony power in a spatial market setting under uniform delivery (UD-) pricing.[5] Assume a line market where processors are located distcance d apart. On this line farmers are uniformly distributed with density $D=1$ and produce a homogenous raw product according to the simple supply function $q_j = u_j$, where u_j is the raw product price paid by

[5] The choice of UD-pricing is due to its obvious higher importance as empirically investigated (see GREENHUT ET AL, 1980, and ALVAREZ ET AL., 2000). For the milk market, ALVAREZ ET AL. (2000) argue that UD-pricing is implemented due to its administrative simplicity and due to its possibility of competing over larger geographical areas relative to the alternative pricing scheme, FOB-pricing.

the processors and $j = C(COOP), I(IOF)$.[6] Assuming UD-pricing, processors are responsible for transportation costs t per-unit and distance r such that each farmer receives the same price. In the selling market, processors receive $\rho = P - c$, which is the price of the processed product net of constant per-unit processing costs. Thus, the selling market is characterized by perfect competition whereas processors have duopsony power towards farmers.[7] We assume that *c* and *t* are identical for, both, the IOF and the COOP.

We modify the model of *AFSZ* by considering, first, a different market form, and, second, by analyzing an equilibrium, which yields non-overlapping market areas: *AFSZ* explicitly consider a duopsony. These two processing firms are located distance d apart on an unbounded line (see FIGURE 1). This assumption allows *AFSZ* to analyze two different situations of direct competition depending on the extent of overlap of firms' desired market areas: First, firms' desired market areas R_I can overlap in between the location of both processors (see FIGURE 1 on the left hand side) or, second, both IOFs might wish to extend their market area R_I beyond the location of the competitor (see FIGURE 1 on the right hand side). As in this model processors face competition only from one direction but not from the other, these IOFs are for significant parts of their market areas in a (local) monopsonistic position. Consequently, one might argue (and it can be verified) that the resulting market power towards farmers will be relatively high compared to the outcome of a model where processors either face competition from both directions (an oligopsony model) or are located at the endpoints of a bounded line (a probably more general duopsony model).[8] This specific set-up of the *AFSZ*-model is, thus, a special case of a duopsony model, which seems to be reasonable for their empirical estimation of spatial competition in the coastal region of Asturias/Spain.

Our first modification of the AFSZ model is to assume that both IOFs are located at the endpoints of a line like in SCHULER AND HOBBS (1982), see FIGURE 2 on the left hand side. Since, again, competition occurs only in one direction such a model also implies the analysis of a duopsony situation but the model does not include a monopsonistic area to the left of firm A or the right of firm B. However, the assumption that there is another competitor to the left of A and to the right of B and assuming symmetric locations (i.e. equal distances d between

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[6] In CHAPTER 2.2 we derive the respective technology of farmers to obtain such a supply function.

[7] A justification of the assumption of perfect competition in the processed good market is the argument that, once the product is processed, it can travel longer distances such that firms face competition from other processors in the processed good market nationally or internationally (KARANTININIS AND ZAGO, 2001).

[8] ALVAREZ ET AL. (2000) implement this approach with firms facing a competitor on one side of the market but not on the other by arguing that any other approach implies symmetry of location, which "…is generally not present in the real world…" (footnote 5).

firms) results in competition in both directions and represents the oligopsony case (see FIGURE 2 on the right hand side). Assuming competition only in between the location of processors, there is no difference regarding the results of optimal UD-prices u_I and market areas R_I between the duopsony model and an oligopsony model.[9] As the market area extends in both directions in the oligopsony case the only difference is that profits of the IOF are double as much. For this reason we choose the duopsony market form where processors are located at the endpoints of the (bounded) line (see FIGURE 2 on the left hand side).

FIGURE 1: Market form in ALVAREZ ET AL. (2000)

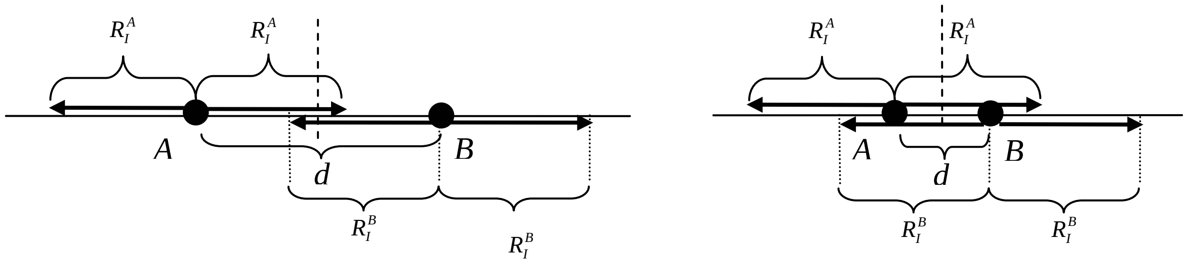
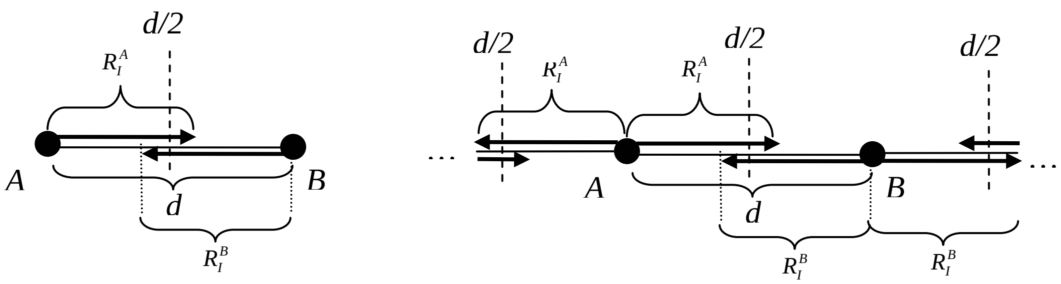


FIGURE 2: Duopsony/oligospony market form



Another reason for choosing this market form is due to our second modification of the *AFSZ*-model: *AFSZ* assume overlapping market areas as processors choose to share farmers in the contested area. GRONBERG AND MEYER (1981) analyse another solution of the problem of who will buy from the farmers in the contested area: This solution results in distinct, non-overlapping market areas. For simplicity, we only consider this solution with non-overlapping market areas in this paper. In the following, we apply this market form and the assumption of

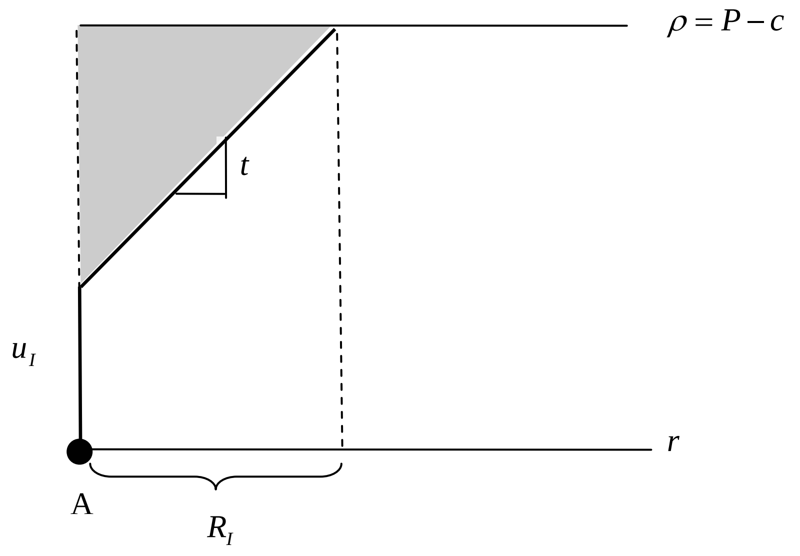
[9] In a duopsony model with processors located at the endpoints of a (bounded) line market competition beyond the location of a competitor cannot occur. In the oligopsony case with more than two firms, the appropriate framework is a circular market.

non-overlapping market areas for the case of a pure IOF market, a pure COOP market and a mixed market.

2.1 PURE IOF MARKET

In this section we analyze a market consisting only of IOFs by adapting the model of *AFSZ*. This allows analyzing differences to a mixed market structure in order to determine any possible competitive yardstick effect. Before setting up the spatial competition model, we briefly discuss the spatial monopsony. As processors are assumed to be private firms, their objective is to maximize their profit from buying, transporting, and processing the raw product and selling it to the final market. FIGURE 3 gives a graphical representation of the profits of a monopsonistic IOF:[10]

FIGURE 3: Monopsony model of the IOF



Processor *A* is located at one endpoint of line *r*. The upper horizontal line gives the net selling price ρ. The distance between the bottom line and the upward sloping line gives the costs of buying and transporting one unit of the raw product from either market point along *r*. The profit of the IOF from buying one unit from each farmer along r up to the boundary of its market area R_I in both directions is given by the grey shaded triangle. As it is assumed that the IOF is *not* a vertically integrated firm farmers in this model are simply input suppliers to

[10] This graphical representation is not provided by *AFSZ*; see also HUCK ET AL. (2005).

the IOF without any claim on a share of the profits.[11] The maximization problem of a monopsonistic IOF paying UD-price u_I and serving all farmers to a distance R_I in one direction is given by[12]

$$\text{(1)} \quad \Pi_I = \max_{R_I, u_I} \left[\int_0^{R_I} [\rho - u_I - tr] q_I \, dr \right] = \max_{R_I, u_I} \left[\left(\rho - u_I - \frac{tR_I}{2} \right) u_I R_I \right].$$

Since $\frac{tR_I}{2}$ are average transportation costs, $\rho - u_I - \frac{tR_I}{2}$ represents the average profit margin. Multiplying this by R_I gives the profit from collecting one unit from each farmer; multiplying this by u_I gives total profits from the IOF. Given ρ, t, and, for the moment, u_I, the processor will collect the raw product up to the point where marginal costs $tr + u_I$ equals marginal revenue ρ (net of processing costs), i.e. up to the point where the marginal profit from going any further becomes negative. Therefore, maximizing the profit function with respect to R_I and taking u_I for the moment as given yields the optimal market area of the IOF:

$$\text{(2)} \quad R_I = \frac{\rho - u_I}{t}.$$

Substituting this into equation (1) and maximizing profits with respect to u_I gives optimal UD-prices:

$$\text{(3)} \quad u_I^M = \frac{\rho}{3}.$$

Note that the optimal UD-price is independent of per-unit transportation costs t.[13] Substituting (3) into (2) gives the optimal market area of a monopsonistic IOF subject to optimal UD-prices:

$$\text{(4)} \quad R_I^M = \frac{2\rho}{3t}.$$

For the IOF to be in a monopsonistic position it must hold that $R_I^M \leq \frac{d}{2}$. Alternatively, *AFSZ* describe this situation by means of the relative importance of space $\frac{s}{\rho}$: The absolute

[11] For example, as opposed to many other models on this issue, ALBAEK AND SCHULTZ (1998) as well as HIGL (2003) assume that the IOF is a vertically integrated firm.
[12] The case of the monopsonistic UD-pricing IOF is also analyzed by LÖFGREN (1986).
[13] This is due to the linearity of supply functions of farmers.

importance of space s is defined by $s = td$, and $\frac{s}{\rho}$ measures the importance of space relative to the net value of the product, ρ. By substituting for the optimal market area (equation (4)), the IOF is in a monopsonistic position for $\frac{s}{\rho} \geq \frac{4}{3}$. The less important space gets (for example, the smaller per-unit transportation costs are relative to the net value of the product), the more likely a processor has to face competition from a rival.

We now consider the case of spatial competition in a duopsony, which is relevant for any $\frac{s}{\rho} < \frac{4}{3}$: Under UD-pricing the market area varies inversely with the price for the raw product u_I (see equation (2)). Löschian competition implies that each processor presumes that its rival will react identically to any proposed price change. The assumption of Löschian competition under UD-pricing implies price-matching between processor *A* and processor *B* as in equilibrium prices of firms engaged in direct competition must be equal: $u_I^A = u_I^B = u_I$. Direct competition under UD-pricing and Löschian competition yields overlapping market areas. *AFSZ* argue that the degree to which market areas overlap depends on the relative importance of space $\frac{s}{\rho}$. For their duopsony model they can identify the situation of overlap in between the location of the processors and overlap if processors want to extend their market area beyond the location of competitors. GRONBERG AND MEYER (1981) find an additional equilibrium for the case of price matching IOFs who desire to serve a market area $R_I > \frac{d}{2}$: "If the two firms overtly collude, deciding to split the market between them exactly, each taking the portion closest to themselves, we then have firms acting as if their market area is fixed at [$d/2$]. This assumption of a fixed market area is precisely the Löschian model of a spatially competitive firm." (p. 760). For our duopsony model, collusion on market areas is illustrated in FIGURE 4.

If processors collude such that market areas do not overlap, the maximization problem of the IOF in a circular market is

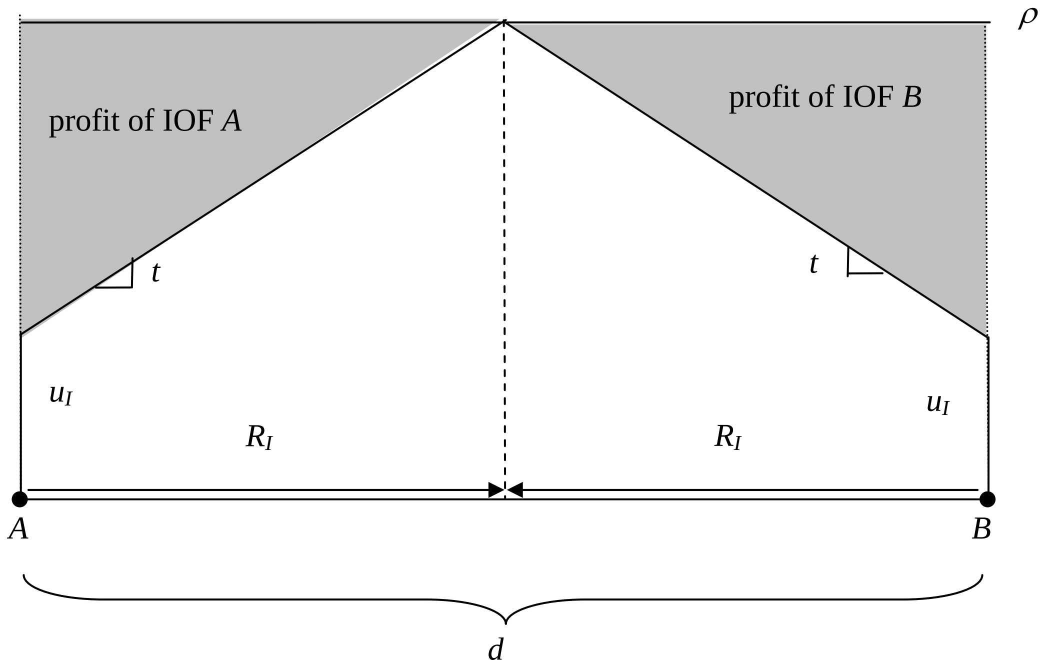
$$(5) \qquad \Pi_I^{NO} = \max_{u_I}\left[\int_0^{\overline{R}_I}[\rho - u_I - tr]u_I\,dr\right] = \max_{u_I}\left[\left(\rho - u_I - \frac{td}{4}\right)u_I\,\frac{d}{2}\right]$$

$$\text{for } \overline{R}_I = \frac{d}{2}$$

with the following solution of the FOC:

(6) $u_I^{NO} = \frac{\rho}{2} - \frac{s}{8}$.

FIGURE 4: Pure IOF market



The relevant range for this outcome of competition is the total range of duopsonistic competition $0 \le \frac{s}{\rho} < \frac{4}{3}$. UD-prices paid by the IOF are higher than the monopsony solution of $u_I = \frac{\rho}{3}$ for any $\frac{s}{\rho} < \frac{4}{3}$ and are decreasing in the relative importance of space (see FIGURE 7 in the following section). Interestingly, this solution for the case of non-overlapping market areas is identical to the *AFSZ*-solution for the case of overlapping market areas in between the location of processors (see *AFSZ*, equation (2)). Price transmission in terms of a pass through of the net selling price to the UD-price paid to farmers is given by

(7) $\frac{\partial u_I^{NO}}{\partial \rho} = \frac{1}{2}$,

which indicates the market power towards farmers by duopsonistic IOFs is lower than in the monospony case with a price transmission of 1/3. Comparative statics are summarized in TABLE A1 and A2. UD-prices are decreasing as space $s = td$ gets more important. While the market area in the duopsony case is, by assumption, only changing due to changes in *d*, a higher *t* reduces the optimal market area in the monopsony case.

2.2 PURE COOP MARKET

Let us now assume that the processor is a marketing COOP with an open membership policy such that farmers can join or resign from the COOP without costs. In the literature, several objectives a COOP might pursue are discussed (see, for example, BATEMAN ET AL., 1979, and COTTERILL, 1987). Most often it is assumed that the COOP maximizes the welfare of its members. In pursuing this goal, the COOP treats raw product production of its members as internal production, and is, thus, modelled as a vertically integrated organisation. The profit function of the COOP is, thus, given by the sum of the profits of COOP members from producing the raw product as well as by the profit of the COOP from selling the processed product after buying the raw product from its members. To derive profits of COOP members some additional information on the cost function of farmers is required: Let a farmer's technology be given by the quadratic cost function

$$(8) \qquad c_j^f = \frac{1}{2} q_j^2$$

for $j = C(COOP), I(IOF)$; q_j is the quantity produced by each farmer. Each farmer maximizes the following profit function from producing the raw product with respect to the raw product price u_j she receives from the processor:

$$(9) \qquad \pi_j^f = \max_{u_j} \left[u_j q_j - c_j^f \right]$$

The solution of the FOC gives the very simple unity supply function already assumed in chapter 2.1 as well as in *AFSZ*:

$$(10) \qquad q_j = u_j ,$$

Now, the profit function of farmers as in equation (9) can be rewritten into

$$(11) \qquad \pi_j^f = \frac{1}{2} u_j^2$$

From (11), per-unit profits of a COOP member from producing the raw product is given by

$$(12) \qquad \frac{\pi_C^f}{q_C} = \frac{u_C}{2}$$

Thus, given the assumption of a uniform distribution of farmers (i.e. COOP members) in space, the sum of profits from supply of the raw product of all COOP members is given by

$$(13)\quad \Pi^f = \frac{u_C^2}{2} R_C$$

By adding the profit of the COOP from processing (which is formally equal to the profit of the IOF), the objective function of a monopsonistic COOP, which maximizes the welfare of its members, is[14]

$$(14)\quad \begin{aligned} \Pi_C^M &= \max_{R_C, u_C} \left[\int_0^{R_C} \left[\frac{u_c}{2} \right] u_C \, dr + \int_0^{R_C} [\rho - u_c - tr] u_C \, dr \right] \\ &= \max_{R_C, u_C} \left[\int_0^{R_C} \left[\rho - \frac{u_c}{2} - tr \right] u_C \, dr \right] \end{aligned}$$

As the COOP treats raw product production of its members as internal production, $\frac{u_C}{2}$ in the reformulation in equation (14) are per-unit production costs of each farmer, given the quadratic cost function as in (8). In line with the IOF, the monopsonistic COOP determines its optimal market area by solving the FOC of the profit function with respect to R_C and taking u_C for the moment as given:

$$(15)\quad R_C = \frac{\rho - \frac{u_c}{2}}{t}$$

The optimal market area is determined by the point in space where marginal member welfare becomes zero. After substitution of the optimal market area into profit function (14) the solution of the FOC gives optimal UD-prices paid to farmers:

$$(16)\quad u_C^M = \frac{2\rho}{3} = 2u_I^M \,.$$

The UD-price paid to COOP members is double the price paid by the IOF to its suppliers (see equation (3)). Given optimal prices paid to farmers, the optimal market area, however, is equal to the IOF:

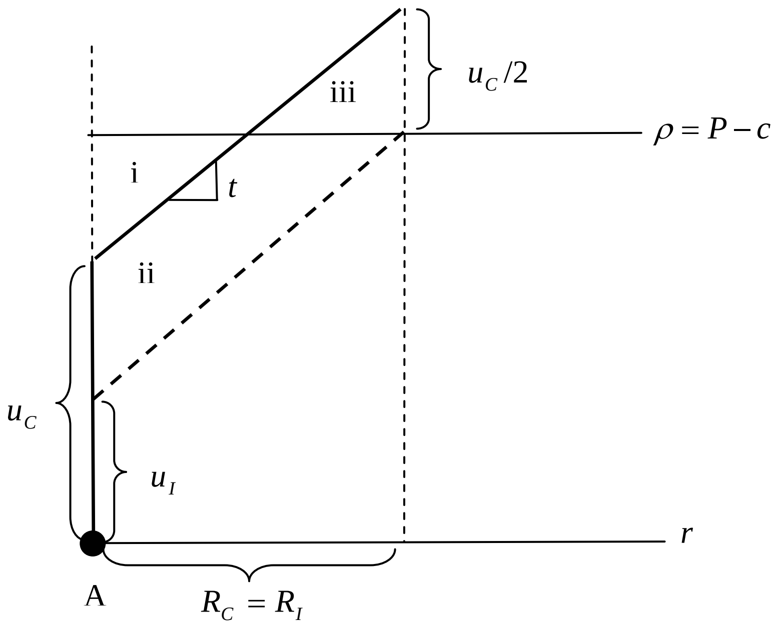
$$(17)\quad R_C^M = \frac{2\rho}{3t} = R_I^M$$

[14] For the monopsonistic COOP as well as a COOP duospony with overlapping market areas similar to *AFSZ* see also HUCK ET AL. (2005).

(see equation (4)). Consequently, the same condition applies for the COOP to be in a monopsonistic condition: $\frac{s}{\rho} \geq \frac{4}{3}$.

A graphical representation of the monopsonistic COOP as well as differences to the monopsonistic IOF is given in FIGURE 5 (see also HUCK ET AL. (2005)).

FIGURE 5: Monopsony model of the COOP compared to the IOF



Compared to the IOF, UD-prices paid by the COOP to farmers are twice as high. The COOP collects the raw product as long as marginal revenues from, both, raw product production and processing are equal to marginal costs: $\rho + \frac{u_C}{2} = tr + u_C$. Hence, the COOP's profits from collecting and processing one unit of the raw product from each COOP member are *i - iii),* with the sum of profits of all members being *ii + iii*. Total profits per unit are *i + ii* and therefore equal to the IOF. However, the quantity supplied by each farmer is twice as much compared to the IOF and therefore total profits of the COOP as well.

Comparative statics of the COOP monopsony model are summarized in TABLE A1. Price transmission is always higher in COOP markets than in IOF markets. For the case of the monopsonistic COOP, price transmission is

(18) $$\frac{\partial u_C^M}{\partial \rho} = \frac{2}{3} = 2\frac{\partial u_I^M}{\partial \rho},$$

which is double as high as for the case of the monopsonistic IOF but still far from being perfect due to the monopsonistic position of the COOP.

The solution of the welfare maximizing COOP requires further analysis: The monopsonistic COOP pays a higher price than the IOF at the cost of profits from processing: Profits of the COOP from processing, Π_C^{M-proc}, are formally equal to the objective function of the IOF and are given by

$$(19)\quad \Pi_C^{M-proc} = \left(\rho - u_C - \frac{tR_C^M}{2}\right) u_C R_C^M$$

Substituting the optimal solutions of u_C^M and R_C^M into equation (19) gives $\Pi_C^{Mp} = 0$. This implies that the welfare maximizing monopsonistic COOP maximizes its price paid to members such that profits from processing are zero. This is, in effect, the objective of a net average revenue (NARP) -pricing COOP, which results in a price that maximizes member welfare subject to satisfying the break-even constraint (SEXTON, 1990). To show this, net revenue product (NRP) and NARP of the monopsonistic COOP is given by

$$(20)\quad NRP = \left(\rho - \frac{tR_C}{2}\right) u_C R_C$$

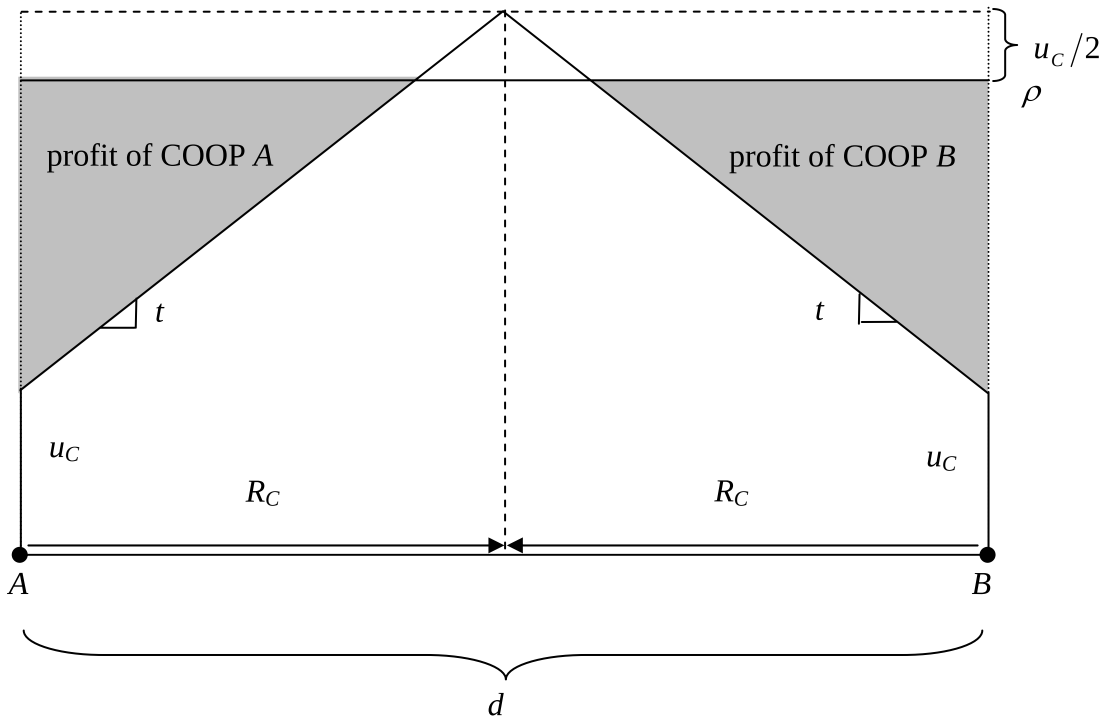
$$(21)\quad NARP = \frac{NRP}{Q_C} = \frac{NRP}{u_C R_C} = \left(\rho - \frac{tR_C}{2}\right)$$

NRP is the revenue net of costs (except the costs of the raw product), which is available for payment of the raw product; consequently, NARP is the net revenue per unit of the processed product (BATEMAN ET AL., 1979, COTTERILL, 1987). Substituting for R_C (see equation (15)), and solving $NARP \overset{!}{=} u_C$ for u_C gives the same result as in equation (16). Given NARP-pricing, the COOP pays the maximum price for the raw product by covering costs.[15]

We, now, consider a pure COOP duopsony where processors are located at the endpoints of a line market and colluding on market areas such that there is no overlap: $\overline{R}_C = \frac{d}{2}$ (see FIGURE 6).

[15] If the welfare maximizing COOP does not pay according to NARP, profits from processing are necessarily positive or negative. Then, these profits must be distributed among members via a two-part pricing scheme.

FIGURE 6: Pure COOP market



Then, the optimization problem of the COOP is

$$(22)\quad \Pi_C^{NO} = \max_{u_C}\left[\int_0^{\bar{R}_C}\left[\rho - \frac{u_C}{2} - tr\right]u_C\,dr\right] = \max_{u_C}\left[\left(\rho - \frac{u_C}{2} - \frac{td}{4}\right)u_C\,\frac{d}{2}\right].$$

with the solution

$$(23)\quad u_C^{NO} = \rho - \frac{s}{4}$$

As in the monopsony case, the COOP pays a price to its members, which is double the price of the IOF (see equation (6)). For $\frac{s}{\rho} < \frac{4}{3}$, the UD-price is higher than the monopsony price of the COOP and is decreasing in $\frac{s}{\rho}$. Like for the monopsonistic COOP, this duopsonistic COOP located at the endpoints of the line market and colluding on the market area with its competitors such that market areas do not overlap makes zero profits from processing. It is, in effect, a NARP-pricing COOP, which pays the highest possible price to its members subject to covering costs.[16]

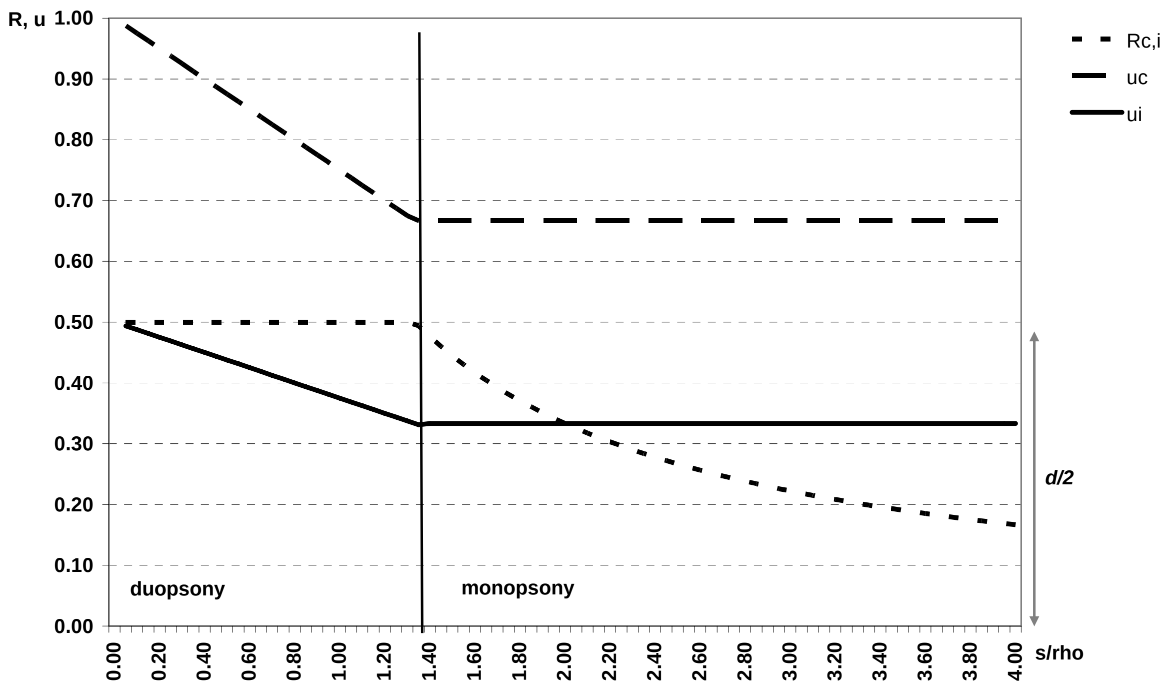
[16] This is not the case if we consider the *AFSZ*-equilibrium of overlapping market areas for welfare maximizing COOPs.

Comparative statics are summarized in TABLE A2. For the pure COOP duopsony, price transmission is given by

$$(24) \quad \frac{\partial u_C^{NO}}{\partial \rho} = 1$$

Price transmission is always higher in a COOP market than in an IOF market. While price transmission is always imperfect for an IOF, it is perfect for the COOP duopsony assuming non-overlapping market areas. If space is relatively unimportant ($0 \leq \frac{s}{\rho} < \frac{4}{3}$, either due to low per-unit transportation costs or due to a smaller distance between processors), UD-prices are decreasing in the relative importance of space. This is illustrated in FIGURE 7.

FIGURE 7: UD-prices and market area in the pure IOF/COOP market



Note: In this figure, *s/rho* is increasing due to increases in *t*. Distance *d* between firms as well as the net selling price *rho* are normalized to 1.

2.3 MIXED MARKET

In the following we analyze a mixed market structure where a profit maximizing IOF competes with a COOP. To simplify the analysis we a priori assume that the COOP prices according to NARP. The set-up of the model is as in the previous (pure) duopsony models, i.e. processors are located at the endpoints of a line market distance d apart and agree to collude on market areas such that there is no overlap. Since the COOP is assumed to be an open membership COOP, UD-prices paid to farmers (i.e. COOP members and IOF suppliers) must be equal for any point r along d. Otherwise, if $u_C > u_I$, farmers would have an incentive to join the COOP and the existence of an equilibrium with the coexistence of a COOP and an IOF is rather unlikely. Put differently, the marginal farmer located at the border of either market area must be indifferent on being a COOP-member or an IOF supplier.

The mixed market model is set up as a leadership model offering two options:

a) The COOP is the leader (or first mover) by offering an optimal price and by noting that its market area is the fraction left by the IOF. The profit maximizing IOF follows by conceding to this price and by determining, in turn, its optimal market area.

b) The IOF is the leader such that the COOP has to concede to the price paid by the COOP. The COOP prices according to NARP by determining its optimal market area given the price of the IOF.

Referring to option a) with the COOP being the leader, we start with the maximization problem of the IOF, i.e. the follower, which takes u, the UD-price determined by the COOP, as given:

$$(25) \quad \Pi_I^a = \max_{R_I}\left[\left(\rho - u - \frac{tR_I}{2}\right)uR_I\right]$$

The solution of the FOC is

$$(26) \quad R_I^a = \frac{\rho - u}{t}.$$

Again, we assume that the COOP prices according to NARP, i.e. maximizes the welfare of its members subject to satisfying the break even constraint. Given this, profits from processing are equal to zero and the COOP pays the highest possible price to its members. In pricing according to NARP, the COOP considers the market area of the IOF as $R_C = d - R_I$:

$$(27) \quad \left(\rho - \frac{t\left(d - R_I^a\right)}{2}\right) \overset{!}{=} u$$

Note that this problem is equal to the problem of sharing total COOP profits across space: For profits from processing to be equal to zero, profits of the COOP at each market point must be equal to the profit of a COOP member, i.e. $\frac{\Pi_C^a}{u\left(d-R_I^a\right)} \overset{!}{=} \frac{u^2}{2}$ for $\Pi_C^a = \left(\rho - \frac{u}{2} - \frac{t\left(d-R_I^a\right)}{2}\right)u\left(d-R_I^a\right)$. Substituting equation (26) into the problem stated in (27) gives optimal UD-prices:

$$(28) \quad u^a = \rho - \frac{s}{3}$$

Substituting this into equation (26) gives the optimal market area of the IOF and of the COOP, respectively:

$$(29) \quad R_I^a = \frac{1}{3}d$$

$$(30) \quad R_C^a = \frac{2}{3}d$$

This implies that for the relevant range of spatial competition ($\frac{s}{\rho} < \frac{4}{3}$) the COOP will always have a higher market area than the IOF.

In the other case, option b), the IOF is the leader. The COOP, the follower, takes the price of the IOF as predetermined and decides on its market area such that profits from processing are zero:

$$(31) \quad \left(\rho - \frac{tR_C^b}{2}\right) \overset{!}{=} u$$

Again, this is equal to the problem $\frac{\Pi_C^b}{uR_C^b} \overset{!}{=} \frac{u^2}{2}$ for $\Pi_C^b = \left(\rho - \frac{u}{2} - \frac{tR_C^b}{2}\right)uR_C^b$. The solution to this problem is

$$(32) \quad R_C^b = \frac{2(\rho - u)}{t}$$

Now, the IOF considers the market area of the COOP as $R_I = d - R_C$ and maximizes its profit function:

$$(33) \quad \Pi_I^b = \max_u \left[\left(\rho - u - \frac{t\left(d-R_C^b\right)}{2}\right)u\left(d-R_C^b\right)\right]$$

The solution to this is

(34) $$u^b = \frac{8\rho - 3s + \sqrt{3s^2 - 12s\rho + 16\rho^2}}{12}$$

Substituting this into equation (32) gives the optimal market area of the COOP and of the IOF, respectively:

(35) $$R_C^b = \frac{3s + 4\rho - \sqrt{3s^2 - 12s\rho + 16\rho^2}}{6t}$$

(36) $$R_I^b = \frac{3s - 4\rho + \sqrt{3s^2 - 12s\rho + 16\rho^2}}{6t}$$

UD-price u^b will be positive for $\frac{s}{\rho} < 4$ implying that $R_C^b > R_I^b$. This means that for the relevant range of spatial competition ($\frac{s}{\rho} < \frac{4}{3}$) the, again, COOP will always have a higher market area than the IOF.

2.4 DISCUSSION OF THE RESULTS

Comparative statics of the mixed market models are given in TABLE A3 and A4. Higher per-unit transportation costs as well as a higher distance between processors decreases UD-prices paid to farmers. If the COOP is the price leader in the model, than market areas of both processors are constant for any t or ρ. If, however, the IOF is the price leader in the model, then the market area of the IOF is increasing in per-unit transportation costs whereas the market area of the COOP is decreasing. The opposite effect can be verified for changes of the net-selling price. Price transmission $\frac{\partial u^{a,b}}{\partial \rho}$ is given by

(37) $$\frac{\partial u^a}{\partial \rho} = 1$$

(38) $$\frac{\partial u^b}{\partial \rho} = \frac{2}{3} + \frac{32\rho - 12s}{24\sqrt{16\rho^2 - 12s\rho + 3s^2}}$$

for $\frac{\partial u^b}{\partial \rho} \to 1$ as $\frac{s}{\rho} \to 0$

Price transmission is perfect under option a) with the COOP being the leader. Under option b) the COOP is the follower. If, however, it sets price according to NARP, price transmission also increases towards 1 if the relative importance of space decreases.

To analyze whether a competitive yardstick effect is at work or not, the solution of the mixed market models are compared with the model of the pure IOF market. Given perfect competition in the processed good market, a competitive yardstick effect is present if $\frac{u^{a,b}}{u_I^{NO}} > 1$ for $u_I^{NO} = \frac{\rho}{2} - \frac{s}{8}$ (see equation (6)). Then, UD-prices paid to IOF suppliers are higher than in a pure IOF market. The results show that a competitive yardstick is present in either case and for any $\frac{s}{\rho} < \frac{4}{3}$:

$$\text{(39)} \quad \frac{u^a}{u_I^{NO}} = \frac{8(s-3\rho)}{3(s-4\rho)} > 1$$

$$\text{(40)} \quad \frac{u^b}{u_I^{NO}} = \frac{2\left(3s - 8\rho - \sqrt{16\rho^2 - 12s\rho + 3s^2}\right)}{3(s-4\rho)} > 1$$

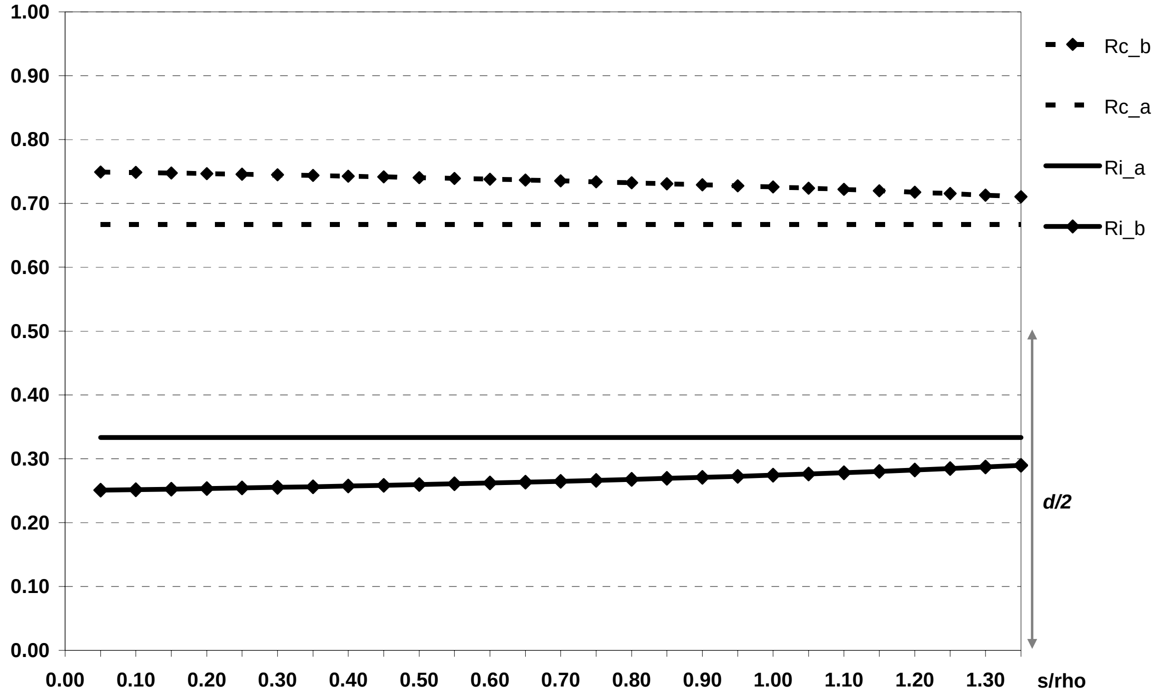
As already indicated by means of price transmission, the competitive yardstick effect is highest under option a), i.e. if the COOP is the first mover and prices according to NARP. Prices in the mixed market are, however, lower than in the pure COOP market:

$$\text{(41)} \quad \frac{u^a}{u_C^{NO}} = \frac{4(s-3\rho)}{3(s-4\rho)} < 1$$

$$\text{(42)} \quad \frac{u^b}{u_C^{NO}} = \frac{3s - 8\rho - \sqrt{16\rho^2 - 12s\rho + 3s^2}}{3(s-4\rho)} < 1$$

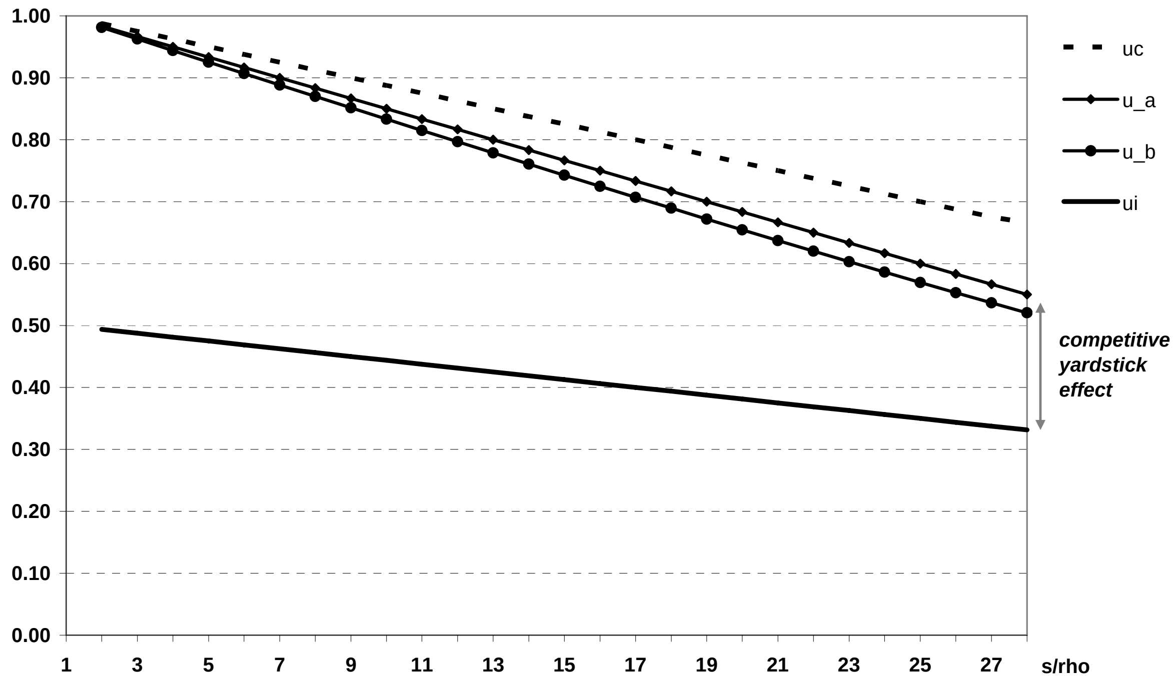
FIGURE 8 and 9 illustrate the results by means of a numerical simulation: In either case, the market area of the COOP is higher than the market area of the IOF and decreases as space gets more important. Despite the result that price transmission is highest if the COOP is the leader, it will never capture almost all of the market area available. FIGURE 9 shows that UD-prices are highest under option a) ($u^a > u^b$) and illustrates the competitive yardstick effect:

FIGURE 8: Market areas – mixed market



Note: In this figure, s/rho is increasing due to increases in *t*. Distance *d* between firms as well as the net selling price *rho* are normalized to 1.

FIGURE 9: UD-prices – mixed market



Note: In this figure, s/rho is increasing due to increases in *t*. Distance *d* between firms as well as the net selling price *rho* are normalized to 1.

In the mixed market, the presence of the COOP increases the price paid by the IOF to its suppliers and, thus, reduces market power towards them. However, compared to the situation of a pure COOP duopsony, COOP members are worse off as the price they receive is lower in the mixed market solution.

3 CONCLUSIONS

The spatial dimension of the production of perishable food products can facilitate the exercise of processor's market power towards input suppliers. In order to evade market power from processors, farmers might form a (marketing) cooperative (COOP) such that the market becomes a mixed one consisting of different legal forms: investor owned firms (IOFs) and COOPs. According to the "yardstick of competition hypothesis" a COOP is able to mitigate oligopsonistic market power of IOFs. In the literature, spatial competition of oligopsonistic processors, which price discriminate across space due to UD-pricing, as well as the possibility of a mixed market structure within a spatial setting has been analyzed to a marginal extent so far.

In this paper we adopt the spatial duopsony model of ALVAREZ ET AL. (2000) to analyze the existence of the competitive yardstick in a mixed market: We assume a line market with processors located at the endpoints of the line. In addition, we assume that market areas of competitors do not overlap but that the total market is shared between the processors. Under the assumption of uniform delivered (UD-) pricing and non-overlapping market areas we, first, analyze an IOF duopsony. Second, we analyze the same model set-up under the assumption that processors are COOPs. Finally, we model a mixed market duopsony consisting of an IOF and a COOP and compare the results with the outcome of the previous models.

Farm gate prices and profits are, ceteris paribus, higher in markets of COOPs than in markets of IOFs. These results apply for, both, the monopsony case as well as for the duopsony case, whereas the latter occurs in a situation where space is relatively unimportant due to low per-unit transportation costs or due to a low distance between processors. In addition, the results show that the member welfare maximizing COOP is, at the same time, a NARP-pricing COOP, which pays its members the maximum price for the raw product by covering costs. For the mixed market structure we analyze two different options: Given that UD-prices paid to farmers must be equal for all farmers located on the line market, either the NARP-pricing COOP or the IOF can be the price leader. For both options we can identify the competitive yardstick effect as prices in the mixed market are higher than in the pure IOF market. This effect is most apparent if the COOP is the leader; then, price transmission (in terms of the pass through of the net selling price to the raw product price) is perfect like in the pure COOP duopsony. Similar results are derived by SEXTON (1990) for the case of a mixed market under FOB-pricing: In his model, the COOP's impact on the market performance is especially significant, if transportation costs are relatively low, and if the COOP adopts an open membership policy, sets prices according to the net average revenue product, and replaces a Löschian IOF competitor.

The results in our paper are, however, primarily driven by the rather strong assumption of non-overlapping market areas. The case of overlapping market areas as well as the objective of member welfare maximization given a two-part pricing scheme will be analyzed in more detail at a further stage of research.

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APPENDIX: COMPARATIVE STATICS

TABLE A1: Monopsony

IOF	COOP
$\frac{\partial u_I^M}{\partial \rho} = \frac{1}{3} > 0$	$\frac{\partial u_C^M}{\partial \rho} = \frac{2}{3} > 0$
$\frac{\partial R_I^M}{\partial t} = -\frac{2\rho}{3t^2} < 0$	$\frac{\partial R_C^M}{\partial t} = -\frac{2\rho}{3t^2} < 0$
$\frac{\partial R_I^M}{\partial \rho} = \frac{2}{3t} > 0$	$\frac{\partial R_C^M}{\partial \rho} = \frac{2}{3t} > 0$

TABLE A2: Pure IOF/COOP market

IOF	COOP
$\frac{\partial u_I^{NO}}{\partial t} = -\frac{1}{8}d < 0$	$\frac{\partial u_C^{NO}}{\partial t} = -\frac{1}{4}d < 0$
$\frac{\partial u_I^{NO}}{\partial d} = -\frac{1}{8}t < 0$	$\frac{\partial u_C^{NO}}{\partial d} = -\frac{1}{4}t < 0$
$\frac{\partial u_I^{NO}}{\partial \rho} = \frac{1}{2} > 0$	$\frac{\partial u_C^{NO}}{\partial \rho} = 1 > 0$

TABLE A3: Mixed market, option a)

IOF	COOP
$\frac{\partial u^a}{\partial t} = -\frac{1}{3}d < 0$	
$\frac{\partial u^a}{\partial d} = -\frac{1}{3}t < 0$	
$\frac{\partial u^a}{\partial d} = 1 > 0$	

TABLE A4: Mixed market, option b)

IOF	COOP
$\frac{\partial u^b}{\partial t} = \frac{6t^2 d - 12\rho t}{24\sqrt{16\rho^2 - 12s\rho + 3s^2}} - \frac{1}{4}d < 0$	
$\frac{\partial u^b}{\partial d} = \frac{6t^2 d - 12\rho t}{24\sqrt{16\rho^2 - 12s\rho + 3s^2}} - \frac{1}{4}t < 0$	
$\frac{\partial u^b}{\partial \rho} = \frac{32\rho - 12s}{24\sqrt{16\rho^2 - 12s\rho + 3s^2}} + \frac{2}{3} > 0$	
$\frac{\partial R_I^b}{\partial t} = \frac{\rho\left(3s + 2\sqrt{16\rho^2 - 12s\rho + 3s^2} - 8\rho\right)}{3t^2\sqrt{16\rho^2 - 12s\rho + 3s^2}} > 0$	$\frac{\partial R_C^b}{\partial t} = -\frac{\rho\left(3s + 2\sqrt{16\rho^2 - 12s\rho + 3s^2} - 8\rho\right)}{3t^2\sqrt{16\rho^2 - 12s\rho + 3s^2}} < 0$
$\frac{\partial R_I^b}{\partial d} = \frac{\sqrt{16\rho^2 - 12s\rho + 3s^2} + s - 2\rho}{2\sqrt{16\rho^2 - 12s\rho + 3s^2}} > 0$	$\frac{\partial R_C^b}{\partial d} = -\frac{s - \sqrt{16\rho^2 - 12s\rho + 3s^2} - 2\rho}{2\sqrt{16\rho^2 - 12s\rho + 3s^2}} > 0$
$\frac{\partial R_I^b}{\partial \rho} = -\frac{3s + 2\sqrt{16\rho^2 - 12s\rho + 3s^2} - 8\rho}{3t\sqrt{16\rho^2 - 12s\rho + 3s^2}} < 0$	$\frac{\partial R_C^b}{\partial \rho} = \frac{3s + 2\sqrt{16\rho^2 - 12s\rho + 3s^2} - 8\rho}{3t\sqrt{16\rho^2 - 12s\rho + 3s^2}} > 0$