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Spatial Competition in a Mixed Market – The Case of Milk Processors

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Abstract

The spatial dimension of the raw milk market facilitates the exercise of oligopsonistic power of milk processors towards farmers. At the same time, the market is characterised by a high share of processing cooperatives (coops). Hence, coops compete with investor-owned firms (IOFs) in a mixed market. Assuming uniform delivered pricing, we theoretically analyse spatial competition in a mixed market. Our theoretical and empirical results for Bavarian milk processors confirm the so-called “competitive yardstick effect”, i.e. coops can mitigate the oligopsony power of IOFs. In our theoretical model, the strength of this effect depends on the behaviour of IOFs.

Keywords: spatial competition, cooperatives, mixed market, raw milk market, spatial error/Durbin model

1 Introduction

One of the main characteristics of many agricultural markets is that many input suppliers (i.e. farmers) are facing only a few buyers of their product (food processors, distributors etc.). One important reason for this phenomenon is the spatial dimension of agricultural production. Transportation of the mostly bulky and perishable agricultural products is costly relative to their product value. This limits the distance the product is shipped and thereby the number of alternative buyers, implying an oligopsonistic market structure and potentially low farm level prices (e.g. Rogers and Sexton, 1994; Graubner et al., 2011). Another, though related, characteristic of agricultural markets is a relatively high share of processing cooperatives (coops), since vertical integration is one way for input suppliers to evade downstream market power. Hence, we often observe mixed markets where coops compete with investor-owned firms (IOFs).

Raw milk markets in many EU countries are a perfect example of this setting. Production of raw milk is widely scattered and collection with refrigerator trucks is relatively costly. This limits each milk processor’s collection area and hence farmers’ number of potential buyers of their raw milk. Moreover, the market share of coops in milk processing exceeds 50% in the EU in general and in many member countries including Germany (Bijman et al., 2012).

According to the “yardstick of competition” hypothesis, coops are able to improve competition by mitigating the oligopsony power of IOFs (e.g. Cotterill, 1987; Sexton, 1990). Payments received by coop members can be regarded as a yardstick for IOF suppliers (Sexton and Lavoie, 2001) so that coops can be considered a legal form that “disciplines” IOFs (Fousekis, 2011b:120). Hence, a competitive yardstick effect of coops may be one justification for a favourable public policy towards coops (e.g. Sexton and Sexton, 1987), e.g. in terms of certain exemptions from corporate tax in Germany (Bundeskartellamt, 2009:31). Moreover, government support of coops can even be perceived as a way of indirectly regulating imperfect competition (Tennbakk, 1995).

Market concentration and market power in the food sector in general and along the milk supply chain in specific is a topic of increasing interest to antitrust agencies, politicians and academics (OECD, 2014; EC, 2010; Graubner et al., 2011). In the last decades the level of raw milk prices has repeatedly been subject to farmer protests and political debates. For example, after severe farmers’ demonstrations in several EU countries in spring 2008, the European Commission (EC) established a High Level Expert Group on Milk (HLG) in 2009 discussing among others “what can be done to strengthen the bargaining power of milk producers” (EC, 2010:10). This initiative also led to the so-called “Milk Package” aiming to improve the position of producers in the milk supply chain via

provisions in regard to compulsory contracts, producer organisations and collective negotiations (EC, 2014). Moreover, market concentration and potential abuse of market power at different stages of the milk supply chain also lead to investigations of antitrust authorities in many EU countries including Germany (OECD, 2014; Bundeskartellamt, 2012).

In regard to academics there is an increasing number of contributions modelling and measuring market power along the food supply chain in general (Sexton and Zhang, 2000) and for the milk supply chain in particular (Gohin and Guyomard, 2000; Salhofer et al., 2012; Perekhozhuk et al. 2015). However, contributions considering spatial competition in inputs markets are rather limited. Exceptions include Alvarez et al. (2000), Graubner et al. (2011) and Tribl (2012) for a pure IOF market and Fousekis (2011a) and Tribl (2012) for a pure coop market. Studies on spatial mixed markets assuming different spatial pricing policies include Sexton (1990) and Fousekis and Panagiotou (2013) for free-on-board (FOB) pricing, Fousekis (2011b) for FOB and uniform delivered (UD) pricing, respectively, and Tribl (2012) for UD pricing. Our contributions to this literature are twofold: First, we develop a theoretical model of spatial competition of oligopsonistic food processors in a mixed market. Based on this, we analyse if coops exhibit a procompetitive effect on the market outcome. Second, we empirically test some of the theoretical results based on an extensive data set of raw milk prices paid by Bavarian milk processors.

The rest of the paper is organised as follows. Chapter 2 presents a theoretical duopsony model of spatial competition a mixed market. In chapter 3 we analyse the existence of a competitive yardstick effect. Chapter 4 presents our empirical model and results. In chapter 5 we draw conclusions and discuss implications of our findings.

2 Theoretical mixed market model

Let's assume a bounded line market where two processors – an IOF and a processing coop – are located distance d away at its endpoints.¹ This is illustrated in Figure 1, where the coop (IOF) is located on the left (right) hand side. Farmers as suppliers of raw milk are assumed to be uniformly distributed with a density equal to 1 along this line and produce a homogeneous raw product (Alvarez et al., 2000). Let the distance from a processor to a farmer be r . As typical for the milk market, we assume uniform delivered (UD) pricing. Therefore, each farmer receives the same price u per unit, irrespective of his location and processors bear the transportation costs tr , with t being the costs of transporting one unit of the raw product per distance at any point r in the line market. We assume that all farmers (f) produce the raw product according to a simple quadratic cost function $c_j^f = q_j^2/2$, implying a supply function with a unitary supply elasticity $q_j = u_j$, where q_j is the quantity of raw milk each farmer supplies and $j=C, I$ indicates if the raw milk is supplied to the coop or IOF, respectively. The net price received by processors in the selling market is $\rho = P - c$, which is the price of the processed product P net of constant per-unit processing costs c . Assuming perfect competition in the selling market, P is constant (Löfgren, 1986; Alvarez et al., 2000). In Figure 1, we measure the market area of either processor on the horizontal axis and prices on the vertical axis.

The IOF is assumed to maximise its profits by choosing the optimal market area for collecting the raw product, R_I , and the optimal UD price u_I . The profit function of an IOF serving all farmers within its market area R_I is given by

$$(1) \quad \Pi_I = \left(\int_0^{R_I} (\rho - u_I - tr) dr \right) u_I .$$

¹ A more detailed description of the model is provided in Tribl (2012).

Maximising equation (1) with respect to R_I and u_I yields the optimal market area taking the UD price as given (equation (2)) and the pricing schedule of the IOF taking the market area as given (equation (3)), respectively:

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

$$(3) \quad u_I = \frac{\rho}{2} - \frac{tR_I}{4}.$$

According to equation (2), and taking the UD price for the moment as given, the IOF will collect raw milk up to the point in space where marginal costs $tr + u_I$ equal marginal revenue ρ (net of processing costs), i.e. where marginal profits are zero. According to equation (3), and taking the market area as given, the optimal UD price increases with net selling price ρ and decreases with unit transportation costs t . To derive the unconstrained optimal market area and UD price, we have to solve equations (2) and (3) for R_I and u_I . To illustrate this in Figure 1, equation (2) can be reformulated to

$$(4) \quad u_I = \rho - tR_I.$$

Equation (4) is illustrated in Figure 1 by the steeper downward-sloping dashed line on the right hand side with intercept ρ and slope $-t$. Equation (3) is illustrated by the downward-sloping dashed line on the right hand side; it is less steep with intercept $\rho/2$ and slope $-t/4$. Assume for the moment that the IOF is in a monopsonistic position. Solving equations (3) and (4), i.e. the intersection of the two dashed lines in Figure 1, yields the optimal monopsonistic (M) market area, R_I^M :

$$(5) \quad R_I^M = 2\rho/3t.$$

Substituting this market area into equation (3) or equation (4) gives the optimal monopsonistic UD price, u_I^M (Alvarez et al., 2000):

$$(6) \quad u_I^M = \rho/3.$$

To extend this model to a mixed market, we assume a processing coop being located at the other endpoint of the line market. Coops differ in at least two respects from IOFs: the membership policy (open or restricted) and the objective function. In regard to the first, according to the German Cooperative Societies Acts, coops in Germany have to follow an open-membership policy (Bundeskartellamt, 2009), which, theoretically, implies an unrestricted number of members. Strictly speaking, any farmer wishing to join the coop must be accepted. In a spatial competition model open membership means that the coop, unlike the IOF, cannot determine its optimal market area. Hence, we allow for an open-membership policy by employing the no-rationing assumption of Iozzi (2004), i.e. the coop takes the market area as given and considers the total distance d as its potential market area. In regard to the second, processing coops are an example of forward vertical integration and farmers as coop members are both, input suppliers and owners at the same time. Therefore, the objective function of a coop is different from that of an IOF. The predominantly non-spatial theoretical literature on coops discusses different objective functions, most prominently total member welfare (TMW) maximisation and net average revenue product (NARP) pricing (Bateman et al., 1979; LeVay, 1983; Cotterill, 1987). Under TMW maximisation, the coop maximises the sum of total profits of members from producing the raw product (Π_C^f) and the coop's profits from processing and selling it on the processed goods market (Π_C^p). Since a single farmer's profits from producing the raw product is $\pi_j^f = u_j^2/2$ and the respective sum of all coop members is $\Pi_C^f = \pi_C^f R_C$, the coop's TMW (Π_C) objective function is given by

$$(7) \quad \Pi_C = \pi_C^f R_C + \Pi_C^p = \left(\int_0^{R_C} \left(\frac{u_C}{2} \right) dr + \int_0^{R_C} (\rho - u_C - tr) dr \right) u_C = \left(\int_0^{R_C} \left(\rho - \frac{u_C}{2} - tr \right) dr \right) u_C.$$

Alternatively, under NARP pricing, the coop breaks even, i.e. profits from processing Π_C^p are zero. Hence, farmers receive the highest possible price for the raw product subject to covering the coop's processing and transportation costs. In this case, the coop pays a UD price, such that TMW per member is equal to the profits of a single coop member: $\Pi_C/R_C = \pi_C^f$. In the absence of fixed costs in processing, the NARP function is identical to the solution of the first-order condition of a (monopsonistic) coop that maximises TMW (equation (7)) with respect to the UD price and takes the market area as given. Thus, without fixed costs in processing the pricing schedule of the coop under both objectives is given by

$$(8) \quad u_C = \rho - \frac{tR_C}{2}.$$

Equation (8) is illustrated in Figure 1 by the solid downward-sloping line (from the perspective of the location of the coop on the left hand side) with intercept ρ and slope $-t/2$. Assuming an open-membership policy by employing the no-rationing rule, the coop does not determine an optimal market area like the IOF does, i.e. it takes the market area as given.

With spatial competition between the IOF and the coop, in equilibrium UD prices of both processors must be equal. Given no rationing by the coop, two different tie-breaking rules (TBR) can be applied (Iozzi, 2004). Assuming for the moment symmetric processors, farmers under the efficient TBR choose to patronise the nearest processor and competing processors have distinct, non-overlapping market areas (similar to Löschian competition in a pure IOF market; see section 3); under the random TBR, supply in each local market is split between processors such that there is a total overlap of market areas between neighbouring processors. However, for the mixed market (i.e. with asymmetric competitors) an analytical solution under the random TBR is not possible under all cases considered in this study (Tribl, 2012). In contrast, the efficient TBR in a mixed market can be interpreted in such a way that no farmer within the market area of the IOF wishes to patronise the coop when both processors pay the same UD price. All farmers in the market that are not served by the IOF will patronise the coop. Since there is no overlap of market areas (as it is assumed in equation (7)), the market area of the coop is given by $R_C = d - R_I$. Substituting the coop's market area into equation (8), the pricing schedule of the coop in the mixed market under the efficient TBR is

$$(9) \quad u_C = \rho - \frac{t(d - R_I)}{2}.$$

Due to the efficient TBR, the profit function of the IOF in the mixed market is equal to the monopsonistic case in equation (1). However, the IOF is constrained by the coop's behaviour. It must pay a UD price u_I that is at least equal to the UD price of the coop u_C , otherwise farmers will switch to the open-membership coop. In this situation of spatial competition, we can distinguish two different situations depending on the IOF's information about the pricing schedule of the coop:

i) In a "sequential moves game" (*seq*), the IOF can use the information that it has about the coop's pricing schedule (equation (9)) in order to determine its optimal market area. Therefore, the coop first determines its pricing schedule, which is then anticipated by the IOF in a second stage, i.e. the IOF mimics this schedule ($u_I = \rho - t(d - R_I)/2$) to guarantee $u_I = u_C$. Analytically, after substituting $u_I = \rho - t(d - R_I)/2$ into equation (1), the IOF maximises its profits with respect to its market area:

$$(10) \quad \Pi_I^{seq} = \max_{R_I} \left[\left(\rho - u_I - \frac{tR_I}{2} \right) u_I R_I \right] \text{ for } u_I = \rho - \frac{t(d - R_I)}{2}.$$

The solution of the first-order condition yields the optimal market of the IOF:

$$(11) \quad R_I^{seq} = \frac{3dt - 4\rho + \sqrt{16\rho^2 - 12dt\rho + 3d^2t^2}}{6t}.$$

Hence, the coop's market area is given by $R_C^{seq} = d - R_I^{seq}$. Substituting equation (11) into the pricing schedule $u_I = \rho - t(d - R_I)/2$, the resulting UD price in the mixed market is

$$(12) \quad u^{seq} = \frac{2\rho}{3} - \frac{td}{4} + \frac{\sqrt{16\rho^2 - 12dt\rho + 3d^2t^2}}{12}.$$

The equilibrium is illustrated in Figure 1. The IOF determines its optimal market area by anticipating the coop's pricing schedule, which is upward sloping for the IOF with intercept $\rho - td/2$ and slope $+t/2$. The IOF collects the raw product up to the point in space where marginal profits (illustrated by the stylised downward-sloping dotted curve $\partial\Pi_I/\partial R_I$ on the right hand side in Figure 1) are equal to zero. The resulting UD price is given by $u^{seq} = u_C^{seq} = u_I^{seq}$. The most distant IOF supplier (located at $r = R_I^{seq}$) will not switch to the coop as the increase in the coop's (reduction in the IOF's) market area will reduce the UD price. Likewise, the most distant coop member cannot switch to the IOF, since the IOF will not serve any point beyond its optimal market boundary R_I^{seq} .

ii) In a "simultaneous moves game" (*sim*), the IOF does not have any information about the coop's pricing schedule and, hence, cannot anticipate it. The coop offers its pricing schedule and, at the same time, the IOF maximises profits with respect to its market area, taking the UD price as given. Hence, each processor assumes the competitors' prices to be fixed. This is comparable to the Hotelling-Smithies conjecture in a spatial setting with symmetric firms (usually two IOFs; e.g. Greenhut et al., 1987:20) and the standard Cournot conjecture in a non-spatial setting. Therefore, the IOF's profit function is equal to that of a monopsonistic IOF in equation (1) and the solution of an IOF taking the UD price as given is given by equation (4) and illustrated by the steeper downward-sloping dashed line on the right hand side in Figure 1. As before, the coop's pricing schedule is given by equation (9) and the solid downward sloping line from the left hand side in Figure 1. Farmers choose the processor based on offered UD prices. Consequently, the market boundary between the IOF and the coop is determined by the location of the farmer who is indifferent between serving the coop and the IOF. Setting equation (4) equal to the pricing schedule of the coop (equation (9)) gives the resulting market area of the IOF, R_I^{sim}

$$(13) \quad R_I^{sim} = d/3$$

and, subsequently, $R_C^{sim} = d - R_I^{sim} = 2d/3$. After substitution into either equation (4) or equation (9), the resulting UD price in the mixed market is²

$$(14) \quad u^{sim} = \rho - td/3.$$

In Figure 1, this solution is given by the intersection of the pricing schedule of the coop and the steeper downward-sloping dashed line of the IOF ($u^{sim} = u_C^{sim} = u_I^{sim}$). In this case, the IOF is not able to control its market area because it is determined by farmers' choice where to deliver the raw product. The solution is a stable equilibrium, where no farmer will switch to the respective other processor.

The degree of competition can be described by means of the relative "importance of space" s/ρ with $s = td$ (Alvarez et al., 2000): space is relatively important if the transportation rate t or the distance d between processors is rather high. In this situation, competition is relatively weak. Competition increases as space becomes less important. Figure 2 provides a numerical simulation of the UD prices with respect to s/ρ . In general, UD prices are decreasing in t and d . It can be shown that the coop and the IOF are in the situation of spatial competition in the mixed market for any $s/\rho < 2$. Figure 2 illustrates that in the situation $s/\rho \geq 2$, and given a coop competitor, the IOF is able to buy

² See also Fousekis (2011b) for a coop's UD price in a mixed market, which is, however, derived in a different way.

raw milk at its optimal monopsonistic UD price $u_I^M = \rho/3$ (see equation (6)), which is higher than the UD price of the coop, indicated by u_C^M (see equation (9)). For the situation of $s/\rho < 2$, the UD price in the mixed market is higher if the IOF has no information about the pricing schedule of the coop and takes the UD price as given (u^{sim}). In this case, the market area of the IOF is larger, i.e. the share of farmers patronising the coop is lower. In addition, price transmission in terms of a pass-through of the net selling price ρ to the UD price in such a mixed market is perfect: $\partial u^{sim} / \partial \rho = 1$. Relative to that, if the IOF has more information and is able to anticipate the coop's pricing schedule, the UD price in the mixed market is lower (u^{seq}). In this case, the IOF has the ability to restrict its market area and its profits are higher. Price transmission $\partial u^{seq} / \partial \rho = \frac{4\sqrt{16\rho^2 - 12dt\rho + 3d^2t^2 - 3td + 8\rho}}{6\sqrt{16\rho^2 - 12dt\rho + 3d^2t^2}} > 0$ is imperfect, but converges to 1 as s/ρ decreases towards zero.

3 Analysis of the “competitive yardstick effect”

Generally, a competitive yardstick effect (CYE) is present if the coop drives the IOF to less oligopsonistic behaviour towards farmers. Thus, if the CYE holds, UD prices should be higher in a mixed market relative to a pure IOF market. To model spatial competition in a pure IOF market as a counterfactual of the mixed market, we need to specify the type of competition among processors. Cooperative behaviour between firms is commonly modelled by Löschian competition where competitors exactly match any price change so that their respective market area remains constant (e.g. Beckmann and Thisse, 1986). The property of a fixed market area under Löschian competition, however, applies per se only under FOB pricing but not under UD pricing (Alvarez et al., 2000; see also equation (2) showing that the market area varies with the UD price). Under UD pricing, an a priori assumption of a fixed market area ($R_I = d/2$) presumes collusion and is similar to a traditional cartel, requiring a high degree of coordination with exclusive, non-overlapping market areas (Graubner et al., 2011). Alternatively, under the “price-matching conjecture” competitors also match any price change, but in the absence of an agreement to split markets, the market areas of competing firms can overlap (Gronberg and Meyer, 1981; Alvarez et al., 2000). In contrast, non-cooperative behaviour between firms is commonly modelled by the Hotelling-Smithies conjecture, i.e. firms set UD prices simultaneously and take the competitor's price as given. Market overlap is generally not possible under the Hotelling-Smithies conjecture (e.g. Alvarez et al., 2000), but observed in reality at a regional level in Germany (e.g. Huber, 2009). Moreover, empirical evidence rather supports the assumption of cooperative behaviour in the German raw milk market (e.g. Graubner et al., 2011). Therefore, we will not further consider non-cooperative competition.

We model the pure IOF market by assuming, as before, both processors being located at the endpoints of the line market.³ Under Löschian (L) competition with symmetric processors the market area in the IOF's profit function is exogenously given by $R_I = d/2$. Hence, the IOF's profit is equal to the monopsonistic situation in equation (1), but contrary to that, the IOF maximises profits with respect to the UD price only. Given the solution of the first-order condition as in equation (3), the optimal UD price under Löschian competition is

$$(15) \quad u_I^L = \frac{\rho}{2} - \frac{td}{8}.$$

As expected under Löschian competition, which is similar to collusion, price transmission of $\partial u_I^L / \partial \rho = 1/2$ is low.

Under the price-matching (PM) conjecture market areas of competing processors can overlap. Since prices between processors must be equal in this situation, suppliers within the area of overlap

³ A more detailed description of the pure IOF model is provided in Tribl (2012).

randomly choose their processor (Gronberg and Meyer, 1981; Alvarez et al., 2000). Each IOF maximises the following profit function with respect to the UD price:

$$(16) \quad \Pi_I^{PM} = \left(\int_0^{d-R_I} (\rho - u_I - tr) dr + \frac{1}{2} \int_{d-R_I}^{R_I} (\rho - u_I - tr) dr \right) u_I \text{ for } R_I = \frac{\rho - u_I}{t}.$$

The first term in this profit function gives the profits in the IOF's area without market overlap, the second term gives the area with market overlap where farmers are shared equally between IOFs. The optimal UD price and market area for an IOF under the price-matching conjecture are:

$$(17) \quad u_I^{PM} = \frac{2(\rho - dt)}{3} + \frac{\sqrt{4\rho^2 - 8dtp + 10d^2t^2}}{6}$$

$$(18) \quad R_I^{PM} = \frac{2\rho + 4dt - \sqrt{4\rho^2 - 8dtp + 10d^2t^2}}{6t}.$$

Price transmission $\partial u_I^{PM} / \partial \rho = \frac{2}{3} + \frac{8(\rho - td)}{12\sqrt{4\rho^2 - 8dtp + 10d^2t^2}} > 0$ is higher than under Löschian competition. In the pure IOF market, each IOF is in a monopsonistic position for $s/\rho \geq 4/3$. A decreasing transportation rate t and a decreasing distance d (e.g. due to a higher number of competitors), puts the IOF into the situation of spatial competition ($s/\rho < 4/3$). As depicted in Figure 2, we can confirm a CYE for any $s/\rho < 2$ since the derived UD prices in the mixed market are higher than in the pure IOF market under Löschian competition (u_I^L) and under price-matching (u_I^{PM}). The CYE is strongest if the IOF does not have any information about the pricing schedule of the coop and takes the UD price in the mixed market as given (u^{sim}) and if the coop replaces an IOF under Löschian competition. In this case, the coop is able to break collusion between IOFs. No CYE can be confirmed for any $s/\rho \geq 2$. In such a situation, IOFs in the pure IOF market are spatially separated monopsonists. However, in the mixed market, the coop's UD price is lower than the (monopsonistic) UD price of the IOF. Consequently, a relatively high transportation rate, a high concentration rate in the processing sector (and thus relatively large distances between processors) as well as market power of food retailers towards processors (and thus a lower net selling price ρ) can reduce the CYE.

4 Empirical model

In our empirical model we are testing two things: first, whether in general spatial competition exists. Therefore, we test if neighbouring milk processors have an influence on dairies' price setting behaviour. Second, whether the CYE exists. Therefore, we test if having a coop as neighbour increases the price set by an IOF. Let p be a vector of cross-section prices and X a matrix of explanatory variables with characteristics of the milk processor. Let a represent a processor-specific intercept which can be explained by a spatially dependent error term, $a = (I_N - \lambda W)^{-1} \varepsilon$ where I_N is the identity matrix of dimension N , λ the spatial lag coefficient, W the spatial weight matrix and ε a normally distributed error term. This leads to a spatial error model (LeSage and Pace, 2009)

$$(19) \quad p = X\beta + (I_N - \lambda W)^{-1} \varepsilon.$$

If the heterogeneity in prices depends not just on the prices of the neighbours, but also on the neighbour's X (e.g. whether it is a coop), the error term can be expressed as $a = (I_N - \lambda W)^{-1} X\gamma + (I_N - \lambda W)^{-1} \varepsilon$. This leads to a spatial Durbin model (LeSage and Pace, 2009)

$$(20) \quad p = \lambda Wp + X(\beta + \gamma) + WX(-\lambda\beta) + \varepsilon.$$

To extend this model from cross-section to panel data, let each variable represent T times N observations and replace W by $(I_T \otimes W_N)$. For a random effects model let the error term be

$\varepsilon = (i_T \otimes I_N)\mu + u$ where i_T is a $T \times 1$ vector of ones and μ are time-invariant (not spatially autocorrelated) individual specific effects (Millo and Piras, 2012).

Our data set consists of a balanced panel of monthly average raw milk prices paid by 89 dairies in Southern Germany (Bavaria and neighbouring States) to farmers between 1999 and 2002 compiled by ZMP (Zentrale Markt- und Preisberichtsstelle für Erzeugnisse der Land-, Forst- und Ernährungswirtschaft). In addition to price information, this data include information on the legal form of the dairies (coops and IOFs), location and quantities processed. Table 1 shows that the average prices vary between 30.49 cent/kg for IOFs in 1999 and 35.23 cent/kg for coops in 2001. The average prices paid by coops are between 0.08 and 0.40 cent higher than the price paid by IOFs. The standard deviations of the prices for coops and IOFs are comparable. The average monthly quantity collected is around 11,500 t/month, with coops being on average smaller and having a higher standard deviation than IOFs.

Using the nearest neighbour to construct a spatial weight matrix W , we estimate model (19) and (20) with the R package “splm”, version 1.4-6 (Millo and Piras, 2012). Results in Table 2 show for both models significantly lower prices from March to September than in January and significantly higher prices in the years 2000 to 2002 compared to 1999. We find a significant spatial error term in the spatial error model and a significant spatial lag in the Durbin model.

In both models, there is no significant difference between the price paid by IOFs and coops. Quantity, however, has a significant influence on the price: the higher the quantity processed, the lower the price. This may be explained in two ways. First, small dairies often specialise in specific high value products (e.g. traditional cheese), generate a higher value added and are able to pay higher prices to farmers. Second, smaller dairies face more severe spatial competition from larger neighbouring dairies that need more space to collect the necessary amount of milk. Jointly, the dummy for coops, the quantity and the crossed terms are significant in both models. In the spatial Durbin model, also the neighbour’s dummy for coops, quantity and the crossed terms are jointly significant (see F-tests in Table 2).

Taking into account spatial interactions in the Durbin model (see LeSage and Pace, 2009, for details), the *average total impact* of the quantity processed is -0.18 . The average total impact of the crossed term is 0.84 . Thus, if a coop increased processing by 10.000 kg/month the average price increase would be, ceteris paribus, $0.84 - 0.18 = 0.66$ cent/kg. If the increase by 10.000 kg/month is at cost of a decrease by an IOF, the total price increase is $0.66 + 0.18 = 0.84$ cent/kg. Finally, the average total impact of coops is -0.20 (i.e. the average price decreases by 0.2 cent/kg for an IOF becoming a coop). Taken together, these results indicate that coops need a certain size to have a positive effect on prices.

5 Conclusions and implications

We develop a theoretical model of spatial competition between an IOF and a coop in a mixed market under the assumption of UD pricing. While the IOF maximises profits, we model the coop’s objective as maximising TMW, i.e. profits from farming and processing, and NARP-pricing, respectively. The coop is assumed to have an open-membership policy. We assume the IOF either to have some information about the coop’s pricing schedule or not. In the first case, the IOF can use this information in a “sequential moves game” and derive its optimal market area. In the second case (“simultaneous moves game”), the IOF takes the UD price as given (similarly to the Hotelling-Smithies conjecture).

Our theoretical findings can be summarised as follows: i) the price farmers receive depends on the distance between the IOF and the coop; ii) we can confirm the so-called “competitive yardstick effect”, i.e. the presence of a coop does not only benefit its members, but also impels an IOF to

increase prices for agricultural inputs, thereby mitigating its oligopsony power; iii) the outcome in the mixed market depends on the behaviour of the IOF: the highest price that farmers receive in the mixed market is achieved when the IOF has no information about the coop's pricing schedule and its behaviour is similar to the Hotelling-Smithies conjecture. Empirical results confirm the influence of the price of neighbours on the own price. We also find that the presence of coops increases the average price. Though, this effect occurs only for processors of a certain size.

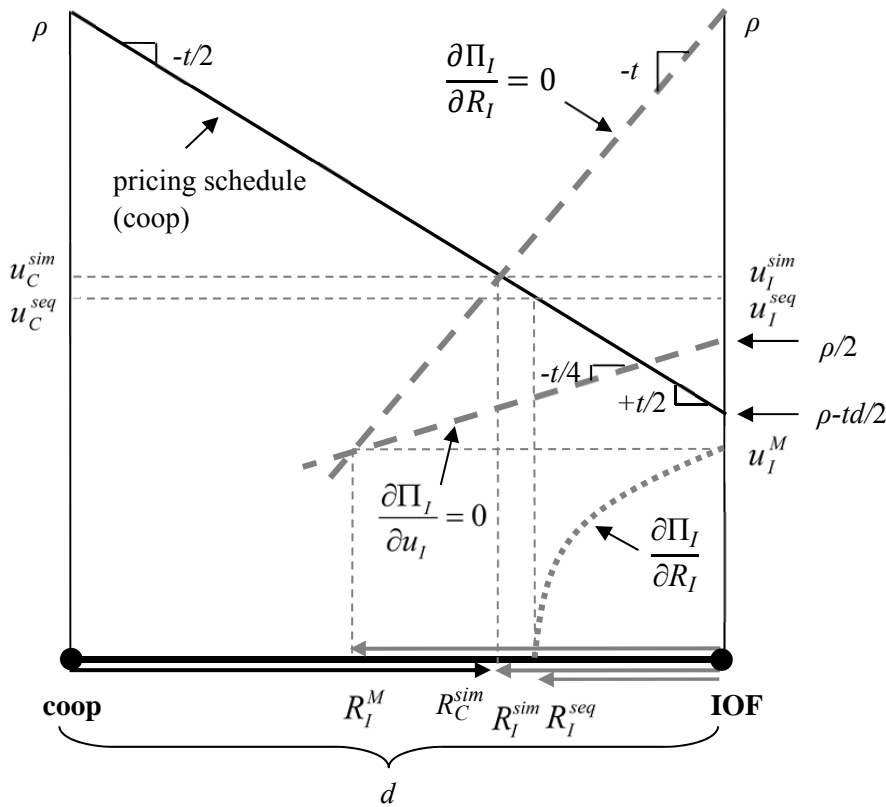
Our results are interesting in at least two dimensions: first, the “yardstick of competition” hypothesis is one argument that is used to justify favourable public policies towards coops. Empirically, if coops constitute a competitive yardstick, we can expect less oligopsonistic power towards farmers in a mixed market. The possible procompetitive effect of coops, however, has not sufficiently been investigated in the empirical literature so far (for a recent related work see Viergutz et al., 2016, and for an empirically more sophisticated approach in a non-agricultural context see Elhorst and Fréret, 2009). Second, our theoretical results indicate that a high transparency of prices paid by processors need not necessarily benefit farmers. This contributes to an ongoing discussion between the German antitrust divisions (Bundeskartellamt, 2012), which decided to prohibit publication of highly disaggregated and up-to-date price information, and the farm lobby, which is in favour of transparent prices.

6 References

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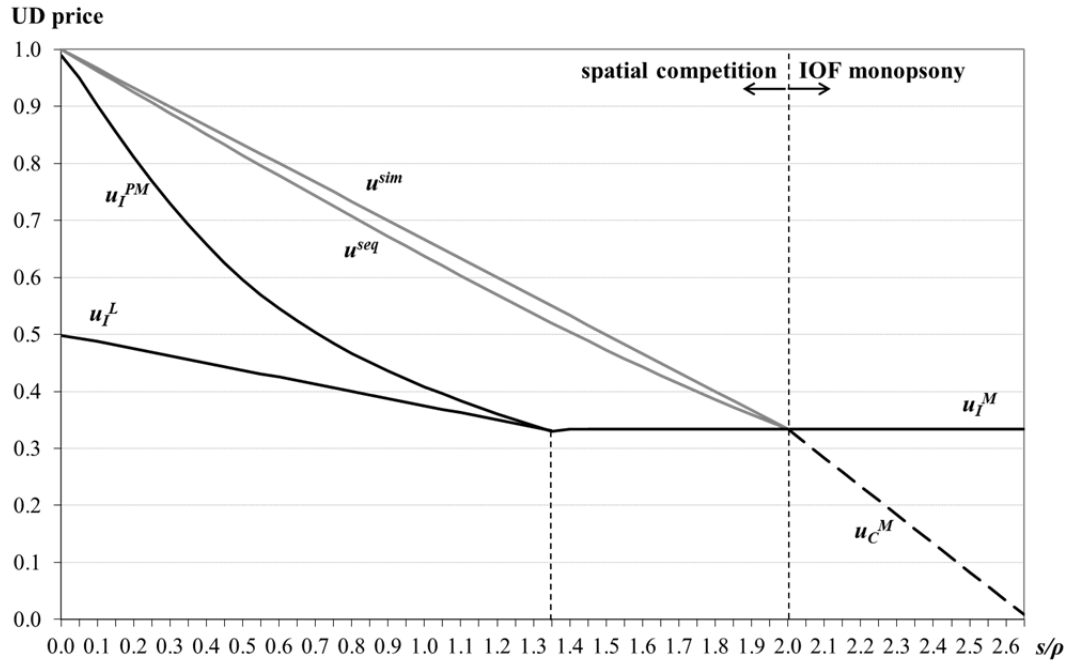
Figure 1. Mixed market



Notes: In this figure, the market area of the coop is given by the difference between distance d and the respective market area of the IOF (exemplified by R_C^{sim}).

Source: own illustration

Figure 2. Comparison of UD prices and competitive yardstick effect



Notes: In this figure, s/p is increasing due to increases in per-unit transportation costs t . Both, the net selling price ρ and the distance d between processors are normalised to 1.

Source: own illustration

	IOFs (N=53)				Coops (N=36)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
<u>Price (Euro cent/kg)</u>								
1999	30.49	1.04	28.29	35.28	30.57	1.06	27.82	34.65
2000	31.95	1.39	28.40	36.46	32.35	1.20	29.33	35.73
2001	34.90	1.46	30.71	40.03	35.23	1.38	31.32	39.22
2002	32.07	1.81	28.50	38.99	32.20	1.59	28.49	36.10
<u>Quantity (t/month)</u>								
1999	11,828	13,402	123	72,744	10,145	8,370	991	34,114
2000	12,333	14,483	132	81,913	10,638	9,014	963	33,610
2001	12,876	15,807	127	101,546	9,616	8,071	808	28,406
2002	12,830	16,404	85	107,435	10,019	8,877	865	37,936

Table 1: Descriptive statistics of balanced data. SD=Standard Deviation

Dependent variable: monthly mean price/kg	Spatial Error Model			Spatial Durbin Model		
	Estimate	St.Err		Estimate	St.Err	
Intercept	31.01	0.15	***	15.29	0.14	***
February (reference category = January)	-0.17	0.12		-0.08	0.06	
March (reference category = January)	-0.30	0.12	*	-0.15	0.06	*
April (reference category = January)	-0.76	0.12	***	-0.38	0.06	***
May (reference category = January)	-0.92	0.12	***	-0.47	0.06	***
June (reference category = January)	-1.01	0.12	***	-0.51	0.06	***
July (reference category = January)	-0.94	0.12	***	-0.47	0.06	***
August (reference category = January)	-0.77	0.12	***	-0.38	0.06	***
September (reference category = January)	-0.49	0.12	***	-0.24	0.06	***
October (reference category = January)	-0.10	0.12		-0.05	0.06	
November (reference category = January)	0.02	0.12		0.02	0.06	
December (reference category = January)	0.04	0.12		0.02	0.06	
year 2000 (reference category =1999)	1.67	0.07	***	0.83	0.03	***
year 2001 (reference category =1999)	4.53	0.07	***	2.25	0.03	***
year 2002 (reference category =1999)	1.67	0.07	***	0.83	0.03	***
Coop (reference category = IOF) ⁺	0.21	0.18		0.11	0.18	
Quantity ⁺	-0.14	0.04	***	-0.11	0.05	*
Coop x quantity ⁺	-0.02	0.08		0.01	0.08	
Nearest neighbour is coop ⁺⁺				-0.21	0.20	
Quantity of nearest neighbour ⁺⁺				0.02	0.04	
Nearest neighbour is coop x quantity ⁺⁺				0.41	0.12	**
Spatial error	0.51	0.01	***			
Spatial lag				0.51	0.01	***
Joint significance variables with ^{“+”}		F _{4257,3} =19.30	***		F _{4254,3} = 08.06	*
Joint significance variables with ^{“++”}					F _{4254,3} = 13.58	***

Observations: 89 milk processors in four years

Notes: Significance: * 5% level, ** 1% level, *** 0.1% level. Quantity measured in 10,000 tons.

Table 2: Spatial error and spatial Durbin model with one nearest neighbour spatial weight matrix.