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Abstract

This paper analyses differences in the pricing behaviour between cooperatives and investor-owned dairies for raw milk in a spatial market setting. We systemize the theoretical literature concerning the relations between price and space in oligopsonistic markets. This provides the foundation for empirically analysing the price-space relationship in the German raw milk market. Space represents the distance to competing dairies and transportation cost. We differentiate between cooperatives and investor-owned dairies in North and South Germany. Specifically, the impact of a dairy's own legal form and that of neighbouring competitors on the pricing behaviour is assessed. For the South of Germany, a negative relationship between space and raw milk price is found while for the North the relationship is positive. In both North and South the effect is stronger for cooperatives compared to investor-owned firms. Overall, our findings do not necessarily suggest an increase in market power and a decrease in raw milk prices when the concentration process of the dairy sector is progressing. Further, this paper provides the first spatial analysis of the competitive yardstick effect, for which we find weak evidence in the South. For the north, the theory of the competitive yardstick effect cannot be supported empirically. The estimation is based on a panel-data set covering all German dairies from 2001 to 2012 providing information on raw milk prices, processing quantities, legal and production form.

Keywords: imperfect competition, spatial competition, competitive yardstick
JEL classification: D43, R32, C51

1 Introduction[1]

Raw milk markets are typically spatially limited due to the high perishableness of the commodity. Therefore, dairy processors compete for raw milk in a certain market area. Understanding the effects of a spatial market setting on raw milk prices is getting more important as the ongoing concentration process among processors may increase their local monopsony power.

The literature provides several theoretical studies deriving positive, negative and inverted U-shaped relations between price and space[2]. In the analysis of mixed markets, the competitive yardstick effect is also evaluated suggesting a procompetitive effect of neighbouring COOPs on IOFs' pricing (Cotterill, 1987; Sexton, 1990; Rogers and Sexton, 1994; Alvarez et al., 2000; Zhang and Sexton, 2001; Fousekis, 2011a and b; Tribl, 2012). However, only few studies conduct an empirical analysis on spatial pricing behaviour. The pioneer in this field is the empirical analysis of Alvarez et al. (2000) which focuses on the relation between price and space on the milk market in the Asturias region. Following this study, Huck et al. (2006), Graubner et al. (2011)[3] and Koller (2012) focus on the German milk market. Alvarez et al. (2000) theoretically derive an inverted U-shaped relationship between price and space[4], which they could verify in their empirical estimation with data on investor-owned firms (IOFs). Based on Alvarez et al.'s (2000) framework, Huck et al. (2000) focus on the analysis of a cooperative (COOP) market only. They theoretically derive an inverted U-shape relationship

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[2] Usually defined as distance to competing firms multiplied by transportation costs.

[3] Graubner et al. (2011) use a vector error correction model and find low price transmission. This methodology is however not relevant for our study.

[4] Also defined as the distance to neighboring dairies multiplied by unit transportation costs.

between price and space that lies above the one of IOFs, implying a higher raw milk price of COOPs. The empirical results for a region in Northern Germany support the shape of the curve but they do not empirically analyse the price spread between COOPs and IOFs. Koller (2012), also building upon Alvarez et al. (2000), empirically shows an inverted U-shaped relationship between price and space for Germany. However, as they use a panel model with fixed effects, they cannot differentiate between effects of legal forms of dairies. The competitive yardstick effect has been evaluated mostly theoretically (Cotterill, 1987; Sexton, 1990; Fousekis, 2011a; Tribl, 2012). Empirically, Hanisch et al. (2013) find evidence for Germany in a national-level analysis of the European dairy market.

Besides (i) providing a literature review categorizing the existing findings on relations between price and space, this paper, in contrast to former empirical studies on spatial pricing, (ii) differentiates between the effects of space on COOPs and IOFs in the North and the South of Germany while incorporating effects of neighbouring dairies' characteristics on raw milk pricing in a spatial regression analysis. Additionally, (iii) the competitive yardstick is analysed on firm-level in this spatial setting.

To investigate to what extent dairies can exercise monopsony power, we explore the relationship between price and space, defined as the average distance to neighbouring dairies multiplied by unit transportation costs. We employ a spatial regression approach to analyse if and how raw milk prices are influenced by space and by neighbouring dairies' characteristics, such as legal and production form. The results allow comparing the shape of the relationship between price and space to the theoretically derived relationships in the literature. In this spatial context, we analyse the competitive yardstick effect. Therefore, and to incorporate the different objectives of COOPs and IOFs, we differentiate between the pricing behaviour of these two legal forms in our empirical analysis. Additionally, we distinguish between North and South Germany to account for different market structures. The estimation is based on a data set covering all German dairies from 2001 to 2012 providing information on dairies’ location, raw milk prices, processing quantities, legal and production form.

2 Relevant literature on spatial pricing

To asses to what extent monopsony power can be exercised in a spatial market, the investigation of the relation between price and space is essential. In order to systemize the relevant literature, table 1 summarizes the identified relationships between price and space and the main underlying assumptions. The price-space relationship may have an inverted U-shape, a monotone negative or a monotone positive relationship. The relationship depends on the type of market actors (mixed or pure IOF or COOP markets), pricing (uniform delivered pricing (UD) where the dairy pays the shipping or free on board shipping (FOB) where the farmer pays the shipping), competition (Hotelling-Smithies (H-S) or Löschian Competition) and COOPs objective function and membership policy (net average revenue product pricing (NARP) or total member welfare maximization (TMW), open membership (OM) or restricted membership (RM)).

Table 1 also reports whether the competitive yardstick was confirmed. This theory states that COOPs have a procompetitive effect in a mixed market. It builds on the assumption that COOPs, which are owned by farmers and do not have to deal with shareholders, will not accept prices below average cost. This pricing will serve as a yardstick for other market actors and thus influence the prices of competing IOFs, which leads to market prices equal to average costs in the long run (Cotterill, 1987). Hanisch et al. (2012) validate the competitive yardstick effect in a country level analysis of the European dairy industry. They find that the higher the market share of COOPs, the higher the milk farm price. In a theoretical framework of spatial competition, the competitive yardstick could also be confirmed (Sexton, 1990; Tribl, 2012; Fousekis, 2011a).

Table 1: Summary of relevant literature

Author Year	Market actors	Pricing/ conjecture	theory: relation price - space	Empirical estimation	CYE	comment
Sexton (1990)	IOF & COOP[a,b,c]	FOB H-S, Lösch, Cournot	bounded line market no explicit relation derived	/	confirmed	focus on farm-retail price spread depending on the different assumptions on competition, market actors and NARP function
Rogers & Sexton (1994)	IOF & COOP	FOB H-S, Lösch, Cournot	bounded line market positive relation: Lösch, IOF negative relation: H-S, Cournot, IOF negative relation: Lösch, H-S, mixed market	/	confirmed	focus on farm-retail price spread, space measured as transport cost
Alvarez et al. (2000)	IOF	UD Lösch	unbounded line market inverted U-shape	confirms theory	/	
Zhang & Sexton (2001)	IOF	FOB, UD H-S	bounded line market negative relation	/	/	focus on strategic choice of FOB or UD
Fousekis (2011a)	IOF & COOP[a,c]	UD, FOB H-S	bounded line market negative relation	/	partially confirmed	CYE depends on pricing
Fousekis (2011b)	COOP	UD , FOB H-S	bounded line market negative relation	/	/	
Huck et al. (2012)	COOP[a,d]	UD Lösch	unbounded line market inverted U-shape	confirms theory	/	assumptions as Alvarez et al. (2000), inverted U-shape for COOPs, lying above IOF
Koller (2012)	IOF & COOP	UD Lösch	unbounded line market inverted U-shape	confirms theory	/	review of Alvarez et al. (2000), no theoretical analysis of spatial pricing in a mixed market, no differentiation between legal forms due to fixed effects
Tribl (2012)	IOF & COOP[a,c]	UD Lösch	bounded line market negative relation of price and space for all scenarios	/	confirmed	analysis of simultaneous and sequential games under different assumptions on COOPs choice of market radius

[a]*open membership*, [b]*restricted membership*, [c]*NARP*, [d]*TMW*

Table 1 shows that only few studies prove their theoretical findings empirically. These studies are conducted on the milk market in Spain by Alvarez et al. (2000), in Germany by Koller (2012) and in the German federal state Schleswig Holstein by Huck et al. (2012). All three studies are based on the theoretical framework of Alvarez et al. (2000) who derive a U-shaped relationship of price and space based on the assumptions of an IOF market and an unbounded line market, which allows for competition in the backyard. In this setting, when space is relatively unimportant (i.e. firms are located close to each other or transportation cost are low), the market areas of rival firms may extend beyond the other firms' location leading to increasing prices in space. According to Alvarez et al. (2000), this follows from UD pricing and Löschian competition leading to a price matching behaviour of dairies. Under UD pricing, dairies are responsible for the shipping costs such that they are willing to increase market area until profits are zero for the most distant farm. Consequently, if a dairy raises its price, it will reduce its market area losing some farmers at the boundary. Due to price-matching behaviour, the dairy expects its rival to increase its price as well. Hence, the market area of the rival is also decreasing and the dairy can capture the farmers in the own backyard abandoned by the rival. Those are more profitable compared to the ones it loses at its market boundary, leading to higher profits under UD pricing. If space gets more important (due to higher transportation costs or a higher distance to neighbouring dairies), competition takes place only between the firms locations and implies a negative relation between price and space in line with the theory of a bounded line market applied in other studies (see Sexton, 1990; Zhang and Sexton, 2001; Tribl, 2012; Fousekis, 2011a and 2011b). The negative relation between price and space is explained by the inverse relationship between transportation costs and market area between firms, which may result in separated monopsonistic markets. In the empirical studies of Alvarez et al. (2000), Huck et al. (2012) and Koller (2012), the inverted U-shape is shown for an IOF market, a COOP market and a mixed market, respectively. Even though Koller (2012) did an empirical analysis for Germany there is no differentiation between legal forms as a panel model with fixed effects is used.

The inverted U-shape mainly stems from the assumption of the unbounded line market. Studies that assume a bounded line market mainly derive a negative relationship, independent of assumptions on market actors, pricing and conjecture (Zhang and Sexton, 2001; Fousekis, 2011a & 2011b; Tribl, 2012). However, Rogers and Sexton (1994) find a positive relation between price and space (defined as transportation costs) for an IOF market under FOB pricing and Löschian competition. The reasoning is that firms' market radius does not overlap under FOB pricing. In combination with Löschian competition firms try to keep their market areas and match price changes of their competitors. Hence, the relation between price and transportation costs is positive as firms increase prices with market area to cover farmers' transportation costs. In Rogers and Sexton's (1994) analysis, this positive relation is only valid for the competition of IOFs. In a mixed market, they only consider the case of a COOP facing an upward sloping NARP curve. In this scenario, the relation between price and space gets negative. This negative relation can be explained as follows. If the IOF gains a larger market area due to a price increase, the COOPs sales are decreasing, which leads to an increase in average fixed costs. Hence, the price the COOP can pay to its members decreases. This leads to separate markets of the COOP and the IOF, hence lower competition and a negative relation between price and space. Furthermore, Rogers and Sexton (1994) analyse IOF markets with FOB pricing and Hotelling or Cournot behaviour and a mixed market with Hotelling behaviour which all result in a negative relation between price and space.

3 Data and Empirical Model

We use a panel data set containing yearly information on the German milk market for the time span 2001-2012. The data provides information on dairies' type of production, processing quantity, legal form and raw milk prices and was gathered by the AMI[5]. The raw milk prices are for milk of grade one with 4.2% fat and 3.4% protein including additional payments, such as boni for large delivered quantities or loyalty, net of costs like quality assessment or storage costs allowing for comparability of the raw milk prices. Additionally, we compose a performance index (*perf*) by using the awards for the best dairy products from the German magazine *Milch Marketing* (Milch Marketing (years 2001-2012)). The index calculates as the sum of award points over the observed period and used as a proxy for the output performance. Data on transportation costs (*t*) are sourced from the Association of the German Petroleum Industry[6].

Following Alvarez et al. (2000), Huck et al. (2012) and Koller (2012), we define neighbours as the nearest dairies that together produce at least as much as the considered dairy[7]. Our analysis is restricted to conventional dairies; however, for the neighbouring definition, also organic dairies are included. The reasoning is that organic milk prices might influence conventional prices as farmers in the long run could switch to organic production when the price spread gets too high. As in Alvarez et al. (2000), we use the neighbouring definitions in order to calculate the average distance of a dairy to its neighbours (*nDist*) and the importance of space as

[5]Agrarmarktinformationsstelle, a German institution that collects data of agricultural entities

[6]Data is published at www.mwv.de.

[7]Due to the identification of the location with postal codes we observe a zero distance to neighbours for some dairies. However, this does not mean that they have zero number of neighbours which is not possible according to our neighbourhood definition.

product of average distance to neighbours and transportation cost, $s = t \cdot nDist$[8]. Further, we use the neighbouring definition to setup a spatial weighting matrix W_t of size $(N_t \times N_t)$ with N_t being the number of dairies in year *t*. The elements of W_t are defined as $w_{ijt} = 1$ if farm i and j are neighbours and $w_{ijt} = 0$ otherwise (also $w_{ijt} = 0$ if $i = j$). The spatial weighting matrix is row standardized and used to calculate the neighbouring share of COOPs (*wCoop*) and organic dairies (*wOrganic*) as well as the number of neighbours (*numNeig*).

In 2012, 41 % of the German milk processors were organized as COOPs, processing 59 % of total milk supplied to dairies, the remaining are privately owned. As we focus on the differences between IOFs and COOPs while differentiating between North and South, table 2 summarizes the key facts for the year 2012.

Taking a closer look at the market structures in the North and South[9] reveals that the market in the North is characterized by few large dairies opposed to the South with a high density of small dairies. From 2001 to 2012, the number of conventional dairy plants in the North changed from 111 to 58, a decrease of 48%, whereas the structural change in the South was not as strong with the number of plants decreasing by 26% from 70 to 52. This change was not accompanied by a decrease in the total amount of milk processed but instead by a massive increase of average processing quantity by 104% in the North and 30% in the South. This results in a 89% higher average processing quantity in the North compared to the

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[8]Transportation cost are measured as the yearly average price per litre diesel fuel. This is in line with ALVAREZ et al. (2000). HUCK et al. (2012) and KOLLER (2012). This definition implicitly assumes constant fuel consumption per kilometre over the sample period. To deviate from this assumption is not possible, however, as we have no information about changes in fuel efficiency over time.

[9] The South comprises the federal states Bavaria and Baden-Wuertemberg, the North the remaining federal states.

South. The differences in dairies' sizes and concentration of plants are also reflected in the market areas that we calculated. The average distance to neighbours is 33.92 km with a maximum distance of 91.28 km in the North compared to an average distance of 20.18 km with a maximum distance of 41.68 km in the South. Differences between North and South can also be observed in the prices that are lower in the North. Differences in COOP's and IOF's pricing cannot be seen clearly from table 2, this issue will be further analysed in a multivariate regression in to following. Overall, a comparison of the descriptive statistics indicate substantial differences in the competitive conditions in the North and South leading to fundamental difference in the market structure and diverse developments over time.

In our empirical analysis we estimate a spatially lagged explanatory variable model (SLX)[10] of the general form $y = X\beta + WX\theta + \varepsilon$ with y being a vector of the dependent variable, X a matrix of explanatory variables, W a row standardized spatial weighting matrix, β and θ coefficients to be estimated and $\varepsilon \sim N(0, \sigma^2 I)$ with I being an identity matrix. As a first step, we estimated a model including cross terms of all variables with the South dummy variable (*SouthDum*). In effect this results in two different regressions for North and South. In a next step, we apply a model selection approach based on the Akaike information criterion (AIC). Specifically, we split our explanatory variables in two sets, where the first includes

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[10] The SLX model is an alternative to the more commonly use spatial lagged dependent variable model (SAR). In principle we could also use the SAR model in order to assess the effect on neighboring prices on own prices. However, GIBBONS and OVERMAN (2012) argue in a paper provocatively entitled "Mostly Pointless Spatial Econometrics?" that the SAR model suffers from an identification problem that is not appropriately addressed in the applied literature. Instead they proposed the SLX model as one appropriate alternative.

all variables related to *s* while the second includes all remaining variables[11]. Then, model specifications are estimated that can be formed from all possible combinations of the variables in the first set. The variables from the second set are always included. We then select the model specification with the lowest AIC. Following, a Wald test is used to test if all remaining insignificant variables from the second set can be jointly excluded. This selection process results in the following specification[12] estimated with OLS,

$$\begin{aligned} price_{it} &= const + \alpha_1 s_{it} \times COOP_i + \alpha_2 s_{it}^2 \times COOP_i \\ &+\alpha_3 s_{it} \times COOP_i \times southDum_i + \alpha_4 COOP_i \\ &+\alpha_5 COOP_i \times southDum_i + \alpha_6 quant_{it} \times COOP_i \\ &+\alpha_7 wOrganic_{it} + \alpha_8 wCOOP_i + \alpha_9 wCOOP_i \times southDum_i \\ &+\alpha_{10} perf_{it} + \alpha_{11} perf_{it} \times southDum_i + \alpha_{12} numNeig_{it} \\ &+\alpha_{13} numNeig_{it} \times southDum_i \\ &+\sum_{j=1}^{12} \phi_j year_{itj} + \sum_{j=1}^{12} \delta_j year_{itj} \times southDum_i + \varepsilon_{it}, \end{aligned} \quad (1)$$

where $southDum_i$ and $COOP_i$ are dummy variables equal to one when a dairy *i* in year *t* is located in the South and a COOP respectively. Interaction terms between $south_i$ and $coop_{it}$ are used to find significant differences between North and South and between the legal forms respectively. The spatial lagged explanatory variables are $wCoop_{it} = \sum_{j=1}^{N} w_{ijt} Coop_{jt}$ and $wOrganic_{it} = \sum_{j=1}^{N} w_{ijt} Organic_{jt}$ with w_{ijt} being elements of W_t.

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[11] Specifically, the variables related to *s* include s, s^2, $s \times southDum$, $s^2 \times southDum$, $s \times COOP$, $s \times COOP \times southDum$, $s^2 \times COOP$, $s^2 \times COOP \times southDum$

Table 2: The milk market in 2012 – key facts

		IOF		COOP	
		North	**South**	**North**	**South**
Number of processing facilities	total	37	45	29	29
	conv.	31	32	27	20
	org.	6	13	2	9
Conventional raw milk price *in ct/kg*	mean	30.92	32.19	30.59	32.12
	min	22.32	24.15	21.84	24.08
	max	37.19	38.65	37.68	40.85
Organic raw milk price *in ct/kg*	mean	38.31	39.72	39.26	39.21
	min	32.13	33.19	33.75	32.70
	max	49.61	50.34	47.16	51.57
Conv. raw milk production *in tons*	sum	5.6 Mio	5.2 Mio	12,4 Mio	3.3 Mio
	mean	183,848	165,476	460,873	166,057
Org. raw milk production *in tons*	sum	173,994	241,179	18,004	188934
	mean	28,999	18,552	9,002	20993
perf	sum	75	648	82	46
	mean	5.32	20.25	3.04	2.3
*nDist**	mean	38.50	20.94	37.06	24.25
	min	0	0	0	2.64
	max	91.28	68.05	116.19	39.75
*numNeig**	Mean	2.42	2.44	3.15	2.4
	min (freq.)	1 (14)	1 (10)	1 (9)	1 (5)
	max	11	12	16	6

Source: own calculation based on AMI (2014) data.

4 Results

The regression results are presented separately for North and South in table 3. The columns for South are constructed from the regression results by adding the estimated coefficients of the cross term between the south dummy and the respective variable to the estimated coefficients of the main effect of the variable. The p-value corresponds to the p-value from a Wald test, testing if the sum of the coefficient from the main effect and the coefficient from the cross term is significantly different from zero. In cases where the cross term with the south dummy is dropped during the model specification the results for South and North are the same.

Table 3: Regression results

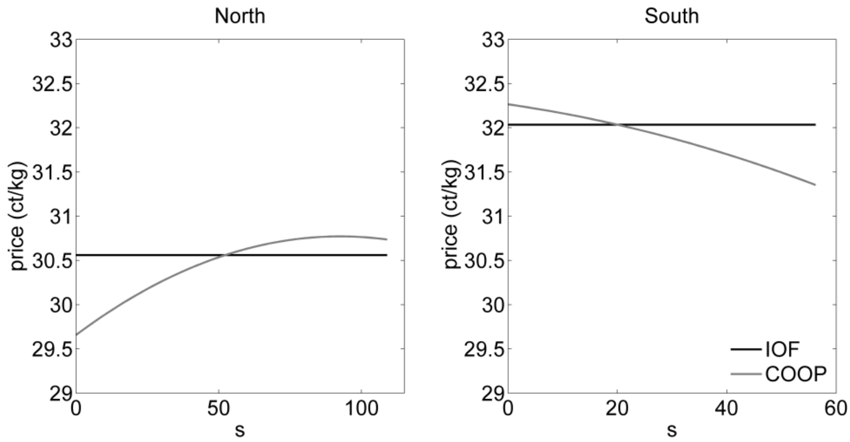
	North		South[a]	
	Coefficient	**P-value**	**Coefficient**	**P-value**
const	24.90	0.00	26.81	0.00
COOP	-1.03	0.00	0.15	0.21
wCOOP	-0.25	0.00	0.25	0.00
wOrganic	0.71	0.00	0.71	0.00
perf	0.02	0.00	0.00	0.01
numNeig	-0.10	0.00	-0.03	0.23
$s \times COOP$	0.02	0.00	-0.01	0.05
$s^2 \times COOP$	-0.00	0.02	-0.00	0.00
$quant \times COOP$	0.00	0.01	0.00	0.00
$yearDum2001$	14.29	0.00	13.24	0.00
$yearDum2002$	10.05	0.00	9.40	0.00
$yearDum2003$	8.39	0.00	7.25	0.00
$yearDum2004$	7.37	0.00	5.97	0.00
$yearDum2005$	6.14	0.00	5.28	0.00
$yearDum2006$	5.43	0.00	4.41	0.00
$yearDum2007$	11.59	0.00	9.80	0.00
$yearDum2008$	9.51	0.00	10.32	0.00
$yearDum2010$	6.28	0.00	4.85	0.00
$yearDum2011$	9.58	0.00	8.07	0.00
$yearDum2012$	5.92	0.00	5.05	0.00

$R^2 = 0.93$; R^2-adj. = 0.92, $\sigma^2 = 0.99$; N = 1761

[a] *In cases where a cross term is included in the model, the reported coefficient is equal to the sum of the coefficient of the main effect and the coefficient of the cross term. The p-value is then the p-value from a Wald test, testing if the sum of the coefficients from main effect and cross term is significantly different from zero.*

The estimated effect of space on price is plotted in figure 1 differentiating between North/South and IOF/COOP. Changes in *s* can result either from a change in transportation costs, from a change in density of neighbours, or simply from a change in production quantity. For the interpretation of the relationships, however, it is important to keep in mind that we control for production quantity in our regression[13]. The figure thus shows the relationship between price and space while keeping production quantity (and all other variables) constant.

Figure 1: Relation between price and space of COOPs and IOFs in the North and the South



Note: for 2012. All other variables are at means.

Figure 1 reveals opposite effects between price and space for North and South. However, the effects of a positive relation in the North and a negative relation in the South are only significant for COOPs. In contrast to Alvarez et al. (2000), Huck et al. (2012) and Koller (2012), we did not find a full inverted-U-shaped function but rather the first increasing part for the North and the decreasing part of the function for the South.

The negative relation between price and space in the South is in line with the theory of competition between firms' locations (Sexton, 1990; Alvarez et al., 2000; Zhang and Sexton, 2001; Tribl, 2012; Fousekis, 2011a and 2011b). In Germany, the dairy pays for the transportation costs and farmers receive the same price

[13] In the presented results the $quant \times COOP$ is included. However, the variable $quant$ was considered in the model selection process. Excluding the $quant$ variable has almost no effect on the estimated coefficients related to s. The interpretation is therefore unchanged.

independent of their location (BKA, 2009), hence theoretical relations between price and space resulting under UD pricing are of interest. The theory finds that under UD pricing in combination with either Löschian or Hotelling-Smithies competition between firms location, prices are decreasing in space. Increasing space is equivalent to increasing transportation costs or increasing distance between firms' locations. Market areas are decreasing resulting in less competition between firms which can lead to separated markets that allow for monopsonistic pricing. This negative relationship between price and space is supported by our empirical findings for COOPs in the South.

The positive relation between price and space in the North could be explained with Alvarez et al.'s (2000) assumption of UD pricing, price matching behaviour and competition in the backyard (see section 2). The theory implies that when space is relatively unimportant, a firm increases its price and expects its rival to also increase its price (price matching behaviour). Higher prices lead to a reduction in the market area so that dairies gain farmers in their backyard. The assumption of competition in the backyard can be supported for the North as dairies maximum collection area is 170 km (BKA, 2009) which is larger than our derived maximum distance to neighbours equal to 116 km (with an average distance to neighbours of 37 km, see table 2). An alternative explanation for a positive relation between price and space is provided by Rogers and Sexton (1994) under the assumption of FOB pricing and Löschian competition, implying that dairies have to increase their prices so that farmers can cover the transportation cost. However, there is no evidence that FOB is practiced in the North.

It is remarkable that the relationship between price and space is stronger for COOPs than for IOFs[14]. The literature reviewed does not provide an obvious

[14] Despite the fact that there is a bit more variation in s for IOFs (std.=24.1) than for COOPs (std.=22.6).

explanation for this effect. However, a possible explanation is that under the open membership policy, which is currently practiced in Germany (BKA, 2009), COOPs cannot reject farmers that want to participate. Hence, the COOP must consider the available market as its market area and cannot choose the optimal market area as an IOF. Therefore, it is possible that COOPs tend to have a larger market area than IOFs (despite the same average distance to neighbours calculated here) and thus space has a stronger effect on COOPs.

We observe that prices are generally higher in the South. This could stem from the general difference in the market structure of dairy farms resulting in lower raw milk production costs in the North (EMB, 2013). Further, we find a positive relation between our performance variable and the South indicating that dairies in the South are producing more innovative and popular products that lead to higher output prices. In the North, large dairies might benefit from economies of scale. Further, the market structure can influence the price differences between North and South. As already observed, the market in the South is much more dense potentially intensifying competition between processors. Farmers have more selling alternatives, which might influence the price positively. The higher concentration of dairies in the North leads to only limited selling alternatives likely supporting market power of dairies and a generally lower price. Lower prices in the North hint at lower competition. However, this is a contradiction to the theory of competition in the backyard. If competition would be low, there is no incentive for a dairy to raise its price under UD pricing. Anyway, based on the results it is difficult to draw conclusion about the fierceness of competition which is also not the objective. Nevertheless, what we can conclude is that space has opposing effects on COOPs in the South and the North and no significant effects on IOFs.

Our regression results in table 3 show that COOPs pay a significant lower price than IOFs in the North (-1.03 ct/kg). In the South, COOPs pay a slightly higher price than IOFs (0.15ct/kg), however the effect is statistically not significant. These findings do not clearly support the general idea that COOPs pay higher prices as discussed in the competitive yardstick theory (Cotterill, 1987) and in Huck et al.'s

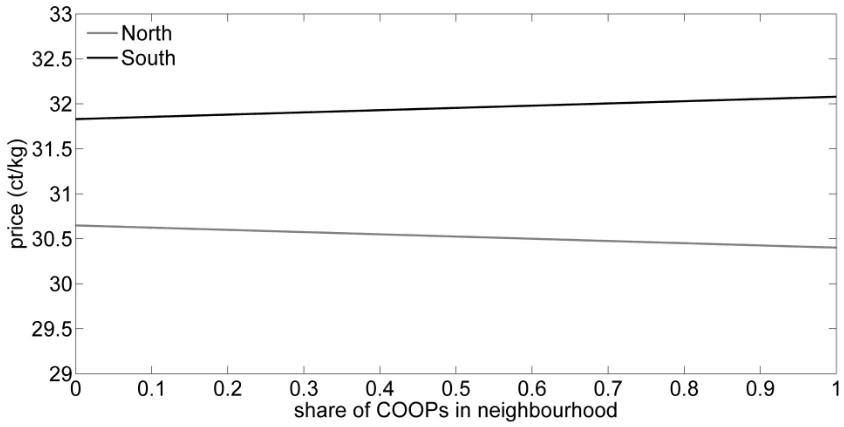
(2012) theoretical analysis. However, other authors such as Cook (1995) Schramm et al. (2005) and EMB (2012) point out that the general idea of a COOP to maximize the welfare of members is debatable. As all members receive the same price and a COOP must not differentiate between members there is a free-rider problem. Furthermore, the heterogeneous risk levels of the members influence investment decisions which in turn may negatively influence producer prices (Gerlach et al., 2006, BKA, 2009; Steffen et al., 2009). Hence, the lower price of COOPs may result from the fact that COOPs produce rather basic milk products like fresh milk and milk powder instead of innovative brand products (BKA, 2009; Steffen et al., 2009). We aim to control for such effects using our performance indicator (see section 3). This indicator is indeed on average higher for IOFs (see table 2) supporting the notion of IOFs being more innovative. We also find a positive effect of the performance index on the raw milk price. However, it might well be that the rather crude indicator does not fully capture product differences between COOPs and IOFS such that the COOP dummy still picks up some of these effects.

We checked the robustness of the model with respect to different neighbouring definitions. Specifically, we defined neighbours as all dairies that together produce at least a multiple of the own production quantity (e.g. all neighbours that together produce at least twice as much as the own quantity). Changes in the neighbouring definitions did not lead to a meaningful change of the results with respect to the main conclusions.

In order to analyse whether COOPs are beneficial for competition as suggested by the competitive yardstick effect, we use the neighbouring share of COOPs (*wCoop*) to test the hypothesis that a higher share has a positive effect on raw milk prices. This hypothesis is only supported in the South, where we find a significant positive influence of the share of COOPs in the neighbourhood on the price (see figure 2). For the North we find a significant negative effect. The negative effect for the North is consistent with the finding that COOPs in the North pay a significantly lower price as IOFs (-1.03 ct/kg). In both cases, however, the effect of the share of

COOPs in the neighbourhood are rather small from an economic perspective as prices change by only -0.25/+0,25 ct/kg from zero COOP share to full COOP share in the North and South, respectively. Cross terms of the neighbouring shares of COOPs with the legal form could not improve the model. Hence, we observe no significant differences of the effects of *wCOOP* on the legal form. Hanisch *et al.*'s (2013) national analysis finds support for the competitive yardstick theory in Germany. In contrast to their study, we conducted a firm level analysis. However, we find no clear empirical support for the competitive yardstick theory in Germany.

Figure 2: Relation between price and share of COOPs in neighbourhood



Note: Estimated relationship for the year 2012. All other variables are at means.

Furthermore, our regression results show a positive influence of a high share of organic dairies in the neighbourhood. To our knowledge, there is no study that analyses the effects of organic prices on conventional prices. We find this effect to be higher in the North than in the South.

5 Conclusion

Unlike other empirical studies on milk markets (Alvarez et al., 2000; Huck et al., 2012; Koller, 2012) we empirically estimate the relation between price and space in a mixed market, differentiating between different market structures. In contrast to these studies, we could not find a complete inverted U-shape of the relation between price and space. However, our empirical study reveals significantly different effects between price and space in the North and South of Germany that could result from the same effects as the inverted U-shape discussed in the literature. For the North, the relation between price and space is positive which can be explained by the effects of competition in the backyard. In the South, the relation between price and space is negative which is in line with the theory of competition on a bounded line market or an unbounded line market without competition in the backyard. Hence, both empirical findings can be interpreted in line with the theory. However, it is not clear why competition in the backyard should not exist in the South. Unfortunately, our results do not allow drawing conclusions in this respect.

Remarkably, significant effects of space on price are only found for COOPs. A possible explanation for this can be that due to the open membership policy, COOPs cannot discriminate between members preventing them from serving an optimal market radius as IOFs do. Hence, space is more important for COOPs.

Generally, we observe that prices are higher in the South which might result from the higher density of dairies fostering competition, a higher performance of dairies and higher production costs of farmers. In the North, large dairies may profit from economies of scales and lower production costs of farmers.

An interesting finding is that COOPs' prices in the North are significantly lower than IOFs' prices while in the South, COOPs' prices are not significantly higher than IOFs' prices. This does not confirm the general idea of COOPs that maximizes member welfare resulting in high prices for farmers. An explanation for the lower prices of COOPs in the North could be that the single farmer's voting right in large COOPs is very small. This may lead COOPs behaving more like shareholder maximizing IOFs. Additionally, COOPs are on average less innovative than IOFs, potentially explaining the lower COOP price in the North. These findings underline the fact that we do not find clear empirical evidence for the competitive yardstick effect. Even though an increase in the share of neighbouring

COOPs in the South increases prices, this effect is rather small from an economic perspective. For the North we found the exactly opposite effect, which is in line with our finding that the COOPs in the North pay significantly lower price than IOFs. In both cases however, even though the effects are significant, they are rather small from an economic perspective.

Overall, our findings suggest that a further concentration of the milk processing sector does not necessarily lead to an increase in market power and a decrease in prices. Our analysis, differentiating between legal forms, reveals that space is irrelevant for IOFs. Only for COOPs space matters for pricing behaviour with opposing effects for North and South.

6 References

Alvarez, A.M., Fidalgo, E.G., Sexton, R.J. and M. Zhang (2000): Oligopsony Power with Uniform Spatial Pricing: Theory and Application to Milk Processing in Spain. *European Review of Agricultural Economics*, 27(3): 347-364.

AMI (Agrarmarktinformationsstelle) (2014): Database on raw milk prices and processing quantities of German dairy processors for the year 2001-2012. Bonn, Germany.

FCO (Federal Cartel Office) (2009): Sektoruntersuchung Milch. Zwischenbericht 2009. Available at http://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Sektoruntersuchungen/Sektoruntersuchung%20Milch%20-%20Zwischen bericht.pdf?__blob=publicationFile&v=3, last accessed 16 Dezember 2015.

Cook, M.L. (1995): The Future of U.S. Agricultural Cooperatives: A Neo-Institutional Approach. *American Journal of Agricultural Economics*, 77 (5): 1153-1159.

Cotterill, R.W. (1987): Agricultural Cooperatives: A Unified Theory of Pricing, Finance and Investment. In: ROYER, J.S. (ed.): Cooperative Theory: New Approaches. Washington DC: U.S. Department of Agriculture, ASC Serv. Rep. No. 18, 171-258.

EMB (European Milk Board) (2013): What is the cost of producing milk? Calculation of the milk production costs in Germany for the years 2002 to 2012. Available at http://www.europeanmilkboard.org/fileadmin/Dokumente/Press_Release/EMB-allgemein/2013/study_milk_production_costs_EN.pdf, (accessed 29 September 2015).

Fousekis, P. (2011a): Free-on-board and Uniform Delivery Pricing Strategies in a Mixed Duopsony. *European Review of Agricultural Economics*, 38(1): 119-139.

Fousekis, P. (2011b): Spatial Price Competition Between Cooperatives Under Hotelling- Smithies Conjectures. *Agricultural Economics Review*, 12(2): 5-15.

Gerlach, S., Spiller, A. and C. Wocken (2006): Der Markt fur Milch und Milcherzeugnisse. *Agrarwirtschaft*, 55: 29-50.

Graubner, M., Koller, I., Salhofer, K. and A. Balmann (2011): Cooperative versus Non-cooperative Spatial Competition for Milk. *European Review of Agricultural Economics*, 38(1): 99-118.

Hanisch, M., Rommel, J. and M. Müller (2013): The Cooperative Yardstick Revisited: Panel Evidence from the European Dairy Sectors. *Journal of Agricultural & Food Industrial Organization*, 11(1): 151-162.

Huck, P., Salhofer, K. and C. Tribl (2006): Spatial Competition of Milk Processing Cooperatives in Northern Germany. Contributed paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Conference; August 12-18, Gold Coast, Australia.

Koller, I. (2012): An Empirical Analysis of Spatial Pricing and Competition in the Raw Milk Market in Germany. Doctoral thesis, Technical University of Munich, Germany.

Milch Marketing (years 2001-2012). Produkte des Jahres. B&L Mediengeselschaft mbh & CO. KG.

Rogers, R.T. and Sexton, R.J. (1994): Assessing the Importance of Oligopsony power in Agricultural Markets. *American Journal of Agricultural Economics* 76: 1143-1150.

Schramm, M., Spiller, S. and T. Staack (2005): Zur Brand Orientierung genossenschaftlicher Unternehmen der Ernährungsindustrie. Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie 14: 141-152.

Sexton, R.J. (1990): Imperfect Competition in Agricultural Markets and the Role of Cooperatives: A Spatial Analysis. *American Journal of Agricultural Economics*, 72(3): 709-720.

Steffen, N., Schlecht, S. and A. Spiller (2009): Ausgestaltung von Milchverträgen nachder Quote. Discussion Paper Nr. 0909, Department für Agrarökonomie und RuraleEntwicklung, Universität Göttingen.

Tribl, C. (2012): Spatial competition of food processors in pure and mixed markets under uniform delivered pricing. Doctoral thesis, Technical University of Munich, Germany.

Zhang, M. and R.J. Sexton (2001): FOB or Uniform Delivered Prices: Strategic Choice and Welfare Effects. *The Journal of Industrial Economics*. XLIX(2): 197-221.