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Pricing behaviour of cooperatives and investor-owned dairies in a spatial market setting

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Abstract

This study analyses spatial competition in Germany's raw milk market differentiating between cooperatives and investor-owned firms. We assess the impact of the own legal form and that of neighboring competitors on the pricing behavior. The focus of the empirical analysis is on the relations of space, measured as the average distance to competing neighbours, and raw milk prices. The results allow testing the shape of the relationship between price and space derived theoretically in the literature. For the south of Germany we find a negative relationship between space and raw milk price while for the north the relationship is positive. In both north and south the effect is stronger for cooperative compared to investor-owned firms. Further, we test for the competitive yardstick effect for which we find only small evidence in the south. The estimation is based on a data set covering all German dairies from 2001 to 2012 providing information on raw milk prices, processing quantities, legal and production form.

Keywords: market power, imperfect competition, spatial competition, cooperatives, investor-owned firms, competitive yardstick

1 Introduction

In this study we focus on the analysis of pricing behaviour of cooperatives (COOPs) and investor-owned dairy processors (IOFs) on the German raw milk market. Due to the high perishableness of raw milk, the market is geographically limited and processors compete for raw milk in a certain market radius. Additionally, an ongoing concentration process can be observed in the dairy sector which might increase local monopsony power of dairies. In this study we aim to assess to what extend dairies can exercise monopsony power. Further, we evaluate the competitive yardstick theory that suggests a procompetitive effect of neighbouring COOPs (Cotterill 1987; Sexton 1990; Fousekis 2011; Hanisch et al. 2013). The German milk market is characterized by different structures in the north and south. The south is characterized by a high density of small dairy processors opposed to the north, where the density of dairies is low and average production high. Therefore, we differentiate between north and south Germany in our empirical analysis.

The use of spatial econometrics has become widespread (Holloway et al. 2007; Bell and Dalton 2007). Especially for the dairy market, market power of processors has been analysed by incorporating the spatial dimension of the market (see Huck et al. 2006; Graubner et al. 2011a and Koller 2012 for the case of Germany and Alvarez et al. 2000 for the case of Asturias in Spain). The common assumption in the literature is that the milk market in Germany and Spain can be characterized by uniform delivered (UD) pricing and price matching behaviour of processors (Alvarez et al. 2000; Huck et al. 2006; Koller 2012). Alvarez et al. (2000) analyse a duopsony of IOFs on an unbounded line market and find empirical support for an inverted U-shaped relationship between price and the importance of space (defined in his study as the product of per-unit transportation costs and the distance between processors). Building on this theoretical framework, Huck et al. (2006) analyse a situation with only COOPs. They show theoretically that the same U-shaped relationship between price and space results but that the function 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 builds upon Alvarez et al. (2000) and estimates a panel model with fixed effects for Germany that also proves a U-shaped relationship between price and space for Germany. However, this study does not clearly differentiate between the legal forms of dairies.

Studies that consider mixed markets and analyse the competitive yardstick theory have been conducted empirically in a non-spatial framework (Hanisch et al. 2013) and theoretically in a spatial market setting (Sexton 1994, Fousekis 2011, Tribl 2012). Hanisch et al. focused on the European dairy market and found empirical evidence for the yardstick effect. The theoretical studies on the competitive yardstick effect in a spatial economics framework find evidence for the yardstick effect.

The objective of this paper is to evaluate the effects of space and legal form on the pricing behaviour of dairy processors in a spatial market setting. The paper contributes to the literature by analysing empirically (1) to what extend IOFs and COOPs in the north and south of Germany can exercise spatial market power and (2) the existence of the competitive yardstick effect.

We employ a spatial regression approach to analyse to what extent raw milk prices are influenced by the distance of competing neighbouring dairies and their characteristics. The results allow testing the shape of the relationship between price and space derived theoretically (Alvarez et al. 2000; Huck et al. 2006; Koller 2012). Additionally, we assess the impact of the own legal form and that of neighbouring competitors on the pricing behaviour. The estimation is based on a data set covering all German dairies from 2001 to 2012 providing information on raw milk prices, processing quantities, legal and production form.

2 Relevant literature on spatial economics

In order to asses to what extent dairies possess monopsony power we investigate the relation between price and space. In the theoretical literature a large set of different assumption concerning the market setting are considered. Table A1 in the appendix summarizes the various assumptions on market actors (mixed market 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), open membership (OM) or restricted membership (RM)) considered in the literate. Additionally, an overview of the derived relation between price and space is provided. There are three different relationships, namely an inverted U-shaped, a negative (linear or convex) or a positive relationship, are identified.

A U-shaped relationship is derived by Alvarez et al. (2000) who assume an unbounded line market which allows for competition in the backyard. In this setting, when space is relatively unimportant (i.e. firms are close to each other or transportation cost are low), the market areas of rival firms can extend beyond the other firms location leading to increasing prices in space. According to Alvarez et al. (2000) this results from the assumption of UD pricing and Löschian competition which leads 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 furthest farm away. This implies that farmers located at the market boundary do then not add to the dairy's profit. Hence if a dairy raises its price it will reduce its market area, losing some farmers at its market boundary. Due to the assumption of 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 its backyard that have been abandoned by its rival. The farmers the dairy get in its backyard are more profitable as the once it loses at its market boundary leading to high profits under UD pricing. If space gets more important competition takes place only on the market between the firms location and results in a negative relation between price and space in line with the theory of a bounded line that has been applied in other studies (see Sexton 1990; Zhang and Sexton 2001; Tribl 2012;Fousekis 2011a and 2011b). For the example of UD pricing and Löschian competition as in Alvarez et al. (2000), Huck

(2012) and Tribl (2012) the negative relation between price and space can be explained with increasing shipping costs that decreases the market area between the firms which may result in separated monopsonistic markets.

Beside these studies that find an inverted U-shape or negative relationship there is one study by Rogers and Sexton (1994) which directed a positive relation between price and space (in the specific case transportation costs) under the assumption FOB pricing and Löschian competition. The reasoning for this 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 in this study is positive as firms increase their prices when their market area gets larger so that farmers' cost for transportation is covered. Interestingly this positive relation is only valid for the competition of IOFs. In a mixed market, the relation of price and space gets negative.

The speciality of mixed markets is the competitive yardstick theory. This theory assumes that COOPs have a procompetitive effect on the market. As COOPs are owned by farmers they do not have to deal with shareholders and will thus not accept prices below average cost. This pricing will serve as a yardstick for other market actors and thus influence the prices of IOFs which leads to market prices equal to average costs in the long run (Cotterill 1987). Hanisch et al. (2012) could validate the competitive yardstick effect in a state level analysis of the European dairy industry. They find that the higher the market share of the 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).

3 Data and descriptive analysis

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[1]. Additionally, we compose a performance index (*perf*) by using the awards for the best products from the German magazine "Milch Marketing". The index is calculated as the sum of award points over the observed period and used as a proxy for the output performance.

In our empirical analysis space is measured as the average distance of a dairy to its neighbours (*nDist*). For the identification of a dairy's location we use postal codes. Following Alvarez et al. (2000) and Huck (2012), we define neighbours as the nearest dairies that together produce at least as much as the considered dairy[2]. Our analysis is restricted to conventional dairies; however, for the neighbouring definitions also organic dairies are included. The reasoning is that organic milk prices influence conventional prices as farmers could switch to organic production when the price spread gets too high. Using this neighbouring definition we setup a row standardized spatial weighting matrix $\mathbf{W}_t$ in order to calculate the neighbouring share of COOPs (*wCoop*) and organic dairies (*wOrganic*) as well as the number of neighbours (*numNeig*).

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

[2] 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.

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 1 summarizes the key facts of these two markets in 2012.

Table 1: 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	173,993.8	241,179.1	18,004	188934.4
	mean	28,999	18,552	9,002	20993
*nDist**	mean	39.0303	19.2037	27.2656	21.9000
	min	0	0	0	2.6426
	max	91.2841	41.6870	50.3425	37.4390
*numNeig**	Mean	2.4667	2.1429	1.8696	1.8125
	min (freq.)	1 (13)	1 (9)	1 (9)	1 (5)
	max	11	5	7	4

**except outliers*
Source: own calculation based on AMI (2012) data.

Taking a closer look at the market structure between north and south[3] reveals that the market in the north is higher concentrated, with fewer dairies and a higher overall and average production. There are large conventional COOPs located in the north with an average production of 460,873 tons whereas the average production in the south is comparably small. This difference is also reflected in the market areas. 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 in the south with a maximum distance of 41.68 km in the south. The density of dairies is much higher in the south with 0.49 dairies per km^2 and only 0.02 dairies per km^2 in the north. Differences between north and south can also be observed in the prices that are lower in the north. We hypothesize that the higher concentration of larger dairies in the north fosters the exercise of market power.

Concerning the differences in the legal form we hypothesize that COOPs pay a higher price due their organizational structure. A simple comparison of the mean prices (table 2) does not support this hypothesis. This issue will be further analysed in a multivariate regression in to following.

The competitive yardstick theory suggests that COOPS are beneficial for competition. Using the neighbouring share of COOPs (*wCoop*) we analyse this effect, by testing the hypothesis that a higher share has a positive effect on raw milk prices.

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[3] The south comprises the federal states Bavaria and Baden-Wuertemberg, the north the remaining federal states.

4 Empirical Model & Results

In our empirical analysis we estimate a spatially lagged explanatory variable model (SLX) [4] of the general form $\mathbf{y} = \mathbf{X\beta} + \mathbf{WX\theta} + \boldsymbol{\varepsilon}$ with $\mathbf{y}$ being a vector of the dependent variable, $\mathbf{X}$ a matrix of explanatory variables, $\mathbf{W}$ a row standardized spatial weighting matrix, $\boldsymbol{\beta}$ and $\boldsymbol{\theta}$ coefficients to be estimated and $\varepsilon \sim N\left(\mathbf{0}, \sigma^2\mathbf{I}\right)$. In our specific case, we estimate the following equation with OLS,

$$
\begin{aligned}
price_{it} = {} & const + \beta_1 south_i + \beta_2 coop_{it} + \beta_3 perf_{it} \\
& + \delta_1 numNeig_{it} + \delta_2 nDist_{it} + \delta_3 nDist_{it} \times coop_{it} + \delta_4 wCoop_{it} + \delta_5 wOrganic_{it} \\
& + \gamma_1 numNeig_{it} \times south_i + \gamma_2 nDist_{it} \times south_i + \gamma_3 nDist_{it} \times coop_{it} \times south_i + \gamma_4 coop_{it} \times south_i \\
& + \gamma_5 wCoop_{it} \times south_i + \gamma_6 perf_{it} \times south_i + \gamma_7 wOrganic_{it} \times south_i \\
& + \sum_{j=1}^{12} \delta_j year_{itj} \times south_i + \sum_{j=1}^{12} \phi_j year_{itj} + \varepsilon_{it},
\end{aligned}
$$

where $south_i$ and $coop_{it}$ are dummy variables equal to one when a dairy i in year t is located in the south and a COOP 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 $\mathbf{W}_t$ (for the definition of $\mathbf{W}_t$ and the remaining variable codes see section 3).

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[4] 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 an appropriate alternative.

The estimated effects of space on price is plotted in figure 1 differentiated between north/south and IOF/COOP (regression results are provided in table A2 in the appendix). For the interpretation of the relationships in figure 1 it is important to keep in mind that we control for production quantity in our regression. This implies that the figure shows the relationship between price and the average distance to neighbours while keeping production quantity (and all other variables) constant. This matters since our neighbouring definition depends on the own production quantity. Changes in the average distance to neighbouring competitors can thus result either from a different density of neighbouring competitors or simply from a different production quantity.

We observe opposite effects between price and space for the north and the south. However, the effects of a positive relation in the north and a negative relation in the south are only significant[5] for COOPs. In contrast to Alvarez et al. (2000) we could not find significant effects for a squared relationship of price and space for either north or south. Nevertheless, the negative relation between price and space in the south is in line with the theory of competition between firms' locations on a bounded line (Sexton 1990; Zhang and Sexton 2001; Tribl 2012; Fousekis 2011a and 2011b) or Alvarez et al. (2000) theory of an unbounded line where no competition in the backyard occurs. The theoretical explanation for the positive relation in the north, in contrast, is less obvious. Based on Alvarez et al. (2000) one explanation could be that in the north competition in the backyard occurs leading to a positive relationship between space and prices under UD pricing and price matching behaviour (see section 2). This reasoning might seem to be counterintuitive as we have large average distances

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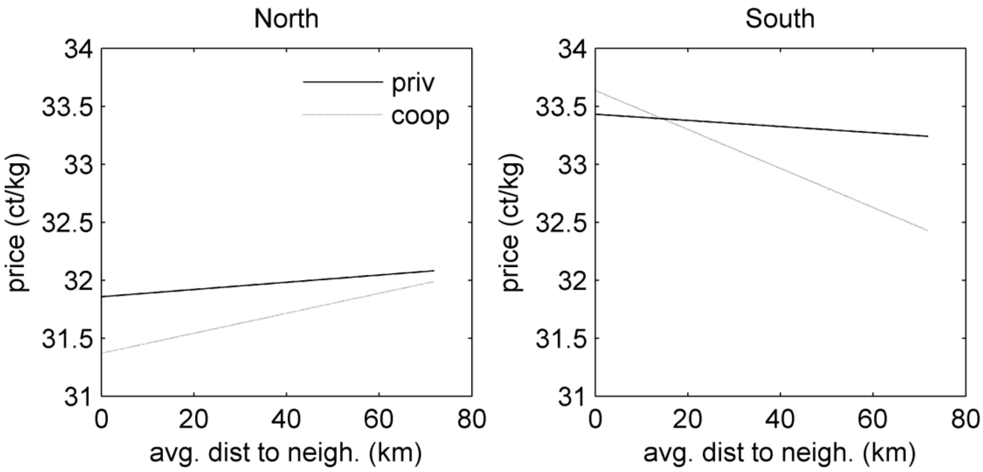
[5] A Wald test is used to test the joint effect of *nDis*t and (*nDist*x*IOF*). Similarly a Wald test is used to test if the joint effects of the dummies and cross terms for COOP in north and south are significant different from zero.

between neighbours in the north (table 2). However, we also have on average higher processing quantities which might imply that there is still competition in the backyard despite the large distances. Another explanation for a positive relation is the assumption of FOB pricing and Löschian competition (Rogers and Sexton 1994). However, this needs to be further analysed as we have no information whether dairies in the north really apply FOB pricing.

Figure 1: Relation between price and space of COOPS and IOF in the North and the South of Germany



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

Interestingly, the positive/negative effect in north/south is stronger for COOPs than for IOFs. The literature reviewed above does not provide an obvious explanation for this effect. However, one explanation could be that under the open membership policy COOPs cannot reject farmers that want to participate. This is the membership policy that is practiced in Germany (BKA 2009). Given open membership and the no-rationing assumption a COOP cannot reject a farmer who wants to participate. Hence, the COOP must consider the available market area as its market radius and cannot choose the optimal market radius as an IOF. Therefore it could be that COOPS in the south tend to have a larger market radius than IOFs despite the same average distance to neighbours and thus need to lower the price to cover transportation costs under UD pricing. However, the different behavior between COOPs and IOFs requires further investigations.

Overall, prices are higher in the south which could stem from general difference in the market structure such as lower raw milk production costs in the north (EMB 2013). Additionally, our regression results (table A2 in appendix) show that COOPs pay a significant lower price then IOF in the north (-0.65ct/kg). In the south we find that COOPs pay a slightly higher price then IOFs (0.10ct/kg), however the effect is statistically not significant different form zero[6]. Concerning the competitive yardstick theory we only find a significant positive influences of the share of COOPS in the neighbourhood on the price in the south that supports the theory (see figure 2). For the north we found a significant negative effect. The negative effect for the north is consistent with the result that COOPs in the north pay a significant lower price as IOF (-0.65ct/kg). However, in both cases the effect of the share of COOPs in the neighbourhood are rather small from an economic perspective as prices change by only -0.21 ct/kg and 0.24 ct/kg from zero coop share to full coop share in the north and south respectively. Taken together we find no clear empirical support for the competitive yardstick theory in Germany.

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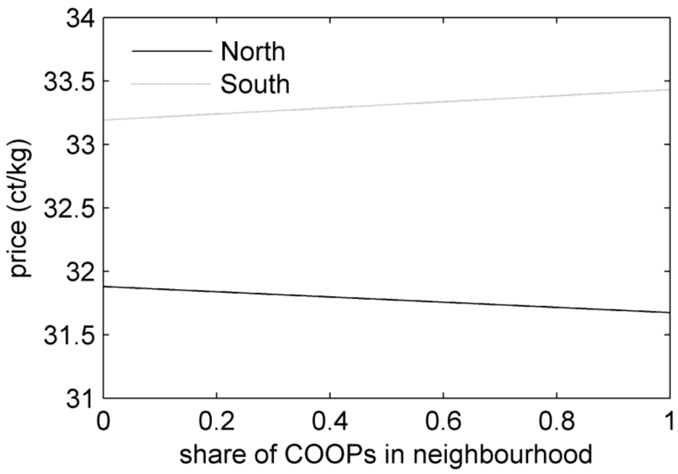
[6] The effect is calculated as the combined effect of coop and (coop x south). A Wald test is used to test the hypothesis that the two coefficients are jointly equal to zero.

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



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

Additionally our regression results indicate to 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. This effect is higher in the north than in the south. As expected we find a positive influence of the performance index which is significant. The number of neighbours (*numNeig*) has a significant negative effect. Here, again it is important to keep in mind that quantity is held fixed in the regression. Given our definition of neighbouring relations a large number of neighbours for the same size thus implies relatively more but smaller neighbours. An increase in the number of neighbours thus imply a relative increase in size compared to neighbouring competitors which might allow the dairy can exercise market power.

For the regression we controlled for the effects of outlier by excluding all observations if they are within the lowest or highest one percent of each continuous variable. Additionally, 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). Neither, the exclusion of outliers nor changes in the neighbouring definitions led to a meaningful change of the results with respect to the main conclusions.

5 Conclusion

Unlike other empirical studies on milk markets (Alvarez et al. 2000; Huck et al. 2012; Koller 2012) we empirically estimated the relation between price and space in a mixed market. In contrast to these studies we could not find an inverted U-shaped relation between price and space. However, iour empirical study reveals significant different linear effects between price and space in the north and south of Germany that could results 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.

Concerning the competitive yardstick effect we do not find clear empirical evidence. Our results support the theory for the south where an increase in the share of neighbouring COOPs increases prices. However, in 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 as in the south. In both cases however, even though the effects are significant, they are rather small from an economic perspective.

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7 Appendix

Table A2: Relevant literature

Author Year	**Market actors**	**Pricing/ competition**	**theory**	**theory: relation price - space**	**CYE/emp. estimation**
Sexton 1990	IOF & COOP (OM, RM, NARP)	FOB H-S, Lösch, Cournot	bounded line market	no explicit relation derived, focus on optimal market radius and pricing under the different assumptions for competition and the market form	Confirmed none
Rogers & Sexton 1994	IOF & COOP	FOB H-S, Lösch, Cournot	bounded line market	focus on price spread, negative relation price-spread and transportation costs under Lösch = positive relation between transportation costs and processors price, positive relation price spread and transportation costs under Hotelling and Cournot for pure IOF=negative relation transportation and processors price, mixed market: leads to positive relation between price spread and transportation costs for H-S and Bertrand= negative relation price - transportation costs	Confirmed none
Alvarez et al. 2000	IOF	UD Lösch	unbounded line market	inverted u-shape	/ confirms inverted u-shape
Zhang & Sexton 2001	IOF	FOB, UD Nash Bertrand	bounded line market	focus on strategic choice of FOB or DU decreasing convex function	/ none
Huck et al. 2012	COOP (OM, TMW)	UD Lösch	unbounded line market	same assumptions as Alvarez inverted u-shape, lying above IOF	/ confirms inverted u-shape
Tribl 2012	IOF & COOP (OM, NARP)	UD Lösch	bounded line market	analysis of simultaneous and sequential games under different assumptions on COOPs choice of market radius negative relation of price and space for all scenarios	Confirmed none
Fousekis 2011a	IOF & COOP (OM, NARP)	UD , FOB H-S	bounded line market	decreasing convex function	depending on pricing, CYE could be confirmed none
Fousekis 2011b	COOP	UD , FOB H-S	bounded line market	decreasing convex function	/ none

Table A2: Regression results (selected variables)

Variable	Coefficient	t-statistic	p-value
const	24.8780	164.7759	0
south	1.6381	7.6386	0.0000
quant	0.0000	0.5791	0.5626
$quant \times south$	0.0000	-1.9381	0.0528
$quant \times coop$	0.0000	3.0148	0.0026
$quant \times coop \times south$	0.0000	-0.4780	0.6327
coop	-0.6479	-5.1992	0.0000
$coop \times south$	0.7516	3.6847	0.0002
wcoop	-0.2054	-2.7755	0.0056
$wCoop \times south$	0.4441	3.7563	0.0002
wOrganic	0.6418	3.7298	0.0002
$wOrganic \times south$	-0.3463	-1.3116	0.1898
perf	0.0156	5.3180	0.0000
$perf \times south$	-0.0114	-3.1529	0.0016
nDist	0.0031	1.4475	0.1480
$nDist \times south$	-0.0058	-1.2389	0.2156
numNeig	-0.1045	-4.2417	0.0000
$numNeig \times south$	0.1872	3.5312	0.0004
$nDist \times coop$	0.0055	1.3229	0.1861
$nDist \times coop \times south$	-0.01967	-2.435936	0.014965
...			

R^2 = 0.9109; R^2-adj. = 0.9086, σ^2 = 0.8095; N = 1645