Full Research Article

Entry deterring effects of contractual relations in the dairy processing sector

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Abstract. The European Commission has launched the so-called "milk package" in October 2012 that allows Member States to require compulsory written contracts between milk producers and investor-owned processors. We argue that compulsory contracts have anticompetitive effects when they are exclusive in the sense that they comprise the obligation to supply to the contractor only. The objective of this paper is to set up a game theoretic model to analyze imperfect competition on the raw milk market that may result from entry deterring effects of exclusive contracts between dairy producers and processors. Building on the antitrust literature, the model incorporates the specific characteristics of the milk market and considers the risk attitude of milk producers and uncertainty of a rival dairy's market entry. Under certain combinations of probability of the rival's market entry and risk aversion of the producer, an incumbent can deter market entry by offering an exclusive contract.

Keywords. Entry deterrence, imperfect competition, buyer power, exclusive contracts, dairy processing

JEL codes. L13, L14, L41

1. Introduction

In the EU-27, milk is one of the most important agricultural goods, representing about 13% of the total turnover of the European food and beverage industry (EDA, 2013). In the past years, structural changes on both producer and processor side, innovations in milk production and the decision of the EU Commission to abolish the quota regime changed the milk market. The increasing concentration of dairy processing[1] facilities raise concerns regarding buyer market power of dairy processors (BKA, 2009, 2012). Addressing producers' position on the market, the European Commission launched the so-called

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[1] Own calculation based on data from the Agrarmarkt Informationsstelle (AMI) 2014, a German institution that collects data of agricultural entities.

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"milk package" in October 2012 which aims at strengthening producers' market position by improving their bargaining power and the transparency of the market. The "milk package" sets criteria for the formation of producer organizations and specifies rules for the regulation of PDO/PGI cheese supply. Further, it suggests Member States to introduce compulsory written contracts between milk producers and investor-owned processors. Due to their specific ownership structure, cooperatives are exempted from this policy. As contracts used in recent years were often not well specified, the recommendation is that contractual agreements should not only become compulsory but also contain a minimum standard of specified criteria (e.g. details on price, volume and duration of contract). Currently, 12 Member States have introduced compulsory contracts (Bulgaria, Croatia, Cyprus, France, Hungary, Italy, Latvia, Lithuania, Portugal, Romania, Slovakia and Spain) with a minimum contract durations of 6 month in most states, 1 year in Spain and even 5 years in France. Other Member States have not introduced compulsory contracts but agreed on codes of good practice between producers and processors (Belgium, United Kingdom). In Germany, contracts between farmers and investor-owned dairies are usually negotiated by producer organizations. These contracts usually contain details on quality, price parameters and specify the length of the contracts. In addition to these criteria, contracts shall be more precise about the contracted milk volume in the future. (EC, 2014)

In the sector inquiry of the German milk market the question arose how long-term contracts in combination with the obligation to supply the whole production quantity to processors affect competition (BKA, 2012). The concern is that by tying up milk producers through long-term contracts without appropriate cancellation periods, strong or dominant processors may use their market power to deter competition or entry to the market for raw milk. Combined with the producer's obligation to supply the full production quantity, this could lead to an abuse of a dominant position, which is prohibited by law (article 102 of the treaty for the Functioning of the European Union (TFEU)) (BKA, 2012, section 106). According to the sector inquiry, 45% of the contracts between private dairies and milk producers have durations longer than two years. Furthermore, 85% of German producers delivering milk to private dairy processing facilities are obliged to supply their entire production and the processing facility is likewise obliged to accept the whole amount (BKA, 2009). In 2012, 60% of milk is processed in cooperatives. However, in terms of number of processing facilities, only approximately 40% of the 137 active processing facilities in 2012 were cooperatives, the remaining ones are investor owned firms (AMI, 2014).[2]

The frequent use of contracts on the milk market may be explained by their ability to reduce price risks and to secure delivery quantities for dairy producers and input quantities for processors. However, they may also let processors exercise buyer market power by binding dairy producers and reducing delivery flexibility, which may even lead to entry deterrence of other dairy processors. We argue that compulsory contracts have anticompetitive effects as they are exclusive given the obligation to deliver to the contractor only.

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[2] Concerning the EU, the importance of investor-owned companies is even more pronounced: Among the top ten of Europe's largest dairy processors in terms of turnover, six firms are organized as investor-owned dairies and four as cooperatives. Among the top three only investor-owned dairies can be found (Nestlé, Danone, Lactalis) (MIV, 2012). Even though investor-owned dairies process only about 36% of European raw milk, this highlights the importance of investor-owned firms in the European dairy market.

This is usually the case between milk producer and processor (BKA, 2009) and holds likewise for investor-owned and cooperative dairies.

Anticompetitive effects of exclusive contracts have been scarcely studied under the specific characteristics of agricultural markets (exception e.g.: Xia and Sexton (2004) for the U.S. cattle industry), and only in the context of the antitrust literature that focusing on seller market power (e.g. Segal and Whinston, 2000; Rasmusen *et al.*, 1991; Aghion and Bolton, 1978). The analysis of seller market power is however of limited relevance on agricultural markets. Although they are often assumed to be perfectly competitive, the structure of agricultural markets is more precisely characterized by a low concentration of producers and a high concentration of processors and retailers (Sexton, 2013; McCorriston, 2002; Rogers, 2001; Rogers and Sexton, 1994). Therefore, the analysis of buyer market power is central (Sexton, 2013; MacDonald *et al.,* 2004). However, oligopsony competition or monopsony behavior in an input market are rarely treated in the agricultural economic literature (exceptions are Sexton, 2013; Mérel, 2011; Crespi *et al.,* 2012; Sexton, 2013; Graubner *et al.,* 2011; Alvarez *et al.,* 2000).

Given the high adoption rate of compulsory contracts and in light of the concern of the German sector inquiry about resulting anticompetitive effects on the milk market, the aim of this paper is to analyse if exclusive contracts between dairy processor and producer restrict competition on the raw milk market.[3] This paper goes beyond the existing literature (1) providing a game theoretic analysis of the competitive effects of exclusive contractual relations based on the antitrust literature but in the framework of a monopsonistic market structure and (2) motivating the signing of an exclusive contract with the uncertainty of rival's entry and risk aversion of the signer - in contrast to former models of exclusive contracts.

Competitive effects of exclusive contracts are modelled between an incumbent investor-owned dairy processor on the milk market and one representative raw milk producer. We assume that a rival (investor-owned) dairy processor with lower marginal production costs threatens to enter the market. A short-term equilibrium in which the incumbent dairy offers an exclusive contract to the producer in order to deter the rival dairy's market entry is analyzed. After the producer decided whether to accept the contract with the incumbent, the rival decides upon entry. By incorporating uncertainty of rival's entry and producer's risk attitude, we show that exclusive contracts can indeed be used to deter entry of a rival processor into a downstream market when the upstream producer is risk averse. Most raw milk producers nowadays are highly specialized farms where the main income source results from milk production (EU Commission, 2014). Not a lot is known about the real "level" of risk aversion among dairy producers, but some evidence exists that dairy farmers are generally risk averse (Loughrey *et al.,* 2014; Melhim and Shumway, 2011). This may lead farmers to sign exclusive contracts with a dairy to reduce the income risk related to their main production activity.

The paper is organized as follows: The next section gives an overview on the relevant literature. Section 3 presents the game theoretic model. In a baseline model, an exclusive contract between dairy producer and processor is analyzed without incorporating uncer-

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[3] Germany, as the largest milk producer in Europe, stays in the focus of our analysis, motivated by the sector inquiry of the German milk market conducted by the German national competition authority (BKA, 2012). However, the analysis may also be relevant for other Member States with a similar market structure.

tainty about the rival's entry and producer's risk attitude, resulting in failure to deter entry. In a next step, we show how the inclusion of risk attitude and uncertainty may allow to deter rival's entry. Subsequently, a numerical example underlines the theoretical results. Section 4 discusses the model while section 5 concludes.

2. Literature review

The analysis of contractual relations in the dairy processing sector requires the consideration of the contract design and the competitive effects. Empirical studies find that producers strongly favor a redesign of raw milk contracts in terms of contract length and cancellation periods (Steffen *et al.,* 2009; Schlecht *et al.,* 2013). Further, releasing producers of their supply obligation and allowing them to sell to more than one dairy processor is seen as an improvement in terms of both producers' flexibility and bargaining position (Steffen *et al.,* 2009; Schlecht *et al.,* 2013; BKA, 2012; Schaper *et al.,* 2008).

Concerning the competitive effects of contracts, entry deterring effects of exclusive contracts are analyzed in the antitrust literature focusing on seller market power (e.g. Aghion and Bolton, 1987; Bork, 1978; Rasmusen *et al.,* 1991; Segal and Whinston, 2000). Roger and Sexton (1994) and Sexton (2013) emphasize the importance of oligopsony power in agricultural markets. However, there is little work on exclusionary effects of contracts in the context of the specific oligopsonistic structure between agricultural producers and food processors. MacDonald *et al.* (2004) and Vavra (2009) analyze the use of contracts in agricultural markets and discuss the possibility to deter entry of buyers into local markets. To our knowledge, none of the existing studies explicitly models risk behavior of producers and its effects on entry deterrence of exclusive contracts (although Innes and Sexton (1994) discuss at least the implication).

The models used in the antitrust literature for the analysis of seller market power are usually designed in the following way: An incumbent seller contracts a buyer who is usually a consumer with an exclusive supply contract. The contract specifies a compensation for the buyer to accept the contract and to not purchase from the incumbent's rival, which leads to entry deterrence in the upstream market. The "Chicago School" view (Director and Levi, 1956; Posner, 1976; Bork, 1978) criticizes the entry deterring effects of contracts and argues that an incumbent confronted with buyers preferring entry of a rival due to increased competition and potentially better prices, would have to pay more for the rival's exclusion than to be gained from it. The reason is that the incumbent has to compensate buyers for the additional consumer surplus they would have gained in case of entry, which they lose by signing the contract. It has been shown that entry deterrence is not profitable in this case as the lost consumer surplus is higher than the monopoly profit in case of entry deterrence. Therefore, the Chicago School explained the observable use of exclusive contracts with efficiency reasons rather than anticompetitive behaviour (Director and Levi, 1956; Posner, 1976; Bork, 1978).

Since the 1980s, economists have developed game theoretic models that analyze anticompetitive effects of exclusive contracts. Aghion and Bolton (1987) developed a model where exclusive contracts are used to extract some of the surplus a potential rival would gain in case of market entry. They analyze the optimal contract length and differentiate between symmetric and asymmetric information about the probability of the rival's entry

and their impacts on entry deterrence. Furthermore, the entrant endures fixed costs for entry. They find that entry deterrence leads to a lower economic welfare. Later, Rasmusen *et al.* (1991) used buyer's lack of information to explain the existence of exclusive contracts and their entry deterring effects. If a buyer expects other buyers to sign an exclusive contract, he will also sign the contract without considering the overall economic effect, which leads to entry deterrence and a lower welfare. Segal and Whinston (2000) reconsidered Rasmusen *et al.*'s (1991) model and showed that market entry is profitable when the rival can sell his product to a minimum number of buyers to cover fixed costs. If buyers sign exclusive contracts, it is difficult for the entrant to get the minimum scale needed and thus entry is deterred. Segal and Whinston (2000) show that when the incumbent makes discriminatory offers to the buyers, the externalities present between buyers lead to a profitable exclusion of rivals. These analyses explain the signing of exclusive contracts with market disorganization (Rasmusen *et al.,* 1991; Segal and Whinston, 2000) or complex contract terms (Aghion and Bolton, 1978), even though the signer would be better off without contracts.

Fumagalli and Motta (2006) point out that the above mentioned models assume that buyers are final consumers whereas typically exclusive agreements are rather signed amongst producers or producers and processors or wholesalers. They consider the case where buyers procure a good from an upstream firm that is either from an incumbent producer or a rival producer and then sell it in a final market. In the case of buyers being final consumers, the demand and the payoff of a buyer depend only on the price of the good. But when buyers compete in a downstream market, their market share, the input price and the rival buyer's price are relevant for demand and affect the possibility of entry deterrence.

In recent years, a separate strand of literature emerged where raw milk pricing behavior and the implications for competition are analysed in a spatial market setting (Alvarez *et al.,* 2000; Huck *et al.,* 2006; Graubner *et al.,* 2011). In our analysis, the spatial dimension is not explicitly considered.

3. The Model

3.1 General model assumptions

On the upstream market one representative[4] dairy producer takes the price for raw milk w as given. The (inverse) supply function for raw milk is defined as an inelastic function with $w = x^2$ defined for $x > 0$ implying that the producer is able to extend production at increasing marginal cost in the short to medium term.

Dairies accept the entire production quantity x of the producer and cannot choose the quantity they would like to procure. Therefore, we assume that processors compete in prices for raw milk à la Bertrand. On the intermediate stage of the market, an incumbent dairy (dairy A) is procuring the milk quantity x_A from the representative milk producer (producer P). A rival dairy (dairy B) with lower marginal production costs than the incumbent, $c_B < c_A$, threatens to enter the market. To enter the market, the rival dairy has to consider fixed costs F. We assume that F is too large for the entrant to offer a compen-

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[4] We do not consider a specific number of dairy producers and as we assume that producers take the price for raw milk is given, we just speak about a producer in the following.

sation for signing an exclusive contract.[5] We abstain from incorporating spatial characteristics of the market and assume that the raw milk price offered to the producer is independent of the transport costs or distance between producer and processor. Regarding the final dairy product q, we assume a processing relation of $x = q$ for both dairies.

If dairy B entered, both processors would be competitors on the market for raw milk and compete in milk prices. Due to Bertrand price competition, the producer delivers milk to the highest bidder. In order to deter rival dairy B's entry, the incumbent dairy A can offer an exclusive contract to the producer. The exclusive contract comprises a compensation θ_A for selling all the produced milk to the incumbent and not to the rival. In case of a signed contract, the fact that the whole amount of raw milk is delivered to the incumbent dairy deters entry as the potential entrant can only procure milk from a free producer. If entry is successfully deterred, monopsony prices and profits are realized.

The marketing of the final dairy product is not restricted to a regional market but can be sold on the national or even on the world market, which allows the assumption of a competitive downstream market. Hence, dairies take the output price p as given.

A short-term equilibrium in which the incumbent dairy offers an exclusive contract to the producer in order to deter the rival dairy's market entry is analyzed. The timing of the game is as follows: At stage one, the incumbent dairy A can offer an exclusive contract that specifies a compensation and an exclusive delivery obligation for the whole production amount. The producer decides whether to accept the contract. At stage two, the rival dairy B decides upon entry. At stage 3, active processors set prices.

First of all, a basic model demonstrates the effects of exclusive contracts in a framework with a risk neutral producer and certainty of rival's entry in absence of an exclusive contract. Then, these restrictions are relaxed and producer's risk attitude and uncertainty of rival's entry are incorporated in the model.

3.2 The basic model

In order to discuss the implications of exclusive contracts we analyze two scenarios. In scenario 1, a basic monopsony model structure without contracts is constructed. Here, only dairy A and the producer are active on the market. Scenario 2 analyzes market entry of dairy B.

Let us assume that $c_i < 1$, $c_i < p$ and $w_{is} < p$ where subindices $i = A, B$ represent the market actor and $s=1,2$ the scenario. In scenario 1, the monopsony scenario, dairy A maximizes its profit over the price for raw milk offered to the producer. The raw milk price that maximizes dairy A's profit is given by w_{A1} and leads to a profit of π_{A1}. The corresponding profit for the producer is denoted by π_{P1} (see Table 1).

In scenario 2, the case of dairy B's market entry, dairies compete à la Bertrand. The highest price dairy B can offer is $\overline{w}_B = p - c_B$ whereas dairy A's highest price is $\overline{w}_A = p - c_A$. Since $c_B < c_A$, processor B is able to offer a higher price for raw milk, $\overline{w}_{B2} > \overline{w}_{A2}$. In case of market entry, dairy B will offer a slightly higher price than dairy A,

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[5] It would become more difficult for the incumbent to deter a rival's entry if we would remove the assumption that rival's fixed costs of entry are too high to also offer a compensation for an exclusive contract. However, the assumption is justified as the entry into a new market involves high entry costs.

$w_{B2} = p - c_A + \varepsilon$ with $\varepsilon > 0$. Consequently, the producer will sell to the rival and dairy A will loose its market share resulting in a positive profit π_{B2} for dairy B and a zero profit for dairy A (see Table 1). In this setup, there exists no equilibrium in which both dairies are active on the market. However, we assume that dairy A will not exit the market but is still present in the region with its production facility. In this case, dairy B's market entry will not result in another monopsony situation, as dairy B has to keep its pricing strategy to prevent dairy A from re-entering the market.

Table 1. Comparison of scenario 1 and 2.

	Sc.	Price for raw milk	Raw milk quantity	Profit
Dairy A	1	$w_{A1} = \dfrac{p - c_A}{3}$	$x_{A1} = (\dfrac{p - c_A}{3})^{1/2}$	$\pi_{A1} = \dfrac{2}{3\sqrt{3}}(p - c_A)^{3/2}$
	2	$\overline{w}_{A2} = p - c_A$	$x_{A2} = 0$	$\pi_{A2} = 0$
Dairy B	1	$w_{B1} = 0$	$x_{B1} = 0$	$\pi_{B1} = 0$
	2	$\overline{w}_{B2} = p - c_A + \varepsilon$	$x_{B2} = (p - c_A + \varepsilon)^{1/2}$	$\pi_{A2} = (c_A - c_B + \varepsilon)(p - c_A + \varepsilon)^{1/2} - F$
Producer	1	$w_{A1} = \dfrac{p - c_A}{3}$	$x_{A1} = (\dfrac{p - c_A}{3})^{1/2}$	$\pi_{P1} = \dfrac{2}{9\sqrt{3}}(p - c_A)^{3/2}$
	2	$w_{B2} = p - c_A + \varepsilon$	$x_{B2} = (p - c_A + \varepsilon)^{1/2}$	$\pi_{P2} = \dfrac{2}{3}(p - c_A + \varepsilon)^{3/2}$

The comparison of the two scenarios demonstrates the incentive for dairy A to deter dairy B's market entry. In case of market entry, dairy A achieves a zero profit, whereas the profit in the monopsony case, π_{A1}, is positive. The producer, on the other hand, is better off in case of dairy B's market entry as $\pi_{P2} > \pi_{P1}$.

Without taking producer's risk aversion and uncertainty of rival's entry into account, the compensation that dairy A needs to offer to the producer for an exclusive contract must compensate for the producer's surplus lost when accepting the contract. This is the difference between the profits in the two scenarios, $\theta_P \geq \pi_{P2} - \pi_{P1}$, which is equal to

$$\theta_P \geq \frac{2}{3}(p - c_A + \varepsilon)^{3/2} - \frac{2}{9\sqrt{3}}(p - c_A)^{3/2} \tag{1}$$

The maximum compensation dairy A is willing to offer is $\theta_A \geq \pi_{A2} - \pi_{A1}$ which leads to

$$\theta_A \leq \frac{2}{3\sqrt{3}}(p - c_A)^{3/2} \tag{2}$$

Comparing (1) with (2) we observe that the compensation the producer requires is higher than the one dairy A is able to offer, i.e. $\theta_P > \theta_A$. Therefore, offering an exclusive

contract is not beneficial for dairy A in this setup. Consequently, if a lower cost producing dairy B enters the market, dairy A is not able to keep its raw milk source, as the compensation dairy A is able to offer does not offset the higher price dairy B is able to pay.

3.3 Risk attitude and uncertainty of entry

In order to incorporate producer's risk attitude, producer's utility function is defined as $u = \pi_p^r$ where the exponent r determines the risk attitude of the producer. If $r > 1$ the utility function implies a risk loving producer, if $r = 1$ risk neutrality and if $0 < r < 1$ absolute risk aversion.

Exogenous determinants lead dairy B to enter the market. Depending on dairy A's assumptions on the probability of dairy B's market entry, dairy A offers an exclusive contract to the milk producer. The probability of entry is denoted by k such that $1 - k$ is the probability of no entry, both for the case of no contract. If successful, the signing of the exclusive contract deters entry of dairy B and thus, probability of entry is zero.

Whether the offering of an exclusive contract leads to entry deterrence depends on the compensation that dairy A can pay, which depends on the entry probability of the rival and producer's risk attitude. Is the compensation high enough for the producer to accept, the contract will be signed and entry of the rival is deterred. The market is in a monopsony situation with prices and quantities being as in scenario 1 of the basic model. If the contract with dairy A is not accepted, the producer will sell the entire production quantity to dairy B. The compensation the producer requires for signing a contract with dairy A depends on the payoff required for not staying free on the market. This compensation is the difference between the certainty equivalent (CE_p) and the payoff under contract (π_{P1}); $\theta_P^{risk} = CE_P - \pi_{P1}$ which is equal to

$$\theta_P^{risk} = \left[k\left(\pi_{P1}\right)^r + \left(1-k\right)\left(\pi_{P2}\right)^r \right]^{1/r} - \pi_{P1} \tag{3}$$

The highest compensation that dairy A is able to offer under uncertainty is equal to

$$\theta_A^{risk} = \pi_{A1} - \left[k\pi_{A2} + (1-k)\pi_{A1} \right] \tag{4}$$

For simplicity we define the margin of dairy A as $p - c_A = m$ and assume that $\varepsilon = 0$. Then, inserting the findings from Table 1 yields

$$\theta_P^{risk}(\rho,r,m) = \left[k\left(\frac{2}{3}m^{3/2}\right)^r + (1-k)\left(\frac{2}{9\sqrt{3}}m^{3/2}\right)^r \right]^{1/r} - \frac{2}{9\sqrt{3}}m^{3/2} \tag{5}$$

$$\theta_A^{risk} = k\left(\frac{2}{3\sqrt{3}}m^{3/2}\right) \tag{6}$$

Rival's entry can be deterred if $\theta_P^{risk} \le \theta_A^{risk}$ ((5) ≤ (6)). Hence, dairy A can offer a compensation that induces the producer to sign the contract and thus deters entry if $\theta_A^{risk} - \theta_P^{risk} \ge 0$

To better understand under which conditions this is valid, rearranging leads to

$$m^{3r/2}\left[\left(k\frac{2}{3\sqrt{3}}+\frac{2}{9\sqrt{3}}\right)^{r}-k\left(\frac{2}{3}\right)^{r}-(1-k)\left(\frac{2}{9\sqrt{3}}\right)^{r}\right]\geq 0 \qquad (7)$$

Whether this inequality holds depends on the values of k, r and m. The margin $m = p - c_A$ is by definition positive. Therefore, entry can only be deterred if the term in brackets in equation is larger than zero, which depends on the variables k and r.

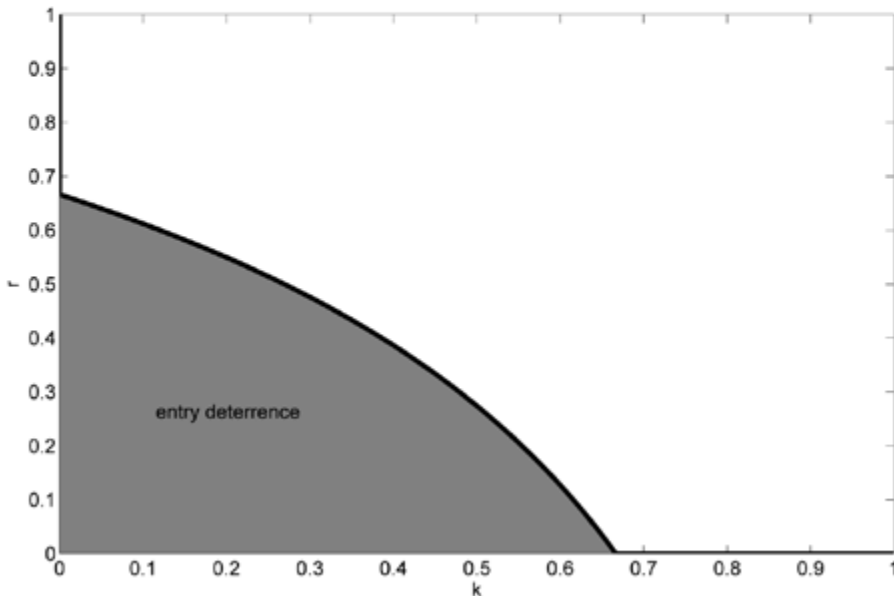**Figure 1.** Effective entry deterrence depending on k and r

Figure 1 shows levels of k and r that lead to a positive term in equation (7) i.e. a situation where entry deterrence is possible. This is valid for all combinations of r and k that lie on the curve and underneath the curve in figure 1. A highly risk averse producer would even accept the contract when the entry probability is high enabling dairy A to maintain the monopsony situation on the market. If, on the other hand, the entry probability is relatively high and risk aversion only moderate dairy A has no possibility to deter entry.

Contrary to the basic model, it is now possible to deter rival's entry for certain levels of producer's risk aversion and the probability of rival's entry. If the market entry is deterred, the market is in a monopsony situation, resulting in prices and profits of the basic scenario 1 and providing the incentive for dairy A to sign an exclusive contract with

the producer. If deterrence is possible, then the level of compensation dairy A has to pay to maintain the monopsony position increases with the probability of market entry by dairy B and decreases with the increasing risk aversion of the farmer.

3.4 Numerical example

Using a numerical example roughly reflecting the current situation on the German dairy market, we assume that the marginal costs of the rival are $c_B = 0.18$ ct/kg and the marginal costs of the incumbent are 20% higher, $c_A = 0.22$ ct/kg. The downstream price p for one unit of a (not further specified) dairy product is assumed to be $p = 0.48$ ct/kg[6].

Basic model

Based on these numbers, the price that dairy A offers in Scenario 1 of the basic model is equal to 9 ct/kg (see Table 2). This is a rather low price for raw milk, which results from our crude assumptions and the monopsonistic market structure.

Table 2. Numerical example of the basic model.

	Sc.	Price for raw milk	Demanded raw milk	Profit
Dairy A	1	$w_{A1} = 0.09$	$x_{A1} = 0.29$	$\pi_{A1} = 0.0510$
	2	$w_{A1} = 0$	$x_{A1} = 0$	$\pi_{A1} = 0$
Dairy B	1	$w_{B1} = 0$	$x_{B1} = 0$	$\pi_{B1} = 0$
	2	$w_{B2} = 0.27$	$x_{B2} = 0.52$	$\pi_{B2} = 0.0156$
Producer	1	$w_{A1} = 0.09$	$x_{A1} = 0.29$	$\pi_{A1} = 0.0170$
	2	$w_{B1} = 0.27$	$x_{B1} = 0.52$	$\pi_{B1} = 0.0935$

For scenario 2 of the basic model, the highest price dairy A is able to offer when dairy B enters the market equals $w_A = p - c_A = 0.26$ and dairy B's highest price is given by $w_B = p - c_B = 0.30$ If dairy A has not contracted the producer and rival B enters the market, dairy B is able to outbid dairy A by offering a slightly higher price for raw milk, say $w_B = 0.27$, given Bertrand competition. Then, dairy A has a profit of zero and dairy B π_B. The producer's expected payoff is given by π_P (see Table 2).

Comparing the two scenarios shows that the Bertrand price competition leads to a higher price in scenario 2 compared to scenario 1 and a higher quantity of raw milk. This results in more than a fivefold producer's profit. The example demonstrates dairy A's incentive to deter rival B's market entry due to the higher profit that can be achieved in the monopsonistic case. From the producer's perspective, it would be better if the rival processor enters the market, as this results in higher competition for raw milk and thus in a higher price.

For dairy A, holding the monopsony position on the market can only be achieved with an exclusive contract that obliges the producer to deliver the full production of raw milk.

[6] Data derived from a cost figure provided by the German dairy association(MIV, 2011).

For the producer to accept, the contract must enclose a compensation for not being able to negotiate/contract with dairy B. Therefore, the compensation must at least contain the difference between producer's profit in Scenario 2 and 1. Consequently, the compensation must be $\theta_P \geq 0.0765$. Dairy A's profit in scenario 1 is $\pi_A = 0.051$ and zero in scenario 2, therefore the highest compensation dairy A is able to offer equals $\theta_A \leq 0.051$. This compensation is not high enough for the producer to accept, therefore market entry of dairy B will take place. Without taking risk aversion into consideration, dairy A cannot deter market entry of dairy B. Dairy B will enter the market and Bertrand competition for raw milk occurs.

Risk attitude and uncertainty of entry

The compensation that dairy A is able to offer depends on the expected entry probability of the rival. Producer's required compensation also depends on the entry probability and further on the risk attitude. Consequently, both affect the possibility to deter the rival's entry. The relationship of affordable and required compensations for entry deterrence depending on entry probability and the risk attitude is presented in Figure 2. The bold line represents the compensation dairy A is able to offer (θ_A - line). The thin lines represent the compensation that the producer requires under a given level of risk attitude (θ_P - lines).

Generally, the figure shows that given our numeric assumptions and if risk aversion of the producer is not lower than $r = 0.1$, entry cannot be deterred if the entry probability is higher than $k = 0.552$. All compensation lines of the producer (θ_P - lines) lie above dairy A's compensation line (θ_A - line) after this point. If $k = 0.552$ and $r = 0.1$ then $\theta_P^{risk} = \theta_A^{risk} = 0.02815$. Therefore, if $r = 0.1$, an exclusive contract and an entry prob-

Figure 2. Development of compensations depending on probability.
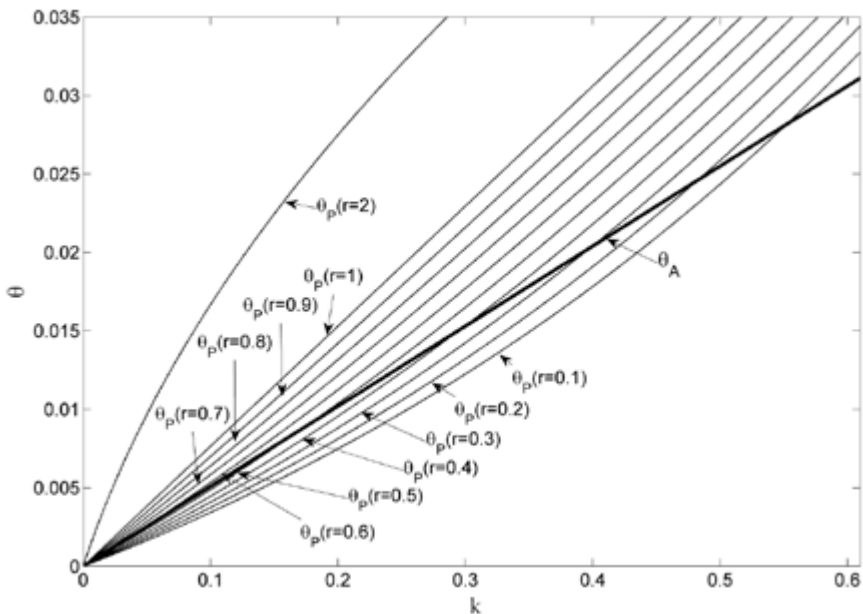
ability of $k \leq 0.552$ lead to an effectively deterred entry. Addressing the risk attitude of the producer, rival's entry can only be deterred if $r \leq 0.6$ and if the entry probability is low enough respectively. Starting from a risk behavior of $r > 0.6$, entry cannot be deterred (all θ_P - lines lie above the θ_A - line there). For a risk averse producer with $r = 0.6$ the entry probability would need to be very low ($k < 0.018$) to effectively deter rival's entry with an exclusive contract. With increasing risk aversion of the producer and with decreasing entry probability, the required compensation of the producer is decreasing. However, at the same time, the compensation that dairy A is able to offer decreases with decreasing entry probability. This shows that under our assumptions regarding marginal costs of production and processing, there are certain ranges of interaction between entry probability and risk attitude where the incumbent dairy A can use an exclusive contract to deter rival dairy B's entry.

4. Discussion

Even though the concentration of dairy processors is increasing, the entry of rivals into an incumbents market area is still relevant. In the dairy concentration process, processing quantities are continuously increasing which leads to larger market areas (AMI, 2014). Hence, a rival's entry can also be interpreted as an existing dairy who wants to increase its market area.

Certainly, the above presented model covers a complex market structure and therefore relies on abstract assumptions. The complexity of the market presents itself in the different relations along the supply chain. On the one hand, consedering the relation between producers and dairies, the model does not take into account the possible existence of producer organizations. These might exert bargaining power in contrast to the model assumption of the producer being a price taker. On the other hand, regarding the relation between dairies and the downstream market, the model lacks to cover the possible existence of buyer power of downstream firms. However, in order to focus the analysis on the relation between the producer and the dairy, perfect competition on the downstream market was assumed. Nevertheless, both assumptions might be worth to relax in future studies.

As cooperatives are exempted from the policy of compulsory and exclusive written contracts, our analysis focused on investor-owned dairies. However, the theory of exclusive contracts can also be applied to cooperatives. The literature provides three possible profit maximizing objectives for cooperatives (Royer and Matthey, 1999). First, cooperatives act like investor-owned firms, they maximize profit and afterwards split profit between members. Second, cooperatives maximize total member welfare by maximizing profit over quantities. However, this is not applicable to the milk market due to the obligation to supply the entire production amount to the same dairy. Third, cooperatives maximize the price paid to their members and generate a zero profit. Therefore, our theory can be applied to cooperatives if we assume that the cooperative maximizes its profit like an investor-owned firm. Then, the compensation corresponds to the shared profit of a cooperative. The model does also not change for the entrant, who can then either be an investor-owned dairy or a cooperative. If we stick to the assumption that the fixed costs of market entry are too high for the entrant to offer a

compensation, the theory can completely be translated to the case of cooperatives that maximize profits like investor-owned firms.

5. Conclusion

In this article, we analyzed entry deterring effects of exclusive contracts in an oligopsonistic market. The model is based on the framework of studies analyzing exclusive contracts in the literature (e.g. Segal and Whinston, 2000; Rasmusen *et al.,* 1991; Aghion and Bolton, 1978, Fumagalli and Motta, 2006). In contrast to these models on exclusive contracts, we incorporate risk aversion of the producer and uncertainty of rival's entry. In our model, we assume increasing marginal cost of the raw milk producer and an exogenous downstream market price. The rival's entry can effectively be deterred under certain combinations of the rival's entry probability and producer's level of risk aversion. Increasing farmer's risk aversion reduces the compensation the producer requires to sign an exclusive contract. This implies that the producer forgoes uncertain higher prices in a competitive market environment for the compensation paid.

Generally, the producer is better off in terms of profit in case of market entry of the rival dairy. Only for rather high values of producer risk aversion and low entry probability of the rival, the incumbent dairy can use an exclusive contract to deter market entry. According to empirical studies, the majority of producers prefer a short-term contract period up to two years (Schlecht *et al.,* 2013) and the possibility to change the processor on a short notice. In addition, short cancellation periods and extraordinary termination clauses are preferred by the majority of producers which is perceived as a strong bargaining instrument for a better milk price (Steffen *et al.,* 2009). These requests are reflected by our model, which shows that the possibility to change the processor is beneficial for producer as he can achieve a higher milk price when the rival dairy processor enters the market. Long-term contracts combined with the obligation to supply and long cancellation periods reduce competition on the raw milk market. To assure decision flexibility for farmers regarding their contractual relationship and to improve their ability to change processors in case of unsatisfactory raw milk pricing, we conclude that contracts should have appropriate cancellation periods.

From the perspective of the dairy processor there is always an incentive to keep the monopsonistic position on the market. This occurs because market entry of the rival results in market foreclosure for the incumbent as the producer will offer all production to the rival who can pay the better price. The market entry of the rival does not lead to another monopsony as we assume that the incumbent is still active with its processing facilities and wants to regain its market share on the market. Therefore, the rival has to maintain its competitive pricing strategy in order to prevent the incumbent from re-entering the market.

Reflecting our results in light of the German sector inquiry on milk, we find that it is possible that a dairy processing company abuses its dominant position with long-term contracts, long cancellation periods and the obligation to supply. Therefore, from a competitive standpoint, it is essential to consider these findings in the contract design so that the flexibility of farmers to change processor at least in the medium term is not completely erased.

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