

Discussion Paper 2014:3

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Abstract

In 2010, the European (EU) High Level Expert Group on milk proposed the introduction of standard contracts between raw milk producers and processors to improve the bargaining position of producers and to stabilize the market by balancing dairy supply and demand. However, contracts may distort competition and deter market entry of rival dairies. We analyze competitive effects of contracts between dairy producers and processors by constructing a game theoretic model. We show that an incumbent dairy can deter a rival dairy's market entry by offering an exclusive contract to a risk averse producer.

Keywords: entry deterrence, imperfect competition, buyer power, delivery contracts, dairy processing

JEL classification: L13, L14, L41

1 Introduction

The liberalization of the EU milk market and the abolishment of the quota system in 2015 raises concerns regarding market power of processors in general and the competitive effects of contractual relations in the dairy processing sector in particular. Empirical studies (Steffen et al., 2009; Schlecht et al., 2013) have shown that farmers strongly favor a redesign of raw milk contracts in terms of contract length and cancellation periods. Further, releasing farmers of their supply obligation and allowing them to sell to more than one dairy processor is seen as an improvement in terms of both farmers' flexibility and bargaining position (Steffen et al., 2009; Schlecht et al., 2013, Bundeskartellamt, 2012).

Contracts may reduce price risks and secure delivery quantities for dairy producers and input quantities for processors. But they may also let processors exercise market power by binding dairy producers and reducing delivery flexibility. This may even lead to entry deterrence of other dairy processors. Consequently, the sector inquiry on milk, conducted by the German federal cartel authority, posed the question whether long term delivery contracts in combination with a supply obligation may lead to an abuse of a dominant market position of processors (Bundeskartellamt, 2012).

Contracts are frequently used in agriculture, but the anticompetitive effects of exclusive contracts, i.e. contracts that comprise the obligation to supply to the contractor only, have been scarcely studied under the specific characteristics of agricultural markets (exceptions e.g.: Xia and Sexton, 2004 for the U.S. cattle industry). In the general antitrust literature, models that analyze exclusive contracts focus on the analysis of seller market power which is of limited relevance on agricultural markets (e.g. Segal and Whinston, 2000; Rasmusen et al., 1991; Aghion and Bolton, 1978).

Although agricultural markets are often assumed to be perfectly competitive, the structure of agricultural markets is more precisely characterized by a low concentration of farmers 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 is scarcely handled in the agricultural economic theory literature (exceptions are Sexton, 2013; Mérel, 2011; Crespi et al., 2012; Sexton 2013; Graubner et al. 2011; Alvarez et al.2000).

The objective of our paper is to analyze the competitive effects of contractual relations in the dairy processing sector in light of the structural changes on the milk market. We thereby contribute to the literature by developing a game theoretic model that is based on the antitrust literature but considers the specific

characteristics of the milk market. Further, in contrast to former models of exclusive contracts, we incorporate uncertainty and risk behavior.

The paper analyzes the competitive effects of exclusive contracts between one representative raw milk producer and a private dairy processor. A rival 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 has decided whether to accept the contract with the incumbent, the rival decides upon entry. By incorporating uncertainty and risk behaviour of the producer, 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.

The paper is organized as follows. The next section gives an overview on contracts in the EU milk market and section 3 presents relevant literature. Section 4 presents the model, where in a first step a baseline model structure is conducted. In a next step, risk attitude and uncertainty is incorporated in this model. Subsequently, a numerical example underlines the theoretical results. Section 4 concludes.

2 Contracts in the EU milk market

The EU milk market is characterized by long term relations between producers and processors and local markets with inelastic market supply due to the high perishableness of the commodity and high investment costs. However, new cooling and transport technologies provide selling alternatives for farmers to sell their commodity also across longer distances.¹ These selling alternatives become now more relevant in light of the deregulation of the milk market and the corresponding expected increase of competition in the dairy sector (Spiller and Wocken, 2006).

¹ The German federal cartel authority assumed a 200 km radius around a dairy for raw milk sourcing (Bundeskartellamt, 2012).

Dairy processing firms are interested in securing their raw milk delivery and consequently want to bind producers through long term contracts. In Germany, 45% of the contracts between private dairies and milk producing farmers have a duration longer than two years. Further, 85 % of German farmers that deliver milk to private dairy processing facilities are obliged to supply their whole production and the processing facility is likewise obliged to take the whole amount.² This supply obligation in combination with long term contracts can potentially lead to an abuse of a dominant position of processors (Bundeskartellamt, 2012). By EU law, the abuse of a dominant position is prohibited (article 102 of the Treaty for the Functioning of the European Union (TFEU)). Strong or dominant processors are not allowed to use their market power to tie up producers through long term contracts without appropriate cancellation periods. The final report of the German federal cartel authority inquiry on milk concludes that an abuse of a dominant position on the milk market can be found when dairy processors deter competition or entry to the market for raw milk using long term contracts and the obligation to supply (Bundeskartellamt, 2012: section 106).

The design of contracts has been discussed by the high level expert group (HLG) on milk set up by the European Commission after the milk market crisis in 2008/2009. The objective of the HLG is to find instruments that help to stabilize and liberalize the milk market in light of the quota abolishment in 2015. As contracts used in recent years were often not well specified, the HLG recommended that contractual agreements should not only become compulsory but also contain a minimum standard of specified criteria. On the basis of the propositions of the HLG, the European Commission released the “milk package”, which is applicable since October 2012 and specifies that the decision on whether or not to introduce standard contracts lies with the member states (European Commission, 2012). Currently, 15 member states have decided to introduce compulsory contracts (Ernst and Young, 2013). Given this high adoption rate and

² In dairy cooperatives this rule applies for 100 % of the milk delivering farmers.

in light of the concern of the German sector inquiry about resulting anticompetitive effects on the milk market, it is important to precisely understand the competitive implications of such obligatory contracts especially when they are exclusive.

3 Relevant Literature

The analysis of contractual relations in the dairy processing sector requires the consideration of both contract design and their potential competitive effects. While dairy producers' preferences for contract design have been investigated in empirical studies with a focus on the German milk market, competitive effects of contracts in general are assessed with theoretical models. Therefore, empirical and theoretical literature is discussed separately in this section.

3.1 Empirical work analyzing contracts for raw milk

Several empirical studies in the German milk market reveal farmers' preferences concerning contract duration, cancellation periods and the possibility to switch between processors. According to a study by Schlecht et al. (2013), 51% of surveyed farmers prefer the option to sell to other dairies in case of an increase in production quantity and nearly 40% prefer to only contractually fix a base amount of milk and keep the flexibility to sell all milk exceeding this contract quantity on the free market at their own risk. Concerning contract duration, a study regarding risk strategies and risk management of dairy farmers in northern Germany, (Schaper et al., 2008), revealed that one third of the interviewed farmers prefer long term contracts with dairies to reduce risk, one third prefer short term contracts and one third is indifferent. In reality, 48% of dairy farmers delivering to private dairies in Germany have contract durations shorter than two years, 29% of 2-4 years and 23 % of more than 5 years. Contract cancellation periods lie between 6 month to one year (52%) and shorter than 6 months (39%). (Bundeskartellamt, 2012). Addressing farmers' perceptions on contract design after the abolishment of the milk quota system, Schlecht et al. (2013) found out that 58% of the surveyed farmers in the north western part of Germany prefer contract durations of one to

two years, 16 % prefer a shorter period and 15% a longer contract period, which is in line with the findings of the sector inquiry on milk. Concerning the obligation to supply, 70 % of farmers prefer to keep the existing system where dairies are obliged to accept the whole delivered production amount and 66 % want to maintain their supply obligation. Steffen et al. (2009) state that short cancellation periods are preferred by 61% of the farmers and 74% wish for extraordinary termination clauses that 44 % perceive as a strong bargaining instrument. The possibility to switch between dairies on short notice is important for 47% of farmers, whereas 33 % see no need for such clauses. Overall, these findings show that farmers would like to be more flexible as they desire shorter contracts, would like to change dairies or even distribute some of their production quantity via the free market. Also the preference for short term contracts stresses the desired flexibility, which should be incorporated in the contract design.

3.2 *Theoretical work analyzing competitive effects of exclusive contracts*

Entry deterring effects of exclusive contracts are analyzed in the antitrust literature with focus 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 on the specific oligopsony 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 considers risk behavior of farmers (although Innes and Sexton (1994) discuss at least the implication).

The antitrust literature focuses on the analysis of exclusive supply contracts with an incumbent seller contracting a buyer who is usually a consumer. 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 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. 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 of exclusive contracts which lead 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 his fixed costs. If buyers sign exclusive contracts, it is difficult for the entrant to get the minimum scale he needs 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 is relevant for demand and affects the possibility of entry deterrence.

In contrast to the models of the antitrust literature, our model explains the signing of an exclusive contract with uncertainty of rival's entry and risk aversion of the signer from the upstream market, the raw milk producer. On the intermediate level of the market, the dairy processing stage, dairy processors procure milk from the raw milk producer and can offer exclusive contracts. Entry takes place in this intermediate buyer level of the market and active dairy processors sell dairy products to the retailer on the downstream market.

4 The Model

The model is constructed as follows. For the upstream market, we assume that there is one milk producing farmer who represents a number of farmers taking the price for raw milk as given. An incumbent dairy processor A is active on the market and procures milk from the raw milk producer and sells the produced dairy product to the retailer. A rival processing dairy B wants to enter the market and to procure raw milk from the producer. The incumbent dairy processor (dairy A) can offer an exclusive contract to the producer in order to deter rival's entry. On the milk market, dairies accept the whole production amount of farmers and cannot choose the quantity they would like to procure. Therefore, we assume that processors compete in prices à la Bertrand on the upstream market. The incumbent dairy A procures the quantity x_A of raw milk from the producer and processes it to an amount q_A of a dairy product according to the relation of $x_A = q_A$. Marginal

processing costs are given by c_A and the price for raw milk is denoted by w_A . The dairy product is sold to the retailer who pays the wholesale price p . For the raw milk producer, we assume a (inverse) supply function $w = x^2$, defined for $x > 0$, implying that the producer is able to extend his production at increasing marginal cost in the short to medium term.

Now consider a rival dairy processor (dairy B) with lower marginal cost of production than the incumbent processor, $c_B < c_A$. If dairy B entered the market, both processors would be competitors on the market for raw milk and compete in milk prices. In the case of Bertrand price competition, the producer delivers milk to the highest bidder on the market. In order to deter the rival dairy B's entry, the incumbent dairy A can offer an exclusive contract to the producer that 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.

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 farmer for all produced raw milk. 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. If the contract is accepted by the producer, monopsony prices and profits are realized.

First, we develop a basic model to demonstrate the effects of exclusive contracts. Then, we further develop the basic model and incorporate risk attitude and uncertainty. In a last step we allow for competition on the downstream market. In all cases we consider two scenarios. In scenario 1, a basic monopsony model structure without contracts is constructed with the incumbent dairy processor and a single milk producer active on the market. Scenario 2 analyzes the case where dairy B enters the market.

4.1 *The basic model*

Let us assume that $c_i < 1$, $c_i < p$ and $w_i < p$, where $i = A, B$. Subindices denote the market actor and the scenario. Table 1 summarizes the findings from the two scenarios of the basic model. In scenario 1, dairy A maximizes its profit over the price for raw milk that it offers 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} .

In case of market entry of dairy B, we observe Bertrand price competition between the processors. The highest price processor B can offer is $\bar{w}_B = p - c_B$, whereas processor A's highest price is $\bar{w}_A = p - c_A$. According to the assumption $c_B < c_A$, processor B is able to offer a higher price for raw milk, $\bar{w}_{B2} > \bar{w}_{A2}$. In case of market entry, dairy B will offer a slightly higher price than dairy A, w_{B2} .³ Consequently, the producer will sell to the rival. As the obligation to supply still exists, there is no possibility to sell more or excessive milk to the other processor. This leads to a positive profit π_{B2} for dairy B and a zero profit for dairy A (see table 1). Consequently, there exists no equilibrium in which both dairies are active on the market. Therefore, dairy A is still present with its production facility after the market expulsion, it just loses its market share on the analyzed market. Then, the market entry of dairy B will not result in another monopsony situation, as dairy B's pricing strategy prevents A from re-entering the market.

³ If $w_A = w_B$, the producer will not split its milk quantity between the two dairies but will sell his whole production to dairy A.

Table 1: Comparison of scenario 1 and 2

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

Source: Own calculations.

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 risk aversion into account, the compensation that dairy A needs to offer to the producer for an exclusive contracts must compensate the producer for the surplus he loses when he accepts the contract. This is the difference between his profits in the two scenarios, $\theta_p \geq \pi_{P2} - \pi_{P1}$, which is equal to

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

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

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

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. This implies that if a lower cost producing dairy B will enter the market, dairy A is not able to keep its raw milk source, as the contract compensation dairy A is able to offer does not offset the higher price that B is able to pay. This changes when we introduce a risk attitude of the producer in the following section.

4.2 *Exclusive contracts under risk attitude and uncertainty*

In order to incorporate risk attitude into our model we assume the producer's utility function to be $u = \pi_p^r$, where the exponent r is the factor for the risk attitude of the producer. If $r > 1$, the utility function implies a risk loving producer, if $r = 1$ a risk neutral producer and $0 < r < 1$ implies absolute risk aversion. The entry of the rival processor is exogenously given by k and $1 - k$ the probability of no entry.

Whether the offering of an exclusive contract leads to entry deterrence depends on the compensation that dairy A can offer. Is the compensation high enough for the producer to accept the contract will be signed and the entry of the rival is deterred. If the exclusive contract is signed, the market is in a monopsony situation which results in the prices and quantities we calculated for scenario 1. The compensation the producer requires depends on the payoff he requires for not staying free on the market, which is equal to his certainty equivalent (CE_p) and the payoff he gets under contract (π_{p1}). Therefore, the compensation that leads to an exclusive contract has to be equal to the difference between the certainty equivalent and the profit in the monopsony situation, $\theta_p^{risk} = CE_p - \pi_{p1}$. which is equal to

$$(3) \quad \theta_p^{risk} = \left[k(\pi_{p1})^r + (1-k)(\pi_{p2})^r \right]^{1/r} - \pi_{p1}.$$

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

$$(4) \quad \theta_A^{risk} = \pi_{A1} - [k * \pi_{A2} + (1-k)\pi_{A1}].$$

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

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

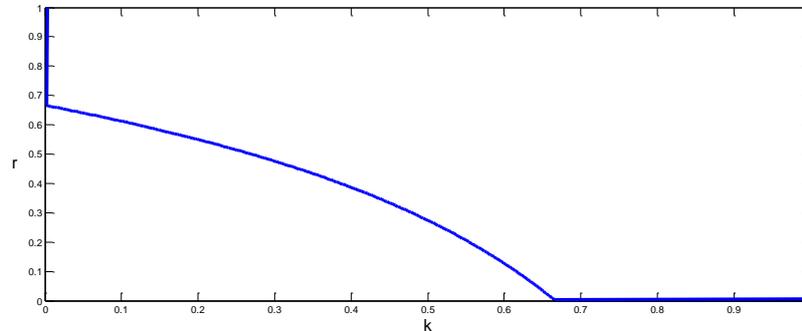
$$(6) \quad \theta_A^{risk} = k \left(\frac{2}{3\sqrt{3}} m^{3/2} \right).$$

Rival's entry can be deterred if $\theta_p^{risk} \leq \theta_A^{risk}$ ((5) ≤ (6)). Hence, dairy A can offer a compensation that induces the producer to sign the contract and thus deters entry if $\theta_A^{risk} - \theta_p^{risk} \geq 0$. To better understand under which conditions this is valid, rearranging leads to

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

Whether this inequality holds depends on the values of k , r and m . The margin $m = p - c_A$ is by definition positive. Therefore whether entry deterrence is possible depends on the term in brackets in equation (7) and thus on the variables k and r . Is the term greater than zero, the inequality holds and entry can be deterred, if it is smaller than zero, entry cannot be deterred.

Figure 1: Effective entry deterrence depending on k and r



Source: Own calculation.

Figure 1 represents levels of k and r that lead to a positive term in equation (7) i.e. 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. Starting from a risk attitude $r \leq 0.66$ and an entry probability $k \leq 0.66$ entry can effectively be deterred with an exclusive contract.

Contrary to the basic scenario without risk aversion and uncertainty it is now possible to deter rival's entry under certain assumptions on producer's risk aversion and on the probability of rival's entry. If the market entry is deterred, monopsony prices and profits as in scenario 1 are realized. As dairy A can achieve a positive profit in scenario 1, dairy A will try to sign contracts with the producers in order to move into a potentially market dominating position. The level of compensation that dairy A needs to maintain a monopsony position depends on the probability of market entry by dairy B and on the assumption about the level of risk aversion: the higher the absolute risk aversion, the lower the required compensation. Not a lot is known about the real "level" of risk aversion among dairy farmers, but it is to assume that in reality, farmers may appreciate some choice regarding where to deliver their raw milk. Further, as empirical studies of farmers' perceptions on contract design have shown, some farmers perceive the possibility to change processors as important and the majority of farmers prefer short cancellation periods and perceive these as a strong bargaining argument

(Steffen et al. 2009). This means that potentially, the incumbent dairy has to offer a rather attractive premium to those farmers in order to remain the sole actor in the market. However, we have shown that, given a medium probability of rival's entry, for risk averse farmers it is possible to deter market entry with exclusive contracts. In the following numerical example we will show how the probability of entry and the risk attitude of the producer concretely influence entry deterrence.

4.3 *Numerical example*

The numerical example is presented to get a better understanding of the results of the model. Therefore, 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 price p that the retailer pays for one unit of a (not further specified) dairy product is assumed to be $p = 0.48$ ct/kg. (Milchindustrieverband 2011)

4.3.1 *Numerical example for the basic model*

For scenario 1 of the basic model, the assumption of monopsonistic behavior by the incumbent dairy results in a very low price for raw milk w_{A1} (see table 2). This is due to the stylized model of milk supply and interaction within the sector but we had to refrain from depicting any other influences on milk price (space, international market etc) and extension to more farmers in order to keep it numerically tractable. Nevertheless the numerical example gives insight in the so far gained results from the theoretical model and helps to get a better understanding of the calculations and discussions.

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	$w_{A1} = 0.09$	$x_{A1} = 0.29$	$\pi_{P1} = 0.0170$
	2	$w_{B2} = 0.27$	$x_{B2} = 0.52$	$\pi_{P2} = 0.0935$

Source: Own calculations.

For scenario 2, the highest price dairy A is able to offer in scenario 2 when dairy B enters the market equals $\bar{w}_A = p - c_A = 0.26$ and dairy B's highest price is given by $\bar{w}_B = p - c_B = 0.30$. If dairy A has not contracted the producer and rival B enters the market, assuming Bertrand competition, dairy B is able to outbid dairy A by offering a slightly higher price for raw milk, say $w_B = 0.27$. Then processor A has a profit of zero and processor B achieves π_B . The producer's expected payoff is given by π_p (see table 2).

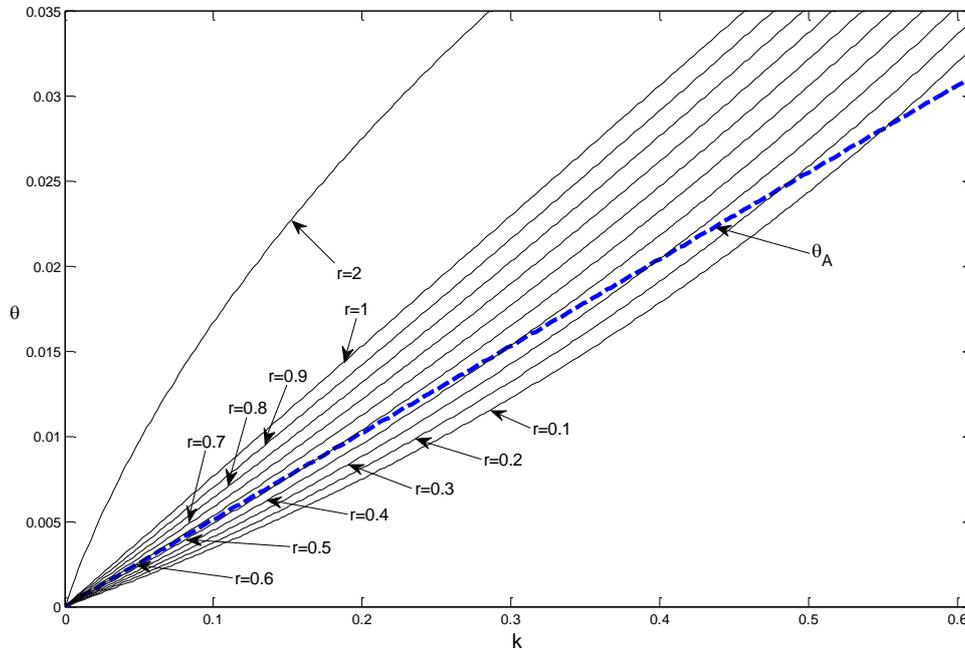
Comparing the two scenarios shows that the Bertrand price competition leads to an extremely high price in scenario 2 compared to scenario 1 and a higher demanded quantity of raw milk which results in more than a quintuplication of producer's profit. Concerning dairy A, the example demonstrates dairy A's incentive to deter rival B's market entry due to the higher profit that can be achieved in the monopsony case. In the producer's view, 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. Holding the monopsony position on the market can only be achieved with an exclusive contract that obliges the producer to deliver his full production of raw milk. For the producer to accept the contract, 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.

4.3.2 Numerical example for exclusive contracts under risk attitude and uncertainty

The compensation that dairy A is able to offer depends on the entry probability of the rival. Producer's demanded compensation depends also on the entry probability and further on the risk attitude. Therefore, the possibility to deter rival's entry depends on the probability of entry and the risk attitude of the producer. The relation of the two compensations depending on the effects of the entry probability and the risk attitude is presented in Figure 2.

Figure 2: Development of compensations depending on probability



Source: Own calculation.

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. 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. However, for a risk averse producer with $r = 0.1$ for example, a entry probability of $k = 0.552$ leads to a compensation of $\theta_p^{risk} = \theta_A^{risk} = 0.2815$. An exclusive contract and a entry probability of $k \leq 0.552$ leads thus to an effectively deterred entry.

The numerical example shows how the incumbent's possibility to deter rival's entry depends on the risk aversion of the farmer and the entry probability of the rival. With increasing risk aversion of the farmer and with decreasing entry probability, the required compensation is decreasing. However, at the same time, the compensation that dairy A is able to offer decreases with decreasing entry

probability. Therefore, whether entry can be deterred depends on the interaction of entry probability and risk attitude.

5 Conclusion

The liberalization of the milk market raises concerns regarding the competition on the market, the design of contracts and the possibilities to enhance farmers' bargaining power. As empirical studies have shown, a redesign of raw milk contracts in terms of contract length and cancellation periods, the supply obligation and the possibility to sell to more than one dairy processor may become crucial. Understanding the competitive effects of contracts in light of the changing structure on the dairy market was the objective of this paper.

Using a game theoretic setting based on the antitrust literature, we showed that exclusive contracts can efficiently deter market entry of a rival when uncertainty is incorporated and the producer is risk averse. This is due to the fact that risk aversion reduces the compensation the producer requires to sign an exclusive contract and to forego higher prices in a competitive market environment. The compensation provides the producer a security and compensates him for the producer surplus he loses by signing the contract. Under monopsony the incumbent dairy's surplus is higher but overall welfare is higher in case of market entry.

Generally the producer is better off in terms of profit in case of market entry of the rival dairy. For certain values of risk aversion and assumptions on the entry probability of the rival, the incumbent dairy A can use an exclusive contract to deter market entry, which leads to a lower profit for the producer. According to empirical studies, the majority of farmers prefer a short term contract periods up to two years (Schlecht et al. 2013). Short cancellation periods and extraordinary termination clauses are preferred by the majority of farmers which is perceived as a strong bargaining instrument for a better milk price. Further, the possibility to change the processor on a short notice is important for some farmers (Steffen et al. 2009). Our study clearly showed that the possibility to change processors is important for farmers as they can achieve a higher milk price when the rival dairy

processor enters the market. If producers have long term contracts combined with the obligation to supply and long cancellation periods, our study shows that then the market entry of the rival dairy processor can be deterred.

From the perspective of the dairy processor there is always an incentive to try to keep the monopsony position on the market. This occurs because market entry of the rival results in market foreclosure for the incumbent as the producer will provide the rival with its whole production amount which leads to the fact that dairy A cannot procure any milk on the market. The market entry of the rival does not lead to another monopsony as we assume that dairy A is still active and wants to regain its market share on the market analysed. Therefore the rival has to keep its pricing strategy in order to prevent dairy A from re-entering the market. Whether dairy A can effectively deter rival's entry depends on the compensation that dairy A can offer the producer as an incentive to accept the contract. That dairy A can effectively deter rival's entry with an exclusive contract holds true for certain values of risk aversion and entry probability.

Reflecting our results in the 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 it is essential to consider these findings in the contract design.

Limitations of the model are the focus restriction to one producer and the fact that only one dairy processor can survive on the market. To get more insight into the changing milk market, further research should be conducted on producer organization. The formation of producer organisations is also regulated in the milk package and should help to enhance farmers' bargaining power regarding contract terms and particularly milk prices. In further research it would be worth to analyze, either in a theoretical or empirical setting, bargaining power of producers and in which way it can be approved by the formation of producer organizations.

6 Literature

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