Contract choice in dynamic markets

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Abstract

This article focuses on vertical agreements when suppliers face efficiency-enhancing effects. In multiple periods, two suppliers produce imperfect substitutes and sell them to a retailer. Learning effects enhance the production efficiency according to the quantity produced. Suppliers separately become more productive over time which directly generates a competitive thread to rivals. The model shows that a dominant supplier uses contracts that reference the rival good to influence all sales levels and hence to optimally profit from the efficiency gains of the rival. Depending on the market structure, the rival can be partially excluded by the contract choice in the long run.

Keywords: Vertical restraints, market-share contracts, dynamic market effects, learning-by-doing.

JEL classification numbers: L13, L42
1 Introduction

Contracts between businesses and their suppliers often contain various conditional terms that either implicitly or explicitly reference rivals. A market-share contract, for example, conditions a special price on the fact whether the share of bought units exceeds a specific percentage level. If the buyer demands this special price, he will arrange the purchase levels of its inputs accordingly to the contractual conditions.

Under competition law, contracts referencing rivals (CRRs) are controversial. Besides pro-competitive reasons as stimulating demand and consumer surplus, there are also anti-competitive reasons to use specific contract terms. When granted by a dominant supplier, antitrust authorities suspect abusive pricing practices behind these contracts as they can be loyalty-inducing, lead to market foreclosure or consumer harm. In the Intel Decision, for example, the European Commission identified Intel’s conditional discounts to present an illegal practice in the x86 CPU market.\(^1\) The rebates applied only if the buyers did not purchase more than a specific amount of CPUs from the rival manufacturer AMD. In particular, the pricing practices of Intel allegedly restricted AMD in competition and in its innovation incentives.\(^2\)

Interestingly, in the time where Intel began to use the discussed contractual terms, the CPUs of AMD had become more and more efficient and were said to be a growing competitive threat against Intel.\(^3\) Not only in Intel but also in further antitrust cases, a dominant supplier started to use modified contract terms at the point in time when the product of a competitor dynamically improved.\(^4\) From an economic point of view, this raises the question in how far the contract choice of a dominant firm could be triggered by an innovative market situation. Moreover it is questionable in how far the contract choice could take influence on the performance of the rival and, for example, could restrict the rival.

In this article, we investigate contractual decisions in a market setting with intertemporal externalities. In particular, we introduce learning effects which make the efficiency of a manufacturer enhance according to its outputs. In doing so, we concentrate on one specific framework in which the above mentioned questions can be analyzed. We suppose that innovation takes place in form of production improvements where, for example, less costs in form of machinery or inputs are necessary after a several time of production. This assumption is realistic and provable in different kinds of markets, especially in the CPU market, which

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\(^2\) The legal proceeding of the Intel case is still ongoing which underlines the complexity of the decision regarding these strategies. Recently, the Court of Justice of the European Union referred the case back to the General Court as it endorses for an effects-based, more economic analysis of Intel's sales strategy.

\(^3\) This market situation is outlined in the Decision of 13 May 2009, COMP/C-3/37.990, paragraph 149-165.

\(^4\) Allied Orthopedic Appliances, Inc. vs. Tyco Health Care Group LP, 592 F:3d 991 (9th Cir. 2010); Concord Boat Corporation v. Brunswick Corporation 309 F:3d 494 (8th Cir. 2002). In both cases, it is mentioned that the contract designs were chronologically accompanied with the introduction of new product versions.
underlines the particular significance of intertemporal effects in current antitrust cases.\footnote{See Cabrera (2008).}

In our model, there is a dominant supplier and its rival which produce imperfect substitutes. Both goods can improve over time, delivering an innovation race due to learning-by-doing. In the downstream market, there is only one active firm. As we suppose complete information, this monopolistic firm maximizes profits, anticipating learning-by-doing of the upstream suppliers. To analyze the contract choice of the dominant supplier and its competitor, we investigate a sequential bargaining game where the dominant firm is characterized by a temporal advantage. Once the vertical agreement is set or negotiations between the dominant supplier and the downstream firm are rejected, the rival supplier can negotiate contractual terms with the downstream firm. We assume that the suppliers always use the simplest contract types which solve for their maximum profits and best long-run outcome.

As a first, general result, we show that a dominant supplier’s contract decision is influenced by learning-by-doing effects. While the dominant supplier could use relatively simple contract types to achieve its best outcome in a static model, it prefers more complicated contract terms when learning-by-doing occurs. In particular, the dominant supplier achieves maximum profits, given by the joint-profit maximizing outcome, only if it uses market-share contracts or similar contract types that influence at least the share of the bought units. We refer to these contract types as contracts that reference the rival supplier’s output (CRRs).

In that regard, our model provides a novel explanation for the use of these specific contracts. The reason why the dominant supplier is reliant on special CRRs is the individual strategic decision of the downstream firm. It chooses quantity levels in the first period of the game to optimally influence its second-period payoffs. The dominant supplier prefers a different relation of sales levels to maximize its own long-run payoffs. Therefore, it will try to influence the decision of the downstream firm. It turns out that the dominant supplier (directly or indirectly) conditions its own prices on the sales of its competitor especially due to the learning process of the rival.

Therefore, the contract choice of the dominant manufacturer takes direct influence on the efficiency gains of the competitor. This means that the dominant supplier has no interest to fully exclude the rival, but to make use of the efficiency progress by establishing the cooperative outcome and siphoning off additional markups.

Depending on the bargaining situation, the contract choice of the dominant supplier could enhance or reduce the efficiency gains of the rival supplier such that the supplier can especially benefit from these effects. We show that the performance of the rival supplier in its negotiations with the downstream firm is decisive for the finding. Whenever the second supplier has relatively high bargaining power, that is if the buyer power vis-à-vis the rival is relatively small, the contract choice of the dominant supplier would even improve the efficiency gains of the rival and increase its outputs. In contrast, if the downstream firm has relatively strong buyer power vis-à-vis the rival supplier, the contract choice of the dominant supplier would restrict the efficiency gains of the rival and would lead to partial
exclusion.

The model contributes to the ongoing discussion about contracts that reference rivals by explaining their use and effects in case of dynamic market effects.

Related Literature

Considering the contract choice of the upstream suppliers, our model is related to the literature on specific vertical agreements as for example loyalty discounts and further contract types that reference competitors. Dealing with loyalty discounts, Semenov and Wright (2013), Ordover and Shaffer (2009), Erutku (2006) focus on exclusionary effects due to specific discount schemes. Packalen (2011) and Chen and Shaffer (2014) show in different model set-ups that market-share contracts offered by an incumbent can deter entry of a potential entrant. In Chao, Tan, and Wong (2018), a dominant firm can partially exclude a capacity-constraint competitor by offering all-units discounts (retroactive quantity discounts). Pro-competitive effects of loyalty discounts are addressed by Mills (2010) and Sloev (2010), for example. They show that market-share discounts can induce selling effort as well as innovation incentives in the downstream market. In addition, double marginalization can be eliminated by the use of these conditional discounts. Inderst and Shaffer (2010) analyze a model with a dominant upstream firm and a competitive fringe that sell their goods to two competing downstream firms. In their model, market-share discounts eliminate downstream competition and lead to the joint profit maximizing outcome. That is, market-share discounts harm downstream competition.

Regarding the sequential contracting structure, the present framework is related to Aghion and Bolton (1987), where an incumbent firm and a potential entrant set contracts with a single buyer. Aghion and Bolton show that the incumbent uses a contract that additionally fixes a penalty fee for the case that the buyer agrees upon exclusive dealing with the incumbent, but deviates from the incumbent’s contract and purchases the entrant’s good. The penalty fee serves to shift rents to the incumbent. Hence, if the potential entrant is relatively efficient, it enters and the incumbent extracts the additional rents. Further models considering entry barriers due to exclusive dealing in related frameworks are inter alia Rasmusen, Ramseyer, and Wiley (1991), Segal and Whinston (2000), Fumagalli and Motta (2006), Simpson and Wickelgren (2007) and Wright (2008). All these models consider take-it-or-leave-it contracts offered by the (upstream) firms. Furthermore, Marx and Shaffer (2008, 2010) analyze single-period sequential bargaining games. In Marx and Shaffer (2008), there are two suppliers of imperfect substitutes that sequentially bargain with a single buyer. If the first supplier can condition its price on the fact whether the second supplier’s good is purchased or not, the profitable contract of the first supplier makes the buyer purchase both goods. Wholesale prices are such that the buyer chooses the industry-profit maximizing outcome and fixed fees are used to shift rents from the second supplier upstream. Sequential negotiations are also studied by Spier and Whinston (1995), as well as Marx and Shaffer (1999).
Similar to Aghion and Bolton (1987), Ide, Montero, and Figueroa (2016) as well as Choné and Linnemer (2015, 2016) deal with sequential bargaining games in set-ups with incomplete information. The models consider that information about the entrant is rare. Neither the production costs nor the demand for the entrant’s product are known when the incumbent and the buyer negotiate their contract. The models emphasize the contract choice of the incumbent. Ide et al. (2016) establish a link between the likelihood of entry deterrence by nonlinear contracts and bargaining power of the incumbent vis-à-vis the buyer. Choné and Linnemer (2015) additionally assume that the buyer can resell units. If the buyer accepts a quantity threshold of the incumbent and, later on, discovers that the quantity overtops its needs, the buyer can throw away or resell unused units. It is shown that the entrant is not fully excluded by conditional contracts such as market-share discounts. Choné and Linnemer (2016) assume that the entrant has a capacity constraint such that the buyer cannot cover all its needs if it purchases only the entrant’s good. In this context it can be shown that a conditional contract may inefficiently exclude the entrant from the market.

In our model, sequential negotiations depict the asymmetry between the first and second supplier. In particular, the dominant supplier is characterized by its first-mover advantage in the sequential setting. Especially with regard to the mentioned legal decisions, we suppose that both suppliers are active firms and negotiate their contract terms one after the other. In this context, we assume complete information, because costs and demand structure of the suppliers could be derived from previous periods.

In addition, our model is related to the literature on buyer power as we allow for negotiations and bargaining power. Determinants and consequences of buyer power are inter alia investigated by Inderst and Wey (2007, 2011). In addition to the above mentioned models, Allain and Chambolle (2011) studies the role of bargaining power on welfare in a vertical structure where producers can set price-floors. Our model is related to Allain and Chambolle (2011), as we show, that buyer power has an impact on long-run efficiency gains and welfare.

Our focus lies on the impact of inter-temporal externalities, especially on learning-by-doing. Doganoglu and Wright (2010) analyze exclusive dealing in a context with network effects in one- and two-sided markets. Karlinger and Motta (2012) also analyze exclusionary contracts in context of network goods. To the best of our knowledge, there is no article dealing with the contract choice of upstream suppliers which face learning effects.

2 Model Setting

The market dynamics we concentrate on are intertemporal externalities which occur during the manufacturing process. In our model, these learning effects manifest in the marginal cost of production. While fixed costs are sunk and therefore left out of consideration, the suppliers’ marginal costs decrease according to the industry-specific learning parameter $\lambda > 0$ and the sum of their produced units.\footnote{With this assumption, we follow Cabral and Riordan (1997).} For simplicity, we analyze two periods. In the
first period, marginal costs of supplier J are \( c_J > 0 \) and exogenously given. As a consequence of learning-by-doing, second-period marginal costs are given by \( c_{J2} = \max\{0, c_J - \lambda q_{J1}\} \) where \( q_{J1} \) is the first-period sales level of supplier J. We concentrate on settings where the learning parameter \( \lambda \) is such that second-period marginal costs stay positive, \( c_{J2} > 0 \).

There are two upstream firms, supplier A and B, facing learning effects. They produce imperfect substitutes with initially given marginal costs \( c_A \) and \( c_B \). In each period, they offer their goods to a single monopolistic downstream firm R. R purchases the goods and, in the same period, resells them to final consumers.

For simplicity, we assume that costs of distribution are normalized to zero. The inverse demand system is time-invariant. It is characterized by

\[
P_A(q_{At}, q_{Bt}), \quad P_B(q_{At}, q_{Bt}),
\]

where \( q_{At}, q_{Bt} \) are quantities sold in period \( t = 1, 2 \). We suppose that \( P_I(q_{At}, q_{Bt}) \in \mathbb{C}_1 \), and \( \frac{\partial P_A}{\partial q_{At}} < \frac{\partial P_B}{\partial q_{Bt}} < 0 \) whenever \( P_I(q_{At}, q_{Bt}) > 0 \) for \( J, I \in \{A, B\} \). In addition, we assume that maximum industry profits \( \pi_I = \max(P_A(q_{At}, q_{Bt}) - c_{At})q_{At} + (P_B(q_{At}, q_{Bt}) - c_{Bt})q_{Bt} \) as well as the maximizing quantities \( q'_{At} \) and \( q'_{Bt} \) are positive. In this way, we attend to the cases where both products are consumed and no good is excluded whenever all firms would cooperate.

Downstream firm R considers \( P_A \) and \( P_B \) maximizing its own profits. It can purchase one, both or no goods and chooses quantities \( q_{At}, q_{Bt} \) depending on the contractual terms of A and B. R bilaterally and sequentially negotiates with both suppliers. Independent of time, downstream firm R possesses bargaining power \( \beta_J \in [0, 1] \) vis-à-vis upstream firm \( J \in \{A, B\} \). If \( \beta_J \) equals zero, the upstream firm has all bargaining power. In that case, J offers a take-it-or-leave-it contract, which R can (only) accept or reject. If however \( \beta_J \) equals one, the downstream firm has all bargaining power and offers a take-it-or-leave-it contract to the upstream firm. In this case, the upstream firm would act as a competitive fringe. We use the Nash-product to solve for bilateral bargaining.

The subject for negotiation are specific contents of contracts. The suppliers decide which contract type they want to offer. Then, the supplier and downstream firm R negotiate the specific values. We suppose that the suppliers always use the simplest contract type that leads to the most profitable outcome that they could reach.

The timing of the sequential bargaining game is as follows. Each period consists of three stages. First, the dominant upstream firm A chooses a contract type and negotiates
the contractual terms of the contract menu with downstream firm R. Then, upstream firm B chooses a contract type. B and downstream firm R negotiate their contractual terms. Afterwards, downstream firm R sets final prices as well as quantities. After the first period, marginal costs of A and B decrease with respect to first period sales.

In our model, both upstream firms face learning effects and both firms act strategically. By this means, the upstream firms generally have the possibility to react on the contract choice of their competitor. The suppliers can be distinguished by the size of their marginal costs or by their bargaining power vis-à-vis the downstream firm. The main asymmetry in this model is however the first-mover advantage of supplier A over supplier B. It emphasizes A’s dominance in the market. We assume that the strategic dominance persists over time and is independent of the efficiency of the suppliers. In contrast, the order of marginal costs could change and it is possible to assume equally efficient suppliers \((c_A = c_B)\) or even a more efficient rival \((c_B < c_A)\) in the initial period. That is, a less or equally efficient competitor might become more efficient over time or might enlarge its efficiency gains over the dominant supplier.

In the following, demand parameters and cost functions are common knowledge. In addition, contractual agreements are observable for all firms and only single-period/short-term contracts are considered.

3 Preliminary Analysis

It is noteworthy that the contract choice of the suppliers is highly dependent on the market structure. Without any market dynamics, relatively simple contract types are sufficient to achieve the maximum outcome in the given context. When suppliers face learning effects, more complicated contracts are needed to achieve the optimal outcome. Prior to the comprehensive analysis, we first focus on the case without market dynamics. Then, we show that the contract choice of the static model is not desirable for the firms in the dynamic setting.

3.1 Contract choice without market dynamics

First of all, we consider the single-period sequential bargaining game. On the one hand, this case shows the outcome whenever market dynamics are not regarded. On the other hand, the single-period outcome is part of the long-run calculations and therefore needed in the following analysis.

In the short-run, both suppliers sequentially offer a contract to the downstream firm. The downstream firm can negotiate the specific contractual terms with the supplier. Then it accepts or rejects the offer. Depending on the accepted contracts, the downstream firm maximizes its own profits. In the following, we assume that the suppliers choose to offer the simplest, sufficient contract type that leads to the maximum profits for them.
Proposition 1 (Single period contract choice).

In a single-period sequential bargaining game, the maximum achievable outcome is \( q_{At} \), \( q_{Bt} \) given by the maximization of integrated profits, \( \pi^I_t = \max(P_A(q_{At}, q_{Bt}) - c_{At})q_{At} + (P_B(q_{At}, q_{Bt}) - c_{Bt})q_{Bt} \). The simplest contracts that lead to this result are a two-part-tariff of supplier B \( (T_{Bt}) \) and an all-unit discount of supplier A \( (T_{At}) \), that is

\[
T_{Bt} = (w_{Bt}, F_{Bt}), \quad \text{and} \quad T_{At} = \begin{cases} 
(w_{At}, F_{At}) & \text{if } q_{At} < q^*_A, \\
(w^*_A, F^*_A) & \text{if } q_{At} \geq q^*_A
\end{cases}
\]

with \( q^*_A = \arg \max((P_A(q_{At}, 0) - c_{At})q_{At} \right) \). Profits of suppliers A and B and downstream firm R are then given by

\[
\begin{align*}
\pi^*_A &= (1 - \beta_A)\pi^I_t - (1 - \beta_A)\beta_B\pi^B_t, \\
\pi^*_B &= 0, \\
\pi^*_R &= \beta_A\pi^*_A + (1 - \beta_A)\beta_B\pi^B_t,
\end{align*}
\]

whereby \( \pi^B_t = \max(P_B(0, q_{Bt}) - c_{Bt})q_{Bt} \) are maximum joint profits of B and R in case the good of supplier A is not sold (outside option of retailer R).

The formal analysis and specific contractual terms are depicted in the Appendix.

Following the backwards induction, downstream firm R decides about quantity levels depending on the negotiated and accepted contractual criteria. If it is more profitable to choose only one contract, downstream firm R would skip negotiations with the corresponding second supplier. The suppliers however will modify their contractual terms to ensure that the retailer accepts their contract and buys its product.

Negotiating with supplier B, the downstream firm and the supplier maximize their joint payoffs and subdivide it with regard to their bargaining power. A simple two-part tariff is sufficient for supplier B, because the market participation of supplier A is settled at this stage of the game. Negotiating with supplier A, the downstream firm and the dominant supplier will also consider their joint payoffs. When the retailer bargains with both suppliers, maximum industry profits could thus be achieved and due to the fixed fees of the suppliers, the dominant supplier could additionally shift rents from supplier B towards himself. For the maximum outcome, however, the dominant supplier has to ensure that the retailer buys both goods. If supplier A would only use a two-part tariff, it would be more profitable to the retailer to accept the contract of supplier A and reject the contract of supplier B. This however would lead to smaller profits for the dominant supplier than in case where both imperfect products are sold. Therefore, the dominant supplier will add a condition to its contractual terms that conditions an unattractive price to the case where only the good of supplier A is in the market. The contractual term could directly condition on exclusivity. But it is also possible to achieve the outcome by using a condition on its own quantity level.

As a result, both suppliers are active and offer relatively simple contract types. The dominant supplier offers a two part tariff with a condition on quantity levels. Supplier B
offers a simple two-part tariff. We denote the determined contract combination as benchmark tariffs. In the static game, the dominant supplier A and downstream firm R finally share maximum industry profits. Payoffs, which technically would be allocated to supplier B, are shifted upwards by the contract of supplier A.

3.2 Maximum long-run industry profits

The static model shows that firms want to maximize industry profits. The reason is that the sequential bilateral negotiations enable the dominant supplier and the downstream firm to achieve these payoffs and to divide them according to their bargaining power.

In the long-run model with learning effects, the sequential bargaining process does not change, compared to the static model. The firms decide about contractual terms and quantity levels in the first period and once again in the second period. However, the negotiation structure stays the same. The desired payoffs in the long-run set-up will thus be maximum industry profits.

To determine long-run industry payoffs, second-period payoffs have to be considered. In particular, \( \pi^I_2 \) includes second-period marginal costs which themselves depend on first-period quantities. We take this dependency into account and denote second-period payoffs by \( \pi^I_2(c_{A2}, c_{B2}) \). Thus, first period quantity levels influence the second-period outcome due to the dynamic effects of learning-by-doing.

Assumption 2.

Long-run industry payoffs depend on first-period quantities and are given by

\[
\Pi_I(q_{A1}, q_{B1}) = (P_A(q_{A1}, q_{B1}) - c_A)q_{A1} + (P_B(q_{A1}, q_{B1}) - c_B)q_{B1} + \delta \pi^I_2(c_{A2}, c_{B2}).
\]

The Hessian matrix is negative definite and the quantity levels \( q^I_{A1}, q^I_{B1} \) which maximize \( \Pi_I(q_{A1}, q_{B1}) \) are positive.

Assumption 2 ensures the existence of a unique maximum of industry payoffs. The optimal quantity levels \( q^I_{A1} \) and \( q^I_{B1} \) are characterized by the equation system

\[
\begin{align*}
\frac{\partial P_A}{\partial q_{A1}} q_{A1} + \frac{\partial P_B}{\partial q_{A1}} q_{B1} + P_A(q_{A1}, q_{B1}) - c_A - \delta \lambda \frac{\partial \pi^I_2}{\partial c_{A2}} &= 0, \\
\frac{\partial P_A}{\partial q_{B1}} q_{A1} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(q_{A1}, q_{B1}) - c_B - \delta \lambda \frac{\partial \pi^I_2}{\partial c_{B2}} &= 0.
\end{align*}
\]

In addition, Assumption 2 ensures that it is optimal when both goods are purchased and hence that both suppliers are active. Note that the influence of learning effects on quantity levels are given by the partial derivatives of second period payoffs \( \pi^I_2 \).

3.3 Benchmark tariffs in the dynamic context

For the time being, we suppose that both suppliers would choose the contract types which are determined in the static model.
Those contracts result as the optimal contractual decisions in the second period of the game (Proposition 1). Hereafter, we present the outcome when the suppliers use these contract types in the first period as well.

**Stage 3**

Following the backwards induction, the downstream firm maximizes its long-run payoffs in period one with respect to both quantity levels $q_{A1}$, $q_{B1}$. To ensure that a unique equilibrium exists, we assume that long-run profits of downstream firm R are concave.

**Assumption 3.**

*Long-run payoffs of downstream firm R are given by*

$$
\Pi_R(q_{A1}, q_{B1}) = (P_A(q_{A1}, q_{B1}) - w_{A1})q_{A1} + (P_B(q_{A1}, q_{B1}) - w_{B1})q_{B1} + \delta \pi^*_R(c_{A2}, c_{B2})
$$

*where the Hessian matrix is negative definite.*

If the downstream firm purchases exclusively from supplier A, it chooses $q^o_{A1}(w^o_{A1})$, given by

$$
\frac{\partial P_A}{\partial q_{A1}}q_{A1} + P_A(q_{A1}, 0) - w_{A1} - \delta \lambda \frac{\partial \pi^*_R}{\partial c_{A2}} = 0.
$$

If downstream firm R purchases only the good of supplier B, R would choose $q^o_{B1}(w^o_{B1})$ in a similar way. If R decides to purchase both goods, it chooses $q_{A1}(w_{A1}, w_{B1})$, $q_{B1}(w_{A1}, w_{B1})$ according to

$$
\frac{\partial P_A}{\partial q_{A1}}q_{A1} + \frac{\partial P_B}{\partial q_{A1}}q_{B1} + P_A(q_{A1}, q_{B1}) - w_{A1} - \delta \lambda \frac{\partial \pi^*_R}{\partial c_{A2}} = 0, \quad (6)
$$

$$
\frac{\partial P_A}{\partial q_{B1}}q_{A1} + \frac{\partial P_B}{\partial q_{B1}}q_{B1} + P_B(q_{A1}, q_{B1}) - w_{B1} - \delta \lambda \frac{\partial \pi^*_R}{\partial c_{B2}} = 0. \quad (7)
$$

In each case, downstream firm R considers the impact of learning-by-doing on its own payoff ($\frac{\partial \pi^*_R}{\partial c_J}$, $J = A, B$). Note that due to this, the decision of R implies that the joint-payoff maximizing outcome would not be achieved by setting wholesale prices equal to marginal costs. The reason is that R does not keep in mind the impact of learning on the suppliers’ payoffs. In this way, the decision of R (considering learning-by-doing) deviates from the one without learning effects.

**Stage 2**

In stage two, the second supplier B and the downstream firm negotiate the terms of a two-part tariff. If supplier B and downstream firm R deal exclusively, the optimization problem is given by

$$
\max \left( (P_B(0, q^o_{B1}(w_{B1})) - w_{B1})q^o_{B1}(w_{B1}) - F_{B1} + \delta \pi^*_R(c_{A}, c_{B2}) \right)^{\beta_B} \cdot \left( q^o_{B1}(w_{B1}) \cdot (w_{B1} - c_B) + F_{B1} + \delta \pi^*_R(c_{A}, c_{B2}) \right)^{1-\beta_B}.
$$
The resulting two-part tariff achieves the outcome that makes B and R maximize their joint payoffs, \( \Pi^{(B)} = \max(P_B(0,q_{B1}) - c_B)q_{B1} + \delta \pi_{R2}(c_A, c_B). \) The payoff of R would be 
\[ \Pi^{(B)}_R = \beta_B \Pi^{(B)}, \]
the payoff of supplier B 
\[ \Pi^{(B)}_B = (1 - \beta_B) \Pi^{(B)}. \]

If supplier A and downstream firm R negotiate a menu of contracts in stage one, supplier B and firm R optimize
\[
\max \left( \Pi_R(w_{A1}, F_{A1}, w_{B1}, F_{B1}) - \Pi_R^{(A)}(w_{A1}^o, F_{A1}^o) \right)^{\beta_B} \cdot (\Pi_B(w_{A1}, w_{B1}, F_{B1}) - 0)^{1-\beta_B},
\]
where \( \Pi_R(w_{A1}, F_{A1}, w_{B1}, F_{B1}) = (P_A(q_{A1}(w_{A1}, w_{B1}), q_{B1}(w_{A1}, w_{B1})) - w_{A1})q_{A1}(w_{A1}, w_{B1}) + (P_B(q_{A1}(w_{A1}, w_{B1}), q_{B1}(w_{A1}, w_{B1})) - w_{B1})q_{B1}(w_{A1}, w_{B1}) - F_{A1} - F_{B1} + \delta \pi_{R2}(c_A, c_B) \)
is the profit of firm R depending on the two-part tariffs, and the profit of supplier B is 
\[ \Pi_B(w_{A1}, w_{B1}, F_{B1}) = q_{B1}(w_{A1}, w_{B1}) \cdot (w_{B1} - c_B) + F_{B1} + \delta \pi_{R2}(c_A, c_B). \]
\[ \Pi_R^{(A)}(w_{A1}^o, F_{A1}^o) = (P_A(q_{A1}(w_{A1}^o), 0) - w_{A1})q_{A1}(w_{A1}^o) - F_{A1} + \delta \pi_{R2}(c_A, c_B) \]
is the outside option of downstream firm R.

The arising two-part tariff between B and R includes \( w_{B1} = c_B. \) Again, the wholesale price \( w_{B1} \) makes R maximize cumulated payoffs of B and R. The reason is that there is no impact of learning-by-doing on the second-period payoff of B, \( \pi_{B2}(c_A, c_B) = 0. \)
Therefore, the quantity choice of downstream firm R includes the impact of learning on cumulated payoffs of B and R. Cumulated payoffs are divided with respect to bargaining power \( \beta_B \) and the outside option of downstream firm R in stage two, which is \( \Pi_R^{(A)}(w_{A1}^o, F_{A1}^o). \)
Payoffs are given by \( \Pi_R(w_{A1}, F_{A1}, w_{A1}^o, F_{A1}^o) \) and \( \Pi_B(w_{A1}, F_{A1}, w_{A1}^o, F_{A1}^o). \)

**Stage 1**

In stage one, the optimization problem of supplier A and downstream firm R is now given by
\[
\max \left( \Pi_R(w_{A1}, F_{A1}, w_{A1}^o, F_{A1}^o) - \Pi^{(B)}_R \right)^{\beta_A} \cdot (q_{A1}(w_{A1}, c_B) \cdot (w_{A1} - c_A) + F_{A1} + \delta \pi_{A2}(c_A, c_B))^{1-\beta_A}
\]
s.t. \( \Pi_R(w_{A1}, F_{A1}, w_{A1}^o, F_{A1}^o) \geq \Pi_R^{(A)}(w_{A1}, F_{A1}). \)

Solving the maximization problem, the negotiated wholesale price is characterized by
\[ w_{A1} = c_A + \delta \lambda \left( \frac{\partial \pi_{A2}}{\partial c_{A2}} + \frac{\partial \pi_{B1}(w_{A1}, c_B) / \partial w_{A1}}{\partial c_{B2}} \right). \tag{8} \]
In contrast to the single-period model, the wholesale price does not equal marginal costs.

As a reason, the dominant supplier modifies the wholesale price due to learning effects. In particular, the downstream firm R chooses quantities according to the prices of the suppliers but also according to the benefits that result due to learning-by-doing. In contrast to the downstream firm that maximizes only its own long-run payoffs, the dominant supplier is interested in achieving the outputs \( q_{A1}^I, q_{B1}^I \) that maximize industry profits. The wholesale

\[ ^{10} \text{Whenever } \pi_{B2} \text{ is positive, the quantity choice of the downstream firm does not maximize cumulated payoffs of B and R, see section ??}. \]
price should make the quantity levels approximate the desired outcome of the dominant supplier.

The second summand on the right-hand side of equation 8 aggregates this reaction. Using (1)-(3), the summand can be reformulated to 

\[(1 - \beta_A) \left( \frac{\partial \pi_1}{\partial q_{A1}} + \frac{\partial q_B}{\partial w_{A1}} \frac{\partial \pi_1}{\partial c_{A1}} + \frac{\partial q_B}{\partial w_{A1}} \frac{\partial \pi_1}{\partial c_{A1}} - \beta_B \frac{\partial \pi_2}{\partial c_{B2}} \right) \]

The first term within the brackets is negative. Separately, it would decrease the wholesale price whereby the output level of supplier A \( q_{A1} \) would increase and the output level of B would decrease. This effect reflects the modification wish of supplier A to influence the quantity choice of the downstream firm corresponding to its own learning effects. The second term however addresses the quantity choice of the downstream firm with regard to the learning effects of supplier B. Yet, the relation of output levels chosen by the downstream firm does not compare to the relation of \( q_{A1} \) and \( q_{B1} \). The second summand in brackets is positive or negative, in particular depending on bargaining power \( \beta_B \). Accordingly, the dominant supplier might use below-cost pricing in the first period to modify the output levels in period one.

**Proposition 4 (Benchmark tariffs).**

The benchmark contracts lead to quantity levels \( q_{A1}^T, q_{B1}^T \) in period one that are characterized by the equation system

\[
\frac{\partial P_A}{\partial q_{A1}} q_{A1} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_A(q_{A1}, q_{B1}) - c_A - \delta \lambda \frac{\partial \pi_2}{\partial c_{A2}} - \delta \lambda (1 - \beta_A) \left( \frac{\partial q_{B1}}{\partial w_{A1}} \frac{\partial \pi_1}{\partial c_{B1}} - \beta_B \frac{\partial \pi_2}{\partial c_{B2}} \right) = 0 \quad (9)
\]

\[
\frac{\partial P_A}{\partial q_{B1}} q_{A1} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(q_{A1}, q_{B1}) - c_B - \delta \lambda \frac{\partial \pi_2}{\partial c_{B2}} - \delta \lambda (1 - \beta_A) \left( \frac{\partial q_{B1}}{\partial w_{A1}} \frac{\partial \pi_1}{\partial c_{B1}} + \beta_B \frac{\partial \pi_2}{\partial c_{B2}} \right) = 0 \quad (10)
\]

The main result following from Proposition 4 is that benchmark tariffs do not lead to the industry profit maximizing outcome when they are used in every period in the dynamic market setting. The reason are the presumed learning effects, and especially the learning effects caused by the rival good.

The calculations in case of the two-period use of benchmark tariffs describes the difficulty. The downstream firm maximizes its own long-run payoffs in period one where it only considers its own benefits from learning-by-doing of the suppliers. Therefore, setting the wholesale prices equal to marginal costs would not lead to the cooperative outcome, given by \( q_{A1}^T \) and \( q_{B1}^T \). While the second supplier takes no influence on the quantity choice of the downstream firm, the dominant supplier has a big interest in modifying the quantity levels. With the benchmark tariffs (a relatively simple two-part tariff), the dominant supplier has only a single instrument to address the quantity choice of the downstream firm. In

\[\text{11} \text{According to the implicit function theorem, we get } \frac{\partial \pi_2}{\partial q_{B1}} = (1 - \beta_A)(\beta_B q_{B1} - q_{A1}^T) \geq 0, \text{ and } \frac{\partial q_B}{\partial w_{A1}} \frac{\partial \pi_1}{\partial c_{B1}} < 0.\]

12
particular, only the wholesale price $w_{A1}$ can influence the quantity levels. With a decrease or increase of the wholesale price (compared to marginal costs), the dominant supplier can increase or decrease its sales level and has an influence on the sales level of its rival. Yet, the relation between the quantity levels chosen by the downstream firm does not confirm to the relation of $q_{A1}$ and $q_{B1}$. An increase or decrease of the wholesale price $w_{A1}$ cannot optimally influence the quantity choice of the downstream firm. That is why the benchmark tariff is not sufficient for the dominant supplier in the dynamic setting.

Note that the reason is especially the learning effect of the rival supplier. If only the dominant supplier would face learning effects, the wholesale price $w_{A1}$ would be a sufficient instrument for the dominant supplier to influence to quantity choice.\(^\text{12}\) Therefore, the suppliers are interested in more complicated contracts than the simple benchmark tariffs because of the competitive threat that stems from learning effects of the rival supplier.

4 Contract Choice

We now analyze the two-period sequential bargaining game with the implied contractual decisions. Solving by backwards induction, the calculation starts with the second period. Proposition 1 already shows the contractual decisions and outcomes for the single period. Second-period payoffs are given by $\pi_{J2}(c_{A2}, c_{B2})$ for $J = \{A, B, R\}$. In general, the first-period long-run analysis corresponds to the single-period approach. Following the backwards induction, the analysis starts with the quantity decision of the downstream firm (stage 3). Then, the contractual decision of the second supplier and its negotiation with the downstream firm have to be considered (stage 2). At last, the contractual decision of the dominant supplier and its negotiation with the downstream firm are considered (stage 1).

As shown above, the benchmark tariffs are not sufficient to achieve maximum payoffs in the long run. That is, in contrast to the calculations of the single-period game, at least the dominant supplier has an interest to choose more complicated contractual terms than simple two-part tariffs. However, the (general) contract choice of the dominant supplier can influence the contract choice of the second supplier and both take influence on the decision-making scope of the downstream firm. To illustrate the modification of the decision-making process, suppose two potential contract combinations out of the set of possibly used contract types. First, if both suppliers use quantity forcing contracts, the downstream firm would not have to decide about quantity levels at all. In contrast, if the dominant supplier chooses a contract that conditions on the sales levels or prices of the rival good, this condition would modify the range in which the downstream firm could choose quantities. That is, the set of sales combinations would be restricted, but the quantity choice would not be fully forestalled. It is therefore not possible to generally follow the backwards induction without any modifications. If we allow for a general contract choice, the decision making process would lead to a massive distinction of cases. To give a transparent overview of the

\(^{12}\)Namely, the second summand in equation 8 would drop out.
calculations, we limit the analysis by prescribing contract types for the dominant supplier.

In particular, the dominant supplier requires contractual terms in period one that directly or indirectly influence the quantity level of the second supplier. Compared to the two-part tariff which was considered in the benchmark situation, the dominant supplier needs an additional term that conditions its price or quantity, for example, on the price or quantity level of its rival. Examples of such contracts that reference the rival’s output are market-share contracts. In the following, we concentrate on these contract types and depict the backwards induction of the first period for this special case. Afterwards, we consider further contract types that reference rivals (CRRs).

4.1 Market-share contract of supplier A

Suppose for now that the dominant supplier A chooses a market-share contract in period one. As before, we suppose that the contract contains a fixed fee, a wholesale price and a condition ensuring that downstream firm R purchases not only the good of supplier A. In addition, the wholesale price is conditioned on the level \( \rho \in [0, 1] \), which defines the relative purchases of the good of supplier A by downstream firm R.\(^\text{13}\)

Supplier B and downstream firm R react on that contract and take their decisions corresponding to the ensuing timing of the game. We outline the analysis of the first period decisions.

Stage 3

Following the backwards induction, the downstream firm R decides about its sales levels. As the relative purchase level is fixed, R maximizes profits according to aggregate quantity or respectively one single quantity \( q_{A1} \), where \( q_{A1}(\rho, q_{A1}) = \frac{1-\rho}{\rho} q_{A1} \).\(^\text{14}\)

If R purchases only one good, it chooses \( q_{J1}^{*}(w_{J1}) \) according to

\[
\frac{\partial P_{J}}{\partial q_{J1}} q_{J1} + P_{J}(q_{J1}, 0) - w_{J1}^{*} - \delta \lambda \frac{\partial \pi_{R2}^{*}}{\partial c_{R2}} = 0 \quad \text{with} \quad J \in \{A, B\}.
\]

If R purchases both goods, it chooses \( q_{A1}(w_{A1}, w_{B1}, \rho) \) and \( q_{B1}(w_{A1}, w_{B1}, \rho) \) according to

\[
\left( \frac{\partial P_{A}}{\partial q_{A1}} q_{A1} + \frac{\partial P_{B}}{\partial q_{A1}} \frac{1-\rho}{\rho} q_{A1} + P_{A}(q_{A1}, \frac{1-\rho}{\rho} q_{A1}) - w_{A1} - \delta \lambda \frac{\partial \pi_{R2}^{*}}{\partial c_{R2}} \right) \frac{1-\rho}{\rho} = 0.
\]

In contrast to the previous cases, the quantity choice depends on both wholesale prices as well as the share of purchases \( \rho \).

Stage 2

If only the good of supplier B is purchased, the supplier and downstream firm R will maximize their joint payoffs and divide those with respect to bargaining power \( \beta_{B} \). Joint

\(^{13}\)In the given context, the incentive compatibility condition could be achieved by combining a specific wholesale price level with purchasing 100 % of supplier A.

\(^{14}\)We initially suppose that the second supplier offers a simple two-part tariff. We refer to the contractual decision of supplier B in stage 2 of the first-period game.
payoffs are given by \( \Pi^{(R)} = \max(P_B(0,q_{B1}) - c_B)q_{B1} + \pi_{R2}^* (c_A,c_{B2}) \) which leads to payoffs \( \Pi^{(R)}_B \) and \( \Pi^{(B)}_R \) for supplier B and downstream firm R. Note that supplier B and downstream firm R consider learning effects in the same way as downstream firm R. The reason is that supplier B does not profit at all from learning effects, \( \pi_{B2}^* = 0 \). Therefore, supplier B has no interest in using more specific contractual terms. It could not improve its situation or take more influence on the outcome.

This result also holds for the case where both goods are purchased. In this case, the optimization problem is

\[
\max_{w_{B1},F_{B1}} \left( \Pi_R(w_{A1},F_{A1},\rho,w_{B1},F_{B1}) - \Pi_R^{(A)}(w_{A1}^o,F_{A1}^o) \right)^{\beta_R} \cdot \left( \frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)(w_{B1} - c_B) + F_{B1} + \delta \pi_{R2}^*(c_{A2},c_{B2}) \right)^{1\beta_R}
\]

where

\[
\Pi_R(w_{A1},F_{A1},\rho,w_{B1},F_{B1}) = (P_A(q_{A1}(w_{A1},w_{B1},\rho),\frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)) - w_{A1}) \cdot q_{A1}(w_{A1},w_{B1},\rho)
\]

\[
+ (P_B(q_{A1}(w_{A1},w_{B1},\rho),\frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)) - w_{B1}) \frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)
\]

\[
- F_{A1} - F_{B1} + \delta \pi_{R2}^*(c_{A2},c_{B2})
\]

and \( \Pi_R^{(A)}(w_{A1}^o,F_{A1}^o) \) is the long-run payoff of downstream firm R if it only purchases the good of supplier A. As before, we denote the conditional prices for this case by superscript ‘o’. The negotiation of supplier B and downstream firm R leads to the wholesale price \( w_{B1}(w_{A1},\rho) = c_B \) and the fixed fee \( F_{B1} \) characterized by

\[
\frac{\beta_R}{\Pi_R(w_{A1},F_{A1},\rho,w_{B1},F_{B1}) - \Pi_R^{(A)}(w_{A1}^o,F_{A1}^o)} = \frac{1 - \beta_B}{\frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)(w_{B1} - c_B) + F_{B1}}.
\]

The payoff of R can thus be written as

\[
\Pi_R(w_{A1},F_{A1},\rho,w_{A1}^o,F_{A1}^o) = \beta_B \Pi_{BR}(w_{A1},F_{A1},\rho) + (1 - \beta_B) \Pi_R^{(A)}(w_{A1}^o,F_{A1}^o)
\]

with \( \Pi_{BR}(w_{A1},F_{A1},\rho) = \)

\[
(P_A(q_{A1}(w_{A1},w_{B1},\rho),\frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)) - w_{A1}) \cdot q_{A1}(w_{A1},w_{B1},\rho)
\]

\[
+ (P_B(q_{A1}(w_{A1},w_{B1},\rho),\frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho)) - c_B) \frac{1 - \rho}{\rho} q_{A1}(w_{A1},w_{B1},\rho) - F_{A1} + \delta \pi_{R2}^*(c_{A2},c_{B2})
\]

**Stage 1**

In stage 1, the dominant supplier and downstream firm R negotiate the contractual terms of a market-share contract. In particular, the negotiation problem is

\[
\max \left( \Pi_R(w_{A1},F_{A1},\rho,w_{A1}^o,F_{A1}^o) - \Pi_R^{(B)} \right)^{\beta_A} \cdot (q_{A1}(w_{A1},w_{B1},\rho)(w_{A1} - c_A) + F_{A1} + \delta \pi_{A2}^*(c_{A2},c_{B2}))^{1\beta_A}
\]

s.t. \( \Pi_{BR}(w_{A1},F_{A1},\rho) \geq \Pi_R^{(A)}(w_{A1}^o,F_{A1}^o) \).
Proposition 5 (Market-share contract of the dominant supplier).

The optimal market-share contract contains the wholesale price $w_{A1}^*$, fixed fee $F_{A1}^*$ and relative purchase level $\rho^*$ such that

- for $\rho = 1$: $\Pi_{BR}(w_{A1}, F_{A1}, \rho) = \Pi_R^{(A)}(w_{A1}, F_{A1})$

- otherwise: the relative purchase level, the related wholesale price and fixed fee are characterized by

$$\frac{\partial P_A}{\partial q_{A1}} q_{A1}(w_{A1}, w_{B1}, \rho) + \frac{\partial P_B}{\partial q_{B1}} \frac{1 - \rho}{\rho} q_{A1}(w_{A1}, w_{B1}, \rho) + P_B(q_{A1}(w_{A1}, w_{B1}, \rho), \frac{1 - \rho}{\rho} q_{A1}(w_{A1}, w_{B1}, \rho)) - c_B - \delta\lambda \frac{\partial \pi^{1}_{I}}{\partial c_{B2}} = 0,$$

(11)

$$w_{A1} = c_A + \delta\lambda \frac{\partial \pi_{A2}^{*}}{\partial c_{A2}} + \delta\lambda \frac{\partial \pi_{A2}^{*}}{\partial c_{B2}} \frac{1 - \rho}{\rho},$$

(12)

$$\frac{\beta_A \beta_B}{\Pi_R(w_{A1}, F_{A1}, \rho, w_{A1}^*, F_{A1}^*) - \Pi_R^{(B)}(w_{A1}, F_{A1}, \rho, w_{A1}^*, F_{A1}^*)} = \frac{q_{A1}(w_{A1}, w_{B1}, \rho)(w_{A1} - c_A) + F_{A1} + \delta\pi_{A2}^{*}(c_{A2}, c_{B2})}{1 - \beta_A}$$

(13)

The contract makes downstream firm $R$ purchase both goods ($\rho < 1$). The final outcome is given by maximum industry payoffs. Output levels are $q_{A1}^I, q_{B1}^I$.

4.2 Further contracts that reference the rival

There are different possibilities to take influence on the quantity choice of the downstream firm. Besides the relative purchase level, the dominant supplier could directly condition prices on the total revenue of the downstream firm or on the relation of retail prices. Such contract types also lead to the joint-payoff maximizing solution. As they all seem to be equally simple and sufficient to achieve the profitable outcome, we refer to them as specific CRRs. On the contrary, conditioning prices on specific quantity levels of its own good, does not make the dominant supplier influence the decision of the downstream firm in the desired way.

Revenue-sharing agreements

One contract type that can influence the quantity choice of the downstream firm in the interest of the dominant supplier implicates revenue-sharing. In these agreements, the supplier promises that the downstream firm will be contributed to its revenues. In particular, the contract implies that the downstream firm will earn a specific percentage of the revenues of the supplier. The exact amount of revenues is thus not fixed. It rather depends on the market outcome.

In the dynamic setting, the dominant supplier might use revenue sharing for the same reason as it prefers market-share contracts over simpler contract types. The dominant supplier can make the downstream firm consider its own levels of learning effects. In particular, the promised revenues of the dominant supplier depend on the quantity choice of the downstream firm $R$. As a part of its payoffs, the downstream firm will modify the quantity levels
so that its own payoffs are maximized. Therefore, the downstream firm changes its quantity
decision to reflect the additional payoffs which occur due to the learning effects of A. The
quantity decision of the downstream firm can thus be changed and can implicate joint payoff
maximizing quantity levels.

**Vertical most-favored nation clauses**

Most-favored nation clauses or price parity rules take influence on the retail price by pre-
scribing the retailers to sell the specific product to the same amount or a lower price than
other retailers do. In contrast, vertical most-favored nation clauses introduced by Carlton
and Winter (2018) condition the retail price of a product on the retail price of a competitor’s
good. For example, the retailer who sells different products is forced to price the good of
one supplier according to the good of a competitor.

This pricing scheme seems to be particularly suitable in the dynamic setting when the
dominant supplier and its rival are equally efficient (in the first period) and both goods
are equally demanded by the final consumers. By prescribing that both final prices are the
same, the downstream firm would be forced to purchase the same amounts of both goods
and therefore the vertical most-favored nation clause would affect the quantity decision in
the same way as a market-share contract.

The contract choice would even be suitable for differences in marginal costs of production
and for different demand structures as long as the dominant supplier could prescribe a
specific price difference for the retail prices of its own good and the good of its competitor.

**All-units discounts**

Last but not least, we focus on all-unit discounts that condition the wholesale price on a
specific quantity level of the supplier’s good. That is, the retailer pays a lower wholesale
price per unit if it purchases at least the prescribed threshold level. If used by the dominant
supplier, the contract might indirectly change the purchase behavior of the downstream
firm with regard to the competitor’s good. As soon as the quantity threshold of the all-unit
discount is relatively large, the downstream firm might either skip buying the competitor’s
good or at least purchase a lower amount than it would be optimal without the specification
of the quantity level.

In the given context with learning-by-doing, it is also imaginable that all-units-discounts
could be used to enhance the efficiency gains of the dominant supplier and to restrict the
efficiency gains of the rival.

Yet, when the dominant supplier forces the downstream firm to purchase $q^I_{A1}$ units of its
good, the downstream firm would still consider only the learning effects of the rival supplier
B. The pricing decision of the dominant supplier in case of an all-unit discounts is not
able to balance the additional demand of the downstream firm regarding the competitive
product.

The calculation is depicted in the Appendix. It rather shows that all-units discounts by
the dominant supplier yield the same result as simple two-part tariffs.

Considering all observed contract types but especially the quantity discount, notice that the dominant supplier has to influence the whole shopping cart of the downstream firm. A stipulation for the quantity level of the rival supplier is decisive for the outcome because of its learning effects.

5 Analysis

In general, the determined outcomes show that the dominant supplier can and will choose a contract type that leads to the industry profit-maximizing outcome. By definition, the initial marginal costs do not vary substantially so that both goods are sold in the joint payoff maximizing case. Therefore, the dominant supplier will not fully exclude its rival supplier by using market-share contracts.

In contrast, the supplier chooses a contract type to profit from the efficiency gains of the rival supplier. However this does not mean that efficiency gains of the second supplier must be sponsored. Compared to the benchmark situation, the learning process of the rival supplier might be limited or also strengthened by the contract choice of the dominant supplier.

In the following, we determine the conditions under which the contract choice of the dominant supplier improves (or reduces) efficiency gains of the rival supplier. We focus on the effects of a ban on market-share contracts and further specific CRRs on the outcome but especially on the dynamic process of the market. In view of competition policy, the question might be especially valuable for equally efficient competitors.

5.1 Efficiency

To analyze the impact of the contract choice on efficiency gains of the rival supplier, we compare the output level \( q_{T}^{I} \) which is reached when the dominant supplier chooses a specific CRR with the quantity level of the benchmark case, that is \( q_{B1}^{T} \).

**Proposition 6 (Efficiency gains).**

Suppose that the bargaining power of the downstream firm vis-à-vis the dominant supplier \( \beta_{A} \) is smaller than one. For the level of bargaining power \( \hat{\beta}_{B} \) of downstream firm R vis-à-vis supplier B that solves \( \beta_{B}q_{B2}^{o} = q_{B2}^{I} \), a menu of simple two-part tariffs of supplier A and downstream firm R leads to the same outcome as market-share contracts, namely to the industry profit maximizing quantity levels.

For \( \beta_{B} > \hat{\beta}_{B} \), a menu of market-share contracts restricts the efficiency gains of supplier B, that is \( q_{B1}^{T} < q_{B1}^{I} \).

For \( \beta_{B} < \hat{\beta}_{B} \), the menu of market-share contracts between dominant supplier A and downstream firm R would in contrast improve supplier B’s efficiency gains, that is \( q_{B1}^{T} < q_{B1}^{I} \).
The proof is delegated to the Appendix.

Note that the result of this comparison stems from the diverse impacts of learning-by-doing on the firm’s payoffs. In case of all firms maximizing payoffs together, they consider

$$\frac{\partial \pi^I_2}{\partial c_{A2}} = -q^I_{A2}(c_{A2}, c_{B2}) < 0, \text{ and } \frac{\partial \pi^I_2}{\partial c_{B2}} = -q^I_{B2}(c_{A2}, c_{B2}).$$

The more marginal costs decrease, the more do industry profits increase. In comparison to the joint profit maximization, learning effects of suppliers A and B have different effects on the single profit functions of the firms. While there is no impact of learning on the payoff of supplier B (because second-period payoffs $\pi^*_B$ are zero), the dominant supplier A and downstream firm R face different effects depending on the bargaining situation. The impact of learning-by-doing on the payoff of supplier A and downstream firm R is

$$\frac{\partial \pi^*_R}{\partial c_{A2}} = -\beta_A q^I_{A2}(c_{A2}, c_{B2}) < 0,$$

$$\frac{\partial \pi^*_R}{\partial c_{B2}} = -(1 - \beta_A)q^I_{A2}(c_{A2}, c_{B2}) < 0,$$

$$\frac{\partial \pi^*_A}{\partial c_{A2}} = -(1 - \beta_A)q^I_{A2}(c_{A2}, c_{B2}) < 0,$$

$$\frac{\partial \pi^*_A}{\partial c_{B2}} = (1 - \beta_A)(\beta_B q^*_B(c_{B2}) - q^I_{B2}(c_{A2}, c_{B2})).$$

If the downstream firm R has all bargaining power over supplier A ($\beta_A = 1$), it maximizes industry payoffs, independent of the contract choice. More interestingly and more logically for a dominant supplier, we henceforth assume that buyer power is smaller than one ($\beta_A < 1$). There are three cases to be mentioned.

First, if $\beta_B = \hat{\beta}_B$ with $\hat{\beta}_B q^*_B(c_{B2}) = q^I_{B2}(c_{A2}, c_{B2})$, the downstream firm considers the impact of learning-by-doing of supplier B to the same extent as in case of joint profit maximization, $\frac{\partial \pi^*_A}{\partial c_{B2}} = \frac{\partial \pi^I}{\partial c_{B2}}$. In this case, the contract choice of the dominant supplier would only have to react on the quantity decision of the downstream firm concerning the good of A. This simplifies the requirements of the contract of supplier A and a simple two-part tariff is sufficient to yield maximum payoffs from the dominant supplier’s point of view. The reason is that the wholesale price could influence the quantity decision of downstream firm R regarding $q_{A1}$. The quantity decision regarding $q_{B1}$ would already be in the interest of the dominant supplier and therefore it does not have to be influenced by the contract of supplier A. Note that this also shows that if only supplier A faced learning effects, specific CRRs would not be necessary. The efficiency gains of the rival supplier B cause the necessity of specified contractual terms for the dominant supplier.

Second, if $\beta_B > \hat{\beta}_B$, downstream firm R supports the product of supplier B more powerfully in its quantity decision than it would be desirable from a joint perspective. The quasi overcompensation of B’s good stems from the second-period payoff of R. On this matter, it stems from the outside option of the downstream firm when it deals with the dominant supplier A. If the downstream firm only purchases the good of supplier B, it would
get $\beta_B$ times the combined payoffs of supplier B and itself. Thus, the larger $\beta_B$ is, the larger is its outside option and the related learning effect. On the contrary, the dominant supplier prefers learning effects to be equal to the joint payoff maximizing levels. A will try to reduce the quantity level $q_{B1}$ with its contract choice, which is also understandable regarding the positive partial derivative $\frac{\partial \pi^*_A}{\partial c_B} > 0$ for $\beta_B > \hat{\beta}_B$. While the specific CRRs do balance the overproduction of $q_{B1}$ triggered by the quantity decision of the downstream firm, the two-part tariffs of the benchmark situation do not fully balance the quantity levels. Therefore, they lead to larger efficiency gains of supplier B than specific CRRs used by supplier A.

Third, in case $\beta_B$ is smaller than $\hat{\beta}_B$, the effects are vice versa. Due to the small buyer power, the downstream firm prefers a smaller quantity level $q_{B1}$ and the dominant supplier will try to increase this level. Simple two-part tariffs do not reach the desired level $q_{B1}$ from supplier A’s point of view and therefore the quantity level as well as learning effects are smaller in case of two-part tariffs than the level in case of joint-profit maximization.

The efficiency effects result for a very general class of demand functions. Proposition 6 implicates that both situations are possible. If buyer power is relatively small, there is an efficiency enhancing effect of the use of specific CRRs. The effect is interesting because it is less predictable in view of competition. Irritatingly, a ban on market-share contracts or specific CRRs would increase the market power of the dominant supplier. And particularly because the competitor could not improve its performance, a ban on these CRRs would limit its sales levels. In the worst case, a ban on CRRs could fully exclude the competitor.

In contrast and probably more realistic is the contrary case. If the buyer power vis-à-vis the rival is relatively large, the use of specific CRRs as for example market-share contracts (used by the dominant supplier) can restrict the efficiency progress of this competitor. That case might be realistic in settings similar to the Intel Decision, for example. There it is said that AMD, the competitor of Intel, was growing and its products became more and more interesting from the view of the original equipment manufacturers (OEMs). At that time, Intel introduced its pricing strategy which inter alia conditioned discounted prices for specific market shares of the OEMs. AMD had problems to increase its sales and offered its good to marginal costs or even to zero for a number of OEMs. Yet the prices could not change the outcome. The strategy is equal to the price setting behavior of a competitive fringe or a supplier without negotiating power ($\beta_B = 0$). For this case, our model shows that market-share contracts of a dominant supplier restrict the sales levels of a rival supplier and also limit the efficiency process of the competitor.

The analysis so far shows that the contract choice of the dominant supplier is triggered by learning effects and its effects depend on the bargaining power. It allows us to differentiate between the efficiency-enhancing and efficiency-restricting effects of CRRs according to buyer power $\beta_B$. However, the analysis does not allow us to draw conclusions on social welfare. In the following, we provide an application with a more specific demand function to analyze welfare effects and to give an overview of the development of outputs.
5.2 An application with linear demand

We now analyze the impact of the contract choice on social welfare. In the generally analyzed setting, it is possible to compare the quantity level of supplier B $q_{B1}$ for specific contract types, but it is not feasible to make a general statement about aggregate sales and therefore about consumer surplus and social welfare. In the following, we specify the demand system and analyze social welfare consequences.\(^\text{15}\)

In the following, we assume that the inverse demand system is given by

\[
P_A(q_{A1}, q_{B1}) = 1 - q_{A1} - \gamma q_{B1},
\]

\[
P_B(q_{A1}, q_{B1}) = 1 - q_{B1} - \gamma q_{A1},
\]

for period $t = 1, 2$, where $\gamma \in (0, 1)$ is the degree of substitutability. In addition, the (time-)discount factor $\delta$ is assumed to be one. That is, we suppose that the second-period payoffs have a strong influence on the present value of long-run profits. We concentrate on the case where suppliers are equally efficient in the initial period $t = 1$.

To ensure that quantity levels are non-negative and second-period marginal costs are still positive, the degree of substitution, initial marginal costs and the learning parameter have to be restricted. For $c_A = c_B = c$ we restrict the analysis to $0 < c < 1$, $0 < \gamma < 1$ and $0 < \lambda < (1 - \gamma)c$.\(^\text{16}\)

Hereafter, we focus on specific bargaining situations to compare the outcome, when the dominant supplier uses CRRs and when he is restricted to the benchmark tariff. First, we observe $\beta_A = 0$, $\beta_B = 1$. In this case, the downstream firm has all bargaining power over the rival supplier, but no bargaining power vis-à-vis the dominant supplier. This case demonstrates the outcome whenever the second supplier is strongly restricted in its action. Then, we concentrate on $\beta_A = 0, 5$. In this case, we specify the bargaining power vis-à-vis the dominant supplier and focus on the influence of the degree of bargaining power of supplier B on the outcome.

i) When the dominant supplier has all bargaining power over the downstream firm and the second supplier has none, it can be shown that for all relevant parameter constellations, social welfare is larger in case of benchmark tariffs compared to the case where the dominant supplier uses CRRs, see Appendix. That is, whenever the second supplier is drastically limited in its action, the benchmark tariffs would lead to a more efficient and, as well, socially more desirable outcome than the use of market-share contracts of the dominant supplier.

With the restriction to the bargaining situation, it can be shown how the dominant supplier influences the innovation race with its contract choice. Using market-share contracts, an equally efficient rival supplier ($c_A = c_B = c$) will be forced to produce an output level that is similar to the one of the dominant supplier, whenever the demand

\(^{15}\)A linear demand system facilitates determining quantities, consumer surplus and social welfare depending on the exogenous parameters.

\(^{16}\)For different levels of initial marginal costs, the parameters have to be limited in a similar way.
Figure 1: Second period marginal costs in case of $\beta_A = 0, \beta_B = 1, \gamma = 0.5$. 

(a) $c_{A2}$ and $c_{B2}$ when $c_A = 0.25$, $c_B$ varies and $\lambda = \frac{1}{4}$.

(b) $c_{A2}$ and $c_{B2}$ when $c_A = 0.25 < c_B = 0.255$ and $\lambda$ varies.
parameters are also symmetric. In case of benchmark tariffs, the rival supplier would produce a larger quantity and would improve its production efficiency more than the dominant supplier \((c_A^T > c_B^T)\). Moreover, it can be shown that there is a range of parameter constellations where a less efficient competitor would become more efficient than the dominant supplier in case of benchmark tariffs, stays less efficient due to the contract choice of the dominant supplier. These effects occur whenever initial marginal costs of the rival supplier \(c_B\) are less but very close to the marginal costs of the dominant supplier \((c_A)\) and whenever the learning parameter is relatively large, given the necessary parameter restrictions. We exemplarily depict second period marginal costs of supplier A and supplier B for the benchmark case ('benchmark') and the case of CRRs ('cooperative') in Figure 1.

\[\text{ii) Suppose now that the bargaining power of supplier A is fixed and given by } \beta_A = \frac{1}{2}.\]

We graphically show the influence of \(\beta_B\) on quantity levels, prices, payoffs and welfare. In figure 2, the outcomes in case of the benchmark tariffs and in case that supplier A uses CRRs are depicted for \(c_A = c_B = 0.3, \gamma = 0.5\) and \(\lambda = 0.2.\)

These findings show that not only the efficiency of the rival is restricted or enhanced in case of a specific level of buyer power, but also social welfare and consumer surplus. Hence in the present setting the specific CRRs have an anticompetitive effect if the buyer power vis-à-vis the rival supplier is relatively large. If buyer power \(\beta_B\) is relatively small, market-share contracts are rather pro-competitive as they support the rival supplier and lead to a larger amount of consumer surplus and social welfare.

6 Conclusion

The use of contracts that directly or indirectly influence the outcome of rivals are a broadly debated topic in competition policy enforcement and antitrust economics. There are particular concerns about these contracts as soon as they are offered by a dominant supplier. They might restrict competitors and especially lead to partial or even full exclusion. Antitrust cases that involve for example market-share contracts have some special but similar market characteristics. The existing literature already addressed a lot of effects which are related to Intel’s conditional discounts, market-share contracts and further CRRs. To the best of our knowledge, there is no article yet which focuses on the dynamic situation when firms change their pricing strategy. In particular, in different cases as for example Concord Boat v. Brunswick Corp, Masimo Corp. v. Tyco Health Care and also in the European case of Intel, the rival firms posed a growing competitive threat on the dominant supplier in the markets. In the Intel Decision of the European Commission of 2009 it is said that

\[\text{We also considered the case, when bargaining power of both suppliers vary. A graphical illustration of } \beta_A = \beta_B \text{ can be found in the Appendix.}\]
Figure 2: Quantities, industry profits and social welfare in case of $\lambda = 0.2$, $\gamma = 0.5$, $c_A = c_B = 0.3$, and $\beta_A = 0.5$. 
Intel itself had recognized that AMD improved its offerings dramatically.\textsuperscript{18} The article at hand deals with dynamic effects that can embody this particular approach.

By modeling a dynamic setting with learning effects of two upstream suppliers, we show that the contract choice of a dominant supplier can actually be caused by the dynamic effects themselves. We find that especially the learning effects of the rival firm, that is the competitive threat, leads to the specific choice of CRRs of the dominant supplier. However, the dominant supplier does not use the contract to exclude its rival. By choosing CRRs, it rather uses the efficiency gains of the rival to enhance its own outcome. Depending on the negotiation set-up, the contract choice of the dominant supplier could thus be efficiency-enhancing or, what is rather realistic, limiting the efficiency process of the rival supplier.

By this, our results show the relevancy of dynamic effects and the consideration of these in competition policy enforcement. It raises awareness for the long-run market effects, the related considerations of firms and their impacts on market outcomes.

\textsuperscript{18}Paragraph 152.
7 Appendix

Proof of Proposition 1 (Single period contract choice)

The three-stage game is solved by backwards induction.

Stage 3 - Downstream firm’s quantity decision

- If downstream firm R agreed to A’s contract, but not to B’s contract, R chooses
  \[ q_{At}^{R}(t_{At}) = \arg \max P_{A}(q_{At}, 0)q_{At} - t_{At}. \]

- If R agreed only to B’s contract, it chooses \[ q_{Bt}^{R}(t_{Bt}) = \arg \max P_{B}(0, q_{Bt})q_{Bt} - t_{Bt}. \]

- If R agreed to both contracts, it chooses \[ (q_{At}(t_{At}, t_{Bt}), q_{Bt}(t_{At}, t_{Bt})) = \arg \max P_{A}(q_{At}, q_{Bt})q_{At} + P_{B}(q_{At}, q_{Bt})q_{Bt} - t_{At} - t_{Bt}. \]

Stage 2 - Contract choice of supplier B and negotiation with retailer R

- If negotiations between A and R fail, only supplier B and downstream firm R will bilaterally bargain contractual terms. Their outside options are both zero, as there are no further negotiations afterwards.

  \[
  \max (P_{B}(0, q_{Bt}(t_{Bt})))q_{Bt}(t_{Bt}) - t_{Bt} - 0)^{\beta_{B}} (t_{Bt} - c_{Bt} - 0)^{(1-\beta_{B})}
  \]

  Following the Nash product, B and R divide joint payoffs according to the bargaining parameter \( \beta_{B} \). Therefore, B will choose a contract type that induces R to maximize their joint payoffs. Hence, a simple two-part tariff with \( w_{Br} = c_{Bt} \) and fixed fee \( F_{Br} = (1-\beta_{B}) \max (P_{B}(0, q_{Bt}) - c_{Bt})q_{Bt} =: (1-\beta_{B})\pi_{t}^{B} \) is sufficient. In this case, payoffs of retailer R are \( \beta_{B}\pi_{t}^{B} \).

- If R agreed upon a contract with supplier A, its outside option in the negotiations with supplier B is purchasing only the product of supplier A. The outside option is \( \pi_{Rt}^{B}(t_{At}) = P_{A}(q_{At}^{o}(t_{At}), 0)q_{At}^{o}(t_{At}) - t_{At} \). The optimization problem of supplier B and retailer R is then given by

  \[
  \max (PA(q_{At}(t_{At}, t_{Bt}), q_{Bt}(t_{At}, t_{Bt})))q_{At}(t_{At}, t_{Bt}) - t_{At}
  + P_{B}(q_{At}(t_{At}, t_{Bt}), q_{Bt}(t_{At}, t_{Bt})))q_{Bt}(t_{At}, t_{Bt}) - t_{Bt} - \pi_{Rt}^{B}(t_{At})\beta_{B}
  \cdot (t_{Bt} - c_{Bt} - 0)^{(1-\beta_{B})}
  \]

  To maximize joint payoffs, which are then divided, supplier B has to make downstream firm R consider marginal costs \( c_{Bt} \). The simple two-part tariff \( T_{Br} = (w_{Bt}, F_{Bt}) \) with \( w_{Bt} = c_{Bt} \) and \( F_{Bt} = (1-\beta_{B}) \{ P_{A}(q_{At}(t_{At}), q_{Bt}(t_{At})))q_{At}(t_{At}) - t_{At}
  + P_{B}(q_{At}(t_{At}), q_{Bt}(t_{At})))q_{Bt}(t_{At}) - \pi_{Rt}^{B}(t_{At})\}
  \] is already sufficient to achieve this outcome. Payoffs are given by \( \pi_{Rt}(t_{At}) = \beta_{B}\pi_{Rt}(t_{At}) + (1-\beta_{B})\pi_{Rt}^{A}(t_{At}) \) and \( \pi_{Br}(t_{At}) = (1-\beta_{B})\pi_{Rt}(t_{At}) - (1-\beta_{B})\pi_{Rt}^{A}(t_{At}) \).
**Stage 1 - Contract choice of supplier A and negotiation with retailer R**

Supplier A will consider whether it is more profitable to achieve that the retailer purchases both goods or only its own product. To achieve full exclusion of supplier B, supplier A would set a contract such that payoffs of retailer R are larger when it only purchases A’s good. That is, \( \pi_{Rt}(t_{At}) < \pi_{Rt}(t_{At}) \). According to the demand system however, joint payoffs of A and R are larger when both goods are purchased. It is thus not profitable for A to exclude supplier B from the market. The optimization problem is given by

\[
\max \left( \pi_{Rt}(t_{At}) - \beta B \pi_t(B) \right)^{\beta A} \cdot (t_{At} - c_{At} q_{At}(t_{At}))^{1-\beta A}
\]

s. t. \( \pi_{Rt}(t_{At}) \geq \pi_{Rt}^o(t_{At}) \)

whereby the incentive compatibility condition ensures that the retailer buys both goods. In addition, this condition is equal to the participation constraint of supplier B.

As payoffs are subdivided between the negotiators, maximum joint payoffs \( \pi_t^l = \max(P_A(q_{At}, q_{Bt}) - c_{At})q_{At} + (P_B(q_{At}, q_{Bt}) - c_{Bt})q_{Bt} \) would lead to the best outcome for supplier A. Yet, a simple two-part tariff without any further restrictions could not achieve the desired maximum payoffs for supplier A due to the incentive compatibility. To fulfill the incentive compatibility and to achieve maximum payoffs, A has to condition its contract on the fact whether the retailer purchases B’s good or whether R exclusively purchases A’s good. A market-share contract naturally comes into mind to solve for this differentiation. The contract would be given by \( t_{At} = \begin{cases} t_{At}^c, & \text{if } q_{Bt} > 0 \\ t_{At}^e, & \text{if } q_{Bt} = 0 \end{cases} \), with two-part tariffs \( t_{At}^c = (w_{At}^c, F_{At}^c) \) such that \( w_{At}^c = c_{At} \), \( F_{At}^c = (1 - \beta_A)\pi_t^l - (1 - \beta_A)\beta_B \pi_t(B) \), and \( t_{At}^o \) such that \( \pi_{Rt}(t_{At}^c) = \beta_A \pi^{o}_R(t_{At}^o) \). However, the differentiation can also be achieved by a contract that conditions on own quantity levels. For example, the all-unit discount

\[
t_{At} = \begin{cases} t_{At}^c, & \text{if } q_{At} < q_{At}^* \\ t_{At}^e, & \text{if } q_{At} \geq q_{At}^* \end{cases}
\]

with \( q_{At}^* = \arg \max(P_A(q_{At}, 0) - c_{At})q_{At} \).

Respectively, the industry-profit maximizing outcome \( q_{At}^l, q_{Bt}^l \) can be achieved by one of the mentioned contracts. Payoffs are given by

\[
\pi_{At}^* = (1 - \beta_A)\pi_t^l - (1 - \beta_A)\beta_B \pi_t(B),
\]

\[
\pi_{Bt}^* = 0,
\]

\[
\pi_{Rt}^* = \beta_A \pi_t^l + (1 - \beta_A)\beta_B \pi_t(B).
\]

**Specific CRRs: All-units discounts by the dominant supplier**

In stage three, the downstream firm decides to purchase the following quantities. If R purchases only A’s good, R chooses exactly the quantity which is set in the quantity forcing contract with A. (R has no decision.) If R purchases only B’s good, it chooses \( q_{Bt}^o(w_{Bt}) \) according to \( \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(0, q_{B1}) - w_{B1} - \delta \lambda \frac{\partial \pi_{R2}}{\partial q_{B2}} = 0 \). If R purchases both goods, it chooses \( q_{B1}(q_{At}^*, w_{B1}) \) according to \( \frac{\partial P_A}{\partial q_{B1}} q_{At} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(q_{At}^*, q_{B1}) - w_{B1} - \delta \lambda \frac{\partial \pi_{R2}}{\partial q_{B2}} = 0 \).
In stage two, if R does not negotiate with A, then B and R choose the two-part tariff similar to the case with simple two-part tariffs. The payoffs are given by $\Pi_R^{(B)}$ and $\Pi_R^{(B)}$. If instead both goods are purchased, the optimization problem is

$$\begin{align*}
\max_{w_{A1}, F_{A1}} \left( (P_A(q_{A1}^*, q_{B1}(q_{A1}^*, w_{A1}))) - w_{A1})q_{A1}^* + (P_B(q_{A1}^*, q_{B1}(q_{A1}^*, w_{A1}))) &- w_{B1} \right) \\
\cdot q_{B1}(q_{A1}^*, w_{B1}) - F_{A1} - F_{B1} + \delta \pi_{R2}(c_{A2}, c_{B2}) - \Pi_R^{(A)}(w_{A1}^*, F_{A1}, q_{A1}^*) \delta_\beta \\
\cdot (q_{B1}(q_{A1}^*, w_{B1}))(w_{B1} - c_B) + F_{B1} + \delta \pi_{B2}(c_{A2}, c_{B2}) \right)^{1-\beta_\delta}
\end{align*}$$

where $\Pi_R^{(A)}(w_{A1}^*, F_{A1}^*, q_{A1}^*) = (P_A(q_{A1}^*, 0) - w_{A1})q_{A1}^* - F_{A1} + \delta \pi_{R2}(c_{A2}, c_{B2})$.

The negotiated wholesale price $w_{A1}^*$ is characterized by $w_{A1}^* = c_B + \delta \lambda \frac{\partial \pi_{B2}}{\partial c_{B2}}$ and $F_{B1}$ is given similar to the case above. Payoffs are given by

$$\begin{align*}
\Pi_R(w_{A1}, F_{A1}, q_{A1}^*, w_{A1}^o, F_{A1}^o, q_{A1}^o) = \beta_B \Pi_{BR}(w_{A1}, F_{A1}, q_{A1}^*) + (1 - \beta_B)\Pi_R^{(A)}(w_{A1}^*, F_{A1}^*, q_{A1}^o), \\
\Pi_B(w_{A1}, F_{A1}, q_{A1}^*, w_{A1}^o, F_{A1}^o, q_{A1}^o) = (1 - \beta_B)(\Pi_{BR}(w_{A1}, F_{A1}, q_{A1}^*) - \Pi_R^{(A)}(w_{A1}^*, F_{A1}^*, q_{A1}^o)),
\end{align*}$$

where $\Pi_{BR}(w_{A1}, F_{A1}, q_{A1}^*) = (P_A(q_{A1}^*, q_{B1}(q_{A1}^*, w_{B1}))) - w_{B1})q_{A1}^*$

$$+ (P_B(q_{A1}^*, q_{B1}(q_{A1}^*, w_{B1}))) - c_B)q_{B1}(q_{A1}^*, w_{B1}^*) - F_{A1} + \delta \pi_{R2}(c_{A2}, c_{B2}) + \delta \pi_{B2}(c_{A2}, c_{B2})$$

In stage one, the optimization problem is

$$\begin{align*}
\max_{w_{A1}^*, F_{A1}^*, q_{A1}^*} \left( \Pi_R(w_{A1}, F_{A1}, q_{A1}^*, w_{A1}^o, F_{A1}^o, q_{A1}^o) - \Pi_R^{(B)} \right) &\beta_\lambda \\
\cdot (q_{A1}^* \cdot (w_{A1} - c_A) + F_{A1} + \delta \pi_{A2}(c_{A2}, c_{B2}))^{1-\beta_\lambda} \\
\text{s.t. } \Pi_{BR}(w_{A1}, F_{A1}, q_{A1}^*) \geq \Pi_R^{(A)}(w_{A1}^*, F_{A1}^*, q_{A1}^*)
\end{align*}$$

Again, $w_{A1}^o, F_{A1}^o, q_{A1}^o$ are set such that

$$\Pi_{BR}(w_{A1}, F_{A1}, q_{A1}^*) = \Pi_R^{(A)}(w_{A1}^*, F_{A1}^*, q_{A1}^*).$$

$w_{A1}$ and $F_{A1}$ are both given by

$$\frac{\beta_\lambda \beta_B}{\Pi_R(w_{A1}, F_{A1}, q_{A1}^*, w_{A1}^o, F_{A1}^o, q_{A1}^o) - \Pi_R^{(B)}} = \frac{q_{A1}^* \cdot (w_{A1} - c_A) + F_{A1} + \delta \pi_{A2}(c_{A2}, c_{B2})}{q_{A1}^*}.$$

Both serve to shift rents. $q_{A1}^*$ is characterized by

$$\begin{align*}
\frac{\partial P_A}{\partial q_{A1}} q_{A1} + \frac{\partial P_B}{\partial q_{A1}} q_{B1} + P_A(q_{A1}^*, q_{B1}(q_{A1}^*, w_{A1})) - c_A - \delta \lambda \frac{\partial \pi_{B2}}{\partial c_{B2}} = 0. \\
- \delta \lambda \frac{\partial \pi_{A2}}{\partial c_{A2}} - \frac{\partial q_{B1}(q_{A1}^*, w_{B1})}{\partial q_{A1}} = 0.
\end{align*}$$

Generally, the outcome $q_{A1}^*, q_{B1}^*$ is characterized by

$$\begin{align*}
\frac{\partial P_A}{\partial q_{A1}} q_{A1} + \frac{\partial P_B}{\partial q_{A1}} q_{B1} + P_A(q_{A1}, q_{B1}) - c_A - \delta \lambda \frac{\partial \pi_{B2}}{\partial c_{B2}} - \delta \lambda \frac{\partial \pi_{A2}}{\partial c_{A2}} - \frac{\partial q_{B1}(q_{A1}, w_{B1})}{\partial q_{A1}} = 0, \tag{14} \\
\frac{\partial P_A}{\partial q_{B1}} q_{A1} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(q_{A1}, q_{B1}) - c_B - \delta \lambda \frac{\partial \pi_{B2}}{\partial c_{B2}} - \delta \lambda \frac{\partial \pi_{A2}}{\partial c_{A2}} - \frac{\partial q_{B1}(q_{A1}, w_{B1})}{\partial q_{B1}} = 0. \tag{15}
\end{align*}$$
Proof of proposition 6 (Efficiency)

Second-period payoffs are given by

\[ \pi_A^2(c_{A2}, c_{B2}) = (1 - \beta_A)(\pi_A^2(c_{A2}, c_{B2}) - \beta_B \pi_B^2), \]
\[ \pi_B^2(c_{A2}, c_{B2}) = \beta_A \pi_B^2(c_{A2}, c_{B2}) + (1 - \beta_A)\beta_B \pi_B^2, \]
\[ \pi_B^2(c_{A2}, c_{B2}) = 0. \]

The impact of learning effects of A on payoffs are given by

\[ \frac{\partial \pi_A^2}{\partial c_{A2}} = -(1 - \beta_A)q_{A2}^I < 0, \quad \frac{\partial \pi_B^2}{\partial c_{A2}} = -\beta_A q_{A2}^I < 0. \]

The impact of learning effects of B on payoffs are

\[ \frac{\partial \pi_A^2}{\partial c_{B2}} = (1 - \beta_B)(\beta_B q_{B2}^0 - q_{B2}^I) \leq 0, \quad \frac{\partial \pi_B^2}{\partial c_{B2}} = -\beta_A q_{B2}^I - (1 - \beta_A)\beta_B q_{B2}^0 < 0. \]

The outcome \( q_{A1}^T, q_{B1}^T \) can be reformulated to

\[ \frac{\partial \pi_A^2}{\partial q_{A1}} + \frac{\partial \pi_B^2}{\partial q_{B1}} q_{B1} + P_A(q_{A1}, q_{B1}) - c_A + \delta \lambda q_{A2}^I - \delta \lambda \alpha(1 - \beta_A)(\beta_B q_{B2}^0 - q_{B2}^I) = 0, \quad (16) \]
\[ \frac{\partial \pi_A^2}{\partial q_{B1}} q_{A1} + \frac{\partial \pi_B^2}{\partial q_{B1}} q_{B1} + P_B(q_{A1}, q_{B1}) - c_B + \delta \lambda q_{B2}^I + \delta \lambda(1 - \beta_A)(\beta_B q_{B2}^0 - q_{B2}^I) = 0, \quad (17) \]

where \( \alpha = -\frac{\partial \pi_B}{\partial q_{A1}}(q_{A1}) \) is positive and smaller than one. In this representation, note that second-period outcomes \( q_{J2}^I \) with \( J \in \{A, B\} \) and \( X = I, T \) have to be treated carefully as they are not constantly given. They depend on second-period marginal costs and thus on first-period sales levels.

Define \( \beta_B \) such that \( \beta_B q_{B2}^0 - q_{B2}^I = 0 \). In this case, conditions (16), (17) equal the first order conditions of the joint-profit maximization.

Suppose now that \( \beta_B q_{B2}^0 > q_{B2}^I \). Compare the joint-profit maximizing outcome \( q_{A1}^I, q_{B1}^I \) with the outcome of the varied system

\[ \frac{\partial P_A}{\partial q_{A1}} q_{A1} + \frac{\partial P_B}{\partial q_{A1}} q_{B1} + P_A(q_{A1}, q_{B1}) - c_A + \delta \lambda q_{A2}^I + \delta \lambda(1 - \beta_A)(\beta_B q_{B2}^0 |_{c_{B2}} - q_{B2}^I |_{c_{B2}}) = 0, \]
\[ \frac{\partial P_A}{\partial q_{B1}} q_{A1} + \frac{\partial P_B}{\partial q_{B1}} q_{B1} + P_B(q_{A1}, q_{B1}) - c_B + \delta \lambda q_{B2}^I + \delta \lambda(1 - \beta_A)(\beta_B q_{B2}^0 |_{c_{B2}} - q_{B2}^I |_{c_{B2}}) = 0. \]

(\text{var})

As \( \delta \lambda(1 - \beta_A)(\beta_B q_{B2}^0 |_{c_{B2}} - q_{B2}^I |_{c_{B2}}) \) is positive and supposed to be constant, \( q_{A1}^{var} \) and \( q_{B1}^{var} \) are larger than \( q_{A1}^I \) and \( q_{B1}^I \). Then, we compare the varied system with (16) and (17). Due to \( \alpha \) being positive and smaller than one, we get \( q_{B1}^T > q_{B1}^{var} \) and \( q_{A1}^T < q_{A1}^{var} \). That is, the value of the first-period sales \( q_{A1}^T \) of the dominant supplier can be smaller or larger than the joint-profit maximizing \( q_{A1}^I \). Yet, the first-period sales \( q_{B1}^T \) of the second supplier is larger than the joint-profit maximizing level.

For \( \beta_B q_{B2}^0 < q_{B2}^I \), the considered steps yield \( q_{B1}^T < q_{B1}^I \).
Welfare

The inverse linear demand system introduced in section 5.2 is implicated by the utility function

\[ U(q_{At}, q_{Bt}) = q_{At} + q_{Bt} - \frac{q_{At}^2 + q_{Bt}^2 + 2\gamma q_{At}q_{Bt}}{2}, \text{ where } 0 < \gamma < 1. \]

The aggregate social welfare function, depending on the sales levels \( q_{It} \), \( J = A, R \) and \( t = 1, 2 \), is given by the sum of consumer surplus and producer surplus for both periods. Consumer surplus is given by

\[ CS_t(q_{At}, q_{Bt}) = U(q_{At}, q_{Bt}) - (1+\gamma)q_{At} - P(t)q_{Bt} \]

and producer surplus is given by the profits of the dominant supplier and the downstream firm.

We specify on the case where suppliers are equally efficient, that is \( c_A = c_B := c \).

The socially efficient outcome is characterized by

\[
q_{At}^W = q_{Bt}^W = \frac{1-c}{2(1+\gamma)-c},
\]

\[
q_{At}^W = q_{Bt}^W = \frac{1-c}{1+\gamma-c}.
\]

The efficiency progress can be characterized by the difference between marginal costs of period one and two, given by \( \lambda q_{At}^W \).

To allow for all parameter constellations in which the suppliers are active (in the socially optimal case) and marginal costs are positive, we assume that \( 0 < c < 1 \) and \( 0 < \lambda < (1-\gamma)c \).

In this case, the joint payoff maximizing outcome is given by

\[
q_{At}^I = q_{Bt}^I = \frac{1-c}{2(1+\gamma)-c},
\]

\[
q_{At}^I = q_{Bt}^I = \frac{1-c}{1+\gamma-c}.
\]

Prices are

\[
P_A^I = P_B^I = \frac{(1+c)(1+\gamma)q_{At}}{2(1+\gamma)-c}.\]

Payoffs are given by

\[
\Pi^I = \frac{2(1-c)^2}{2(1+\gamma)-c},
\]

and social welfare is given by

\[
SW^I = \frac{2(1-c)^2(4+3\gamma-\gamma^2-q_{At})}{(2(1+\gamma)-c)^3}.
\]

These are thus the output levels, prices, cooperative payoff and social welfare whenever the dominant supplier could offer a market-share contract or further specific CRRs.

To compare this case with the benchmark case, the outcome in case of the benchmark tariffs is needed. The output levels can be determined by the equations (8) and (9), (10).

We illustrate the outcome for the following different cases.

i) If \( \beta_A = 0 \) and \( \beta_B = 1 \), the quantities are given by

\[
q_{At}^T = \frac{(1-c)(2+\lambda)(2-\lambda)(2+\lambda)^2+2\gamma^2(8-8\lambda+\lambda^3)+4\gamma^3(4-2\lambda+\lambda^2)+(4-\lambda^2)^2)}{4\gamma(32-4\lambda+\lambda^2)-(4-\lambda^2)^2-32\gamma(2-\lambda^2)};
\]

\[
q_{Bt}^T = \frac{(1-c)(16+\lambda^4-4\lambda(2+\lambda)^2-4\gamma^2(8+\lambda^3)+8\gamma^3(4-2\lambda+\lambda^2)+(2-\lambda)^2(2+\lambda)^3)}{4\gamma(32-4\lambda+\lambda^2)-(4-\lambda^2)^2-32\gamma^2(2-\lambda^2)}.
\]

Comparing these with the values above, it shows that \( q_{At}^T < q_{At}^I = q_{Bt}^I < q_{Bt}^T \). In addition, the quantity levels also show that \( SW^T > SW^I \) for the relevant parameter
constellations.

ii) Next, we observe the quantity levels in case of $\beta_A = \frac{1}{2}$. In addition, we restrict ourselves to $\gamma = \frac{1}{3}$ for simplicity reasons.

\[
q_{T_{A1}} = (1 - c) \frac{288 + 96\lambda - 72\lambda^2 (4 + \beta_B) - \lambda^3 (80 + 54\beta_B - 9\beta^2_B) + 3\lambda^4 (8 + 14\beta_B + 3\beta^2_B) + 2\lambda^5 (4 + 6\beta_B + 3\beta^2_B)}{2(332 - 72\lambda (40 + 9\beta_B) + \lambda^4 (76 + 90\beta_B + 9\beta^2_B) + \lambda^6 (4 + 6\beta_B + 3\beta^2_B)}
\]

\[
q_{T_{B1}} = (1 - c) \frac{444 + 6\lambda (2 + 9\beta_B) - 6\lambda^2 (26 + 3\beta_B) - \lambda^3 (22 + 45\beta_B + 9\beta^2_B) + 3\lambda^4 (6 + 5\beta_B) + \lambda^6 (4 + 6\beta_B + 3\beta^2_B)}{432 - 12\lambda^4 (40 + 9\beta_B) + \lambda^4 (76 + 90\beta_B + 9\beta^2_B) + \lambda^6 (4 + 6\beta_B + 3\beta^2_B)}
\]

The comparison of these values and the according payoffs as well as welfare is graphically shown in section 5.2.

iii) In a last step, we show the case, when $\beta_A = \beta_B := \beta$, again for $\gamma = \frac{1}{3}$. Quantity levels are given by

\[
q_{T_{A1}} = (1 - c) \cdot (72 + 24\lambda - 12\lambda^2 (4 + 7\beta - 3\beta^2) - \beta\lambda^3 (90 - 97\beta + 48\beta^2 - 9\beta^3) + 3\beta\lambda^4 (2 + 19\beta - 16\beta^2 + 3\beta^3) + 2\beta^2\lambda^5 (13 - 12\beta + 3\beta^2)) / (2(108 - \lambda^2 (84 + 126\beta - 54\beta^2) + \beta^2 (54 + 37\beta - 48\beta^2 + 9\beta^3) - \beta^2\lambda^6 (13 - 12\beta + 3\beta^2)),
\]

\[
q_{T_{B1}} = (1 - c) \cdot (36 - 3\lambda (2 - 15\beta + 9\beta^2) - 3\lambda^2 (10 + 9\beta - 3\beta^2) - \beta\lambda^3 (18 + 28\beta - 39\beta^2 + 9\beta^3) + 3\beta\lambda^4 (4 - 12\beta + 9\beta^2))
\]

The comparison of these values and the related payoffs as well as welfare is graphically shown in the following figure. It shows the different appearance of quantities, prices, and welfare whenever $\beta_A$ changes as well.

References


Figure 3: Quantities, industry profits and social welfare in case of $\lambda = 0.2$, $\gamma = 0.5$, $c_A = c_B = 0.3$, and $\beta_A = \beta_B = \beta$. 


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