Competition and Bargaining
The Optimal Size of Buyer Groups

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Abstract

We investigate the formation of buyer groups which are widespread in many industries as an organizational set-up in which downstream firms act together vis-à-vis upstream suppliers to negotiate sourcing prices while competing against each other in downstream markets. Our analysis of the resulting size of buyer groups rests on the following trade-off. On the one hand, enlarging the size of the buyer group increases its bargaining power against the upstream (monopolistic) supplier that leads to lower sourcing prices. On the other hand, for its members a larger buyer group means that they compete in the downstream market with more firms which benefit from lower sourcing prices. Against the background of this trade-off, we show that forming a partial buyer group may be optimal for a subset of downstream firms. However, a partial buyer group may be too small from a welfare point of view.

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1 Introduction

Buyer groups are a widespread phenomenon in many industries. As of 2023, the market research had identified more than 700 buyer groups in the US alone (see IBIS World (2023)). Buyer groups depict an organizational set-up through which buyers join forces vis-à-vis upstream suppliers to negotiate more favorable terms, most notably lower sourcing prices (see EU Commission (2023), p. 30).[1] While joining forces in the upstream market in order to counter market power of upstream producers, members of the buyer group compete against each other in the downstream market. Many real-life cases can be observed in product markets. One example exists in the airline industry, where Air Canada, Lufthansa, SAS, and Austrian Airways joined to purchase aircrafts from Airbus and Boeing (see Dana (2012)) while competing against each other in downstream markets. Other prominent examples stem from the food retailing industry, such as Agecore or Epic Partners, in which national supermarket chains – which are at the same time partially buyer groups at the national level Molina (2019) – join forces on an European level. Buyer groups also play a role in labor markets. Examples arise in labors market in which wage negotiations are organized decentrally between an industry-wide union and a coalition of employers such as in Germany, the Netherlands, Norway and Sweden (see Denk *et al.* (2019)). Another example exists in the field of global supply chains (e.g. Grossmann *et al.* (2024)). Firms can build a supply chain together, leading to better quality or lower prices for their inputs (supply chain collaboration). But they compete against each other on downstream markets. Not least due to the fact that members of buyer groups compete against each other in downstream markets leading to potentially lower consumer prices (see, e.g., Molina (2019) competition-policy authorities have treated buyer groups rather favorably. Competition authorities link this favorable treatment to the market share of the buyer groups. The European Union's guide line states a 15 percent threshold after which a buyer group is considered to be potentially problematic (see EU Commission (2023)). The US Department of Justice's Antitrust Division is more lenient by allowing buyer groups to comprise firms with up to 35% market share of a particular industry (see, e.g., Carstensen (2010)).

These conditions are, however, rather little based on sound analysis. The main aim of our paper is to partially fill this gap. In order to do so, we investigate the privately-optimal market share/size of buyer groups and relate this decision to the welfare-optimal size of buyer groups. More precisely, we address the following research question: what is the size of a buyer group if decided in the absence of regulation by the relevant firms and does it exceed the welfare-optimal

[1] Often buyer groups are also referred to as purchasing alliances or groups (see, e.g., Capobianco (2022) and EU Commission (2023)). In addition, competition law distinguishes between buyer groups and buyer cartels (see, e.g., Carstensen (2010)). While the latter has the objective of limiting and restricting the supply of the upstream firms per se to only the members of the buyer cartel, this objective does not hold true for buyer groups. Empirically, this distinction is rather blurred in most cases.

size of the respective buyer group?

In order to investigate the size of a buyer group, we analyze the interplay between the bargaining of buyer groups with upstream firms with the latter having market power on the one hand and their subsequent competition in the downstream market on the other hand. By sourcing from the upstream firms with market power, buyer groups can exert countervailing market power in the upstream market, therefore bargaining for lower sourcing prices. We look for the privately optimal size of the bargaining group (full or partial buyer group). We analyze these aspects against the background of the following trade-off. On the one hand, enlarging the size of the buyer group increases its bargaining power that leads to a reduction in sourcing prices for the members of the buyer group. On the other hand, a larger buyer group leads to an expansion of the set of firms which source at lower costs and are able to compete more fiercely in downstream markets. Whereas the first effect speaks in favor of a larger buyer group, the second one provides incentives to form a smaller buyer group. We analyze the size of buyer groups against the background of this trade-off and compare the private incentives with the welfare optimal outcome. To the best of our knowledge, we are the first to look at the complete game in which all decisions, especially the choice of the size of the bargaining group, are endogenous.

We find that with regard to the profit-maximizing size, an interior solution exists if competition in the downstream market is sufficiently pronounced. It is in the interest of the members of the buyer group to exclude some downstream competitors in order to mitigate competition in the downstream market even if this comes at the cost of less bargaining power over the upstream supplier resulting in higher sourcing prices. This finding is robust to a wide range of market-structure settings. We show that the formation of buyer groups is clearly in the interest of consumers. Even further, we show that the welfare-optimal size of the buyer group exceeds the privately optimal one.

We build and contribute to a number of strands of the literature. First, and foremost, we aim to contribute to the theoretical literature on purchasing alliances and buyer groups. This literature stresses the particular interaction between upstream bargaining and downstream competition. Horn and Wolinsky (1988), for instance, use a model in which downstream oligopolists who bargain with upstream suppliers to show that the bargaining element may significantly weaken the incentives for horizontal upstream mergers. Furthermore, Allain *et al.* (2020) find that buyer groups may enhance the retailers' buying power and reduce the overall product variety that thereby hurts consumers. Other papers in this context stress aspects of buyer groups beyond bargaining power. Marvel and Yang (2008) show that buyer groups may achieve more attractive prices from suppliers not through stronger bargaining power but rather through their ability to impose rates that more effectively pit suppliers against each other. Symeonidis (2008) shows that bargaining over the input price implies that a decrease in the intensity of competition (or a merger) between downstream firms may raise consumer surplus and overall welfare. Dana (2012) shows that even a small buyer group can increase price competition among rival sellers and that for more than two sellers a partial buyer group is expected.

Second, our analysis is related to models of bargaining between suppliers and buyers per se in cases when both market sides possess (oligopolistic) market power. Inderst and Wey (2003) as well as Inderst and Wey (2007) focus on the bargaining between suppliers and buyers and their incentives to vertically integrate. They show that incentives to merge depend on the cost structure of the upstream firm and on whether the products are substitutes or complements.

Third, we build and relate to the rather small body of empirical papers on buyer groups. Chipty (1995) focuses on the cable television industry and shows that bargaining power increases with the sizes of the buyer groups. Sorensen (2003) looks at the bargaining between insurers and hospitals. He also states that size matters but also the possibility of influencing the market share. Normann *et al.* (2015) use an experimental set-up to theoretically show that buyer groups facilitate collusion especially if the groups can exclude single firms. By looking at the market for pharmaceuticals, Ellison and Snyder (2010) show that countervailing power is most pronounced in settings in which the suppliers compete as well.

Finally, our paper is also closely related to and builds on the literature on countervailing power. In his famous contribution (Galbraith (1952)), Galbraith describes countervailing power and its influence on the economy. Building on Galbraith (1952), Chen (2003) shows that an increase in countervailing power can lead to a fall in consumers prices. However, total surplus does not always increase with the increase in countervailing power. Using Nash bargaining, von Ungern-Sternberg (1996) shows that in a Cournot setting a decrease in the number of retailers leads to an increase in the consumer prices.

Our analysis is structured in the following manner. In the next section, we outline our model structure which builds the base for our analysis in Section 3. Section 4 contains our welfare analysis. In Section 5, we check for the robustness and extensions of our analysis. In the last chapter, we summarize our main findings and conclude.

2 The Model Set-Up

2.1 The basic setting

In order to identify the privately optimal size of a buyer group, we develop a model that depicts the two main aspects of buyer groups. These two main aspects are on the one hand the fact that firms in the buyer group cooperate among themselves vis-à-vis the suppliers while competing on the other hand in product markets.

We model the market power of the supplier by allowing for one supplier only. In contrast, a number of downstream firms compete in the product market. They source their single homogeneous input from the monopolistic supplier. To facilitate the analysis we assume the absence of any production costs at either level. We start by analyzing the three-downstream-firms case. Later, we expand the analysis to N downstream firms.

Downstream firms face linear demand functions. In order to model a wide variety of different degrees of substitutability (and hence, competition) in downstream markets we use the following demand functions:

$$p_i = 1 - q_i - \sum_{j \neq i}^{2} \gamma q_j$$

with q_i and q_j denoting the quantities of firms i and j respectively. We use $\gamma \in [0,1]$ as our measure for the intensity of competition. With $\gamma = 0$, all firms are in a monopolistic situation with their respective customers. With $\gamma = 1$, the products of downstream firms are perfect substitutes that represents perfect competition, that is, Bertrand competition.

We derive in the Appendix the inverse demand functions:

$$q_i = \frac{1}{m}((1-\gamma) - (1+\gamma)p_i + \sum_{j \neq i} \gamma p_j), \tag{1}$$

with $m = 1 + \gamma - 2\gamma^2$.

2.2 Timing

Decisions are undertaken in three different stages.

Stage 1: In the first stage, downstream firms determine the size of the buyer group as follows: They choose to form buyer groups of different sizes in a non-cooperative manner. The realization of a buyer group of size $N_b \in \{2,3\}$ depends on the choices of coalition structures by all players. Any coalition is only formed and expanded if the potential members agree on it, otherwise non-selected member have to stay out (see, e.g., Levando (2016)).[2] While we rule out – for competition-policy

[2] The detailed decision-mechanism can be displayed by the following sequence (cf. Moldovanu (1992)). A randomly

reasons – transfers across firms we discuss relaxing this assumption in our discussion section (see chapter 5.4).

Stage 2: In the second stage, sourcing prices in the upstream market are determined. In the absence of any buyer group or for firms outside the buyer group (firms operating on a stand-alone basis), the upstream monopolist sets the price for a downstream firm i (c_i) in a profit-maximizing manner.

In contrast, firms in the buyer group engage in a Nash bargaining game with the upstream firm (supplier) to determine the sourcing price the upstream monopolist charges to the members of the buyer group. Thereby, the determined price maximizes the product of their (i.e. the monopolist's and the buyer group's) net surplus, that is, the respective surplus in case of an agreement minus the surplus in case the bargaining process does not yield an agreement. Before this Nash bargaining takes place the upstream monopolist puts forward a take-it-or-leave-it price offer for the independent firms. We use the static Nash bargaining approach, as an approximation of a dynamic, non-cooperative alternating offer game (see Binmore *et al.* (1986) and Collard-Wexler *et al.* (2019) for a justification of this).

Stage 3: In the third stage the downstream firms which are able to source from the upstream firm engage in price competition.

By conducting backward induction we solve for an equilibrium at every stage. Before proceeding, we want to stress the main underlying mechanism of our model with regard to the decision to form a buyer group. In our model, this decision takes place against the background of the following trade-off. Adding more members increases the bargaining power of the buyer group by deteriorating the outside option of the upstream monopolist. On the other hand, increasing the number of members means that more firms in the downstream market compete against each other with lower costs that intensifies the competition. While the first decision speaks in favor of increasing the size of the buyer group, the second effect speaks against it.

3 Model Analysis

Given our setting, only three different outcomes in the first stage of our model are feasible. The first outcome is a full buyer group in which all three downstream firms are part of the buyer group. Second, at the other extreme, no buyer group emerges, and all three downstream firms operate on

chosen player i has the first initiative. An initiator may shift the initiative to another player, or she may make a proposal. A proposal consists of a coalition and a responder who must be a player of the coalition. The responder can accept or not accept the proposal. If the responder does not accept, then she becomes the new initiator. If the responder accepts she may either form the coalition and the game ends if the responder was the last player in the coalition needed to accept the proposal. Or, alternatively the responder must select the next responder to the existing proposal. There is discounting of payoffs between periods.

a stand-alone basis. While with the first two outcomes, all three downstream firms are symmetric; this is not true with our third setting in which two downstream firms form a partial buyer group, while the third firm stays independent. We make use of this fact in the subsequent analysis of price competition.

3.1 Price Competition in the Downstream Market

We start with the analysis of price competition in the downstream market (stage 3). Competition takes place for given sourcing prices (c_i) of all downstream firms ($i = 1,..,3$). Given our set-up, we distinguish between two types of downstream firms. Firms which are part of the buyer group purchase from the upstream monopolist at a price of c_b while those outside the group do so at a price of c_o.

Downstream firms choose prices to maximize their profits:

$$\Pi_i = (p_i - c_i)q_i, \tag{2}$$

by taking the above demand function (Eq. (1)) into account.

Our three settings can be characterized as symmetric (full buyer (fb) group and no buyer (nb) group) or asymmetric (partial buyer (pb) group). In the symmetric cases all downstream firms face the same sourcing price c_i. Therefore, solving the maximization problem in Eq. (2) with taking Eq. (1) as well as the symmetry of firms into account leads to equilibrium prices of:

$$p_i^e = \frac{(1-\gamma) + (1+\gamma)c_i^e}{2} \quad \text{with} \quad e = \{fb, nb\} \tag{3}$$

The price-cost margin ($p_i - c_i$) is given by:

$$p_i^e - c_i^e = \frac{(1-\gamma)(1-c_i^e)}{2} \tag{4}$$

In the partial bargaining setting, there are two firms inside the buyer group facing a sourcing price of c_b^{pb} and one firm outside the buyer group facing a sourcing price of c_o^{pb} (with $c_b^{pb} < c_o^{pb}$). Taking the first order conditions of Eq. (2), we can state the two reaction functions (of firms inside and outside the group) as:

$$p_b^{pb} = \frac{(1-\gamma) + \gamma p_o^{pb} + (1+\gamma)c_b^{pb}}{2+\gamma} \tag{5}$$

$$p_o^{pb} = \frac{(1-\gamma) + 2\gamma p_b^{pb} + (1+\gamma)c_o^{pb}}{2(1+\gamma)} \tag{6}$$

Solving these two equations yields:

$$p_b^{pb} = \frac{(2+3\gamma)(1-\gamma)+2(1+\gamma)^2 c_b^{pb}+\gamma(1+\gamma)c_o^{pb}}{2(2+3\gamma)} \quad (7)$$

$$p_o^{pb} = \frac{(2+3\gamma)(1-\gamma)+2\gamma(1+\gamma)c_b^{pb}+(2+3\gamma+\gamma^2)c_o^{pb}}{(2+3\gamma)} \quad (8)$$

The price-cost margins ($p_i^{pb}-c_i^{pb}$) of the two kinds of firms are hence given by:

$$p_b^{pb}-c_b^{pb} = \frac{(2+3\gamma)(1-\gamma)-(2+2\gamma-2\gamma^2)c_b^{pb}+\gamma(1+\gamma)c_o^{pb}}{2(2+3\gamma)} \quad (9)$$

$$p_o^{pb}-c_o^{pb} = \frac{(2+3\gamma)(1-\gamma)+2\gamma(1+\gamma)c_b^{pb}-(2+3\gamma-\gamma^2)c_o^{pb}}{2(2+3\gamma)} \quad (10)$$

This price-cost margin for the members of the buyer group (which has due to our linear demand function its correspondence in the respective quantities) reveals already an important part of the underlying mechanism of our model. The lower the costs of the members (c_b^{pb}), the higher the profit margin (see Eq. (9)). By contrast, the members of the partial buyer group benefit if the independent firm competes in the product market with higher costs c_o^{pb}. We refer to this latter effect as the product-market-competition effect. The negative effect between the size of the buyer group and its sourcing price is called in the following the bargaining-group-size effect. While the product-market-competition effect speaks against an enlargement of the buyer group, the bargaining-group-size effect points in the direction of the formation of a full buyer group.

3.2 Price Determination in Upstream Market

In the upstream market, the monopolistic supplier either faces a buyer group or independent downstream firms or a combination. We assume that Nash bargaining takes places when the buyer group bargains with the supplier. While the monopolistic supplier can exert perfect pricing power when dealing with small independent downstream firms. We are now going through the three possible cases (nb,fb and pb).

No buyer group In this case, the upstream monopolist faces only independent downstream firms. Therefore, the price c_o will be determined via the maximization of the upstream monopolists' total profits:

$$\max_{c_o^{nb}} = 3q_o c_o^{nb} \quad (11)$$

Plugging (3) into (1) yields the following Proposition for the symmetric case:

$$q_o^{nb} = \frac{1+\gamma}{2m}(1-c_o^{nb}) \tag{12}$$

Hence, by inserting this equation into (11) after maximization, we get:

$$c_o^{nb} = \frac{1}{2} \tag{13}$$

as the monopolistic price of the upstream supplier. This price stems from the fact that the upstream monopolist faces a linear demand curve with a slope of minus one.

Full buyer group When facing a buyer group of three, the upstream price is determined via Nash bargaining between the upstream monopolist and the buyer group. In the case when bargaining breaks down, the firms in the buyer group will not be supplied leading to zero profits for them. If all firms are in the buyer group, the upstream monopolist also realizes zero profits when bargaining breaks down since there are no other firms to which the product can be shipped. Hence, for both parties the respective threats (deviation) lead to a payoff of zero. Assuming equal bargaining power implies that in this case bargaining aims to maximize the product of the profits of the two parties, that is, $3q_b^{fb}(p_b^{fb}-c_b^{fb})$ of the buyer group and $3q_b^{fb}c_b^{fb}$ for the upstream monopolist.

The maximization problem hence can be written as:

$$\max_{c_b^{fb}} \quad ((3q_b^{fb}(p_b^{fb}-c_b^{fb})-0)(3q_b^{fb}c_b^{fb}-0) = \left(\frac{1-2\gamma}{2-2\gamma}\right)^3 (1-c_b^{fb})^3 c_b^{fb} \tag{14}$$

whereby the second part of the equation stems from plugging (3) into (1) for the full bargaining case as well as Eq. (4).

The maximization problem then yields $c_b^{fb} = 0.25$. Since Nash bargaining partially internalizes the negative externality of a high supplier price to the buyer group in downstream competition, the resulting price is just between the monopolistic supplier's price and the transfer price which would maximize joint profits. The latter would require a transfer price which is equal to the marginal cost of the upstream producer, that is, zero.

Partial buyer group In this case, two firms form a buyer group while the third firm remains independent. The latter firm faces a take-it-or-leave-it offer from the upstream monopolist who maximizes their profits with the independent firm anticipating the outcome of the Nash bargaining game. We analyze these decisions in reverse order and address the bargaining problem first, and then analyze the take-it-or-leave-it offer from the monopolist.

Nash Bargaining The buyer group engages in Nash bargaining where again the product of the respective net surpluses is maximized. The net surplus of the upstream firm is the differential profits which emerges from a successful bargaining outcome and from a break-down of the bargaining. In the latter case, the monopolist would sell only to the independent firm that indicates firms in the buyer group do not operate on the downstream market. Hence, the optimization problem is structurally identical to the one denoted in Eq. (14) with the only difference that the monopolist faces two different types of firms: the two firms in the buyer group and the independent firm for which deliveries will be undertaken even if the bargaining breaks down.

The Nash bargaining in this setting in which all three firms sell positive quantities in the downstream market is:

$$\max_{c_b^{pb}} \ (2q_b^{pb}(p_b^{pb}-c_b^{pb})-0)((2q_b^{pb}c_b^{pb}(c_o^{pb})+q_o^{pb}c_o^{pb}-\frac{(1-c_o^{pb})c_o^{pb}}{2}) \tag{15}$$

with

$$\begin{aligned} q_b^{pb} &= \frac{(1+\gamma)\left(2+\gamma-3\gamma^2-2(1+\gamma-\gamma^2)c_b^{pb}+\gamma(1+\gamma)c_o^{pb}\right)}{(4+6\gamma)(1+\gamma-\gamma^2)} \\ q_o &= \frac{(1+\gamma)\left(2+\gamma-3\gamma^2-(2+3\gamma-\gamma^2)c_o^{pb}+2\gamma(1+\gamma)c_b^{pb}\right)}{(4+6\gamma)(1+\gamma-\gamma^2)}. \end{aligned}$$

These latter expressions are derived by plugging Eqs. (7) and (8) into Eqs. (1).

In the last sub-stage, the upstream monopolist maximizes their total profits $2q_b^{pb}c_b^{pb}+q_o^{pb}c_o^{pb}$ by setting the c_o in a take-it-or-leave-it manner.

We derive the following in the Appendix:

Proposition 1 *In a setting with a two-firm partial buyer group co-existing with a third, independent firm (all three with non-negative quantities sold) in which the upstream monopolist sets a take-it-or-leave it sourcing price for the independent firm and subsequently bargains with the partial buyer group, the resulting sourcing prices are:*

$$c_b^{pb} = \frac{10+19\gamma-2\gamma^2-11\gamma^3-\sqrt{36+108\gamma+25\gamma^2-160\gamma^3-94\gamma^4+52\gamma^5+33\gamma^6}}{16(1+2\gamma-\gamma^3)} \quad \textit{if} \quad \gamma \leq \bar{\gamma} \tag{16}$$

with $\partial c_b^{pb}/\partial\gamma > 0$, $c_b^{pb} \in [0.25, 0.3504], \bar{\gamma} = 0.80344$ *and*

$$c_o^{pb} = 0.5$$

The reasoning behind this finding is the following: The more competitive the downstream market is (i.e., the larger γ is), the less pronounced the downside effect of c_b is on q_b, $p_b - c_b$, and the profits of the members of the buyer group (with $dq_b/dc_b = -1/(2+3\gamma)$, see Eq. (16)). This weaker effect means that the immediate effect of c_b on the profits of the upstream monopolist dominates leading to an increase in c_b^{pb}. Furthermore, a larger γ means that the difference between the quantity sold to the third firm with and without a successful bargaining outcome becomes larger that increases the bargaining power of the upstream firm, leading to an increase in c_b^{pb} too.

The upper limit of c_b stems from the fact that with a larger γ, the cost advantage of the firms in the buyer group drive the third firm beyond a certain threshold out of the market. This critical competition intensity $\bar{\gamma}$ is equal to 0.80344.

The reasoning behind our finding that $c_o^{pb} = 0.5$ independent of γ is the following: The benchmark of the no-buyer group shows that a sourcing price of $c_o^{nb} = 0.5$ quoted to all downstream firms is optimal for the upstream monopolist. This is not possible to implement in a partial buyer group setting. But setting $c_o = 0.5$ maximizes the deviation point of the upstream firm. A higher deviation point increases the bargaining power of the upstream firm leading to a higher sourcing price c_b (meaning c_b is closest to 0.5). Additionally, it also maximizes the profits earned from the firm outside the pool. Since the bargaining price c_b must be smaller than c_o (otherwise there will never be incentives to form a group), the best price the upstream firm could set independent of γ is $c_o^{pb} = 0.5$.

Proposition 1 depicts a setting in which all three firms are selling positive amounts in the downstream market. However, if competition is fierce enough, then the cost advantage of the buyer group drives the third firm out of the downstream market (i.e. if $\gamma > \bar{\gamma}$). This departure alters the setting, such that the Nash bargaining problem reads as:

$$\max_{c_b^{pb}} \ (2q_b^{pb}(p_b^{pb} - c_b^{pb}))((2q_b^{pb}c_b^{pb}(c_o^{pb}) - \frac{(1-c_o^{pb})c_o^{pb}}{2}) \tag{17}$$

Correspondingly, c_o^{pb} is chosen such that $2q_b^{pb}c_b^{pb}(c_o^{pb})$ is maximized.

We derive the following proposition in the Appendix:

Proposition 2 *In a setting in which the buyer group consists of two firms and the independent firm leaves the market, the resulting sourcing prices are:*

$$c_b^{pb} = \frac{5-\sqrt{9-2(2+\gamma-\gamma^2)}}{8} \quad \textit{for} \quad \gamma > \bar{\gamma} \tag{18}$$

and

$$c_o^{pb} = 0.5$$

Here, too, the upstream monopolist has an incentive to quote a take-it-or-leave-it price of 0.5 that serves the sole purpose of maximizing the outside option for the upstream monopolist in the subsequent bargaining game.

The price resulting from bargaining remains in the following range: $c_b^{pb} \in [0.3455, 0.3544]$ with $\partial c_b^{pb}/\partial \gamma < 0$. A larger γ describes a situation with more pronouned competition in the downstream market, with *ceteris paribus* lower downstream prices. This level leads to a decrease of the profit margin of the firms inside the buyer group. The realized profits of the supplier in case of successful bargaining only depend on the quantities produced by the firms inside the group. Therefore, if prices decrease, then the quantities of the firms increase and the profits of the supplier increase as well. The Nash bargaining balances this effect that thereby leads to c_b which declines with γ if the independent producer leaves the market. Figure 1 displays the sourcing prices described in Propositions 1 and 2.

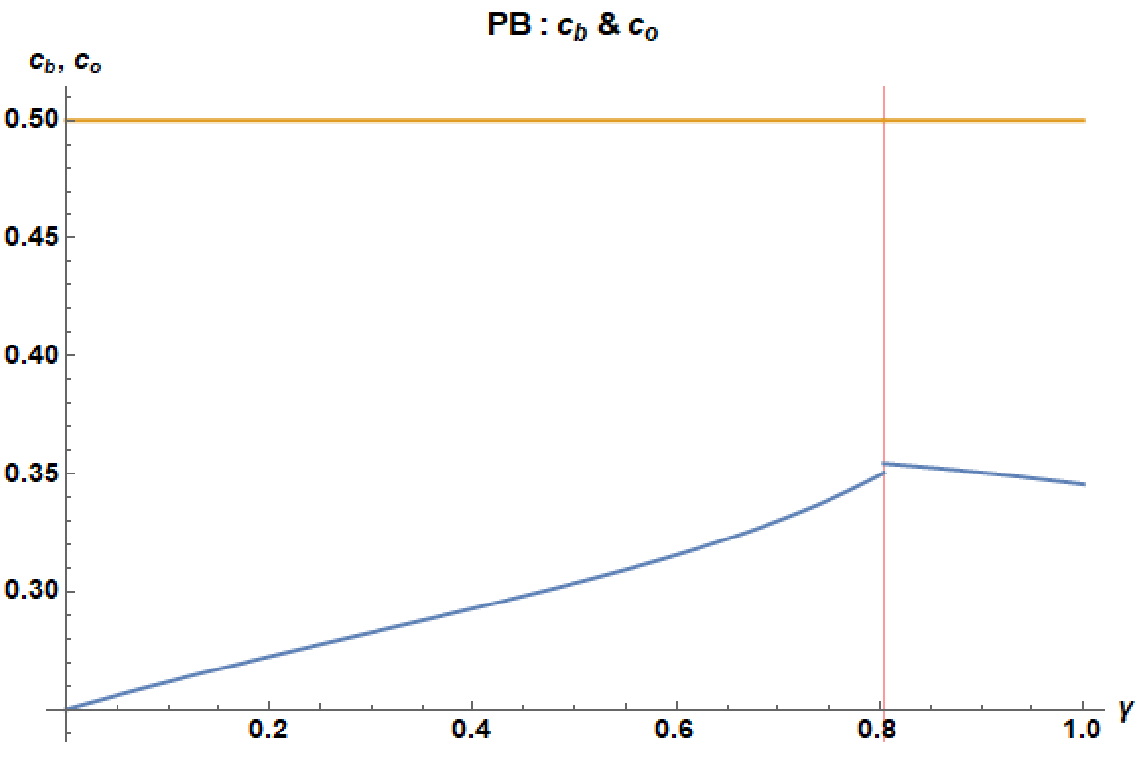

Figure 1: Orange: c_o Blue: c_b

3.3 Size of Buyer Group

We assume that players can freely discuss their strategies, but cannot make binding commitments. In this setting, a stronger concept than the Nash equilibrium is the concept of coalition proofness.

A coalition-proof equilibrium is a correlated strategy from which no coalition has an improving and self-enforcing deviation (see Bernheim *et al.* (1987) and Moreno and Wooders (1996)). The set of coalition-proof equilibria can be characterized as the set of agreements from which no coalition has a self-enforcing deviation making all its members better off. In our case, this set means that strategies are coalition proof when neither an individual firm inside a coalition nor a coalition has an incentive to deviate. The formation of a partial buyer group is coalition proof if its firms have no incentives to individually or jointly deviate from the partial buyer group setting. Our coalition-formation rule states that members of the buyer group can prevent a firm from joining; this rule means that a buyer group of a certain size is an equilibrium if it is in the interest of the members to neither reduce nor increase its size.

For our symmetric cases, that is, the no buyer group and the full buyer group, from Eqs. (1), (3), and (4) we get:

$$q_e = \frac{(1+\gamma)(1-c_e)}{2(1+\gamma-2\gamma^2)} \quad \text{with} \quad e = \{nb, fb\} \tag{19}$$

and

$$p_e - c_e = \frac{(1-\gamma)(1-c_e)}{2} \tag{20}$$

and hence for the profits of the individual firms we get:

$$\Pi_e = q_e(p_e - c_e) = \frac{(1-\gamma^2)(1-c_e)^2}{2(1+\gamma-2\gamma^2)} \tag{21}$$

Since the sourcing price in the absence of a buyer group is 0.5 and hence, larger than the one with a full buyer group (which amounts to 0.25), all firms prefer a full buyer group compared to no buyer group.

With a partial buyer group, the sourcing price for the independent firm remains at 0.5 (see Propositions 1 and 2). However, for the two members of the partial buyer group, the sourcing price is in between the two extremes. Hence, while they profit from their relative cost advantage over the independent firm in the downstream market, they pay a higher price to the upstream firm.

Figure 7 maps the profits of the members of the buyer groups as a function of γ in the partial and full buyer group setting.

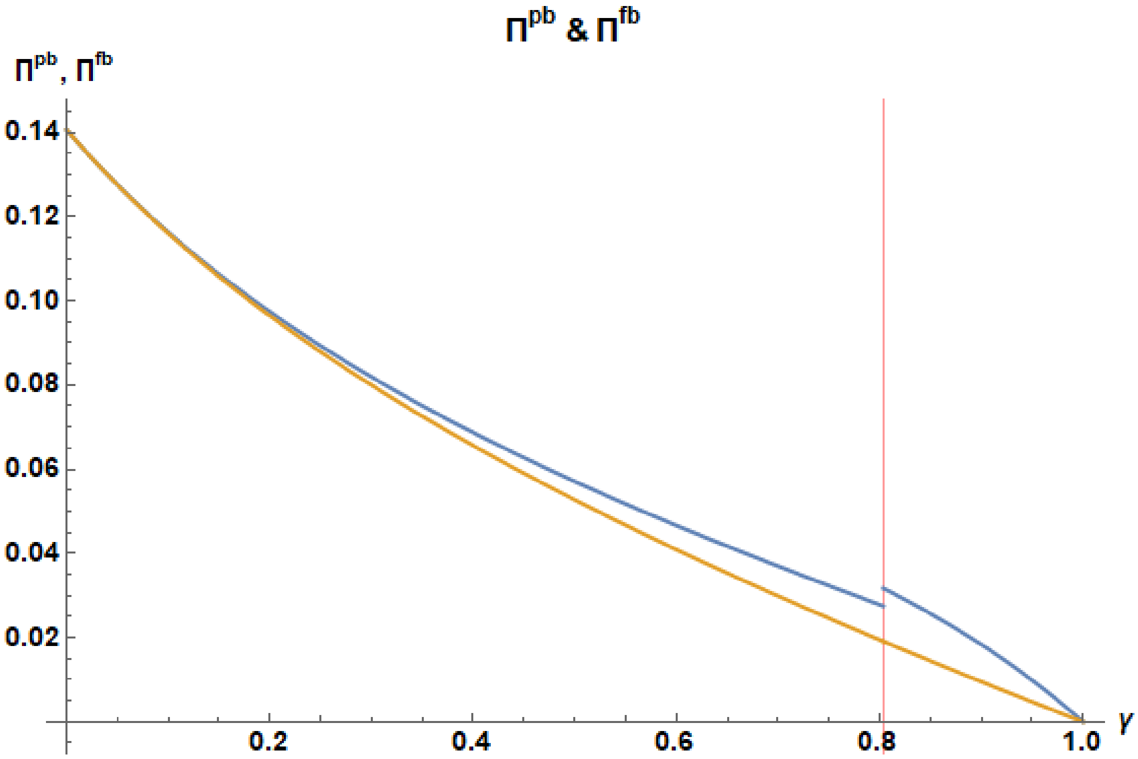

Figure 2: Orange:Π^{fb} Blue:Π^{pb}

Figure 7 shows that for all intensities of competition, the members in the partial buyer group earn higher profits as compared to the full buyer group. Furthermore, they have no incentive to deviate unilaterally or jointly. Hence, the partial-buyer-group setting is coalition proof. Being coalition proof shows that from the point of view of the members of the partial buyer group, the anti-competitive effect of the smaller buyer group (the product-market-competition effect) outweighs the lower degree of bargaining power in the partial buyer group (the bargaining-group-size). Or to put it differently: the member firms in the partial buyer group are willing to pay a higher sourcing price because at the same time the higher price reflects the fact that the competitor in the downstream market outside the buyer group pays even a higher price.

We can summarize as follows:

Proposition 3 *A partial buyer group consisting of two firms payoff-dominates the full buyer group. The partial buyer group setting is hence a coalition-proof equilibrium.*

Only for the extreme cases ($\gamma = 0$ and $\gamma = 1$) are the firms indifferent to forming either a full buyer group or a partial buyer group. This indifference is rather straight forward since in the case of γ equals zero downward firms are monopolists in their respective product markets. There, the sourcing prices are the same for both settings. This is due to the fact that the downstream firms have the same market power as the upstream monopolist, and there is no competition between the firms. Therefore, the profits are the same for firms inside a full or a partial buyer group. If γ equals one, then it leads to underbidding in a Bertrand-like manner. Therefore, if at least two firms face the same sourcing price, then the profits are zero; this is the case in all three settings. Hence, downstream firms are indifferent to either a full or a partial buyer group.

4 Welfare

In our welfare analysis, we use a broad measure comprising the upstream, the downstream firms, as well as the consumers in the downstream markets. In this analysis, prices are transfers between parties which cancel out. Hence, our main measure is the total quantities supplied and consumed in downstream markets. The first-best result would be the case in which all goods are sold at a price of zero. As long as prices are positive (and γ is smaller than one), this value never occurs in our setting. The second-best result is the full buyer group with a sourcing price of 0.25.

In both other settings sourcing prices and hence downstream prices are higher leading to a lower welfare level. The comparison between the partial-buyer-group and the no-buyer–group case is potentially more complicated. While in the partial-buyer-group sourcing prices are lower leading to higher overall quantities produced and sold, the partial-buyer-group case also leads for high enough γs to a market outcome in which the independent firm is driven out of the market. Hence, for our welfare analysis we need to compare the total quantities produced and sold in these two set-ups in order to be able to reach a conclusion with regard to our welfare analysis.

Figure 3 which depicts the different levels of welfare in the different settings as a function of γ as reveals that the partial-buyer-group case always dominate the no-buyer group case. For small as well as large γs, the total quantities sold in the partial-buyer group case are larger compared to the no-buyer-group case.

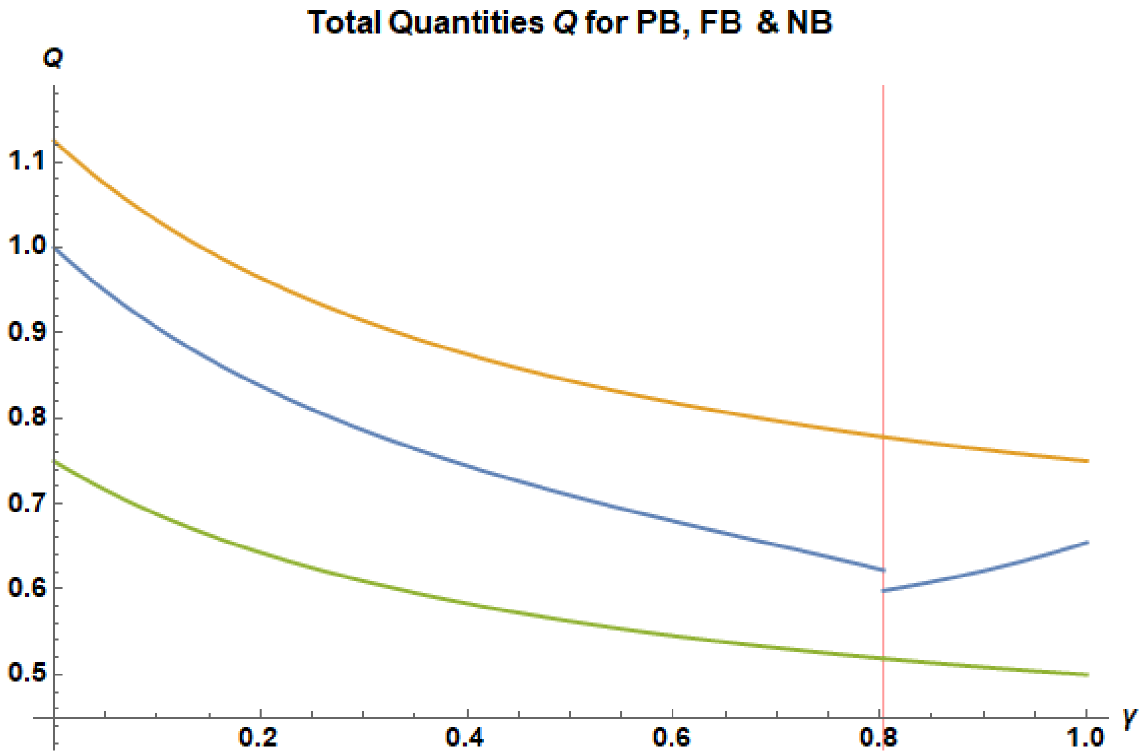

Figure 3: Orange:Q^{fb} Blue:Q^{pb} Green: Q^{nb}

We summarize this as the following:

Proposition 4 *A full buyer group welfare-dominates the partial buyer group which itself welfare-dominates the no buyer group case.*

From a competition point of view, this proposition indicates that a buyer group should be treated favorably. Due to the fact that they provide a counterbalance to the market power of the upstream suppliers while competing in downstream markets, they are very different compared to conventional (seller) cooperations and cartels. Our set-up speaks in favor of a complete liberalization with regard to the size of the buyer group.

5 Extensions and Discussion

So far we have relied on the case of three downstream firms with price competition. In order to identify the main underlying mechanism, we extend the setting in three directions. First, we consider the N-firm case. Second, we look into the Cournot case (firms compete in quantities), a case in which downstream competition is *ceteris-paribus* less fierce than with price competition as analyzed in our main setting. Third, we investigate the implications of a direct improvement of the buyer group's bargaining power through the extension of buyer group size.

Broadly speaking we thereby show that our findings carry over to the N-firm case: we find that an interior solution prevails. The analysis of the Cournot case strengthens our competition argument: if downstream competition becomes less fierce the formation of partial buyer groups becomes less likely. The details of the analysis of both extensions are laid out in the Appendix. Furthermore, we show that an increase in bargaining power associated with a (larger) buyer group makes a partial buyer group less likely. Lastly, we discuss relaxing the no transfer between firms condition.

5.1 The N-firm case

Allowing for a general number of downstream firms confirms our findings in the three-firm-case. Not only do we see the same price patterns, we also can prove the emergence of a partial buyer group. Since it turns out that matters become quite complex very quickly we delineate our findings graphically (see for the derivation and an additional figure Appendix A.4).

With N firms the firms inside the buyer group have an incentive to exclude some opponents. The optimal size of the buyer group is exactly the size in which the independent firms do not operate on the market anymore (see figures 4, and 5 as well as 9 in the Appendix). Furthermore, group sizes smaller than the optimal one lead to higher profits for the group members compared to a full bargaining group, too. This is not true for larger group sizes. In this case extending the size of the buyer group means to include firms which do not operate on the market anymore to the group. Therefore, competition on the downstream market increases, which is not in the interested of the group members (see figures 4). The optimal size of the buyer group is relatively larger if downstream-market competition is weaker (see figure 5). Stefan: stimmt das wirklich?. Lower competition intensity makes it harder to push the independent firms out of the market. While a larger number of firms decreases the relative optimal size of the buyer group (see figure 9). More firms operating on the downstream market lead to smaller quantities provided by each firm. Therefore, the independent firms do not operate on the market anymore already for relatively smaller groups.

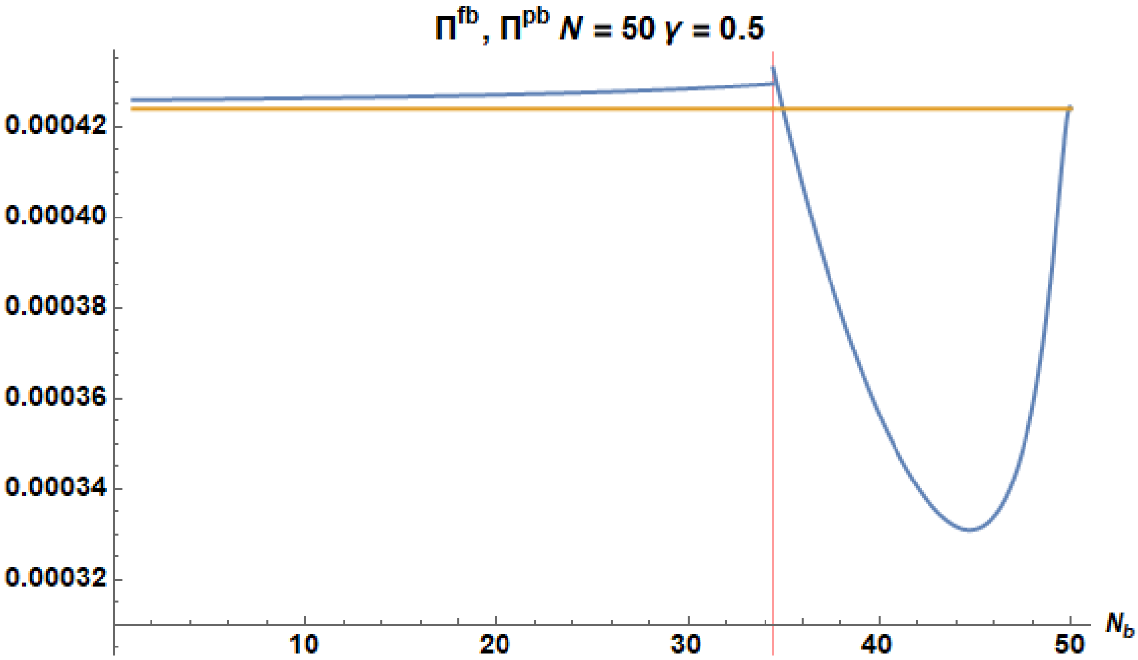

Figure 4: Orange:Π^{fb} Blue:Π^{pb} for $N = 50$ and $\gamma = 0.5$

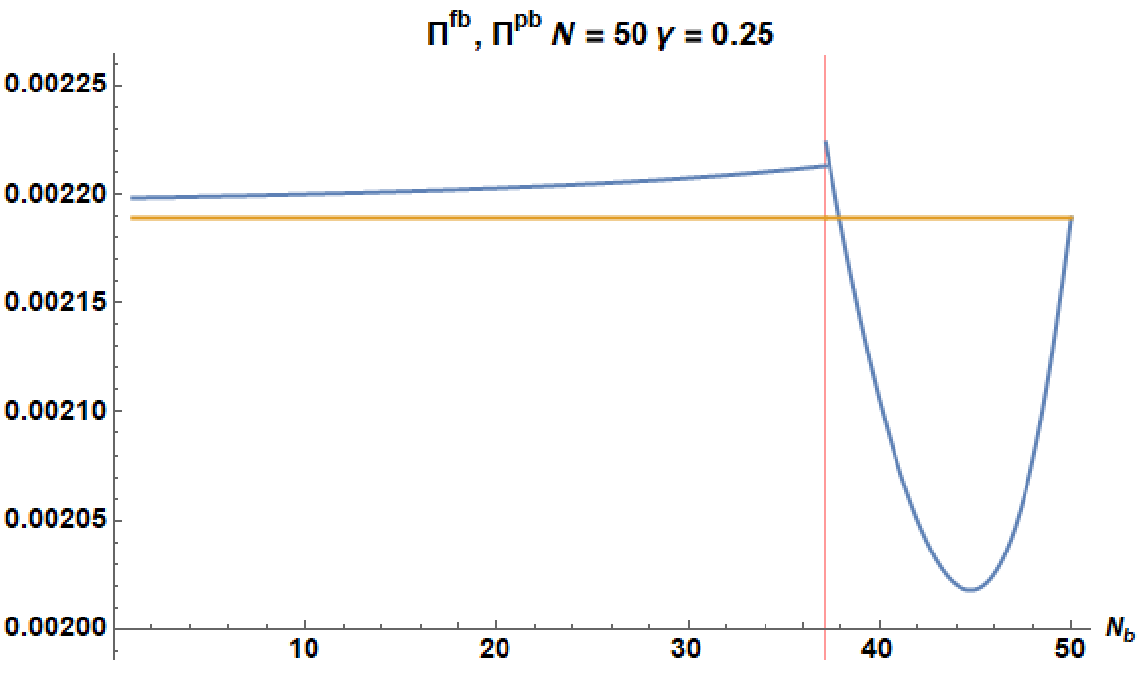

Figure 5: Orange:Π^{fb} Blue:Π^{pb} for $N = 50$ and $\gamma = 0.25$

5.2 Different Market Structure: The Cournot case

Looking at the Cournot case strengthens our point that competition in downstream markets has to be strong enough. With Cournot competition, the effect of competition is significantly weaker that indicates the exclusion of other firms from the buyer group does not pay off (see a detailed analysis in Appendix A.5). Figure 6 shows the profits for firms inside a partial buyer group or a full buyer group if they compete in quantities. The profits are higher for firms inside a full buyer group and hence, we expect that only full buyer groups emerge in this setting.

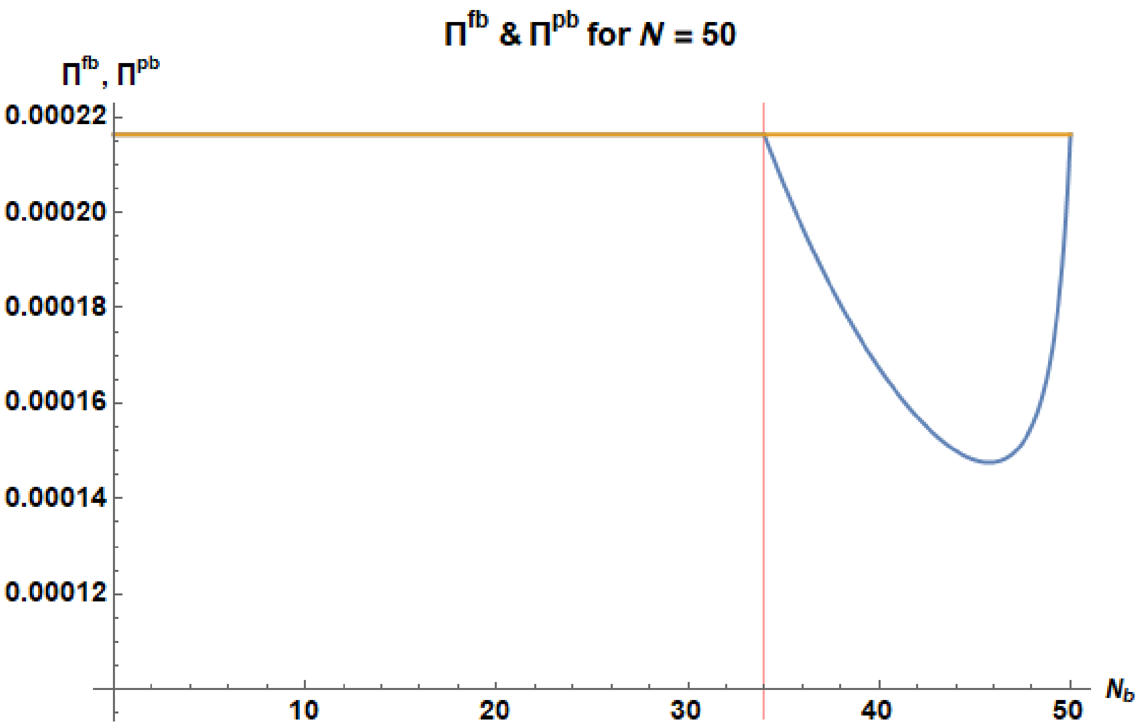

Figure 6: Orange:Π^{fb} Blue:Π^{pb} for $N = 50$

5.3 Increasing Bargaining Power

In our main analysis we assume that the bargaining power effect works indirectly through the outside option and bundled supply mechanism only, i.e. we assume equal bargaining strength in the full- as well as the partial-buyer group. This clearly works against the full-buyer group since it is reasonable to expect a change in the bargaining power of the buyers if the size of the buyer group increases.

We aim to look into this channel now by assuming that the bargaining power of the buyer group increases with size. More specifically, we model the bargaining power parameter of the buyer group as $\theta = 1 - 1/N_b$ implying $1 - \theta = 1/N_b$. This implies that with the partial buyer group $\theta = 0.5 = 1 - \theta$ leading us to the same result as in the previous sections.

With the full-buyer group the Nash bargaining problem now implies the maximization of

$$\max_{c_b} \ (3q_b(p_b - c_b) - 0)^{2/3}((3q_b c_b - 0)^{1/3} \tag{22}$$

Plugging the resulting sourcing price ($c_B^{fb} = \frac{1}{6}$) into our profit differential allows us to depict the two profit lines with the partial and the full buyer group.

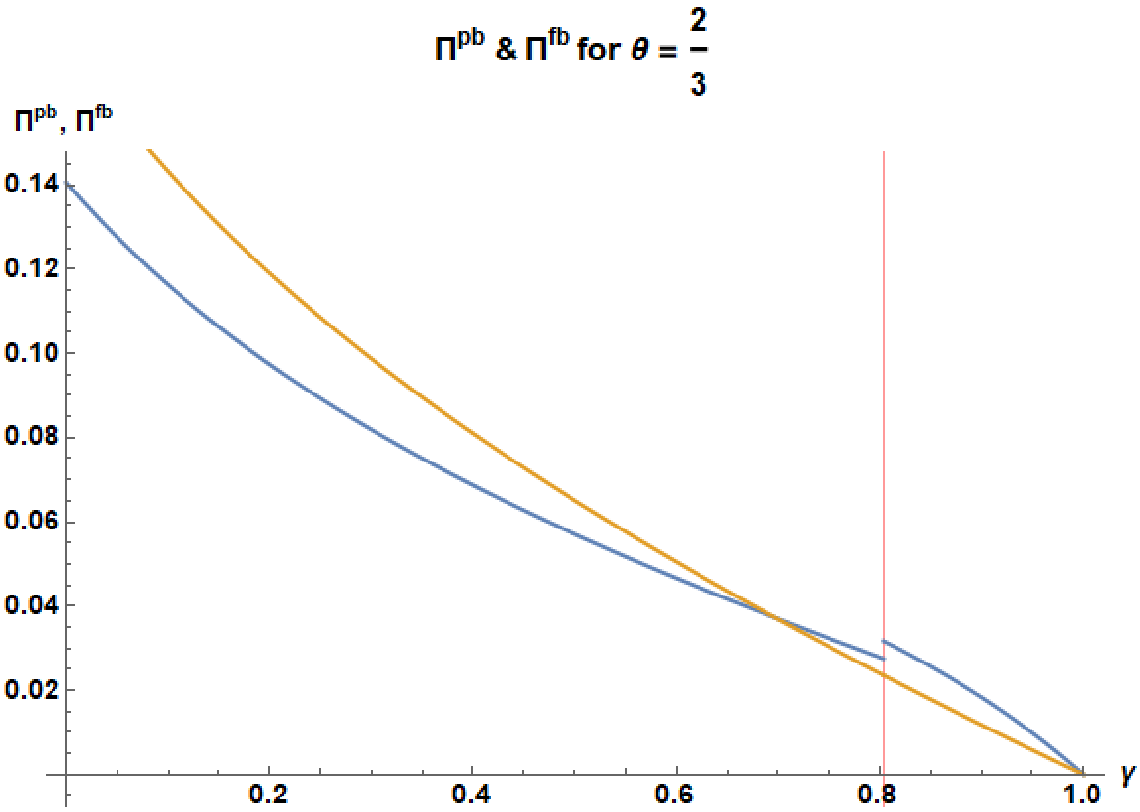

Figure 7: Orange:Π^{fb} Blue:Π^{pb}

With an additional mechanism for the increase of the bargaining power in the full-buyer-group case we find that for sufficiently high levels of competition, the partial-buyer-group solution still prevails. However, for small levels of γ the bargaining-group-size effect dominates with our new additional mechanism.

5.4 Transfers Across Firms

In this subsection we relax our assumption of no-transfers across downstream firms. In particular, we consider the possibility that the outside firm has an incentive to pay the two other downstream firms which form a partial buyer group to extend the buyer group to a full one.

We show and argue in the following that if transfers are possible it may be feasible for the outside firm to pay the members of the partial buyer group to extend the buyer group to a full one if the degree of competition is small. If in contrast the degree of competition is large, it is not feasible to extend the buyer group to a full one even under this rather drastic assumption of allowing for transfers among the firms.

We show this by contrasting firm total profits with the full buyer group and with the partial buyer group. The outside firm may compensate the two buyer group firms to engage in a full buyer group if

$$\Pi^{fb} - \Pi^{o} > 2(\Pi^{pb} - \Pi^{fb}),$$

or

$$3\Pi^{fb} - 2\Pi^{pb} - \Pi^{o} > 0.$$

We display this differential in Figure 8

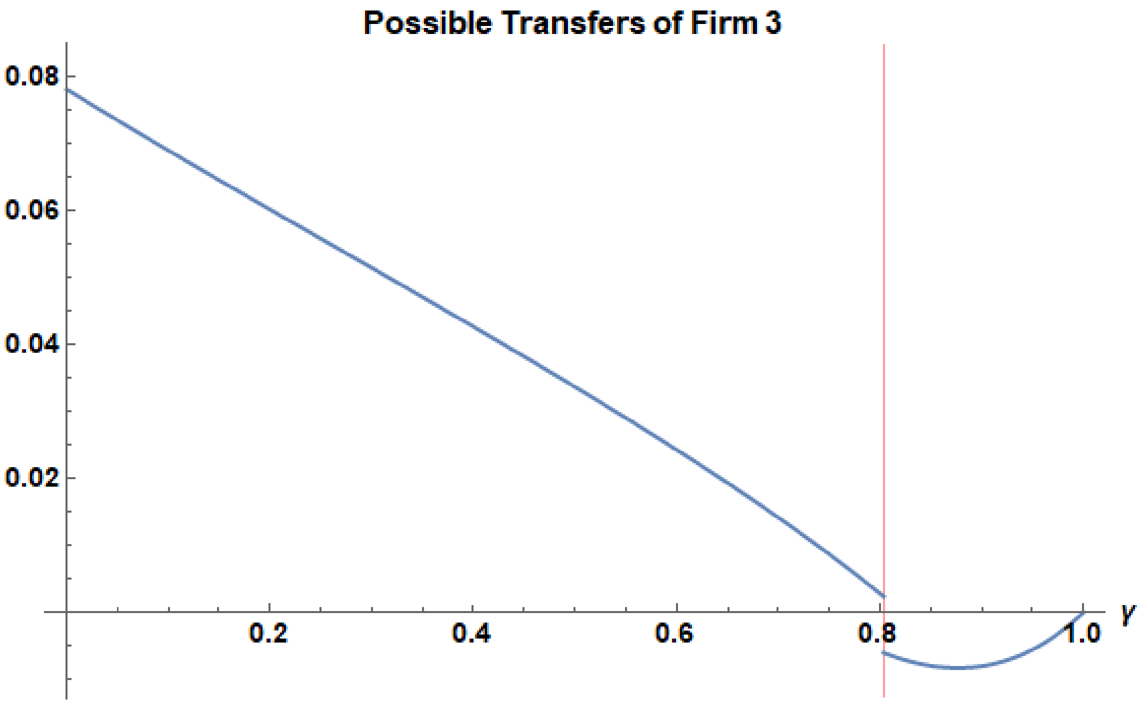

Figure 8: Blue line: $\{3\Pi^{fb} - 2(\Pi^{pb} + \Pi^{o})\}$

For small degrees of competition (low γ) the profit differential is positive implying that the outside firm would not only have the incentive but also the possibility to compensate the two other downstream firms to form a full buyer group. With intense competition (large γ) this is not the case. In the latter situation, total profits with a partial buyer group exceeds the one of a full buyer group. The intuition behind this is that in this latter case, the mitigation of competition via the partial buyer group (which is associated with the outside firm being quite uncompetitive) is in particular valuable for members of the partial buyer group. This is an immediate consequence of our competition effect: the larger is γ the more it pays to reduce downstream competition via partial buyer group.

Our analysis also displays that for the intense-competition case, a partial buyer emerges even if we allow for inter-firm transfers among downstream firms. As Figure 8 displays these transfers are not feasible for high competition levels while Figure 7 shows that for these cases (without transfers) a partial buyer groups is formed.

Let us finally provide some aspects on our upstream monopolist assumption. To keep our analysis simple we have modeled the upstream market to be a monopolistic one. Our main economic mechanism, however, is quite general that the buyer group counterbalances the market power of upstream sellers and then transfers it back – via lower sourcing costs – to downstream markets and competition. In order to mitigate the competition effect in the downstream market, the partial buyer group emerges. Hence, we do not see any reason why our general mechanism hinges on our assumption of the upstream supplier being a monopolist. Rather we conjecture that as long as upstream sellers have sufficient market power, then our main findings prevail.

A further simplification of our analysis is the focus on linear prices. Allowing for nonlinear prices would complicate our analysis considerably not least because of the interaction of upstream sourcing prices on downstream oligopolistic competition. Equating upstream prices with (zero) marginal costs increases downstream competition sharply and hence is, *ceteris paribus*, not in the joint interest of upstream monopolist and downstream firms. Hence, it is not in the interest of the downstream firms and upstream monopolist to charge $c_b = c_0 = 0$ and to redirect rents via a fixed component T. Hence, we can – given the underlying mechanisms of our set-up - expect that $0 < c_b < c_o$ and $\Pi_b > \Pi_o$ leaving the main trade-off of our model and hence, the qualitative results intact.

6 Concluding Remarks

In this paper, we have provided an in-depth analysis of the formation of buyer groups. By modeling all vertical aspects of buyer groups (including upstream price determination and downstream competition), we have investigated the trade-off between the product-market competition effect speaking in favor of limiting the size of the buyer group and the bargaining effect which favors larger buyer groups. Against this background we have shown that partial buyer groups emerge in equilibrium if competition is rather pronounced. It pays for the members of the partial buyer group to exclude some firms. While this exclusion reduces the bargaining power of the buyer group over the upstream monopolist and hence leads to higher sourcing prices, it mitigates competition in downstream markets.

Furthermore, we have shown that the optimal size of the buyer group is too small from a welfare perspective. This is due to the fact that the negative externality imposed on non-buyer group firms and consumers by limiting the size of the buyer group in the market equilibrium is not internalized that leads to a too small buyer group in comparison to the welfare optimal solution which is a full buyer group in our setting.

From this last finding, we can argue that from a competition-policy point of view that buyer groups should receive considerably more freedom compared to a seller-type form of cartelization and cooperation.

Our wording with regard to the policy recommendation of our analysis is rather cautious since we recognize a couple of limitations to our analysis. One limitation is that we do not consider an exclusion rule that indicates that only members of the buyer group receive delivery while independent firms are excluded.

However, overall, we would like to conclude by arguing that buyer groups should be viewed with a significantly more positive connotation. As long as the buyer group provides a countervailing market power to upstream producers which translates into lower sourcing prices which they pass through to a certain extent to consumers they should clearly be treated very differently to any type of cartelization in downstream markets. The only crucial prerequisite is the need to avoid any spillover from the cooperation in the buyer group to any cooperation in downstream markets.

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A Appendix

A.1 Derivation of inverse demand functions

Since we are analysing price competition we need to find the inverse demand function. In order to use this formulation in the N-case setting we employ the general formulation. Therefore, we need to invert the matrix first.

$$\begin{pmatrix} -1 & -\gamma & \dots & -\gamma \\ -\gamma & -1 & \dots & -\gamma \\ \dots & \dots & \dots & \dots \\ -\gamma & -\gamma & \dots & -1 \end{pmatrix}^{-1} = \begin{pmatrix} \frac{-(1+(N-2)\gamma)}{1+(N-2)\gamma-(N-1)\gamma^2} & \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} & \dots & \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} \\ \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} & \frac{-(1+(N-2)\gamma)}{1+(N-2)\gamma-(N-1)\gamma^2} & \dots & \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} \\ \dots & \dots & \dots & \dots \\ \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} & \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2} & \dots & \frac{-(1+(N-2)\gamma)}{1+(N-2)\gamma-(N-1)\gamma^2} \end{pmatrix} = A$$

Therefore, the inverse demand function can be written as:

$$\begin{pmatrix} q_1 \\ q_2 \\ \dots \\ q_N \end{pmatrix} = A \begin{pmatrix} p_1 \\ p_2 \\ \dots \\ p_N \end{pmatrix} - A \begin{pmatrix} 1 \\ 1 \\ \dots \\ 1 \end{pmatrix}$$

For the benchmark cases full bargaining group and no bargaining group all firms are symmetric. Therefore, the demand of firm i is described by:

$$q_i = (p_i - 1)\frac{-(1+(N-2)\gamma)}{1+(N-2)\gamma-(N-1)\gamma^2} + \sum_{j\neq i}(p_j - 1)\frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2}$$

For matters of readability in the following we define $a = \frac{(1+(N-2)\gamma)}{1+(N-2)\gamma-(N-1)\gamma^2}$ and $b = \frac{\gamma}{1+(N-2)\gamma-(N-1)\gamma^2}$.

Hence, we can reformulate the demand functions as follows

$$q_i = (a-(N-1)b) - ap_i + \sum_{j\neq i} bp_j - 1)$$

A.2 Derivation of Proposition 1

We employ backward induction to derive the result. We proceed in three steps. First, we deduce c_b from the bargaining game for given c_o. Second, we determine c_o from (15) anticipating the effect of c_o on c_b. Third, and last, we plug in $c_b(c_o)$ the resulting c_o.

The first-order condition for (14) reads as:

$$\begin{aligned} &\left(\frac{\partial p_b}{\partial c_b} - 1\right)\left(2q_b^2 c_b + q_o + q_b c_o - q_o\frac{(1-c_o)c_o}{2}\right) + c_o q_b \frac{\partial q_o}{\partial c_b} \\ &(p_b - c_b)\left(2q_b^2 + \left(4q_b c_b + q_o c_o - \frac{(1-c_o)c_o}{2}\right)\frac{\partial q_b}{\partial c_b}\right) = 0 \end{aligned} \quad (23)$$

Using the partial derivatives from Eqs (16) and (12) we get after quite tedious calculations

$$\begin{aligned} c_b(c_o) = \big(&10+\gamma^5(15-8c_o) - \gamma^4(5+8c_o) + 8\gamma^3(2c_o-5) + \gamma^2(24c_o-5) + \gamma(25+8c_o) - \\ &\sqrt{(1+\gamma-\gamma^2)^2(-2-3\gamma+2\gamma^2+3\gamma^3)(-18-27\gamma+2\gamma^2(9-16c_o+16c_o^2)+\gamma^3(27-64c_o+64c_o^2)}\big) / \\ &\big(16(1+\gamma)(1+\gamma-\gamma^2)^2\big) \end{aligned} \quad (24)$$

In the second step, we aim to solve the problem for c_o taking the effect of c_b into account We deduce the first-order-condition from (15) as:

$$
\begin{aligned}
&2c_b\frac{\partial q_b}{\partial c_o}+2\frac{\partial q_b}{\partial c_b}\frac{\partial c_b}{\partial c_o}c_b+2q_b\frac{\partial c_b}{\partial c_o}+\\
&+\frac{\partial q_o}{\partial c_o}c_o+\frac{\partial q_o}{\partial c_b}\frac{\partial c_b}{\partial c_o}c_o+q_o=0
\end{aligned}
\tag{25}
$$

Using $\partial c_b/\partial c_o$ from Eq. (24) we get from (25) after tedious calculations

$$
c_o^{pb}=0.5
$$

Plugging this back into (24) yields

$$
c_b^{pb}=\frac{10+19\gamma-2\gamma^2-11\gamma^3-\sqrt{36-108\gamma-25\gamma^2+160\gamma^3+94\gamma^4-52\gamma^5-33\gamma^6}}{16(1+2\gamma-\gamma^3)}
\tag{26}
$$

and, hence,

$$
\partial c_b/\partial\gamma>0
\tag{27}
$$

A.3 Derivation of Proposition 2

In case the third firm is driven out of the market (i.e. if $\gamma>0.80344$,, see Proposition 1), the bargaining problem looks as follows:

$$
c_b^{pbo}(c_o^{pbo})=\frac{5-\sqrt{9-8c_o^{pbo}(1-c_o^{pbo})(2+\gamma-\gamma^2)}}{8}
\tag{28}
$$

By choosing c_o to maximize $2q_bc_b$ we note that in our two-firm symmetric equilibrium on the downstream market $p(2)=$ and hence

$$
q_b(2)=\frac{(1-c_b)}{(1+\gamma)(2-\gamma)}
$$

Hence, our objective function becomes

$$
2q_bc_b=\frac{2(1-c_b)c_b}{(1+\gamma)(2-\gamma)}
\tag{29}
$$

Hence, the first-order condition becomes

$$
(1-2c_b^{pbo})\frac{\partial c_b^{pbo}}{\partial c_o^{pbo}}=\frac{(1-2c_b^{pbo})}{\sqrt{9-8c_o^{pbo}(1-c_o^{pbo})(2+\gamma-\gamma^2)}}8(1-2c_o^{pbo})=0
$$

whereby the second term stems from plugging in the partial derivative from Eq. (28). Since all terms but $(1-2c_o^{pbo})$ are strictly positive we find

$$
c_o^{pbo}=0.5
$$

and hence,

$$
c_b^{pbo}=\frac{5-\sqrt{9-2(2+\gamma-\gamma^2)}}{8}
$$

A.4 N firms

We extend our basic model by analysing the setting of N downstream firms. There are again the three settings of a full buyer group, no buyer group and a partial buyer group. With N downstream firms the size of the partial buyer group (N_b) can be in the range of $0 < N_b < N$. The advantage of this extension is that we can show when it is optimal to form a partial buyer group and the optimal size of the buyer group. Everything else is similar to the basic model. Because of the complexity of the calculations we calculate it with Mathematica. We can provide the code on request. The results are presented in the following the figures in the text (see Figures 4 and 5) as well as the one below

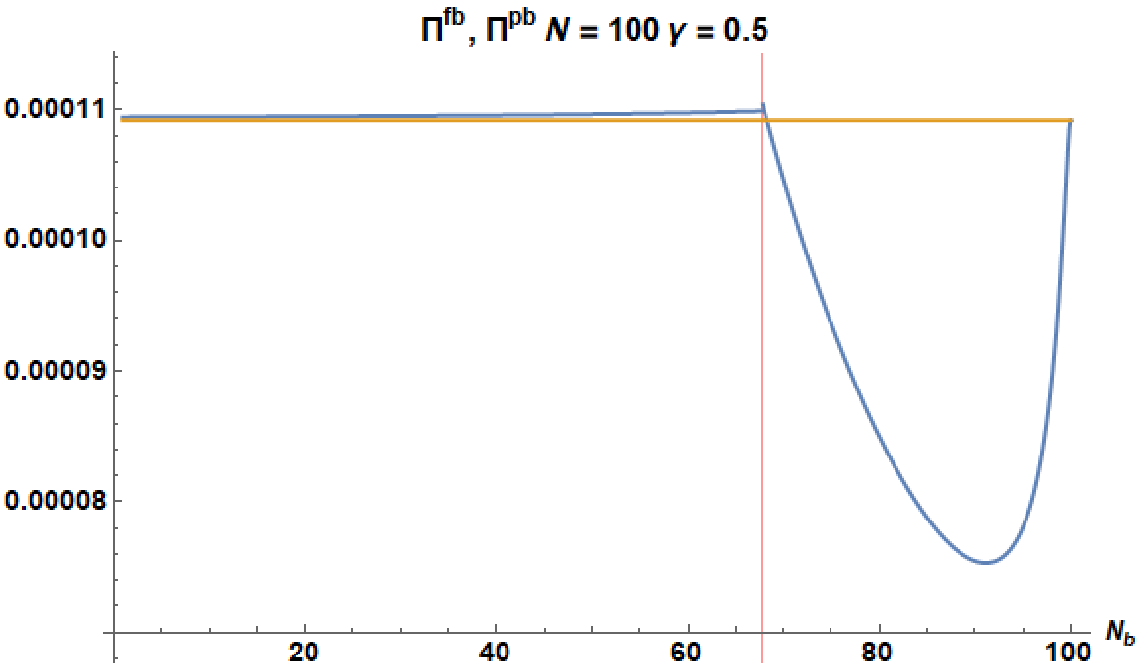

Figure 9: Orange:Π^{fb} Blue:Π^{pb} for $N = 100$ and $\gamma = 0.5$

A.5 Cournot competition

We consider the Cournot competition case. To facilitate the analysis we consider the case of homogeneous goods only. In this setting the production-market-competition is fiercest turning our analysis towards an interior solution for the size of the buyer group. The smaller is γ, the less pronounced is the production-market-competition speaking against an interior solution for the size of the buyer group.

The structure of the main model remains unchanged with the only alteration that downstream firms compete in the third stage in quantities (Cournot competition). There exist one supplier and N downstream firms facing in downstream markets the demand function $p = 1 - \sum_{i=1}^{N} q_i$. The number of firms in a bargaining group is given by N_b. Therefore, the number of stand alone based firms is given by $N_o = N - N_b$.

In the following we consider our three cases: no bargaining group, full bargaining group, and partial bargaining group. All cases are derived by backward induction solving the competitive equilibrium on stage 3 first, subsequently the determination of the input price in stage 2 and finally we deduce the equilibrium profits of downstream firms which allows us – in comparison – to determine the size of the buyer group.

No buyer group
Stage 3: Each downstream firm receives the same price on stage 1 c_i. Each firm maximizes its profits:

$$\max_{q_i} \ (1-\sum_{i=1}^{N} q_i - c_i)q_i$$
$$1-(N-1)q_{-i}-2q_i-c_i \overset{!}{=} 0 \quad with \ \ q_i = q_{-i}$$
$$q_i^* = \frac{1-c_i}{N+1}$$

Stage 2:
Since there is no bargaining on this stage the supplier chooses c_i which maximizes its profits:

$$\Pi_o = N(\frac{1-c_i}{N+1})c_i$$
$$\frac{Nc_i - Nc_i^2}{N+1}$$
$$c_i^* = \frac{1}{2}$$

The equilibrium quantities of each firm are given by $q_i^* = \frac{1}{2(N+1)}$ with profits emerging to $\Pi_i^{nb} = (\frac{1}{2(N+1)})^2$.

Full buyer group

All downstream firms form a bargaining group ($N_b = N$). Therefore, stage 3 is unchanged because all downstream firms receive the same price c_i.
Stage 2: The supplier is not able to make a take it or leave it offer. The equilibrium input price is derived by Nash bargaining. The deviation points of the supplier and the bargaining group are both 0 since if they are not able to make a contract both receive zero profits. Using the profits and the quantities calculated above the bargaining problem looks as follows:

$$\max_{c_i} \ \left(N\left(\frac{1-c_i}{N+1}\right)^2 - 0\right)\left(\left(\frac{1-c_i}{N+1}\right)Nc_i - 0\right)$$
$$-2(1-c_i)^2(Nc_i)+(N-2c_iN)(1-c_i)^2 \overset{!}{=} 0$$
$$\Rightarrow c^F = \frac{1}{4} = 0.25$$

c must be smaller than one otherwise there is no positive demand at all. Therefore, there is a unique solution $c^F = 0.25$. The profits of each downstream firms are given by $\Pi_i^{fb} = (\frac{0.75}{N+1})^2 > (\frac{0.5}{N+1})^2 = \Pi_i^{nb}$. Therefore, the downstream firms prefer always a full buyer group than no group at all.

Partial buyer group

This setting differs from the benchmark since now firms on the downstream market are not anymore symmetric because of different costs. Therefore, at stage 2 the stand-alone firms N_o receive a take it or leave it offer (c_o) while the buyer-group members are charged c_b resulting from Nash bargaining.

In stage 3 downstream firms maximizes their profits taking input prices into account:

$$\max_{q_i} \; q_b(1-q_b-(N_b-1)q_{-b}-N_oq_o-c_b)$$
$$1-2q_b-(N_b-1)q_{-b}-N_oq_o-c_b \stackrel{!}{=} 0 \quad with \;\; q_b=q_{-b}$$
$$q_b(q_o)=\frac{1-N_oq_o-c_b}{N_b+1}$$

For the independent downstream firms the problem is structurally similar bit with different costs c_o:

$$q_o(q_b)=\frac{1-N_bq_b-c_o}{N_o+1}$$

Plugging q_o into q_b leads to ;

$$q_b^{pb}=\frac{1+N_oc_o-(N_b+1)c_b}{N+1}$$
$$q_o^{pb}=\frac{1+N_bc_b-(N_o+1)c_o}{N+1}$$

On stage 1 the setting is also different now. For the buyer group the deviation point is still 0, while this is not true anymore for the supplier. The deviation point is here defined by the profits it can make by only serving the stand alone based firms. All in all the Nash Bargaining problem looks the following:

$$\max_{c_b} \; (N_b(q_b^{pb})^2-0)\left(N_bq_b^{pb}c_b+N_oq_o^{pb}c_o-N_oc_o\frac{1-c_o}{N_o+1}\right)$$
$$\left(\frac{1+N_oc_o-(N_b+1)c_b}{N+1}\right)^2\left(N_bc_b\frac{1+N_oc_o-(N_o+1)c_b}{N+1}+N_oc_o\frac{1+N_bc_b-(N_o+1)c_o}{N+1}-N_oc_o\frac{1-c_o}{N_b+1}\right)$$

The first derivative can be expressed by:

$$\frac{N_b(-1+c_b+N_o(c_b-c_o)^2(1+4c_oN_o+1+4c_b(-1-N_o))}{(1+N)^3} \stackrel{!}{=} 0$$

Next steps allocate the concrete solution and plug this solution into the maximization problem of the supplier. Derive the profit maximizing costs c_b and c_o. Plug them into profits of each firm inside the group and derive the optimal size N_b. The solution to the bargaining problem described before is given by:

$$c_b(c_o)=\frac{4c_oN_o+1}{4N_o+4}$$

Assuming that the supplier is knowing the bargaining outcome, the maximization problem of the supplier is given by (plugging in the function $c_b(c_o)$ for all c_b's):

$$\max_{c_o}\Pi_o=N_bc_b(c_o)\frac{1+N_oc_o-(N_o+1)c_b(c_o)}{N+1}+N_oc_o\frac{1+N_bc_b(c_o)-(N_b+1)c_o}{N+1}$$

The solution to this is given by:

$$c_o^*=\frac{1}{2} \;\;\Rightarrow\;\; c_b^*=\frac{2N_o+1}{4N_o+4}$$

Therefore, the supplier chooses for the stand alone based firms exactly the price which it will choose in the abstinence of a buyer group . The derived solution is not the solution for the whole range of bargaining group sizes N_b. If the buyer group is too large, the quantities firms outside the buyer group will produce are negative. Of course firms cannot produce negative quantities in this setting. There must exists a different solution for very large N_b's. The critical value for the size of the bargaining group is $\hat{N}_b = \frac{2+2N}{3}$. For N_b's larger than $\hat{N}_b$ the bargaining assumption looks the following:

$$\max_{c_b} \; N_b \left(\frac{1-c_b}{N_b+1} \right)^2 \left(c_b N_b \frac{1-c_b}{N_b+1} - N_o c_o \frac{1-c_o}{N_o+1} \right)$$

The intuition is that both (buyer group and the supplier) know that the buyer group is too large and therefore, the stand alone based firms will not participate on the market in equilibrium. But still the stand alone based firms are important because they define the deviation point. The solution of this maximization problem is given by:

$$c_b^C(c_o) = \frac{5}{8} - \frac{1}{8} \sqrt{\frac{-9N_b + 9N_b^2 - 32N_b c_o - 32N_b^2 c_o + 32N_b c_o^2 - 9N_b N + 32N c_o + 32N_b N c_o - 32c_o^2 N - 32N_b c_o^2 N}{N_b(-N-1+N_b)}}$$

Again plugging this into the profit maximization problem of the supplier $\max_{c_o} \; \Pi_o^C = q_i N_b c_b(c_o)$ the optimal prices are given by:

$$c_o^* = \frac{1}{2} \;\; \Rightarrow \;\; c_b^C = \frac{5}{8} - \frac{1}{8} \sqrt{\frac{N_b(N+17) - N_b^2 - 8N}{N_b(N+1) - N_b^2}}$$

In every case the price for the stand alone based firms is $c_o = \frac{1}{2}$. This is completely in line with the intuition given in our main analysis .

Profits:

The last step is to compare the profits in each scenario. The setting which guarantees the highest profits for each firm inside the buyer group will be the expected one. The profits of each firms in every scenario are given by $\Pi_i^{fb} = q_i^2$ due our linear demand function. Figure 2 compares the profits in the case of a full bargaining group (yellow line) with the profits of a bargaining group of different sizes (blue line).

$$\Pi^{fb} = (\frac{0.75}{N+1})^2$$
$$\Pi^{pb} = \Pi^{fb}$$

On the left side of the red line the profits are equal so firms are indifferent between building a full buyer group or a partial one. While they prefer a full buyer group if the size gets too large (right of the red line). The intuition here is that the firms inside the group do not have a competition advantage towards firms outside the group since there are no competing stand alone based firms anymore. Therefore, they prefer to build a full buyer group in this case.

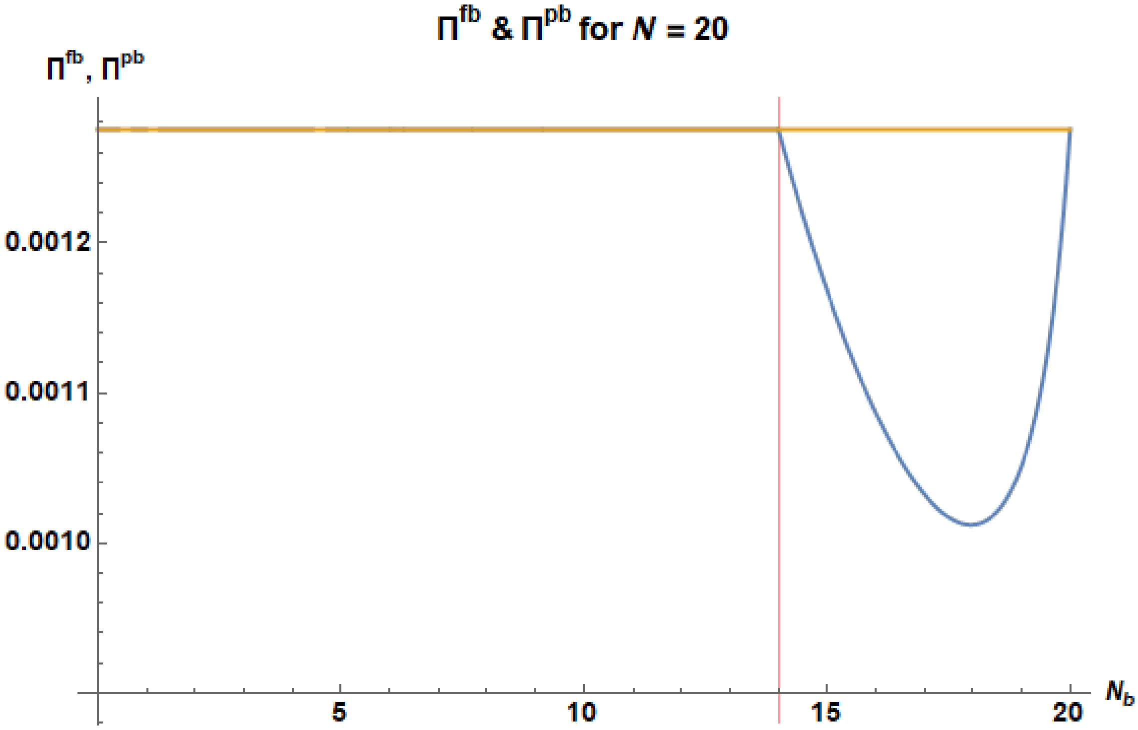

Figure 10: Orange:Π^{fb} Blue:Π^{pb} for $N = 20$