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Abstract. This paper studies the incentives for, and the welfare effects of, pre-donation in a vertically related industry where two downstream firms that produce a homogenous good jointly bargain, using the generalized Nash rule, with an upstream firm over a linear input price before they engage in Cournot competition. We theoretically show that the downstream industry has no incentive to make any pre-donation and this is irrespective of its bargaining power. We also show computationally that (i) the upstream firm finds to make unilateral pre-donation optimal if and only if its bargaining power is sufficiently small and (ii) its optimal pre-donation (whenever positive) always yields Pareto welfare gains.

Keywords: Vertically related industry; Nash bargaining; pre-donation.

JEL codes: L12, L13, L22, C78

1 Introduction

This paper studies the incentives for, and the welfare effects of, pre-donation (transfer of would-be profits) in a vertically related industry where two downstream firms that produce a homogenous good jointly bargain, using the generalized Nash rule, with an upstream firm over a linear input price before they engage in Cournot competition. The idea of pre-donation in collective bargaining was first introduced by Sertel (1992), who showed that in two-player bargaining problems with linear and asymmetric boundaries, the Nash bargaining rule can be manipulated by the player that has a higher valuation if this player commits, before the bargaining takes place, to pre-donate to the other player a certain fraction of each potential payoff that it could obtain in the bargaining set.[1] Recently, Saglam (2022a) applied the idea of pre-donation to the optimal regulation of a natural monopoly (with asymmetric information) using the regulatory bargaining setup in Saglam (2022b) and showed that (i) among consumers and the monopoly, only the latter party has an incentive to pre-donate, and (ii) both the monopoly and consumers become ex-ante (and in some cases ex-post) better off if the monopoly finds it optimal to make pre-donation before bargaining between the monopoly and consumers over the regulated output and price takes place. Our paper aims to explore whether Pareto gains of pre-donation enjoyed by consumers and the industry may also arise when all bargaining parties are firms like in a vertically related (and unregulated) industry.

While integrating the idea of pre-donation with a vertically related industry –as we propose in our paper– is novel, the effects of collective bargaining in such industries have extensively been studied in the previous literature. Most of the studies that can be related to our paper assumed that two or more downstream firms (retailers) first bargain using the symmetric or generalized Nash rule with an upstream firm (supplier) jointly (in a centralized way) or separately (in a decentralized way) over a linear or affinely-linear (two-part)

[1] Several extensions of Sertel's (1992) model can be found in the works of Sertel and Orbay (1998), Orbay (2003), Akyol (2008), and Akin et al. (2011).

input price and then engage in Cournot (quantity) competition or Bertrand (price) competition in the downstream (final goods) market. Among these studies, Dobson and Waterson (1997) pioneered the benchmark model of decentralized bargaining between a supplier and retailers and investigated using this model the effects of increased retailer competition on consumer prices and welfare.[2] Alipranti et al. (2014) showed that when a two-part pricing contract is determined by decentralized bargaining, Cournot competition in the downstream market yields higher consumer surplus and social welfare than Bertrand competition. This result was proven to be reversed if there is a non-negativity constraint in input prices (Basak and Mukherjee, 2017) or if retailers can engage in demand-enhancing investment (Liu and Wang, 2022). Basak and Wang (2016) further showed that if a two-part pricing contract is determined by centralized bargaining, then Bertrand competition becomes the equilibrium mode of competition when the strategic variables in the final goods market are endogenized. Very recently, Din and Sun (2022) extended the work of Basak and Wang (2016) to study the effects of endogenizing the mode of bargaining (centralized or decentralized), in addition to endogenizing the strategic variables (quantities or prices) in the final goods market.

Many other works explored the other aspects of the equilibrium in the vertically related industries. For example, Aghadadashli et al. (2016) studied how demand elasticities of downstream firms affect their profit shares under decentralized bargaining and Yoshida (2018) investigated how the bargaining power of the upstream firm affects the welfare distribution under decentralized bargaining when two downstream firms engage in Cournot competition under different marginal costs of production. More recently, Wang and Li (2020) analyzed the effects of the intensity of (Cournot or Bertrand) competition in the final goods market on the profits of the upstream and downstream firms when they engage in decentralized bargaining over a two-part tariffs in-

[2] Earlier studies that dealt with bargaining in vertically related industries –e.g., Bennett and Ulph (1988), Davidson (1988), Horn and Wolinsky (1988), Dobson (1994, 1995)– focused on interactions between firms and labor unions.

put price, Wang and Wang (2021) studied the incentives of downstream firms for managerial delegation in a vertically related industry under decentralized bargaining over two-part tariffs, and Constantatos and Pinopoulos (2021) endogenized the choices of the upstream and downstream firms between the linear and two-part tariffs contracts as a function of their bargaining powers.

The industry structure in our paper borrows from Yoshida (2018). In more detail, we retain his assumption that two downstream firms at the bottom of the vertical industry face an affinely linear demand function and compete in quantities after they bargain using the generalized Nash rule over the linear price of a common input. However, differing from Yoshida (2018) we also assume that (i) the downstream firms are symmetric concerning their efficiencies and (ii) their bargaining with the upstream firm is centralized (joint). More distinctively, we also integrate Sertel's (1992) idea of pre-donation with the bargaining game in a vertically related industry. We assume that both the upstream firm and the downstream industry are allowed to make pre-donation before they bargain over the input price. Given the described structure, we theoretically show that the downstream industry has never any incentive to make pre-donation. We also show computationally that (i) the upstream firm has an incentive to make unilateral pre-donation if its bargaining power is sufficiently small and (ii) the optimal pre-donation by the upstream firm always yields Pareto welfare gains; i.e., it increases the welfare of both the upstream firm and the downstream firms as well as the consumer surplus.

The rest of the paper is organized as follows. Section 2 presents the basic structures, Section 3 contains the results, and Section 4 concludes.

2 Basic Structures

We consider a vertically related industry where an upstream monopolist (U) supplies a factor of production (input) to two downstream firms (D_1 and D_2) that produce a homogenous good under quantity (Cournot) competition. The downstream firms face the inverse demand function

$$P(q_i, q_j) = a - q_i - q_j, \tag{1}$$

where a is a positive parameter representing the size of demand and q_i and q_j are respectively the outputs of firms D_i and D_j with $j \neq i$. We assume that each downstream firm can produce its output at the common constant marginal cost c, without incurring any fixed costs. The parameter c satisfies

$$c = e + \omega, \tag{2}$$

where e is the common efficiency level of each downstream firm and ω is the common per-unit input price charged by the upstream firm to the downstream firms.

The production process is a game involving two stages. In the first stage, the upstream firm determines the common input price ω through bargaining with the downstream firms and in the second stage downstream firms simultaneously determine their outputs, q_1 and q_2, by maximizing their (operating) profits.

3 Results

We will solve the two-stage production game faced by the upstream firm and the downstream game backward. Thus, we will first consider the second-stage Cournot competition between the downstream firms. Given any $\omega \geq 0$ determined in the first stage, the profit of firm D_i is given by

$$\pi_i(q_i, q_j) = P(q_i, q_j)q_i - cq_i = (a - q_i - q_j)q_i - (e + \omega)q_i, \quad i, j = 1, 2, \;\; j \neq i. \tag{3}$$

The symmetric equilibrium outputs can be obtained as $q_1(\omega) = q_2(\omega) \equiv q(\omega)$ where

$$q(\omega) = \frac{a - e - \omega}{3}, \tag{4}$$

resulting in the symmetric equilibrium profits $\pi_1(\omega) = \pi_2(\omega) \equiv \pi(\omega)$ for the downstream firms, where

$$\pi(\omega) = q(\omega)^2 = \frac{(a - e - \omega)^2}{9}. \tag{5}$$

Let $\pi_D(\omega)$ denote the equilibrium profit of the downstream industry. Then,

$$\pi_D(\omega) = 2\pi(\omega) = \frac{2(a-e-\omega)^2}{9}. \tag{6}$$

On the other hand, the profit of the upstream firm is

$$\pi_U(\omega) = \omega[q_1(\omega) + q_2(\omega)] = \frac{2\omega(a-e-\omega)}{3}. \tag{7}$$

Now, we can consider the first-stage game, where the input price ω is determined through a bargaining process between the upstream firm and an authority acting on behalf of the downstream firms. We assume that both the upstream firm and the downstream firms will obtain zero profits if they fail to agree on any input price during the bargaining process. Thus, the net gains of the upstream firm and the downstream union from bargaining will be $\pi_U(\omega)$ and $\pi_D(\omega)$ respectively. In the absence of pre-donation, the bargaining process will aim to maximize the generalized Nash bargaining product of these net gains. The solution will be the equilibrium input price, ω^*, i.e.,

$$\omega^* = \mathrm{argmax}_{\omega \geq 0}\ [\pi_U(\omega)]^{\beta}[\pi_D(\omega)]^{1-\beta}, \tag{8}$$

where $\beta \in (0,1)$ is a known constant representing the bargaining power of the upstream firm. Solving (8), one can easily calculate that

$$\omega^* \equiv \omega^*(\beta) = \frac{\beta(a-e)}{2}, \tag{9}$$

for each $\beta \in [0,1]$. Equation (9) implies that the equilibrium input price $\omega^*(\beta)$ is (i) equal to zero if the downstream firms have the whole bargaining power ($\beta = 0$) and (ii) equal to the monopoly price $(a-e)/2$ if the upstream firm has the whole bargaining power ($\beta = 1$).

Given any $\beta \in [0,1]$ and the corresponding equilibrium price $\omega^*(\beta)$, we can calculate the profit of the downstream industry as

$$\pi_D(\omega^*(\beta)) = \frac{(2-\beta)^2(a-e)^2}{18}. \tag{10}$$

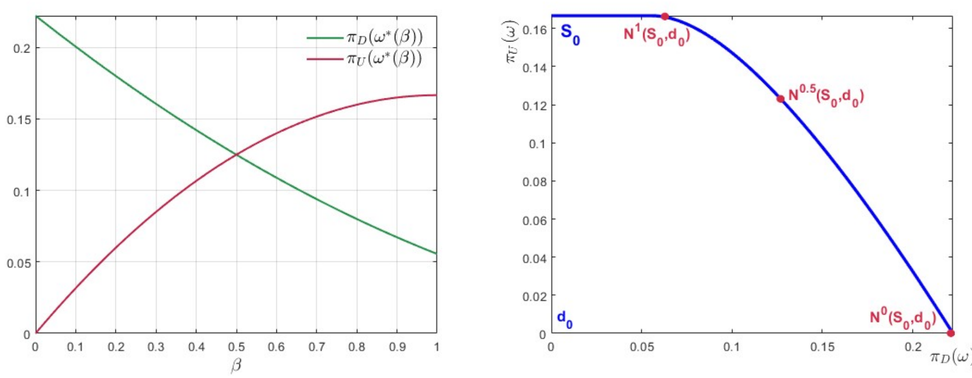
and the profit of the upstream firm as

$$\pi_U(\omega^*(\beta)) = \frac{\beta(2-\beta)(a-e)^2}{6}. \tag{11}$$

In panel (i) of Figure 1 we draw the equilibrium profits $\pi_D(\omega^*(\beta))$ and $\pi_U(\omega^*(\beta))$ with respect to β, under the parameter setting $a - e = 1$. Notice that $\pi_D(\omega^*(\beta))$ monotonically decreases and $\pi_U(\omega^*(\beta))$ monotonically increases as β is increased from 0 to 1. When $\beta = 0$, the downstream firms as a whole obtain the highest attainable profit (monopolizing the whole industry) while the upstream firm obtains zero profit. In contrast, when $\beta = 1$, the downstream firms as a whole obtain their lowest profit while the upstream firm obtains its highest profit. One can also notice that the downstream industry and the upstream firm obtain the same profit when the bargaining powers of the players are the same ($\beta = 0.5$).

Figure 1. The Bargaining Equilibrium Without Pre-donation ($a - e = 1$)

(i) Equilibrium Profits (ii) The Bargaining Problem



So far, we have felt no need to construct a bargaining set (and to use the formalities of bargaining theory). Such a construction will however simplify the analysis of the bargaining problem in the presence of pre-donation. To this end, we will first construct the bargaining problem without pre-donation. Formally, we consider a set of players $N = \{D, U\}$, involving the downstream industry (D) and the upstream firm (U). Following Nash (1950), we denote the bargaining problem facing the set of players N (in the absence of pre-donation) by a pair (S_0, d_0), where S_0 is the bargaining set, involving the possible profit allocations of the players, and $d_0 \in S$ is the disagreement point specifying the profit each player will enjoy in case of disagreement. Recall from our earlier treatment of the problem that if the players fail to agree in the bargaining process, then each party ends up with zero profit. Thus, we set the disagreement point to $d_0 = (0, 0)$.

Also notice that as the input price ω is varied on the interval $[0, a-e]$, equations (6) and (7) together define the frontier of the bargaining set in the absence of pre-donation. We can write this frontier as

$$\pi_U(\omega) = (a-e)\sqrt{2\pi_D(\omega)} - 3\pi_D(\omega), \tag{12}$$

where $\pi_D(\omega)$ satisfies (6) for each $\omega \in [0, a-e]$. The convex and comprehensive hull of the above frontier defines the bargaining set, S_0, facing the players when they are not allowed to pre-donate:

$$S_0 = \left\{ \begin{aligned} &(s_D(\omega), s_U(\omega)) : \ 0 \le s_D(\omega) \le \pi_D(\omega), \\ &\qquad\qquad\qquad\qquad 0 \le s_U(\omega) \le \pi_U(\omega), \quad \omega \in [0, a-e] \end{aligned} \right\} \tag{13}$$

The pair (S_0, d_0) is the bargaining problem without pre-donation. We plot the bargaining problem (S_0, d_0) in panel (ii) of Figure 1, under the parameter setting $a - e = 1$.

Given any $S \subset \mathbb{R}^2_+$, we let $WPO(S) = \{s \in S \mid t > s \text{ implies } t \notin S\}$ denote the set of weakly Pareto optimal allocations in S and $PO(S) = \{s \in S \mid t \ge s \text{ implies } t \notin S\}$ denote the set of Pareto optimal allocations in S. We can observe from Figure 1-(ii) that $WPO(S_0)$ coincides with the whole blue curve (involving both horizontal and downward-sloping segments) and $PO(S_0)$ coincides with the downward-sloping blue curve. Notice also that the set S_0 is compact and convex, and it contains a point s with $s > d$. Also, S_0 is d_0-comprehensive; i.e., for all $s, s' \in \mathbb{R}^2_+$, $s \in S_0$ and $s \ge s' \ge d_0$ only if $s' \in S_0$. Thus, the bargaining problem (S_0, d_0) satisfies the assumptions in Nash (1950) and it can be solved by bargaining rules that are defined on convex and comprehensive subsets of the cartesian plane. In this paper, we only consider the generalized Nash (bargaining) rule.

Given the problem (S_0, d_0) with $d_0 = (0, 0)$, the generalized Nash rule N^β associated with any $\beta \in [0, 1]$ selects the solution $N^\beta(S_0, d_0)$ on S_0 such that

$$N^\beta(S_0, d_0) = \text{argmax}_{(s_D, s_U) \in S_0} \ [s_U]^\beta [s_D]^{1-\beta}. \tag{14}$$

Notice that $N^\beta(S_0, d_0)$ must be on $PO(S)$, for otherwise some point on $PO(S)$ would give a higher utility product. We plot the solutions corresponding to $\beta = 1$, $\beta = 0.5$, $\beta = 0$ in panel (ii) of Figure 1. As β rises from 0 to 1, the bargaining solution $N^\beta(S_0, d_0)$ moves on $PO(S_0)$, from the best (worst) solution for the downstream firms (the upstream firm), $N^0(S_0, d_0)$, to the worst (best) solution for them (it), $N^1(S_0, d_0)$. Notice also that given any $\beta \in [0, 1]$ and the associated rule N^β, the profits of players D and U at the solution $N^\beta(S_0, d_0)$, which we can obtain by solving (14), correspond to their equilibrium profits $\pi_D(\omega^*(\beta))$ and $\pi_U(\omega^*(\beta))$ that we have already calculated in panel (i) by solving the problem in (8). That is, $N^\beta(S_0, d_0) = (\pi_D(\omega^*(\beta)), \pi_U(\omega^*(\beta)))$ for all $\beta \in [0, 1]$.

3.1 Bargaining with Pre-donation

Now, we will allow the upstream and downstream firms to strategically predonate in the first-stage game where bargaining occurs. To consider this new game, we will use Sertel's (1992) idea of pre-donation. A *pre-donation* from player $i \in \{D, U\}$ to player $j \neq i$ is a function $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}} : \mathbb{R}^2_+ \to \mathbb{R}^2_+$, parameterized by a constant $\rho \in [0, 1)$. This function transforms each $s \in \mathbb{R}^2_+$ into $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}(s)$ such that $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}_i(s) = (1 - \rho)s_i$ and $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}_j(s) = s_j + \rho s_i$ if $j \neq i$. Given the bargaining set S_0 and any pre-donation $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}$, we can calculate the set

$$\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0) = \{\lambda^{\rho,i}(s) \mid s \in S_0\} \tag{15}$$

and its comprehensive closure

$$\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0) = \{s \in \mathbb{R}^2_+ : \ s_1 \leq t_1 \text{ and } s_2 \leq t_2 \text{ for some } t \in \boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0)\}. \tag{16}$$

The set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0)$ is a convex and comprehensive. Moreover for $d_0 = (0,0)$, we have $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}(d_0) = d_0 \in \underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0)$. Thus, the pre-donation $\boldsymbol{\lambda}^{\boldsymbol{\rho},\boldsymbol{i}}$ transforms the bargaining problem (S_0, d_0) into the problem $(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{i}}(S_0), d_0)$.

Below, we will determine how the bargaining problem (S_0, d_0) is affected when the player $i \in \{D, U\}$ pre-donates. Recall that the disagreement point $d_0 = (0,0)$ becomes intact under a pre-donation of any player. So, we have to only find how the bargaining set S_0 is affected by a pre-donation of any player i. If player D pre-donates a fraction ρ of its payoffs in S_0, then the bargaining set transforms into the set

$$\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0) = \left\{ \begin{array}{l} (s_D(\omega), s_U(\omega)) : \;\; 0 \leq s_D(\omega) \leq (1-\rho)\pi_D(\omega), \\ \\ \qquad\qquad 0 \leq s_U(\omega) \leq \pi_U(\omega) + \rho\pi_D(\omega), \;\;\; \omega \in [0, a-e] \end{array} \right\}. \tag{17}$$

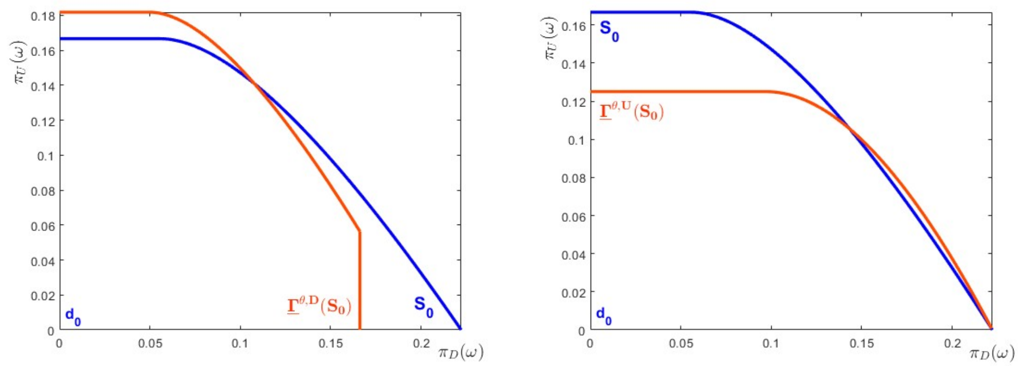
Likewise, if player U pre-donates a fraction ρ of its payoffs in S_0, then the bargaining set transforms into the set

$$\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{U}}(S_0) = \left\{ \begin{array}{l} (s_D(\omega), s_U(\omega)) : \;\; 0 \leq s_D(\omega) \leq \pi_D(\omega) + \rho\pi_U(\omega), \\ \\ \qquad\qquad 0 \leq s_U(\omega) \leq (1-\rho)\pi_U(\omega), \;\;\; \omega \in [0, a-e] \end{array} \right\}. \tag{18}$$

Panels (i) and (ii) of Figure 2 portray, under some parameter settings, the bargaining sets $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0)$ and $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{U}}(S_0)$ transformed (twisted) due to pre-donation of player D and U respectively. Panel (i) shows that pre-donation by player D may twist the bargaining set S_0 in such a way that when $\pi_D(\omega)$ is sufficiently small, the Pareto frontier of the transformed set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0)$ lies above the Pareto frontier of S_0, creating a region (set) where Pareto improvements are potentially possible. In contrast, panel (ii) shows that a pre-donation by player U may twist the bargaining set S_0 in such a way that when $\pi_D(\omega)$ is sufficiently large, the Pareto frontier of the transformed set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0)$ lies above the Pareto frontier of S_0, creating a region where Pareto improvements are potentially possible. A room for potential Pareto improvements, i.e., a non-empty set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho,i}}(S_0) \setminus S_0$, created by pre-donation of each player i under the problem (S_0, d_0) seems to be quite promising for society.[3] However, whether a positive amount of pre-donation by any player i will actually lead to a Pareto improvement or a Pareto deterioration depends entirely on the sensitivity of the generalized Nash rule towards the set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho,i}}(S_0) \setminus S_0$. Below, we will formally explore this by calculating the bargaining solution on the problem $(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho,i}}(S_0), d_0)$ for each $i = D, U$.

Figure 2. The Bargaining Problem with Pre-donation
$(a - e = 1 \ \& \ \rho = 0.25)$

(i) Downstream Firm Pre-donates (ii) Upstream Industry Pre-donates



Given a bargaining problem (S_0, d_0) and a generalized Nash rule N^β with $\beta \in [0, 1]$, we say that player $i \in \{D, U\}$ finds to make the unilateral pre-donation $\lambda^{\rho^*,i}$ optimal if

$$N_i^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho^*,i}}(S_0), d_0) \geq N_i^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho,i}}(S_0), d_0), \quad \text{for all } \rho \in [0, 1].$$

[3] In the previous literature, pre-donation leads to a non-empty Pareto improvement set only after the pre-donation of one of the players. The other player's pre-donation shrinks the bargaining set inwards everywhere. This is true even in Saglam (2022a) where the Pareto frontier of the bargaining set is non-linear unlike in the previous literature.

Below, we first consider pre-donation by player D.

Proposition 1. *Given any rule N^β with $\beta \in [0,1]$, player D finds no positive amount of unilateral pre-donation ever optimal; i.e. it always chooses $\lambda^{\rho^*,D}$ with $\rho^* = 0$.*

Proof. Pick any solution N^β with $\beta \in [0,1]$. The optimal pre-donation $\lambda^{\rho^*,D}$ of player D must satisfy

$$\rho^* = argmax_{\rho\in[0,1]}\ N_D^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0), d_0),$$

where

$$N^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0), d_0) = argmax_{(s_D,s_U)\in S_0}\ [s_U + \rho s_D]^\beta[(1-\rho)s_D]^{1-\beta}.$$

Using $s_U(s_D) = (a-e)\sqrt{2s_D} - 3s_D$, we calculate the first-order condition associated with the above maximization problem:

$$\frac{(1-\beta)}{s_D} + \beta\frac{s_U'(s_D)+\rho}{s_U(s_D)+\rho s_D} = 0.$$

Inserting $s_U'(s_D) = -3 + (a-e)/\sqrt{2s_D}$ into the above equation and doing some algebra, we obtain the bargaining utility of player D as

$$N_D^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0), d_0) = (1-\rho)\frac{(a-e)^2}{(3-\rho)^2}\left[(1-\beta)\sqrt{2} + \beta\sqrt{1/2}\right]^2.$$

Differentiating it with respect to ρ yields

$$\frac{\partial}{\partial\rho}N_D^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0), d_0) = -(1+\rho)\frac{(a-e)^2}{(3-\rho)^3}\left[(1-\beta)\sqrt{2} + \beta\sqrt{1/2}\right]^2,$$

which is negative for all $\rho \in [0,1]$. Thus, player D maximizes $N_D^\beta(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0), d_0)$ at $\rho = 0$. ■

Proposition 1 shows that the generalized Nash rule never selects a solution on the set of potential improvements, $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0) \setminus S_0$, created by player D's pre-donation associated with $\rho > 0$. Indeed, for any positive amount of pre-donation ($\rho > 0$), the rule N^{β} with $\beta \in [0,1]$ would select its solution on the bargaining set $\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0)$ always to the right of the twisting point, i.e., on the exclusion set $S_0 \setminus \underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{D}}(S_0)$, and at such a solution the utility of both players would always be less than what they would enjoy in the absence of pre-donation ($\rho = 0$).

Now we will turn to the problem of player U. For this player, the optimal pre-donation $\lambda^{\rho^*,U}$ must satisfy

$$\rho^* = argmax_{\rho \in [0,1]} \; N_U^{\beta}(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{U}}(S_0), d_0),$$

where

$$N^{\beta}(\underline{\boldsymbol{\lambda}}^{\boldsymbol{\rho},\boldsymbol{U}}(S_0), d_0) = argmax_{(s_D,s_U) \in S_0} \; [(1-\rho)s_U]^{\beta}[s_D + \rho s_U]^{1-\beta},$$

and $s_U(s_D) = (a-e)\sqrt{2s_D} - 3s_D$. Unfortunately, we cannot calculate ρ^* chosen by player U in closed form. Therefore, we will compute it using GAUSS Software Version 3.2.34 (Aptech Systems, 1998). (The program code and the resulting data are available from the author upon request.) For our computations, we set $a - e = 1$ and vary β inside the set $\{0.00, 0.001, \ldots, 1.00\}$ with increments of 0.01. Figure 3 illustrates the graphs of the optimal pre-donation level ρ^* (as a function of β) and the induced welfare distribution, in contrast to the welfare distribution obtained in the absence of pre-donation ($\rho = 0$).

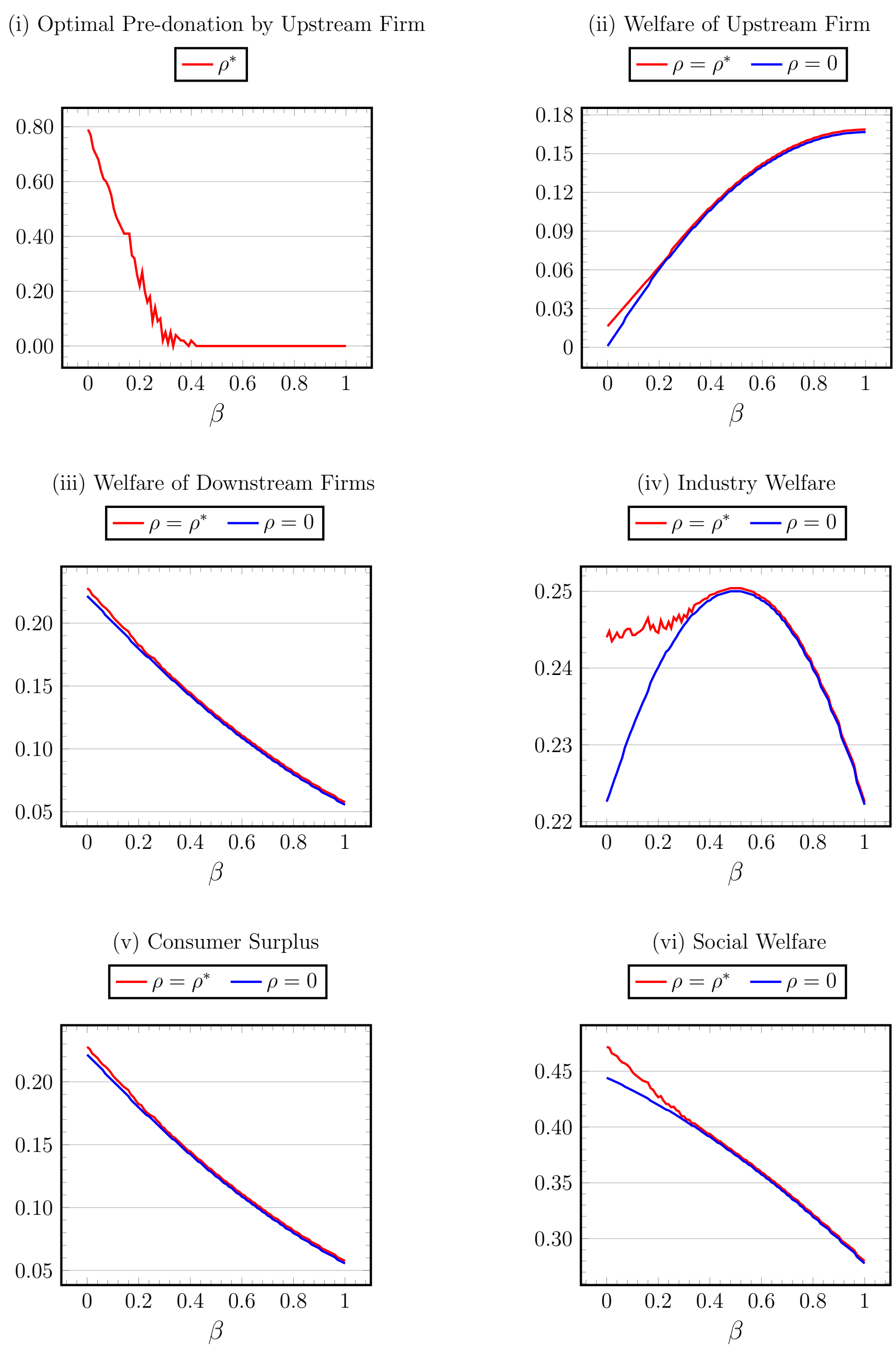
Panel (i) of Figure 3 shows that player U has an incentive to pre-donate a positive fraction ρ^* of its bargaining utilities if and only if its bargaining power, β, is sufficiently small. We observe that ρ^* becomes as high as 0.79 when β is equal to zero. When β increases, ρ^* decreases almost linearly and falls to 0 at $\beta = 0.42$. Panel (ii) shows that a positive amount of pre-donation always increases the welfare of player U. Panel (iii) shows that player D also benefits, though slightly, from the optimal pre-donation of player U. Thus, player D has no incentive to reject the pre-donation of player U. In fact, the earlier result in Proposition 1 also implies that player D has no incentive to reverse any part of the pre-donation offered by player U.

To better understand the above results, recall that the welfare of player D is positively linked to the output $q(\omega)$ of each downstream firm, i.e., $\pi_D(\omega) = 2q^2(\omega) = 2(a - e - \omega)^2/9$, in the absence of pre-donation. Panel (iii) implies that pre-donation by the upstream firm reduces the equilibrium input price ω charged by it and thus increases the production of firms in the downstream industry. On the other hand, panel (ii) implies that such a reduction in ω is not harmful to the upstream firm: This reduction is more than offset by the increase in the industry output $q_D(\omega) = 2q(\omega)$, leading to an increase in the profit of the upstream firm $\pi_U(\omega) = \omega q_D(\omega)$, as well. Panel (ii) and (iii) also show that the welfare of player U is increasing in β while the welfare of player D is decreasing in β both in the presence and absence of pre-donation possibility. In consequence, the effect of β on the industry welfare (the sum of the welfares of players U and D) becomes hump-shaped. Panel (iv) shows that the industry welfare is increasing with β if $\beta < 0.5$ and decreasing if $\beta > 0.5$, both in the presence and absence of pre-donation possibility.

A very pleasant result illustrated in panels (v) and (vi) of Figure 3 is that consumers and society as a whole benefit from a positive pre-donation optimally made by player U. Panels (ii), (iii), and (v) together imply that the optimal pre-donation by player U yields Pareto welfare gains when the bargaining power of player U is sufficiently small ($\beta \leq 0.41$). Panels (v) and (vi) also reveal that the welfares of consumers and society as a whole are decreasing in β independent of the possibility of pre-donation; thus what they prefer the most is that player D has the full power ($\beta = 0$) in the bargaining process. The above results can be summarized in the following existence result.

Proposition 2. *There are vertically related industry settings such that under the bargaining rule N^β, (i) player U finds a positive amount of unilateral pre-donation optimal if β is sufficiently small, and (ii) the optimal pre-donation by player U, whenever positive, yields Pareto welfare gains.*

Figure 3. Welfare Effects of Pre-donation by the Upstream Firm ($a - e = 1$)



4 Conclusion

This paper studied the incentives for, and welfare effects of, pre-donation in a vertical industry where a single supplier (upstream firm) of a single input and two retailers (downstream firms) cooperatively bargain using the generalized Nash rule on the linear price of the input before the retailers engage in Cournot competition to produce a single homogenous good. Our findings showed that the downstream firms as an industry have never any incentive to make pre-donation before the bargaining with the upstream firm takes place whereas the upstream firm finds to make pre-donation optimal if and only if its bargaining power is sufficiently small. Our findings also established that an optimal pre-donation by the upstream firm, whenever positive, always leads to Pareto welfare gains. Such a pre-donation increases, in addition to the profit of the upstream firm, the profit of each downstream firm and the consumer surplus.

Following the existing literature on vertically related industries, we restricted our focus to the generalized Nash rule to determine the solution to the bargaining problem between the upstream firm and the downstream industry. However, our work can be extended by allowing players to select their bargaining rule from a menu of alternative rules. For example, if the players were to use a proportional bargaining rule (Kalai, 1977) that chooses the maximal point in the bargaining set along a positively-sloped ray passing through the disagreement point, one can easily show using panel (i) of Figure 2 that the downstream industry would also have incentives for pre-donation (if and only if its bargaining power is sufficiently high) and their optimal pre-donation would lead to Pareto welfare gains just like the optimal pre-donation of the upstream firm.

Future research may also extend our work fruitfully to vertically related industries where the bargaining is decentralized, or endogenously determined, instead of being centralized; the contracts on the input prices are two-part tariffs instead of being linear; the final goods produced by the downstream firms are differentiated instead of being homogenous; or the strategic choice variable in the final good market is prices, or determined endogenously, instead of being quantities.

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