Bertrand Competition under Three-part Tariffs in Vertically Related Markets

Maria Alipranti Emmanuel Petrakis*

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Abstract

This paper shows that Bertrand competition emerges in equilibrium in the downstream market of a vertically related industry with upstream monopoly and trading via three-part tariffs. This is in sharp contrast with the bulk of the literature in which Cournot competition is the equilibium mode of competition. Bertrand competition turns out to be beneficial for all firms, but not for consumers and the society.

Keywords: Bertrand competition; Cournot competition; vertical relations.

JEL classification: D43; L13; L14

*Alipranti: Düsseldorf Institute for Competition Economics (DICE), Heinrich-Heine University of Düsseldorf, e-mail: alipranti@dice.hhu.de; Petrakis: Department of Economics, University of Crete, Univ. Campus at Gallos, Rethymnon 74100, Greece, e-mail: petrakis@uoc.gr. This research has been co-financed by the European Union (European Social Fund - ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Thalis - Athens University of Economics and Business - "New Methods in the Analysis of Market Competition: Oligopoly, Networks and Regulation". Full responsibility for all shortcomings is ours.

1 Introduction

Nowadays, contracts signed among vertically related firms (e.g., input suppliers and final good manufacturers) have become more complex, including often besides a per-unit of input price, a variety of other terms, such as trade discounts, slotting and listing fees, and other lump-sum payments. Such contracts have received lately a lot of attention by researchers and policy makers due to their significant implications on firms' behavior, market outcomes and social welfare.

In this paper, we investigate the mode of competition that arises in equilibrium in a vertically related market in which an upstream firm trades with two competing downstream firms using three-part tariff contracts. The latter include a wholesale price and a fixed fee to be paid by the downstream firm to the upstream supplier *plus* a compensation fee (i.e., a discount over the fixed fee) to be transferred downstream in the end of the game. The sequence of the moves is as follows. First, the upstream monopolist makes simultaneous take-it-or-leave-it offers to the downstream firms stipulating the type of contract (*price* or *quantity*) to be offered by the downstream firm to customers[1] along with a compensation fee that the supplier will pay back to the downstream firm if the latter abides by the agreed contract. Second, the upstream monopolist bargains simultaneously and separately with the downstream firms about their two-part tariff (wholesale price plus fixed fee) trading terms. Finally, downstream firms compete in the market.

It is well known, since the seminal paper of Singh and Vives (1984), that if firms are free to choose their strategic variable to compete in the market, it is a dominant strategy for each of them to choose quantity, provided that firms' goods are substitutes. Thus, Cournot competition arises in equilibrium. Over the last thirty years, the Singh and Vives result has been generalized and also extended in a variety of alternative economic settings (see e.g., Tanaka, 2001a&b; Tasnádi, 2006; Reisinger and Ressner, 2009; Matsumura and Ogawa, 2012; Scrimitore, 2013). For instance, Tanaka (2001a&b) generalize it to a market with n oligopolistic firms and a market with vertical product differentiation, respectively. Reisinger and Ressner (2009) point out the sensitivity of the Singh and Vives result in markets with demand uncertainty, while Matsumura and Ogawa (2012) and Scrimitore (2013) explore its robustness in mixed markets consisting of welfare maximizing and profit maximizing firms.[2]

In the present paper, we show that, contrary to Singh and Vives (1984) and the bulk of the literature thereof, Bertrand competition arises in equilibrium in a vertically related

[1] Here we adopt the terminology used in recent papers (see e.g., Matsumura and Ogawa, 2012; Chirco and Scrimitore, 2013): a downstream firm offering a price contract to customers is another way to say that the downstream firm chooses price as its strategic variable.

[2] Matsumura and Ogawa (2012) show that in a mixed duopoly, price instead of quantity competition arises in equilibrium, independently of whether products are substitutes or complements. While Scrimitore (2013) indicates that the latter can be reversed in the presence of sufficiently high firm subsidization.

industry where the upstream supplier and the downstream firms trade via three-part tariff contracts. In particular, we show that each supplier-buyer pair (i.e., a pair consisting of the upstream monopolist and one downstream firm) has incentives to agree on a price instead of a quantity contract to be offered by the downstream firm to customers. This is so because the (excess) joint profits of the supplier-buyer pair are higher under a price rather than under a quantity contract, independently of the contract choice of the rival pair. Nevertheless, the downstream firms obtain higher profits offering quantity rather than price contracts, while the opposite is true for the upstream supplier. Thus, the latter can motivate the downstream firms to switch to price contracts by offering them appropriate compensation fees - discounts over the fixed fee of the two-part tariff. In equilibrium, the upstream supplier has incentive to do so and thus Bertrand competition arises in the downstream market.

Our work contributes to the literature that examines the endogenous selection of strategic variables in vertically related markets (see e.g., Correa-López, 2007; Chirco and Scrimitore, 2013; Manasakis and Vlassis, 2014). In particular, Correa-López (2007) and Manasakis and Vlassis (2014) reconfirm Singh and Vives's result, respectively, in a unionized market with an industry-wide union and in a vertically related market in which vertical chains trade via wholesale price contracts.[3] Chirco and Scrimitore (2013) indicate that in a market with network externalities and managerial delegation a reversal of Singh and Vives's result occurs, but only if network externalities are sufficiently strong. Our analysis extends this literature, showing that Bertrand competition constitutes the equilibrium mode of competition when trading in a vertically related market is conducted via more complex three-part tariffs contracts.

We also contribute to the recently growing literature on vertical contracting via three-part tariff contracts that considers a number of alternative forms of payments made by the upstream to the downstream firms, such as slotting allowances, upfront payments, and discount fees (de Fontenay and Gans, 2005; Marx and Shaffer, 2007; Miklós-Thal et al., 2011; Rey and Whinston, 2013). In particular, we highlight how the presence of lump-sum payments, in the form of discounts over the fixed fee of the two-part tariff contracts, made by the upstream supplier to the downstream firms can affect the equilibrium mode of downstream competition.

2 The Model

Following Alipranti et al. (2014), we consider an upstream firm, U, that produces, at zero marginal cost, an input that two downstream firms, D_1 and D_2, use, in one-to-one-proportion, to produce their final goods. Downstream firms incur no costs of production other than what

[3] However, Correa-López (2007) shows that a reversal of this result can occur under decentralized unions, depending upon the bargaining power distribution and the union's relative preference over wages.

they pay to the upstream supplier to obtain the input.

Consumers' inverse and direct demands for D_i's final good are:

$$p_i = a - q_i - \gamma q_j \text{ and } q_i = \frac{(a - p_i) - \gamma(a - p_j)}{1 - \gamma^2},\ i, j = 1, 2,\ \ i \neq j,$$

where p_i and q_i are respectively D_i's price and quantity, and γ, with $\gamma \in (0, 1)$, is a measure of the product substitutability.

The firms play a three stage game with observable actions. In stage one, U makes simultaneous take-it-or-leave-it offers to the downstream firms regarding the type of contract (price, p, or quantity, q) that each D_i will offer to customers and a compensation fee, G_i, to be paid by U to D_i. Each downstream firm then, simultaneously and separately, accepts or rejects the offer.[4] We envisage this compensation fee as a transfer that U will make to D_i in the end of the game, provided that D_i abides by the agreement. In stage two, U bargains simultaneously and separately with each D_i over the terms of a two-part tariff contract, i.e., over a wholesale price, w_i, and a fixed fee, F_i. Finally, D_1 and D_2 choose each its price or its quantity, depending on the outcome of the first stage.[5] Note that trading between U and D_i takes the form of a three-part tariff contract (G_i, F_i, w_i), where G_i is a back payment from U to D_i in case that D_i complies with the first-stage agreement and (w_i, F_i) are the two-part tariff terms. In this sense, G_i can also be thought as a discount over the fixed fee F_i that the downstream firm D_i transfers upstream. The bargaining power of U and D_i is given, respectively, by β and $1 - \beta$, with $\beta \in (0, 1]$.

We solve the game by backwards induction and by invoking the Nash equilibrium of simultaneous generalized Nash bargaining problems in Stage 2. That is, the (U, D_i) pair takes as given the outcome of the simultaneously-run negotiations of the (U, D_j) pair.[6] Moreover, as is standard in the literature, to obtain a unique equilibrium we assume *pairwise proofness* on the equilibrium contracts, i.e., we require that the contract between U and D_1 is immune to a bilateral deviation of U with D_2 and vise versa.[7] To guarantee existence and stability of all the (candidate) equilibria we assume throughout:[8]

Assumption 1: $\beta \geqslant \overline{\beta}(\gamma) \equiv \frac{\gamma^3}{(2-\gamma)(2-\gamma^2)}$ and $\gamma < (\sqrt{17} - 1)/4$

[4] Our results still hold if we assume instead that in the first stage U bargains, simultaneously and separately, with each D_i over the type of contract (p or q) to be offered from D_i to customers and a compensation fee G_i. See also Footnote 12.

[5] According to Rey and Vergé's (2004) terminology, we assume that contracts are interim observable. Interim observability of contracts has been also used by, among others, Horn and Wolinsky (1988), Gal-Or (1991), McAfee and Schwartz (1995), and Milliou and Petrakis (2007).

[6] This is a common assumption in the literature on multilateral contracting used by, among others, Cremer and Riordan (1987), Horn and Wolinsky (1988), O'Brien and Shaffer (1992), and Milliou and Petrakis (2007).

[7] A more detailed analysis regarding the possible non-existence of a pure strategy pairwise proof equilibrium can be found in McAfee and Schwartz (1995), and Rey and Vergé (2004).

[8] See Tremblay and Tremblay (2011) for details regarding the stability conditions under the mixed Cournot-Betrand model.

For notational reasons, we use superscript $m = pp,\ qq,\ pq$ denoting respectively the equilibrium values under price, quantity and mixed contracts offered to customers in the downstream market.

3 Equilibrium Analysis

Conditional on the first stage outcome, there are three possible subgames in the last stage of the game: Both downstream firms offer quantity contracts (qq), both downstream firms offer price contracts (pp), and one downstream firm offers a price contract with the other offering a quantity contract (pq). Next, we analyze each of these subgames.

(i) qq subgame: Each D_i chooses q_i to maximize its gross profits:

$$\max_{q_i} \pi_i(q_i, q_j) = (a - q_i - \gamma q_j)q_i - w_i q_i. \tag{1}$$

The reaction functions are: $R_i^{qq}(q_j) = (a - w_i - \gamma q_j)/2$. Thus, a reduction in w_i makes D_i a more aggressive competitor. Solving the system of reaction functions, we obtain the quantities and the upstream and downstream gross profits in terms of the wholesale prices:

$$\begin{aligned} q_i^{qq}(w_i, w_j) &= \frac{a(2-\gamma) - 2w_i + \gamma w_j}{4 - \gamma^2}, \\ \pi_{D_i}^{qq}(w_i, w_j) &= [q_i^{qq}(w_i, w_j)]^2; \;\; \pi_U^{qq} = \sum_{i=1}^{2} w_i q_i^{qq}(w_i, w_j). \end{aligned} \tag{2}$$

(ii) pp subgame: Each D_i chooses p_i to maximize its gross profits:

$$\max_{p_i} \; \pi_i(p_i, p_j) = (p_i - w_i)\frac{(a - p_i) - \gamma(a - p_j)}{1 - \gamma^2}. \tag{3}$$

The reaction functions are: $R_i^{pp}(p_j) = [a(1-\gamma) + \gamma p_j + w_i]/2$. Thus, a reduction in w_i makes again D_i a more aggressive competitor. Solving the system of reaction functions, we obtain the quantities and the upstream and downstream gross profits in terms of the wholesale prices:

$$\begin{aligned} p_i^{pp}(w_i, w_j) &= \frac{a(2-\gamma-\gamma^2) + 2w_i + \gamma w_j}{4-\gamma^2}; \;\; q_i^{pp}(w_i, w_j) = \frac{1}{1-\gamma^2}[p_i^{pp}(w_i, w_j) - w_i] \\ \pi_{D_i}^{pp}(w_i, w_j) &= (1-\gamma^2)[q_i^{pp}(w_i, w_j)]^2; \;\; \pi_U^{pp} = \sum_{i=1}^{2} w_i q_i^{pp}(w_i, w_j). \end{aligned} \tag{4}$$

(iii) pq subgame: Without loss of generality, assume that D_1 offers the price contract and D_2 the quantity contract. Thus, D_1 chooses p_1, while D_2 chooses q_2, in order each to maximize its gross profits:

$$\max_{p_1} \; \pi_1(p_1, q_2) = (a - p_1 - \gamma q_2)(p_1 - w_1). \tag{5}$$

$$\max_{q_2} \pi_2(p_1, q_2) = [(1-\gamma)a - (1-\gamma^2)q_2 + \gamma p_1]q_2 - w_2 q_2. \tag{6}$$

The reaction functions are: $R_1^{pq}(q_2) = (a - \gamma q_2 + w_1)/2$ and $R_2^{pq}(p_1) = [(1-\gamma)a - w_2 + \gamma p_1]/2(1-\gamma^2)$. As above, a decrease in w_i makes D_i a more aggressive competitor. Solving the system of reaction functions, we obtain the quantities and the upstream and downstream gross profits in terms of the wholesale prices:

$$\begin{aligned}
q_1^{pq}(w_1, w_2) &= \frac{a(2-\gamma-\gamma^2) - (2-\gamma^2)w_1 + \gamma w_2}{4-3\gamma^2}; q_2^{pq}(w_1, w_2) = \frac{a(2-\gamma) - 2w_2 + \gamma w_1}{4-3\gamma^2}, \\
\pi_{D_1}^{pq}(w_1, w_2) &= [q_1^{pq}(w_1, w_2)]^2; \quad \pi_{D_2}^{pq}(w_1, w_2) = (1-\gamma^2)[q_2^{pq}(w_1, w_2)]^2, \qquad (7) \\
\pi_U^{pq}(w_1, w_2) &= w_1 q_1^{pq}(w_1, w_2)] + w_2 q_2^{pq}(w_1, w_2).
\end{aligned}$$

In the second stage, U bargains with D_i over $(w_i,\ F_i)$, taking as given the equilibrium trading terms offered to D_j, $(w_j^*,\ F_j^*)$. In particular, w_i and F_i are chosen to solve the following generalized Nash product, where $m = qq, pp, pq$.

$$\max_{w_i, F_i} [\pi_U^m(w_i, w_j^*) + F_i + F_j^* - d(w_j^*, F_j^*)]^\beta [\pi_{D_i}^m(w_i, w_j^*) - F_i]^{1-\beta}, \qquad (8)$$

where $d(w_j^*, F_j^*) = w_j^* q_j^{mon}(w_j^*) + F_j^*$, with $q_j^{mon}(w_j^*) = (a - w_j^*)/2$, is U's disagreement payoff, i.e., U's profits when negotiations with D_i break down and D_j acts as a monopolist in the downstream market facing w_j^*.[9]

Maximizing (8) with respect to F_i, we obtain $F_i = \beta\pi_{D_i}^m(w_i, w_j^*) - (1-\beta)[\pi_U^m(w_i, w_j^*) - w_j^* q_j^{mon}(w_j^*)]$. Substituting this into (8), it follows that w_i is chosen in order to maximize the excess joint surplus of U and D_i, i.e., the profits of U and D_i minus U's disagreement payoff:

$$\max_{w_i} \ [\pi_U^m(w_i, w_j^*) + \pi_{D_i}^m(w_i, w_j^*) - w_j^* q_j^{mon}(w_j^*)]. \qquad (9)$$

As is well-know in the literature, the upstream monopolist faces the so-called *commitment problem* when it deals with several downstream firms and the contracts are either interim observable or secret.[10] The unobservability of the contracts gives room for opportunistic behavior by the upstream monopolist. Thus, since U is unable to commit not to act opportunistically, it cannot fully exploit its monopoly power. As a consequence, the overall industry profits are not maximized.[11]

Substituting successively (2), (4) and (7) into (9), taking the first order conditions and solving the system of equations, we obtain the respective equilibrium wholesale prices in the

[9] This is standard in the literature. Note that our results still hold if we assume instead that D_j acts as a duopolist in the downstream market facing w_j^* (as in Horn and Wolinsky, 1988).

[10] For more details over the commitment problem see, among others, Hart and Tirole (1990), O'Brien and Shaffer (1992), McAfee and Schwartz (1994, 1995), Rey and Vergé (2004) and de Fontenay and Gans (2005). A detailed discussion of the nature of the commitment problem in our setting can be found in Alipranti et al. (2014).

[11] In contrast, under public contracts in which each downstream firm observes all firms' contract terms before deciding to accept or not its own terms, U can publicly commit to all terms of trade, and therefore the overall industry profits are maximized.

qq, pp and pq subgames:

$$w_i^{qq} = -\frac{a\gamma^2}{2(2-\gamma^2)} < 0. \tag{10}$$

$$w_i^{pp} = \frac{a\gamma^2}{4} > 0. \tag{11}$$

$$w_1^{pq} = -\frac{a\gamma^2}{2(1+\gamma)(2-\gamma^2)} < 0; \; w_2^{pq} = \frac{a\gamma^2}{4(1+\gamma)} > 0. \tag{12}$$

Observe that in the qq subgame, the equilibrium wholesale prices are below U's marginal cost, i.e., U subsidizes via the wholesale prices the downstream production. Intuitively, a reduction in the wholesale price charged by U to D_i, increases D_i's output and decreases D_j's output (quantities are strategic substitutes) that results into higher gross profits for D_i that U can transfer upstream via a higher F_i. In contrast, in the pp subgame, there is no subsidization. This is because a reduction in the input price charged to D_i, leads to a decrease in both D_i's and D_j's prices (prices are strategic complements), that causes a relatively smaller increase in D_i's profits that U can transfer upstream via F_i. Interestingly, in the pq subgame, U subsidizes the price setting downstream firm, while there is no subsidization for the quantity setting one. In this case, a reduction in the wholesale price charged to D_1- the price setting downstream firm- leads to a reduction in D_1's price, and thus to a reduction in D_2's output leading to higher D_1's profits that U can transfer upstream via F_i. The opposite is true for the quantity setting downstream firm D_2; hence it is charged a wholesale price above U's marginal cost.

The above discussion indicates that U has stronger incentives to increase the aggressiveness of the downstream firms when the latter offer quantity contracts to customers instead of price or mixed contracts. In other words, U has stronger incentives to behave opportunistically, and thus it faces a more severe commitment problem in the qq subgame than in either the pq or the pp subgame. The following Lemma summarizes,

Lemma 1 *The equilibrium wholesale prices satisfy:* $w_i^{pp} > w_2^{pq} > 0 > w_1^{pq} > w_i^{qq}$.

After proper substitutions, the equilibrium market outcomes in each subgame are reported in Table 1.

qq subgame	**pp** subgame
$q_i^{qq} = \frac{a(2-\gamma)}{2(2-\gamma^2)}$	$q_i^{pp} = \frac{a(2+\gamma)}{4(1+\gamma)}$
$p_i^{qq} = \frac{a(1-\gamma)(2+\gamma)}{2(2-\gamma^2)}$	$p_i^{pp} = \frac{a(2-\gamma)}{4}$
$\pi_{D_i}^{qq} = \frac{a^2(1-\beta)(2-\gamma)^2}{8(2-\gamma^2)}$	$\pi_{D_i}^{pp} = \frac{a^2(1-\beta)(2+\gamma)[4-2\gamma-\gamma^3+\gamma^4]}{32(1+\gamma)}$
$\pi_U^{qq} = \frac{a^2(2-\gamma)[\beta(2-\gamma)(2-\gamma^2)-\gamma^3]}{4(2-\gamma^2)^2}$	$\pi_U^{pp} = \frac{a^2(2+\gamma)[2\beta(2-\gamma)+(1-\beta)\gamma^3(1-\gamma)]}{16(1+\gamma)}$
pq subgame	
$q_1^{pq} = \frac{a(2+\gamma)}{4(1+\gamma)}$	$q_2^{pq} = \frac{a(2-\gamma)}{2(2-\gamma^2)}$
$p_1^{pq} = \frac{a(4+2\gamma-4\gamma^2-\gamma^3)}{4(1+\gamma)(2-\gamma^2)}$	$p_2^{pq} = \frac{a(4+2\gamma-4\gamma^2-2\gamma^3+\gamma^4)}{4(1+\gamma)(2-\gamma^2)}$
$\pi_{D_1}^{pq} = \frac{a^2(1-\beta)[16(1+\gamma)-\gamma^2(12+16\gamma-4\gamma^3+\gamma^4)]}{32(1+\gamma)^2(2-\gamma^2)}$	$\pi_{D_2}^{pq} = \frac{a^2(1-\beta)(2-\gamma)^2}{8(2-\gamma^2)}$
$\pi_U^{pq} = \frac{a^2[(1+\gamma)\Omega+2\gamma^6(2-3\beta)+\gamma^7(1-\beta)(4-\gamma)]}{32(1+\gamma)^2(2-\gamma^2)^2}$, $\Omega = 16\beta(4-5\gamma^2) - 8\gamma^4(1+4\beta)$	

Table 1: Equilibrium quantities, prices, upstream and downstream gross (from compensation fees) profits.

Lemma 2 *i) The equilibrium outputs and prices satisfy:* $q_i^{qq} = q_2^{pq} > q_1^{pq} = q_i^{pp}$ *and* $p_i^{pp} > p_1^{pq} > p_2^{pq} > p_i^{qq}$.

ii) The equilibrium downstream profits satisfy: $\pi_{D_i}^{qq} = \pi_{D_2}^{pq} \equiv \pi_{D_1}^{qp} > \pi_{D_i}^{pp} > \pi_{D_1}^{pq}$.

iii) The equilibrium upstream profits satisfy: $\pi_U^{pp} > \pi_U^{pq} > \pi_U^{qq}$.

iv) The joint profits of U and D_i, $\Pi_{U,D_i}^m = \pi_U^m + \pi_{D_i}^m$*, satisfy:* $\Pi_{U,D_i}^{pp} > \Pi_{U,D_2}^{pq} \equiv \Pi_{U,D_1}^{qp} > \Pi_{U,D_1}^{pq} > \Pi_{U,D_i}^{qq}$.

As wholesale prices are substantially lower when the downstream firms offer quantity contracts than price contracts to customers (Lemma 1), quantities are higher and prices are lower in the *qq* than in the *pp* subgame. Further, in the *pq* subgame, the quantities and prices lie in between the latter two subgames. Yet, although the quantity setting downstream firm faces a higher wholesale price (Lemma 1), it produces more (and sets a lower price) than the price setting one.

In addition, we observe that a downstream firm obtains higher profits when it offers a quantity rather than a price contract. Intuitively, downstream firms are better-off in the *qq* than in the *pp* subgame, since they enjoy higher efficiency under the former due to the substantially lower marginal production costs. Further, in the *pq* subgame, the price setting firm obtains the lowest profits since its quantity is lower and its price higher than those of the quantity setting firm.

More importantly, the upstream monopolist and the downstream firms have completely opposing interests: The upstream monopolist obtains the highest profits in the *pp* subgame in which case the downstream firms' profits are the lowest ones. The opposite holds in the *qq* subgame. This is so because the upstream monopolist suffers more from the commitment problem in the latter case. For a similar reason, the upstream firm's profits in the *pq* subgame lie in between the *qq* and *pp* subgames.

Last, but not least, the joint profits of each (U, D_i) pair in the pp subgame always exceed those in the qq subgame, while the respective profits in the pq subgame lie in between. In addition, the joint profits of the quantity setting pair exceeds those of the price setting pair in the pq subgame.

We now turn to the first stage. U makes simultaneous take-it-or-leave-it offers to the downstream firms regarding the contract type (p or q) that each D_i will offer to customers along with a compensation fee, G_i, that U will pay back to D_i in the end of the game provided that D_i abides by the agreed contract. Each downstream firm then, simultaneously and separately, accepts or rejects the offer.[12]

Lemma 2 informs us that U prefers both downstream firms to offer p contracts to customers; moreover, that the joint profits of each (U, D_i) pair are higher under a p than under a q contract, irrespectively of whether the rival downstream firm offers a p or a q contract. Therefore, U can make an offer (p, G_i), with $G_i = \pi^{qp}_{D_1} - \pi^{pp}_{D_i}$, to each downstream firm such that D_i will accept. This is so because G_i compensates D_i for its losses when switching from a q to a p contract offered to customers (given that D_j offers a p contract). But does U have incentives to make such offers? This will be the case if $\pi^{pp}_U - 2G_i > \pi^{qq}_U$, or else, $\pi^{pp}_U - 2(\pi^{qp}_{D_1} - \pi^{pp}_{D_i}) > \pi^{qq}_U$. It can be checked that the latter inequality always holds. It remains to be checked whether U has incentives to make an offer only to one of the downstream firms, say, to D_1. By Lemma 2 we know that $\pi^{pq}_U > \pi^{qq}_U$, so in principle it could be so. However, D_1 will accept an offer (p, G_1) only if $G_1 > \widehat{G} \equiv \pi^{qq}_{D_i} - \pi^{pq}_{D_1} = \pi^{qp}_{D_1} - \pi^{pq}_{D_1} > G_i$ (since by Lemma 2, $\pi^{qq}_{D_i} = \pi^{qp}_{D_1}$ and $\pi^{pq}_{D_1} < \pi^{pp}_{D_i}$). But if U makes such an offer $(p, \widehat{G})$ to D_1, then its profits will be $\pi^{pq}_U - (\pi^{qq}_{D_i} - \pi^{pq}_{D_1})$, which are lower than those obtained when U makes (p, G_i) offers to both downstream firms. Hence, U will not make a p offer to just one downstream firm. Proposition 1 summarizes our findings.

Proposition 1 *In equilibrium, the upstream monopolist offers (p, G^*), with $G^* = \pi^{qp}_{D_1} - \pi^{pp}_{D_i}$, to each downstream firm and these offers are accepted by both downstream firms. Hence, Bertrand competition is established in the downstream market.*

Finally, the welfare consequences of alternative contract configurations offered to customers by downstream firms are summarized in the next Proposition.

[12] If instead U bargains, simultaneously and separately, with each D_i over p or q and G_i the analysis is as follows. Bargaining over a discrete variable (p or q) in case that transfers are allowed reduces to the choice of the contract type that maximizes (U, D_i)'s joint profits, given the contract choice of the other pair (U, D_j). Moreover, the incremental (U, D_i)'s joint profits stemming from the best choice over the alternative one are distributed among the two parties according to their respective bargaining powers, β and $1 - \beta$. According to Lemma 2, independently of the contract type chosen by (U, D_j), the joint profits of the (U, D_i) pair are always higher when selecting a p than a q contract. Hence, it is a dominant strategy for each (U, D_i) pair to choose a contract type p instead of q and as a result, Bertrand competition arises in equilibrium.

Proposition 2 *Consumers' surplus and total welfare satisfy:* $CS^{qq} > CS^{pq} > CS^{pp}$ *and* $TW^{qq} > TW^{pq} > TW^{pp}$.

Proposition 2 inform us that there is a misalignment of societal and market incentives. Cournot downstream competition is socially preferable than either mixed (i.e. Bertrand-Cournot) or Bertrand downstream competition, but Bertrand competition prevails in the market equilibrium (Proposition 1). Consumers' are better off when both downstream firms offer quantity contracts, since in the qq subgame the prices are lower and the output is higher than under any other subgame. Total welfare is higher too in this case, due to the higher consumer surplus and downstream firms profits (Lemma 1). However, the existence of back payments that U can make to the downstream firms leads to socially inefficient contracts offered to customers.

4 Conclusion

We have shown that in a vertically related market in which an upstream monopolist trades with two competing downstream firms via three-part tariff contracts, Bertrand competition arises as the equilibrium mode of competition in the downstream market. In the presence of compensation fees that the upstream monopolist can pay back to the downstream firms, all firms are better-off when price contracts are offered in the downstream market. The explanation behind this result comes from the fact that a price contract yields higher joint profits for each supplier-buyer pair than a quantity contract, irrespectively of the contract offered by the rival downstream firm. As the losses of the downstream firms when selecting price instead of quantity contracts are outweighed by the overall gain of the upstream monopolist, the latter offers them appropriate compensation fees, or else discounts over the fix fee of the two-part tariff, in order to motivate them to switch to price contracts.

Finally, note that our results have been obtained under a monopolistic upstream market structure and interim observable two-part tariff contracts employed in the input trading between the vertically related firms. It would be interesting to check whether our results still hold under alternative assumptions about the upstream market structure and the nature of input trading terms between the upstream and the downstream firms.

5 Appendix

Proof of Lemma 1: First, $w_i^{pp} - w_2^{pq} = \frac{a\gamma^3}{4+4\gamma} > 0$; second, $w_2^{pq} > 0 > w_1^{pq}$; finally, $w_1^{pq} - w_i^{qq} = \frac{a\gamma^3}{2(1+\gamma)(2-\gamma^2)} > 0$. Hence, $w_i^{pp} > w_2^{pq} > 0 > w_1^{pq} > w_i^{qq}$.■

Proof of Lemma 2: i) First, note that $q_i^{qq} = q_2^{pq}$ and $q_i^{pp} = q_1^{pq}$; also, $q_i^{qq} - q_i^{pp} = \frac{a\gamma^3}{4(1+\gamma)(2-\gamma^2)} > 0$; hence, $q_i^{qq} \equiv q_2^{pq} > q_i^{pp} \equiv q_1^{pq}$. Further, $p_i^{pp} - p_1^{pq} = \frac{a\gamma^4}{4(1+\gamma)(2-\gamma^2)} > 0$; $p_1^{pq} -$

$p_2^{pq} = \frac{a(1-\gamma)\gamma^3}{4(1+\gamma)(2-\gamma^2)} > 0$; and $p_2^{pq} - p_i^{qq} = \frac{a\gamma^4}{4(1+\gamma)(2-\gamma^2)} > 0$; hence, $p_i^{pp} > p_1^{pq} > p_2^{pq} > p_i^{qq}$.

ii) First, note that $\pi_{D_i}^{qq} = \pi_{D_2}^{pq}$. Then $\pi_{D_2}^{pq} - \pi_{D_i}^{pp} = \frac{a^2(1-\beta)\gamma^3[8-\gamma(1+\gamma)(4-\gamma^2)]}{32(1+\gamma)(2-\gamma^2)} > 0$ and $\pi_{D_i}^{pp} - \pi_{D_1}^{pq} = \frac{a^2(1-\beta)\gamma^5[4(1+\gamma)-\gamma^2(2+\gamma)]}{32(1+\gamma)(2-\gamma^2)} > 0$; hence, $\pi_{D_i}^{qq} \equiv \pi_{D_2}^{pq} > \pi_{D_i}^{pp} > \pi_{D_1}^{pq}$.

iii) First, $\pi_U^{pp} - \pi_U^{pq} = \frac{a\gamma^3[\Lambda-\Xi]}{32(1+\gamma)^2(2-\gamma^2)^2}$, where $\Lambda = 16(1+\gamma+\gamma^4) + \gamma^5(11-4\gamma-2\gamma^2) + 11\gamma^5$, $\Xi = 2\gamma^2(12+10\gamma-2\gamma^3) + 2\gamma^7 + \beta(8(2+\gamma) - \gamma^2(32+18\gamma-20\gamma^2)$ and $\Lambda - \Xi > 0$. Thus $\pi_U^{pp} - \pi_U^{pq} > 0$; second, $\pi_U^{pq} - \pi_U^{qq} = \frac{a\gamma^3[16(1+\gamma)+(8+\gamma(\gamma-2)^2)((1-\beta)\gamma^2-2\beta))]}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$; hence, $\pi_U^{pp} > \pi_U^{pq} > \pi_U^{qq}$.

iv) First, $\Pi_{U,D_i}^{pp} - \Pi_{U,D_2}^{pq} = \frac{a^2\gamma^4[8-2\gamma^2(5-2\gamma-3\gamma^2+\gamma^3)-\gamma^6+\beta\gamma(8(1+\gamma+\gamma^2)-2\gamma^3(2-\gamma)+\gamma^5)]}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$; second, $\Pi_{U,D_2}^{pq} - \Pi_{U,D_1}^{pq} = \frac{a^2(1-\beta)\gamma^3(8+\gamma(\gamma-2)^2)}{32(1+\gamma)^2(2-\gamma^2)} > 0$; third, $\Pi_{U,D_1}^{pq} - \Pi_{U,D_i}^{qq} = \frac{a^2\gamma^4[4(1+\gamma)-\gamma^2]}{16(1+\gamma)^2(2-\gamma^2)^2} > 0$; hence, $\Pi_{U,D_i}^{pp} > \Pi_{U,D_2}^{pq} > \Pi_{U,D_1}^{pq} > \Pi_{U,D_i}^{qq}$.■

Proof of Proposition 1: Proof of Proposition 1: First, $G_i = \pi_{D_1}^{qp} - \pi_{D_i}^{pp} = \frac{a^2(1-\beta)\gamma^3[8-(2-\gamma)\gamma(1+\gamma)(2+\gamma)]}{32(1+\gamma)(2-\gamma^2)} > 0$; second, $\pi_U^{pp} - 2G_i - \pi_U^{qq} = \frac{\alpha^2\gamma^4(4-\gamma)^2}{8(1+\gamma)(2-\gamma^2)^2} > 0$; hence $\pi_U^{pp} - 2G_i > \pi_U^{qq}$; third, $\pi_U^{pq} - (\pi_{D_i}^{qq} - \pi_{D_1}^{pq}) - \pi_U^{pp} = \frac{a^2\gamma^3[\beta(1+\gamma)(2-\gamma^2)((2-\gamma)\gamma(1+\gamma)(2+\gamma)-8)+(2+\gamma)(8+\gamma(2-11\gamma+5\gamma^3-\gamma^5))]}{16(1+\gamma)^2(2-\gamma^2)^2} < 0$; hence $\pi_U^{pq} - (\pi_{D_i}^{qq} - \pi_{D_1}^{pq}) < \pi_U^{pp}$.■

Proof of Proposition 2: Consumers' surplus is given by $CS^m = \frac{1}{2}(q_1^{m^2} + q_2^{m^2} + 2\gamma q_1^m q_2^m)$. Substituting the respective equilibrium quantities (Table 1), it follows that, $CS^{qq} = \frac{a^2(2-\gamma)^2(1+\gamma)}{4(2-\gamma^2)^2}$, $CS^{pq} = \frac{a^2[32+64\gamma+8\gamma^2(1+\gamma^3)-48\gamma^3-5\gamma^4(4-\gamma^2)]}{32(1+\gamma)^2(2-\gamma^2)^2}$, $CS^{pp} = \frac{a^2(2+\gamma)^2}{16(1+\gamma)}$. Taking the differences, $CS^{qq} - CS^{pq} = \frac{a^2\gamma^3(8+12\gamma-5\gamma^3)}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$ and $CS^{pq} - CS^{pp} = \frac{a^2\gamma^3(8+12\gamma-5\gamma^3-2\gamma^4)}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$; hence , $CS^{qq} > CS^{pq} > CS^{pp}$.

Total welfare is given by $TW^m = CS^m + \Pi_U^m + \Pi_{D_1}^m + \Pi_{D_2}^m$. From Table 1 it follows that, $TW^{qq} = \frac{a^2(2-\gamma)(6-\gamma-3\gamma^2)}{4(\gamma^2-2)^2}$, $TW^{pq} = \frac{a^2[96+128\gamma(1-\gamma^2)+32\gamma^5+\gamma^4(4+3\gamma^2)-72\gamma^2]}{32(1+\gamma)^2(2-\gamma^2)^2}$ and $TW^{pp} = \frac{a^2(2+\gamma)(6-\gamma)}{16(1+\gamma)}$. Taking the differences, $TW^{qq} - TW^{pq} = \frac{a^2\gamma^3[8+\gamma(4-\gamma(8+3\gamma)]}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$ and $TW^{pq} - TW^{pp} = \frac{a^2\gamma^3[8(1-\gamma^2)+4\gamma-3\gamma^3+2\gamma^4]}{32(1+\gamma)^2(2-\gamma^2)^2} > 0$;hence, $TW^{qq} > TW^{pq} > TW^{pp}$. ■

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