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The possibility to renegotiate the contracts and the equilibrium mode of competition in vertically related markets

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Abstract

The paper demonstrates that if to allow renegotiation of the contract terms, then the result on profits in Alipranti et al. (2014) may be reversed, that is downstream firms may earn more under Bertrand competition than under Cournot competition. Furthermore, in equilibrium each downstream firm chooses price as a strategic variable.

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1 Introduction

Alipranti et al. (2014) find that downstream firms get higher profits under Cournot competition than under Bertrand competition. The current work shows that the result on profits in Alipranti et al. (2014) is sensitive to the assumption on whether or not the contract terms renegotiation is possible between the parties.[1]

In the current paper it is assumed that the disruption of the negotiations between one of the downstream firms and the upstream firm triggers the renegotiation between the other downstream firm and the upstream firm. So, in contrast to Alipranti et al. (2014), renegotiation of the contract terms is allowed in the setup studied here. Due to the possibility to renegotiate the contract terms and due to the fact that there are just two downstream firms, the disagreement payoff that the upstream firm gets does not depend on the mode of competition downstream. On the contrary, in the framework considered in Alipranti et al. (2014) the disagreement payoff depends on the mode of competition downstream. The disagreement payoffs affect the fixed fees, that finally affect the downstream profits. Once again, it is shown in the current paper that if the renegotiation of the contract terms is possible, then the downstream firms earn more under Bertrand competition than under Cournot competition.

The works by H*ä*ckner (2000), Zanchettin (2006), Arya et al. (2008) show that under demand, cost and institutional asymmetries the profits of the competitors in the price game may be higher than those in the quantity game. The current work, however, obtains this result in the setup with totally symmetric firms.

Furthermore, in the game where the selection of strategic variable of each downstream firm is endogenized, it turns out that both downstream firms choose price (rather than quantity) for the product market competition stage. In other words, the equilibrium mode of competition is Bertrand. This differs from the result found in the seminal paper by Singh and Vives (1984) and in numerous subsequent studies (see, for example, Tanaka (2001 *a*&*b*) and Manasakis and Vlassis (2014)), which find that the dominant strategy is output (Cournot) competition. Nevertheless, there are studies that support Bertrand competition, but only under quite different economic conditions. For example, price competition can arise in equilibrium when there are demand uncertainties (Reisinger and Ressner, 2009), the market consists of both profit-maximizing and welfare-maximizing firms (Matsumura and Ogawa, 2012), there is a three-part tariff contract between upstream and downstream firms (Alipranti and Petrakis, 2015), and there is centralized bargaining among all market participants (Basak and Wang, 2016). Unlike previous literature, Bertrand competition emerges in this paper when demand is certain, all firms are profit-maximizers, firms negotiate a two-part tariff contract, and bargaining is decentralized.

In addition the paper shows that, when the renegotiation of the contract terms is allowed in case the agreement is not reached between the upstream firm and one of the downstream firms, the profits of Cournot-type and Bertrand-type downstream firms are the same under Cournot-Bertrand mode of competition downstream. This contrasts the result in Tremblay and Tremblay (2011).

2 Model

An upstream firm U sells the input to two downstream firms, D_1 and D_2. One unit of input allows producing one unit of output. There is a two-part tariff contract (w_i, F_i) between U and each D_i, where w_i is a wholesale price and F_i is a fixed fee. The marginal costs of U are normalized to zero (i.e. $c = 0$). Each D_i does not have other costs besides spending on the input from U.

Let q_i and p_i be the quantity and price of D_i, respectively. Then the indirect demand for good i is:

$$p_i = a - q_i - \gamma q_j. \tag{1}$$

The direct demand is:

$$q_i = \frac{a(1-\gamma) - p_i + \gamma p_j}{1-\gamma^2}, \tag{2}$$

where $i, j = 1, 2$, $i \neq j$, $\gamma \in (0,1)$.

In Alipranti et al. (2014) and Alipranti and Petrakis (2015) U receives the following disagreement payoff K_i in case it does not reach the agreement with D_i:

$$K_i = F_j^* + w_j^* \cdot q_j^{mon}(w_j^*), \tag{3}$$

where (w_j^*, F_j^*) are the equilibrium levels of (w_j, F_j) paid by D_j to U and $q_j^{mon}(w_j^*)$ is the monopoly quantity sold by downstream firm j, when it faces wholesale price equal to w_j^*.

As it was already mentioned in the introduction the renegotiation of the contract terms between U and D_j takes place if U and D_i did not manage to reach a contract agreement. At the contract terms renegotiation stage (if it takes place) the wholesale price is equal to the marginal costs of the upstream firm (i.e. $w = c$). This is the case, because at both upstream and downstream levels there is a monopoly (since the downstream firm, with which the contract terms agreement were

[1]Therefore, this result on downstream profits is sensitive to the form of the disagreement payoff.

not reached, does not participate at the product market competition stage). Therefore, in the setup considered here, the disagreement payoff of U does not depend on the mode of competition downstream.[2]

The timing is as follows. Firstly, each D_i chooses the strategic variable s_i, $i = 1,2$ (i.e. price or quantity). Secondly, U bargains with each D_i about the terms of the two-part tariff contracts (w_i, F_i). If both contract agreements (i.e. an agreement between U and D_i and an agreement between U and D_j) are reached, then the product market competition downstream takes place. If, however, the agreement between U and one of the downstream firms is not reached, then there is a renegotiation of the contract terms between U and another downstream firm. Thus, potentially there are four stages in the game (but actually there are only three stages, since both contract agreements will always be reached in equilibrium).

3 Product market competition stage

Backward induction technique is used to find the Subgame Perfect Nash Equilibrium of the game. So, the final stage of the game is considered first. Potentially at the final stage of the game three types of competition can take place. They are: Cournot competition (i.e. $s_1 = s_2 = Quantity$ or $M = CC$),[3] Bertrand competition (i.e. $s_1 = s_2 = Price$ or $M = BB$), Cournot-Bertrand competition (i.e. $s_i = Quantity$, $s_j = Price$, $i \neq j$, $M = CB\, or\, BC$).

3.1 Cournot competition

The profit-maximization problem of D_i, $(i, j = 1,2,\ i \neq j)$ is:

$$max_{q_i}(a - q_i - \gamma q_j - w_i)q_i - F_i. \tag{4}$$

The solution of the system of first-order conditions (F.O.C.s) to (4) produces equilibrium quantities as functions of wholesale prices:

$$q_i^{CC} = \frac{a(2-\gamma) - 2w_i^{CC} + \gamma w_j^{CC}}{4-\gamma^2}. \tag{5}$$

3.2 Bertrand competition

The profit-maximization problem of D_i, $(i, j = 1,2,\ i \neq j)$ is:

$$max_{p_i}(p_i - w_i)\frac{a(1-\gamma) - p_i + \gamma p_j}{1-\gamma^2} - F_i. \tag{6}$$

The solution of the system of F.O.C.s to (6) produces equilibrium final prices as functions of wholesale prices:

$$p_i^{BB} = \frac{a(2-\gamma-\gamma^2) + 2w_i^{BB} + \gamma w_j^{BB}}{4-\gamma^2}. \tag{7}$$

3.3 Cournot-Bertrand model

Here it is assumed that D_1 is a Cournot-type firm (i.e. it chooses quantity), while D_2 is a Bertrand-type firm (i.e. it chooses price). The demands faced by the first and the second firms are respectively:

$$\begin{cases} p_1 = a(1-\gamma) + \gamma p_2 - (1-\gamma^2)q_1 \\ q_2 = a - \gamma q_1 - p_2. \end{cases} \tag{8}$$

D_1 solves the following profit-maximization problem:

$$max_{q_1}(a(1-\gamma) + \gamma p_2 - (1-\gamma^2)q_1 - w_1)q_1 - F_1. \tag{9}$$

D_2 solves the following profit-maximization problem:

$$max_{p_2}(p_2 - w_2)(a - \gamma q_1 - p_2) - F_2. \tag{10}$$

Having solved the system of F.O.C.s to (9) and (10) we get the equilibrium q_1 and p_2 as functions of wholesale prices:

$$\begin{cases} q_1^{CB} = \dfrac{a(2-\gamma) - 2w_1^{CB} + \gamma w_2^{CB}}{4-3\gamma^2} \\ p_2^{CB} = \dfrac{a(2-\gamma-\gamma^2) + \gamma w_1^{CB} + 2(1-\gamma^2)w_2^{CB}}{4-3\gamma^2}. \end{cases} \tag{11}$$

[2] A more formal justification of this statement is given in Section 5.

[3] M denotes the mode of competition.

4 Equilibrium wholesale prices

At the negotiation stage each pair (D_i, U) bargains about the terms of the two-part tariff contract (w_i, F_i). Let π_{Di}^M and π_U^M be the profits of D_i and U (under mode of competition M), without taking into account fixed fees F_i^M, F_j^M and disagreement payoff K. Formally for $i, j = 1,2$; $i \neq j$; $M = CC, BB, CB$:

$$\begin{cases} \pi_{Di}^M = (p_i^M - w_i^M)q_i^M \\ \pi_U^M = w_i^M q_i^M + w_j^M q_j^M. \end{cases} \tag{12}$$

Nash bargaining solution is used to determine the equilibrium terms of the contract.[4] More precisely, at the second stage of the game each pair $i = 1,2$ (i.e. (D_i, U)) maximizes its Nash Product taking into account the way the prices and quantities depend on the wholesale prices (i.e. taking into account (5) or (7) or (11) depending on M). As in Alipranti et al. (2014) the pairs bargain simultaneously and separately. The bargaining powers of D_i and U are $1-\beta$ and β (where $\beta \in (0,1]$)[5] respectively.

$$max_{w_i^M, F_i^M}(\pi_{Di}^M - F_i^M)^{1-\beta}(\pi_U^M + F_i^M + F_j^M - K)^{\beta}. \tag{13}$$

Maximizing the Nash product above with respect to F_i^M we get:

$$F_i^M = \beta\pi_{Di}^M - (1-\beta)(\pi_U^M + F_j^M - K). \tag{14}$$

Having plugged (14) into (13) we conclude that the wholesale prices are found from:

$$max_{w_i^M}(\pi_{Di}^M + \pi_U^M + F_j^M - K). \tag{15}$$

Since K is constant, it does not depend on w_i^M. The terms of the contracts w_i^M, F_i^M are set simultaneously by the pairs $i = 1,2$ at the second stage of the game. It means that the pair i does not take into account the way F_j^M depends on w_i^M at the moment w_i^M is chosen. So, in the expression (15) the pair (D_i, U) treats only π_{Di}^M and π_U^M as the functions of w_i^M. Therefore, it can be concluded that the wholesale prices are found from the following maximization problem:

$$max_{w_i^M}(\pi_{Di}^M + \pi_U^M). \tag{16}$$

Under the disagreement payoff considered in Alipranti et al. (2014) and Alipranti and Petrakis (2015) the wholesale prices are found from:[6]

$$max_{w_i^M}(\pi_{Di}^M + \pi_U^M - w_j^M \cdot q_j^{mon}(w_j^M)). \tag{17}$$

Again, due to the fact that the wholesale prices w_i^M and w_j^M are set simultaneously, the pair i treats w_j^M as if it were not dependent on w_i^M. So, it can be said that under the disagreement payoffs in Alipranti et al. (2014) and Alipranti and Petrakis (2015) the wholesale prices are found from (16) as well. Therefore, the wholesale prices, quantities, final prices are the same under the disagreement payoff considered in the current paper and the one in Alipranti et al. (2014) and Alipranti and Petrakis (2015).[7]

Table 1 gives the equilibrium values of wholesale prices, quantities and final prices for different modes of competition.

[4] Nash bargaining solution concept is widely used in the literature. See, for example, Roth (2012), McDonald and Solow (1981), Schroeder and Tremblay (2014).

[5] $\beta = 1$ implies that U has all the bargaining power.

[6] See expression (12) in Alipranti et al. (2014).

[7] However, the same can not be stated for the disagreement payoff analyzed in Horn and Wolinsky (1988), where it is assumed that (in case of disruption in the negotiations between D_i and U) D_j behaves as a duopolist in the downstream market. Formally, in Horn and Wolinsky (1988) it is assumed that the disagreement payoff is $K_i^{*M} = F_j^M + w_j^M \cdot q_j^M(w_i^M, w_j^M)$. In this case $F_j^M - K_j^M = -w_j^M \cdot q_j^M(w_i^M, w_j^M)$. Therefore, the wholesale prices are found from $max_{w_i^M}(\pi_{Di}^M + \pi_U^M - w_j^M \cdot q_j^M(w_i^M, w_j^M))$. The term $w_j^M \cdot q_j^M(w_i^M, w_j^M)$ depends on w_i^M. Therefore, this maximization problem is **not** identical to the one in (16). As a result, the wholesale prices, outputs and final prices under disagreement payoff in Horn and Wolinsky (1988) differ from those in Alipranti et al. (2014), Alipranti and Petrakis (2015) and the ones in the current work.

Table 1: Equilibrium wholesale prices, quantities, final prices.

$M=CC$	$M=BB$	$M=CB$
$w_i^{*CC}=\frac{-a\gamma^2}{2(2-\gamma^2)}$	$w_i^{*BB}=\frac{a\gamma^2}{4}$	$w_1^{*CB}=\frac{a\gamma^2}{4(1+\gamma)}, w_2^{*CB}=\frac{-a\gamma^2}{2(1+\gamma)(2-\gamma^2)}$
$q_i^{*CC}=\frac{a(2-\gamma)}{2(2-\gamma^2)}$	$q_i^{*BB}=\frac{a(2+\gamma)}{4(1+\gamma)}$	$q_1^{*CB}=\frac{a(2-\gamma)}{2(2-\gamma^2)}, q_2^{*CB}=\frac{a(2+\gamma)}{4(1+\gamma)}$
$p_i^{*CC}=\frac{a(1-\gamma)(2+\gamma)}{2(2-\gamma^2)}$	$p_i^{*BB}=\frac{a(2-\gamma)}{4}$	$p_1^{*CB}=\frac{a(4+2\gamma-4\gamma^2-2\gamma^3+\gamma^4)}{4(1+\gamma)(2-\gamma^2)}, p_2^{*CB}=\frac{a(4+2\gamma-4\gamma^2-\gamma^3)}{4(1+\gamma)(2-\gamma^2)}$

As it was mentioned earlier, for $M=CC, BB, CB$ equilibrium values of w, p, q coincide with the ones in Alipranti and Petrakis (2015). For $M=CC, BB$ w, p, q also coincide with the ones in Alipranti et al. (2014).

The wholesale prices are used to relax the competition downstream. Positive wholesale prices under $M=BB$ reflect the fact that increase in the marginal costs of D_i leads to rise in the price set by D_j. Negative wholesale prices under $M=CC$ are due to the reason that decrease in the marginal costs of D_i makes lower the output supplied by D_j. Under $M=CB$ $w_1>0$ (respectively, $w_2<0$) since rise in the marginal costs of the Cournot-type (respectively, Bertrand-type) firm tends to increase p_2 (respectively, decrease q_1).[8]

5 Profits

Let Π_{Di}^M and Π_U^M be the profits of D_i and U, respectively. These profits are calculated as follows:

$$\begin{cases} \Pi_{Di}^M = \pi_{Di}^M - F_i^M \\ \Pi_U^M = \pi_U^M + F_i^M + F_j^M. \end{cases} \quad (18)$$

In contrast to w_i^{*M}, p_i^{*M}, q_i^{*M}, Π_{Di}^M and Π_U^M in the current work differ from those in Alipranti et al. (2014) and Alipranti and Petrakis (2015). This happens due to the fact that the profits Π_{Di}^M and Π_U^M depend on F_i^M, that is in turn the function of the disagreement payoff (see (14)).

Alipranti et al. (2014) calculate Π_{Di}^M and Π_U^M for the case $K_i^M = F_j^{*M} + w_j^{*M}\cdot q_j^{mon}(w_j^{*M})$, where $q_j^{mon}(w_j^{*M}) = \frac{a-w_j^{*M}}{2}$.

As it was already mentioned, in the current setup the disagreement payoff differs from the one in Alipranti et al. (2014). This happens due to the fact that contract renegotiations are possible in the present framework. To find U's disagreement payoff here, assume for the moment that indeed U and D_i have not managed to reach an agreement. Then there is a contract terms renegotiation between U and D_j. In the setup with the monopoly at both levels (i.e. upstream and downstream) and two-part tariff contracts, equilibrium wholesale price equals to U's marginal costs (i.e. $w^*=0$). This result on the wholesale price depends neither on the mode of competition (i.e. M) nor on the types of the firms i, j (i.e. it holds irrespectively of whether firms i, j are of Cournot or Bertrand type). When $w^*=0$, the industry profit is equal to $\frac{a^2}{4}$. Under the assumption that bargaining powers stay intact if an agreement between upstream and one of the downstream firms was not reached, U gets share β of the joint industry profit, that is $\beta\cdot\frac{a^2}{4}$. Thus, the disagreement payoff of U when it bargains with D_i is equal to $\beta\cdot\frac{a^2}{4}$. Once again, this disagreement payoff does not depend on the types (i.e. Cournot or Bertrand) of firms D_i, D_j. Therefore, $K=\beta\cdot\frac{a^2}{4}\,\forall M, i$. In words the disagreement payoff in the framework considered here is not affected by the choice variables of the downstream firms. On the contrary, the disagreement payoff assumed in Alipranti et al. (2014) and Alipranti and Petrakis (2015) depends on the choice variables of the downstream firms. This can be easily verified by looking at the corresponding disagreement payoffs expressions and the values of wholesale prices and quantities in Table 1.

Using (14) and (18), Table 2 presents the equilibrium fixed fees and profits of the retailers and manufacturers for the setup considered here and for the one studied in Alipranti et al. (2014).

[8] For more explanations about the sign of wholesale prices see Caillaud and Rey (1995), Alipranti et al. (2014) [$M=BB, CC$ are considered in these papers] and Bonanno and Vickers (1988) [for $M=BB$]. Rozanova (2015) proves the generality of the result on wholesale prices for $M=BB, CC$. Rozanova (2016) proves that under $M=CB$ $w_1>0>w_2$ for the competing vertical structures setup.

Table 2: Disagreement payoffs scenarios. Profits, fixed fees

$Alipranti\, et\, al.\,(2014)$ $K_i^M = F_j^{*M} + w_j^{*M} q_j^{mon}(w_j^{*M})$	$Current\ setup$ $K_i^M = K = \beta \cdot \frac{a^2}{4}\ \forall M, i$
$F_i^{*M} = \beta \pi_{Di}^{*M} - (1-\beta)(\pi_U^{*M} - w_j^{*M} \cdot q_j^{mon}(w_j^{*M})).$	$F_i^{*M} = \frac{\pi_{Di}^{*M} - (1-\beta)\pi_{Dj}^{*M} - (1-\beta)\pi_U^{*M} + (1-\beta)K}{2-\beta}$
$\Pi_{Di}^{*M} = (1-\beta)[p_i^{*M} \cdot q_i^{*M} + w_j^{*M}(q_j^M - q_j^{mon}(w_j^{*M}))]$	$\Pi_{Di}^{*M} = \frac{1-\beta}{2-\beta}(p_1^{*M} q_1^{*M} + p_2^{*M} q_2^{*M} - K)$
$\Pi_U^{*M} = \beta \Sigma_{l=1,2} p_l^{*M} q_l^{*M} + (1-\beta)\Sigma_{l=1,2} w_l^M (q_l^{mon}(w_l^{*M}) - q_l^M)$	$\Pi_U^{*M} = \frac{\beta(p_1^{*M} q_1^{*M} + p_2^{*M} q_2^{*M}) + 2(1-\beta)K}{2-\beta}$

For the setup considered here (i.e. $K = \beta \cdot \frac{a^2}{4}$), the condition that guarantees that U prefers dealing with both downstream firms rather than with one downstream firm (i.e. $\Pi_U^{*M} = \frac{\beta(p_1^{*M} q_1^{*M} + p_2^{*M} q_2^{*M}) + 2(1-\beta)K}{2-\beta} \geq \beta \cdot \frac{a^2}{4}$) coincides with the condition under which $\Pi_{D_i}^{*M} \geq 0$ (i.e. $p_1^{*M} q_1^{*M} + p_2^{*M} q_2^{*M} \geq K = \beta \frac{a^2}{4}$). Using the values in Table 1 one may verify that $\Pi_U^{CC} > \beta \frac{a^2}{4}$ guarantees that U prefers dealing with both downstream firms instead of one downstream firm for all M. The inequality $\Pi_U^{CC} > \beta \frac{a^2}{4}$ is satisfied whenever $\beta < \frac{2(1-\gamma)(4-\gamma^2)}{(2-\gamma^2)^2}$.

Lemma 1: The difference in the fixed fees under Cournot and Bertrand regimes is greater under the disagreement payoff considered here than under the one in Alipranti et al. (2014).
Formally: $(F_i^{*CC} - F_i^{*BB})_{K_i^M = K} > (F_i^{*CC} - F_i^{*BB})|_{K_i^M = F_j^{*M} + w_j^{*M} \cdot q_j^{mon}(w_j^{*M})}$.

Proof:
Taking into account the information in Table 2, (12) and the fact that in a symmetric equilibrium $\pi_U^{*M} = 2 w_j^{*M} q_j^{*M}$ for $M = CC, BB$, we get:

$$(F_i^{*CC} - F_i^{*BB})|_{K_i^M = K} - (F_i^{*CC} - F_i^{*BB})|_{K_i^M = F^{*M} + w_j^{*M} \cdot q_j^{mon}(w_j^{*M})} =$$
$$-\frac{1-\beta}{2-\beta}[\beta(p_i^{*CC} q_i^{*CC} - p_i^{*BB} q_i^{*BB}) + (2-\beta)(w_j^{*CC} \cdot (q_j^{mon}(w_j^{*CC}) - q_j^{*CC}) - w_j^{*BB} \cdot (q_j^{mon}(w_j^{*BB}) - q_j^{*BB}))] > 0.$$

The last inequality follows from the following facts:

- $w_j^{*CC} < 0 < w_j^{*BB}$ (see Table 1) and $q_j^{mon}(w_j^{*M}) > q_j^{*M}$.[9] These inequalities guarantee that $(w_j^{*CC} \cdot (q_j^{mon}(w_j^{*CC}) - q_j^{*CC}) - w_j^{*BB} \cdot (q_j^{mon}(w_j^{*BB}) - q_j^{*BB})) < 0$.

- $p_i^{*CC} < p_i^{*BB}$ (see Table 1). This price relationship implies that the industry profit under Cournot competition downstream is lower than the one under Bertrand competition. That is, $2(p_i^{*CC} q_i^{*CC} - p_i^{*BB} q_i^{*BB}) < 0$. Q.E.D.

Here is the intuition for Lemma 1:
The fixed fees under the scenario considered in Alipranti et al. (2014) are: $F_i^{*M} = A_i^M + L_i^M$, where $A_i^M = \beta \pi_{Di}^{*M} - (1-\beta)\pi_U^{*M}$ and $L_i^M = (1-\beta) w_j^{*M} q_j^{mon} \cdot (w_j^{*M}))$.

$A_i^{CC} > A_i^{BB}$ due to the following reasons:

- $\pi_{Di}^{*CC} > \pi_{Di}^{*BB}$ since even if the marginal costs of the downstream firms are the same, then Cournot-type firms earn more than Bertrand-type ones, but here under $M = CC$ the firms have lower marginal costs than under $M = BB$. Therefore, it is even more evident that the downstream profits under $M = CC$ exceed those under $M = BB$.

- $\pi_U^{*BB} > 0 > \pi_U^{*CC}$ since $w^{*BB} > 0 > w^{*CC}$ [see Table 1].

[9] Based on the values in Table 1 we get $q_j^{mon}(w_j^{*CC}) = \frac{a(4-\gamma^2)}{4(2-\gamma^2)} > \frac{a(2-\gamma)}{2(2-\gamma^2)} = q_j^{*CC}$ and $q_j^{mon}(w_j^{*BB}) = \frac{a(4-\gamma^2)}{8} > \frac{a(2+\gamma)}{4(1+\gamma^2)} = q_j^{*BB}$.

Contrary to the relationship between A components, $L_i^{BB} > 0 > L_i^{CC}$. The latter inequality is due to the fact that $w^{*BB} > 0 > w^{*CC}$. It means that the presence of L component in the expression for F_i^{*M} makes F_i^{*CC} (respectively, F_i^{*BB}) lower (respectively, higher) than it would be the case without its presence. In other words, L partly offsets the difference between the fixed fees under $M = CC$ and under $M = BB$.

Once again L is negative under Cournot mode of competition (i.e. $L_i^{CC} < 0$) and positive under Bertrand one (i.e. $L_i^{BB} > 0$). This discrepancy in the values of L components under different modes of competition is due to the fact that under the framework in Alipranti et al. (2014) the contract renegotiation is not allowed.

In the current setup, however, contract terms renegotiation is allowed. Due to this here there is no component that *a priori* reduces the level of the fixed fees under $M = CC$ and increases it under $M = BB$. This explains why $(F_i^{*CC} - F_i^{*BB})_{K_i^M=K} > (F_i^{*CC} - F_i^{*BB})|_{K_i^M=F_j^{*M}+w_j^{*M}\cdot q_j^{mon}(w_j^{*M})}$.

Based on the information in Table 1 and Table 2, Table 3 presents the profits of upstream and downstream firms for various modes of competition under the disagreement payoffs considered here.

Table 3: Profits under different modes of competition

$M = CC$	$\Pi_{D_i}^{CC} = \frac{1-\beta}{2-\beta}(\frac{a^2(1-\gamma)(4-\gamma^2)}{2(2-\gamma^2)^2} - K)$ $\Pi_U^{CC} = (\beta(\frac{a^2(1-\gamma)(4-\gamma^2)}{2(2-\gamma^2)^2}) + 2(1-\beta)K)\cdot\frac{1}{2-\beta}$
$M = BB$	$\Pi_{D_i}^{BB} = \frac{1-\beta}{2-\beta}(\frac{a^2(4-\gamma^2)}{8(1+\gamma)} - K)$ $\Pi_U^{BB} = (\beta\frac{a^2(4-\gamma^2)}{8(1+\gamma)} + 2(1-\beta)K)\cdot\frac{1}{2-\beta}$
$M = CB$	$\Pi_{D_i}^{CB} = \frac{1-\beta}{2-\beta}(\frac{a^2(32+32\gamma-40\gamma^2-40\gamma^3+12\gamma^4+12\gamma^5-\gamma^6)}{16(1+\gamma)^2(2-\gamma^2)^2} - K)$ $\Pi_U^{CB} = (\frac{\beta}{2-\beta}\frac{a^2(32+32\gamma-40\gamma^2-40\gamma^3+12\gamma^4+12\gamma^5-\gamma^6)}{16(1+\gamma)^2(2-\gamma^2)^2} + \frac{2(1-\beta)}{2-\beta}K)$

Proposition 1 is formulated using the information in Table 3.

Proposition 1: For $K_i^M = K$ the following holds:

1. $\Pi_{Di}^{*BB} > \Pi_{Di}^{*CC}$
2. $\Pi_U^{*BB} > \Pi_U^{*CC}$.

Proof:
Table 3 allows getting:

1. Comparison of downstream profits for $M = CC, BB$.
   - $\Pi_{D_i}^{BB} - \Pi_{D_i}^{CC} = \frac{(1-\beta)a^2(4-\gamma^2)\gamma^4}{(2-\beta)8(1+\gamma)(2-\gamma^2)^2} > 0.$
2. Comparison of upstream profits for $M = CC, BB$.
   - $\Pi_U^{BB} - \Pi_U^{CC} = \frac{\beta a^2(4-\gamma^2)\gamma^4}{(2-\beta)8(1+\gamma)(2-\gamma^2)^2} > 0.$ Q.E.D.

The first statement in Proposition 1 is different from the result in Alipranti et al. (2014), while the second statement repeats the outcome in Alipranti et al. (2014) and Alipranti and Petrakis (2015).

Why does the conclusion on downstream profits here differs from the one in Alipranti et al. (2014)? The result on downstream profits is driven by the form of the disagreement payoffs. The profit of each downstream firm consists of two parts: the variable one and the fixed fees: $\Pi_{Di}^{*M} = \pi_{Di}^{*M} - F_i^{*M}$. So, the difference in downstream profits is: $\Pi_{Di}^{*BB} - \Pi_{Di}^{*CC} = (\pi_{Di}^{*BB} - \pi_{Di}^{*CC}) + (F_i^{*CC} - F_i^{*BB})$. For each M, π_{Di}^{*M} is the same for the framework in Alipranti et al. (2014) and the current setup. Therefore, $(\pi_{Di}^{*BB} - \pi_{Di}^{*CC})$ is not affected by the way the disagreement payoff is calculated. On the contrary, as it follows from (14), F_i^{*M} is affected by the way disagreement payoff is defined. Due to Lemma 1 it can be stated that the switch from $K_i^M = w_j^{*M} q_j^{mon}(w_j^{*M}) + F_j^{*M}$ to $K_i^M = K$ increases (F_i^{*CC}-F_i^{*BB}). Therefore, this switch in the disagreement payoffs increases ($\Pi^{*BB}_{Di} - \Pi^{*CC}_{Di}$). As the calculations demonstrate, the effect of the switch in the disagreement payoff is strong enough to change the sign of $\Pi^{*BB}_{Di} - \Pi^{*CC}_{Di}$ in the current framework compared to the one in Alipranti et al. (2014).

Proposition 2: $\Pi^{*CB}_{D_1} = \Pi^{*CB}_{D_2}$, if $K^M_i = K$.

Proof:
Proposition 2 follows directly from the second column of Table 2. Q.E.D.

To understand better why Proposition 2 holds it is enough to look more attentively at (14).

- According to (14) $F^M_i = \beta \pi^M_{Di} - (1-\beta)(\pi^M_U + F^M_j - K)$.
- (14) can be rewritten as $F^M_i = \beta(\pi^M_{Di} - F^M_i + F^M_i) - (1-\beta)(\pi^M_U + F^M_j - K)$.
- The above expression allows getting the following: $\beta(\pi^M_{D_i} - F^M_i) = (1-\beta)(F^M_i + F^M_j + \pi^M_U - K)$.
- From the previous statement it follows that $\Pi^M_{D_i} = \pi^M_{D_i} - F^M_i$ is equal to $\Pi^M_{D_j} = \pi^M_{D_j} - F^M_j$ for any M (including $M = CB$).

The conclusion that the downstream firms' profits are the same for the firms i and j under Cournot-Bertrand mode of competition does not hold in the setup studied in Alipranti et al. (2014). The reason for this is the fact that in Alipranti et al. (2014) the disagreement payoff depends on the mode of competition and the type of the firm. Therefore, the disagreement payoff in the framework used in Alipranti et al. (2014) should be denoted K^M_i (instead of K).
Proposition 2 contrasts the result in Singh and Vives (1984) and Tremblay and Tremblay (2011).

6 Equilibrium mode of competition

Now consider the first stage of the game. Here each D_i chooses s_i, $i = 1,2$.

Proposition 3: For $K^M_i = K$ in the Subgame-Perfect Nash Equilibrium each D_i ($i = 1,2$) selects price as a strategic variable for the final stage of the game.
Proof:
Based on the information in Table 3 we get:

1. $\Pi^{*BB}_{Di} - \Pi^{*CB}_{D_1} = \frac{1-\beta}{2-\beta} a^2 \frac{(4+4\gamma-\gamma^2-2\gamma^3)\gamma^4}{16(1+\gamma)^2(2-\gamma^2)^2} > 0,$
2. $\Pi^{*CC}_{Di} - \Pi^{*CB}_{D_2} = -\frac{1-\beta}{2-\beta} a^2 \frac{(4+4\gamma-\gamma^2)\gamma^4}{16(1+\gamma)^2(2-\gamma^2)^2} < 0.$

Due to $\Pi^{*BB}_{Di} > \Pi^{*CB}_{D_1}$ $s_1 = s_2 = Price$ is an equilibrium (since none of the players has an incentives to deviate unilaterally from $s_i = Price$). Due to the same reason $(s_i = Price, s_j = Quantity)$ is not an equilibrium (Cournot-type firm has incentives to deviate unilaterally from $s = Quantity$).
Due to $\Pi^{*CC}_{Di} < \Pi^{*CB}_{D_2}$ $s_1 = s_2 = Quantity$ is not an equilibrium since each Cournot-type firm has an incentives to deviate unilaterally from $s = Quantity$. Thus, the only equilibrium is $s_1 = s_2 = Price$. Q.E.D.
Proposition 3 contrasts the result in Singh and Vives (1984).

7 Concluding remarks

Current note demonstrates that in the framework with two-part tariff contracts the profitability of the mode of competition for the downstream firms depends on the possibility to renegotiate the terms of the contract and, therefore, on the form of the disagreement payoff. Under the disagreement payoff considered here competition in prices yields higher downstream firms' profits than competition in quantities (this result contrasts the one in Alipranti et al. (2014)). Moreover, it is shown that the Bertrand mode of competition arises in equilibrium.

References

[1] M. Alipranti, C. Milliou, and E. Petrakis. Price vs. quantity competition in a vertically related market. *Economics Letters*, 124(1):122–126, 2014.

[2] M. Alipranti and E. Petrakis. Bertrand competition under three-part tariffs in vertically related markets. 2015.

[3] A. Arya, B. Mittendorf, and D. E. Sappington. Outsourcing, vertical integration, and price vs. quantity competition. *International Journal of Industrial Organization*, 26(1):1–16, 2008.

[4] D. Basak and L. F. Wang. Endogenous choice of price or quantity contract and the implications of two-part-tariff in a vertical structure. *Economics Letters*, 138:53–56, 2016.

[5] G. Bonanno and J. Vickers. Vertical separation. *The Journal of Industrial Economics*, 36(3):257–265, 1988.

[6] B. Caillaud and P. Rey. Strategic aspects of vertical delegation. *European Economic Review*, 39(3):421–431, 1995.

[7] J. Häckner. A note on price and quantity competition in differentiated oligopolies. *Journal of Economic Theory*, 93(2):233–239, 2000.

[8] H. Horn and A. Wolinsky. Bilateral monopolies and incentives for merger. *The RAND Journal of Economics*, 19(3):408–419, 1988.

[9] C. Manasakis and M. Vlassis. Downstream mode of competition with upstream market power. *Research in Economics*, 68(1):84–93, 2014.

[10] T. Matsumura and A. Ogawa. Price versus quantity in a mixed duopoly. *Economics Letters*, 116(2):174–177, 2012.

[11] I. M. McDonald and R. M. Solow. Wage bargaining and employment. *The American Economic Review*, 71(5):896–908, 1981.

[12] M. Reisinger and L. Ressner. The choice of prices versus quantities under uncertainty. *Journal of Economics & Management Strategy*, 18(4):1155–1177, 2009.

[13] A. E. Roth. *Axiomatic models of bargaining*, volume 170. Springer Science & Business Media, 2012.

[14] O. Rozanova. Price vs. quantity competition in vertically related markets. Generalization. *Economics Letters*, 135:92–95, 2015.

[15] O. Rozanova. Wholesale prices and Cournot-Bertrand competition. *Bulletin of Economic Research*, 2016.

[16] E. Schroeder and V. J. Tremblay. Union bargaining in an oligopoly market with Cournot-Bertrand competition: welfare and policy implications. *Economies*, 2(2):95–108, 2014.

[17] N. Singh and X. Vives. Price and quantity competition in a differentiated duopoly. *The RAND Journal of Economics*, 15(4):546–554, 1984.

[18] Y. Tanaka. Profitability of price and quantity strategies in a duopoly with vertical product differentiation. *Economic Theory*, 17(3):693–700, 2001a.

[19] Y. Tanaka. Profitability of price and quantity strategies in an oligopoly. *Journal of Mathematical Economics*, 35(3):409–418, 2001b.

[20] C. H. Tremblay and V. J. Tremblay. The Cournot–Bertrand model and the degree of product differentiation. *Economics Letters*, 111(3):233–235, 2011.

[21] P. Zanchettin. Differentiated duopoly with asymmetric costs. *Journal of Economics & Management Strategy*, 15(4):999–1015, 2006.