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Downstream mode of competition with upstream market power

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Downstream Mode of Competition With Upstream Market Power*

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Abstract

In a two-tier oligopoly, where the downstream firms are locked in pair-wise exclusive relationships with their upstream input suppliers, the equilibrium mode of competition in the downstream market is endogenously determined as a renegotiation-proof contract signed between each downstream firm and its exclusive upstream input supplier. We find that the upstream-downstream exclusive relationships credibly sustain the Cournot (Bertrand) mode of competition in the downstream market, when the goods are substitutes (complements). In contrast to previous studies, this result holds irrespectively of the degree of product differentiation and the distribution of bargaining power between the upstream and the downstream firm, over the pair-specific input price.

JEL Classification: D43; L13; L42

Keywords: Oligopoly; Vertical relations; Wholesale prices; Equilibrium mode of competition

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1. Introduction

The cornerstones of modern oligopoly theory are the models of Cournot-Nash, where rival firms compete by setting their own quantities, and Bertrand-Nash, where the firms' strategic variables are their own prices. Tremblay and Tremblay (2011) argue that "In the real world, both Cournot and Bertrand behavior are observed" and cite relevant evidence by Tremblay et al. (2013). Though these alternative models deliver highly significant implications to the theory and practice of industrial economics (see, e.g., Vives, 2001), a full understanding of what induces and sustains the mode of competition in oligopolistic industries is, however, still to come.

In their seminal paper, Singh and Vives (1984) analyzed a one-shot two-stage downstream duopoly game with differentiated goods. In the first stage of the game, each firm "commits" over the type of the binding contract to offer consumers. If a firm chooses the quantity (price) contract it is committed to set quantity (price) as the strategy variable in market competition, regardless of the rival's choice. In the second stage, firms compete by each choosing the level of its strategy variable, so as each to maximize own profits. Assuming that there are prohibitively high costs associated with changing the type of contract made to consumers in the first stage, the main finding is that when the goods are substitutes (complements), a firm's dominant strategy is to choose the quantity (price) contract; as well as that Bertrand (Cournot) competition is more efficient.^{1,2}

¹ Keeping the assumption for exogenous and identical marginal costs across firms, but allowing for vertical quality differences across the horizontally differentiated goods, Häckner (2000) finds that when goods are complements, Bertrand profits are higher than the Cournot ones. When goods are substitutes and quality differences are large (small), high-quality firms earn higher profits under Bertrand (Cournot) competition. In the context of vertical product differentiation with quality enhancement R&D investments, Symeonidis (2003) finds that quality enhancement is higher in the Cournot equilibrium, and that output, consumer surplus and total welfare are higher under Cournot if R&D spillovers are large and goods are not too differentiated.

In a similar vein, Kreps and Scheinkman (1983) study a game generating Cournot outcomes too. In the first stage, producers decide non-cooperatively how much they will produce, and this production takes place. In the second stage, they bring these quantities to market, each learns how much the other produced, and they engage in Bertrand-like price competition. They find that the Cournot outcome is the subgame Nash perfect equilibrium in output levels and prices.

More recently, Dastidar (1996) was the first to endogenize a firm's choice of quantity versus price as a strategic one. In his words "assuming that the technology of production and marketing makes either strategy feasible, it does seem fruitful to treat the choice of strategy itself as a variable". In a homogeneous product setting, duopolists, with symmetric and strictly convex costs, choose the strategic mode of operation in the first stage and in the second stage, price or output are chosen simultaneously according to the mode chosen in the first stage. He finds that both firms choosing quantity is always a Nash equilibrium, while both choosing prices can be a Nash equilibrium, but only in some situations, depending on the structure of the cost functions.

The bulk of the relevant literature is grounded on the assumption that downstream firms ex-ante commit to a particular competition conduct (price or quantity), i.e., there is a silent assumption according to which there is a *stage zero* in the game, where each firm *credibly commits* to a particular competition conduct. This reproduces the argument of Singh and Vives (1984) for "prohibitively high costs associated with changing the type of contract made to consumers", without unraveling any mechanism or device which might render credibility to such a commitment.

² Allowing for a wider range of cost asymmetry between firms, compared to Singh and Vives (1984), Zanchettin (2006) finds that for high degrees of cost asymmetry and low degrees of product differentiation, the efficient firm's profits are higher under price than under quantity competition.

In this framework, the following questions can then be addressed: How does a firm's particular competition conduct emerge? What sustains a particular competition conduct in a downstream market?

To address the above questions, we consider an industry with two upstream input suppliers and two downstream firms, producing substitute final goods, which are locked in pair-wise exclusive relationships.³ Each downstream firm's cost is the price per-unit of input bought by its exclusive upstream supplier. In the first stage of the game, within each upstream – downstream pair, the downstream firm and its exclusive input supplier negotiate over the competition (price or quantity) conduct (which the firm will materialize in the second stage) and the contingent pair-specific input price. Note that any upstream – downstream pair's agreed input price / competition conduct scheme is not observable by the rival pair before market competition is in place, since there is nothing to prevent any upstream – downstream pair to shift from any (first stage- presumed) input price / competition conduct scheme to another. In the second stage, downstream firms compete in the product market, i.e., each downstream firm sets either its own price or its own quantity, based on the agreed competition conduct.

Our analysis is grounded on the postulate that a contract signed between a downstream firm and its exclusive input supplier must be *renegotiation-proof* (see, e.g., Dewatripont, 1988; Petrakis and Vlassis, 2000), implying that an upstream-downstream bargaining pair can deviate from a certain input price / competition conduct scheme to another one only if this deviation is beneficial for both the downstream and the upstream firm. Therefore, a downstream firm cannot

³ Lafontaine and Slade (2008) refer to a series of industries with vertical chains' exclusive relations: Car equipment suppliers have exclusive contracts with car manufacturers, petroleum firms with gasoline retailers and soft drinks producers with food retailers.

unanimously (e.g., without the consent of its input supplier) deviate, after the input price has been set, from a particular downstream competition conduct to another. Such upstream-downstream contracts may thus effectively act as commitment devices for the emergence and sustainability of a particular mode of competition in the market of the final good.

Our central result is that, when the goods are substitutes (complements), the Cournot (Bertrand) mode of competition is endogenously sustained in the market of the final good, and that this holds independently of the degree of product differentiation and the distribution of bargaining power, over the input price, between the upstream and the downstream firm, within each bargaining pair.⁴ The reason is that, compared with a price-setting downstream firm, a quantity-setting one can raise more its price above its marginal cost, since its elasticity of demand is lower than the respective when taking the rival's price as given. The input supplier can thus enjoy a share from a larger pie in the first than in the second instance. Therefore, what sustains the Cournot mode of competition is the upstream and downstream firm's unanimous agreement, within each bargaining pair.⁵

Our finding contributes to the literature by addressing a plausible solution for the emergence and sustainability of the mode of competition in the downstream tier of a vertically related market. Hence, exclusive upstream-downstream relations within a vertical chain can be a plausible mechanism for the downstream firms' credible commitment over a particular competition conduct. Our finding is in line with Singh and Vives (1984) and Kreps and Scheinkman (1983), according to which, when the

⁴ This is in contrast to Correa-López and Naylor (2004) and Correa-López (2007) who suggest that the downstream firms' mode of competition depends on the distribution of bargaining power between the downstream firms and the input suppliers (labour unions), over the input price (wage rate).

⁵ In a similar vein, Petrakis and Vlassis (2000) endogenously determine the scope of firm - union bargaining, i.e., the issues over which firms and unions negotiate, arguing that the equilibrium scope of bargaining is the one resulting to the most beneficial outcome for both the firm and its labour union.

goods are substitutes, the Cournot mode of competition is endogenously sustained in the market. However, based on the diversity of results reported in the relevant literature (see footnotes 1 and 2), we cannot conclude that when the goods are substitutes, the Cournot outcome is the natural equilibrium mode of competition. This is in line with Kreps and Scheinkman (1983, p. 327) suggesting that “solutions to oligopoly games depend on both the strategic variables that firms are assumed to employ and on the context (game form) in which those variables are employed.”

Notice that our finding partially reconfirms Dastidar (1996), as long as, besides the case where both firms choose quantities, he further finds that the case where both firms choose prices can be a Nash equilibrium, depending on the structure of the cost functions. Interestingly, the contrast between this finding and our result can be interpreted by the two differences in the cost function. First, Dastidar (1996) assumes strictly convex cost while we consider a linear cost function. Second, in Dastidar (1996) the cost per unit of output is exogenous while in our framework it is endogenously determined through bargaining between the downstream firm and its exclusive input supplier within each vertical chain.

Our paper also contributes to the literature studying the upstream supplier’s optimal pricing policy with respect to downstream market competition. In the context of a single upstream supplier selling input to downstream firms producing differentiated products under free entry, Pinopoulos (2011) finds that the supplier charges a higher input price under Bertrand downstream competition than under Cournot. In our context, an upstream supplier charges a higher input price to a downstream firm setting its quantity as compared to the respective price to a downstream firm setting its price.

Our analysis further entails that the consumer surplus-effect always dominates the vertical chains' joint profits-effect. Hence, we reconfirm that the symmetric Bertrand (Cournot) mode of competition always leads to the highest (lowest) social welfare; we further suggest that the asymmetric configuration, where the one downstream firm sets its quantity while the other firm sets its price, lies-in between.

The rest of the paper is organized as follows. Section 2 presents the model. In Section 3 the various configurations-modes of competition in the product market are postulated. In Section 4 we determine the equilibrium mode of competition and Section 5 contains our welfare analysis. In Section 6, we consider a number of extensions of our model and in Section 7, we conclude.

2. The model

We consider a two-tier industry consisting of two upstream and two downstream firms. One could think of the upstream and the downstream firms as respectively being input producers and final good manufacturers, or wholesalers and retailers. There is a one-to-one relation between the products of the upstream and the downstream firms and an exclusive relation between upstream firm i and downstream firm i , with $i = 1, 2$.⁶ The latter can result from various sources; like for instance in Milliou and Petrakis (2007) where “when the upstream firms produce inputs which are tailored for specific final good manufacturers, there may be irreversible R&D investments that create *lock-in* effects and high switching costs”.

Following Singh and Vives (1984), it is assumed that the representative consumer's preferences are described by the utility function

⁶ This is a quite common assumption in the vertical relations literature (see e.g. Horn and Wolinsky, 1988; Ziss, 1995; Lommerud et al., 2005). In Section 6, we relax it and in line with some recent papers (see e.g. de Fontenay and Gans, 2005, 2013; Björnerstedt and Stennek, 2006) we discuss what would happen if we allow for non-exclusive relations.

$U(q_i, q_j) = (q_i + q_j) - (q_i^2 + q_j^2 + 2\gamma q_i q_j)/2$, where q_i is the downstream firm i 's quantity. Hence, each downstream firm faces the following demand function:

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

Where p_i and q_i are respectively firm i 's price and output. $\gamma \in (0, 1]$ denotes the degree of product substitutability; as $\gamma \rightarrow 0$ brands are regarded as unrelated, whereas $\gamma \rightarrow 1$ corresponds to the case of homogeneous goods.⁷ The corresponding inverse demand function is given by:

$$p_i = 1 - q_i - \gamma q_j, i, j = 1, 2, i \neq j \quad (2)$$

Downstream firms are endowed with constant returns to scale technologies which transform one unit of input to one unit of output, that is, $q_i = L_i$; $i = 1, 2$, where L_i denotes the downstream firm i 's specific input bought from its exclusive supplier, upstream firm i . Each downstream firm faces no other costs than the cost of obtaining the input from its upstream supplier. The latter consists of a per-unit of input price w_i , i.e., trading is conducted through a linear wholesale price contract. Moreover, each upstream firm faces a normalized to zero unit cost. Hence, upstream firm i 's profit function is:⁸

$$\pi_i(w_i, L_i) = w_i L_i, i, j = 1, 2, i \neq j \quad (3)$$

⁷ In section 6, we also examine the case where the products are complements.

⁸ The existence of an exclusive relation within each upstream-downstream pair is a natural assumption if input suppliers are trade unions. In this case, we would assume that all workers have identical skills and are organized into two separate firm-level unions. Each union is of the utilitarian type, maximizing the sum of its (risk-neutral) members' utilities, given fixed union membership (see e.g. Oswald, 1982; Booth 1996). That is, union i 's objective is to maximize $U_i(w_i, L_i) = (w_i)^b L_i$. Where, w_i is the wage paid by firm i and captures all short-run marginal costs for the downstream firm i (Correa-López and Naylor, 2004) and $b \in (0, 1]$ can be thought of as the representative member's relative rate of risk aversion, provided that union membership is fixed and all members are identical. Alternatively, b , which in our context is normalized to unity, denotes the representative union member's elasticity of substitution between wages and employment. We have also applied our model for the case of $b \in (0, 1]$ and our results remain robust.

We assume that upstream firms are symmetric and endowed with the same bargaining power, during negotiations with their downstream firms. We invoke the Nash equilibrium of simultaneous generalized Nash bargaining problems, in which the upstream and the downstream firm's bargaining power is given respectively by β and $1-\beta$, with $0 < \beta \leq 1$. This implies that during the negotiations within a bargaining pair, each of its agents takes as given the outcome of the simultaneously-run negotiations of the other bargaining pair.

In this market, we consider the following two-stage game: In the first stage, within each upstream – downstream pair i , the downstream firm and its exclusive input supplier negotiate over $[M, w(M)]$, $M = P, Q$ that is, they negotiate over the competition conduct (Price or Quantity, discrete variable) that downstream firm i will materialize in the second stage, and the contingent pair-specific input price (continuous variable). Similarly to Petrakis and Vlassis (2000), the crucial and reasonable assumption here is that upstream – downstream pair i 's agreed input price / competition conduct scheme is not observable by the rival pair before negotiations are everywhere completed. In the second stage, downstream firms compete in the product market, i.e., each downstream firm sets either its own price or its own quantity, based on the agreed competition conduct.

The above structure of the game allows us to capture the idea that contracts signed between each downstream firm and its input supplier must be *renegotiation-proof* (see, e.g., Dewatripont, 1988; Petrakis and Vlassis, 2000). This implies that an upstream – downstream bargaining pair can deviate from a certain $[M, w(M)]$ scheme to another one, only if such a deviation is beneficial for both the downstream firm and its upstream supplier. On the other hand, if any deviation from a certain

$[M, w(M)]$ scheme hurts the downstream firm and/or its supplier, then the original scheme is immune to renegotiation.

In this context, a first-stage agreement over a $[M, w(M)]$ scheme would be sustained ex-post, implying that an input price contract is a credible commitment device for downstream firm i over a particular competition conduct to be materialized in the second stage. The reason is that downstream firm i cannot unilaterally deviate from a particular competition conduct, once the input price has been set contingent on that. In such an event, downstream firm i 's exclusive supplier would naturally reset its pair-specific input price, as the downstream firm's deviation to a different competition conduct would prove to be time inconsistent for the supplier's objective regarding the quantity of input to be sold. Therefore both agents have better to agree on a particular scheme, in advance, and stick to it to the end of the game.

3. Modes of competition

In this section, we define all the possible modes of competition that can emerge in equilibrium in the downstream market. In particular, in Section 3.1, we present the configuration where both downstream firms set prices, i.e., $[P, w^P][P, w^P]$ and in Section 3.2, the configuration where they both set quantities, i.e., $[Q, w^Q][Q, w^Q]$. Then, in Section 3.3 we consider the case where the one downstream firm sets its quantity while the other firm sets its price, i.e., $[Q, w^Q][P, w^P]$.

3.1 Universal price setting

Under this scenario, in the second stage of the game, each downstream firm i chooses its price p_i to maximize own profits:

$$\Pi_i^P(p_i, p_j, w_i) = (p_i - w_i) \frac{(1 - \gamma) - p_i + \gamma p_j}{1 - \gamma^2} \quad (4)$$

Taking the first order conditions and solving the system of equations, the respective downstream firm i 's price and profits are:

$$p_i^P(w_i, w_j) = \frac{(2 - \gamma - \gamma^2) + 2w_i + \gamma w_j}{4 - \gamma^2} \quad (5)$$

$$\Pi_i^P(w_i, w_j) = \left[\frac{(2 - \gamma - \gamma^2) - (2 - \gamma^2)w_i + \gamma w_j}{4 - 5\gamma^2 + \gamma^4} \right]^2 \quad (6)$$

Substituting $p_i^P(w_i, w_j)$ into (1) and (3), we get downstream firm i 's demand for input and upstream firm i 's profits, respectively:

$$L_i^P(w_i, w_j) = \frac{(2 - \gamma - \gamma^2) - (2 - \gamma^2)w_i + \gamma w_j}{4 - 5\gamma^2 + \gamma^4} \quad (7)$$

$$\pi_i^P(w_i, w_j) = w_i L_i^P(w_i, w_j) \quad (8)$$

To solve for the equilibrium input prices, we employ the Nash equilibrium between two simultaneous upstream - downstream generalized Nash Bargaining games. Hence, in the first stage of the game each upstream – downstream bargaining pair i chooses w_i to maximize $[\Pi_i^P(w_i, w_j)]^\beta [\pi_i^P(w_i, w_j)]^{1-\beta}$, given the input price negotiated in the pair j , w_j . The respective upstream – downstream bargaining pair i 's input price reaction function is given by:

$$w_i^P(w_j) = \frac{(1 - \beta)[2 - \gamma(1 + \gamma - w_j)]}{2(2 - \gamma^2)} \quad (9)$$

Solving the system of the input price reaction functions, we get a unique stable solution for the input prices w^P . Then, using w^P , we subsequently derive downstream firm i 's price p^P ; quantity q^P , profits Π^P ; and upstream firm i 's profits π^P (see Appendix 1A).

3.2 Universal quantity setting

We next consider the scenario, where, in the second stage of the game, each downstream firm i chooses its quantity q_i to maximize own profits:

$$\Pi_i^Q(q_i, q_j, w_i) = (1 - q_i - \gamma q_j - w_i) q_i \quad (10)$$

Taking the first order conditions and solving the system of equations, the respective downstream firm i 's input demand and profits are:

$$L_i^Q(w_i, w_j) = \frac{(2 - \gamma) - 2w_i + \gamma w_j}{\gamma^2 - 4} \quad (11)$$

$$\Pi_i^Q(w_i, w_j) = [L_i^Q(w_i, w_j)]^2 \quad (12)$$

Substituting $L_i^Q(w_i, w_j)$ into (3), we get upstream firm i 's profits:

$$\pi_i^Q(w_i, w_j) = w_i L_i^Q(w_i, w_j) \quad (13)$$

In the first stage of the game, each upstream – downstream bargaining pair i chooses w_i to maximize $[\Pi_i^Q(w_i, w_j)]^\beta [\pi_i^Q(w_i, w_j)]^{1-\beta}$, given the input price negotiated in the upstream – downstream bargaining pair j , w_j . The respective upstream – downstream bargaining pair i 's input price reaction function is given by:

$$w_i^Q(w_j) = \frac{1}{4}(1 - \beta)[2 + \gamma(w_j - 1)] \quad (14)$$

Solving the system of the input price reaction functions, we get a unique stable solution for the input prices w^Q . Then, using w^Q , we subsequently derive downstream firm i 's price p^Q ; quantity q^Q , profits Π^Q ; and upstream firm i 's profits π^Q (see Appendix 1B).

3.3 Coexistence of quantity setting and price setting

Let us finally consider the case where, in the second stage of the game, downstream firm $i(j)$ chooses its own quantity (price), q_i (p_j) to maximize its

profits:⁹ Suppose, without loss of generality that, in the second stage, downstream firm 1 sets its quantity and firm 2 sets its price. That is, firm 1 chooses q_1 so as to maximize its profits, subject to $p_1 = (1 - \gamma) + \gamma p_2 - (1 - \gamma^2)q_1$, taking p_2 as given. Hence, firm 1's profit function is:

$$\Pi_1^{QP} = q_1 [(1 - \gamma) + \gamma p_2 + (\gamma^2 - 1)q_1 - w_1] \quad (15)$$

On the other hand, firm 2 sets p_2 in order to maximize its profits subject to $q_2 = 1 - \gamma q_1 - p_2$ taking p_1 as given. Thus firm 2's profit function is:

$$\Pi_2^{QP} = (p_2 - w_2)(1 - \gamma q_1 - p_2) \quad (16)$$

Taking the first order conditions and solving the system of equations, the respective downstream firm 1's input demand and firm 2's price are:

$$L_1^{QP}(w_1, w_2) = \frac{(\gamma - 2) + 2w_1 - \gamma w_2}{3\gamma^2 - 4} \quad (17)$$

$$p_2^{QP}(w_1, w_2) = \frac{(2 - \gamma - \gamma^2) + \gamma w_1 - (2\gamma^2 - 2)w_2}{4 - 3\gamma^2} \quad (18)$$

It follows that firm 2's input demand is:

$$L_2^{QP}(w_1, w_2) = \frac{(2 - \gamma - \gamma^2) + \gamma w_1 - (2 - \gamma^2)w_2}{4 - 3\gamma^2} \quad (19)$$

Hence, the respective downstream firm 1's and firm 2's profits are:

$$\Pi_1^{QP}(w_1, w_2) = \frac{(1 - \gamma^2)[(\gamma - 2) + 2w_1 - \gamma w_2]^2}{(3\gamma^2 - 4)^2} \quad (20)$$

$$\Pi_2^{QP}(w_1, w_2) = \left[\frac{(2 - \gamma - \gamma^2) + \gamma w_1 - (2 - \gamma^2)w_2}{4 - 3\gamma^2} \right]^2 \quad (21)$$

Substituting $L_1^{QP}(w_1, w_2)$ and $L_2^{QP}(w_1, w_2)$ into (3), we get the respective upstream firm 1's and 2's profits:

⁹ Of course, due to the symmetric industry structure, the reverse configuration is by default addressed as similar candidate equilibrium.

$$\pi_1^{OP}(w_1, w_2) = w_1 L_1^{OP}(w_1, w_2) \quad (22)$$

$$\pi_2^{OP}(w_1, w_2) = w_2 L_2^{OP}(w_1, w_2) \quad (23)$$

In the first stage of the game the upstream – downstream bargaining pair 1 chooses w_1 to maximize $[\Pi_1^{OP}(w_1, w_2)]^\beta [\pi_1^{OP}(w_1, w_2)]^{1-\beta}$, and pair 2 chooses w_2 to maximize $[\Pi_2^{OP}(w_1, w_2)]^\beta [\pi_2^{OP}(w_1, w_2)]^{1-\beta}$. The respective pair 1's and 2's input price reaction function is given by:

$$w_1^{OP}(w_2) = \frac{(1-\beta)[2 + \gamma(w_2 - 1)]}{4} \quad (24)$$

$$w_2^{OP}(w_1) = \frac{(1-\beta)[2 - \gamma(1 + \gamma - w_1)]}{2(2 - \gamma^2)} \quad (25)$$

Solving the system of these reaction functions, we then get a unique stable solution for the input prices w_1^{OP} and w_2^{OP} . Then, using w_1^{OP} and w_2^{OP} , we subsequently derive each downstream firm's quantity $(q_1^{OP}; q_2^{OP})$, price $(p_1^{OP}; p_2^{OP})$, and profits $(\Pi_1^{OP}; \Pi_2^{OP})$ as well as each upstream firm's profits $(\pi_1^{OP}; \pi_2^{OP})$ (see Appendix 1C).

4. Equilibrium mode of competition

In order to obtain a Nash equilibrium in the first stage (negotiation stage) of the game, we consider a candidate equilibrium and then test whether it is immune to all possible deviations. For the *universal price setting* configuration, i.e., $[P, w^P][P, w^P]$, there is only one possible deviation: an upstream – downstream bargaining pair switches to quantity-setting, readjusting the pair-specific input price, i.e., $[Q, w_{id}^Q]$. Such a deviation has to be profitable for both the upstream and the downstream firm, within pair i , otherwise the partner who is hurt will certainly veto this deviation. For the *universal quantity setting* configuration, i.e., $[Q, w^Q][Q, w^Q]$,

there is only one possible deviation: an upstream – downstream bargaining pair switches to price-setting, readjusting the pair-specific input price accordingly, i.e., $[P, w_{1d}^P]$. Finally, in the *quantity - price* configuration, both the aforementioned deviations have to be checked. Note that the above exercise reflects the idea that switching from a certain competition conduct to another, requires agreement between the upstream and the downstream firm within the bargaining pair. The veto of one of them is sufficient to block the switching.

4.1 Universal price setting

The configuration $[P, w^P][P, w^P]$ constitutes a sub-game perfect Nash equilibrium only if no upstream – downstream bargaining pair has an incentive to unilaterally deviate to a different input price / competition conduct scheme, in the first stage of the game.

Suppose that upstream – downstream pair $i \equiv 2$ sticks to $[P, w^P]$. Does upstream – downstream pair $i \equiv 1$ have incentives to switch to $[Q, w_{1d}^Q]$? In such a deviation, w_{1d}^Q would be the pair $i \equiv 1$'s best response to w^P , in the ensuing *Coexistence of quantity setting and price setting* game (see eq. 24). Note that $w_{1d}^Q > w^P$ always.¹⁰ This inequality holds because the elasticity of input demand of downstream firm i when firm $j(i)$ sets the quantity (price) is lower than the respective one in case where both firms set their own prices in the second stage.¹¹ In this scenario, the upstream firm 1 exploits a relatively higher input level capacity per

¹⁰ Because of space limitations, the analytical expression for the input price, upstream firm's and downstream firm's profits under the considered deviation, are available from the authors upon request.

¹¹ The elasticity of input demand for downstream firm i , when both downstream firms set the price is $|\epsilon_{Li}^P| = \frac{(2 - \gamma^2)w_i}{(2 - \gamma - \gamma^2) - (2 - \gamma^2)w_i + \gamma w_j}$. The respective elasticity, when downstream firm i sets the quantity and firm j sets the price is $|\epsilon_{Li}^{QP}| = \frac{2w_i}{(2 - \gamma) - 2w_i + \gamma w_j}$.

unit of input price increase and sets a higher input price. This in turn, since

$$\frac{g_{q_i}^{PQ}(w_i, w_j)}{g_{w_i}} = \frac{2}{3\gamma^2 - 4} < 0, \text{ decreases downstream firm 1's demand for input, reduces}$$

its output, and increases the final good's market-clearing price.

In such a deviation, it is easy to see that the downstream firm 1 would become the Stackelberg leader in the product market, since its input and output level decisions precede the downstream firm 2's respective decisions (Dewatripont, 1987, 1988; Petrakis and Vlassis, 2000).¹²

Given w_{1d}^Q and w^P , for downstream firms 1 and 2 respectively, upstream firm 1's profits, under the considered deviation, would be given by the ensuing price-quantity setting game, i.e., $\pi_{1d}^Q = \pi_1^{QP}(w_{1d}^Q, w^P)$ (see eq. 22). It holds that $\pi_{1d}^Q > \pi^P$ always, and hence, it proves that the upstream firm 1 has an incentive that downstream firm 1 switches from price-setting to quantity-setting. Intuitively, the positive input price-increase effect on upstream 1's profits dominates the negative input quantity-reduction effect. Regarding the downstream firm 1, its profits under the considered deviation would be $\Pi_{1d}^Q = \Pi_1^{QP}(w_{1d}^Q, w^P)$ (see eq. 20). It holds that $\Pi_{1d}^Q > \Pi^P$ always, and hence, downstream firm 1 also has an incentive to switch from price-setting to quantity-setting. The reason is that the positive final good price-increase effect on its profits dominates two negative effects: The input price-reduction effect and the output-reduction effect. The following proposition summarizes.

Proposition 1

Universal price setting can never be an equilibrium mode of competition configuration.

¹² The same mechanism exists in the strategic delegation literature (see e.g. Vickers, 1985; Fershtman and Judd, 1987; Sklivas, 1987).

4.2 Universal quantity setting

Here too, the configuration $[Q, w^Q]$ constitutes a sub-game perfect Nash equilibrium only if no upstream – downstream bargaining pair has an incentive to deviate to a different input price / competition conduct scheme, in the first stage of the game.

Suppose that upstream – downstream pair $i \equiv 2$ sticks to $[Q, w^Q]$. Does upstream – downstream pair $i \equiv 1$ have incentives to switch to $[P, w_{1d}^P]$? In such a deviation, w_{1d}^P would be the pair $i \equiv 1$'s best response to w^Q , in the ensuing *Coexistence of price setting and quantity setting* game (see eq. 25). Note that $w_{1d}^P < w^Q$ always. This inequality holds because the elasticity of input demand for downstream firm i , when firm $i(j)$ sets the price (quantity), is higher than the respective elasticity when both downstream firms set the quantity in the second stage of the game.¹³ Hence, in case of a percentage increase in the input price that the downstream firm i faces, the resulting percentage decrease in its respective demand for input will be higher in the former than in the latter configuration. This, in turn, implies a direct cost saving for the deviant downstream firm 1 which, since
$$\frac{\mathcal{G}p_i^{PQ}(\gamma, w_i, w_j)}{\mathcal{G}w_i} = \frac{2(\gamma^2 - 1)}{3\gamma^2 - 4} > 0,$$
 decreases the price of the (final) good. An immediate consequence will then be the expansion of downstream firm 1's final good sold in the market.

¹³ The elasticity of input demand for downstream firm i , when both downstream firms set the quantity, is $|\varepsilon_{Li}^Q| = \frac{2w_i}{a(2 - \gamma) - 2w_i + \gamma w_j}$. The respective elasticity, when downstream firm i sets

the price and firm j sets the quantity, is $|\varepsilon_{Li}^{PQ}| = \frac{(2 - \gamma^2)w_i}{a(2 - \gamma - \gamma^2) - (2 - \gamma^2)w_i + \gamma w_j}$.

Given w_{1d}^P and w^Q , for downstream firms 1 and 2 respectively, upstream firm 1's profits under the considered deviation would be given by the ensuing price-quantity setting game, i.e., $\pi_{1d}^P = \pi_1^{PQ}(w_{1d}^P, w^Q)$ (see eq. 23). One can check that $\pi_{1d}^P < \pi^Q$ always. Hence, upstream firm 1 has no incentive for downstream firm 1 to switch from quantity-setting to price-setting. This is so, because the negative input price-reduction effect dominates the positive output-expansion effect. Similarly, since $\Pi_{1d}^Q(\gamma) < \Pi_1^Q(\gamma)$ always, the downstream firm 1 has no incentive to switch from quantity-setting to price-setting. Intuitively, the negative price-reduction effect dominates two positive effects: The cost-saving effect and the output-expansion effect. The following proposition summarizes.

Proposition 2

Universal quantity setting is always an equilibrium mode of competition configuration.

4.3 Coexistence of price setting and quantity setting

In an analogous way, the configuration $[Q, w_1^{OP}][P, w_2^{OP}]$ has two deviations to be checked: The upstream - downstream pair 1 (2) may consider the downstream firm 1 (2) to adjust its own price (quantity), instead of its quantity (price) at the second stage. If at least one of the above two deviations is profitable, for both the upstream and the downstream firm within a pair, the *Coexistence of price setting and quantity setting* configuration can never be an equilibrium mode of competition configuration.

Let us consider whether upstream – downstream bargaining pair $i \equiv 2$ has incentives to switch to $[Q, w_{2d}^Q]$, given that firm - union pair $i \equiv 1$ sticks to $[Q, w_1^{OP}]$. In this scenario, w_{2d}^Q would be the upstream – downstream pair $i \equiv 2$'s best response

to w_1^{QP} , in the ensuing *Universal quantity setting* game (see eq. 14), with $L_{2d}^Q > L_2^{QP}$ and $w_{2d}^Q > w_2^{QP}$ always. Then, given w_{2d}^Q and w_1^{QP} , downstream firm 2's profits and upstream firm 2's profits, under the considered deviation, would be given by $\Pi_{2d}^Q = \Pi_i^Q(w_1^{QP}, w_{2d}^Q)$ (see eq. 12) and $\pi_{2d}^Q = \pi_i^Q(w_1^{QP}, w_{2d}^Q)$ (see eq. 13) respectively. It proves that $\Pi_{2d}^Q > \Pi_2^{QP}$ and $\pi_{2d}^Q > \pi_2^{QP}$ always hold and hence both upstream firm 2 and downstream firm 2 have incentives that the latter switches from price-setting to quantity-setting. The following proposition summarizes.

Proposition 3

The Coexistence of price setting and quantity setting configuration can never be an equilibrium mode of competition configuration.

5. Welfare analysis

In this Section we focus on the welfare effects of the different modes of competition. Social welfare is defined as the sum of consumers' surplus, downstream firms' profits, and upstream firms' profits:

$$SW^m = \frac{1+\gamma}{4}(Q^m)^2 + 2\Pi_i^m + 2\pi_i^m, m = Q, P, QP \quad (26)$$

Q^m is the total quantity of the final products. Substituting the relevant expressions into eq. (26), we obtain social welfare in the three cases under consideration.¹⁴ The following proposition summarizes.

Proposition 4

Universal price setting competition always leads to the highest social welfare; Universal quantity setting competition always leads to the lowest; Coexistence of price setting and quantity setting lies in-between, i.e., $SW^P > SW^{QP} > SW^Q$.

¹⁴ Due to space limitations, the mathematical expressions for the three cases are available from the authors upon request.

The intuition behind this result is straightforward. Downstream firms' profits are the highest (lowest) in the *Universal quantity (price) setting* competition, while the *Universal quantity (price) setting* competition results in the lowest (highest) consumers' surplus. This is a direct consequence of the fact that prices in the Cournot competition are higher than those in the Bertrand competition (Singh and Vives, 1984).

Regarding the upstream firms' profits, they are higher in the *Coexistence of price setting and quantity setting* as compared with the respective ones in the *Universal quantity setting*. Yet, in the *Universal price setting*, if products are sufficiently differentiated (homogenous), the upstream firms' profits are higher than the respective ones in the *Coexistence of price setting and quantity setting* configuration (*Universal quantity setting*). On the contrary, if products are relatively homogenous the upstream firms' profits in the *Universal price setting* are higher than the respective ones in the *Universal quantity setting*. Nevertheless, the consumer surplus-effect always dominates the sum of the downstream firm's profits- and the upstream firm's profits- effects. As a consequence, the *Universal price setting* is always preferable from the social welfare point of view.

Moreover, social welfare exhibits a U-shaped in the degree of product differentiation. This happens because product differentiation has a negative effect on both the downstream and upstream firms' profits, whilst it has a positive effect on consumers' surplus. Hence, if products are sufficiently differentiated the profits effect dominates, while as products become more homogenous, i.e., closer substitutes, the consumer surplus effect dominates.¹⁵

¹⁵ This is in the spirit of Fanti and Meccheri (2011) who find that, as the two goods become closer substitutes and market competition becomes fiercer, besides the standard downstream competition effect that tends to reduce profits, there is an upstream competition effect too, suggesting an increase of

6. Discussion – extensions

We now briefly discuss two extensions of our model.

6.1 Non-exclusive relationships

Throughout we have assumed that there is an exclusive relationship between upstream firm i and downstream firm i , in each pair $i = 1, 2$. We may now in short discuss the effects of non-exclusive relationships, where each downstream firm can obtain its input from both input suppliers. In this case, if upstream suppliers sell perfectly homogenous inputs, they will be driven to zero profits, implying that they will be unable to affect the mode of competition that downstream firms will materialize. If, on the other hand, exists a positive degree of input-specificity, then upstream profits will be positive but lower than the respective ones under exclusive relationships. In the background, the higher is the degree of input-specificity the higher will be the input suppliers' bargaining power over the input price / competition conduct scheme.

6.2 Complement products

In our model we have also assumed that final products are substitutes. Assume now that final products are complements. It proves that the *Universal price setting* will always emerge in equilibrium, irrespective to the degree of product complementarity.¹⁶ Intuitively, this happens because Bertrand competition with complements is the dual of Cournot competition with substitutes (Singh and Vives, 1984).

competition between labour unions which drives them to wage undercutting in order to sufficiently preserve employment.

¹⁶ The detailed proof is available from the authors upon request.

7. Conclusions

The objective of this paper is to study the endogenous emergence of the mode of competition in the downstream tier of a vertically related industry.

In a two-tier oligopoly, the equilibrium mode of competition in the downstream market is endogenously determined as a *renegotiation-proof* contract, signed between each downstream producer and its exclusive input supplier. We find that if the final products are substitutes, the Cournot mode of competition endogenously emerges in the industry. This holds independently of the degree of product differentiation and the distribution of bargaining power, over the input price, between the upstream and the downstream firm, within each bargaining pair. In contrast with previous studies, we therefore suggest that what sustains the Cournot mode of competition in the downstream tier of a vertically related market is the downstream and upstream firm's unanimous agreement, within the bargaining pair. This finding contributes to the literature by addressing a plausible solution for the emergence and sustainability of the equilibrium mode of competition in the downstream tier of a vertically related market.

In our analysis we have assumed two separate upstream firms. An interesting direction for further research is giving those firms the opportunity to merge. By doing so, we can investigate the input market structure which will endogenously emerge. Another direction is allowing the upstream firms to trade with their downstream firms through two-part tariff contracts instead through wholesale price contracts. Both the above directions would link our research to the literature of mergers and contracting in vertically related industries.

Appendix 1A: Universal price setting

$$w^P = \frac{(2 - \gamma - \gamma^2)(1 - \beta)}{4 + \gamma(\beta - 2\gamma - 1)}$$

$$q^P = \frac{(2 - \gamma^2)(1 + \beta)}{[2\gamma^2 + \gamma(1 - \beta) - 4](\gamma^2 - \gamma - 2)}$$

$$p^P = \frac{2(1 - \gamma)(3 - \beta - \gamma^2)}{[2\gamma^2 + \gamma(1 - \beta) - 4](\gamma - 2)}$$

$$\Pi^P = (p^P - w^P)q^P; \pi^P = w^P q^P$$

Appendix 1B: Universal quantity setting

$$w^Q = \frac{(\gamma - 2)(\beta - 1)}{4 + \gamma(\beta - 1)}$$

$$q^Q = \frac{2(1 + \beta)}{(\gamma + 2)[4 + \gamma(\beta - 1)]}$$

$$p^Q = \frac{\gamma^2(\beta - 1) - 2\beta + 6}{(\gamma + 2)[4 + \gamma(\beta - 1)]}$$

$$\Pi^Q = (p^Q - w^Q)q^Q; \pi^Q = w^Q q^Q$$

Appendix 1C: Coexistence of price setting and quantity setting

$$w_1^{QP} = \frac{(1 - \beta)[8 + \gamma[\beta(\gamma^2 + \gamma - 2) - \gamma(5 - \gamma) - 2]]}{16 - \gamma^2[9 + \beta(\beta - 2)]}$$

$$w_2^{QP} = \frac{(1 - \beta)[8 - 2(1 + \beta)\gamma - 5(5 - \beta)\gamma^2]}{16 - \gamma^2[9 + \beta(\beta - 2)]}$$

$$L_1^{QP} = \frac{2(1 + \beta)[8 + \gamma[\beta(\gamma^2 + \gamma - 2) - \gamma(5 - \gamma) - 2]]}{(4 - 3\gamma^2)[16 - \gamma^2[9 + \beta(\beta - 2)]]}$$

$$L_2^{QP} = \frac{(1 + \beta)(2 - \gamma^2)[8 - 2(1 + \beta)\gamma - 5(5 - \beta)\gamma^2]}{(4 - 3\gamma^2)[16 - \gamma^2[9 + \beta(\beta - 2)]]}$$

$$p_1^{QP} = 1 - L_1^{QP} - \gamma L_2^{QP}; p_2^{QP} = 1 - L_2^{QP} - \gamma L_1^{QP}$$

$$\Pi_1^{QP} = (p_1^{QP} - w_1^{QP})L_1^{QP}; \Pi_2^{QP} = (p_2^{QP} - w_2^{QP})L_2^{QP}$$

$$\pi_1^{QP} = w_1^{QP} L_1^{QP}; \pi_2^{QP} = w_2^{QP} L_2^{QP}$$

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