



Endogenous choice of price or quantity contract and the implications of two-part-tariff in a vertical structure[☆]



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ARTICLE INFO

Article history:

Received 12 November 2015

Accepted 25 November 2015

Available online 3 December 2015

JEL classification:

D43

L13

L14

Keywords:

Bargaining

Bertrand

Cournot

Two-part tariffs

Vertical pricing

Welfare

ABSTRACT

We re-investigate the endogenous choice of price (Bertrand) and quantity (Cournot) contract in the presence of a vertically related upstream market for input. We find that choosing price contract is the dominant strategy for downstream firms when the two-part-tariff pricing contract is determined through centralised Nash bargaining. We further show that the level of social welfare is the same regardless of the mode of product market competition (i.e., Bertrand or Cournot).

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1. Introduction

There is a well-established line of research analysing the effects of Bertrand and Cournot competition on profit and social welfare. In a seminal paper, Singh and Vives (1984) show that choosing quantity (price) contract is the dominant strategy for both firms when the goods are substitutes (complements). Furthermore, firms' profits are higher under Cournot competition whereas Bertrand competition yields higher social welfare when the input markets are competitive¹. However, it is often found that input suppliers and the final goods producers are involved in two-part tariff vertical pricing contracts (Berto Villa-Boas, 2007 and Bonnet and Dubois, 2010). Alipranti et al. (2014) show that when a monopoly input supplier and two final goods producers determine

the two-part tariff vertical pricing contracts through a *decentralised* generalised Nash bargaining process, the equilibrium profits of the final goods producers and social welfare are higher under Cournot competition.

We, on the other hand, aim to revisit the classic question of price and quantity contract where the downstream firms involve in *centralised bargaining*² with an upstream input supplier to determine the two-part tariff vertical pricing contracts. We show that choosing price contract is the dominant strategy for the downstream firms and both Bertrand and Cournot entail equal welfare level. López and Naylor (2004), López (2007), Mukherjee et al. (2012) also consider the implications of Bertrand and Cournot competition in isolation, under strategic input-price determination. Their results mostly confirm Singh and Vives' (1984) findings and hence, our results are in stark contrast with the existing literature.

[☆] We sincerely appreciate the comments that we received from the editor and the anonymous referee of this journal that helped us to improve the paper. We would also like to thank Arijit Mukherjee for extremely helpful discussions and suggestions.

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¹ See Delbono and Denicolò (1990), Qiu (1997) and Häckner (2000) for some works on Bertrand and Cournot competition under competitive input markets.

² The implications of centralised bargaining is justifiable in most continental European countries, such as Germany (Hirsch et al., 2014). In the context of strategic input-price determination (Calmfors and Driffill, 1988; Danthine and Hunt, 1994) argue that collective bargaining is more widely accepted as it internalises various negative externalities, such as unemployment. Also, see Flanagan (2003), Boeri and Burda (2009) for a critical survey on this strand of literature.

2. The model

We consider an economy with two downstream firms, denoted by D_i producing differentiated products where $i, j = 1, 2$ and $i \neq j$. The downstream firms require a critical input for production that they purchase from a monopoly input supplier, U , through two-part tariff contracts involving an up-front fixed-fee and a per-unit price. U produces the inputs at a constant marginal cost of production, c which we assume to be zero. We assume that one unit of input is required to produce one unit of the output, and D_i and D_j can convert the inputs to the final goods without incurring any further cost.

We develop a model of three stage game. At stage 1, each downstream firm simultaneously chooses whether to adopt *quantity contract* or *price contract*. At stage 2, U is involved in a centralised bargaining with a representative of D_1 and D_2 to determine the terms of the two-part tariff contracts involving an up-front fixed-fee, F_i , and a per-unit price, w_i , $i = 1, 2$. At stage 3, firms compete contingent to the decisions made in stage 1. We solve the game through backward induction.

Hence, we start our discussion at stage 3. To this extent we consider four possible constellations, $\{\rho = qq, pp, pq, qp\}$; that attribute to the following properties:

- ($\rho = qq$): where both firms adopt quantity contracts
- ($\rho = pp$): where both firms adopt price contracts
- ($\rho = pq$): where D_1 chooses price contract and D_2 chooses quantity contract
- ($\rho = qp$): where D_1 chooses quantity contract and D_2 chooses price contract.

We work out the equilibrium outcomes under each of these strategy combinations.

At stage 2 U , the monopoly input supplier and a representative of D_1 and D_2 determine the terms of the two-part tariff contract by maximising the following generalised Nash bargaining expression

$$\text{Max}_{F_i^\rho, w_i^\rho} \left[\sum_{i=1}^2 (w_i^\rho q_i^\rho + F_i^\rho) \right]^\beta \left[\sum_{i=1}^2 (\pi_i^\rho - F_i^\rho) \right]^{1-\beta} \quad (1)$$

where q_i^ρ and $(\pi_i^\rho - F_i^\rho)$ denote the output and net profit of the downstream firms and β (resp. $(1 - \beta)$) shows the bargaining power of the input supplier (resp. final goods producers). We restrict our analysis to $\beta \in (0, 1)$.

Maximising the above with respect to F_i gives the following³

$$F_i^\rho = \frac{1}{2} \left[\beta \sum_{i=1}^2 \pi_i^\rho - (1 - \beta) \sum_{i=1}^2 w_i^\rho q_i^\rho \right]. \quad (2)$$

Substituting (2) in (1), we get the maximisation problem as

$$\text{Max}_{w_i^\rho} \left[\beta \sum_{i=1}^2 (\pi_i^\rho + w_i^\rho q_i^\rho) \right]^\beta \left[(1 - \beta) \sum_{i=1}^2 (\pi_i^\rho + w_i^\rho q_i^\rho) \right]^{1-\beta}. \quad (3)$$

Eq. (3) shows that the per-unit input price is determined to maximise the industry profit (i.e., the total profits of U, D_1 and D_2), since

$$\begin{aligned} \sum_{i=1}^2 (\pi_i^\rho + w_i^\rho q_i^\rho) &= \sum_{i=1}^2 [(P_i^\rho - w_i^\rho) q_i^\rho + w_i^\rho q_i^\rho] \\ &= \sum_{i=1}^2 P_i^\rho q_i^\rho \end{aligned}$$

which is the profit of a monopoly final goods producer, producing both the products at zero marginal cost of production. Hence, it is intuitive that the centralised bargaining entails same level of output, consumer surplus and social welfare irrespective of the mode of the contract (i.e., Bertrand or Cournot) chosen by the final goods producers.

Corollary 1. *If the final goods producers and a monopoly input supplier involve in centralised generalised Nash bargaining to determine the two-part tariff vertical pricing contract, the outcomes yield equal level of output, consumer surplus and social welfare irrespective of the type of the product market competition.*

3. Equilibrium outcomes

We now find out the equilibrium outcomes under a specific (inverse) demand function: $P_i = 1 - q_i - \gamma q_j$, similar to Alipranti et al. (2014) with an exception that we normalise the demand intercept to unity for simplicity. $\gamma \in (0, 1)$ measures the degree of product differentiation. If $\gamma = 1$, the goods are perfect substitutes, and if $\gamma = 0$, the goods are isolated.

3.1. (q-q) contract

Downstream firm's profit motive yields

$$\begin{aligned} \text{Max}_{q_i} D\pi_i^{qq} &= \pi_i^{qq} - F_i \\ &= (1 - q_i - \gamma q_j - w_i) q_i - F_i. \end{aligned} \quad (4)$$

Solving the first order conditions we obtain the equilibrium output of the i th firm

$$q_i^{qq} = \frac{(2 - \gamma) - 2w_i + \gamma w_j}{4 - \gamma^2}. \quad (5)$$

Given (5), the profit equation in (4) reduces to

$$D\pi_i^{qq} = (q_i)^2 - F_i. \quad (6)$$

Maximising (3) subject to (5) and (6) gives the equilibrium per-unit input price and upfront fixed fee as

$$w_i^{qq} = \frac{1}{2} \left(\frac{\gamma}{1 + \gamma} \right).$$

Given the per-unit input price, the equilibrium fixed-fees gives

$$F_i^{qq} = \frac{(\beta - \gamma + \beta\gamma)}{4(1 + \gamma)^2}.$$

The equilibrium downstream profit is

$$D\pi_i^{qq} = \frac{1}{4} \left(\frac{1 - \beta}{1 + \gamma} \right). \quad (7)$$

Next, we work out the consumer surplus and social welfare, are respectively as

$$CS^{qq} = \frac{1}{4} \left(\frac{1}{1 + \gamma} \right) \quad \text{and} \quad SW^{qq} = \frac{3}{4} \left(\frac{1}{1 + \gamma} \right). \quad (8)$$

3.2. (p-p) contract

In order to solve the Bertrand game we derive the direct demand function $q_i = \frac{(1-\gamma) - P_i + \gamma P_j}{1-\gamma^2}$. Accordingly, the representative

³ Like Alipranti et al. (2014) we also allow negative fixed-fees, which occurs for a small β . The upstream firm, in this case, subsidises downstream's production via fixed-fee.

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