Economics Letters 154 (2017) 124–127

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Cournot vs. Bertrand under centralised bargaining☆

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HIGHLIGHTS

- The paper reinvestigates Cournot and Bertrand profit differential in a vertically related market.
- The results are different to the ones obtained in other vertical pricing models.
- The downstream profits are higher under Cournot than Bertrand if the goods are substitutes.
- The profit ranking reverses when the goods are complements.

ARTICLE INFO

Article history:
Received 19 October 2016
Received in revised form
12 February 2017
Accepted 24 February 2017
Available online 2 March 2017

JEL classification:
D43
L13
L14

Keywords:
Bargaining
Bertrand
Cournot
Centralised bargaining
Vertical pricing
Welfare

ABSTRACT

We revisit the debate on Cournot and Bertrand profit comparison in a vertically related upstream market for inputs. We find that when an input pricing contract is determined through centralised bargaining, the final goods producers earn higher (lower) profit under quantity competition than under price competition if the goods are substitutes (complements). Our results are strikingly different to the ones obtained from a similar comparison in other vertical pricing models.

1. Introduction

In a seminal paper, Singh and Vives (1984) show that firms' profits are higher (lower) under Cournot compared to Bertrand competition when the goods are substitutes (complements) and the input markets are competitive. However, it is often found that input suppliers and the final goods producers are involved in vertical pricing contracts. Considering the input suppliers as labour unions López and Naylor (2004) argue that the standard profit ranking shown in Singh and Vives (1984) is reversed when a monopoly input supplier and two final goods producers determine input prices through *decentralised bargaining* process and the input suppliers place sufficient weight on wage (input price) determination. Using a model of two-part tariff vertical pricing contract where the input supplier and the final goods producers involve in *decentralised bargaining*, Alipranti et al. (2014) further confirms the results of López and Naylor (2004).[2]

While the assumption of decentralised bargaining process is a useful starting point, it is equally intriguing to investigate whether the results alluded above hold when the input price contract constitutes centralised bargaining. The implication of centralised bargaining is justifiable in most continental European countries,

☆ I sincerely appreciate the comments received from the anonymous referee and the editor of this journal. I would also like to thank Arijit Mukherjee and Subhradeep De Sarkar for helpful discussions.

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[2] See López (2007), Mukherjee et al. (2012), Basak and Wang (2016) for related works on strategic input-price determination.

http://dx.doi.org/10.1016/j.econlet.2017.02.031

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. In light of this, we consider a model where the downstream firms involve in *centralised bargaining* with an upstream input supplier to determine the equilibrium input price. In contrast to the existing results on vertical pricing models, we show that the final goods producers earn a higher (lower) profit under Cournot structure than Bertrand when the goods are substitutes (complements) thus supporting the findings of Singh and Vives (1984).

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 at a per unit price w_i which is determined through generalised centralised Nash Bargaining. U produces the inputs at a constant marginal cost of production, $c \in (0, a)$. 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 two stage game. At stage 1, U involves in a centralised bargaining with a representative of D_1 and D_2 to determine the price of the critical input, w_i, $i = 1, 2$. At stage 2, D_1 and D_2 compete either in quantities (Cournot competition) or in prices (Bertrand competition) and the profits are realised. We solve the game through backward induction.

3. Equilibrium outcomes

We assume that a representative consumer's utility function is given by

$$V\left(q_i, q_j\right) = a\sum_i q_i - \frac{1}{2}\sum_i q_i^2 - \gamma \sum_{i,i\neq j} q_i q_j + \zeta \tag{1}$$

where ζ is the numeraire good and q denotes the final good produced by the downstream firm. The parameter $\gamma \in (-1, 1)$ measures the degree of product differentiation. If $\gamma > 0$ the goods are substitutes and if $\gamma < 0$ the goods are complements.

Using Eq. (1) we obtain downstreams' inverse and direct demand functions respectively

$$P_i = a - q_i - \gamma q_j \quad \text{and} \quad q_i = \frac{a(1-\gamma) - P_i + \gamma P_j}{1-\gamma^2}.$$

Next, we derive the equilibrium outcomes contingent to the game structure discussed earlier.

3.1. Cournot competition

We begin with the case where the downstream firms compete in quantities. Downstream firm's profit motive yields

$$\underset{q_i}{\text{Max}}\ D\Pi_i^C = \left(a - q_i - \gamma q_j - w_i\right) q_i. \tag{2}$$

Solving the first order conditions we obtain the equilibrium output of the ith firm

$$q_i^C = \frac{a(2-\gamma) - 2w_i + \gamma w_j}{1-\gamma^2}. \tag{3}$$

Given (3), the profit equation in (2) reduces to $D\Pi_i^C = \left(q_i^C\right)^2$.

Next we turn our analysis to stage 1 where the input prices are determined. To this extent we consider two types of price setting behaviour of the upstream firm — (i) uniform pricing and (ii) discriminatory pricing. In case of uniform pricing the upstream firm maximises $U\Pi^C = (w - c)\sum_i q_i$ with respect to w whereas it maximises $U\Pi^C = \sum_i (w_i - c)\, q_i$ with respect to w_i if input pricing is discriminatory. Our modelling is similar to *right-to-manage* model.[3] We assume that the input price determination is an outcome of generalised Nash bargaining[4]:

$$w_i^C = max\left[\left(U\Pi^C - \widehat{U\Pi}\right)^{\beta}\left(\sum_i \left(D\Pi_i^C - \widehat{D\Pi}\right)\right)^{1-\beta}\right] \tag{4}$$

where $\widehat{U\Pi}$ and $\widehat{D\Pi}$ are the disagreement pay-offs of the upstream and downstream firms respectively. We assume that in the event of disagreement the downstream firms stop producing which entails zero reservation pay-offs for both input suppliers and final goods producers. The parameter β (respectively $1 - \beta$) measures the relative bargaining power of the input supplier (respectively final goods producers). A higher (lower) value of β corresponds to a higher (lower) bargaining power of the input supplier. At the extreme, if $\beta = 1$, the input supplier has full bargaining power, and if $\beta = 0$ the downstream firms have full bargaining power. We restrict our analysis to $\beta \in (0, 1)$.

Maximising (4) we obtain the equilibrium input price as $w_i^C = \frac{1}{2}(a\beta - c\beta + 2c)$ both under uniform and discriminatory price setting.[5]

We derive the downstream and upstream profits as

$$D\Pi_i^C = \left[\frac{(a-c)(2-\beta)}{2(2+\gamma)}\right]^2 \quad \text{and} \quad U\Pi^C = \frac{\beta(a-c)^2(2-\beta)}{2(2+\gamma)}. \tag{5}$$

The consumer surplus and social welfare ($= CS + PS + U\Pi$) are

$$CS^C = \frac{(a-c)^2(2-\beta)^2(1+\gamma)}{4(2+\gamma)^2}$$

$$\text{and,} \quad SW^C = \frac{(a-c)^2(2-\beta)(6+\beta+2\gamma+\beta\gamma)}{4(2+\gamma)^2}. \tag{6}$$

3.2. Bertrand competition

Now, we consider the situation where the downstream firms compete in prices and repeat the same exercise as in Section 3.1. Downstream firms maximise the following

$$\underset{P_i}{\text{Max}}\ D\Pi_i^B = (P_i - w_i)\left(\frac{a(1-\gamma) - P_i + \gamma P_j}{1-\gamma^2}\right). \tag{7}$$

3 The right-to-manage model has gained more popularity in the policy circle compared to efficient bargaining model. See Oswald (1993) and Layard et al. (1991) who offered some arguments in favour of this issue.

4 See Serrano (2008a,b) for a survey on Nash bargaining.

5 In discriminatory input price setting, the negotiation between U and the two downstream firms could be such that U charges an exorbitantly high input price to one of the downstream firms that it becomes inactive and the other downstream firm produces like a monopolist. Straightforward calculations show that by charging $w^C \geq \frac{a(4-2\gamma+\beta\gamma)+c(2-\beta)\gamma}{4}$ and $w^B \geq \frac{a(4-2\gamma+\beta\gamma-2\gamma^2)+c(2-\beta)\gamma}{2(2-\gamma^2)}$ under Cournot and Bertrand competition respectively, U can oust away one of the downstream firms and let the other downstream firm to produce like a monopolist. The upstream profit, in this situation, becomes $\frac{\beta(a-c)^2(2-\beta)}{8}$ which is lower than $U\Pi^C$ in Eq. (5) and $U\Pi^B$ in Eq. (9). As U behaves opportunistically and always maximises its profit, our main focus remains on the duopoly case.