A NOTE ON THIRD DEGREE PRICE DISCRIMINATION IN INTERMEDIATE GOOD MARKETS*

YOUPING LI†

This note studies third degree price discrimination in intermediate good markets. I show that whether a more efficient downstream firm is charged a higher or lower price than a less efficient firm depends on the shape of the demand function. Different from the case in which final market demand is linear, the usual assumption in the literature, constant elasticity demand, for example, results in a more efficient firm’s receiving a discount.

SUPPORTING INFORMATION

The complete paper can be found as supporting information together with the online version of this article.

*I wish to thank the Editor and two anonymous referees for helpful comments and suggestions. The usual disclaimer applies.
†Author’s affiliation: School of Business, East China University of Science and Technology, 130 Meilong Road, Shanghai 200237, China.
e-mail: liyouping@ecust.edu.cn.

© 2014 The Editorial Board of The Journal of Industrial Economics and John Wiley & Sons Ltd
I. INTRODUCTION

PRICE DISCRIMINATION IN INTERMEDIATE GOOD MARKETS is prevalent especially in countries where such practices are not legally prohibited or in international markets where national antitrust laws do not apply. Perhaps counter-intuitively, models of third degree price discrimination have generally shown that a less efficient downstream firm receives a discount from the monopolistic upstream firm relative to a more efficient firm (DeGraba [1990] and Yoshida [2000]). Inderst and Valletti [2009] and Inderst and Shaffer [2009] resolved this puzzle by introducing demand-side substitution for the intermediate good and by allowing for the use of two-part tariff contracts, respectively. In this note, I stick to the setup of DeGraba [1990] and Yoshida [2000] and study price discrimination under linear pricing, without altering the upstream firm’s monopolistic status. By relaxing the assumption of linear demand in the final good market used in their models, I provide an alternative explanation for a more efficient firm receiving a discount.

I focus on the case of downstream firms that operate in separate markets. This can be due to geographical or technological barriers. For instance, in many countries, one mobile service provider is the exclusive contractor with Apple Inc. to provide mobile services bundling iPhone products. Because of differences in language and telecommunication standards, cross-border shopping is rare and each service provider can be seen as a monopolist in its own country. The assumption of separate markets can also be appropriate when the downstream firms pursue monopolistic competition in the final good market. A unique branding, distinctive packaging and different after-sale services can all grant a firm substantial market power in the short run. Independence among final markets reduces the analytical complexity under a general demand function. Also, it enables us to focus on the important difference between intermediate and final good markets: demand for an intermediate good (referred to as derived demand in the literature) is determined not only by consumer preferences but also by a downstream firm’s production technology.

I show that whether a more efficient downstream firm is charged a higher input price depends on the shape of the demand function. A necessary and sufficient condition is identified. Linear demand, based on which researchers found a less efficient firm receiving a discount, is only a special case that satisfies this condition. Constant elasticity demand, for example, leads to an opposite conclusion.

II. MODEL SETUP

Consider a monopolistic upstream firm which sells an intermediate good to \( n \) downstream firms. To produce each unit of the final good, each downstream firm uses one unit of the intermediate good as input. Also, downstream firm \( i, i = 1, 2, \ldots, n \), incurs a constant marginal cost, \( c_i \), to transform the intermediate good into the final good. The upstream firm’s cost of supplying the intermediate good is normalized to zero.

---

1 Inderst and Valletti [2009] argued that “geographic market segmentation is particularly relevant for Europe”.
The downstream firms operate in $n$ separate markets and each serves as a monopolist in its own market. In market $i$, consumer demand for the final good is represented by $p_i = P(q_i)$, with $P'(\cdot) < 0$. The game is played in the following sequence: in stage 1, knowing the downstream firms’ costs of production, the upstream firm sets input prices, $w = (w_1, w_2, ..., w_n)$, where $w_i$ is the unit input price charged to firm $i$; in stage 2, downstream firms purchase the intermediate goods, produce final products and sell them in the final markets.

III. ANALYSIS

Using backward induction, I start with the downstream firms’ choice of quantities, which also determine their demand for input in the intermediate good market. In stage 2, given $w_i$, the input price charged by the upstream firm, and $c_i$, its marginal cost of production, downstream firm $i$’s optimal production level is given by:

$$P'(q_i)q_i + P(q_i) - (c_i + w_i) = 0.$$  \hfill (1)

And the sufficient second order condition is:

$$P''(q_i)q_i + 2P'(q_i) < 0.$$  \hfill (2)

Writing $q_i = q(c_i + w_i)$, I have $q'(\cdot) = \frac{1}{P''q + 2P'} < 0$, which means a downstream firm’s demand for input decreases in its production cost and the price charged by the upstream firm in the first stage.

In stage 1, given the production costs of the downstream firms, $c_i$, the upstream firm sets input prices $w$ to solve:

$$\max_w \sum_{i=1}^{n} q(c_i + w_i)w_i$$

The first order condition determines the input prices charged to each downstream firm:

$$q(c_i + w_i) + q'(c_i + w_i)w_i = 0.$$  \hfill (3)

The second order condition ensuring a unique interior solution is: $2q'(\cdot) + w_iq''(\cdot) < 0$. By plugging in $q'(\cdot)$ and $q''(\cdot)$, and using (3), it can be written as:

$$4P'(\cdot) + 5P''(\cdot)q(\cdot) + P''''(\cdot)q^2(\cdot) < 0.$$  \hfill (4)

The following can be proved:

Proposition 1. The upstream monopolist charges a higher price of the intermediate good to the more efficient downstream firm than to a less efficient firm if
a lower price if the LHS of (5) is positive, and an equal price if the LHS of (5) is equal to zero.

Proof. See Appendix.

Condition (5) is stronger than the second order condition (4). Together with (2), it implies (4). It is valid for a number of demand functions including linear demand which has been widely employed in the literature. Other functions satisfying this condition include $p = a - bq^s$ for $s > 0$, and $p = a - be^q$. In this case, a downstream firm’s cost efficiency in production will result in a higher input price charged by the upstream monopolist.

However, for demand functions like $p = a - b \ln q$, and $p = aq^{-1/\varepsilon}$ for $\varepsilon > 1$, condition (5) does not hold. For the former functional form, the LHS of (5) is equal to zero, which implies an equal price charged to each downstream firm regardless of their production costs. The latter is the inverse form of a constant elasticity demand function. With this form, the LHS of (5) is strictly positive. Discriminatory pricing amplifies, instead of offsets, the cost disparity among the downstream firms.

So whether a more efficient downstream firm is charged a higher or lower price for the intermediate good depends on the shape of the demand function, a factor that has been neglected in the literature. Depending on whether condition (5) holds or not, a lower marginal cost can make one’s demand for inputs less or more elastic. Linear demand, based on which researchers found a less efficient firm receiving a discount under third degree price discrimination, is only a special case which satisfies this condition. With other forms of the demand function, e.g. constant elasticity demand, a more efficient firm is charged a lower input price.

IV. CONCLUDING REMARKS

In this note, I relax the usual assumption of linear final market demand and study third degree price discrimination in intermediate good markets. I show that the upstream monopolist may charge the more efficient downstream firm a higher or lower price than the less efficient firm, and that depends on the shape of the demand function. Linear demand leads to a discount received by the less efficient firm, a result that has been established in the literature. But other forms of demand can generate different results.

For analytical tractability, I assumed that downstream firms operate as monopolists in their respective markets. This may best characterize international settings in which competition across borders are obstructed due to geographical or technological barriers. In the U.S., however, the Robinson-Patman Act only applies to downstream firms that are in the same

---

2 To satisfy the second order condition (2), the price elasticity, $\varepsilon$, has to be greater than 1.

3 In Europe, for example, price discrimination along the boundaries of the European Union’s member states is sanctioned based on Article 81 and 82(c) EC (Inderst and Valletti [2009]).
market. With Cournot or Bertrand competition in the final market,\(^4\) the upstream monopolist has to consider not only a first order effect of its price on a downstream firm’s derived demand (as was analyzed in this note), but also a second order effect of the price on the other downstream firms’ quantity choices (which will finally reach an equilibrium). Both of these effects depend crucially on the shape of the demand function in the final good market.

**APPENDIX**

*Proof of Proposition 1.* From (3) I have \( \frac{\partial w_i}{\partial c_i} = \frac{-q'w_i q''}{2q' + w_i q'''} = \frac{-1}{2q' + w_i q'''} \left( q' - \frac{q q''}{q} \right) =
\]
\[-\frac{1}{2q' + w_i q'''} \left( \frac{1}{p''_q q + 2p'_q} + \frac{3p''_q q + p'''_q q^2}{(p''_q q + 2p'_q)^2} \right) = -\frac{2p' + 4p''_q q + p'''_q q^2}{(2q' + w_i q''')(p''_q q + 2p'_q)^2}, \]
which has the same sign as the LHS of (5).

**REFERENCES**


\(^4\) The literature has focused on Cournot competition (with homogeneous product) though.