Economic Modelling 36 (2014) 600–606

Contents lists available at ScienceDirect

Economic Modelling

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

Licensing under vertical product differentiation: Price vs. quantity competition ☆

Xuan Nguyen *, Pasquale Sgro, Munirul Nabin

Deakin Graduate School of Business, Faculty of Business and Law, Deakin University, VIC 3125, Australia

ARTICLE INFO

JEL classification:
L13
L15
O33

Keywords:
Bertrand
Cournot
Licensing
Oligopoly
Product differentiation
Welfare

ABSTRACT

This paper develops a duopoly model of vertical product differentiation where two domestic firms incur variable costs of quality development. These domestic firms can purchase a superior foreign technology through licensing. Outcomes between Bertrand and Cournot competition are compared. We find that licensing raises domestic welfare, and domestic welfare is higher in Bertrand than in Cournot competition regardless of whether or not domestic firms engage in licensing. Non-exclusive licensing is also found to benefit the domestic country more than exclusive licensing.

1. Introduction

This paper develops a duopoly model of vertical product differentiation where two domestic competing firms incur variable costs of quality development. Following Motta (1993), we interpret these variable costs of quality development as investment in expensive inputs such as human capital. The domestic firms can purchase an advanced technology, possessed by a multinational firm, by engaging in an international licensing arrangement. Our focus is on the case of exclusive licensing, in which the multinational firm offers a licensing contract exclusively to one domestic firm. Outcomes are compared between price competition (Bertrand) and quantity competition (Cournot). The central research question which the paper seeks to address is as follows: When licensing takes place, how does the nature of competition (Bertrand and Cournot) affect the degree of product differentiation, the licensing fee, domestic firms' profitability, and domestic welfare?

We find that domestic firms differentiate their products more vigorously under Bertrand than under Cournot competition in both cases: with and without licensing. The intuition is that in Bertrand competition, firms tend to separate from their rival when choosing their product quality as doing so gives them larger advantages in setting prices. In the absence of licensing, such a "harsher competition" leads to larger domestic welfare in Bertrand than in Cournot competition. When licensing takes place, we find that the multinational firm can charge a higher licensing fee to the domestic licensee firm in Bertrand than in Cournot competition. However, domestic welfare remains larger in Bertrand than in Cournot competition. Finally, non-exclusive licensing benefits the domestic country more than exclusive licensing from a welfare standpoint.

Our results, as summarized above, are consistent with real world observations. Specifically, in many industries where products sold by the firms are highly substitutable (i.e. not very different in quality), Cournot competition rather than Bertrand competition is often observed. For instance, Reisinger and Ressner (2009) demonstrate that in the audiotapes and disks industry in the U.S., as the goods are highly substitutable, firms usually write quantity contracts with their customers. On the other hand, Bertrand competition is observed in industries where products are highly differentiated, such as the case when quality improvement is costly. Take the motorbike industry as an example. In China, there is a big gap in price (and quality) between Japanese made motorbikes and Chinese made motorbikes.[1] Similarly, in the U.S. automobile industry, Gatesman (2005) shows that mean prices of different standard car models fell between $11,593 and $20,151, with performance rating in the range of [40.0, 53.7]. He also finds a strong relationship between the quality and price, where Japanese cars are

☆ We would like to thank two anonymous referees, the organizers and participants of the Asia Pacific Trade Seminars 2012 and the European Economics and Finance Society 2012 for useful comments.

* Corresponding author. Tel.: +61 3 9251 7798; fax: +61 3 9244 5533.
E-mail addresses: xuan.nguyen@deakin.edu.au (X. Nguyen), pasquale.sgro@deakin.edu.au (P. Sgro), munirul.nabin@deakin.edu.au (M. Nabin).

[1] Source: http://www.businessweek.com/globalbiz/content/jul2006/gb20060717_673201.htm.

0264-9993/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.econmod.2013.10.013

rated as high-quality ones so that their prices are higher compared to U.S. manufactured cars.

We have used the World Bank's Enterprises Surveys (WES) data for India in 2005 to analyze the performance of firms that used foreign technologies and those that did not in the auto components industry. We found that Indian firms using foreign technologies in the auto components industry performed much better than the firms that used domestic technologies. On average, mean profit and mean profit per worker of firms using domestic technologies were equal to 13.87% and 24.88% of those who used foreign technologies, respectively.[2]

Concerning our welfare results, government's support to induce domestic firms to purchase foreign technologies is popular, especially in the industries of developing countries where investment in expensive inputs is required. In the case of the Chinese automobile industry, the government has asked domestic firms to upgrade their technological capabilities by using foreign technologies. Specifically, Gallagher (2003) documents that since the 1970s, the Chinese government has asked Japanese for help in the production of trucks in China. Following this move, Chinese automaker Chang An licensed technology from Suzuki in 1983 to produce its own mini car, and Tianjin Automotive Industry Corporation, another Chinese automaker, licensed technology from Daihatsu in 1986 to produce the mini-sedan Charade. In 1987, the Chinese government established the National Automotive Industry Federation with an aim to assist local automakers to absorb the imported technologies (Vause, 1988).

In the 2000s, a new trend has appeared in the Chinese automobile industry: Chinese automakers purchased a stake in foreign automakers. For example, McGrath (2010) reports that in 2009, Beijing Automotive Industry Holding reached an agreement to acquire certain assets of General Motors' Saab unit. Similarly, in 2010, Geely, another Chinese automaker, purchased Ford's Volvo unit in Sweden. According to many analysts, the purchase of a stake in foreign automakers is a quick way for Chinese automakers to get access to modern technology to produce cars with greater quality. Since Geely purchased Volvo, for instance, the Chinese firm will now have access to the crash test facility of Volvo and, hence, it will be able to improve its car quality (Corkery, 2009).

The above examples suggest that licensing in vertical markets has become an important trend especially in developing countries. At the same time, the government of these developing countries often encourages licensing as they anticipate the long-term benefit of the technological development in the domestic industries. However, very little has been known in the literature regarding the welfare benefits that different modes of competition (Bertrand and Cournot) could bring about to the developing countries in this context. This motivates the present study.

It should be noted that Li and Song (2009), Li and Wang (2010), Nabin et al. (2013), and Nguyen et al. (2013) have similar analysis on international technology licensing using vertical product differentiation models. However, these papers assume away the variable costs of quality development so that they do not address the situation in which firms invest in expensive inputs (such as human capital). Furthermore, Li and Song (2009) and Li and Wang (2010) assume exogenous quality; thus, the strategic quality choice is absent in their analysis.

Meanwhile, a number of papers have discussed variable costs of quality development, but in models without technology licensing (Das and Donnenfeld, 1987, 1989; Johnson and Myatt, 2003; Motta, 1993; Mussa and Rosen, 1978). These papers also focus on the case of symmetric firms. In practice, competing firms invest differently in human capital, especially in the case where some firms seek international technology licensing to improve their product quality, while some other firms undertake their own investment to improve their product quality. Competition in this context is, therefore, between asymmetric firms: the firms that use superior foreign technologies and the firms that use obsolete local technologies.

By focusing on variable costs of quality development, this paper fills in the gap in the literature by examining the impact of international technology licensing on the choices of quality by the domestic firms and their impact on welfare. The rest of the paper will proceed as follows. Section 2 presents a simple duopoly model of vertical product differentiation with international technology licensing, in which the domestic firms incur variable costs of quality development. Sections 3 and 4 examine the Bertrand and Cournot outcomes, respectively, followed by a comparison of results between Bertrand and Cournot competition in Section 5. Section 6 discusses exclusive licensing and non-exclusive licensing. Section 7 offers some concluding remarks.

2. The model

Two domestic firms, denoted by firm 1 and firm 2, compete by producing differentiated products in the domestic market. Without loss of generality, we assume that firm 1 is the producer of the high-quality product and firm 2 is the producer of the low-quality product. Each firm i incurs a marginal variable cost of the form $c_i = q_i^2/2$, where q_i (≤ 1) is the level of quality it chooses. These variable costs can be interpreted as investment in human capital (Motta, 1993). There is a multinational firm who possesses a superior technology and can licence the technology exclusively to one of the domestic firms.[3] By purchasing the superior technology from the multinational firm, the domestic firm incurs a licensing fee and it can choose the maximum level of quality without incurring the quality development costs. For tractability, assume that the licensing fee, F, is a lump-sum payment (fixed-fee licensing) set by the multinational firm on a take-it-or-leave-it basis, and that with exclusive licensing, firm 1 is the domestic firm that engages in the licensing arrangement.[4]

Consider the following four-stage game. In the first stage, the multinational firm announces its offer of technology licensing to firm 1 and the licensing fee, F, on a take-it-or-leave-it basis. In the second stage, firm 1 chooses whether to engage in the licensing arrangement with the multinational firm. Observing firm 1's decision in the second stage, in the third stage, firms 1 and 2 simultaneously choose the quality level for their product (where if licensing takes place in stage 1 then the quality level set by firm 1 is $q_1 = 1$). In the last stage, they compete in either prices (Bertrand) or quantities (Cournot).[5]

Consumers are indexed by a taste parameter v, which is uniformly distributed between 0 and 1. We assume that each consumer can buy at most one unit of the product. The indirect utility for the consumer j, indexed by v_j, who purchases the product of quality q_i at the price p_i, is given by $U_j = v_j q_i - p_i$, and it is zero if she does not buy any product.

The game described above has two stage-3 subgames. One is where there is no licensing arrangement in stage 2 between firm 1 and the

[2] There is no information on exclusive or non-exclusive licensing in the WES data. However, given the nature of vertical differentiation in the auto components industries, it is expected that non-exclusive licensing where licensee firms produce products of same quality is not likely the case. Whether technology licensing is the sole factor driving the result is left for future research, since doing so requires an econometric assessment which falls outside the scope of the present paper.

[3] In Section 6, we consider non-exclusive licensing where the multinational firm can license its technology to both domestic firms.

[4] Dhar and Joseph (2012), in their survey of literature and evidence on North–South technology licensing, report that in reality, the owners of patented technologies (Northern firms) are often inclined to enter into licensing agreements only if the recipients (Southern firms) have adequate domestic capabilities to assimilate the technologies. Li and Wang (2010) also present several evidences suggesting that exclusive licensing is a popular licensing scheme used in practice. Hence, our assumption that the multinational firm offers the licensing contract to firm 1 (the high-quality firm) in the case of exclusive licensing is consistent with reality.

[5] Hence, there will be two different scenarios concerning the quality choice by the domestic firms. The first scenario is one in which both firms simultaneously and non-cooperatively choose their product quality, and incur a variable cost (which is convex in quality). The second is one in which firm 1's quality is fixed, and importantly, its cost of quality structure changes from a variable to a fixed cost (in the form of a licensing fee). Firm 2 is the only firm that chooses product quality in this second scenario.