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Trade liberalization and product R&D in a differentiated duopoly

Hong Hwang [a,b], Yi-Shan Hsueh [c], Cheng-Hau Peng [c,*]

[a] Department of Economics, National Taiwan University, Taipei, Taiwan
[b] RCHSS, Academia Sinica, Taiwan
[c] Department of Economics, Fu Jen Catholic University, Taipei, Taiwan

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ABSTRACT

This paper employs an intra-industry trade model with one firm in each country to examine the impact of trade liberalization on firms' incentives to engage in product R&D. We show that trade liberalization may decrease a firm's product R&D if the marginal willingness to pay for the firm's innovation from its home consumers is higher than that from its foreign consumers. This negative relationship between trade liberalization and R&D investments is opposite to the standard result in the literature where the firms engage in process R&D.

1. Introduction

The growth of the world economy has been driven in part by trade liberalization, and more and more countries are engaging in the signing of free trade agreements. For example, the Trans-Pacific Partnership is a proposed free trade agreement among twelve Pacific Rim countries, while the Transatlantic Trade and Investment Partnership is another proposed free trade agreement between the European Union and the United States. Both agreements aim to promote trade and multilateral economic growth.

International trade increases the potential size of the market and brings gains from trade. For example, Brox (2003) shows that the formation of free trade agreement between the US and Canada increases the shares for the consumption of all categories of goods. However, it also creates more challenges for firms as they face stronger competition from overseas. Firms need to enhance innovation to compete with rivals from other countries.[1] Therefore, the impact of trade liberalization on a firm's R&D has become an important issue in the trade literature (e.g., Haaland & Kind, 2008; Braun, 2008, among others).[2] According to the literature on innovation, a firm can engage in process R&D or product R&D. The former reduces the firm's marginal cost, whereas the latter enhances the consumers' willingness to pay.

Haaland and Kind (2008) find that holding governments' subsidies fixed, trade liberalization leads to higher process R&D investments of firms. Braun (2008) shows that trade liberalization increases competition between firms, inducing them to invest more aggressively in both process and product R&D. Hwang, Marjit, and Peng (2016) also find that trade liberalization has a positive effect on

* Corresponding author. Department of Economics, Fu Jen Catholic University, 510 Chung Cheng Road, Hsinchuang District, New Taipei City, 24205, Taiwan
E-mail address: chpon@mail.fju.edu.tw (C.-H. Peng).

[1] A firm's innovation incentive may come from different sources. For example, Li, Shu, Tang, and Zheng (2017) show that firms with strong internal controls have less incentive to engage in innovation.

[2] This paper is relevant to studies on firms' R&D. See, for example, Lin and Saggi (2002), Hwang, Peng, and Shih (2014), Kao and Peng (2016), and Wang, Wang, Liang, and Lee (2018).

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the foreign firm's R&D, leading to better technology being transferred to the domestic firm. These papers all show that trade liberalization encourages firms to do more *cost-reducing R&D*. None of them investigates how trade liberalization affects a firm's product R&D investment.

Empirical studies suggest that domestic consumers have patriotic feelings about their home products (Han, 1988; Maheswaran, 1994). Bilkey and Nes (1982) show that consumers are willing to pay higher prices to their home products than to the foreign ones. Kaynak and Cavusgil (1983) and Knight (1999) both find that there is a tendency that consumers prefer their domestic products to the foreign imports. Namely, there exists a patriotic effect for domestic products which is worthy of being considered while we examine the effects of trade liberalization on firms' R&D.

This paper aims to investigate the relationship between trade liberalization and product R&D in an intra-industry trade model. In our model, firms invest in product R&D to increase the willingness to pay of consumers. To echo the above-mentioned empirical studies, we assume that consumers value their home innovations more favorably than the foreign ones.

The remainder of this paper is as follows. Section 2 introduces our basic model. Section 3 investigates the effect of trade liberalization on firms' product R&D investments. Section 4 concludes the paper.

2. The basic model

Assume that there are two countries, a home country and a foreign country, hosting one firm each. Firm 1 (2) is the firm in the home (foreign) country. Each firm produces a horizontally differentiated good, serving both the home and the foreign markets. Following Dixit (1979), we assume that the utilities of the representative consumers in the two countries are functions of the two goods and the numéraire good m as follows:

$$U(q_1, q_2) = \alpha(k_1)q_1 + \alpha_2(k_2)q_2 - \left(q_1^2 + q_2^2 + 2\beta q_1 q_2\right)/2 + m,$$

$$U^*\left(q_1^*, q_2^*\right) = \alpha_1^*(k_1)q_1^* + \alpha_2^*(k_2)q_2^* - \left(q_1^{*2} + q_2^{*2} + 2\beta q_1^* q_2^*\right)/2 + m,$$

where α_i (α_i^*), $i = 1, 2$, represents the highest willingness to pay of consumers in the home (foreign) country and $\alpha_i(0) = \overline{\alpha}, \alpha_i^*(0) = \overline{\alpha}^*$; m is denoted as the numéraire good. Moreover, firm i invests in product R&D, k_i, which increases the product quality. It is assumed that consumers in the domestic and foreign countries can fully observe the quality change and increase their willingness to pay, α_i and α_i^*. The R&D cost is $v(k_i)$with $v' > 0$ and $v'' > 0$. Owing to the patriotic effect, we assume that $\partial\alpha_1/\partial k_1 > \partial\alpha_1^*/\partial k_1 > 0, \partial\alpha_2^*/\partial k_2 > \partial\alpha_2/\partial k_2 > 0$, $\partial^2\alpha_i/\partial^2 k_i^2 = 0$, and $\partial^2\alpha_i^*/\partial k_i^2 = 0$. q_i (q_i^*) is firm i's output sold to the home (foreign) country. The parameter $\beta \in [0, 1]$ measures the degree of substitutability between the two products: products are homogeneous if $\beta = 1$ and independent if $\beta = 0$.

Utility maximization gives rise to the following inverse demand functions:

$$p_i = \alpha_i(k_i) - q_i - \beta q_j, \quad p_i^* = \alpha_i^*(k_i) - q_i^* - \beta q_j^* \quad \text{for} \quad i,j = 1,2 \quad \text{and} \quad i \neq j \tag{1}$$

where p_i (p_i^*) denotes the price of firm i's good sold in the home (foreign) country. The two firms compete in Cournot fashion in the two markets. Given the above assumptions, the profit functions of the two firms are expressed respectively as follows:

$$\pi_1 = (p_1 - c)q_1 + \left(p_1^* - c - t\right)q_1^* - v(k_1), \quad \text{and} \quad \pi_2 = (p_2 - c - t)q_2 + \left(p_2^* - c\right)q_2^* - v(k_2) \tag{2}$$

where c is the marginal production cost and t is the trade cost. It is worth noting that the cost of product R&D investment, $v(k_i)$, is a fixed cost involved in developing the product. This product R&D investment does not affect the firm's marginal cost, which is in contrast to process R&D investment that reduces a firm's marginal cost.

The game in question encompasses two stages. In the first stage, the two firms determine their product R&D investments simultaneously. In the second stage, given the R&D investments, both firms compete in quantity terms in both countries. We solve for the subgame perfect Nash equilibrium via backward induction.

By differentiating (2) with respect to q_i and q_i^*, $i = 1, 2$, we derive the first-order conditions for profit maximization of the second-stage game as follows:

$$\frac{\partial\pi_1}{\partial q_1} = \alpha_1(k_1) - 2q_1 - \beta q_2 - c = 0, \tag{3}$$

$$\frac{\partial\pi_1}{\partial q_1^*} = \alpha_1^*(k_1) - 2q_1^* - \beta q_2^* - c - t = 0, \tag{4}$$

$$\frac{\partial\pi_2}{\partial q_2} = \alpha_2(k_2) - 2q_2 - \beta q_1 - c - t = 0, \tag{5}$$

$$\frac{\partial\pi_2}{\partial q_2^*} = \alpha_2^*(k_2) - 2q_2^* - \beta q_1^* - c = 0. \tag{6}$$