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Product differentiation, research & development and IPR enforcement

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ABSTRACT

This paper uses a spatial Hotelling price competition model with quadratic transportation costs to analyse the nature of firm's competition with respect to level of product differentiation (i.e. product design) and process R & D in the presence of strong and weak intellectual property rights (IPR) enforcement. We consider two possible cases: (i) a foreign firm becomes an exporting firm or (ii) a foreign firm becomes a Multinational Enterprise (MNE). We find that, in both cases the optimum level of product differentiation is negatively related to Process R & D. We also allow the local firm to imitate MNE's product differentiation level as well as its Process R & D; and we find that, under spatial Hotelling price competition, the local firm has no incentive to imitate the MNE's product design, i.e. the level of product differentiation of the MNE, at Nash Equilibrium. Compared to the behaviour of a social planner, the MNE provides more differentiated goods than a social planner and when the local firm does not do undertake any R & D activities but can imitate the Process R & D of the MNE, a social planer has no incentive to enforce strong IPR at the optimum level.

1. Introduction

Firm innovation can take place along two dimensions, that of the product design (that includes the level of product differentiation) and that of the process R & D that lowers its marginal cost of production. The literature has for a long time treated these aspects separately (Lambertini & Orsini, 2000). Rosenkranz (1996) was the first to consider product and process research and development (R & D) expenditures conjointly in a Cournot competition model. She considers a duopoly in which the two firms have an incentive to choose investments in both production technology and product differentiation. In her model, the investment decision depends on market size: firms tend towards product differentiation as consumers' willingness to pay increases, and welfare increases if firms share R & D costs. The welfare effect of product and process innovation is investigated further by Lambertini and Orsini (2000). In their monopolistic model with vertical integration, the social incentive towards engaging in both product and process innovation is higher than the monopolist's private incentive.

Research has since extended the study of product design and process innovation to explore the impact of competition intensity. Based on Mussa and Rosen (1978) vertical differentiation model, Bonanno and Haworth (1998) compare two otherwise identical industries in Bertrand and Cournot competition models to find that firms have a stronger incentive to engage in process R & D when competition is less intense (i.e. Cournot). Accounting for diminishing returns to product innovation, Weiss (2003) comes to the same conclusion. Moreover, in their comparison of competition models Bonanno and Haworth (1998) find that when a firm chooses

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between an investment in product and process R & D, a firm which sells a high quality product favours product R & D in Bertrand competition, and process R & D in Cournot competition. For a low quality firm, these findings are reversed. They, thus, explain key drivers in the firms' decisions in the trade-off between product and process innovation. Vives (2008) extends the study of these key drivers, coming to conclusions that hold for both Bertrand and Cournot competition models. In markets with restricted entry, an increase in the number of competitors decreases process R & D per firm, thus concurring with Bonanno and Haworth's (1998) model. At the same time, an increase in product R & D increases process R & D expenditure per firm. In markets with free entry, a market size increase results in larger process R & D expenditure and has an ambiguous effect on product R & D expenditure. However, an increase in product R & D expenditure increases process R & D expenditure if the demand for varieties remains unchanged.

This stream of research emphasizes complementarity. That is, R & D of one kind provides an incentive to engage in R & D of the other kind, in both monopolies and oligopolies (Lambertini & Montovani, 2010). This complementarity is the subject of a study by Lin and Saggi (2002) who consider a simultaneous investment in product design and process technology and find that process R & D investment increases as product differentiation does. Moreover, firms invest more in product R & D when they can carry out process R & D than when they cannot. They also find support for Bonnano and Haworth's (1998) finding that the incentive for product R & D expenditure is higher for Bertrand firms than Cournot firms, and vice versa for process R & D. This joint complementarity is the outcome in Rosenkranz (1996) and Lambertini and Montovano's (2010) models as well.

Our paper contributes to the above literature, and is most closely related to Lin and Saggi (2002). Note that, Lin and Saggi (2002) define process R & D and product design as technology that reduces firm's marginal cost of production and the level of product differentiation chosen by a firm respectively. In their scenario firms engage in product differentiation to the extent that it increases demand for these products. However, they note that the complementarity between process R & D and product differentiation may fail if product R & D results in completely new products. This aligns with Rosenkranz (1996) notion that the product and process R & D complementarities may not hold for different demand structures. Thus, the motivation of this paper is to investigate the relationship between process R & D and product differentiation under Hotelling price competition, in situations where a consumers utility from consuming more differentiated goods may be decreasing, and marginal cost competition is prevalent.

To exemplify this, we note the German Reinheitsgebot, or purity order. Since as early as 1516, Germany has strictly regulated the ingredients that are to be used in the production of beer (traditionally water, barley and hops) to the extent that the use of differing ingredients is generally prohibited. Deviation from these ingredients even results in companies not being permitted to label the product as beer. The Reinheitsgebot thus limits the level of product differentiation in the German beer market and firms are engaging in marginal cost competition (ie process R & D). If a company differentiates its product it may cause a consumers utility to decrease accordingly. In this context, while an investment in process R & D decreases a German beer manufacturers marginal costs, increasing its products degree of differentiation does not necessarily increase demand for this product even though the manufacturers level of product differentiation may be suboptimal from a welfare perspective.

In addition to the literature on investment in process and product R & D our paper also extends the literature that is concerned with R & D investments and the possibility of imitation. Here, the extent to which the possibility of imitation takes place is a negative function of the strength of intellectual property rights (IPR) protection. Studying the relationship between R & D and firm internationalisation in a duopoly model, Petit and Sanna-Randaccio (2000) find that firms' level of R & D is higher if they are MNEs rather than exporters, though that this relationship is contingent on a relatively low level of imitation i.e. when IPR enforcement is strong. This is in line with earlier studies in which strong IPR protection is beneficial to innovation (Marjit & Yang, 2015), but does not take into account the difference between developed (Northern) and developing (Southern) countries. Between Northern and Southern countries it may even be the case that stronger IPR in the Southern country reduces inward FDI by the Northern country (Mathew & Mukherjee, 2014), depending on the innovation capacity in the Southern country and the extent to which imitation occurs under both exports and FDI as evidenced by Marjit and Yang (2015) as well. A common thread in this literature is that they consider R & D investments in process R & D only, while the literature related to Lin and Saggi (2002) above establishes the necessity of considering the joint investment in process and product R & D. Thus, the second contribution of our paper lies in jointly considering process and product R & D decisions by MNEs under varying degrees of IPR protection regimes.

We develop a theoretical model in which, unlike Lin and Saggi (2002), the optimum level of product differentiation is negatively related to the process R & D, and we also find that a social planner of a country that does not undertake any R & D activities, has less incentive to enforce strong IPR. Our paper is organised as follows: Section 2 provides the model, Section 3 provides the welfare analysis, and Section 4 concludes.

2. Model

2.1. Preliminaries

There are two countries, denoted West and East. We assume that the West has one firm called *W* and the East has one firm called *E*. For simplicity, we assume that only the firm *W* is capable of undertaking both product differentiation and process R & D.[2] The market exists only in country *E* and both firms compete in that market. Thus the firm *W* has two options: (i) it exports goods to country *E* and becomes an exporter, or (ii) sets-up its plant in a country *E* and competes as a multi-national enterprise (MNE). If the

[2] Indeed, our work is closely related to Lin and Saggi (2002). Note that, process R & D refers to R & D expenditure that lowers the marginal cost of production. Unlike their works, we consider a Hotelling location model with price competition.