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Endogenous product differentiation and international R&D policy

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ABSTRACT

The aim of this paper is to analyse the optimal R&D policy for internationally active firms investing in product innovation. The evidence shows that firms invest significantly in product innovation, and policy makers have shown renewed interest in evaluating potential impact of advances when targeting R&D support. I show that the optimal R&D policy – a tax or a subsidy – depends on the strength of the market-expansion effect, which is linked to the strength of the consumer's preference for differentiated goods. This paper therefore provides a clear rationale for targeting sectors with a strong market-expansion effect with subsidies.

1. Introduction

Increasing global competitive pressure, amongst other factors, has reinvigorated the prominence of R&D policy as a key instrument for policy makers in industrialised and industrialising countries. The aim of this paper is to analyse the optimal R&D policy for internationally active firms investing in product innovation. Central to the motivation of this paper are two observations. First, a large share of firms' investment is in product innovation. For example, the average share of product innovation for US firms is three quarters (Scherer and Ross, 1990). Second, R&D policy has increasingly gained importance as a tool for policy makers. For example, 12 OECD countries in 1995 used tax incentives for R&D, whereas 26 OECD countries used them in 2011 (OECD, 2011). Furthermore, a wide range of countries give tax breaks for R&D expenditures, like R&D allowances, increasing the sum of government support.

So far there has been a relative disconnect between existing literature on international R&D policy and product innovation. This paper provides a step in closing this gap. Following the existing literature on product innovation, I develop a three stage duopoly model in which firms are able to invest in product innovation. More specifically, I consider a market in which the new product has already been marketed. Product innovation takes the form of changing the characteristic of the product each firm produces and thus reducing the substitutability between products.[1]

Product innovation in this work takes the form of horizontal differentiation rather than a definite change in quality (vertical differentiation). Whilst firms change the characteristics of their product by investing in product innovation, consumers do not agree

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[1] This definition of product innovation follows the existing literature, for example in Motta and Polo (1998), Lin and Saggi (2002) or Rosenkranz (2003).

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on a definite ranking of the product. The main novelty of this paper is to consider the strength of the consumer's preference for differentiated goods, which implies a market-expansion effect in the model. The strength of the effect may differ across industries in the real world. The car industry invests heavily in technologies to differentiate their products, competing for consumer's appreciation, for example developing new materials to allow designers greater flexibility or new electronic equipment for cars. Or consider the pharmaceutical industry, for example, investing in the development of new ways to administer a drug.[2] However it is not obvious in which industry consumers have the stronger preference for differentiation and it is therefore important to take into account different strengths of the consumer's preference for differentiated goods, and thus different strengths of the market-expansion effect, when analysing product innovation.[3]

In the paper I show that the investments are of a different strategic nature depending on the strength of the market expansion effect. This result on the strategic nature of the investments has interesting implications for international R&D policies. To this aim I extend the model to a two country setting, adding a further stage – R&D policy – to the game.[4] Amongst others, Brander and Spencer (1983) and Leahy and Neary (2009) show that the optimal policy of a government depends on the strategic nature of the investments and on the "friendliness" of the investments.[5] Within the framework developed, I show that the investments are strategic substitutes if the market-expansion effect is weak, and strategic complements if the market-expansion effect is strong. Furthermore, I establish that the investments are friendly when considering product innovation. Building on the prior literature on international R&D policies, I show that the optimal non-cooperative policy is a subsidy if the investments are complements and a tax if the investments are substitutes. In the case of a subsidy, governments want to exploit the increase in the market, whereas a tax shifts the burden of investment to the foreign firm. If policy makers coordinate their efforts, subsidising the R&D efforts is optimal, as it eliminates the incentive to shift the investment burden.

The paper provides a rationale for policy makers to use a different policy instrument, either a tax or a subsidy, to support their domestic industries' investment in product innovation. Policy makers direct large amounts of money into R&D, so it is essential to evaluate its impact on welfare. It would enhance welfare if a policy maker was to subsidise – for example, the development of a new or different way of administering a drug or medical treatment – only if consumers value variety highly. If this is not the case, then a tax on R&D would be welfare optimal.[6] This paper therefore provides a clear rationale for targeting sectors with a strong preference for differentiated products, and thus a strong market expansion effect, with government subsidies in sectors with global competition.

Although the policy debate has conventionally been dominated by concern over levels of investment in R&D (European Commission, 2007), there has been additional imperative to target specific sectors. For instance, the European Commission states that policies focused on '… innovation in specific industries and certain types of firms will be more effective than more generalised encouragement to increase R&D spending'. Related to this, is an emerging focus on designing policies that consider preference for differentiated products, and not product differentiation in and of itself. More specifically, the European Commission (2007) implies that it is increasingly necessary to evaluate potential impact, rather than technological feasibility, of different advances in the sector. For instance policy makers should not aim R&D support in healthcare at a new or different way of administering a drug or medical treatment because it is technologically possible, but because it enlarges the options for better healthcare. The model in this paper provides support to this growing appreciation in the policy field for the targeting of R&D policy, and specifically for establishing whether there exists a clear preference for variety and strong market expansion effect.

In addition to identifying the optimal R&D policies, the model in this paper also allows the ranking of policy and policy-making context – the ability to coordinate, or not – according to their welfare implications. In an environment in which two or more governments are active, a welfare reducing policy war might be the outcome. The resulting Prisoners Dilemma can be solved by credibly banning R&D policies all together. Furthermore, policy makers have the possibility of coordinating their efforts, which might results in a higher welfare than the noncooperative or laissez-faire policies. I show that coordinating policy efforts is always welfare maximising, regardless of the market-expansion effect. In the absence of coordination, banning R&D policies is welfare improving for a weak market-expansion effect. If the market-expansion effect is strong, a non-cooperative policy provides the greater incentives to invest, however, it is ambiguous whether welfare increases if non-cooperative policies are banned.

An example for subsidising investment in (horizontal) product innovation in an oligopolistic industry is Airbus and Boeing. Each of the airplane manufacturers is subsidised by its domestic government, the EU and the US respectively.[7] Both firms competed over decades in the world-wide market for aircrafts and have considerable market share.[8] Both firms differentiate their products by offering different functional designs.[9] Furthermore, most airlines use airplanes from both manufacturers, which suggest that there is no unique quality difference between them. Both aircraft manufacturers receive subsidies by their respective governments, including subsidies for product development.[10] For example, the EU and the US offered subsidies to their respective domestic aircraft manufacturers for developing the *A*380 and the 787 Dreamliner.[11] Both airplanes are developed to increase fuel efficiency, however, the underlying

[2] This example is developed in Rosenkranz (2003).

[3] Related evidence from a love-of-variety effect by Ardelean (2006) suggests a large variation in the strength of love-of variety across industries. Whilst the evidence is not directly applicable to this model, one might expect a similar variation between industries exists for the consumer's preference for differentiation.

[4] Note, there are two *active* countries with each hosting a firm selling on a third market.

[5] Investments are (not) friendly if an increase in one firm's investment (decreases) increases the other firm's profits.

[6] Another example is governmental support for the development of gluten free wheat in the US (Stoll, 2010). In this market, it is not clear whether it is a clear quality improvement for the average consumer, whilst there is a market expansion effect due to people with gluten allergies being able to consume wheat.

[7] For the sake of the argument the EU is treated as a single government, which is of course not strictly true.

[8] In fact, both firms form a duopoly in the market for large body aircrafts.

[9] For example different cockpits or flight deck designs (Thorton, 1995).

[10] For example, see the dispute DS316 at the WTO, which explicitly states R&D subsidies.

[11] Note that both governments reached an agreement to limit subsidies, which led to a dispute in front of the WTO.