Available online at www.sciencedirect.com
ScienceDirect
Technovation 27 (2007) 766–773
technovation
www.elsevier.com/locate/technovation

The innovation decision: An economic analysis

Jun Du*, James H. Love[1], Stephen Roper[2]

Economics and Strategy Group, Aston Business School, Aston University, Birmingham B4 7ET, UK

Abstract

Studies of the determinants and effects of innovation commonly make an assumption about the way in which firms make the decision to innovate, but rarely test this assumption. Using a panel of Irish manufacturing firms we test the performance of two alternative models of the innovation decision, and find that a two-stage model (the firm decides whether to innovate, then whether to perform product only, process only or both) outperforms a one-stage, simultaneous model. We also find that external knowledge sourcing affects the innovation decision and the type of innovation undertaken in a way not previously recognised in the literature.

JEL: O31; O32; O33

Keywords: Innovation; Decision-making

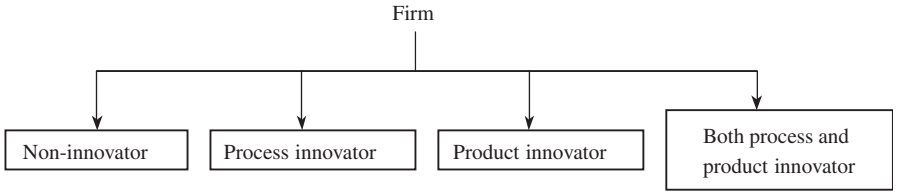
1. Introduction

How do firms make the decision to innovate and how do they choose between product and process innovation, or doing both? Are these decisions sequential or simultaneous? Despite the substantial body of research on the determinants and effects of innovation, surprisingly little is known about the decision-making process of the innovation decision. Since the early observations by Abernathy and Utterback (1982) that the distribution of firms' resources between product and process innovation depends on the market phase of the relevant technology, there has been an advance in the theoretical literature which examines the product/process mix (Klepper, 1996; Yin and Zuscovitch, 1998; Rosencranz, 2003). But this has not been reflected in the empirical work on the microeconomics of innovation, where it is still common to proceed as if firms concentrate wholly on product innovation. This is most evident in the recent empirical literature examining the 'knowledge production function', which invariably either ignores process innovation or treats it as a subsidiary issue with no explicit consideration of how firms make the relevant decisions (e.g. Crépon et al, 1998; Lööf and Heshmati, 2001, 2002; Klomp and Van Leeuwen, 2001).

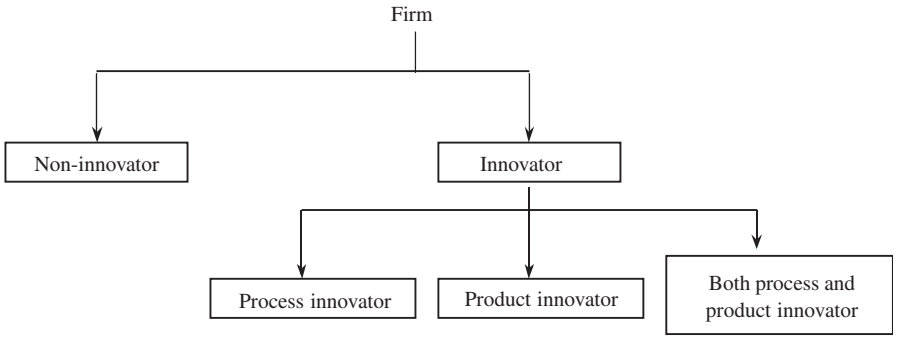
Virtually the only empirical study that explicitly deals with the choice between product, process or both is Cabagnols and Le Bas (2002), which examines the determinants of 12,779 French innovating firms' product innovation and process innovation during 1987–1992. Cabagnols and Le Bas (2002) analyse how French innovating firms' choices among product innovation, process innovation and both are determined. However, they investigate innovating firms only, which excludes a crucial part of the innovation decision: whether the firm decides to innovate at all. This begs the question of whether the innovation decision is a one-off or a two-stage process. The answer to this question is important both conceptually and econometrically: if it is a two-stage decision we need a better understanding of the process in order to distinguish and differentiate the determinants of firms' innovation strategies in each stage. On the other hand, if it is a one-off decision, excluding non-innovating as one potential choice unquestionably violates the exhaustiveness assumption of multiple-choice model, such as the multinomial logit model used by Cabagnols and Le Bas (2002), suggesting that more caution should be exercised in future research.

*Corresponding author. Tel.: +44 01212043340; fax: +44 01212043306.
E-mail addresses: j.du@aston.ac.uk (J. Du), j.h.love@aston.ac.uk (J.H. Love), s.roper@aston.ac.uk (S. Roper).
[1]Tel.: +44 01212043162.
[2]Tel.: +44 01212043216.

0166-4972/$ - see front matter
doi:10.1016/j.technovation.2007.05.008



[1-A: One-stage Model]



[1-B: Two-stage model]

Fig. 1. Firms' decision tree of innovation activity.

This paper directly addresses the issue of the nature of the innovation decision from an economic perspective. More specifically, we consider two competing models of firms' innovation decision process involving the choice of undertaking: (1) no innovation; (2) product innovation; (3) process innovation; and (4) both product and process innovation, and test which is statistically more reliable. The purpose of the analysis is therefore to examine the economics behind the innovation decisions actually made by firms, rather than to offer advice to management on how the innovation process should be structured. Throughout the analysis we use a panel dataset of Irish manufacturing firms spanning the period 1994–2002, which allows us to capture the information on firms' business environment, knowledge sourcing activities, absorptive capacities and other firm characteristics.

2. Two models

To model the firm's decision-making on innovation, we consider two alternative modelling pathways. Described in Fig. 1A, the one-stage model assumes that the firm faces four choices: not to innovate at all, to innovate on product only, to innovate on process only or to innovate both on product and process. This model therefore involves a one-off choice between four discrete alternatives. By contrast, the two-stage model as depicted in Fig. 1B assumes that the firm first decides whether or not to engage in any innovation activity, then considers what category of innovation activities it would participate in. By evaluating and comparing the accuracy of the predicting power of these two models, we seek a (more) reliable way to model firms' innovation behaviour.

2.1. One-stage model

For a multiple discrete choices setting, we adopt the multinomial probit model (MNP) for its obvious advantage of being able to relax the Independence for Irrelevant Alternatives (IIA) restriction.[3] For individual firm i ($i = 1,2,\ldots, n$), maximising the utility of choosing the jth innovating behaviour can be expressed in Model I as

$$U_{ij} = X'_{ij}\beta_{ij} + \varepsilon_{ij},\ j = 0, 1, 2, 3;\ [\varepsilon_0, \varepsilon_1, \varepsilon_2, \varepsilon_3] \sim [0, \Sigma], \tag{1}$$

where the choice set $j = 0, 1, 2, 3$ when the firm chooses not to innovate, to innovate in process only, to innovate in product only and to innovate both in process and product innovation, respectively. The random errors $\varepsilon_0, \varepsilon_1, \ldots, \varepsilon_3$ follow multivariate normal distributions. The dataset has been organised in such a way that four choices are exclusive to each other. The implied probability that observed alternative i occurs is

$$\begin{aligned}\text{prob}[Y_i = j] &= \text{Prob}[U_{ij} > U_{ik}, j, k = 1, 2, 3, 4, j \neq k] \\ &= \text{prob}[\varepsilon_{i1} - \varepsilon_{ij} > (X_{ij} - X_{i1})'\beta, \ldots, \varepsilon_{i4} \\ &\quad - \varepsilon_{ij} > (X_{i4} - X_{ij})'\beta].\end{aligned} \tag{2}$$

The coefficients are estimated by using method of maximum likelihood:

$$\log L = \sum_{i=1}^{n}\sum_{j=1}^{4} d_{ij} \log \text{prob}(Y_i = j). \tag{3}$$

[3]For details see Greene (2005 chapter 21).