R&D Experience and Innovation Success

Beneito, Pilar (University of Valencia)
Rochina-Barrachina, María-Engracia (University of Valencia and LINEEX)
Sanchis-Llopis, Amparo (University of Valencia and LINEEX)

I. Introduction

- ✓ Still scarce literature on the **dynamics of firms' innovation behaviour.**

- ✓ Recently: empirical analysis of **PERSISTENCE** in innovation at the firm-level.

- ✓ **Sources** of persistence in innovation:

  1. Firms' *persistent* characteristics.

  2. *True state dependence*: innovation decisions/results taken in one period are dependent on the innovation decisions/results taken in previous periods → Why?

I. Introduction

Theoretical literature:

→ Hypothesis behind a state dependent behaviour in innovation:

i) ***Success-breeds-success*** (e.g. Mansfield, 1968) : innovation success positively affect the probability of subsequent sucessfull innovations.

ii) ***Dynamic increasing returns*** (Nelson and Winter, 1982; Malerba and Orsenigo, 1993): derived from the accumulative nature of knowledge and learning effects (*evolutionary theory*).

iii) ***Sunk costs*** (Sutton, 1991): represent a barrier both to entry into and to exit from R&D activities.

I. Introduction

Empirical literature → Analysis of persistence in:

i) Innovation output (patents, innovation counts, innovative sales).

Flaig and Stadler (1994, 1998)
Geroski et al. (1997)
Malerba and Orsenigo (1999)
Cefis (1999, 2003)
Cefis and Orsenigo (2001)
Duguet and Monjon (2004)
Rogers (2004)
Peters (2007)

ii) Innovation input (R&D activities).

Mairesse et al. (1999)
Mulkay et al. (2001)
Máñez et al. (2004)
Peters (2005)

I. Introduction

✓ How the theoretical and the empirical approaches match?
(i.e. Peters, 2007)

i) ***Success-breeds-success*** → **persistence in output**

ii) ***Dynamic increasing returns***

→ **persistence in output (?)**

→ **persistence in the "learning process" increases output**

iii) ***Sunk costs*** → **persistence in input (R&D investments)**

I. Introduction

- ✓ We focus on the idea that firms become more efficient as they accumulate EXPERIENCE in doing what they are already doing!: learning from continuous engagement in R&D gives rise to **dynamic increasing returns** in innovation which, in turn, enhances firms' innovation success.

- ✓ Experience could be defined as *experience in the consecution of innovations* or as *experience in the realisation of innovation efforts.*

- ✓ We prefer a definition of experience based on innovation efforts, irrespective of the already achieved results since it is also possible that *"failure-breeds-success".*

I. Introduction

Arrow, 1962 (RES)

pp155: "*Learning is the product of* ***experience****. Learning can only take place through the attempt to solve a problem and therefore only takes place during activity".*

pp.156 "*I advance the hypothesis here that technical change in general can be ascribed to* ***experience****, that it is the very activity of production which gives rise to problems for which favourable responses are selected over time*."

I. Introduction

- Our hypothesis:

R&D experience matters for innovation success.

- Our starting point:

An **Innovation Production Function,**
where R&D effectiveness depends on R&D experience.

- Our “empirical problem”:

The ‘R&D experience’ variable, defined as past time (years) performing R&D activities, is not directly observable.

II. Empirical model and econometric procedure

- **Objective**: to estimate an **innovation production function** where the effectiveness of the R&D input depends on R&D-experience (past time performing R&D activities).

$$N_{it} = A(t)\, R_{it}^{\beta_1} \exp(z_{it}\beta_2)$$

$$N_{it} = A(t)\, R_{it}^{(\alpha_0 + \alpha_1 E_{it} + \alpha_2 E_{it}^2)} \exp(z_{it}\beta_2)$$

$$\downarrow$$

$$\beta_1 = \alpha_0 + \alpha_1 E_{it} + \alpha_2 E_{it}^2$$

N=innovation output (patents and product innovations); R= R&D-capital; E=R&D-experience (number of years performing R&D); z=control variables.

III. Data and empirical issues

- ***Estimation method*** → **count data models** for panel data.

- ***Data***: Survey of Entrepreneurial Strategies (ESEE), a panel data set for Spanish manufacturing firms.

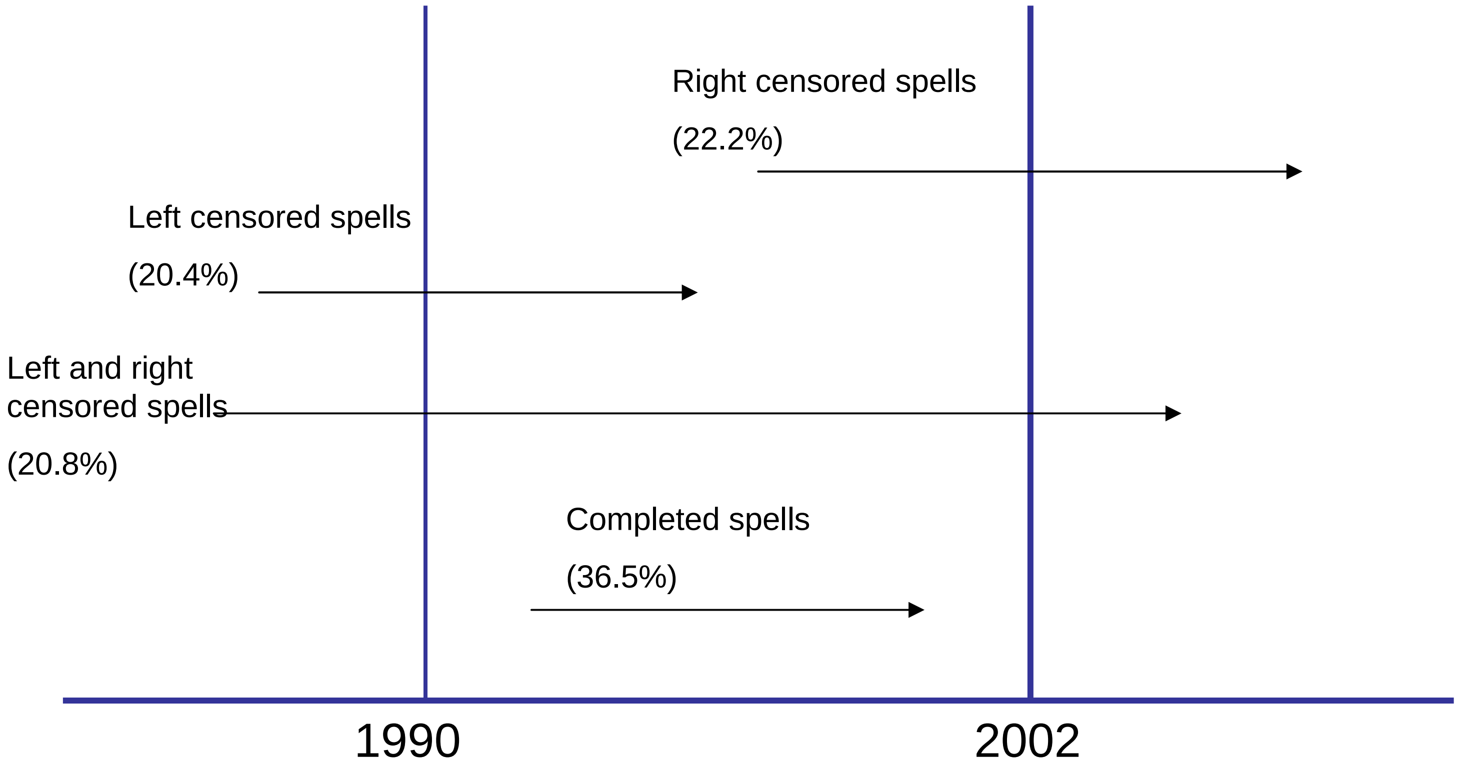
- ***Sample period***: 1990-2002.

- ***After sample selection***: 6,627 observations corresponding to 671 firms.

Problem: "R&D-experience" is not completely observed. For some firms, we do not know the first year of their R&D history (*left-censored* cases).

III. Data and empirical issues

Define "R&D spell" as the number of uninterrupted periods of R&D activity. We can observe the following cases:



IV. The estimation of R&D-experience

A ***three steps*** *procedure to measure R&D-experience:*

- *1st step*: Estimation of a **duration model**, to analyse the factors explaining the duration of firms' R&D histories.

- *2nd step*: Calculus of the **average duration** of firms' R&D histories. For right censored cases, the results of the duration model are used to make a prediction of the total expected duration. For completed spells, we simply take the observed duration.

- 3rd step: **Imputation** of previously calculated average R&D durations to left-censored cases.

  We impute to each left censored spell a duration equivalent to a weighted sum of complete durations (either originally observed or predicted, as it is the case for right censored spells), with weights based on similarities in the firm and industry characteristics used in the duration model. This imputation is made using kernel regression.

V. Estimation of the innovation production function

We use our measure of R&D-experience to estimate the innovation production function. In logs, it takes the form:

$$\log N_{it} = \log A(t) + (\alpha_0 + \alpha_1 E_{it} + \alpha_2 E_{it}^2) \log R_{it} + z_{it}\beta_2 =$$

$$= \log A(t) + \alpha_0 \log R_{it} + \alpha_1 E_{it} \log R_{it} + \alpha_2 E_{it}^2 \log R_{it} + z_{it}\beta_2$$

Estimation is made for both product innovations and patent counts.

Econometric procedure: **Count data models** adapted for panel data (Hausman, Hall and Griliches, 1984)

V. Estimation of the innovation production function

Innovation Production Function

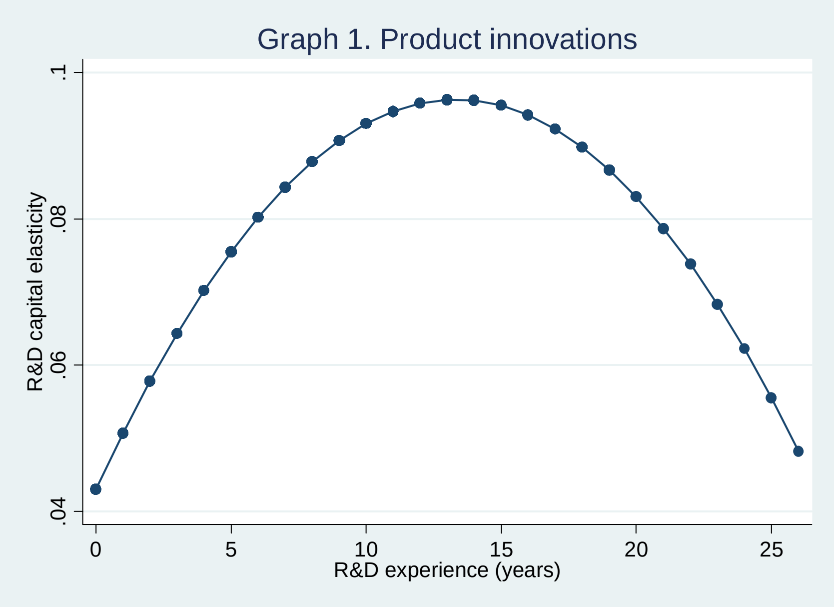
(Neg. Binom. Fixed Effects estimation)

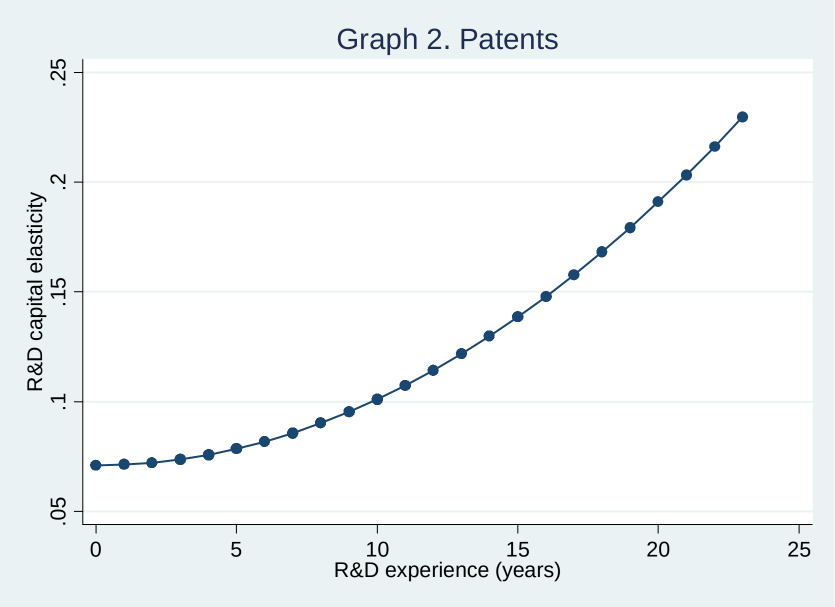
	Product Innovations	Patents
α_0	.043**	.071**
α_1	.008**	-.003
α_2	-.3e-04**	.3e-04**
	$\beta_1 = 0.43 + 0.008 \cdot E_{it} - 0.0004 \cdot E_{it}^2$	$\beta_1 = 0.71 + 0.0004 \cdot E_{it}^2$

V. Estimation of the innovation production function

The relationship between

R&D-elasticity and R&D-experience





R&D Experience and Innovation Success.

(Beneito, Rochina and Sanchis)

ASIGO conference, Nurenberg 2009

VI. Conclusions

- **General conclusion:** The innovation production process seems to exhibit dynamic increasing returns. In general, our study concludes that longer R&D experiences permit firms to achieve higher innovation success rates.

- **Some implications:**

  ✓ For firms: it pays to perform R&D activities in a stable and not sporadic manner.

  ✓ For policy makers: measures aimed at inducing firms to engage in R&D in a continuous way, creating a stable institutional framework.

  ✓ For researchers: further investigation in dynamic issues.

  ✓ For responsible of survey design: retrospective questions?