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Firms' age, process innovation and productivity growth

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Abstract

This paper looks directly at the impact of firms' age and (process) innovations on productivity growth. A model that specifies productivity growth as an unknown function of these variables is devised and estimated using semiparametric methods. Results show that firms enter the market experiencing high productivity growth and that above-average growth rates tend to last for many years, but also that productivity growth of surviving firms converges. Process innovations at some point then lead to extra productivity growth, which also tends to persist somewhat attenuated for a number of years.

JEL classification: D24; L6; O3

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1. Introduction

There is a vast amount of literature about the impact of technological activities on productivity, including an important tradition of empirical estimations of this effect using firm-level data (see Griliches, 1995, for a survey and Griliches, 2000, for example, for an updated assessment[2]). The standard form of these exercises has been the construction of a

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[2] See Hall and Mairesse (1995) and Klette (1996) for recent examples of this literature.

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stock of knowledge capital, starting from R&D investment data, and its introduction as an additional input into the firms' production function. However, as Griliches (1979) already pointed out in his pioneering work, the relationship between productivity and the (constrained) weighted average of R&D expenditures embodies in a simplified way two very different and presumably complex processes: the production of innovations starting from R&D activities and the incorporation of these innovations to production.

The knowledge capital construction and specification imply a number of important constraints on the form of these processes (see Klette, 1996, for a discussion and the relaxation of a number of these constraints). This provides an important reason for looking more closely at every one of these processes. Moreover, recently, data on the innovative output of R&D activities have become increasingly available, opening the possibility of these types of analyses. For example, Crepon et al. (1998) constitute an interesting departure from the traditional modelling using innovation data.

This paper carries out an investigation focussed on the relationships between the introduction of innovations and the growth of productivity. It looks directly at the effects of innovation on total factor productivity growth, using (unbalanced) panel data on the age of more than 2300 Spanish manufacturing firms and their process innovations brought in during the period 1990–1998. The investigation is mainly intended to examine whether innovations really induce growth, the life span and time pattern of these productivity effects and the presumed heterogeneity associated with different frequencies of innovations. To answer these questions, it seems the effects of firm age must also be disentangled (in some sense, the first radical process innovation takes place with entry into a market). Conclusions contribute evidence on the effects of firms' innovative activity and have interesting implications for their modelling.

Productivity growth is measured by means of the (cost shares-based[3]) Solow residual, corrected for (possible) nonconstant returns to scale. To address the presumably highly nonlinear relationships between productivity growth, age and process innovation, we devise a specific semiparametric model. A central piece of this model is the flexible estimation of the expectation of productivity growth conditional on age and innovations, while controls enter linearly. The main advantage of this modelling is that we avoid imposing any a priori functional form constraint on the impact of the key variables of age and innovation. Estimation can then be claimed to be fully robust, in the sense of being free of specification bias, in the involved relationships. This seems a particularly appropriate way to learn about a subject on which there is little evidence and for which we can hardly guess the specific form of the relationships.

Estimates show that firms enter the market experiencing high productivity growth, and that above-average growth rates tend to last, although progressively weakened, for many years. The estimates also point out that productivity growth of surviving firms converges to different values according to activities and, on average, to almost 1.5% annually. Process innovations at some point then lead to some extra productivity growth, which tends to persist, although somewhat attenuated, for a number of years. If the introduction of process innovations then stops, however, innovation appears to be associated with an end to all productivity growth in the following years.

[3] The cost shares-based Solow residual is robust to the presence of market power. See, e.g., Hall (1990).