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Total factor productivity and the spillover hypothesis: Some new evidence

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Abstract

In this paper I test the spillover hypothesis of the endogenous growth literature on a sample of manufacturing firms in Italy, 1989–1994, using a new approach based on the Malmquist index. First, I measure the productivity growth registered by the high- and non-high-tech firms computing the Malmquist index with DEA. I decompose it into technical change and technical efficiency change. Then I test whether the technical change registered by high-tech firms affects productivity growth of non-high-tech firms, after controlling for factors which can potentially affect productivity growth.

Keywords: Productivity; Spillover effects; DEA

1. Introduction

The hypothesis that technological knowledge acquired by a firm can spillover to other firms and enhance the latter group's total factor productivity[1] was first suggested by Arrow (1962) in his work on the effects of learning embodied in new capital equipment. Since then, there has been a considerable theoretical debate on the extent to which a firm can benefit from spillovers and also how much of its productivity growth such spillovers can explain (Romer, 1986; Grossman and Helpman, 1990; Cohen and Levinthal, 1989).

These debates have sparkled a wealth of empirical studies searching for evidence in favour of the spillover hypothesis.[2] Several channels through which spillovers can diffuse have been identified. They may take the form of intra- and inter-industry relationships (where firms can imitate patented innovations produced by technologically similar leading firms), supplier and purchaser connections (where spillovers are embodied in intermediate-input flows between sectors) and geographical location (where geographical proximity may facilitate informal contacts among firms and therefore knowledge spillovers). This paper proposes an alternative measure of the spillover effect. As suggested by Griliches (1979), the ideal measure should be able to capture the

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[1] In this paper, total factor productivity growth and productivity growth will be used as synonymous.

[2] Among others, see Jaffe (1986), Bernstein and Nadiri (1988) and Raut (1995).

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actual improvement in the technology available to a firm following the innovative effort. In this respect, a measure of the technology change experienced by either the innovating firm or the innovating sector is a good candidate. In this paper, I propose to use as a measure of the spillover effect the index of technology change computed with the so-called Malmquist index, first proposed by Caves et al. (1982) and Fare et al. (1992). The Malmquist index is an index of productivity growth which allows to decompose the change of productivity over time into two components: changes in technical efficiency and changes in the technology available to a firm. Finally, the proposed approach is implemented on a panel of firms from the Chemicals sector in Italy, to gauge the importance of the spillover phenomena for these firms over the period 1989–1994.

The structure of the paper is the following. In Section 2, I provide a brief overview of some of the themes and outcomes of the empirical literature on the spillover hypothesis highlighting the methodological problems encountered when trying to measure the influence of the spillovers on productivity growth. I conclude by pointing out to some gaps in the existing literature and thus sets out the main lines along which my empirical work will be developed. In Section 3, I present an empirical strategy to test for the spillover hypothesis. Section 4 reports the data source and the summary statistics; also it outlines the procedure used to construct the variables. The main results are presented and discussed in Section 5. Finally, some concluding remarks are offered in Section 6.

2. The spillover hypothesis: A short survey

Theoretical models in the endogenous growth literature emphasise that innovative activities of individual firms contribute to sustained long-run economic growth through industry-wide spillover effects (Romer, 1986; Grossman and Helpman, 1990). According to this view, individual firms produce technological knowledge. At first, this is private to the firm; afterwards, it spills over to the rest of the economy as it can be copied immediately and at almost no cost by any number of firms, becoming social knowledge acting as an external effect in enhancing the productivity of all firms. With the spillover effect, an aggregate production function which would otherwise have either constant or decreasing returns to scale may exhibit increasing returns to scale allowing sustained long-run growth (Romer, 1986; Raut and Srinivasan, 1993). An implication of this view is that a firm, not able to innovate on its own, can benefit from the research findings of firms working along similar lines. Cohen and Levinthal (1989), among others, have argued against this view. They wrote (p. 570):

> ... economists have assumed that technological knowledge which is in the public domain is a public good. Like a radio signal or smoke pollution, its efforts are thought to be costlessly realised by all firms located within the neighbourhood of the emission...we suggest that if these costs are relatively small, it is by virtue of the considerable R&D already conducted by the firms in the vicinity of the "emission".

They suggest that the cost of utilising public domain knowledge fruitfully is minimal only for firms which have accumulated sufficient technological capability to absorb external knowledge (so-called *absorption view*). Hence, the importance of spillovers in enhancing productivity is limited only to these firms.

These theoretical debates have been followed by a quite large literature searching for empirical evidence in support of the joint hypothesis that knowledge spillovers exist and that they can also enhance a firm's productivity. In its simplest form, the empirical strategy employed involves estimating a relationship between the productivity (or productivity growth) of firm (or industry) j and a measure of the innovative activity of some other firm (or industry) i, linked to firm (or industry) j by some type of relationship.[3] If a positive and significant relationship is found, then this is interpreted as evidence in favour of knowledge

[3] In the rest of the section, to avoid repetitions and where applicable, I will use only the word "firm", instead of "firm (or industry)", to indicate the unit of analysis of these studies. I will specify in the section when this is no longer the case.