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The impact of R&D spillovers on UK manufacturing TFP: A dynamic panel approach

Dolores Añón Higón *

Aston Business School, Aston University, Birmingham B4 7ET, United Kingdom

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Abstract

One of the benefits claimed for investment in Research and Development (R&D) is that there is a spillover effect. Industries benefit from both their own R&D efforts as well as the efforts of other national and overseas industries. The present research presents new evidence on the long-term impact of R&D investment upon UK industry's productivity performance and on the nature of these "R&D spillovers". The results suggest that R&D efforts from the industry itself and from other national industries have a positive impact on the industry's productivity but, interestingly, there is no gain from foreign R&D investment.

Keywords: R&D spillovers; Total factor productivity (TFP); Heterogeneous dynamic panel

1. Introduction

Advances in knowledge through technical change are regarded as a key determinant of productivity growth in the long run. Research and development (R&D) investment directly contributes to knowledge accumulation, hence R&D activities are a potentially important source of productivity gains and ultimately a source of economic growth.[1] A large number of empirical studies have concluded that both domestic and foreign R&D are major drivers of economic growth.[2] Having recognised the contribution of R&D spillovers to productivity growth, it is only recently that the empirical measure of the magnitude and the direction of such effects has become a major point in the research agenda on the economics of innovation.

In a seminal contribution to the literature, Coe and Helpman (1995) asserted that there is "*convincing empirical evidence that cumulative domestic R&D is an important determinant of productivity*". Nevertheless, the "convincing empirical evidence" can be criticised on several grounds. For example, there are measurement problems associated with estimates of total factor productivity (TFP) based on the growth accounting framework. When the underlying assumptions of growth accounting fail, the Solow residual produces biases that can alter the relationship between productivity and its causal determinants; in particular R&D efforts (Atella and Quintieri, 2001). Moreover, beyond concerns about the biases of the Solow residual, there are reasons to study the role of knowledge and the presence of market power using an integrated approach (Romer, 1990).

The objectives of this paper are twofold. First, we seek to study the long-term relationship between R&D efforts

* Tel.: +44 121 204 3203.
E-mail address: D.Anon@Aston.ac.uk.

[1] Classic references in this literature include Griliches (1980, 1992) and Griliches and Lichtenberg (1984).

[2] Surveys on R&D spillovers may be found in Mohnen (1996) and Nadiri (1993), among others.

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and productivity. Second, we assess the importance of domestic and foreign R&D spillovers for productivity in UK manufacturing industries. More specifically, we explore data for eight UK manufacturing industries to examine the long-term impact on factor productivity of R&D activities by the sector itself, by other UK manufacturing sectors and by foreign sectors. This approach would allow us to answer whether externalities are important in the process of economic growth and whether R&D spillovers are national or international in scope. In this study, R&D spillovers are estimated using R&D expenditures, input–output statistics and bilateral import transactions.

A contribution of the present study is to provide additional insights on the relationship between R&D and productivity by focusing on industry heterogeneity and the time series properties of the data. The wide variation of patterns of R&D investment across UK manufacturing industries and the dynamic pattern of the data are issues that cannot be neglected.[3] To tackle both issues we employ a dynamic heterogeneous error correction panel model, which is estimated by using the pooled mean group (PMG) estimator (Pesaran et al., 1999). This allows short-term adjustments and convergence speeds to vary across industries and imposes cross-industry homogeneity restrictions on the long-run coefficients.

The rest of the paper is organised as follows. Next section describes previous UK-based studies on the relationship between R&D and productivity. Section 3 describes the empirical model relating productivity to the innovation and spillovers variables. Section 4 gives an overview of the data and characteristics of the sectors considered. The main empirical findings are presented in Section 5. Finally, Section 6 provides some concluding remarks.

2. Previous studies on productive knowledge in relation to factor productivity

The literature on the impact of knowledge on productivity and the presence of spillovers is a large and diverse one. Despite differences in the data and methodologies used, the majority of empirical studies found that R&D spending (measured in a variety of ways) contributed significantly to productivity growth. In this regard, Nadiri (1993) indicates that, for industry data, the estimated elasticity of output with respect to R&D is between 0.10 and 0.30, while rates of return range between 20 and 40%.

Table 1 summarises the results of a number of empirical studies on the relationship between knowledge and productivity for the UK economy. Despite the shortcomings and differences in approach, the majority of the selected studies find a positive link between own R&D activities and output, or productivity. Indeed, the average estimated elasticity of R&D stock on output (based on the estimates in Table 1, fourth column) is about 0.17, with a lower bound of 0.02 and an upper bound of 0.37. Moreover, the estimated rate of return to R&D lies between 0.12 and 0.27.

Less extensive is the literature dealing with national and international spillovers in the UK, and by implication with the measurement of the social rate of return to R&D. The latter refers to the total benefits from research activities, i.e. the benefits that are appropriated by the original R&D performer (the private rate of return) and the returns that revert to the industry in which the R&D performer is located or to society at large (R&D spillovers). The basic methodology used to evaluate the social return to R&D consists in estimating a production or a cost function, which incorporates both the internal and external R&D capital stock (i.e. the R&D spillovers). The key issue is then to determine how this external R&D capital stock has to be aggregated and which weights are to be used in the aggregation process (see Mohnen, 1996).

As can be seen from Table 1, results are mixed depending on the weights used to obtain the inter-industry and foreign knowledge capital stock. The balance tendency, however, is that the social return to R&D is important and significant. However, even when significant, the estimates presented in Table 1 suggest that international spillovers contribute to productivity growth in UK significantly less than do domestic inter-industry spillovers.

Although not taken into account in the present empirical analysis, there is also a suggestion that R&D activities may also boost productivity indirectly by promoting technology transfer (Cohen and Levinthal, 1989). In this sense, R&D not only stimulates innovation but may also improve the ability of firms to learn and exploit outside knowledge (known as "absorptive capacity"). Empirical research on the "two faces of R&D" includes Cameron et al. (2005) and Griffith et al. (2004).

[3] While some attention has been paid to the impact of R&D upon productivity in the context of static econometric models, the dynamic evidence is more limited (see Los and Verspagen, 2000; Cameron, 2003; Guellec and Van Pottelsberghe de la Potterie, 2004).