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European Economic Review 49 (2005) 775–807
EUROPEAN ECONOMIC REVIEW
www.elsevier.com/locate/econbase

Technological convergence, R&D, trade and productivity growth

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Received 29 August 1999; accepted 12 May 2003

Abstract

This paper analyses productivity growth in a panel of 14 United Kingdom manufacturing industries since 1970. Innovation and technology transfer provide two potential sources of productivity growth for a country behind the technological frontier. We examine the roles played by research and development (R&D), international trade, and human capital in stimulating each source of productivity growth. Technology transfer is statistically significant and quantitatively important. While R&D raises rates of innovation, international trade enhances the speed of technology transfer. Human capital primarily affects output through private rates of return (captured in our index of labour quality) rather than measured TFP.

JEL classification: O30; O47; O57

Keywords: Economic growth; International trade; Total factor productivity (TFP); Research and development (R&D)

1. Introduction

'It may be seriously argued that, historically, European receptivity to new technologies, and the capacity to assimilate them whatever their origin, has been as important as inventiveness itself.' [1]

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[1] Rosenberg (1982, p. 245).

0014-2921/$ - see front matter
doi:10.1016/S0014-2921(03)00070-9

A number of authors have emphasised the transfer of technology from leader to follower countries as an important source of economic growth. Rosenberg (1982) notes that three of the great European technical developments – printing, gunpowder and the compass – are the result of technology transfer. Less prosaic examples include the development of the crucible steel industry in early 19th Century France based on British technology, the diffusion of mass production techniques for motor car manufacture from the US to Europe during the early 20th Century, and the development of the Japanese semi-conductor industry.[2]

This paper evaluates the role of technology transfer in explaining productivity growth at the industry-level in the United Kingdom since 1970. We present an empirical framework in which innovation and technology transfer provide two sources of productivity growth for an economy behind the technological frontier. The difference in levels of total factor productivity (TFP) between the United Kingdom and a frontier country (the United States) is used as a direct measure of the potential for technology transfer.[3] This approach allows for knowledge spillovers from both formal research and development (R&D) and the informal activities not captured in R&D statistics that a wide range of empirical evidence suggests are important for productivity growth.[4] 'Technology transfer' is used in the paper to refer to convergence in technical efficiency within individual industries over time. The analysis controls for both observable and unobservable characteristics that determine whether and at what speed technology transfer occurs. We consider the roles played by R&D, international trade, and human capital. We examine whether each variable has a direct effect on rates of TFP growth (innovation) and whether the variable's effect on TFP growth depends on distance behind the technological frontier (technology transfer).

The use of panel data on industries over time enables us to examine the disaggregated forces underlying country-level growth performance, while at the same time controlling for unobserved heterogeneity in the sources of productivity growth. Existing work on R&D knowledge spillovers often assumes that technology transfer occurs through a specific mechanism such as international trade. An advantage of our approach is that we explicitly test whether technology transfer occurs through international trade against the alternatives that its pace is determined by domestic 'absorptive capacity' (in the form of human capital and R&D investments) and that it proceeds autonomously (independently of the economic variables considered).[5] In steady-state, the level of productivity in non-frontier countries lies an equilibrium distance behind the frontier, such that productivity growth from innovation *and* technology transfer exactly equals productivity growth from innovation alone in the frontier. The analysis thus sheds

[2] See respectively Landes (1998, pp. 285–288), Womack et al. (1990, chapter 2), and Rosenberg (1994, chapter 7). Authors who have emphasised the role of technology transfer include Abramovitz (1986), Nelson and Phelps (1966), and Parente and Prescott (1994, 2000).

[3] See Cameron (1996a) for an analysis of Japan and the United States and Griffith et al. (2000) for a study of 12 OECD countries.

[4] See, for example, Enos (1958) and Bahk and Gort (1993) for evidence on learning by doing.

[5] For further discussion of 'absorptive capacity' and the related concept of 'tacit knowledge' in a historical context, see David (1992) and Rosenberg (1982).