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Research Policy 36 (2007) 121–133
research policy
www.elsevier.com/locate/respol

Trade in disembodied technology and total factor productivity in OECD countries

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Received 5 August 2003; received in revised form 24 January 2005; accepted 21 September 2006
Available online 8 December 2006

Abstract

This paper searches for evidence of the importance of international trade in disembodied technology as a specific diffusion mechanism, using a sample of 16 OECD countries from 1971 to 1995. Consistent with previous research, this paper finds that there is international diffusion of technology. The measure for international trade in technology is OECD's Technology Balance of Payments statistics, which are country-level data on international transactions of disembodied technology. The econometric analysis explicitly takes into account non-stationarity of the variables, and for this reason, dynamic ordinary least squares (DOLS) is the estimation method used in the present study. The analysis shows that the effect of trade in disembodied technology on the importer's productivity varies across countries. Specifically, within OECD countries not in the G7 group, technology imports increase the host-country's total factor productivity, with the effect being stronger in the initial years of the sampling period. There is no evidence on this positive effect of technology trade on productivity in the case of G7 countries.

Keywords: Technology diffusion; R&D spillovers; Disembodied technology trade

1. Introduction

The transmission of technology across countries takes a wide variety of forms. Technology can be embodied in intermediate inputs, capital goods, or people; it can be purchased and sold in disembodied form; or it can diffuse by other means, such as imitation. This paper specifically focuses on international trade in disembodied technology as a diffusion channel. In 2005, the U.S. sold $57.4 billion and purchased $23.2 billion worth of disembodied technology, comprising both affiliated and unaffiliated transactions. Imported technology is expected to have a positive effect on the host-country's productivity for several reasons. First, total factor productivity (TFP) may increase simply because firms using a superior technology raise average productivity. Second, these firms may foster competition among domestic firms, leading to the survival of the most efficient ones. Additionally, imported technology may be imitated by local competitors, or even by the licensee once the licensing contract expires. Regardless of the specific mechanism by which a superior technology increases productivity, differences in TFP partially explain cross-country differences in income per worker (see for instance Hall and Jones, 1999). Hence, the identification of the mechanisms by which TFP increases is very relevant in order to understand the development of nations.

Consistent with the previous literature, this paper confirms the existence of a positive effect of domestic R&D

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doi:10.1016/j.respol.2006.09.028

on TFP, using a sample of 16 OECD countries from 1971 to 1995. Also consistent with previous results, it confirms the existence of technology diffusion effects, since R&D performed abroad is found to have a positive effect on domestic productivity. This paper contributes to the previous literature by making use of OECD's Technology Balance of Payments statistics as a measure of trade in disembodied technology. The results show that there is a positive relationship between TFP and the measure of the stock of imported technology for the sample countries that do not belong to the G7[1] group. In the case of G7 countries, no evidence of a positive effect of imported technology on TFP is found. Furthermore, the effect of technological imports is found to be stronger for non-G7 countries in the early years of the sampling period, suggesting that these countries relied more on foreign technology when they were technologically less advanced. As these countries developed technologically, they relied less on imported technology, and more on domestically produced technology. All these results highlight the relevance of international trade in disembodied technology as a diffusion channel.

An additional contribution of this paper is methodological. The data employed in this study is a panel of countries where variables present non-stationarity. This feature of the data may cause biases in the estimation and invalidate inference on the estimated coefficients if using traditional regression methods. The estimation method used in this paper will be dynamic ordinary least squares (DOLS), which introduces lags and leads of the first differences of the regressors, allowing the econometrician to carry out valid inference on the estimated coefficients. Chiang and Kao (2000) discuss the properties of this estimation method, comparing them with those of alternative estimation procedures and showing the better performance of DOLS in small samples.

The results of the paper show first that conclusions from the econometric estimations are indeed very sensitive to the estimation method used. This paper also finds that domestic R&D has a positive effect on productivity, both within G7 and non-G7 countries, and throughout the whole sampling period. By contrast, the effect of imported technology is heterogeneous across countries and along time. In the first half of the sampling period, imported technology has a positive effect on host-country productivity in the group of non-G7 countries, and a negative effect in the group of G7 countries. By contrast, in the second part of the sampling period, the effect of imported technology is found to be statistically insignificant.

This paper is organized as follows: Section 2 discusses the previous contributions on the relationship of foreign R&D on domestic productivity. Section 3 presents and describes the data to be used in this study. Empirical results are discussed in Section 4, and Section 5 presents some conclusions drawn from the results obtained.

2. The impact of foreign R&D on host-country productivity

Many previous studies have aimed at identifying the effect of R&D efforts on the domestic country as well as on other countries' productivity. For instance, Dosi et al. (1990) reports that countries' productivity in the 1960s and 1970s were positively affected by domestic R&D expenditure and foreign patenting. Gong and Keller (2003) provides an excellent survey of empirical evidence on the role of technological diffusion on the evolution of countries' income, reviewing contributions that study the effect of trade, foreign direct investment or geography on international technology diffusion. Among the studies that consider trade as a specific diffusion channel, Coe and Helpman (1995) analyze the effect of variations in the domestic and foreign stocks of R&D on total factor productivity in a sample of OECD countries plus Israel. Their theoretical foundation, from Grossman and Helpman (1991), is that R&D effort increases either the variety of intermediate inputs or their quality. Trade in these intermediates makes the number or quality of available inputs be an increasing function of cumulative domestic, as well as foreign, R&D expenditures. They obtain estimates of the elasticity of TFP with respect to the domestic- and trade-weighted R&D stocks to be 0.23 and 0.3, respectively, with the effect of the domestic stock of R&D being stronger in G7 countries.

Keller (1998) finds that randomly generated import shares or an unweighted average of the foreign stock of R&D capital explains more of the variability of TFP than the measure for the foreign stock of R&D proposed in Coe and Helpman (1995). For this reason, other transmission channels, not necessarily linked to trade in goods, should be considered. For instance, Keller (2002) suggests that the effect of technology transfer on productivity has an important geographic component. Additionally, Lichtenberg and van Pottelsberghe de la Potterie (1998) propose a new measure of foreign R&D stock that does not suffer from indexation, aggregation, or endogeneity problems as the measure proposed in

[1] G7 countries are: US, UK, Canada, Japan, France, Germany and Italy.