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Embodied and disembodied R&D spillovers to developed and developing countries

Linghui Tang [a,*], Peter E. Koveos [b,1]

[a] School of Business, The College of New Jersey, Ewing, NJ 08628, USA
[b] International Business, Whitman School of Business, Syracuse University, Syracuse, NY 13244, USA

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ABSTRACT

This paper examines R&D spillovers from G7 countries to other developed and developing countries. We find that knowledge diffusion to developed countries dominates developing countries through both trade and international telephone traffic. However, there is no significant differing effect for R&D spillovers through FDI. Overall, the impact of knowledge spillovers through FDI is smaller than that through trade and information technology.

1. Introduction

Globalization has accelerated the pace of technology diffusion across national borders. Existing research on R&D spillovers, following the seminal work by Coe and Helpman (1995) (henceforth, CH) and Coe, Helpman, and Hoffmaister (1997) (henceforth, CHH), has mainly focused on embodied channels.[2] That is, the transfer of knowledge associated with a piece of equipment or the emergence of a multinational corporation (MNC). With the rapid development of technology in the past two decades, international knowledge diffusion also occurs at an increasing rate through disembodied channels such as the Internet, scientific literature, international patenting, and international conferences. In particular, information technology (IT) presents both opportunities and threats for companies engaging in international business. On one hand, IT allows firms to increase global sales and lower production costs. On the other hand, it imposes a serious threat to the protection of intellectual property rights as "…digital information can be perfectly copied and instantaneously transmitted around the world…" (Shapiro & Varian, 1999, p. 4). Consequently, globalization and new technology bring up a managerial challenge regarding how to leverage firms' proprietary assets around the world.

This paper contributes to the existing spillover literature by including a disembodied channel, international telephone traffic. Although Madden and Savage (2000) find that imports of communications and computer equipment and outgoing per capita telephone traffic help to encourage R&D spillovers through trade, they do not directly test international communications as a channel for knowledge diffusion. Portes and Rey (2005) are the first to use global telephone call traffic as a proxy for overall information flows between countries. They find that countries communicating more with each other

* Corresponding author. Tel.: +1 609 771 2240; fax: +1 609 637 5129.
E-mail addresses: tang@tcnj.edu (L. Tang), peter@syr.edu (P.E. Koveos).
[1] Tel.: +1 315 443 1386; fax: +1 315 443 1449.
[2] For a complete survey in international R&D spillovers, see Keller (2004).

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tend to know each other better and consequently trade more equity securities. In addition, Wong (2004) finds that knowledge flows through international telephone traffic have a quantitatively larger impact on income and productivity growth than trade does, further confirming the importance of IT as an important conduit for R&D spillovers.

Following this line of research, we propose to use international telephone traffic as a measure to capture R&D spillovers through disembodied channels. Although telephone traffic is not a perfect proxy for disembodied channels, there are several reasons why we think it is a reasonable one. First, given the limited availability of bilateral Internet traffic and international tourism data, bilateral telephone traffic is a logical proxy to capture international knowledge spillovers through channels other than trade and FDI. The reason is because countries that talk regularly to each other by phone are more likely to communicate with each other through email, the Internet, conferences, and tourism. Second, bilateral telephone traffic is positively related to bilateral trade and FDI, with correlation coefficients equal to 0.77 and 0.36 respectively in our sample. In other words, countries that trade and invest more with each other talk more frequently with each other at the same time. Nonetheless, the pattern of telephone traffic is not exactly the same as those for trade and FDI. For instance, according to Appendix A, about 46% of US imports of capital goods and 32% of US inward FDI from G7 countries came from Japan in 1990. However, the US outgoing telephone traffic to Japan only accounted for 11% of its total traffic to other G7 countries. In contrast, the US imported less capital goods and received less FDI from Canada, 28 and 11% respectively. But, the US communicated a lot more with its neighbor in the North: the outgoing telephone traffic from the US to Canada accounted for 38% of the total traffic to other G7 countries. Therefore, we argue that telephone traffic is, at minimum, a good representative of both trade and FDI while it offers additional information for the paths of knowledge spillovers that are not fully represented by trade and FDI.

The second purpose of this paper is to compare the effectiveness of knowledge diffusion to developed countries with developing countries through both embodied and disembodied channels. Due to weak intellectual rights protection in developing countries, there is increasing concern of R&D spillovers from the North to the South. However, using data for 22 OECD and 21 non-OECD countries from 1983 to 1997, we find that developing countries are less able to benefit from R&D investment in G7 countries than other developed countries through trade and IT. On the other hand, there is no significant difference for knowledge diffusion to developed and developing countries through FDI. Overall, the impact of R&D spillovers through FDI is smaller than those through trade and telephone traffic.

The paper is organized as follows. Section 2 presents the theoretical framework and hypotheses. The empirical findings are reported in Section 3. The concluding remarks and managerial implications are provided in Section 4.

2. The theoretical framework

According to Vernon's (1966) product cycle theory, the development of cutting edge or labor-saving new products normally occurs in countries like the US where per capita income and labor cost are the highest in the world. Meanwhile, Lim, Sharkey, and Heinrichs (2006) find that firms with a shorter new product development cycle have higher export involvement than less innovative firms. The reason is because the ability to develop new products gives firms competitive advantage in the global market. In other words, advanced economies not only have a higher rate of producing new products, they also have a higher tendency to export those products.

On the other hand, other developed countries, such as Germany and Japan, are the primary destinations for the new products invented by the US. First, in order to remain innovative, it is important for firms to operate in key global markets because new ideas, products, and technologies are more likely to emerge from major global markets. According to Zou and Cavusgil (2002), global market participation is positively related to firms' strategic and financial performance. Second, the product cycle theory indicates that developed countries have a better chance to capitalize on the initial monopoly rent given the larger size of high-income consumers at home and the potential to benefit from new labor-saving products.

In sum, we posit that R&D investment in leading economies diffuse faster to developed countries than developing countries through trade. In fact, CHH find that the average elasticity of total factor productivity (TFP) with respect to foreign R&D through trade for developing countries is around 0.058. Although the estimate elasticity of TFP with respect to foreign R&D through trade for OECD countries varies substantially, it is in general above 0.06 except for the US and Japan (CH, p.871). To summarize, we have the first hypothesis of the paper.

Hypothesis 1. International R&D spillovers through trade are higher for developed countries than for developing countries.

Research on R&D spillovers through FDI has produced mixed results so far, partly due to the diverse motivations for firms to invest abroad.[3] According to the ownership specific advantage in Dunning's eclectic paradigm (1988), FDI is driven by the incentive to exploit economies of scales from firms' intangible assets such as technology, patents, trademark, and know-how. However, insufficient human capital and intellectual rights protection in developing countries hinder technology-intensive companies to invest in developing countries. For instance, Xu (2000) finds that technology transfer from US parents to their affiliates in developing countries only have a positive and statistically significant impact on host

[3] Research using firm or plant level data for R&D spillovers through FDI includes Haddad and Harrison (1993), Aitken and Harrison (1999), and Chung, Mitchell, and Yeung (2003). The studies that use national level FDI data include Lichtenberg and van Pottelsberghe de la Potterie (1996), Hejazi and Safarian (1999), and Xu (2000).