International Trade and Economic Growth:  
A Methodology for Estimating Cross-Border R&D Spillovers

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3 Literature Review

Research exploring linkages between economic growth, domestic R&D capital, and foreign R&D capital has abundantly grown over the past 15 years, largely as a result of improved modeling techniques and the increasing availability of micro-level data sources. In their survey paper, Cincera and van Pottelsberghe de la Potterie (2001) documented research that has provided strong evidence that R&D implemented in any country contributes to global productivity growth. They also emphasize that research on the measurement and effectiveness of spillover flows through non-trade channels of transmission should be further developed.

3.1 Channels of Transmission

In the literature, the cross-border channels of transmission of embodied R&D spillovers are international trade and foreign direct investment/multinational companies (MNCs), while the disembodied channel is represented by the transmission of knowledge and ideas (e.g. international conferences, scientific journals, and patents). Much of the literature on international trade as a transmission channel focuses on very specific aspects of trade and productivity relationships, such as measuring the volume of trade (Coe and Helpman, 1995), capital vs. non-capital goods trade (Xu and Wang, 1999), the

\(^7\)Keller also recognizes that disembodied R&D spillovers are difficult to estimate with a high degree of certainty because they reflect the acquisition of technology that is not connected to any particular form. However, he concluded that these types of spillovers may be a stronger form of technology diffusion than spillovers occurring through intermediate goods trade.
importance of relative country sizes (Eaton and Kortum, 1999) and nations’ geographic distance relative to one another (Harhoff, 2000 and Branstetter, 2000). The importance of imports as a conduit for R&D spillovers has received positive attention recently. Blalock and Veloso (2004) provided a relatively rare micro-level study which assesses imports as integral for international technology transfer. On the other hand, learning-by-exporting does not appear to be an important spillover channel (Keller, 2004).

With regard to the FDI channel, the literature emphasizes three transmission sub-channels: 1) domestic firms learning efficiency-enhancing production techniques from foreign MNCs (‘demonstration effect’), 2) competition from MNCs resulting in improved productivity in domestic firms (‘competition effect’), and 3) the movements of highly skilled staff from MNCs to domestic firms (Gorg and Strobl, 2001). Although research has been underway since the mid-1960s, the results are very mixed as to which of these sub-channels are conduits for positive spillovers. In their meta-analysis, Gorg and Strobl emphasized that in order to gauge the significance of these sub-channels, it is very important to utilize lengthy time-series FDI data as opposed to cross-sectional data. Finally, the literature provides evidence that firm-specific innovations transfer across borders through MNC parent and subsidiary technology sharing (Branstetter, 2000).

Patents are widely viewed as a robust source of information for studying innovation and technical change (Hall, Jaffe, and Trajtenberg, 2001). Attempts to capture the spillovers associated with international knowledge flows have relied specifically on patent citation or licensing data (Al-Azzawi, 2004). In a study designed to measure R&D spillovers from trade and patents, Xu and Chiang (2005) found that the rate of foreign patenting is determined by growth of world R&D stocks, intensity of capital goods imports from innovating countries, and by the capability of domestic countries to adopt foreign technology.

3.2 Modeling Cross-Border R&D Spillovers

The utilization of complex models to measure the domestic impact of foreign R&D investment has grown, though there is no widely accepted approach due to the aforementioned difficulties involved with the estimation. Keller (2004) stated that the majority of research attempting to measure cross-border spillovers employ regression
These studies are predominately at the aggregate (industry- or country-) level of analysis and many are based on Grossman and Helpman’s innovation-led model. The next section introduces this model’s fundamental theoretical properties.

### 3.2.1 The Grossman and Helpman Model and R&D Spillovers

Traditional growth theory highlights the incentives for capital accumulation while technological progress (innovation) is viewed as an exogenous process. Grossman and Helpman (1991, hereafter GH) were important contributors to the development of a new growth theory which is based on endogenous innovation. As in Romer (1990) and Aghion and Howitt (1992), the GH model adopted the Schumpeterian position, whereby successful ongoing innovation results in some amount of market power which creates opportunities to profit and reinvest in R&D activities. Fundamentally, GH ground their theoretical foundations within an oligopolistic setting rather than the traditionally competitive and establish the stylized fact that R&D incorporates, in every case, some of the spillovers which are inherent in the knowledge generation process. They treat knowledge capital as an input into R&D, therefore at any point, fewer additional factors of production are needed to produce new types of product.

Their model elucidates endogenous innovation as a means for improving the understanding of the relationship between trade and long run growth. In their simplified version of the model, they incorporate trade, knowledge accumulation, and endogenous growth to emphasize that when final goods are traded on international markets, international trade can have a positive or negative impact on a country’s domestic innovation process. Increased trade can have a positive effect on R&D activities

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8He cautions that researchers should be aware that these models are only able to partially capture spillovers and that these types of models typically cannot account for endogeneity problems (i.e. what determines R&D).

9Historically, comparable cross-country data (such as patent flows, intermediate inputs, and investment goods) at the firm level have been difficult to assemble. Although, there is a growing availability of micro-level data, which has resulted in more studies increasingly relying on traditionally microeconomic cost and production functions, such as the flexible translog production function, to measure the impact of foreign R&D spillovers. See the conclusion for more on the translog.

10See the appendix for an elaboration of the GH model.

11See Romer (2001, Chapter 3) for a theoretical overview of the development of new growth theory in macroeconomics.

12This also depends on whether that country is an importer or exporter of goods. The model also predicts that foreign R&D leads to the creation of new intermediate inputs for nonperformers.
because it leads to increased flows of technological information from foreign countries, which leads to increased productivity, ceteris paribus. By making technological progress a function of world output of an intermediate good, the domestic nonperformers who import the intermediate good would automatically acquire the R&D spillover benefits from foreign performers. Increased trade can have a negative effect on R&D activities, according to GH, if:

In the trade situation the world economy has a relatively greater abundance of unskilled labor than the human capital-rich country...As a result the integrated economy undertakes more of the activity that uses unskilled labor intensively. Thus the scale of industrial research activities may shrink in the human capital-rich country despite the productivity gains that result from any international spillovers of knowledge.

13Oftentimes, nonperformers have to invest funds into the acquisition of spillover benefits. Therefore, this model does not capture the full impact of international R&D spillovers. Grossman and Helpman’s later life-cycle models account for the cost factor of nonperformer imitation.

14Conversely, if the imported items are human capital-rich, then increased flows lead to lower costs of domestic innovation because of decreased derived demand for human capital.
References


