Contribution of Own R&D and R&D Spillovers to Total Factor Productivity Growth of Canadian Manufacturing and Services Industries, 1973-2000

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Productivity growth is one of the most important factor in stimulating economic growth, prosperity and standards of living. Productivity may be measured in several ways. The widely used measure of labor productivity is intuitively easy to grasp, but it provides only a partial view of the complex relationship between output and all productive inputs. Total factor productivity TFP takes into consideration all inputs and is, therefore, a preferable, even though a less transparent, measure of the relationship between inputs used in production and output. Even though the debate about whether TFP actually measures technological change or the "free lunches" associated with it, or something else, is far from over (Lipsey and Carlaw, 2004), most economists would agree that increasing TFP is desirable.

There is growing, mostly indirect, econometric evidence that innovation is among the main sources of TFP growth. The evidence is indirect, because systematic data on the rate of innovation over time is still very rare.In contrast, most industrial countries have collected for over forty years internationally comparable data on the principal innovation input, the R&D activity in manufacturing industries. Thus instead of modelling the relationship between TFP and innovation, most econometric work examines the nexus between TFP growth and various measures of R&D activity.

R&D investment has been regarded as an important factor behind increases in productivity and hence standard of living since the 1960s. Product-related R&D activity expands existing or creates new markets and process-related R&D activity reduces the production cost. Both types of R&D are often combined when the innovation is a new product requiring a new or improved production technology. When the innovation is commercially successful and its benefits accrue to the firm that invested on the R&D activity, it yields a private return to R&D investment. Given the partially free and non-rival nature of new knowledge created by private R&D activity, its effects often spill over to other firms and sectors over regional and national boundaries. This fraction of R&D-related knowledge and its spillover effects which generate benefits to other economic agents can not be appropriated by the original innovator. In this case, the social benefits of the R&D investment are larger than the private benefits.

A large body of research has been devoted to discovering the relationship between productivity growth and R&D activity in the United States and Canada. However, in Canada the empirical evidence on the link between productivity growth and R&D investment is still mixed. Assessing the contribution of R&D activity to productivity growth is particularly important for Canada, whose economy is closely integrated with U.S. economy and actively involved in international trade and open to foreign direct investment. Open economies benefit from international flows of technology at least in two ways. First, by importing intermediate inputs, capital equipment and services that incorporate new technology, firms in the importing country embody new technology in their own production. In the process they acquire inputs embodying new technology often at a lower cost than the full value of the input and adopt new productive knowledge. Second, foreign direct investment, reputedly the most efficient way of technology transfer, is another potentially important source of R&D spillovers from abroad. Given the high foreign trade content and the important share of foreign-owned firms in Canadian economy, R&D spillovers through imports and transfer of technology associated with operations of foreign–owned subsidiaries are potentially very important for this country.

The objective of this paper is to estimate the relationship between TFP growth, industry's own R&D expenditures and spillovers from other industries, domestic and foreign, using Canadian manufacturing, mining and services data. We construct indicators for the domestic interindustry spillovers and for the two principal types of international spillovers discussed above. The domestic R&D spillovers indicators are estimated using Canadian patent statistics, complemented by information from input-output statistics. The cross-border R&D spillovers are estimated using the information on imports, foreign ownership of manufacturing firms in Canada and interindustry spillovers within each of the G7 countries. Taking into account concurrently both import-related and foreign-ownership related cross-border spillovers at the industry level is one of the two original contributions of this paper.

Another novel feature of this paper is that it is among the first studies looking into the relationship between TFP and R&D in non-manufacturing industries. In addition to twenty manufacturing industries, the database we created for this study includes four mining and nine service industries.