Statistical Indicators of Technologies and Practices: Definitions and Issues of Measurement and Aggregation

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1. Introduction

Economic growth matters to policy makers. The belief that the 'new economy' contributes to longer growth periods in business cycles, or eliminates business cycles altogether, leads to a demand for more data and better data to substantiate this belief. The call by Alan Greenspan for more data is an apt example. Official statisticians, if they are to be relevant, must rise to this challenge and convert the intangible concept of the 'new economy' to a quantifiable reality. This paper looks at some of the new statistics that take statistical offices closer to this objective.

The new economy is different from what has gone before and so should be the statistics which describe it. One of the differences is the linkage between economic agents, or actors. Linkages there have always been but now they are supported by elaborate networks made possible by information and communications technologies, the ICTs. The financial markets are accessible twenty four hours a day, and the global market puts downward pressure on commodity prices and wages providing a check to inflation and influencing the business cycle. ICTs provide the infrastructure for these networks and there should be statistics on the production of ICTs as well as the uses to which the networks are put.

Another difference is the mix of bio and computing technologies that tries to remove the mystery from life and provides new cures for illness, new foods, and new ways of mediating environmental degradation. Biotechnology firms can be different from the conventional model of a firm with income and expenditure, capital investment, trade, and employees, all changing little over a period of years. Biotechnology firms can exist for over a decade on venture capital, have hundreds of employees, large R&D expenditures, and no revenues, until the product being developed has survived all phases of testing. This is a different economic model from that of the oil well, the utility or the manufacturing firm.

Firms and public institutions, whatever they produce, are behaving differently. This is more than the changes in organization facilitated by ICT networks. However, the ubiquitous networks permit firms to gather knowledge of their clients, their suppliers and their competitors and to integrate that with knowledge of their production processes with a view to doing better what they do. Part of this is analysing the economic and social environment in which the firm navigates, with a view to foreseeing change and altering the direction of the enterprise to take advantage of opportunities or to avoid dangers. As the management of knowledge is a factor in the success and productivity of both public and private institutions, it becomes a subject for official statisticians.

This paper focuses on the transmission of knowledge and its use, rather than on the creation of knowledge, which is well covered in the R&D literature, but the classifications used are compared with those based on R&D intensity. R&D may give rise to invention, which may be protected by intellectual property instruments, such as patents. Patent statistics are covered elsewhere in these proceedings (Guellec 2001) as are the statistics on the commercialization of invention, or innovation (Klomp 2001).

2. Knowledge Flows and Knowledge Use

This paper argues that linkage between economic agents is an important variable to measure. The System of National Accounts incorporates the linkage between industries and commodities in the Input-Output tables. In response to the changing economic environment, both the SNA and the supporting classifications are regularly revised. The last SNA revision was in 1993 and the UN International Standard Industrial Classification (ISIC) was revised in 1990 and is currently undergoing a minor revision. The UN Central Product Classification (CPC) is still evolving, especially for service industries. While the international and national classifications change in response the economic and social change, they will never change rapidly enough for the policy process and that presents a challenge to the official statistician.

The challenge is more than presenting an up-to-date picture of the links between industries and commodities, as there are other links that are policy relevant. For example, the Community Innovation Surveys asks about the sources of ideas and technologies contributing to innovation, as do Canadian innovation and technology use surveys. Data on these linkages shed light on which institutions are influencing the activities of innovation, or technology use, and on how close the links are between R&D and outcomes of commercial significance.

The need for statistics on both the infrastructure and the activities of the information society has been recognized by both the OECD and the statistical office of the European Union, Eurostat. OECD established what became the Working Party on Indicators for the Information Society (WPIIS) to develop statistical indicators. Eurostat has its Working Group for Statistics for the Information Society. In 1998, the OECD approved an industry-based definition of the ICT sector and followed that with definitions of electronic commerce in 2000. Work continues on classifying the electronic products that are moving about on the network infrastructure.

Defining the ICT sector as an aggregation of ISIC rev.3 industries ensures that all of the standard statistics of national accounting can be produced for the sector, augmented by other industry-based statistics such as expenditure on R&D, propensity to innovate or to use particular sets of technologies. The advantage of such an aggregation is that every firm contributing to the aggregate statistics is unambiguously classified to the ISIC class. The OECD (2000) and other countries, of which Canada (Statistics Canada 2001), and the Nordic countries (Statistics Denmark et al. 2000), are examples have produced compendia on the production and use of ICT goods and services.

A second transforming factor in the 21st century is biotechnology. It will be some time before the products of modern biotechnology appear in the I-O tables and there are immediate policy issues around their development and use. In Canada, one of the main uses of biotechnology is for environmental remediation (Rose 1998). Measuring the use of these technologies is an input to environmental policy, as is information on the sources and the reasons for use.

While surveys of technology use are well established, but are outside of the SNA, surveys of firms principally engaged in the production of biotech products suffer from a number of statistical problems. First, these firms are found in many industries and it is inappropriate to develop a 'biotechnology industry'. In the absence of an indication that a firm is engaged in biotechnology as part of its main activity, survey samples cannot be drawn from conventional business registers. Second, statistical offices have rules for protecting small firms from excessive respondent burden. Statistics Canada is no exception and the measure of size is revenue. However, biotech firms can be quite large and be in place for a long time and still have little or no revenue. To survey these firms, the rules had to be interpreted differently and based, for example, on number of employees and expenditure on R&D. Finally, there is the issue of international comparability of any measurement that is made. At the OECD, there is an ad hoc committee working on this problem (van Beuzekom, 2000)

Finally, there are the techniques of survival used by firms in the new economy that need better statistics. The networks permit firms to collect information on their suppliers, their clients, and about the processes that they use to create their products. Firms have always been able to do this and clients and suppliers have long been recognized as sources of ideas and technologies for innovation. What is now different is that the networks and the associated computing power make it much easier to collect, store, classify, retrieve and analyse this information. Add to this the knowledge of the firm about what it does and its vision about where it is going and there is a beginning of a strategy of knowledge management which becomes a tool for helping the firm, or the public institution to do better what it does (Dierkes 2001). This is not just a matter of electronic networks and information processing, a knowledge management strategy includes practices, such as knowledge sharing, incentive structure to reward sharing, and the communication of visions through story telling (Denning 2000). Of course, some of the practices are built on electronic networks, such as broadband links for tele-conferences or tele-learning, and they use software tools to facilitate knowledge sharing.

Again the official statistician is faced with a need to provide current information on knowledge management, especially if it is be a set of transforming practices in the 21st century economy. The OECD has been active in this area for some years (OECD 2000a) and is in the process of reviewing a draft questionnaire for collecting information on knowledge management practices, tools and infrastructure in business. Pilot surveys are under consideration in Canada, Denmark, France, and the US.

3. Classifications and Conclusions

The three examples in this paper have different methods of classification to clarify the presentation of statistical information. The ICT sector is defined as an aggregation of ISIC rev.3 and its products are being defined within existing commodity classifications. The production and use of biotechnology products requires definitions of those products, which can either be applied to existing commodity classifications or used to propose new products for inclusion. With a product classification, statistics can be produced on firms which principally produce biotechnology products and on firms which use biotechnology products. In the case of knowledge management practices, tools and infrastructure, there is no sector aggregation and there is no product classification as the products used would be classified to other purposes, such as ICT, and practices are not classified as products. As well, the activity of knowledge management can be identified in any public or private institution. This is a work in progress.

What is common to the three examples is that they deal with a measure of linkage through use of the products or practices and the products include both goods and services. The linkage measures support questions about why the products or practices were used and the outcomes of that use and this in turn supports policy measures. This differs from identifying high-tech industries and high-tech products (Hatzichronoglou 1997), as ' high-tech' is a characteristic which does not necessarily describe linkage. It may do if the industry is characterized by its use of high-tech intermediate and capital goods, but even then, the present classification excludes linkages through the use of services. While R&D intensity is a useful indicator of knowledge production, it is a firm characteristic, rather than an industry characteristic (Baldwin and Gellatly 1998) and it is the firm that is the target of policy measures as economic decisions are made in firms, not in industries.

There is no question that R&D contributes to new products, processes and practices, and that measures of R&D and R&D intensities are useful. However, what is lacking in official statistics is better information on the linkages of economic actors through the use of products and practices.

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RESUME

Les décideurs souhaitent disposer d'un large éventail d'indicateurs statistiques pour appuyer leurs travaux. Des exemples d'un intérêt immédiat sont les indicateurs pour la société de l'information, pour l'économie du savoir, pour les activités du secteur des technologies de l'information et des communications (TIC), pour les secteurs « de pointe », pour le commerce des produits « de pointe » et pour les entreprises et les produits de biotechnologie. D'autre part, les bureaux de la statistique font appel depuis longtemps au Système de comptabilité nationale (SCN) pour la collecte et l'interprétation de renseignements sur la production de biens et de services, sur le commerce et les investissements, et sur les caractéristiques des branches d'activité et de la population active. Le présent exposé se penche sur d'autres agrégations de données statistiques sur les activités, les pratiques, les produits et les secteurs, de même que sur des questions de classification connexes en fonction de l'élaboration de stratégies et de comparaisons internationales.